AGRICULTURAL PRODUCTIVITY MEASUREMENT AND ANALYSIS IN SRI LANKA*

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1. INTRODUCTION

Agriculture plays a leading role in the economy of Sri Lanka. Since independence in 1948, the agricultural sector, including both the domestic and export sectors, has received the prime focus in the economic development strategies adopted by successive governments. The output produced and the employment generated through agriculture and agro-based industries is vital to achieve the welfare objectives of the rural population.

Agriculture contributes nearly 27 percent of the Gross Domestic Product (GDP) and accounts for 45 percent of the employed labour force and 31 percent of total export earnings (1991). In 1963 its contribution was 38 percent to the GDP and accounted for 53 percent of all employment. A decline in agriculture's share in the GDP was experienced over the years reflecting a structural transformation in the economy, where other non-agricultural sectors were allowed to take the lead in the economic development process.

2. INSTITUTIONAL MECHANISM FOR GENERATING PRODUCTIVITY STATISTICS

Since independence in 1948, various government institutions and non governmental organizations have been involved in the collection and analysis of data and information in relation to the production aspects of various crops in the domestic agricultural sector and the export agricultural sector. In the domestic agricultural sector, the Department of Census and Statistics (DCS) has conducted 4 macro level surveys, namely Agricultural Census, Labour Force and Socio Economic Survey - Household Income and Expenditure, Crop Cutting Surveys on Paddy Production, and Cost of Production Surveys for tea, rubber and coconut production in the country.

The DCS has undertaken census of agriculture regularly since 1946. The series of data on agriculture is available from census taken in 1946, 1952, 1962, 1973

Paper presented at the Seminar on Agricultural Productivity Measurement and Analysis, organized by the Asian Productivity Organization, Selangor, Malaysia, 27th Oct. to 6th Nov. 1992

and 1982. Information is available on age, sex and educational characteristics of operators, type of ownership of holding, operational status, area of operational holding, area under major crops, source of irrigation, agricultural machinery used and number of livestock kept. In addition, 10% of the sample of holdings is used to collect additional information on the population of the operator's household, sources of income, main occupation of operator, type of holding, use of agro-chemicals, land utilization and tenurial status. In fact this survey is very comprehensive in the context of providing a macro level data base for the development of planning in the agriculture sector. However, productivity measurements in crop enterprises have been given low priority in the analysis of survey results. In addition the DCS has conducted a Labour Force and Socio-Economic Survey especially to collect information on food consumption and the labour force. Through this survey, the per capita consumption of food items, income elasticity of food consumption, total family budgets, total family income, consumption levels in relation to level of family income etc. are analyzed comprehensively.

One of the major tasks of the DCS is to carry out island wide seasonal crop-cutting surveys on paddy. Generally, two seasonal surveys are undertaken to specifically estimate paddy production in the country, extent cultivated, extent harvested and the yield per acre (productivity) of paddy during the year, considering two major cultivation seasons, namely, yala (May-Sept.) and maha (Nov.-March). These paddy statistics, based mainly on crop cutting surveys, estimate the country's paddy production annually. In this context the DCS is in a position to construct indicators on total paddy production in the country and on the partial productivity of land (yield/ha.). Usually the DCS constructs a volume index for paddy and OFCs, based on the results of these surveys.

In addition, under the National Household Sample Survey Program, cost of production surveys on paddy, potatoes and chillies have been conducted for the year 1988/89. Accordingly, detailed information on the cost of production with a breakdown of costs has been analyzed considering the financial cost for cultivation, productivity on land, profitability etc.

As far as the DCS is concerned, it has the responsibility for the collection, compilation and dissemination of statistical data and information. As explained earlier, in this process, from national level to sub national and to district level, productivity measurements in the domestic agricultural sector (especially paddy and selected OFCs) are analyzed for policy makers, with a view to help formulate policy guidelines on productivity and to evaluate the progress in development programs. Most reports based on such analysis target intellectuals, policy makers and administrators to facilitate rational decision-making on development strategies.

The major functions of the Department of Agriculture (DA) are: the development of technology and seed material for the food crops sector and dissemination of technology among farmers in the domestic agricultural sector. In this context the

DA has conducted various island wide surveys on the cost of cultivation of agricultural crops since 1979 to find out the economic feasibility of adopted technology in increasing productivity and incomes. In this survey, at the end of each cultivation season, 50 farmers are selected per crop, per district, making a total sample of about 3000 farmers throughout the country. The major aspects considered are: the adoption rate of various technologies used, labour use, other input and draft power use, costs of inputs, yields, prices, incomes etc. The necessary analysis is carried out and indicators are computed for monitoring and evaluation purposes.

The economic feasibility of adopted technology is monitored by computing the values of various indicators in relation to income, returns and the productivity of the farm. The main indicators used are:

a. Net income per hectare
b. Net income per unit of output
c. Returns per unit of labour
d. Returns per unit of capital and
e. Yield per hectare (land productivity)

These indicators provide valuable feed back to extension officers, researchers and policy makers on the economic feasibility of adopted technologies at the field level and help them design future programs, formulate policies and strategies for the development of the domestic agricultural sector.

The export agricultural sector comprises of tea, rubber, coconut and other export agricultural crops. The generation of crop specific statistics on agricultural productivity is carried out by various government authorities and corporations. In the tea sector, collection of necessary data on the total production of tea, extent cultivated, subsidies given for replanting and new planting etc., is undertaken by the Tea Small Holdings Authority (TSHA) in the small holder tea sector and the Tea Board for the state sector. In the rubber sector, the function of generating such data is performed by the Rubber Controller's Department. With regard to the coconut sector, the compilation of data is carried out by the Ministry of Coconut Industries and the Coconut Cultivation Board. Productivity statistics on other export crops are maintained by the Department of Export Agriculture. Data on productivity statistics in the export agricultural sector are analyzed by the above mentioned government institutions and published annually in their reports. These productivity measurements are published in the Annual Reports of the Central Bank of Sri Lanka.

The Agrarian Research and Training Institute has been carrying out a study titled "Food Production Policy Analysis" from the maha season of1989/90 onwards. An island wide sample survey is carried out at the end of each cultivation season to generate necessary data and information on cost of production, marketing cost etc., for paddy/rice and selected other field crops in the domestic agricultural sector. By means of a structured questionnaire, data on input use (seed, fertilizer, agro-

chemicals, labour, draft power, etc.), cost of inputs, yields, prices, incomes etc., are collected from farmers. In this context, a number of indicators, namely, net income per hectare, net income per unit of output, return per unit of labour and land productivity (yield per hectare), labour productivity (yield per man day) etc., are computed.

Research and development programs constitute an important part of government involvement in agriculture. The Department of Agriculture, the Agrarian Research and Training Institute and the various crop specific research institutions play an important role in this regard. Although it is expected that agricultural research would have a positive effect on productivity, unless there exists adequate extension facilities, dissemination of new knowledge becomes a problem. In this context, the restructuring process needs to be viewed with some caution.

3 TRENDS IN AGRICULTURAL PRODUCTIVITY

National productivity, expressed as the value of domestic product per capita indicates the prosperity of a nation, which also reflects its economic development. However, improvement of national productivity alone will not be sufficient unless it can provide an adequate income for maintaining the living standards of the people. Further, this income needs to be equitably distributed, region-wise across the country and sector-wise among the various economic sectors.

Economic growth is associated with the expansion of output, by increasing efficiency in the use of factors of production, namely land, labour, capital and management. Generally, production increases enhance the level of employment and thereby increase incomes. In this context, a productivity increase enables resources, primarily capital and labour, to shift from one sector to another or from one enterprise to another. Therefore, the agriculture sector plays a vital role as the primary and the largest sector of the economy by affecting the transfer of labour and capital resources to other sectors while constituting a market for the non-agricultural sector.

Productivity growth necessitates changes in technology to achieve economies of scale in the production process. As far as land productivity and labour productivity are concerned, they are influenced by technological innovations used in the different cultivation operations at the farm level. In fact overall change in productivity will be composed of these individual changes in the operations of the production process.

3.1 TRENDS IN AGRICULTURAL OUTPUT

In Sri Lanka the agriculture sector consists of crops, fisheries, livestock and forestry. The crop sub sector, including both domestic agricultural crops (paddy, other field crops, horticultural crops, livestock etc.) and export agricultural crops (tea, rubber, coconut and other export crops), contributes about 82 percent to the total

value of the agriculture sector. The rest is contributed by the fishing (9%) and forestry (9%) sub sectors. The annual contribution of the agriculture sector to the GDP has been about 27 percent during the 1980s.

Sri Lanka's agriculture has undergone tremendous technological changes. Modern methods of cultivation have replaced traditional systems. Chemical fertilizers replacing farm manure, use of improved high yielding varieties and modern pesticides and insecticides, heavy investment on new construction and rehabilitation of irrigation systems were witnessed in the development of the agriculture sector. A histogram of the performance of the agriculture sector, including crops and livestock, forestry and fishing is given in Table 1.

Agricultural production (output) is the main indicator for estimating agricultural productivity. It refers to the value of all domestic agricultural productions exclusive of intermediate goods used to further production. In this context, the volume index for each crop and the overall index for total agricultural production were estimated to analyze agricultural productivity in the country (Department of Census and Statistics -1991). The overall volume index for agriculture has shown an increasing trend due to increased production both in the domestic agricultural sector and the export agricultural sector during the period 1980 to 1986. After 1986 a declined growth in production is indicated mainly due to the unsettled political environment that prevailed in the country (Table 1).

TABLE 1 : VOLUME INDEX OF AGRICULTURAL PRODUCTION, 1980-1991 (BASE PERIOD : 1977 - 1979 = 100)

Year	Domestic Agric. Sector				Export Agric. Sector			
	Paddy	Highland crops	Livestock and products	Tea	Rubber	Coconut	Export agricul-tural crops	Overall Index
1980	116.62	116.83	108.88	93.22	87.88	94.66	99.62	106.47
1981	121.99	104.96	114.88	102.36	81.81	105.54	110.29	109.59
1982	117.88	109.24	112.67	91.48	82.66	117.79	111.89	107.53
1983	135.79	129.12	115.94	87.33	92.40	108.02	117.12	116.40
1984	132.37	147.25	136.74	101.34	93.67	90.73	119.65	123.90
1985	145.49	174.86	118.39	104.28	90.75	138.20	120.91	131.82
1986	141.83	180.07	124.82	102.92	90.96	141.99	114.09	132.11
1987	116.38	141.69	114.47	103.91	80.40	107.09	101.98	113.69
1988	135.46	149.83	136.05	110.54	80.78	90.31	103.37	124.54
1989	112.87	137.65	140.69	100.61	73.07	116.01	101.21	115.43
1990	138.84	168.38	127.94	113.57	74.65	118.30	112.03	121.49
1991*	130.62	172.51	124.75	117.26	68.55	102.04	23.07	118.29

* Provisional
Source: Department of Census and Statistics.

3.2 TRENDS IN PARTIAL PRODUCTIVITY

Partial productivity measures the relationship of output to a single input used in the production process, assuming that the effect of other units of inputs are constant. Partial productivity measures include the effects of factor substitution. At the same time, partial productivity measures are convenient indicators of changes in production efficiency.

3.2.1 LAND PRODUCTIVITY

Land is fast becoming a limiting factor in agriculture. But land productivity has been improved through biological and chemical innovations. Modern improved technology and inputs have increased land fertility considerably. In the 1970's due to heavy investments on irrigation under the Mahaweli Development Scheme, new lands were brought under the cultivation of paddy and other field crops. This was a dramatic move to increase agricultural production in the country. Trends in land productivity (yield per hectare) of selected crops in the domestic agricultural sector are depicted in table 2.

It is clear that productivity of land has increased marginally in 1991 compared to 1980 for crops like paddy, kurakkan, maize, meneri, cowpea, gingelly and chillies, whereas the land productivity of other crops such as sorghum, greengram, red onion, potatoes and big onion has decreased in 1991 compared with 1980. In particular the national average yield per hectare of paddy has increased between 1980 and 1983 and then declined to 3.46 mt. per hectare in 1991. Productivity of most selected vegetable crops have shown a significant increase in 1991 compared to 1980. As far as land productivity is concerned, most selected OFCs achieved more or less potential land productivity levels.

As indicated in table 2, the land productivity of paddy under major irrigation in Sri Lanka has increased by 23 and 7 percent in the 1991 maha and yala seasons respectively compared to 1980. The level of land productivity achieved is approximately the operationally potential productivity level. However, in Sri Lanka, under minor irrigation and rainfed conditions the level of land productivity achieved is well below the operationally potential productivity levels. This is mainly due to the scarcity of water and consequent inability to use improved farm management practices, especially during the yala season.

TABLE 2 :
TRENDS IN LAND PRODUCTIVITY OF PADDY IN SRI LANKA
LAND PRODUCTIVITY (Kg/Ha)

Year	Maha Season				Yala Season			
	Major Irrigated	Minor Irrigated	Rainfed	Total	Major Irrigated	Minor Irrigated	Rainfed	Total
1980	3555	2949	2339	2950	3420	2621	2385	2888
1981	3642	2716	2553	3007	3471	2730	2361	2934
1982	3762	3028	2614	3151	4127	3213	2569	3331
1983	4470	3406	2878	3641	4118	3222	2537	3605
1984	3496	2934	2583	3032	3598	3045	2484	3146
1985	4169	3327	2866	3496	3976	2997	2539	3342
1986	4166	3646	2778	3584	3809	3012	2446	3290
1987	4293	3429	2857	3677	3809	3097	2408	3362
1988	3948	3276	2782	3440	3986	3000	2636	3373
1989	3816	3370	2777	3429	3769	3084	2423	3280
1990	4138	3413	2834	3563	3935	2928	2528	3264
1991	4380	3625	2942	3775	3672	2687	2251	3043

Source: Department of Census & Statistics.

In the export agricultural sector, land productivity of tea (all types), rubber and coconut has increased marginally, whereas land productivity of selected export crops other than the above, has declined significantly during the period 1980-1991 (Table 3). As explained earlier, increasing productivity has been the dominant contributor to overall production growth in the agriculture sector.

3.2.2 LABOUR PRODUCTIVITY

Productivity of labour is closely related to land productivity and the land-man ratio in the agricultural sector. Productivity of labour is another important indicator of economic efficiency and hence increase in labour productivity results in increasing the farm income and thereby in the improvement of the standards of living of farmers. Growth in labour productivity can be achieved through increasing output (yield/ hectare) and increasing the land per worker, by effecting improvements in the quality of land or labour (Table 4). In Sri Lanka, with regard to productivity measurements, prominence has been given only to land productivity measurements rather than for labour productivity (i.e., yield per man day or per worker) measurements.

TABLE 3 :
INDEX OF LAND PRODUCTIVITY FOR SELECTED CROPS IN THE EXPORT AGRICULTURAL SECTOR

(1981 -100)

YEAR	MAJOR CROPS					OTHER EXPORT CROPS						
	Tea			Rubber	Coconut	Cardamo	Cloves	Nutmeg	Cinnamon	Cocoa	Coffee	Pepper
	high	middle	low									
1981	100.0	100.0	100.0	100.0	100.0	N.A	100.0	N.A	100.0	100.0	100.0	100.0
1982	90.1	87.4	96.1	103.4	100.0	100.0	N.A	N.A	106.7	120.6	102.0	93.5
1983	79.3	66.4	66.7	116.0	91.7	104.7	N.A	N.A	85.1	129.8	123.4	100.5
1984	94.1	75.6	78.8	119.2	77.0	44.7	100.0	100.0	50.0	63.4	66.9	45.7
1985	104.0	105.3	125.0	126.8	117.4	49.4	57.6	89.7	56.0	67.9	55.8	46.2
1986	104.3	108.9	138.1	130.4	120.6	37.7	48.5	32.2	49.3	56.5	42.2	33.7
1987	100.2	110.7	150.2	117.2	90.9	36.5	60.6	24.1	42.5	51.2	40.3	34.7
1988	104.7	113.2	167.2	119.3	76.8	25.9	54.6	26.4	35.1	32.1	26.6	22.1
1989	100.8	104.7	144.8	106.7	98.5	8.2	60.6	48.3	37.3	34.4	30.5	26.6
1990	N.A	N.A	N.A	110.5	100.1	14.1	69.7	49.4	38.8	N.A	N.A	28.1

N.A - Not Available

1982 = 100 for coconut and cardomom
1984 = 100 for cloves and nutmeg

Source: Sri Lanka Tea Board
Rubber Control Department
Department of Census and Statistics

TABLE 4 :
INDEX OF LABOUR PRODUCTIVITY OF SELECTED CROPS IN THE DOMESTIC AGRICULTURAL SECTOR LABOUR PRODUCTIVITY (KG/MAN DAY)

(1982 = 100)

CROPS	SEASON	SOURCE OF IRRIGATION	1983	1984	1985	1986	1987	1988	1989	1990
Paddy	Yala	MI	97.49	79.79	88.24	96.43	88.43	N.A.	155.09	101.96
	Maha	MI	72.30	53.68	80.88	150.49	211.76	N.A	70.34	71.81
OFC										
Chillies	Maha	RF	50.72	42.03	134.78	112.32	136.96	N.A	110.87	85.51
Greengram	Maha	RF	106.47	194.53	228.36	227.86	214.93	N.A	268.16	190.05
Cowpea	Maha	RF	52.81	21.03	113.20	110.02	105.62	N.A	105.87	136.43
Red onion	Maha	RF	102.22	120.00	124.44	79.11	N.A	N.A	104.89	86.22
Soyabean	Maha	RF	80.00	96.67	120.00	54.44	58.89	N.A	101.11	123.33
Maize	Maha	RF	50.75	56.72	61.19	229.85	189.55	N.A	165.67	198.51

OFC - Other Field Crops RF - Rainfed MI - Major Irrigation

Source: Department of Agriculture
Survey on Food Production Policy Analysis - ARTI.

As indicated in table 4, labour productivity in the domestic agricultural sector has only marginally increased for selected crops like paddy (yala), chillies, greengram, cowpea, soyabeans and maize in 1990, compared with 1982. Population pressure is intense and consequently the cultivated land area per farm worker (land-labour ratio) has decreased gradually. Therefore growth in labour productivity has been brought about mainly by increasing land productivity. However estimating labour productivity in the export agricultural sector in Sri Lanka is very difficult because of the unavailability of the required data for analysis.

3.3 FACTORS AFFECTING PRODUCTIVITY TRENDS

In general, the enhancement of productivity needs to be directed systematically towards the improvement of various factors influencing labour, land and system productivity. These factors are mainly human resources, farm management and technology in any system or crop enterprise. Human resource factors include mental attitude, commitment to and a high quality of work, education, skill; in terms of ability and experience to perform the particular tasks; adequate income, good health and nutrition and the availability of other benefits (housing, transportation, health care etc.). As far as farm management in crop enterprise is concerned, mobilizing resources, managing and controlling them efficiently, maintaining good labour relations and creating career opportunities for farm employees are vital aspects to be addressed in order to enhance productivity. Accordingly, inputs that are of good quality should be used to minimize losses. In terms of technology, appropriate technology and a consideration of capacity, quality and timing of the various on-farm operations, generally leads to a high quality and quantity of production, which in turn generate higher productivity levels.

In Sri Lanka, there are both social and technical factors which influence land productivity levels. Increased land productivity assumes importance as a means of agricultural production, particularly in countries like Sri Lanka where land is a scarce factor. Increases in land productivity of crops in the domestic agricultural sector have been achieved through various strategies, namely, the provision of irrigation facilities, introduction of new technology in the production process (e.g. mechanization of various aspects in pest control, weeding and other crop management practices), and the usage of improved high yielding seeds and yield - increasing inputs such as chemical fertilizers and pesticides. In fact increased productivity of most domestic agricultural crops at the farm level is the result of a long series of efforts supported by a very favourable policy environment. The success of the rice breeding research programme and extension work carried out have been complemented by a policy of fertilizer use promotion and the provision of irrigation facilities.

The liberalization of agricultural markets after 1977 provided a conducive price and marketing structure for the increased use of yield increasing technology and inputs by farmers. In addition Sri Lanka maintained a very high adoption rate of high-

yielding varieties of paddy (99%), OFCs and vegetables. This was one of the major factors influencing agricultural productivity in the country. In the paddy sector especially, most high potential major irrigated paddy producing districts in the country appear to have achieved the expected operationally feasible land productivity levels, compared with the potential yield.

Changes in food distribution policy also indirectly helped maintain high levels of productivity. Prior to 1977, a guaranteed price scheme had been put in place by the government to ensure a remunerative income for farmers and for establishing a procurement system for paddy and most OFCs. However with the policy environment undergoing radical change in 1977, the government assured a guaranteed price and a floor price for paddy and OFCs respectively, while at the same time the private sector was allowed to enter the market for the collection and distribution of paddy, rice and OFCs. As a result, in the open market the farm gate price for paddy has prevailed at a level about 20 percent higher than the floor price during the 1980s. This price policy indirectly helped maintain increased productivity levels by facilitating the rational selection of profitable crop enterprises.

Land fragmentation has over the years developed into an acute problem in the agricultural sector. This has led to inefficient management of farms and thereby to low land productivity and labour productivity.

The growth of land productivity can be traced back to improvement in estate management, fertilizer application, subsidies and technological advancement in processing in the export agricultural sector. Most government owned tea, rubber and coconut estates were managed by the State Plantation Corporation (SPC) and Janatha Estate Development Board (JEDB) during the last decade. As a result the state has invested enormous resources for the improvement of productivity in this sector. Under the Asian Development Bank credit scheme, established for granting credit specifically for the tea sector, credit provided for various purposes such as field development, nursery development and factory rehabilitation amounted to about Rs. 442 million between March 1989 and December 1990 (Central Bank of Sri Lanka, 1990). In the rubber and coconut sub sectors, there were specific subsidy programs implemented for improving land productivity. From 1980 to 1990, the total subsidy granted to the coconut sub sector amounted to approximately Rs. 456.2 million. The effectiveness of these subsidy schemes are reflected in the increased productivity levels recroded over the years.

Even though the tea, rubber and coconut sub sectors have shown a significant improvement in productivity, the other export crops have evidenced a decline in productivity over the years due to the implemented price policy. In order to turn back the low productivity levels, the Department of Export Agriculture launched a price support program for other export agricultural products in 1992 to protect farmers from unforseen price fluctuations in the market. The objective of this incentive package was to protect farmers by increasing the productivity of land.

In theory increased labour productivity can be achieved either by increased land productivity or by raising the land-labour ratio. In Sri Lanka family labour is extensively used for agricultural purposes in the domestic agricultural sector whereas hired labour is extensively used in the export agricultural sector. However the measurement of labour productivity is hampered by the absence of reliable and adequate statistics on the agricultural work force and the actual total labour inputs in this sector.

In Sri Lanka greater investment in farm machinery during the last decade also contributed to a higher level of labour productivity as well as land productivity, especially in paddy cultivation. Mechanization of agriculture has taken place mainly in operations of ploughing, threshing and winnowing of paddy (Mechanization Survey Report, Nov. 1991, GTZ/FMRC Project). This labour saving mechanization has been in the form of tractors (4 wheel and 2 wheel tractors) and threshers. After the liberalization of trade, tractor imports also expanded greatly. According to the Commissioner of Motor Traffic, about 30,000 2-wheel tractors and 4-wheel tractors were registered between 1980 and 1990. These labour displacing devices have been an important factor in increasing the productivity of labour. In this context, it is clear that in Sri Lanka's agriculture, three factors basically affect the growth of labour productivity per worker:

a. Land productivity per unit of cultivated area
b. Labour utilization (work days per worker)
c. Labour intensity (work days per unit of cultivated area)

In both the domestic and export agricultural sectors land productivity and labour utilization contribute positively to the growth in labour productivity.

The labour displaced by mechanization is mainly family labour. In paddy cultivation, tilling, weeding and threshing have been performed entirely by family labour. Therefore, when tractors, weeders and threshers were introduced for these purposes, family labour was totally displaced and hired labour came to dominate these activities. Labour productivity in these operations have improved remarkably. In addition, the adoption of labour saving technology is very high in the domestic agricultural sector and this has helped enhance labour productivity.

Activities in the export agricultural sector, especially tea and coconut plucking, rubber tapping and processing of other export crops like coffee, cocoa, cinnamon etc. are usually labour intensive operations. Even though the cost of production of tea, rubber and coconut is calculated by the Department of Census and Statistics, labour productivity is not estimated comprehensively. As a result, efficiency in labour utilization in these crop enterprises is not evaluated. Improved farm management (fertilizer application, weeding, factory modernization etc.), adoption of high yielding seedlings, technological advancement and the introduction of agro based industries

are some of the factors influencing the productivity of tea, rubber and coconut. In 1992, government owned tea, rubber and coconut estates in the export agricultural sector were given to private sector companies with the intention of improving the management system under the restructuring programme. It was expected that through the profit sharing system with the government, productivity of land and thereby incomes would improve.

4.1 METHODOLOGIES OF AGRICULTURAL PRODUCTIVITY MEASUREMENT

Productivity changes in the crop enterprise or product line are affected by the different factors of production which can beconsidered individually and collectively. The concepts of partial productivity and total productivity arise from this situation.

In Sri Lanka, two major measurements, namely, total productivity and partial productivity are employed in the analysis of productivity. Productivity is defined as the ratio between output and input, which measures the efficiency of the particular product line or enterprise. Further, productivity is explained as the ratio between effectiveness in achieving outputs and efficiency in using inputs in the cost of a particular crop enterprise or product line.

In the case of partial productivity* there are three important measurements, namely, land productivity, labour productivity and capital productivity, employed to measure efficiency in the process. In addition, total factor productivity ** can be measured in relation to output and input measurements of the crop or product line. Total productivity *** can be employed as a measure of evaluating efficiency in the value added of a product, crop or product line. By using the value added, one can avoid double counting of outputs when a crop, product line or enterprise uses outputs of other product lines or enterprises. In fact, value added is the measure of true output generated by the enterprise or product line when considering internal operational capabilities and the enterprise or product line.

In Sri Lanka, the methodology used to measure productivity in crop enterprises in both the domestic and export agricultural sector is partial productivity of land (yield

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* Partial Productivity:

Land productivity $= \frac{O}{A}$

Labour productivity $= \frac{O}{L}$

Capital productivity $= \frac{O}{K}$

Where, O = Output, A = Area, L = Labour, K = Capital

** Total Factor Productivity (TFP) $= \frac{\text{Output}}{\text{Input}} = \frac{O}{W_1A + W_2L + W_3K}$

Where, O = Output

I = Input $= W_1A + W_2L + W_3K$

W = Weight of each component

*** Total productivity $= \frac{\text{Value added}}{\text{Labour + Capital inputs}}$

per hectare). In order to measure partial productivity, the following formula is used in both the domestic agricultural sector and in the export agricultural sector.

a. Partial productivity of land

1. Land Productivity for paddy, OFC and vegetables	=	Total production (mt)*f* / Extent harvested (ha)
2. Land Productivity for made tea	=	Production of made tea (mt) / Extent harvested (ha)
3. Land Productivity of coconut	=	Production of no. of nuts (No.) / Extent cultivated (ha)
4. Land Productivity of made rubber	=	Production of made rubber (mt) / Extent cultivated (ha)
5. Land Productivity of other export crops	=	Total production (mt) / Total Extent cultivated (ha.)

4.2 PROBLEMS AND CONSTRAINTS IN MEASURING PRODUCTIVITY

In Sri Lanka, productivity measurements and analysis have not received the importance they deserve. This has led to various problems in analyzing agricultural growth which in turn have potential policy implications for both the domestic and export agricultural sectors. Although total productivity is far more insightful as a comprehensive concept in analyzing economic growth compared to partial productivity, the measurement of total productivity runs into statistical difficulties. With regard to partial productivity, land productivity is consequently used more frequently than labour and capital productivities for policy analysis in Sri Lanka. Partial productivity measurements are employed to obtain rational decisions on crop enterprises or product lines only in micro analysis. However estimates of land productivity is invariably available in the form of yield per hectare relating to the crop area for perennial crops (tea, rubber, coconut and other export crops) or to the area sown/harvested for seasonal crops (paddy, OFCs, vegetables etc.).

In the macro level analysis, labour productivity is more difficult to estimate, because reliable and adequate statistics on the agricultural work force and the actual labour inputs are lacking. However in micro level analyses of the domestic, agricultural sector, government institutions such as the Agrarian Research and Training Institute (ARTI) and the Department of Agriculture (DA) have carried out adhoc studies to measure productivity in the paddy and OFC sectors. In the export

agricultural sector the vital productivity measurement used is land productivity because even the respective authorities who deal in this sector do not collect and analyze the data in relation to labour use/labour cost and capital. Therefore it can be said that productivity measurements in relation to labour and capital investment is lacking due to structural problems.

Agricultural productivity growth requires technological changes in the agricultural sector as the source of increasing returns to specific factors of production. Technology change is mainly based on mechano-engineering developments for labour saving devices and partly on bio-chemical improvements for applying land saving measures. Accordingly new types of capital equipment and machinery are necessary for saving labour. Basically, in order to implement land saving devices, various intermediate inputs are required in the production process (seed, fertilizer, agro chemicals, irrigation etc.). As a result, analyzing partial productivity on the intermediate inputs utilized is very difficult because the full potential of productivity can be obtained only as a combination of the inputs used rather than as the sum of separate single inputs used. Therefore the measurement of productivity on each input has less value than on a combination of all inputs.

In Sri Lanka the absence of productivity analysis has influenced macro level policy analysis. The existing approach of agricultural policy analysis has been based on the expansion of production. Such analyses have limited value in terms of reviewing the prevailing policy environment. Generally production changes are assessed on the basis of estimated production targets. But the analysis should be directed to other areas in resource allocation and efficiency. In this context, land use intensity, value added, factor market and factor prices should be taken into account to measure the efficiency of resource allocation. In the case of paddy, the emphasis is placed on assessing only total production, when it is equally important to analyze the relationship between foreign exchange savings and growth in production as well.

Inadequacy of data on productivity measurements and analysis is another problem experienced in Sri Lanka. The data base in crop acreage and production developed by various government institutions is mainly on paddy, Other Field Crops (OFCs), livestock and some export agricultural crops such as tea, rubber, coconut and other minor export crops. Vegetables and fruit have received less importance in this respect. As a result, the existing data base does not permit the analysis of agricultural changes within an integrated framework over time, on both total and partial productivity measurements.

Remedial measures therefore should be applied to maintain a conducive environment for the generation of productivity statistics and analysis. In this context the required data base should be developed by a particular government institute in order to maintain an effective support service for enhancing productivity. This authority can analyze productivity measurements continuously over time, considering all necessary partial productivity measurements as well. This of course would

lead to the development of a data base to analyze macro level data on growth and productivity. In addition the existing analysis, carried out through micro level studies by various institutions, should be developed to analyze all partial productivity measurements of land, labour and capital in relation to the national level estimates.

5. CONCLUDING REMARKS

As far as agricultural productivity is concerned, most crops grown in the domestic agricultural sector achieved land productivity close to the potential level. However it seems that for selected commodities, the labour productivity obtained was below the potential level. In this context, the government should intervene and formulate long term strategies to fulfill the nation's major objective of obtaining a high level of growth in the agriculture sector through enhancing productivity levels further. Policies should be formulated with a view of increasing efficiency in the production process, maintaining land saving technology in the form of new seed and other yield increasing inputs since the land-man ratio is decreasing very rapidly.

In the domestic agricultural sector among the important agricultural commodities, rice plays a vital role and the proportion of rice sub-sector to the total value of output in the agriculture sector was maintained at a constant level (around 25%) during the1980's. This implies that the agricultural production mix has not changed and that the crop diversification strategy has not been taking place at a rapid rate.

In Sri Lanka's agriculture, mechanical power has often been substituted for human and animal power in order to raise labour efficiency and thereby enhance productivity. It is therefore advisable to conduct a case study on the economics and application of labour machinery substitution in agriculture, especially in the domestic sector.

In terms of productivity measurement in the country, it is necessary to analyze partial productivities in relation to each and every input used in the production process. This may lead to evaluating the efficiency in each input use over time and facilitate the application of corrective measures to achieve efficiency and higher productivity in both the domestic as well as in export agricultural sectors.

The present mechanism of generating productivity statistics should be reviewed and a new data compilation system should be formulated by the Department of Census and Statistics in collaboration with the Agrarian Research and Training Institute and the Department of Agriculture in order to avoid duplication of work in analysing total productivity and partial productivities in relation to inputs used. This would help to improve policy formulation and to evaluate the effectiveness of the agricultural policies implemented.

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