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A FRAMEWORK FOR ANALYSIS OF AGRICULTURAL DIVERSIFICATION

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Introduction

Agricultural diversification is the expansion of farm production to more than one commodity or service, or one set of joint commodities or services. An example of joint products is paddy (unmilled rice) and paddy straw. Cattle raising may produce the service of draught power jointly with the commodities of meat, milk, manure and/or calves. A processed commodity such as milled rice is not a joint product with paddy, but rather is the product of an additional activity. Hence neither the production of paddy and paddy straw nor the production of draft power and manure represent diversification of enterprise. However, the production of both paddy and milled rice, paddy and onions, or paddy and cattle, each reflect enterprise diversification.

The scale at which farming activity is observed can determine whether it appears diversified. Enterprise diversity may be observed at the farm, community, regional and national levels. Some of the benefits gained from diversification can only be realized when it occurs at the farm or farm plot level; other diversification benefits can accrue when diversification can be observed only at the community, regional or national level of aggregation. This will be discussed. However, the principle purpose of this paper is to identify the conditions under which farmers choose to diversify and to assess methods by which the Department of Agriculture (DOA) might facilitate this process. Since farmers' individual choices are the focus, the scale of activity to be examined here is the individual farm.

This paper is divided into five sections which discuss the following:

(1) The relationship between the scale at which agricultural diversification is observed, and the benefits from diversification;

(2) A description of generalized forms of diversification;

(3) The conditions under which farmers may choose to diversify production;

(4) Some unique aspects of Sri Lanka's agricultural economy; and

(5) Methods by which the Department of Agriculture might program support for commercial agriculture in Sri Lanka.

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Relationship of Benefits to the Scale of Diversification

It is has been suggested that although diversification may not be widely practised at the farm level in Sri Lanka, diversification is evident when one considers the country as a whole. This raises the question of whether diversification should be pursued at the farm, community, regional or national level. The answer may lie in considering the benefits that are expected from diversification. Their benefits, in fact, are not equally realizable at all levels of aggregation. This section examines the relationship of benefits to the scale of economy at which diversification is achieved. Four categories of benefits from diversification have been identified (Price, 1991). They are: (1) risk reduction; (2) self-sufficiency; (3) production efficiency; and (4) natural resource conservation. Risk reduction and the other benefits of diversification will be examined at various scales of agricultural enterprise.

Risk Reduction

At the farm level, risk reduction is often cited as a reason for engaging in several farm enterprises. Recently farmers in Aralaganwila, Sri Lanka, told researchers (Mahrouf, et al.) that their main motivation for planting several field crops, other than paddy, was to assure that if one crop resulted in a low profit or loss due to low yield or price, chances are that one of the other crops would compensate with a higher profit. Particularly in highly variable agroclimatic regimes, such as Gunung Kidil, Indonesia, farmers rely on a mix of crops to assure that at least one crop will thrive (Price, 1991). Nevertheless, agroclimatic regimes or economic conditions at the farm level may place limits on the opportunities farmers have for diversification.

Limited by agroclimatic regime, diversification can only be partially achieved at the farm level. However, to the degree that diversification can be achieved, a reduction in risk is likely. Diversification at the farm level throughout a region or country can have even greater benefit to the country as a whole. In aggregate, diversified farms are likely to have employed nearly every production opportunity available in the varied agroclimatic regimes across the country.

It is useful to consider the risk effects of diversification when risk is pooled at successively higher levels of aggregation, the community, region or country. While it is likely that farm families within a community to some extent share in one another's good or bad fortune, it is doubtful that any planning for such effect is done at the **community level.** It is unlikely that decisions or policies at the community level would lead each of several farmers to specialize in the production of a different crop and pool their risk. Nevertheless, to the degree that diversification could be achieved at the rice community level, the risk reduction effect would be effectively transferred through the community, region and country.

Increasingly **regional** authorities are being established which have planning and development responsibility. They can be effective in bringing about diversification through research, extension, development of market infrastructure, and provision of various incentives in terms of price support or input subsidy. It is also clear that the reduction of risk for the region as a whole, through diversification, is a meaningful concept. Indeed in cases where regions are recognised to be highly dependent upon a single enterprise, say

banana export, rice production, or logging, considerable effort is often made to diversify the economy at the regional level.

However, regions of a country are often delineated by agroclimatic or economic regime. Sri Lankan Zones refer to moisture regimes and therefore, within each zone, there are limits to which diversification can be achieved. Examples of economic conditions that affect diversification include population density (labour availability) and transportation, communication and other market infrastructure.

The following series charts illustrate alternatives for diversification within the principal agroclimatic zones of Sri Lanka. Table 1 identifies the crops which fall within principal crop groups, in Sri Lanka.

Table 1. Principal Crop Groups In Sri Lanka

Oilseeds, Seed Legumes and Pulses (SLP)	Bulbs, Roots, and Tubers (BRT)	Cucurbits (Cb)	Crucifers and Leafy Vegetables (Lv)	Fruit Vegetables (Fv)	Cereals (non-rice) (C)	R (
Gingelly	Cassava	Cucumbers	Cabbage	Brinjals	Maize	
Cowpea	Sweet Potato	Chertlin	Broccoli	Tomato	Kurrakan	
Greengram	Potato	Snake gourd	Brussel	Okra	Meneri	
Blackgram	Ginger	Ash gourd	Sprouts	Chillies		
Soybean	Radish	Bitter	Lettuce	Capsicum		
Beans	Turmeric	Cucumber	KanKun			
Greenpeas	Beet					
Mustard	Carrot					
Bush Sitao	Garlic					
Kollu	Leeks					
Dambala	Spring Onions					
Me	Diascareas					
	Kiri-ala					
	Innala					

Table 2 shows the number of districts within which each of the crop groups is grown, or recommended to be grown, in the wet (Maha) season, and the dry (Yala) season. The abbreviations of each crop group that are used in later tables are also shown in this chart.

Table 2. Number of districts in which crop groups are grown under rainfed conditions.

Crop Group	Maha Season		Yala Season	
	Lowland	Upland	Lowland	Upland
Rice (R)	71	0	40	0
Fruit Vegetable (FV)	8	75	11	21
Bulb, Root, Tuber (BRT)	8	68	8	59
Oilseed, Seed Legumes & Pulses (SLP)	16	63	22	50
Cereals (C)	0	41	1	1
Leafy Vegetable (LV)	6	19	6	5
Other (tobacco, Cotton, etc.) (O)	0	23	0	1
Cucurbits (Cb)	0	60	10	11

Tables 3a and 3b demonstrate that the potential for diversification varies widely with agroclimatic regime. Within the limitations of the agroclimatic regime of their region, farm families must also adopt attempts at diversification with prevailing economic conditions, transport and communications infrastructure, market availability, access to credit and their own management capabilities.

When diversification is accomplished, through the development of new enterprise in discrete locales, individual farmers or communities may fail to benefit. When they do, it is often because members of a farm family leave their disadvantaged community and migrate to where successful new enterprise has been introduced. This can be an inconvenient form of risk sharing because of the social disruption that occurs.

Reduction of dependence on a few agricultural commodities can be a powerful motivation to diversify agricultural enterprise at the **national level**. Employing customary policy, research and service instruments, countries often are able to bring about new agricultural enterprise for the purpose of stabilizing export earnings. (such effort often begins with the motivation of protecting an infant industry, but later the protection proves difficult to eliminate.) However, diversification at a national level is unlikely to take advantage of micro agroclimatic and economic regimes as effectively as country-wide diversification at the farm level. Therefore the greatest benefits in risk reduction are realized when a national plan for diversification at the farm level is followed throughout the country.

Table 3a. Cropping patterns by agroclimatic zone
Upland

Zone	Cropping Pattern	No. of Districts
DL_1 $DL_{2\text{-}5}$	SLP/FV/C/Cb/BRT/O - SLP SLP/BRT/FV/C/Cb - SLP	81 51
IL_1 $IL_{2\text{-}3}$	BRT/FV/Cb/C/LVC - SLP/BRT/FV C/SLP/Cb/FV/BRT - SLP/BRT	35 33
WL	FV=BRT=Cb/SLP/LVC - BRT/FV/Cb	108
WM IM	BRT/FV/Cb/SLP-BRT/FV/Cb/SLP SLP=FV/Cb/BRT/C/0 - SLP/BRT	44 56
WU IU	BRT/LVC/SLP/FV - FV≠BRT≠SLP BRT=LVC/FV/SLP - BRT/FV/SLP	27 22

Table 3b. Cropping patterns by agroclimatic zone
Lowland

Zone	Cropping Pattern	No. of Districts
DL_1 $DL_{2\text{-}5}$	Rice/SLP - SLP Rice/fallow-fallow	25 12
IL_1 $IL_{2\text{-}3}$	Rice - Rice/SLP/FV/Cb Rice - fallow/SLP	24 11
WL_1 $WL_{2\text{-}4}$	Rice/FV/BRT/LVC - Rice (w. first dry) Rice - Rice/FV/LVC/SLP	28 33
WM IM	Rice - Rice Rice - Rice/SLP	23 21
WU IU	Fallow/BRT/LVC/SLP - Fallow/FV/BRT/LVC Rice/FV/BRT/LVC/SLP - Fallow/BRT/SLP/LVC/C	7 17

D=Dry, I=Intermediate; W=Wet; L=Low; M=Medium; U=Upland;
/=alternatives within a season; -=indicates crop sequence;
Numerals after zone notation indicate gradation of condition, high numbers indicate drier conditions.

If diversification is accomplished at a national level, while leaving regions, communities and farms relatively specialized, the risk-reducing benefits of diversification are unlikely to be realized by regional, community or household economies. The allocation of national income flows to relieve financial distress in communities or households dependant upon a declining industry is difficult because of a lack of mechanisms to assist those communities inefficiencies in the delivery of relief, the short term and shifting locality of distress, and logistical problems. When the cause of distress is the decline of a specific industry, the remedy recommended is usually local diversification.

In summary, diversification at the farm, community, regional or national levels varies as to whether it can be achieved and the degree to which results benefits of risk reduction are transferred to other levels. The trend which emerges from an analysis of Table 4 is that benefits from reduced risk associated with diversification are much more likely to be transferred from lower to higher forms of organization than from higher to lower forms. For example, risk reduction benefits are transferred from the farm level to the community, regional and national levels. However, diversification at the regional level is only likely to transfer benefits of risk reduction to the national level. These benefits are less likely to be transferred to the community and farm levels.

Table 4. Summary of capabilities for diversification and effects on risk reduction at the farm, community, regional and national levels.

Diversification at the level of the:	Can be achieved:	With the transfer of resulting benefits from reduced risk to the level of:			
		Farm	Community	Region	Country
Farm	Somewhat	Likely	Likely	Likely	Very Likely
Community	Poorly	Somewhat Likely	Likely	Likely	Likely
Region	Somewhat	Somewhat Likely	Unlikely	Likely	Likely
Nation	Somewhat	Unlikely	Unlikely	Somewhat Likely	Likely

Self-sufficiency

Self sufficiency at the farm level was desirable historically when markets were less efficient in meeting household needs, and led farmers to engage in a wide range of enterprise. This is less common now, except that many Asian farmers express the desire to be self-sufficient in rice. Sri Lankan farmers' desire to be self-sufficient in rice can retard diversification in areas that are well-suited to rice, but support diversification in areas that are best suited to other crops. Examples of each case were found in the Aralaganwila area (Mahrouf, et. al.). A farmer who had been provided with 2.5 hectares of poorly irrigated upland, best suited to livestock and non-rice field crops, chose to make considerable effort to grow rice along with other enterprises because he wished to meet his family's rice

requirements. In this typical case of an upland farmer, further diversification of an already diverse farm resulted from the desire to be self-sufficient in rice.

In contrast, a farmer having an excellent water supply does not make an equivalent effort to grow additional crops to rice. He suggests, as is typical of farmers in this well-irrigated area, that one can never grow too much rice. (This may be related to the view, discussed below, that for the general security of a community, those who can produce a surplus of rice should do so.) However there is some evidence that changing values can increase farmers' desires to provide for family needs in a range of non-rice enterprises. Yet another farmer stated that it gave him satisfaction to provide the milk, fruit and vegetables that were important to his children's health. This factor could be more widely promoted in Sri Lanka.

The desire to be self-sufficient in rice is often evident in informal institutions at the **community level**. Farm families that usually do not produce enough rice for themselves, feel some security in knowing that other families usually have a rice surplus which they can purchase through their labour, or other means of exchange. Reciprocally, farmers who can produce a surplus of rice, are inclined to do so, rather than produce non rice crops, because of the readily available market and the importance of his surplus to others in the community.

Certain other agricultural production and processing roles also support community members' notions of self-sufficiency. Among these activities are rice milling, custom land preparation and threshing, agricultural lending, production of alcoholic beverages, sales of farm inputs, production and sales of livestock products, livestock trading, collection and marketing of various annual and perennial crops. However, cases are not immediately evident of crop diversification undertaken by farmers in order to meet a perceived need for a community to be self-sufficient in a non-rice crop.

It has been noted that agricultural planning and development is increasingly undertaken at the **regional level**. Self-sufficiency is not a commonly expressed objective of regional planning, much less as a motivation for crop diversification. China, where provincial authorities do express the desire for provinces to be self sufficient in food crops, livestock products, and a range of agricultural inputs, is an exception. In meeting this need, provincial authorities engage directly in foreign acquisition of technology, genetic material, equipment and training.

Self-sufficiency at the **national level** is pursued for the purpose of food security, but more often in a effort to save foreign exchange. Import substitution has been an objective of crop diversification in Sri Lanka. It has guided agricultural research and various policies intended to encourage farmers to grow such crops as potatoes, pigeonpea (a possible substitute for imported lentils and chickpeas), and sugar cane. Other agricultural imports to Sri Lanka for which local production may be considered include seed and other planting materials.

This import substitution strategy has recently evolved into a mixed import substitution and market driven export promotion orientation. Under this strategy, diversification of agricultural production is market oriented and crops are produced to meet specific market niches (local or export) for which they have the capability to produce the quantity and quality

of product demanded by the market. Emphasis in diversification has been shifting away from staple food crops to higher value horticultural crops and value added processing.

Production Efficiencies

A third reason for diversification in agricultural production is the economic attractiveness of certain beneficial relationships among various farm enterprises and how such production relationships are affected by the scale of observation. It will be seen that these production relationships which are highly important in achieving the adoption of diversified farming systems, have relevance mainly at the farm level.

Two or more products are called **complements** if an increase in the production of one increases the productivity of resources employed in the other(s). Certain crop rotations reflect complementary relationships. An Aralaganwila farmer reported that most definitely he could greatly increase the yield of his rice by first growing onions on the field in the previous dry season. He speculated that this resulted from the residual effects of fertilizer. Many such effects are known, some that benefit crops through increased fertility, others through beneficial effects on insect pests, weeds and plant diseases. Other beneficial relationships result from animal and crop interactions -- ducks raised in paddy fields reduce insect damage, and themselves gain weight from the feed.

Interaction among enterprises is often solely economic. An example of this is the supplementary use of labour or land among two or more enterprises. Similarly, as Maha rice and Yala chili utilize land in a supplementary fashion, there are periods when family labor can be used in a complementary fashion among several enterprises.

Supplementary products are those whose production has no effect on the other. Certain crops grown in rotation may show this relationship. A Maha season rice crop, for example, may not influence the yield of a following yala season chili crop grown on the same land. Or, fish produced in a farm pond, are unlikely to affect livestock or crops produced elsewhere.

In contrast to complementary and supplementary production systems, are **competitive products**. In this case, increased production of one product leads to a reduction in the production of another. This is one of the most common situations confronted int he process of crop diversification. As land is allocated to a new crop, the acreage of other crops grown on the farm is reduced. Where land is not a limiting factor or where successful intercropping systems have been developed completion can be avoided. Land allocated to one crop reduces the area that can be used by another. Intercropping can somewhat alleviate such competition for land.

Linear programming is a technique that can be used to carefully plan a farm so as to take advantage of the opportunities for supplementary use of labour, capital and land. LP also takes account of competitiveness among enterprises and provides farm plans that make the most advantageous use of farm resources. (See Gleason, 1989; March, 1990; and October, 1990.)

Beneficial relationships among enterprises make diversification attractive to farmers. Economic interactions such as supplementary use of land or labour can be realized at the level of the resource owner, usually the farmer, and serves as an incentive to follow diversified farming. Biological interactions are often only realizable on specific fields within a farm -- that is, crops or other complementary activities must be operated in close spatial or temporal proximity in order for beneficial biological interactions to be realized. Thus, beneficial production relationships can only be realized at the farm level. An exception is in the case of centrally planned economies in which the community is organized into a commune in which the use of labor, land and capital resources can be planned and executed at the community level. Also beneficial economic interactions can be planned and executed at regional or national levels in centrally planned economies, such as supplementary use of electrical power or water resources. Even in centrally planned economies, wide exploitation of beneficial economic relationships among enterprises at the regional and national level are limited by the immobility of land, and relative immobility of labor.

Conservation of Resources

Conservation of natural resources benefits the present human population by assuring a healthy, productive environment within their lifetimes. It also helps to assure that future generations will have opportunities for meeting their needs, in a manner equivalent to the opportunities available to present society. Diversification of crop and animal enterprises helps to conserve natural resources in several ways, some of which are suggested below. These benefits are most readily realizable at the field level, within farms.

Distributed resource utilization. Different enterprises require different resources. Careful selection of enterprises can result in minimal use of a wide range of resources, rather than the rapid depletion of a few. The rate of utilization in a diversified system may be slow enough to permit some regeneration of the resources that are used, leaving the original stock relatively unchanged. In order to avoid depletion of resource diversification in the use of precisely that same resource must occur. For example, proper crop rotations conscience or replace some of the soil nutrients in a given field. Diversification at the community level, through specialized farms, or distributed, specialized production within regions or countries would not maintain individual resource regimes.

Resource restoration. While using certain resources, specific enterprises may help to restore others so that careful selection of a range of activities can provide for restoration of certain resources that are most used in production. Similarly as the case of diversification for the purpose of distributed (gradual) utilization, restoration of a resource to near its original state requires that diversification of precisely that resource be practised. In the case of soil, this would require within farm diversification. Restoration of water resources and erosion control could be somewhat dispersed geographically, say through afforestation, perennial crops, or range and management.

Reduced utilization. Interaction among certain enterprises are such that the needs of one enterprise can be directly provided by another enterprise, resulting in lower use of resources to achieve equivalent levels of production. Benefits from the biological interaction among enterprises requires that they be followed in immediate spatial or temporal proximity. Only micro-level diversification, within farm or within plot, can offer this benefit.

Resource preservation. Certain biological resources, plant and animal species, microorganisms, or genetic material generally, can be best preserved for present and future needs by employing them directly in production, or maintaining a sufficiently robust production environment that they can be naturally maintained. Many biological resources require a robust environment for their survival, and therefore suggest within farm, or within plot diversification. Other species survive well in monoculture. In this situation, diversification at the community, regional or national level would serve the purpose of resource preservation.

Resource enhancement. Biological resources that are in use in production or natural systems continue to evolve, and the wider the range of environments in which they live, the greater the opportunity for evolutionary change. The environmental exposure of biological resources can be broadened both through their placement in diversified production systems. Resource enhancement is best advanced through micro diversification at the farm level, and to a lesser extent at the community level. Regional level or national level diversification is unlikely to offer the gains from continually evolving biological resources.

Summary

Four kinds of benefits from diversification have been reviewed at four levels of the farm economy. It is apparent that while the benefits of risk reduction and self sufficiency can be realized through diversification at macro levels, the same gains can be realized through diversification at the farm level, and additionally offer the same benefits to the farmer and farm community. Economic benefits from beneficial enterprise interaction can only be realized at the farm level, except for the case of centrally planned economics. Resource conservation is best accomplished through diversification at the farm level. Hence a strong case is made for pursuing opportunities for enterprise diversification at the farm level, through government policies and research and extension programs. The following sections of this paper will examine the status and opportunities for diversification at the farm level.

Forms of Agricultural Diversification at the Farm Level

The Diversified Agricultural Research Project administered by the Division of Agricultural Economics and Projects, Department of Agriculture, Ministry of Agriculture and Development, Sri Lanka, is directed mainly at crop diversification. Here a crop is defined as the cultivation of plant species from which produce is customarily taken annually. This includes annual plant species and perennial species from which plant parts (fruits, leaves, stems, sap, etc.) can be harvested each year. Non-crop, primary production activities on a farm may include forestry and such livestock activities as poultry, aquaculture, apiculture and sericulture. A third type of farm activity is various forms of agribusiness: provision of mechanical power and labour services, rural money lending, input sales, and the performance of various product marketing functions (storage, processing, transportation, information services, brokering, assembly of products and other functions).

Agricultural diversification may include the adoption of multiple enterprises from any of these types of farm activity. Simply put, the forms of farm diversification include (a) crop

diversification, (b) crop and other farm production, and (c) farm production and agribusiness. Each form of diversification offers different benefits, as shown in Table 5. The table is constructed to show the relative additional (or, marginal) benefit that results from moving to more complex forms of diversification. No entry is shown for crop monoculture because that is the base against which the additional benefit from multiple crops is measured.

Table 5. Marginal benefits from increasingly complex forms of diversification

Forms of Diversification	Marginal Benefits from Diversification			
	Risk Reduction	Self Sufficiency	Production Efficiency	Resource Conservation
Crop Monoculture	--	--	--	--
Multiple Crops	High	High	High	High
Crops + Other farm Production	High	High	High	High
Farm Production + ag'business	High	Low	Low	Non

Essentially, the addition of either additional crops, or of other farm activities to a multiple crop system, each offers high potential increments of all benefits. The addition of agribusiness to diversified farming, can further reduce risk, but offers relatively lower additional benefit from self-sufficiency, and production efficiency. An example of increased self-sufficiency from an agribusiness activity would be the milling of one's own paddy. Increased economic efficiency would derive solely from the use of slack farm labor or capital resources, and unlikely from any technical relationships. Finally, agribusiness is unlikely to directly offer an advantages with respect to resource conservation.

Conditions Under Which Farmers Choose to Diversify

Farmers will choose to diversify if they deem the conduct of multiple enterprises to be more profitable than the conduct of a single enterprise. Many factors influence the relative profitability of multiple enterprises compared to a single enterprise. These factors are outlined below in a "framework for analysis of diversification".

Farm economics and diversification:

Shared Fixed Input

Enterprises that are able to utilise the same investment in fixed cost without interfering with one another may be more profitable to pursue than any one of the enterprises, or a different enterprise, alone. This is because the fixed cost would likely be spread across more units of outputs. For example, using land that has been purchased, or

rented for one year, for two or more successive crops, is likely to be more profitable than producing a single crop. The case of annual land use, as in any case of sharing fixed costs, is not automatically more profitable than a single enterprise. One must examine and compare the specific multiple enterprises and specific single enterprises, to be sure that an apparently multiple use of a fixed input is more profitable than using the input for a single enterprise.

Some of the fixed investments of a farm that might lead to greater profitability from multiple enterprises include:

Land rent;
Land structures;
Equipment; and
Human resources (family labour, management capacity).

Shared Variable Inputs

Often it is found that increased use of one or more variable inputs in one enterprise affects the output of another enterprise. The effect may or may not be beneficial. These effects often derive from biological or physiological effects between enterprises. For example, using more fertilizer on a first crop, may also improve the productivity of the second crop. However more thorough puddling of soil for a rice crop (by using more labour and traction power), may make the soil less suitable for a subsequent dryland crop.

These examples were of enterprises in "temporal" proximity, e.g. following one another in time. Enterprises that are conducted in "spatial proximity" may also show similar "complementary" or "competitive" effects. It has been found, for example, that groundnut grown in spatial proximity to maize, may result in reduced pest infestation in the maize. However, certain herbicides that are safe for maize, could be quite damaging to groundnut that is grown in close proximity.

The wide range of variable inputs that may result in beneficial or non-beneficial interactions among crops include:

Labour use (land prep., weeding, plating, harvesting, pest control); and
Material inputs (fertilizer, pesticides, other);

Further, these inputs affect multiple crops and farm enterprises through:

Moisture effects;
Pest effects;
Fertility effects;
Allelopathogens;
Light modification;
Ventilation;
Physical obstruction or convenience;

The above analysis of diversification suggests some of the underlying economic and biological relationships that affect the profitability of diversification. There are many other

possible motivations for farmers to diversify, that are not as obviously accountable as current profitability. In addition to profitability, motivations to diversify may also include: positive benefits from increased self-sufficiency; risk reduction; production efficiency; and environmental conservation as described previously.

Other conditions where farmers may choose to diversify production include:

- Productive capability - The crop must be adapted to a given agroclimatic zone or production may not be feasible. The farmer must also have access to the required inputs and must have the knowledge and technical capacity to produce the crop.

- Markets - Diversification is accelerated when farmers know there is a market for their produce in which they have confidence. This is particularly true for perishable horticultural produce. Recently, much emphasis has been placed on encouraging Sri Lankan farmer to produce diversified crops to meet specific demand and market niches.

- Logistics - To diversify, farmers must also have confidence that the logistical system will ensure timely supplies of production inputs, credit as well as transportation and storage for produce.

- Aesthetic Value - Diversification may also be encouraged by the aesthetic value of producing a range of specialty crops. Some farmers may diversify into production of floriculture and tropical foliage, not only because of its potential market and profit, but also due to the aesthetic value of producing these commodities.

Unique Aspects of Sri Lanka's Agricultural Economy

The preceding review of agricultural production and profitability, particularly with respect to the conditions for continuing crop diversification,can be evaluated in light of the unique aspects of the Sri Lankan agricultural economy as compared to production and economic conditions elsewhere in the Asia Region. A summary of those conditions is presented below.

High Cost of Production

The analysis is based primarily upon two major "other field crop" (OFC) groups: a high value group including potatoes, chillies and red onion, and the lower valued but important group of oilseed and pulses including cowpea, greengram, blackgram, groundnut and gingelly (sesame). Altogether, diversification into these crops proceeded fairly rapidly during the 15 years 1970-71 through 1985-86, but slowed somewhat thereafter. Nevertheless, about 60 per cent greater land area was devoted to OFC's during the decade of the 80's than in the decade of the 70's (Table 6).

Table 6. Summary of OFC production from 1971 to 1990.

	High Value O.F.C.s	Lower Value O.F.C.s	TOTAL	All O.F.C.s
1997-75	38,448	29,292	67,740	93,532
1976-80	44,115	75,214	119,329	
1981-85	43,533	106,554	150,087	146,739
1986-90	50,126	93,264	143,390	

High value OFCs=potatoes, chillies, red onions
Lower value OFCs=cowpea, greengram, blackgram, groundnut, gingelly

The most striking aspect of OFC production in Sri Lanka, compared to other countries is their relatively low profitability. In successive sample years, 1981-82, 1985-86, and 1989-90, the ratio of returns to variable costs was 1.37, 1.27 and 1.61, across the major crop groups (Table 7). A ratio of about 2 is commonly expected in subsistence oriented economies. These data were summarized from "Cost of Cultivation" reports published by the Division of Agricultural Economics and Planning, based upon 122 samples of about 50 farmers, taken during the three crops years (Table 8).

The computation of variable costs includes the imputed cost of family labor, the use of power and machinery, chemicals, fertilizer and other variable costs. FAO and other sources have noted the common expectation of a 2:1 ratio of gross returns to variable costs. In especially unfavourable production regimes the rate may fall as low as 50 %, and higher rates of 150 % are noted in especially favourable conditions.

Across the OFC crops examined, labor and machinery accounted for 83, 77 and 78 per cent of variable production costs during the three years (Table 9). Relatively little mechanization found, except in pulse production in Jaffna and Vavuniya samples. This ratio varied from a low of about 25 per cent for potatoes, to 95 per cent for gingelly. The overall ratios were computed by weighting individual crop ratios by their relative extent of cultivation. While OFC's are generally more labor intensive than rice, the ratio of labor to materials costs on tropical Asian farms more commonly vary between 50 to 70 percent, assuming market wage rates for all labor (family plus hired labor). Thus Sri Lankan farmers appear to pay a relatively

Table 7. Gross returns/variable cost of selected OFCs

	Potato	Chillies	Red Onion	Cowpea	Cucurbits	Gingelly	Blackgram	Greengram	All Crops
Maha 1981-82	1.81	1.17	2.12	1.12	1.24	.84	1.84	1.46	
Yala 82	1.75	1.99	1.59	1.14	1.52	1.43	--	1.13	
Average	1.78	1.58	1.86	1.13	1.38	1.14	1.84	1.30	1.37
Proportion of these crops	.04	.16	.06	.22	.10	.22	.06	.14	
Maha 1985-86	1.95	1.89	2.08	.92	1.25	1.17	1.31	1.49	
Yala 86	1.89	.65	.58	.96	.94	1.35	2.04	.97	
Average	1.92	1.27	1.33	.94	1.10	1.27	1.68	1.23	1.27
Proportion area these crops	.06	.27	.06	.17	.07	.11	.08	.18	
Maha 1989-90	1.02	1.41	1.61	1.47	2.32	--	1.31	1.98	
Yala 90	1.36	1.99	2.34	1.23	1.25	1.34	--	1.80	
Average	1.19	1.70	1.98	1.35	1.78	1.34	1.31	1.89	1.61
Weight	.03	.25	.05	.16	.06	.11	.11	.23	

Table 8. Number of sites from which farm data taken for cost of cultivation data

	Potato	Chillies	Red Onion	Cowpea	Cucurbits	Gingelly	Blackgram	Greengram	Total
Maha 1981-82	3	1	3	6	8	1	3	4	29
Yala 82	2	10	2	7	2	6	0	3	32
Maha 1985-86	2	3	3	5	3	1	2	4	23
Yala 86	2	6	1	3	1	2	2	3	20
Maha 1989-90	2	1	1	1	1	--	1	1	8
Yala 90	2	3	1	1	1	1	--	1	10
Total	13	24	11	23	16	11	8	16	122

Table 9. Labor as percent of variable costs

	Potato	Chillies	Red Onion	Cowpea	Cucurbits	Gingelly	Blackgram	Greengram	All Crops
Maha 1981-82	28	90	35	89	78	95	85	87	
Yala 82	27	73	58	89	86	96	--	82	
Average	28	82	47	89	82	96	85	85	83
Maha 1985-86	24	86	49	90	78	98	89	84	
Yala 86	28	77	56	92	81	95	92	81	
Average	26	82	53	91	80	97	48	83	77
Maha 1989-90	22	86	44	85	64	--	79	85	
Yala 90	23	68	31	88	76	91	--	87	
Average	23	77	38	87	70	91	78	86	78

high labor bill, if not to hired workers, implicitly to themselves, assuming market wage rates.

Wage rates are high relative to product prices, but this conclusion particularly requires a more careful national and cross-regional comparison. Data from the Mahaweli System B suggests that a 1990-91 spurt in wage rates pose significant problems to OFC profitability. However over a longer term, between the sample years 1981-82 to 1989-90, the ratio of the indices wages paid by crop, to indices of crop prices, suggest a 14 per cent increase of crop prices relative to labor wages (Table 10). A tentative suggestion is that Sri Lankan farmers pay high wage rates relative to crop prices, but over the long term, this situation is improving.

Table 10. Wage indices in Mahaweli System B.

	1981-1982	1985-1986	1989-1990
High Valued Root and Fruit Vegetables			
Red Onion	100	92	118
Chilli	100	96	134
Potato	100	99	94
Grain Legumes and Oilseed			
Cowpea	100	111	128
Greengrams	100	110	99
Blackgrams	100	156	85
Groundnut	100	122	136
Gingelly	100	108	100

Labor, Mechanization and Diversification

The above conditions suggest certain initiatives for consideration by the Department of Agriculture. High wages and a high wage bill in the agricultural sector, and farmers' apparent satisfaction with low rates of return, has positive aspects that should be considered. Speculatively, it is suggested that there is a political and social ethic in Sri Lanka which provides that all citizens shall be cared for, and that in turn, each citizen can expect to be cared for. While other societies may have such beliefs, in Sri Lanka it actually occurs, to such an extent that the reservation wage at which persons are willing to work, is relatively high. There is a kind of economic safety net that agriculture provides to rural dwellers, reinforced by the bureaucracy, that is likely to be found in other sectors as well.

Clearly such a system cannot be changed quickly, and perhaps should not. The high wage bill retains for the rural sector resources generated by the sector. It is notable that in other agricultural economies, marked by higher bills for off-farm inputs relative to labor, the alienation of resources generated by agriculture, or "rents," to suppliers of machinery, inputs, credit and other factors of production, has occurred fairly readily. If the situation in Sri Lanka with respect to farm profitability and the cost of labor is accurate and deemed positive, then care might be taken in bringing about changes.

One such change which appear imminent, useful with respect to diversification, and likely to have far reaching impact is mechanization. Some mechanization has occurred, but is likely to proceed at a much more rapid pace. The DOA might consider what policies would insure that the returns from mechanization remain in farm communities. How can the wages that farm families implicitly pay themselves, be kept by the family when mechanization occurs? The promotion of small tractors that are economical for a single farmer to own and operate is a possible choice.

Mechanization is likely to have a positive impact on crop diversification. Quick farm operations are often the key to utilizing rainfall for other field crops. A number of farmers have reported that when the planting of each plot of OFC was completed in rainfed areas, they would judge whether there would be enough moisture left to warrant planting in the remaining idle area. Many reported that with any income above their immediate needs, their highest priority purchase would be a hand tractor. They said that with hand tractors, they would plant larger areas of OFC's. This appears to be the case of "agrowell" farmers who are using pump irrigation. Both because the well-water supply is limited, and because the cost of pumping is high, they stressed the need to use rainfall as much as possible.

Diversification for Export

Much interest is currently expressed in diversification into crops for export. (As a matter of definition, it is probably not always useful to distinguish export crops from commercial crops, or either of these from crops in general, because the disposition of a crop or crop variety varies from time to time.) The prospects for such industry appears to be closely related to the conditions with respect to labor and profitability that have been mentioned, and to the availability use of suitable technologies. Low profit margins and high wage bills suggest that Sri Lankan exports will (1) need to compete based upon high quality products, and (2) farmers' accurate use of advanced technologies. High quality products are an advantage in any case, but since there is not a wide margin of profitability to support price competition, quality will be especially important for Sri Lankan products. Accurate use of advanced technologies of production and processing are needed in order to assure high quality.

Even if quality were not a major consideration, accurate use of advanced technologies would be required anyway, because farmers' margins are low and would suffer further if inefficient technologies were used, or if good technologies were applied poorly. The availability and use of advanced technologies of production and processing raises three questions, that may

suggest responses by the Department of Agriculture. Are appropriate technologies available? Is the technology extension process sufficiently effective in Sri Lanka to assure accurate use of advanced technologies by farmers? Is a sufficiently large scale of operation to utilize advanced technologies of production and processing presently possible in Sri Lanka?

Source of Technologies. It is often suggested that while Sri Lanka may not have the requisite technologies for the production and processing of high quality export commodities, these technologies are widely available in the Region and can be quickly implemented in Sri Lanka. It is difficult to assess whether technologies, including crop varieties and production techniques, presently outside the country can indeed be effective under Sri Lankan conditions. Chances are that many of them can be. This does not mean that research need not be continued and emphasized in Sri Lanka. Research will be required to adapt imported technologies. Also, much of the internationally supported research (e.g. that at international agricultural research centers) is only possible through regional networks of skilled scientists in national programs, working together to generate and test improved technologies. In such situations it is not possible to simply take the technologies that others develop. Finally, there are those commodities for which there are no immediately applicable technologies external to the country.

At least these three conditions suggest the maintenance of a strong crops research capacity in the DOA. Further, however, it is not clear that even the basic crops research of common commodities is as strong as it needs to be. The persistence of doubt about the identification and control measures for narrow leaf disease of chillies, is a case in point. The view that no research support is needed for export crops, and that only a free rein need be given to the private sector, is unlikely to be a viable long term position for the Department -- there are likely to be diseases, pests and problems of environmental adaptation. Adaptive research may also be required to attain maximum productivity and increase profitability. However, the key question is how best to utilize the willingness of private enterprises and others to develop export crops using imported technologies.

The resources of the private sector and those others outside the DOA willing to conduct crop development can usefully augment the DOA's capacity. Such efforts might be coordinated with the DOA so that support can be programmed for especially worthy initiatives to improve the likelihood of their success. Consistent with an overall philosophy of support to the agricultural sector in general, the DOA might increasingly see itself as supplying support services to promising, emergent initiatives throughout the agricultural sector, rather than choosing and taking responsibility for specific avenues of development. With respect to crop development, the presentation by potential technology importers (or, other initiatives originating outside the DOA, but needing DOA support) of an impact statement and implementation plan would help the DOA understand the importance of the initiative and outline aspects of possible DOA cooperation.

An impact statement might cover areas such as biological environment, but also include projections of potential geographic areas of adaptation, economic potential, and potential impacts on rural and urban employment, gender roles, rural landless or other groups within society. An

implementation plan would specifically indicate expected opportunities or need for DOA cooperation, as well as amounts and origin of resources needed, implementation schedule, indicators of success and other factors with respect to implementation. With this information, the DOA might assign particularly meritorious initiatives to working groups within the DOA to support through research and client services. Clearly the DOA could not respond to every such initiative. Through judicious selection of projects for active support and cooperation, the DOA's role and effectiveness in the agricultural sector could be expanded.

Technology extension. If technologies are available for the production and processing of export crops, it is not clear that the capacity for extending the technologies to farmers is in place. Anecdotal evidence suggests that the DOA's professional resources for moving technology from research or other high level sources is overextended at this time. The capabilities of the regional agencies responsible at the farmer level are particularly weak in their ability to deliver agricultural technology. Farmers visited in several areas stated that they had not had visits from extension workers. Of particular concern were the agrowell farmers with heavy risk exposure due to the high cost of their production systems and large balances due on irrigation equipment and who were facing significant losses from serious pest and disease problems. Meanwhile, the DOA's agricultural instructors and the provincial agronomists are very heavily engaged and unable to do more to improve technology delivery.

In a situation of weak technology delivery, the development of export crops can be quite difficult. For the reasons previously indicated, international competitiveness and already low farmer profit margins, there is little room for error in the technology delivery process. This may rule out a highly distributed farmer participation in the production of export crops or crops that require new cultural techniques. There is possibly little that the DOA can directly do to improve the technology delivery process, except encourage the Ministry to allocate more resources to the effort. Another approach might involve the private sector.

It has been observed above that private and other organizations appear willing to take on initiatives that involve the import of technologies, including seeds of improved crop varieties. It was suggested that such efforts be facilitated by the DOA as a way of expanding the DOA's role and effectiveness.

Scale of Farming. Export-oriented or other commercial farms are being encouraged in the Mahaweli System by granting areas of 25 hectares. High expectations are widely expressed, for the private sector to provide for the development of commercial crops and possibly also for dissemination of technologies to farmers. Any costs incurred would have to be recovered by firms, ultimately from production enterprises. Commercial farms of 25 hectares, especially those that require substantial infrastructural development, are unlikely to prove large enough to (1) afford the costs of crop development and technology dissemination, or (2) utilize advanced technologies. Again, this concern is based upon production conditions in which agricultural labor is relatively costly and margins are already relatively small.

An alternative is the provision for land grants of a larger size, (or, other incentives if land is purchased) that would be attractive to large-scale agricultural production firms. Such firms could then be expected to conduct a substantial amount of the needed product development, and extension of technologies to other smaller farms or contract farmers.

These are the considerations needed in order to augment the capacity of the DOA's capability for product development and technology extension. In those cases in which the DOA is fully prepared to conduct needed crop development, and dissemination of technologies, are efforts to facilitate private sector initiatives needed? It is likely that the DOA would find it appropriate to develop a system comprising a balance of both approaches.

Diversification and Environment

The first part of this paper comments extensively on the on the gains in environmental protection that can be realized from crop diversification. Field reconnaissance suggests that there is an urgent need in Sri Lanka for initiatives with respect to pesticide safety, of which crop diversification is a possible component. Farmers were widely found to be using unsafe pesticide application practices. The following anecdotes may be informative.

> Farmer A was spraying pesticides with a knapsack sprayer when we arrive at the farm. A young farmer with four school-aged children, in many respects he was quite progressive, operating five acres of land with perennial crops, rice, OFCs and milk and cattle. While spraying, he wore shorts and no shirt. He said he would be spraying all day, so we should talk now rather than waiting for him to finish. He washed with no soap, and continued smelling his hands and arms through the interview, as if he might have some concern himself. Coincidentally, while an interview on production practices was in process, the farm well was observed, not in the farmer's presence. The multipurpose well from which drinking water was taken, was unlined and had no above-ground wall. About two feet from the edge of the well and close together were two open pesticide bottles, one partly filled, and the bucket used to draw water. One surmises that the pesticides were mixed and the sprayer filled, there in the vicinity of the well.
>
> Farmer B was middle-aged and a relatively prosperous rice farmer with seven acres. Some distance from the interview process, the household outdoor kitchen annex was observed. On a table here cooking pots were kept, and there was evidence of occasional outdoor cooking near the table of pots. Adjoining the table with pots, was a second table with several filled and empty litre-sized pesticide containers. The table appeared oily, as if some spillage had occurred there.
>
> Farmer C was elderly and he and his wife farmed two hectares acres of lowland, mostly by hand. He planted onions, okra and other OFCs after rice. He had definite ideas about farming, and felt he himself did relatively well. About pesticides he said, "We in this area are addicted to pesticides." "We use a lot and could farm without them." To the question of whether indeed he could farm without pesticides, he said, "I have some

ideas." "I would experiment, and in a while I could discover how to grow crops without pesticides."

Farmer D was newly married and was planting his second crop on his recently acquired land. He owed money and said he couldn't afford to purchase pesticides. When asked what he did about insects he said "We have all kinds of kinds of concoctions." "I mix up different things." "For example, over there I used sugar."

Diversification can sometimes help to reduce pest incidence and recommendations to that effect are available in Sri Lanka. The Department of Agriculture "Crop Recommendations Technoguide 1990," (Department of Agriculture, 1990) for example notes some of the advantages of intercropping with respect to pest incidence. Diversification out of rice also helps to conserve water, and farmers themselves point out advantageous use of water and fertilizer when perennial and annual crops are intercropped. One agrowell farmer who was particularly conscious of the value of his pumped water, intercropped coconut and several different vegetables for market.

Morris examined fertilizer efficiencies in various crop sequences in his "Fertilizer Management for Crop Sequences," (Morris, 1988). Savings of nitrogen, phosphorous and potassium were identified for certain crop sequences and when crop residues were incorporated into the soil.

DOA Environmental Initiative. Technical recommendations issued by the Department that promote crop diversification and conserve resources have been noted. Farmers appear conscious of and responsive to these opportunities. The DOA can usefully continue to emphasize these advantages to farmers, and to identify and recommend specific environmentally advantageous diversification strategies.

Early indications by project staff of the AID-funded Natural Resources and Environmental Policy and Planning indicated that urban and industrial issues other than agriculture would be emphasized in the project. There is ample indication, however, that particularly with respect to pesticide use, an agricultural environmental initiative is needed. Therefore, the DOA's expected further development and utilization of a pesticides residue laboratory and regulatory services are on target. Similarly, plans for a pesticide safety campaign are highly appropriate.

DOA Response to Commercial Agriculture and Other Interests

A general approach to export agriculture and other initiatives that emerge outside the Department of Agriculture, or in parallel with DOA programs was briefly introduced above. It has been suggested that the DOA might usefully consider a policy of evaluating such efforts and facilitating such efforts, providing services to those that appear most promising. The increasing sophistication of agricultural producers, the diversification of the rural sector into

non-agricultural production activities, and regional and worldwide policies toward open markets and economies, reduce the need (and possibility) for governmental organizations to advantageously administer agricultural development.

Ways need to be found of utilizing resources and influences outside the public sector to choose and support the direction of future agricultural development. It is probably not possible for the Department to choose whether or not to commercialize agriculture. Commercialization of agriculture will either occur or not occur regardless of government efforts.

The public sector, specifically the DOA, can usefully identify the processes that are taking place in agriculture and related sectors, evaluate their potential impact and accordingly facilitate those processes coinciding with the purposes of the Department. Such an approach would represent a shift from a strongly advocate and administrative orientation, to a strongly analytical, informational and service orientation. It also requires increased capacity for sectoral analysis, policy formulation and management, described below.

Sectoral Analysis

The above information on trends in diversification, prices and other factors, was taken from published reports and data series maintained by the DAEP. The information could be much improved, if electronic processing were more advanced, and a greater number of analytical data series were kept. The present staff are doing an excellent job with the resources they have. However, it would be highly useful if computational and professional resources were added to the DAEP to support a continual comprehensive, detailed and current sectoral analysis. Related to this suggestion of investment, is the recommendation that a thorough agricultural sector analysis be completed. One has the impression that changes are occurring in the sector, but that there is insufficient information about them to formulate accurate policy responses.

Planning and Management

A second suggestion which coincides with initiatives which are already underway, is to evolve an integrated policy formulation and management system that would utilize current sectoral information, and carry out the policies based on that information. (See the separate paper, "Notes on Planning for the Department of Agriculture"). This system might emphasize a vision for near term directions within the DOA, responding to intermediate as well as final clientele, or "customers."

Suggestions for Future DOA Activities

(1) The DOA should consider undertaking a thorough analysis of the agricultural sector coupled with further development of a technically advanced capacity for continual sectoral analysis for the purpose of policy determination.

(2) Concurrent with sector analysis, the DOA might undertake a continual process of policy definition, integrated with management activities aimed at carrying out those policies.

(3) A policy initiative the Department might consider would be a shift from leading and directing development in the agricultural sector to a position of continual analysis of emergent trends in the sector and providing services to promising initiatives.

(4) An approach to creating a more efficient and responsive farm labor/power sector might be to support more rapid mechanization through small farm tractors, taking care to observe welfare effects of the changes.

(5) An agricultural environmental initiative is urgently needed, particularly with respect to pesticide use and safety, but emphasizing water and soil fertility conservation as well.

(6) Strong crop development research must be maintained for the long term interests of the agricultural sector, especially to support a viable commercial and export sector.

(7) Remedy to a weakening capacity for technology delivery needs to be found, particularly if smaller farms are to participate in further agricultural modernization and commercialization.

(8) Farm size is also a factor in the utilization of those technologies needed for regionally competitive agriculture, with some attention given to the encouragement of larger farms.