Chapter 5
The Data

5.1 Introduction

The previous chapter was devoted to discussing the concept of TFP and various methods for computing transitive TFP indices, regional productivity differences and the estimation of the effect of OLT on regional TFP.

In this chapter, focus is given to the nature of data, their sources and their limitations. The present study was originally aimed at a comprehensive analysis of cross-section and time series data from the Philippines to study or examine the effects of OLT on rice and corn productivity levels. As various sources of data were examined, a number of data deficiencies were identified. Fairly reliable data on outputs were available for both rice and corn production, but input data were extremely scarce.

In view of the limitations on input data, the study is restricted to using regional data for the year 1991 drawn from extensive farm surveys undertaken.

5.2 Data Sources

The basic data used for this study were obtained mainly from secondary sources. They include statistics collected by the mandated agencies and data from studies conducted by individual researchers or published by other government and non-government institutions.

5.2.1 Outputs

The main source of rice and corn output data were the statistics maintained by the Bureau of Agricultural Statistics (BAS). Figures from 1973 to 1992 are computed from the Integrated Agricultural Survey or IAS (1969 to 1976) and the Rice and Corn Survey or RCS (1977 to 1994). Figures from 1993 to 1995 came from statistics maintained by the Cereals Section of the BAS. The IAS was conducted quarterly in four rounds, namely, October-first round, January-second round, April-third round, and June-final round. The RCS is undertaken by the BAS also on a quarterly basis. It covers about 5,800 sample barangays (villages) and 58,000 sample households and provides forecasts and final estimates for rice and corn crops (PhilRice-BAS, 1994).

Farmgate prices of rice and corn were taken from compilations of weekly and monthly surveys on prices by the BAS (PhilRice-BAS, 1994). The study used regional and national prices of rice and corn. The regional price is the unweighted average of the prices in the sample municipalities, which represent the weighted average of the prices for villages using the number of farms in the annual IAS sample villages as weights. The national average price is the weighted average of the regional prices using the number of sample farms in the region as weights (PhilRice-BAS, 1994).

5.2.2 Factor Inputs

Data on fertilizer utilization were obtained from the Agricultural Accounts and Statistical Indicators Division, BAS; from the PhilRice-BAS Collaborative Project on Rice Statistics and from the Fertilizer and Pesticides Authority (FPA). Data on irrigation aspects came from the National Irrigation Administration (NIA).

In terms of input prices, data came from BAS, FPA, NIA and the Bureau of Plant Industry (BPI). Data on agricultural wages were collected from the Bureau of Labour and Employment Statistics, Department of Labor and Employment (BLES-DOLE).

Land data were taken from the area planted to rice and corn. Irrigated rice area are available from the Regional Rice Statistics Handbook (Philrice-BAS, 1994). There are no information that reflect land qualities.

5.2.3 The Costs and Returns Survey (CRS)

In 1991, a Costs and Returns Survey (CRS) was conducted by the BAS for rice and corn. It was carried out to establish the cost structure of irrigated, rainfed and upland rice as well as white and yellow corn at the regional and provincial levels. Through the survey, interregional and inter-provincial comparisons of costs and returns were possible.

The CRS followed the structure of the RCS design. A three-stage sampling was designed with the municipality as the first stage sampling unit, the village as the second stage and the household as the ultimate sampling unit. The non-response samples in the July 1991 CRS round were omitted from the list. The households were classified into rice and corn separately, and by type of farm such as irrigated, rainfed and upland. The basis for classifying rice and corn farms was the proportion of area planted to either crop.

BAS estimation results were capable of producing provincial estimates. Provincial estimates represent the average cost and returns of rice and corn for the relevant provinces. For this study, only the regional estimates were desired. The regional estimates, thus, like the provincial estimates, represent the average costs and returns and rates of input usage in irrigated, rainfed, and upland farms for rice; and in yellow and white corn. These averages were weighted by the number of sample farms (BAS, 1993).

The 1991 CRS was updated by the BAS for the succeeding years, 1992-1995. In the first instance, the CRS data set was considered for a time-series cross-section analysis. A close examination of the data suggested that costs were updated by valuing production inputs by their current prices while outputs were updated using current yields and output prices. This was done to compensate for the lack of regularity in cost and returns survey (BAS, 1993). This assumption of constancy in input usage made the 5-year series of costs and returns not usable for computing TFPs growth for rice and corn due to the underlying assumptions about input use.

5.2.4 OLT and Other Data

OLT distribution data and support services projects implemented were obtained from the Field Operations and Support Services Office, Department of Agrarian Reform (DAR) and from annual reports of CARP cooperating agencies such as the Department of Agriculture (DA), Department of Trade and Industry (DTI), National Irrigation Administration (NIA), and Land Bank of the Philippines (LBP) submitted through the Presidential Agrarian Reform Council Secretariat (PARC Sec). Data on credit aspects were obtained from the Agricultural Credit and Policy Council (ACPC) and the Department of Economic Research, Bangko Sentral ng Pilipinas (Central Bank of the Philippines, DER-BSP). Rainfall data were taken from the Philippine Yearbook from figures provided by the Philippine Agronomical Geophysical and Astronomical Services Administration (PAG-ASA).

Other useful sources of data used in establishing assumptions for the study and undertaking necessary conversions are the National Statistical Coordination Board (NSCB) and National Statistics Office (NSO). The Philippine Statistical Yearbook contains useful agricultural indicators.

An aggregate agricultural sector's TFP study is suited to the Philippine data. The Census of Agriculture, though not conducted annually, contains a comprehensive body of information necessary for a sector-wide TFP analysis. However, input utilization aspects are aggregated into all crops from which rice and corn's share could not be isolated reasonably.

5.3 Data Limitations

In developing countries, measurement problems pose major constraints for many empirical studies. In the Philippines, like in most LDCs, researchers are rarely fortunate enough to secure the necessary data to enable them to undertake the desired analysis necessary to the formulated models. Often, researchers have to work with what is available using little data specifically configured for their needs (Rola, 1991).

David (1989) wrote that the Southeast Asian statistical system is characterised by an unequal allocation of resources in favour of non-agricultural statistics regardless of whether the system is centralised or decentralised. In the decentralised system used in the Philippines, agricultural statistics are more disadvantaged when the agriculture agency is both the principal agricultural data user and producer. The little priority given to the statistical bureau and the limited importance accorded to agricultural statistics often results in serious consequences for the statistical system. There is a dichotomy between data availability and data quality as separate concerns of data users and producers, respectively. For the Philippines, mere data availability is a problem that limits the feasibility of conducting a long time-series based study, especially those that require information on input quantities.

In addition, there is a bias in terms of the number of studies conducted for rice as compared to those for corn, such that availability of references to substantiate certain assumptions is limited. Although data collection for agriculture has been 'heavily oriented towards the survey of rice and corn at the expense of "lesser" food and commercial crops' (Boyce, 1993 in Rose, 1985), 'statistics on rice are generally better than those of corn' (Boyce, 1993 in World Bank, 1979a).

5.3.1 Outputs

The output series for rice and corn by region is complete from 1973 to 1995 and so are the price figures. The output statistics are used in obtaining the output indices whose trends are illustrated and discussed in Chapter 6. Data collected for output quantities of rice and corn were expressed in 000 metric tons while area harvested was expressed in 000 hectares. Prices are in Philippine pesos per metric ton (PhP/mt). Yield per hectare was computed by dividing quantity produced by area harvested.

5.3.2 Factor Inputs

Hayami, Ruttan and Southworth's (1979) comparative study on the agricultural growth of Japan, Taiwan, Korea and the Philippines cited that, for the Philippines until 1979, no government statistical agency had attempted to measure the quantities of agricultural inputs other than land and labour. Even for the two inputs considerable supplementation was necessary to develop suitable series for their study (Hayami, Ruttan and Southworth, 1979).

No complete series were available for any of the input quantities. Although fertilizer price series from 1973-1995 by region for 5 fertilizer types from 1973-1995 were available, fertilizer utilization figures by region started only in 1988.

There are no existing data on aggregate pesticide use for rice and corn, data were not being collected by the Fertilizer and Pesticides Authority (FPA) due to difficulty in standardizing pesticide quantities (FPA, pers com). Prices of major pesticide brands were collected by BAS for a short period (1981-1991).

Data on the amount of labour used for rice and corn production per region are not being collected, although agricultural wage statistics exist. In earlier years, (1973-1974), wages for labour in rice and corn production by farm operation were published. Regional prices of hired labour were available for 1973-1978. From 1978-1987, national data were broken down into types of operation. For 1988-1995, national average prices were collected, representing the average of all operations.

Prices of rice seeds were mainly based on prices of certified seeds determined by the Department of Agriculture (DA) and implemented by the Bureau of Plant Industry (BPI). For 1981-1987, regional prices were collected by the Bureau of Agricultural Statistics (BAS). For years earlier than 1981 and later than 1988, national figures were available. Data on quantity of rice seeds used were not collected for the whole period but estimates of production and use of rice by region were able to provide a partial picture of rice seed utilization.

Prices of corn seed by region were available for 1981-1987. For 1988 to 1995, national figures are compiled based on the prices of certified seeds determined by DA and implemented by the BPI. Similarly, quantity of corn seeds used were not collected for the whole period, but the production and use estimates of corn provide a partial picture of corn seed utilization.

Irrigation fees by region were computable using the support prices for rice and corn as determined by the National Food Authority (NFA) and implemented by the National Irrigation Administration (NIA). Irrigation service fees expressed in kind were computable using the volume paid multiplied by the current support price.

It was not possible to construct series of tractor rent costs. Available data were only for 1973-1974 and no information on tractor use and area subjected exists.

Fuel prices from 1973-1983 could be estimated using current price in 1984 and the backward movements in the CPIs for fuel. For 1984-1995, actual data were available.

5.3.3 The Costs and Returns Survey (CRS)

A previous CRS was conducted in 1983. It generated data on costs and returns of rice and corn production for the same year. However, the survey could not be conducted annually for want of sufficient funding. A similar survey was done in 1991 following the structure of the RCS. The 1991 data alone represents a fairly reliable estimate of the costs and returns of rice and corn.

The CRS updates for the succeeding years after 1991 were limited because they assumed constancy in input usage. Costs for 1992-1995 were derived by keeping input-output ratios constant and then updated using price indices. Specifically, updates were computed using the movement of farmgate prices for seeds and planting materials; movement of gross value of production per hectare for irrigation fee, harvester/thresher and sheller's share and rents; movement of Urea retail prices for fertilizer and chemicals; changes in the current agricultural wages for labour and other rentals; and movements in the Consumer Price Indices (CPIs) for food, transportation and fuel. Updates on interest in capital investment were based on a 16 percent addition to total cash paid to seeds, fertilizer, chemicals and hired labour (BAS, 1993). This approach of CRS which assumes constancy of input usage made the five-year cost structure data not amenable to a TFP growth-oriented analysis.

Given the uneven nature of most series on input prices and the absence of information on aggregate input quantities, estimation of a complete time series on TFP and their growth rates was not possible. While there were previous studies that estimated TFP for the entire agricultural sector, isolating the input variables needed for estimating TFP for rice and corn would be tedious and would not hold sufficient base. For instance, the labour variable used in estimating the entire agriculture's TFP was the total agricultural labour force from which the exclusive rice and corn labour force was difficult to determine.

Notwithstanding the limitations of the CRS updates, the actual survey results conducted for 1991 represent the best available data required for computing the regional TFP indices for that year. The 1991 regional data on rice and corn production from CRS forms the basic data for this study.

5.3.4 OLT and Other Data

OLT area distributed from 1972-1986 could not be disaggregated by year for all regions. Systematic databasing of DAR's records on OLT occurred only after 1986. There is no reasonable basis by which OLT area from 1972-1986 could be disaggregated. While there exist national figures for claims approved for payment by the Land Bank of the Philippines (LBP) which was initially identified to be closely linked to OLT accomplishment, there were significant time gaps between approval of payment and actual title distribution. These activities may not have been undertaken in the same year because of administrative and technical procedures and problems. Likewise, the number of CLTs distributed on a per year basis from 1974 onwards, while they are disaggregated by region could not be used to represent Emancipation Patent (EP) distribution due to the intermediate nature of CLT titles. Similar to payment approval, there exists a significant time gap between CLT distribution and effective EP distribution.

Another important limitation was that OLT area distributed could not be broken down into rice and corn areas by region. Separating between the crops would require extensive review of provincial inventories, a process that requires a tremendous amount of time.

The apparent imperfections in the Philippine input database renders a TFP growth-oriented analysis for rice and corn non-feasible. Forecasting input series may lead to major biases affecting the subsequent values of TFP. Hence, a test case using 1991 data was undertaken highlighting the regional differences in productivity.

5.4 Construction of Data Series

This section presents the methods adopted to construct the regional output, input and TFP indices and the means employed to estimate the effects of OLT on regional TFP.

Regions are numbered from 1 to 13 for purposes of construction of the index number matrices and subsequent discussions. The actual and official regional classification is Region 1 representing Ilocos, Region 2 representing Cagayan Valley and so on until Region 12 representing Central Mindanao (see Tables 2.1 and 2.3). For purposes of this dissertation, CAR, a region whose provinces used to be part of Ilocos and Cagayan Valley is considered as Region 1 in order to avoid discontinuity after the original Region 2 (Cagayan Valley). The succeeding 12 regions follow after CAR.

5.4.1 TFP Estimation

Input Aggregates

The CRS generated data represented the cost structure of rice and corn by region for 1991. It also estimated the rates of input usage on a per hectare basis on such inputs as seeds, fertilizer, pesticides and labour. These rates were multiplied by the area harvested to obtain aggregate input use estimates. Inputs were then aggregated into total rice inputs, total corn inputs and aggregate inputs for rice and corn production

Inputs used for TFP computation included only those for which BAS provided rates of usage such as seeds, fertilizer, pesticides, labour and fuel. For irrigation, no quantity rates (i.e., volume of water per hectare) were available and neither was BAS able to account for them in its survey. No information is available for stock of capital investment although depreciation is properly accounted for in the data. Available information on capital investment represents new investments in 1991.

Value aggregates were computed by multiplying the regional aggregate quantity of inputs by the 1991 current prices of inputs. For the rice and corn combination, weighted average price was applied where necessary as the price multiplier for the aggregate quantity of inputs.

Effectively, the input aggregates calculated represent, on the average, 80-85 percent of all inputs owing to the inability to include irrigation, capital, tractor and interest. This can be gleaned from the factor shares tables, Tables 6.2 and 6.3, which show the relative factor value shares of all factor inputs.

Interest refers to interest on investments held by rice and corn farmers as of the time of survey by BAS. Depreciation refers to the depreciation value of farm equipment, tools and other assets which were not specified in the survey report.

Output Aggregates

The Philrice-BAS regional data on rice output were sufficient to represent aggregate rice output while the BAS-compiled regional corn data were likewise sufficient for the aggregate corn output. Values for the two crops were combined for aggregate regional output values of rice and corn.

Value aggregates for outputs were computed by multiplying the regional aggregate quantity of output by the 1991 current prices of rice and corn.

Factor Shares

Factor shares were computed using the relative shares of the value of each factor input to the total value of inputs. The factor shares were useful in indicating the relative share of each input with respect to total inputs per region.

Inputs like irrigation, for which no quantity per hectare rates were available, but for which cost per hectare were given in the BAS survey, were included in the factor shares computation. The same was true for depreciation, irrigation, interest and land rent and land tax which were lumped together.

Input Indices

Four types of indices, namely, Divisia, Paasche, Laspeyres and Fisher were computed using the Shazam econometrics package (White, 1993) which calculates index numbers automatically. From Shazam's output, a set of 13 x 13 matrices of regional input indices were constructed. Each region served as a base region for each column vector. This resulted in matrices with ones along the main diagonal.

Output Indices

Output indices were computed by dividing the regional output levels by the output level of a designated base region. A single type of output index was computed in a spreadsheet. Similar to the input indices, the ouput indices are in the form of a 13 x 13 matrix with ones along the main diagonal.

TFP Indices

TFP indices were computed from the ratio of the output to the input indices. They are likewise presented in matrices. Alternatively, TFP indices could be computed through a set of commands from Shazam.

A set of input, output and TFP indices were computed for rice, corn and for the combination of rice and corn. The indices initially generated and mentioned above were non-transitive. The EKS-CCD Approach and MST as descibed in the previous Chapter were applied to the indices to come-up with transitive sets.

5.5 Comments and Conclusion

This Chapter has identified a number of imperfections and inconsistencies in the Philippine database, which render a thorough TFP growth-oriented analysis of rice and corn non-feasible. Hence, a limited analysis using 1991 data is undertaken to study regional differences in productivity. The methods adopted, as described in this Chapter, represent a systematic means of employing cross-sectional data to estimate regional differences in TFP and the effects of government programs.

Chapter 6
Results and Discussion

6.1 Introduction

This Chapter discusses the main results of the study based on the framework presented in Chapter 4 and the means of estimation discussed in Chapter 5.

Results presented in the chapter focus on the following: (i) various output and input indices; (ii) TFP measures based on Fisher indices and standard transitive measures; (iii) TFP measures derived using transitive measures based on the minimum spanning trees; (iv) TFP indices for rice and corn separately and also based on aggregate output; and (v) simple regression analysis that attempts to relate regional TFP measures with OLT and other characteristics.

6.2 Output, Input and Area Indices

At the onset, regional output index numbers over time are presented. This was done to establish a background on the nature of output growth in rice and corn by region as shown by index numbers. Regional input value shares are also shown, as these provide insights into regional differences, they are discussed in some detail. This discussion is followed by a presentation of regional TFP indices.

6.2.1 Output and Area Indices

National indices, relative to 1973 as base period, of rice and corn area (Figure 6.1) show that area harvested to rice grew steadily until the latter part of the 1970s. There was a small decline between 1978 and 1983 followed by an increase in area harvested to rice between 1984 and 1991.

On the other hand, area harvested to corn increased at higher rates than rice area. From the 1973 base period, area indices increased sharply until 1978. Following the trend for rice, area harvested to corn declined in 1983. Sharp to smooth increases followed until 1990. Continuous decline in aggregate area is observable from the downward trend in the indices from 1990 until 1995.

Regional rice ouput indices (Appendix 1) show that among the regions, Northern Mindanao achieved the highest output growth over the period 1973-1995, followed by Southern and Central Mindanao. Cordillera and Bicol achieved the lowest output growth rates over the whole period.

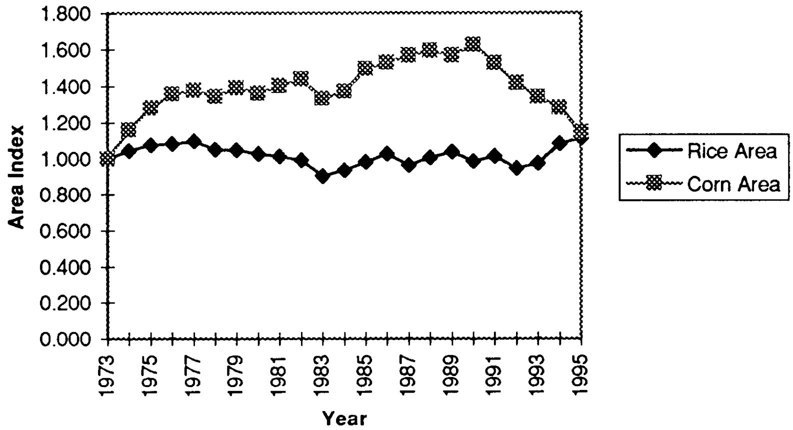

Figure 6.1 **Rice and Corn Area Indices, 1973-1995**

Indices of corn output (Appendix 2) show that Central Luzon, a traditionally rice predominant region, achieved remarkable output growth for corn over the period 1973-1995. A similar trend is evident for Central Mindanao, a predominantly corn planting region. For Southern Tagalog, which is a major corn producing region, outputs were decreasing over recent years. From the indices, a decreasing output trend is also observable for Central Visayas, a predominantly corn consuming region.

Looking at combined rice and corn output indices (Table 6.1), aggregate output for the two crops increased more than twofold over the 23-year period. The highest output growth rates for both crops combined were achieved in Northern Mindanao followed by Central Mindanao and Cagayan Valley. Central Luzon achieved lower rates over the period than Cagayan Valley despite the historically high rice outputs attained by the region. From the index table, national aggregate output of rice and corn for the Philippines is shown to have doubled over time.

Table 6.1 ***Rice and Corn Regional Output Indices, 1973-1995***

YEAR	*Cordillera*	*Ilocos*	*Cagayan*	*Central Luzon*	*So. Tagalog*	*Bicol*	*Western Visayas*	*Central Visayas*	*Eastern Visayas*	*Western Mindanao*	*Northern Mindanao*	*Southern Mindanao*	*Central Mindanao*	*PHILS*
1973	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1974	1.017	0.781	1.077	1.138	0.988	1.143	1.120	1.151	1.127	1.124	1.080	1.250	1.279	1.073
1975	1.113	1.092	1.244	1.026	1.127	1.218	1.247	1.228	1.201	1.232	1.209	1.569	1.471	1.224
1976	1.130	0.933	1.296	1.030	1.177	1.276	1.435	1.319	1.279	1.364	1.252	1.749	1.477	1.272
1977	1.097	1.069	1.381	1.035	1.303	1.287	1.523	1.326	1.363	1.564	1.336	1.895	1.684	1.382
1978	1.115	1.190	1.373	1.028	1.207	1.180	1.500	1.326	1.389	1.705	1.546	1.987	1.640	1.378
1979	1.129	1.229	1.471	1.029	1.249	1.254	1.699	1.336	1.494	1.606	1.645	2.129	1.741	1.482
1980	1.391	1.116	1.124	1.049	1.162	1.312	1.841	1.636	1.779	1.315	1.913	2.063	1.920	1.472
1981	1.323	1.300	1.275	1.073	1.099	1.138	1.846	1.484	1.944	1.376	1.903	2.198	1.999	1.540
1982	1.248	1.601	1.275	1.076	1.169	1.198	1.811	1.456	2.066	1.387	1.987	2.393	1.840	1.614
1983	1.229	1.352	1.212	1.100	1.137	1.143	1.563	1.285	1.691	1.256	1.699	2.173	1.680	1.431
1984	1.321	1.419	1.493	1.224	1.202	1.367	1.696	1.276	2.153	1.347	1.421	2.239	1.985	1.522
1985	1.261	1.569	1.851	1.320	1.377	1.419	1.761	1.328	2.549	1.522	1.926	2.631	2.277	1.737
1986	1.439	1.630	1.843	1.251	1.357	1.430	1.836	1.451	2.376	1.583	2.166	2.769	2.590	1.828
1987	1.288	1.392	1.829	1.266	1.236	1.199	1.908	1.449	2.167	1.484	2.242	2.772	2.457	1.749
1988	1.497	1.700	2.005	1.314	1.383	1.437	1.818	1.504	2.280	1.638	2.480	2.826	2.621	1.829
1989	1.310	1.593	2.021	1.417	1.408	1.346	1.738	1.820	2.171	1.731	3.020	2.907	2.673	1.911
1990	1.330	1.742	2.225	1.496	1.321	1.434	1.421	1.670	2.029	1.714	3.034	2.889	2.659	1.930
1991	1.209	1.852	1.951	1.454	1.506	1.523	1.892	1.593	2.183	1.799	3.348	2.794	2.541	1.957
1992	1.306	1.668	2.217	1.461	1.447	1.443	1.994	1.298	1.841	1.500	2.956	2.397	2.417	1.875
1993	1.363	1.703	1.726	1.595	1.375	1.347	2.394	1.347	1.856	1.675	3.976	2.621	2.860	1.940
1994	1.565	1.905	2.283	1.650	1.425	1.365	2.333	1.396	1.673	1.490	4.048	2.284	3.383	2.066
1995	1.598	1.885	2.544	1.757	1.281	1.208	2.079	1.416	1.802	1.554	4.478	2.149	3.278	2.020

Note: Fisher Indices, Base = 1973

6.2.2 Input Value Shares

The input value shares tables provide a background on the differences among regions in terms of levels of input usage through the differences in the relative proportion of input values to their respective regional total values. For rice, Table 6.2 shows that the share of seeds is highest in Western and Eastern Visayas. Seeds account for one fifth of total input value for Western Visayas. Cagayan Valley and Central Luzon, two contiguous regions had similar input value shares for seeds (0.15) which was not far from an adjacent region's or Southern Tagalog's value share (0.16). On average, the value share of seeds to all inputs is 14 percent.

In terms of fertilizer's share, the rice growing regions of Luzon, namely Ilocos, Cagayan Valley and Central Luzon had the largest relative shares (11 to 14 percent) as well as Western Visayas (12 percent). The lowest relative share occured in Eastern Visayas. Southern Tagalog, Central Visayas, Southern and Central Mindanao had equal fertilizer value shares (0.09).

Labour values shares provide additional insight into regional differences in inputs. For instance, the share of labour was high for Ilocos (0.51) and Central Visayas (0.50). It is interesting to note that for major rice producing regions such as Central Luzon and Western Visayas, labour's share was relatively low (0.33 and 0.32 respectively). This observation suggests that supply factors effectively play a role. Rice labour wages tend to be lower in regions where rice is the dominant crop, as the supply of labour is relatively more abundant than in regions where rice is not the predominant crop. For instance, labour demand in garlic, tobacco and other cash crops which are widely planted in Ilocos, and corn in Central Visayas, compete with rice labour demand. On the average, the national share of labour to total input value is 42 percent.

An implication of a low labour share is the extent of mechanization, which is evident in Central Luzon. This can be infered from the large value share of rentals that include payment for machinery services.

Western Visayas and Central Mindanao had the highest value share for chemical inputs. Geographical contiguity appears to play a role in the pattern of chemical pesticide use, indicating similar input patterns in neighboring regions. For instance,

Table 6.2 ***Rice, Input Value Shares, By Region, 1991***

REGION	Seeds	Fertilizer	Labour	Chem.	Rentals	Fuel/Oil	Land	Irrign. Fee	Interest	Depcn.	TOTAL
Cordillera Admin. Region	0.12	0.08	0.49	0.03	0.05	0.01	0.08	0.01	0.04	0.09	1.00
Reg I - Ilocos	0.10	0.14	0.51	0.04	0.04	0.02	0.05	0.01	0.05	0.04	1.00
Reg II - Cagayan Valley	0.15	0.11	0.38	0.04	0.04	0.00	0.12	0.04	0.07	0.04	1.00
Reg III - Central Luzon	0.15	0.14	0.33	0.03	0.08	0.02	0.09	0.03	0.06	0.07	1.00
Reg IV - Southern Tagalog	0.16	0.09	0.44	0.05	0.06	0.01	0.07	0.02	0.05	0.06	1.00
Reg V - Bicol	0.17	0.10	0.42	0.04	0.04	0.01	0.08	0.02	0.05	0.07	1.00
Reg VI - Western Visayas	0.20	0.12	0.32	0.07	0.07	0.01	0.08	0.03	0.05	0.06	1.00
Reg VII - Central Visayas	0.13	0.09	0.50	0.04	0.05	0.01	0.07	0.02	0.04	0.05	1.00
Reg VIII - Eastern Visayas	0.19	0.06	0.49	0.04	0.05	0.00	0.07	0.02	0.04	0.05	1.00
Reg IX - Western Mindanao	0.14	0.07	0.42	0.06	0.07	0.01	0.06	0.02	0.06	0.09	1.00
Reg X - Northern Mindanao	0.12	0.11	0.45	0.06	0.07	0.01	0.05	0.01	0.06	0.06	1.00
Reg XI - Southern Mindanao	0.11	0.09	0.39	0.06	0.05	0.01	0.11	0.03	0.06	0.09	1.00
Reg XII - Central Mindanao	0.12	0.09	0.38	0.07	0.05	0.01	0.11	0.03	0.05	0.09	1.00

the input value shares for chemicals were equal for Ilocos and Cagayan Valley (0.04) as well as for Western, Northern and Southern Mindanao. Such similarities reflect similar cultural practices which include the cultural beliefs associated with rice pest control.

Rentals for machines, tools and equipment, and animal hire comprised around 5 percent on the average. The disparity in regional shares was however, not very wide. Rental value shares ranged from 4 to 8 percent. The highest rentals value share was in Central Luzon (8 percent). Rental items represent rents for tools and equipment, machinery and animals. The relatively large share implies a more mechanized production technology for the region. Value shares for depreciation were greater for CAR, and the Mindanao regions, except Northern Mindanao. While, a greater value share could be due to higher factor prices, the prices of such factors, i.e., machines, tools, equipment and animal hire were not available.

For corn, Table 6.3 shows that share of seeds to total input values ranged from 5 to 9 percent. A close look at regional differences in seed input shares reveal that Central Luzon, a major rice growing region had the lowest share for seeds. On the other hand, mountainous and hilly regions where corn is one of the major crops had higher proportion of seed input values. These regions include Cordillera, Southern Tagalog, Bicol, and Northern, Southern and Central Mindanao. However, Western Visayas also had a considerably high seed input value share. The national average input value share for seed was 7 percent, which is half of the national average obtained for rice.

Fertilizer value shares provide a good illustration of regional differences in input use. For instance, for Cagayan Valley and Central Luzon, fertilizer comprised 23 and 25 percent respectively. In contrast, in other Luzon regions fertilizer shares were considerably lower; such as in Southern Tagalog (6 percent), Bicol (9 percent) and Eastern Visayas (almost nil). The insignificant value share for Eastern Visayas is due to the very low level of fertilizer use. The BAS rice and corn CRS survey results show that the average regional input usage per hectare is only 10 kg. The national average value share of fertilizer for corn was higher than for rice.

Table 6.3 ***Corn, Input Value Shares, By Region, 1991***

REGION	Seeds	Fertilizer	Labour	Chem	Rentals	Fuel/Oil	Land	Interest	Depcn	TOTAL
Cordillera Admin. Region	0.09	0.15	0.61	0.02	0.00	0.00	0.03	0.05	0.05	1.00
Reg I - Ilocos	0.06	0.16	0.48	0.05	0.03	0.04	0.04	0.08	0.07	1.00
Reg II - Cagayan Valley	0.06	0.23	0.46	0.03	0.00	0.02	0.06	0.07	0.07	1.00
Reg III - Central Luzon	0.05	0.25	0.32	0.04	0.02	0.06	0.04	0.10	0.12	1.00
Reg IV - Southern Tagalog	0.07	0.06	0.56	0.04	0.00	0.01	0.09	0.09	0.08	1.00
Reg V - Bicol	0.08	0.09	0.65	0.01	0.02	0.00	0.04	0.02	0.09	1.00
Reg VI - Western Visayas	0.09	0.12	0.61	0.02	0.03	0.00	0.04	0.04	0.05	1.00
Reg VII - Central Visayas	0.06	0.13	0.61	0.00	0.03	0.01	0.06	0.05	0.05	1.00
Reg VIII - Eastern Visayas	0.07	0.02	0.74	0.00	0.01	0.00	0.04	0.03	0.08	1.00
Reg IX - Western Mindanao	0.06	0.10	0.63	0.02	0.03	0.00	0.07	0.04	0.07	1.00
Reg X - Northern Mindanao	0.07	0.17	0.57	0.01	0.00	0.01	0.04	0.06	0.05	1.00
Reg XI - Southern Mindanao	0.07	0.16	0.51	0.00	0.02	0.01	0.06	0.08	0.09	1.00
Reg XII - Central Mindanao	0.08	0.17	0.53	0.02	0.03	0.01	0.03	0.07	0.07	1.00

Regional differences in labour usage were also pronounced in corn production. The share of labour was highest for Eastern Visayas where fertilizer value share was almost nil. In contrast, Central Luzon had the lowest value share for labour but had the highest value share for fertilizer. These differences suggest input substitution between fertilizer and labour specially in the two regions. The three Mindanao regions (Northern, Southern and Central) have been consistently high, relative to the national average, in their value shares for seeds, fertilizer and labour.

Value shares for chemical inputs were highest in Luzon, particularly for Ilocos, Central Luzon and Southern Tagalog; while for Central and Eastern Visayas and Southern Mindanao, value shares were nil. As in the case of rice, geographical contiguity is apparently associated with chemical use in corn production as observable from the value shares of Luzon regions except Cordillera and Bicol.

Rentals for machines, tools and equipment, and animal hire comprised around 2 percent on the average.

Across regions and between crops, substantial differences exist in the value shares for major inputs supporting the regional difference in rates of usage. These differences provide insights on the differences in regional factor input combinations. However, it should be emphasized that price differentials across region played a role in input use differentials.

6.3 TFP Indices, The EKS Method

Table 6.4 shows a summary of the transformed transitive regional indices for inputs, outputs and TFP using the EKS Method (see Chapter 5 for details of the method). In general, the same pattern of differences among regions as those generated from the Minimum Spanning Trees discussed later was observed. A column by column comparison with the original Fisher matrix shows that, between the two sets, EKS transitive indices had smaller absolute differences with respect to the original Fisher index than those generated from the MSTs.

Since the indices presented satisfy the transitivity property, all results are presented relative to Cordillera which is used as the numeraire for purposes of presentation.

6.3.1 Input, Output and TFP Indices

Again, although there are differences in the decimal point values between the EKS - generated and MST-generated sets of indices, they show a similar pattern of regional differences. Hence, analysis is based on a general interpretation of their values.

Tables 6.4 and 6.5 show the computed regional indices for inputs, outputs and TFP. Using CAR as the base region, input index values indicate the significance of Central Luzon over other regions in rice input utilization. This is on account of the fact that general area under cultivation is large. It is followed by Western Visayas (VI). Ilocos (I), Cagayan Valley (II) and Bicol (V) have more or less the same input index pattern for rice. The bias of Central Visayas towards corn production is revealed by the relatively large index for inputs (30.78) and corn outputs (11.99) compared to an insignificant index value for rice (1.5.

On the output side, regional differences are confirmed by the output index values. Again, the advantage of Central Luzon in rice production over other regions is highlighted. Relative to the base region, the output index for Central Visayas (VII) is lowest. The regional indices suggest that the geographical contiguity effect is more closely associated with inputs than with outputs given the closeness in the input indices for Ilocos (I), Cagayan (II) and Bicol (V) for the Luzon group of regions; and Northern (X), Southern (XI) and Central Mindanao (XII) for the Mindanao group of regions. There were exceptions for the Visayas group, which is an archipelagic group. Ranking rice output indices, Central Luzon leads, followed by Southern Tagalog and Cagayan Valley.

6.3.2 The TFP Indices, Interpretation and Implications

In terms of TFP indices for rice, productivity was higher for Cagayan Valley than for Central Luzon (which had higher output and input indices). The highest TFP was achieved by Southern Mindanao. Central and Eastern Visayas had the lowest rice TFP, with 0.889 and 0.736 respectively. In general, the variation in regional rice TFP values was due to variation in output rather than in inputs, as shown by the wider disparities in regional output index numbers.

Table 6.4 *Indices of Input, Output and TFP by Region, 1991 based on Transitive Fisher-EKS Method*

REGION	RICE				CORN				RICE AND CORN			
	Input	Output	TFP	Yield (t/ha)	Input	Output	TFP	Yield (t/ha)	Input	Output	TFP	Yield (t/ha)
Cordillera	1.000	1.000	1.000	2.570	1.000	1.000	1.000	0.980	1.000	1.000	1.000	1.775
Ilocos	4.951	5.890	1.190	2.880	6.090	4.659	0.765	1.150	5.081	5.762	1.134	2.015
Cagayan Valley	4.879	6.775	1.388	3.180	19.444	22.434	1.154	1.530	6.861	8.411	1.226	2.355
Central Luzon	9.399	11.461	1.219	3.500	1.055	0.925	0.877	1.560	8.246	10.482	1.271	2.530
Southern Tagalog	6.654	7.328	1.101	2.710	14.028	10.175	0.725	0.920	7.712	7.776	1.008	1.815
Bicol	4.767	4.878	1.023	2.520	9.006	7.261	0.806	0.800	5.386	5.145	0.955	1.660
Western Visayas	7.709	7.760	1.007	2.600	2.935	1.965	0.669	0.580	7.121	7.240	1.017	1.590
Central Visayas	1.531	1.362	0.889	1.670	30.787	11.444	0.372	0.520	4.525	2.388	0.528	1.095
Eastern Visayas	3.412	2.510	0.736	1.730	8.607	10.445	1.214	1.010	4.173	3.332	0.798	1.370
Western Mindanao	2.386	2.592	1.087	2.930	10.783	11.379	1.055	0.900	3.591	3.488	0.971	1.915
Northern Mindanao	2.994	3.486	1.164	3.130	15.292	21.994	1.438	1.410	4.708	5.374	1.141	2.270
Southern Mindanao	3.158	4.512	1.429	3.350	37.135	60.292	1.624	1.660	7.807	10.075	1.291	2.505
Central Mindanao	3.321	3.828	1.152	3.240	36.917	60.244	1.632	1.890	7.871	9.414	1.196	2.565

Notes: Computed from Fisher Indices Using EKS
Base Region = CAR

Table 6.5 ***Indices of Input, Output and TFP by Region, 1991 based on Transitive Minimum Spanning Tree Method***

REGION	RICE				CORN				RICE AND CORN			
	Input	Output	TFP	Yield (t/ha)	Input	Output	TFP	Yield (t/ha)	Input	Output	TFP	Yield (t/ha)
Cordillera	1.000	1.000	1.000	2.570	1.000	1.000	1.000	0.980	1.000	1.000	1.000	1.775
Ilocos	4.928	5.890	1.195	2.880	6.030	4.659	0.773	1.150	5.078	5.755	1.133	2.015
Cagayan Valley	4.889	6.775	1.386	3.180	19.334	22.434	1.160	1.530	6.874	8.267	1.203	2.355
Central Luzon	9.576	11.461	1.197	3.500	1.036	0.925	0.899	1.560	8.304	10.349	1.246	2.530
Southern Tagalog	6.678	7.328	1.097	2.710	13.950	10.175	0.729	0.920	7.736	7.605	0.983	1.815
Bicol	4.775	4.878	1.022	2.520	8.870	7.261	0.819	0.800	5.391	5.133	0.952	1.660
Western Visayas	7.760	7.760	1.000	2.600	2.931	1.965	0.669	0.580	7.180	7.142	0.995	1.590
Central Visayas	1.545	1.362	0.881	1.670	30.666	11.444	0.373	0.520	4.530	2.428	0.536	1.095
Eastern Visayas	3.440	2.510	0.730	1.730	8.624	10.445	1.211	1.010	4.179	3.385	0.810	1.370
Western Mindanao	2.390	2.592	1.084	2.930	10.766	11.379	1.057	0.900	3.581	3.592	1.003	1.915
Northern Mindanao	2.994	3.486	1.164	3.130	15.302	21.994	1.437	1.410	4.739	5.492	1.159	2.270
Southern Mindanao	3.162	4.512	1.427	3.350	36.992	60.292	1.630	1.660	7.783	10.204	1.311	2.505
Central Mindanao	3.334	3.828	1.148	3.240	36.960	60.244	1.630	1.890	7.868	9.518	1.210	2.565

Note: Computed from Fisher Indices Applying the MST
Base Region=CAR

For corn, input and output index values varied highly across region. The relative dominance of Central Visayas (VII) and the inferiority of Central Luzon and Western Visayas in corn production are evident from the input indices. Southern and Central Mindanao have close input index values which suggest similar input structures for the two regions.

In output terms, indices show that the last two Mindanao regions (XI and XII) lead, followed by Cagayan Valley (II). The output index for Cagayan Valley (II) was considerably higher than for Southern Tagalog while the difference was not as large on the input side.

Rice-predominant regions performed poorly in corn productivity especially Ilocos (I) and Bicol (V). The TFP value for Southern Tagalog was surprisingly lower than for Central Luzon. Another interesting finding is that Central Visayas, whose staple grain is corn, has the lowest TFP among all regions. The region's low TFP is attributable to low output relative to input use. A further look at other regions reveals that input indices for Southern (XI) and Central Mindanao (XII) are not much higher than for Central Visayas (VII) but the two regions' individual outputs are much higher than for Central Visayas (VII). This provides a crucial insight regarding the quality of lands planted to corn in Central Visayas (VII), which has implications on the sustainability or otherwise, of a self-sufficiency program for the region.

Regional rice TFPs were generally lower while regional corn TFPs were higher for certain regions like Bicol, Western and Eastern Visayas and Western and Northern Mindanao.

Concerning yields per hectare, Central Luzon had the highest rice yield rate while Central Mindanao had the highest corn yield rate. However, the highest TFP was achieved by Southern Mindanao for both individual crops and for aggregate output. This indicates the greater productivity of factor inputs in Southern Mindanao. The sheer values of input and output indices for the Luzon regions (Cordillera to Bicol) show relative dominance over Mindanao regions in rice. However, the latter group of regions compare favorably with Luzon regions in terms of TFP. These differential pattern is explained by the favourable growing environment for rice and corn in Mindanao.

The regional differences in TFP are driven by factors such as technological variation across regions, inefficiency, scale, regional factors like land quality and climate and irrigation.

Taking the regional differences in rice and corn together, TFP indices show that Southern Mindanao and Central Luzon have the highest TFP although the output index is higher for Central Luzon. Aggregate TFP values are pulled upwards by the crop for which TFP index is higher. Overall, Central Visayas had the lowest TFP of all regions for both crops.

A general observation is the presence of substantial differences between TFP and the average yields per hectare in both crops and their combination.

Aggregation affected the relative ranking of regions in terms of TFP. Ranking the regions in terms of relative TFP values show that for rice, Southern Mindanao, Cagayan Valley and Central Luzon lead while for corn, Central, Southern and Northern Mindanao dominate the rest of the regions. Aggregate TFP follow the pattern for rice. The general trend (Figure 6.2) shows that aggregate TFP values lie between rice and corn TFPs with few exceptions. Intuitively, aggregate TFP values appeared to be a weighted average of the TFPs.

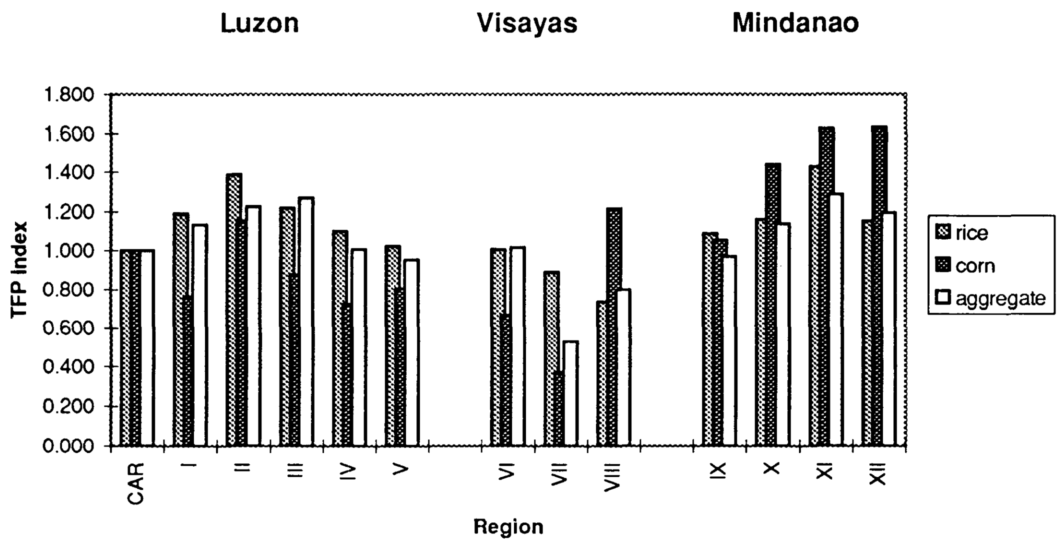

Figure 6.2 **Effect of Aggregation on Regional TFP**

To gain additional insight into regional differences, and to compare techniques of estimating transitive indices, the TFP matrix was also estimated using the MST technique, as discussed in the following section.

6.4 Minimum Spanning Tree (MST) Method and TFP Indices

The method of constructing TFP indices using MSTs is relatively new, hence a section is devoted to a close examination of what is involved. MSTs attempt to identify the chaining procedure to identify various pairs of regions with some optimal properties.

6.4.1 Distance Matrices

Distance matrices measure the similarity in the price-quantity structures across regions. These makes use of the Laspeyres-Paasche indices (see Chapter 5). Discussion for the distance matrices is broken down into input, output and TFP distances. The same was done for the Minimum Spanning Trees (MSTs).

Input Distance Matrix

The symmetic input distance matrix for rice is shown in Appendix 5. Clearly, there are differences among regions in relative gaps between Laspeyres and Paasche index number estimates, as shown by the individual distance values. These magnitudes are expected to be small since the regions are all units within a country. It is evident that, as the base region changes, the relative differences between regional input distances also vary. Taking CAR as base, the highest distance value occurs for Western Visayas suggesting a greater gap between the Laspeyres and Paasche input indices for the region which suggests dissimilar price and quantity structures between these regions. Going over the column vectors, when Ilocos (I) is taken as the base, Central Luzon (III) and Southern Tagalog (IV) have equal input distances while the largest distance is represented by Central Visayas (0.0360). Further, when Cagayan (II) is set as the base region, the highest input distance is again, Central Visayas (VII) but with an even higher value (0.0535). When Central Luzon (III), which consumes the largest amount of inputs on an aggregate and per hectare basis, is taken as base, input distance values tend to be large with respect to Central (VII) and Eastern Visayas (VIII), the lowest rice input users. In view of these results, a possible relationship between the input distances (Paasche and Laspeyres Spread or PLS) and regional differences in rice input levels is suggested.

In the case of corn input distances, (Appendix 6) it can be observed that when CAR is taken as base, input distances for Bicol (V) and Southern Mindanao (XI) are both nil, indicating that there is little difference between Paasche and Laspeyres indices. This consequently implies that the Fisher binary index between these two regions is highly reliable. When a major corn producing region is taken as base, input distances are the same for Cagayan Valley and Central Luzon (0.0210), two adjacent regions. The same holds true if Western Visayas is taken as a base.

From the input distances of rice and corn combined (Table 6.6), an interesting observation is that for column vectors whose base are predominantly rice regions, the regional PLS tend to be lower while for column vectors whose base are corn regions, regional PLS values are higher. This pattern is illustrated in the column vectors where the base regions are Central Luzon (III) and Western Visayas (VI), the rice regions; and Southern Tagalog (IV), Central Visayas (VII) and Central Mindanao (XII), the corn regions. Column vector 13, whose base region is Central Mindanao has generally the highest PLS values.

Output Distance Matrix

It is notable from the output distances of rice and corn combined (Table 6.7) that the PLS values in the column where Central Luzon (III) is the base has generally higher values. For the Western Visayas-based column (VI), values after the base are higher than their counterparts in the preceeding and succeeding columns while for the Central Visayas-based columns (VII), values above the base are higher than their other column counterparts. These observations suggest an association between the nature of predominant crop and the relative size of PLS values with respect to the base. The aggregate TFP Distance Matrix is shown in Table 6.8.

6.4.2 Minimum Spanning Trees

As explained before, the minimum spanning tree provides a chaining system to link various regions such that the total distance associated with the linking is minimum. Different spanning trees are obtained for different distance matrices. Thus, a linking

Table 6.6
RICE AND CORN AGGREGATE INPUT INDICES
Distance Matrix

	CAR	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
CAR	0	0.0000	0.0080	0.0090	0.0085	0.0010	0.0070	0.0410	0.0205	0.0510	0.0380	0.0800	0.0940
I	0.0000	0	0.0090	0.0060	0.0150	0.0035	0.0060	0.0430	0.0225	0.0545	0.0390	0.0805	0.0965
II	0.0080	0.0090	0	0.0105	0.0305	0.0005	0.0130	0.0135	0.0025	0.0100	0.0105	0.0355	0.0465
III	0.0090	0.0060	0.0105	0	0.0230	0.0040	0.0000	0.0085	0.0025	0.0405	0.0120	0.0400	0.0545
IV	0.0085	0.0150	0.0305	0.0230	0	0.0015	0.0185	0.0605	0.0340	0.0115	0.0440	0.0575	0.0535
V	0.0010	0.0035	0.0005	0.0040	0.0015	0	0.0055	0.0175	0.0065	0.0305	0.0175	0.0470	0.0605
VI	0.0070	0.0060	0.0130	0.0000	0.0185	0.0055	0	0.0035	0.0005	0.0360	0.0080	0.0345	0.0470
VII	0.0410	0.0430	0.0135	0.0085	0.0605	0.0175	0.0035	0	0.0015	0.0170	0.0005	0.0050	0.0115
VIII	0.0205	0.0225	0.0025	0.0025	0.0340	0.0065	0.0005	0.0015	0	0.0015	0.0020	0.0160	0.0255
IX	0.0510	0.0545	0.0100	0.0405	0.0115	0.0305	0.0360	0.0170	0.0015	0	0.0085	0.0170	0.0135
X	0.0380	0.0390	0.0105	0.0120	0.0440	0.0175	0.0080	0.0005	0.0020	0.0085	0	0.0075	0.0135
XI	0.0800	0.0805	0.0355	0.0400	0.0575	0.0470	0.0345	0.0050	0.0160	0.0170	0.0075	0	0.0005
XII	0.0940	0.0965	0.0465	0.0545	0.0535	0.0605	0.0470	0.0115	0.0255	0.0135	0.0135	0.0005	0

Table 6.7
RICE AND CORN AGGREGATE OUTPUT INDICES
Distance Matrix

	CAR	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
CAR	0	0.0040	0.0065	0.0175	0.0010	0.0030	0.0135	0.0390	0.0340	0.0300	0.0145	0.0175	0.0300
I	0.0040	0	0.0085	0.0310	0.0050	0.0095	0.0040	0.0310	0.0330	0.0255	0.0110	0.0040	0.0230
II	0.0065	0.0085	0	0.0295	0.0010	0.0045	0.0050	0.0395	0.0310	0.0290	0.0125	0.0195	0.0290
III	0.0175	0.0310	0.0295	0	0.0235	0.0480	0.0060	0.0935	0.0535	0.0450	0.0825	0.0965	0.0460
IV	0.0010	0.0050	0.0010	0.0235	0	0.0090	0.0085	0.0345	0.0250	0.0235	0.0230	0.0245	0.0250
V	0.0030	0.0095	0.0045	0.0480	0.0090	0	0.0135	0.0210	0.0195	0.0180	0.0080	0.0075	0.0185
VI	0.0135	0.0040	0.0050	0.0060	0.0085	0.0135	0	0.0350	0.0280	0.0285	0.0320	0.0360	0.0285
VII	0.0390	0.0310	0.0395	0.0935	0.0345	0.0210	0.0350	0	0.0025	0.0040	0.0125	0.0130	0.0085
VIII	0.0340	0.0330	0.0310	0.0535	0.0250	0.0195	0.0280	0.0025	0	0.0040	0.0095	0.0095	0.0080
IX	0.0300	0.0255	0.0290	0.0450	0.0235	0.0180	0.0285	0.0040	0.0040	0	0.0005	0.0010	0.0015
X	0.0145	0.0110	0.0125	0.0825	0.0230	0.0080	0.0320	0.0125	0.0095	0.0005	0	0.0050	0.0015
XI	0.0175	0.0040	0.0195	0.0965	0.0245	0.0075	0.0360	0.0130	0.0095	0.0010	0.0050	0	0.0020
XII	0.0300	0.0230	0.0290	0.0460	0.0250	0.0185	0.0285	0.0085	0.0080	0.0015	0.0015	0.0020	0

Table 6.8
RICE AND CORN AGGREGATE TFP INDICES
Distance Matrix

	CAR	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
CAR	0	0.0050	0.0155	0.0260	0.0090	0.0040	0.0060	0.0400	0.0325	0.0660	0.0235	0.0628	0.1105
I	0.0050	0	0.0165	0.0365	0.0100	0.0060	0.0105	0.0315	0.0330	0.0655	0.0285	0.0771	0.1110
II	0.0155	0.0165	0	0.0395	0.0325	0.0045	0.0070	0.0390	0.0310	0.0295	0.0025	0.0154	0.0590
III	0.0260	0.0365	0.0395	0	0.0005	0.0525	0.0060	0.0850	0.0515	0.0455	0.0715	0.0564	0.0460
IV	0.0090	0.0100	0.0325	0.0005	0	0.0105	0.0270	0.0930	0.0425	0.0235	0.0670	0.0824	0.0530
V	0.0040	0.0060	0.0045	0.0525	0.0105	0	0.0185	0.0205	0.0200	0.0460	0.0100	0.0388	0.0710
VI	0.0060	0.0105	0.0070	0.0060	0.0270	0.0185	0	0.0350	0.0285	0.0385	0.0240	0.0016	0.0365
VII	0.0400	0.0315	0.0390	0.0850	0.0930	0.0205	0.0350	0	0.0020	0.0205	0.0130	0.0077	0.0050
VIII	0.0325	0.0330	0.0310	0.0515	0.0425	0.0200	0.0285	0.0020	0	0.0050	0.0070	0.0083	0.0170
IX	0.0660	0.0655	0.0295	0.0455	0.0235	0.0460	0.0385	0.0205	0.0050	0	0.0090	0.0183	0.0150
X	0.0235	0.0285	0.0025	0.0715	0.0670	0.0100	0.0240	0.0130	0.0070	0.0090	0	0.0122	0.0145
XI	0.0628	0.0771	0.0154	0.0564	0.0824	0.0388	0.0016	0.0077	0.0083	0.0183	0.0122	0	0.0026
XII	0.1105	0.1110	0.0590	0.0460	0.0530	0.0710	0.0365	0.0050	0.0170	0.0150	0.0145	0.0026	0

or chaining tree is obtained for each production activity (rice only, corn only and rice and corn together).

In this section, it is shown how the regional input, output and TFP indices are compared by chaining them across spanning trees whose minimum distance are least sensitive to the choice of bilateral index number formula. The results of MST construction using the input, output and TFP distances are shown in Figures 6.3 to 6.7. All of the constructed MSTs have the first region as base.

Input Distance Chaining

For the rice input distance (Figure 6.3), it is shown that PLS of Eastern Visayas, and Northern Mindanao are nearest to Cordillera's while the PLS for Southern Tagalog is farthest. Since any two nodes of the tree represent a bilateral comparison, a farther node from the base denotes a number of bilateral comparisons, i.e., getting to a farther node requires passing through the intervening nodes.

For the corn input distance MST (Figure 6.5), a different set of regions, except Northern Mindanao, surrounds the base. They are Western Visayas and Western Mindanao. It is worth noting that the node for Central Luzon is farthest from the base.

There is an apparent difference between the rice and corn input distance MSTs in terms of the clustering of regions in the tree branches. Even if nodes NM-Iloc and WV-CL in the rice tree are drawn on the opposite side of the main branch to make the whole tree a near mirror-image of the corn input distance tree, the string of regions radiating from node WM and succeeding after CM in the corn tree are longer than those in the rice input distance tree.

The effect of geographical contiguity is not pronounced in the rice input distance MST. For instance, the regions clustered around the base are Eastern Visayas and Northern Mindanao which are geographically remote. There is some degree of contiguity effects in node pairs WM-CM and WM-SM, which represent Western (IX), Southern (XI) and Central Mindanao (XII).

On the other hand, geographical contiguity effects are distinct in the corn input distance MST. For instance, there is clustering between EV (Eastern Visayas);

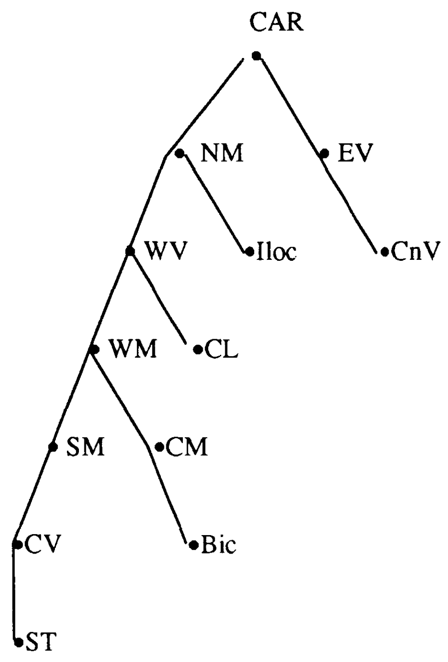

Figure 6.3
Rice Input Distance Minimum Spanning Tree

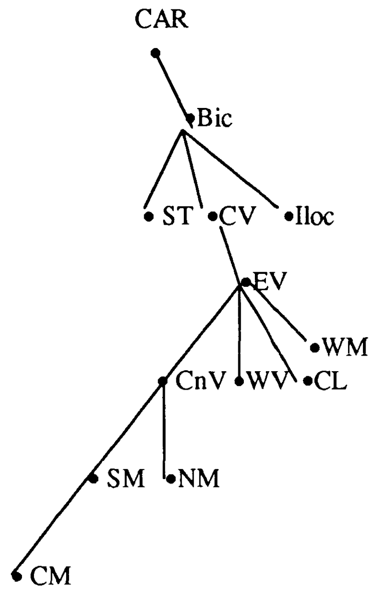

Figure 6.4
Aggregate Input Distance Minimum Spanning Tree

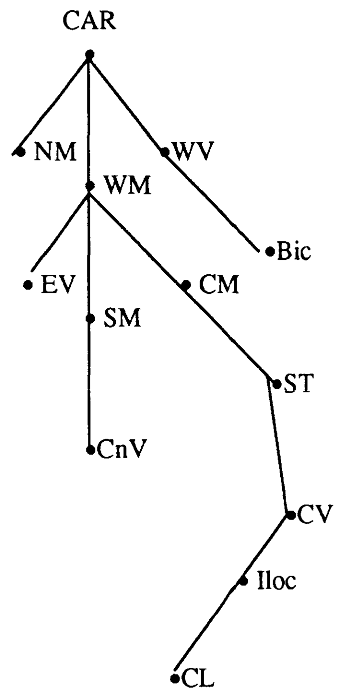

Figure 6.5
Corn Input Distance Minimum Spanning Tree

Legend: CAR-Cordillera; Iloc-Ilocos; CV-CagValley; CL-Central Luzon; ST-So. Tagalog;Bic-Bicol; WV-West. Visayas; CnV-Central Visayas; EV-Eastern Visayas; WM-West. Mindanao; NM-Northern Mindanao; SM-South Mindanao; CM-Central Mindanao

A Comparison of MSTs from Individual Rice and Corn Input Distances and Aggregate Input Distance

WM, (Western Mindanao); SM (Southern Mindanao) and CM (Central Mindanao). Node NM representing Northern Mindanao, though originating from the base, is not very far from the cluster. Although node EV, representing Eastern Visayas is physically detached from the Mindanao mainland, it has been a transit point from the mainland where WM (Western Mindanao), SM (Southern Mindanao) and CM (Central Mindanao) are located. Hence, a spatial analysis involving the four regions may be in order. The same is true for nodes ST (Southern Tagalog), CV (Cagayan Valley), Iloc (Ilocos) and CL (Central Luzon), which represent 4 contiguous Luzon regions.

The combined inputs distance MST (Figure 6.4) shows that the PLSs of Bicol's input indices is highly related to the base. In the same manner, the PLSs of Southern Tagalog, Cagayan Valley and Ilocos are near Bicol's. There are obvious clustering of regions from the tree. Aside from the previously mentioned one, clustering is evident at WV, CnV, EV and WM and NM, SM and CM.

Output Distance Chaining

No distance matrices and MSTs were constructed for the individual outputs because there is only one set output indices which are already considered to be transitive.

For the output distance (MST) when both crops are combined, Figure 6.6 show that there is a good clustering and radiation of regional nodes around the base. Only node CL (Central Luzon, III) was segregated from the upper cluster. This suggests that the PLS for Central Luzon is considerably far from the base's PLS. A look at the transitive aggregate output indices show that the connection between nodes CM and CL; and CM and SM is supported by the nearness of the output index values of Central Luzon (III) at node CL and Southern Mindanao (XI) at node SM to the output index value of Central Mindanao (XII) at node CM. Nodes NM, SM and CM are also clustered together although the actual output index for node NM (Northern Mindanao) is considerably lower than the other two.

TFP Distance Chaining

From the TFP distance MST (Figure 6.7), a clustering of regions is present around node 1, namely Ilocos, Bicol and Eastern Visayas, although such regions are actually geographically distant from each other. The MST generated from the TFP distance

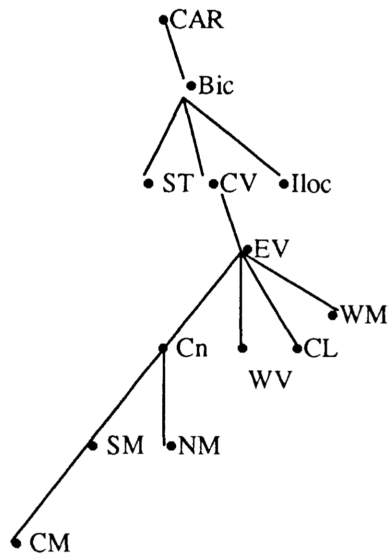

Figure 6.4
Aggregate Input Distance Minimum Spanning Tree

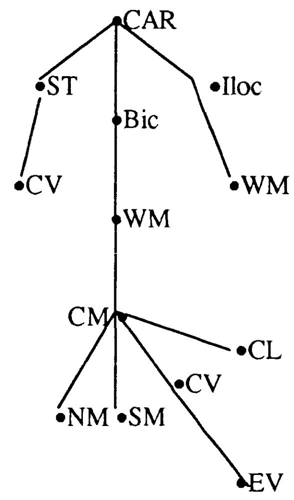

Figure 6.6
Aggregate Output Distance Minimum Spanning Tree

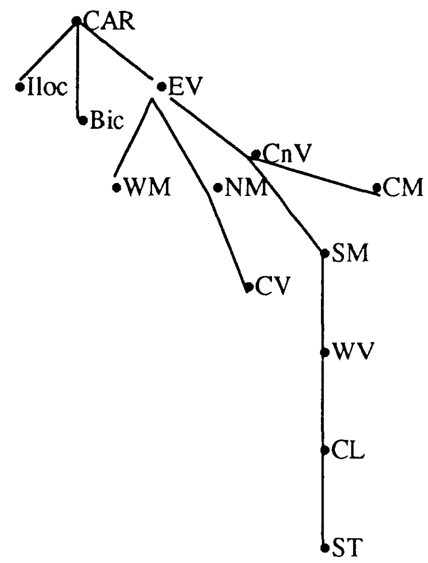

Figure 6.7
Aggregate TFP Distance Minimum Spanning Tree

A Comparison of MSTs from Aggregate Distances

differ from those of the input and output distances in terms of the degree of regional clustering. In the TFP distance, regional clustering did not exist. Only in pair CAR-Iloc was there a close association between the regional PLS values. Hence, for TFP distance matrix, geographical contiguity effects did not seem to prevail. It can be infered that aggregation of both crops yields non-regional clustering effects for the TFP MSTs

6.4.3 Matrices of Transitive Index Numbers

The above discussion has shown two approaches to constructing transitive output, input and TFP matrices. The transitive matrix is a matrix of internally consistent index numbers such that any direct comparison between two regions is equal to an indirect comparison for the two regions through another region.

Input, output and TFP indices from the two approaches were summarized in Tables 6.4 and 6.5. which have been discussed above. The two sets of transitive matrices were compared based on their absolute percentage differences (Table 6.9). From the table, there is no outstanding difference between the two sets of values, although a relatively high difference occured for Central Luzon (III) for both rice and corn input and TFP indices. The same is true for Bicol (V) for corn. In general, absolute differences for output indices for the individual crops are small ranging from 0 to 0.298, with larger differences occuring in aggregate output indices.

However, it should be noted that, since the comparisons made in this section refers to regions within a country, the differences measured by distance are not as large as one would expect under a cross-country comparison.

6.5 Regression Analysis

The TFP indices discussed above were used as dependent variables in the second stage of the analysis, where the effects of OLT on productivity was determined. This section explores the relationship between TFP and OLT and other variables through regression analysis, using the functions developed in Chapter 4.

The principal objective of this section is to determine how TFP is related to various factors, in particular the OLT program and irrigation. The model is very

Table 6.9 ***Absolute Percent Difference Between EKS and MST Indices, By Region, 1991***

REGION	RICE			CORN			RICE AND CORN		
	Input	Output	TFP	Input	Output	TFP	Input	Output	TFP
Cordillera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ilocos	0.46	0.00	0.42	0.99	0.00	1.05	0.06	0.12	0.09
Cagayan Valley	0.20	0.00	0.14	0.57	0.00	0.52	0.19	1.71	1.88
Central Luzon	1.88	0.00	1.80	1.80	0.00	2.51	0.70	1.27	1.97
Southern Tagalog	0.36	0.00	0.36	0.56	0.00	0.55	0.31	2.20	2.48
Bicol	0.17	0.00	0.10	1.51	0.00	1.61	0.09	0.23	0.31
Western Visayas	0.66	0.00	0.70	0.14	0.00	0.00	0.83	1.35	2.16
Central Visayas	0.91	0.00	0.90	0.39	0.00	0.27	0.11	1.68	1.52
Eastern Visayas	0.82	0.00	0.82	0.20	0.00	0.25	0.14	1.59	1.50
Western Mindanao	0.17	0.00	0.28	0.16	0.00	0.19	0.28	2.98	3.30
Northern Mindanao	0.00	0.00	0.00	0.07	0.00	0.07	0.66	2.20	1.58
Southern Mindanao	0.13	0.00	0.14	0.39	0.00	0.37	0.31	1.28	1.55
Central Mindanao	0.39	0.00	0.35	0.12	0.00	0.12	0.04	1.10	1.17

limited due to the lack of degrees of freedom. Only 13 observations representing the regions were available.

6.5.1 Effects of OLT and other Productivity Variables on TFP

The TFP response equation was evaluated using two models. The credit variable was included in model 1 and excluded from model 2. The variable was omitted on the assumption that the effect of such credit is already captured in the variation in input usage, particularly fertiliser and chemicals, thereby affecting the variation in regional TFPs.

Rice TFP Equation

Model 1 Results

Results for model 1 (Table 6.10) show that all variables except rainfall have a positive relationship with rice TFP. The share of irrigated area has a very significant effect on TFP variations (t-ratio=4.57). Both OLT and credit variables had positive influences upon rice TFP. The negative coefficent for rainfall suggests that there was enough rainfall in 1991 (although not significant at α=0.05). The model fit is reasonably good, judging from the value of R^2 (0.80).

The significance of irrigated area reflects the importance of irrigation to rice cultivation such that relative TFPs across region were affected by the differences in the amounts of water used for rice production in 1991. The productivity of inputs is affected by the availability of water. Similarly, the OLT program which includes a package of land distribution, training and some infrastructure support services, exerted positive effects upon rice productivity. The amount of credit that flowed in 1991 was not as significant as irrigation, although there was a positive effect.

Model 2 Results

Omitting the 'loans' variable resulted in an increase in the significance of the irrigation variable for rice and the OLT variable, both showing a significant relationship (t ratios = 2.56 and 5.27 respectively). Again, rainfall had a negative coefficient and an insignificant t-ratio. The explanatory power of the whole model (R^2 = 0.79) did not vary significantly from Model 1 on rice.

Omission of the credit variable, which leads to a further improvement in irrigation's relative significance, may imply that, at least for 1991, the availability of irrigation compensated for the inadequacy of credit through which inputs could be bought or irrigation and credit were correlated.

Table 6.10 **Regression Results for the Effects of OLT and Other Variables on TFP**

VARIABLES		*EQUATIONS*					
		Rice		*Corn*		*Rice and Corn*	
		Model 1	*Model 2*	*Model 1*	*Model 2*	*Model 1*	*Model 2*
Constant	*Coefficient*	-0.9114	-0.9113	0.5888	0.5959	1.0766	0.6653
	Std. Error	0.5777	0.5470	2.1890	2.2890	1.1600	1.0830
	t-ratio	-1.5780	-1.6660	0.2689	0.2604	0.9285	0.6145
log OLT until t-1							
	Coefficient	0.0550	0.0635	0.2427	0.0584	0.1551	0.0794
	Std. Error	0.0419	0.0248	0.1744	0.1182	0.0939	0.0550
	t-ratio	1.3130	2.5640	1.3920	0.4943	1.6520	1.4440
log Share of Irrigated Area $_{(t)}$							
	Coefficient	0.4749	0.4846	*not included*		0.2940	0.2215
	Std. Error	0.1039	0.0919			0.1292	0.1065
	t-ratio	4.5710	5.2750			2.2760	2.0780
log Credit $_{(t)}$							
	Coefficient	0.0148	*not included*	-0.3200	*not included*	-0.1350	*not included*
	Std. Error	0.0571		0.2305		0.1357	
	t-ratio	0.2589		-1.3880		-0.9947	
log Amount of Rainfall $_{(t)}$							
	Coefficient	-0.1581	-0.1548	-0.0031	-0.1078	-0.2214	-0.2156
	Std. Error	0.0711	0.0662	0.3042	0.3080	0.1611	0.1609
	t-ratio	-2.2250	-2.3400	-0.0100	-0.3498	-1.3750	-1.3400
R^2		0.80	0.79	0.20	0.03	0.49	0.43
n=13							

Note: Base region for TFP dependent variable was CAR

Corn TFP Equation

Model 1 Results

Model 1 did not yield significant results for corn. The OLT variable had positive (but insignificant) coefficients while credit and rainfall had negative signs. In general, all variables were non-significant. The same explanation as above for the effect of rainfall is offered given the negative coefficient for corn. There is no evidence that rainfall levels achieved by the regions were not beneficial for corn TFPs in991. The explanatory power of the model for corn is considerably low (R^2 =0.20).

Model 2 Results

Omitting the 'loans' variable lead to even poorer results for corn. Although the OLT and rainfall variables retained their original signs, coefficients for OLT were even lower and R^2 was extremely low (0.03).

Both models for corn showed poor results for the effects of explanatory variables. This suggest that corn TFP was not affected by the same variables that affected rice TFP, in the context of this study.

Rice and Corn TFP Equation

Model 1 Results

Model 1 for aggregate TFP resulted in a more significant coefficient for OLT than those obtained for rice and corn alone (Table 6.10). The irrigation effect was also significant with respect to aggregate TFP. The overall explanatory power of the model was relatively low (R^2 =0.49), and generally show higher coefficient values and t-ratios were obtained for aggregate output than for rice or corn alone.

Model 2 Results

The omission of the credit variable led to a reduction in the overall fitness of the model. Only irrigated area remained significant but the t-ratio of the OLT variable was close to significant and positive. Rainfall remained negatively related to TFP. The explanatory power of the aggregate Model 2 was low (R^2 =0.43). In the case of rainfall, implications of a negative rainfall coefficient suggests that rains in 1991 might have been unevenly distributed across months, thereby affecting the critical growing periods for both rice and corn.

The poor results for corn in both sets of regression results are attributed to the fact that most of OLT land distribution and the corresponding support services were accorded to rice areas whose share at the program was larger. Consequently, higher TFP results for rice were obtained for such regions as Central Luzon and Cagayan Valley.

A possible correlation between the variables was suspected in recognition of the fact that the OLT variable includes some credit which are provided by other land reform implementing agencies, such as LBP and OLT areas irrigated from agrarian reform funded projects. These were thought to be correlated with the credit variable which represents aggregate credit for rice and corn; and 'irrigation proportion' which is based on irrigated areas reported by the National Irrigation Administration outside the agrarian reform fund. However, it appeared that in general, there is weak correlation between OLT and other explanatory variables (Table 6.11). Of particular concern was the possible high correlation between share of irrigated area and OLT area, because the latter may include redistributed irrigated lands. The correlation coefficients ranging between -0.06 and 0.43 do not suggest a strong relationship between the two variables. The credit variable was negatively related to OLT and proportion of irrigated area.

Table 6.11 **Correlation Matrices of TFP Explanatory Variables**

MODEL 1

Rice

	LOLT	LIrrig	LCredit	LRnfall	Constant
LOLT	1				
LIrrig	0.2696	1			
LICredit	-0.7812	-0.3577	1		
LRnfall	0.0666	-0.1377	-0.1802	1	
Constant	-0.0058	-0.4489	0.0008	-0.7265	1

Rice and Corn

	LOLT	LIrrig	LCredit	LRnfall	Constant
LOLT	1				
LIrrig	0.4302	1			
LCredit	-0.8102	-0.5649	1		
LRnfall	-0.0810	-0.3976	-0.0368	1	
Constant	0.2718	0.3475	-0.3566	-0.8992	1

MODEL 2

Rice

	LOLT	LIrrig	LRnfall	Constant
LOLT	1			
LIrrig	0.0168	1		
LRnfall	-0.1208	-0.2201	1	
Constant	-0.0103	-0.4810	-0.7387	1

Rice and Corn

	LOLT	LIrrig	LRnfall	Constant
LOLT	1			
LIrrig	-0.0567	1		
LRnfall	-0.0874	-0.4570	1	
Constant	-0.0313	0.1894	-0.9490	1

The poor results may have been due to the small number degrees of freedom in the sample.

6.4 Comments and Conclusion

The regional TFP indices provided valuable insights into productivity levels as attributed to inputs or output. The relative advantage of Central Luzon in terms of rice output confirms Antonio's (1979) findings regarding the uneveness of resource allocations among regions such that Central Luzon and Southern Tagalog were beneficiaries of irrigation, credit and transportation enhancement while the Mindanao regions were less benefited. The same pattern of services allocation may still be true towards the 1990's judging from the results of this study. However, results also show that the Mindanao regions, specially Southern Mindanao, had the highest TFP for both rice and corn, which implies that relative TFP results were not necessarily a function of the provision of services, but they were dominated by other regional factors like soil endowment or climatic factors favourable in Mindanao, which affect the productivity of factor inputs.

In the context of this study, input, output and TFP indices are expressed in spatial relatives. Relativities remain the same irrespective of which region is taken as the base. The regional differences have been effectively demonstrated and can be inspected im more detail by studying the tables in the Appendix.

Notwithstanding the limited data set, the study was successful in evaluating the regional variation in TFP and the effects of the OLT program.

Chapter 7
Summary and Conclusion

7.1 Introduction

The principal objective of the study was to analyze the differences in regional productivity of rice and corn and to determine the effects of OLT on rice and corn productivity. Such objectives were translated into the construction of regional TFP indices for rice and corn using 1991 data. The results were used to (i) examine the nature of multilateral TFP indices and explore alternative transitive indices; (ii) observe the effects of aggregation in regional TFP measures; and (iii) determine the effects of OLT, other services and regional factors on rice and corn TFP.

In this chapter, policy recommendations are presented which are valuable in helping to narrow the gap between regional productivity and to improve the effects of the OLT program in general. Recommendations centering on the weakness of the data are important for improving the state of data collection in areas pertinent to the estimation of crop-specific and regional TFP that account for changes through time.

This Chapter summarizes the major findings of the study, draws conclusions based on the results and formulates policy implications as well as recommendations for future research.

7.2 Summary of Chapters

Chapter 1 provided a background on the productivity objective of the land reform program for rice and corn, known as OLT and pointed out the importance of determining the productivity effects of the program using a different approach, that is, through TFP indices which have not been used by most previous studies that evaluated the effects of OLT on productivity.

Chapter 2 provided a broad background on the Philippine regions by summarizing major regional indicators and mentioning the differences in their natural attributes. A review of the rice and corn sectors was done through a description of the major trends in production, consumption and prices. In general, Central Luzon had the highest rice yield per hectare through time while Southern and Central Mindanao had highest corn yields. The OLT program was reviewed by discussing the land distribution process including its component steps, the trends in land distribution and related activities through time, and support services provision.

Chapter 3 reviewed the relevant studies on output growth and TFP, regional productivity differences, methods involved in constructing transitive indices, land reform and productivity and effects of a government program on productivity. These studies provided major insights on the productivity objective and on enhancing the methodological aspect of the study. In general, most of the long-term output growth studies were conducted when OLT was not yet implemented or did not include the program in their analyses.

Chapter 4 discussed the framework of the study based on existing literature regarding the methods of estimating TFP and relating the estimated indices to the OLT program. A significant part of the chapter was devoted to ensuring the internal consistency of the regional indices which is a requirement for a spatial-oriented TFP. This included the EKS Method and the MST Method.

Chapter 5 dealt with the nature of data, the sources and their limitations. The study used cross-sectional 1991 data for different regions, which represent the results of the BAS conducted Costs and Returns Survey for Rice and Corn. Four types of index numbers were constructed, namely, Laspeyres, Paasche, Fisher and Divisia, of which Fisher was used in subsequent comparisons and calculations and Paasche and Laspeyres were used to estimate distance matrices. OLS was applied to the estimated regional TFP indices to determine the effects of OLT and other explanatory variables.

Chapter 6 presented the results of index number construction, using two alternative tools to obtain transitive or internally consistent index numbers (the EKS method and the MST method). Also, the effects of OLT on TFP of rice and corn were analysed by OLS.

7.3 Major Findings

The following are the major findings of the study in relation to its specific objectives and hypotheses.

1. Considering the first objective, the constructed indices of input, output and TFP matrices using the four most-widely used indices show how their values differ, as affected by prices and quantity aggregation. It was shown from the matrices (Appendix 6-9) that the Fisher index lies between Paasche and Laspeyres indices. In terms of regional differences, it was observed that outputs varied more widely than inputs across regions. This leads to an inference that the variation in TFP across regions can be attributed more to output than to input differences.

In general, there was variation in the relative sizes of input and output indices across regions, but in terms of TFP, the relative position of each region with respect to the base did not vary widely.

2. To address the second objective, alternative transitive TFP indices were explored. It was observed that the values from EKS differed least from the original Fisher than those generated from MST. Absolute percent differences between the two methods showed were higher for aggregate TFP than for individual rice and corn TFPs.

3. The effects of aggregation on regional TFP were measured to address objective three. Southern Mindanao and Central Luzon had the highest aggregate TFP, although the output index was higher for Central Luzon. Aggregation affected the relative ranking of regions in terms of TFP. For rice, Southern Mindanao, Cagayan Valley and Central Luzon led while for corn, Central, Southern and Northern Mindanao dominated. In general, aggregate TFP values lay between rice and corn TFPs, with few exceptions.

4. From the OLS results, it can be infered that OLT had a positive overall effect upon rice and corn aggregate TFP. However, at the individual crop level, the results were positive for rice but insignificant for corn. This was explained by the fact that most of OLT land distribution and the corresponding support services were extended to rice regions, which has larger share at the program.

5. Consistently, the irrigation variable showed significant effects for rice TFP. The effects of credit and rainfall variables were not significant. Based on the above findings, the fifth objective is answered through policy recommendations and directions for future research which are discussed later in this Chapter.

In terms of economies of scale effects, although no hypothesis was tested, some evidence of scale differences can be identified. For rice, scale effects would be in favour of Central Luzon which has the highest average parcel size. However, Southern Mindanao had a higher rice TFP, which implies that the effect of regional factors other than parcel size dominated TFP. For corn, some scale effects were identified. For instance, corn is planted at a higher scale in Northern, Southern and Central Mindanao, which have higher TFPs for the crop relative to the Luzon and Visayas regions.

7.4 Policy Implications

Since the data used are cross-sectional, it was impossible to isolate the effects of OLT from previous technical change, which would require a time-series analysis. The lack of input data rendered a time-series TFP decomposition impossible.

An argument for increasing research efforts in terms of collecting time-series input data is thus, in order. Collection of such data will, eventually, enable the systematic decomposition of growth trends across regions due to OLT and other programs aimed at improving rice and corn productivity.

The favourable productivity (TFP) findings for Central Luzon particularly for rice, confirm results from earlier literature that land reform in the Philippines has been influenced in its development by the facts that first it was limited for the most part to ricelands, second, it has been confined mainly to Central Luzon, the principal rice growing area and, third, it has been directed mostly towards eliminating tenancy. This study did not deal with the extent to which tenancy was eliminated, but the first two facts are supported by the findings of this study. In this light, it can be infered that OLT has been successful in improving productivity in areas where it has a high concentration. It should be considered that resource constraints have always been a major factor in the implementation of the program, thus, there was a need to concentrate the complementary services to such regions were the scope for land redistribution was larger. A policy recommendation to improve services to regions where there are relatively lesser OLT lands is also order. This is to enable regions to maximise the productivity effects of the program. This measure can only be implemented subject to availability of funds.

The differences in input patterns are indicative of the degree by which the regions benefited from technical change before 1991, or the degree by which some regions' farmers avoided or failed to embrace new technology. The indices for 1991 reflect the static technological differences for that year across different regions, in the context of this study.

Be that as it may, there is a need to narrow down the relative gaps between regional factor productivities, which can be achieved through enhancing input usage in regions where average factor ulilization is low, and improving production programming strategies for regions where seasonal climatic variation affect rice and corn output. This holds a strong policy implication for the agriculture department in terms of ensuring the appropriate quantity and quality of extension programs delivered across regions.

7.5 Recommendations for Future Research

The study leaves much room for improvement and provides a broad springboard for further research. As a final statement, the soundness or appropriateness of the methodology in future research will depend on the availability of time-series data across regions. As already mentioned, there is a need to improve on the body of input data to make the regional TFPs amenable to a time-series analysis.

To enable the analysis of longer TFP series, an earlier series of regional OLT accomplishment is also required. Thus, there is a need to segregate between rice and corn OLT land distribution data, including support services provision, and to disaggregate 1972-1986 accomplishment. This will enable the proper delineation and attribution of productivity effects between crops, across regions, and through time.

Irrigation inputs measured in terms of volume should be included in the BAS survey, in recognition of the importance of irrigation inputs to rice TFP. Aside from input quantity data, there is a need to improve the price information system for capital, equipment, machinery and animals. Most of the earlier TFP studies suffered from problems of accounting for capital stock and pricing of the above-mentioned factor inputs. Further studies on rice and corn TFP must take into account such inputs.

It is also worth looking at partial factor productivities of labour, fertilizer and significant factor inputs to account for the differences in TFP due to specific inputs. Moreover, since the BAS survey separate between irrigated and non-irrigated rice farms and yellow and white corn varieties, a comparative analysis between such systems will yield substantial additional insight into productivity differences.

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APPENDIX

Appendix 1

Rice Regional Output Indices, 1973-1995

Year	Cordillera	Ilocos	Cagayan	Central Luzon	Southern Tagalog	Bicol	Western Visayas	Central Visayas	Eastern Visayas	Western Mindanao	Northern Mindanao	Southern Mindanao	Central Mindanao	PHILS
1973	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1974	1.017	0.761	1.051	0.955	0.980	1.109	1.120	1.028	1.085	1.113	1.202	1.133	1.197	1.030
1975	1.113	1.090	1.234	1.026	1.136	1.218	1.246	1.169	1.179	1.265	1.475	1.362	1.385	1.185
1976	1.130	0.940	1.279	0.981	1.158	1.289	1.446	1.228	1.246	1.403	1.527	1.405	1.413	1.215
1977	1.097	1.075	1.398	1.106	1.259	1.309	1.533	1.261	1.293	1.644	1.660	1.709	1.816	1.347
1978	1.115	1.198	1.357	1.058	1.161	1.155	1.507	1.187	1.314	1.819	1.949	1.932	1.814	1.339
1979	1.129	1.231	1.456	1.283	1.202	1.218	1.717	1.233	1.401	1.615	2.115	1.868	1.803	1.427
1980	1.266	1.115	1.201	1.248	1.120	1.275	1.881	2.022	1.616	1.260	2.351	1.807	1.906	1.419
1981	1.188	1.307	1.283	1.506	1.046	1.118	1.881	1.618	1.615	1.322	2.408	2.042	1.817	1.469
1982	1.111	1.604	1.307	1.723	1.144	1.163	1.828	1.451	1.762	1.277	2.614	2.146	1.645	1.547
1983	1.100	1.333	1.264	1.372	1.098	1.070	1.573	0.965	1.429	1.125	2.101	2.101	1.543	1.354
1984	1.188	1.397	1.533	1.178	1.231	1.356	1.734	1.339	1.918	1.352	1.756	2.076	1.705	1.453
1985	1.130	1.542	1.916	1.368	1.397	1.359	1.790	1.266	2.379	1.444	2.396	2.524	1.839	1.635
1986	1.296	1.614	1.897	1.545	1.363	1.352	1.855	1.374	2.245	1.532	2.663	2.664	2.144	1.717
1987	1.134	1.353	1.826	1.481	1.222	1.117	1.918	1.341	1.936	1.379	2.658	2.543	1.802	1.585
1988	1.301	1.668	1.999	1.222	1.409	1.362	1.826	1.348	2.078	1.509	2.863	2.783	1.995	1.665
1989	1.139	1.558	2.006	1.620	1.451	1.284	1.761	2.067	1.937	1.617	3.506	2.946	1.985	1.756
1990	1.155	1.681	2.133	1.837	1.350	1.320	1.443	1.638	1.723	1.545	3.529	2.890	1.636	1.730
1991	1.065	1.781	1.893	1.681	1.577	1.430	1.927	1.859	1.955	1.680	3.969	2.806	1.508	1.795
1992	1.092	1.638	1.994	1.669	1.523	1.375	2.016	1.465	1.848	1.367	2.969	2.102	1.360	1.695
1993	1.165	1.662	1.633	1.542	1.524	1.278	2.417	1.779	1.985	1.585	3.738	2.286	1.757	1.751
1994	1.334	1.819	2.266	1.814	1.559	1.325	2.348	1.866	2.031	1.386	4.151	2.474	2.512	1.956
1995	1.348	1.758	2.472	1.690	1.400	1.150	2.102	2.066	2.277	1.468	5.114	2.790	2.788	1.957

Appendix 2

Corn Regional Output Indices, 1973-1995

Year	Cordillera	Ilocos	Cagayan	Central Luzon	Southern Tagalog	Bicol	Western Visayas	Central Visayas	Eastern Visayas	Western Mindanao	Northern Mindanao	Southern Mindanao	Central Mindanao	PHIL
1973		1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1974		1.252	1.168	0.925	1.028	1.280	1.118	1.259	1.233	1.160	0.928	1.333	1.407	1.225
1975		1.134	1.281	0.840	1.080	1.218	1.280	1.280	1.256	1.129	0.875	1.715	1.607	1.364
1976		0.757	1.353	0.788	1.281	1.225	1.199	1.398	1.363	1.241	0.907	1.993	1.578	1.474
1977		0.921	1.322	0.743	1.544	1.198	1.324	1.383	1.538	1.314	0.931	2.026	1.477	1.506
1978		1.022	1.431	0.851	1.455	1.281	1.336	1.447	1.577	1.351	1.040	2.026	1.367	1.517
1979		1.197	1.526	1.283	1.501	1.402	1.316	1.426	1.729	1.578	1.058	2.315	1.643	1.677
1980	1.000	1.152	0.857	1.133	1.393	1.459	0.977	1.300	2.191	1.485	1.365	2.244	1.942	1.655
1981	1.082	1.119	1.246	0.954	1.384	1.215	1.075	1.367	2.776	1.546	1.270	2.309	2.285	1.788
1982	1.096	1.526	1.162	1.244	1.309	1.342	1.450	1.460	2.837	1.731	1.202	2.568	2.148	1.847
1983	1.036	1.781	1.028	1.220	1.346	1.442	1.359	1.562	2.351	1.669	1.196	2.224	1.894	1.701
1984	1.068	1.918	1.351	1.188	1.044	1.410	0.874	1.221	2.749	1.333	1.002	2.355	2.427	1.764
1985	1.054	2.190	1.624	1.537	1.268	1.662	1.120	1.381	2.979	1.768	1.337	2.706	2.967	2.096
1986	1.151	1.987	1.656	1.723	1.323	1.745	1.414	1.518	2.708	1.744	1.545	2.843	3.293	2.220
1987	1.237	2.299	1.842	1.881	1.313	1.529	1.690	1.542	2.751	1.812	1.721	2.934	3.486	2.322
1986	1.578	2.442	2.026	2.374	1.245	1.739	1.640	1.638	2.792	2.041	2.000	2.856	3.607	2.403
1989	1.373	2.409	2.074	2.604	1.176	1.599	1.246	1.605	2.763	2.087	2.411	2.880	3.757	2.454
1990	1.403	3.168	2.546	3.495	1.163	1.893	0.946	1.698	2.804	2.243	2.414	2.888	4.268	2.634
1991	1.162	3.486	2.153	3.905	1.118	1.898	1.122	1.361	2.759	2.174	2.570	2.785	4.166	2.526
1992	1.721	2.357	2.996	3.426	1.034	1.718	1.511	1.152	1.824	1.915	2.940	2.606	4.080	2.506
1993	1.591	2.650	2.049	4.376	0.565	1.627	1.901	0.971	1.531	1.957	4.274	2.859	4.595	2.604
1994	1.851	3.911	2.341	5.388	0.696	1.525	2.005	0.987	0.771	1.815	3.919	2.150	4.752	2.452
1995	2.003	4.845	2.796	7.461	0.629	1.443	1.587	0.852	0.600	1.826	3.682	1.695	4.048	2.240

Note: CAR Indices start in 1980 due to lack of output data for earlier years.
Output data for CAR for 1973-1979 are still included in Regions I and II.

Appendix 3

Indices of Rice and Corn Area Harvested by Region

Year	Cordillera	Ilocos	Cagayan	Central Luzon	Southern Tagalog	Bicol	Western Visayas	Central Visayas	Eastern Visayas	Western Mindanao	Northern Mindanao	Southern Mindanao	Central Mindanao	PHIL
1973	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1974	1.042	0.999	1.079	1.011	1.077	1.056	1.100	1.163	1.095	1.014	1.059	1.263	1.121	1.092
1975	1.067	1.016	1.122	0.962	1.114	1.067	1.133	1.257	1.203	1.034	1.093	1.542	1.261	1.160
1976	1.083	0.877	1.158	0.856	1.172	1.060	1.186	1.320	1.214	1.079	1.078	1.752	1.406	1.195
1977	1.063	0.907	1.170	0.841	1.213	1.019	1.218	1.329	1.232	1.075	1.096	1.782	1.482	1.213
1978	1.029	0.917	1.122	0.801	1.041	0.953	1.183	1.357	1.193	1.086	1.110	1.770	1.416	1.171
1979	1.028	0.913	1.122	0.829	1.045	0.959	1.233	1.346	1.222	1.093	1.139	1.840	1.447	1.190
1980	1.307	0.935	0.893	0.962	0.992	1.057	1.297	1.456	1.314	1.037	0.934	1.807	1.277	1.165
1981	1.176	0.940	0.979	0.976	0.977	0.962	1.208	1.458	1.407	1.083	0.838	1.865	1.348	1.172
1982	0.980	0.986	0.912	1.027	1.021	0.971	1.191	1.420	1.444	1.103	0.828	1.967	1.299	1.176
1983	0.982	0.944	0.905	0.936	0.992	0.918	1.062	1.254	1.390	1.009	0.684	1.806	1.097	1.080
1984	1.007	0.956	1.004	0.813	0.938	1.037	1.097	1.366	1.448	1.017	0.690	1.808	1.292	1.116
1985	0.910	0.983	1.103	0.942	0.972	1.063	1.128	1.432	1.593	1.132	0.790	1.925	1.377	1.190
1986	0.980	1.008	1.132	1.006	0.994	1.086	1.207	1.486	1.628	1.172	0.829	1.879	1.503	1.233
1987	0.933	0.958	1.031	0.980	0.966	0.995	1.244	1.479	1.584	1.137	0.893	1.889	1.463	1.212
1988	1.002	1.053	1.055	0.946	1.006	1.113	1.214	1.488	1.575	1.223	0.929	1.934	1.495	1.246
1989	0.907	1.006	1.109	1.052	1.004	1.059	1.135	1.568	1.586	1.129	1.051	1.937	1.504	1.257
1990	0.913	1.046	1.075	1.059	0.970	0.993	0.942	1.549	1.578	1.259	1.046	1.968	1.569	1.246
1991	0.845	1.075	1.006	1.016	1.007	1.027	1.136	1.358	1.598	1.214	1.121	1.887	1.446	1.225
1992	0.862	1.011	1.010	0.958	0.983	0.975	1.105	1.167	1.331	1.049	1.026	1.712	1.345	1.140
1993	0.841	1.026	0.913	0.969	0.769	0.912	1.172	0.922	1.199	1.026	1.232	1.831	1.406	1.123
1994	0.946	1.028	1.173	1.085	0.828	0.876	1.267	0.936	1.037	1.005	1.251	1.659	1.548	1.163
1995	1.041	1.020	1.245	1.120	0.780	0.848	1.161	0.882	0.983	0.962	1.276	1.447	1.507	1.126

Appendix 4

RICE: Input Usage per Hectare, By Region , 1991

REGION	Seeds *kg/ha*	Fertilizer *kg/ha*	Labour *md/ha*	Chemicals *li/ha*	Fuel/Oil *li/ha*
Cordillera	126.59	123.00	78.90	1.43	8.59
Ilocos	91.82	197.00	67.00	1.66	13.92
Cagayan Valley	141.84	160.50	57.15	1.99	3.03
Central Luzon	196.91	256.00	63.96	2.15	21.79
Southern Tagalog	170.05	137.00	62.83	2.37	5.92
Bicol	156.90	138.50	67.43	1.39	6.85
Western Visayas	209.27	203.50	62.69	3.65	5.84
Central Visayas	82.20	80.50	59.60	1.04	2.74
Eastern Visayas	145.95	71.50	73.05	1.34	0.72
Western Mindanao	146.45	121.50	73.29	2.45	8.44
Northern Mindanao	116.22	184.00	76.48	2.65	5.92
Southern Mindanao	105.99	157.50	63.23	2.80	4.33
Central Mindanao	125.96	156.50	68.16	3.01	8.15
Philippines	**144.81**	**152.85**	**67.21**	**2.15**	**7.40**

Source: BAS Costs and Returns Survey for Rice, 1991

Appendix 5

CORN: Input Usage per Hectare, By Region, 1991

REGION	Seeds *kg/ha*	Fertilizer *kg/ha*	Labour *md/ha*	Chemicals *li/ha*	Fuel/Oil *li/ha*
Cordillera	17.24	79.50	37.47	0.34	0.00
Ilocos	19.00	153.50	50.01	1.61	14.07
Cagayan Valley	16.31	182.00	43.07	0.67	5.99
Central Luzon	19.68	274.50	45.35	1.35	32.54
Southern Tagalog	15.00	201.50	38.03	0.66	1.95
Bicol	16.00	54.50	41.10	0.18	0.07
Western Visayas	14.64	54.00	32.63	0.32	0.07
Central Visayas	13.00	76.50	44.31	0.06	2.60
Eastern Visayas	12.00	10.00	39.55	0.02	0.00
Western Mindanao	10.00	97.50	36.18	0.19	0.07
Northern Mindanao	13.43	91.50	36.52	0.20	3.10
Southern Mindanao	16.00	99.00	38.25	0.10	1.88
Central Mindanao	19.30	122.00	41.51	0.32	1.52
Philippines	**15.51**	**115.08**	**40.31**	**0.46**	**5.80**

Source: BAS Costs and Returns Survey for Corn, 1991

Appendix 6

Rice Input Indices

	CAR	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
DIVISIA													
CAR	1	0.203	0.207	0.107	0.152	0.212	0.131	0.664	0.298	0.424	0.338	0.320	0.305
I	4.934	1	1.023	0.530	0.750	1.047	0.645	3.278	1.472	2.093	1.669	1.579	1.505
II	4.822	0.977	1	0.518	0.733	1.024	0.630	3.203	1.439	2.045	1.631	1.543	1.471
III	9.304	1.885	1.929	1	1.414	1.975	1.216	6.180	2.776	3.946	3.147	2.977	2.837
IV	6.581	1.334	1.365	0.707	1	1.397	0.860	4.372	1.964	2.792	2.226	2.106	2.007
V	4.711	0.955	0.977	0.506	0.716	1	0.616	3.129	1.406	1.998	1.593	1.507	1.437
VI	7.653	1.551	1.587	0.823	1.163	1.624	1	5.084	2.283	3.246	2.588	2.449	2.334
VII	1.505	0.305	0.312	0.162	0.229	0.320	0.197	1	0.449	0.639	0.509	0.482	0.459
VIII	3.351	0.679	0.695	0.360	0.509	0.711	0.438	2.226	1	1.422	1.134	1.072	1.022
IX	2.358	0.478	0.489	0.253	0.358	0.500	0.308	1.566	0.703	1	0.797	0.754	0.719
X	2.957	0.599	0.613	0.318	0.449	0.628	0.386	1.964	0.882	1.254	1	0.946	0.902
XI	3.125	0.633	0.648	0.336	0.475	0.663	0.408	2.076	0.933	1.326	1.057	1	0.953
XII	3.279	0.664	0.680	0.352	0.498	0.696	0.428	2.178	0.978	1.391	1.109	1.049	1
PAASCHE													
CAR	1	0.202	0.206	0.107	0.150	0.21	0.131	0.639	0.29	0.421	0.335	0.318	0.303
I	4.907	1	1.024	0.526	0.743	1.035	0.648	3.181	1.427	2.069	1.648	1.576	1.494
II	4.885	0.984	1	0.520	0.732	1.021	0.641	3.089	1.414	2.055	1.638	1.547	1.477
III	9.292	1.871	1.913	1	1.403	1.953	1.234	5.853	2.694	3.923	3.116	2.945	2.817
IV	6.560	1.324	1.367	0.706	1	1.388	0.883	4.212	1.916	2.779	2.194	2.095	1.997
V	4.802	0.963	0.975	0.499	0.710	1	0.616	3.091	1.396	2.001	1.591	1.505	1.431
VI	7.799	1.565	1.580	0.811	1.152	1.621	1	4.990	2.261	3.251	2.593	2.447	2.329
VII	1.529	0.303	0.307	0.154	0.224	0.317	0.195	1	0.448	0.634	0.501	0.475	0.451
VIII	3.434	0.686	0.692	0.351	0.504	0.712	0.436	2.226	1	1.424	1.132	1.071	1.017
IX	2.398	0.484	0.491	0.252	0.357	0.501	0.308	1.549	0.696	1	0.797	0.756	0.717
X	3.002	0.608	0.616	0.315	0.447	0.628	0.386	1.944	0.871	1.253	1	0.950	0.900
XI	3.163	0.641	0.647	0.337	0.471	0.661	0.408	2.003	0.912	1.324	1.061	1	0.953
XII	3.347	0.673	0.679	0.353	0.496	0.698	0.430	2.116	0.967	1.396	1.115	1.048	1

LASPEYRES

	CAR	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
CAR	1	0.204	0.205	0.108	0.152	0.208	0.128	0.654	0.291	0.417	0.333	0.316	0.299
I	4.944	1	1.016	0.535	0.756	1.039	0.639	3.299	1.458	2.065	1.644	1.561	1.486
II	4.848	0.976	1	0.523	0.732	1.026	0.633	3.256	1.445	2.037	1.622	1.546	1.473
III	9.381	1.902	1.925	1	1.416	2.005	1.233	6.474	2.848	3.974	3.170	2.972	2.832
IV	6.647	1.345	1.366	0.713	1	1.408	0.868	4.463	1.985	2.805	2.237	2.121	2.016
V	4.764	0.966	0.979	0.512	0.721	1	0.617	3.158	1.405	1.994	1.592	1.513	1.433
VI	7.612	1.542	1.560	0.810	1.133	1.623	1	5.133	2.294	3.244	2.590	2.449	2.327
VII	1.564	0.314	0.324	0.171	0.237	0.323	0.200	1	0.449	0.646	0.514	0.499	0.473
VIII	3.447	0.701	0.707	0.371	0.522	0.716	0.442	2.231	1	1.436	1.148	1.097	1.034
IX	2.377	0.483	0.487	0.255	0.360	0.500	0.308	1.577	0.702	1	0.798	0.755	0.716
X	2.985	0.607	0.610	0.321	0.456	0.629	0.386	1.996	0.883	1.255	1	0.943	0.897
XI	3.145	0.635	0.646	0.340	0.477	0.665	0.409	2.104	0.934	1.323	1.053	1	0.954
XII	3.304	0.669	0.677	0.355	0.501	0.699	0.429	2.217	0.984	1.394	1.111	1.050	1

FISHER

	CAR	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
CAR	1	0.203	0.205	0.107	0.151	0.209	0.130	0.647	0.291	0.419	0.334	0.317	0.301
I	4.925	1	1.020	0.530	0.749	1.037	0.644	3.240	1.442	2.067	1.646	1.568	1.490
II	4.867	0.980	1	0.521	0.732	1.024	0.637	3.171	1.429	2.046	1.630	1.546	1.475
III	9.336	1.886	1.919	1	1.410	1.979	1.234	6.156	2.770	3.948	3.143	2.958	2.825
IV	6.604	1.334	1.366	0.709	1	1.398	0.875	4.336	1.950	2.792	2.215	2.108	2.006
V	4.783	0.964	0.977	0.505	0.716	1	0.617	3.125	1.401	1.997	1.591	1.509	1.432
VI	7.705	1.553	1.570	0.811	1.143	1.622	1	5.061	2.278	3.248	2.592	2.448	2.328
VII	1.547	0.309	0.315	0.162	0.231	0.320	0.198	1	0.449	0.640	0.508	0.487	0.462
VIII	3.440	0.693	0.700	0.361	0.513	0.714	0.439	2.228	1	1.430	1.140	1.084	1.025
IX	2.387	0.484	0.489	0.253	0.358	0.501	0.308	1.563	0.699	1	0.798	0.756	0.717
X	2.994	0.608	0.613	0.318	0.451	0.628	0.386	1.970	0.877	1.254	1	0.946	0.899
XI	3.154	0.638	0.647	0.338	0.474	0.663	0.409	2.053	0.923	1.323	1.057	1	0.953
XII	3.325	0.671	0.678	0.354	0.498	0.698	0.430	2.166	0.975	1.395	1.113	1.049	1

Appendix 7
Corn Input Indices

	CAR	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
DIVISIA													
CAR	1	0.148	0.046	0.851	0.065	0.103	0.316	0.030	0.112	0.089	0.061	0.025	0.025
I	6.776	1	0.313	5.769	0.443	0.699	2.144	0.205	0.762	0.601	0.416	0.172	0.172
II	21.669	3.198	1	18.448	1.416	2.235	6.856	0.655	2.435	1.922	1.331	0.550	0.551
III	1.175	0.173	0.054	1	0.077	0.121	0.372	0.035	0.132	0.104	0.072	0.030	0.030
IV	15.298	2.258	0.706	13.024	1	1.578	4.840	0.462	1.719	1.357	0.940	0.388	0.389
V	9.695	1.431	0.447	8.254	0.634	1	3.067	0.293	1.090	0.860	0.596	0.246	0.247
VI	3.161	0.466	0.146	2.691	0.207	0.326	1	0.095	0.355	0.280	0.194	0.080	0.080
VII	33.102	4.885	1.528	28.182	2.164	3.414	10.473	1	3.720	2.937	2.033	0.840	0.842
VIII	8.898	1.313	0.411	7.575	0.582	0.918	2.815	0.269	1	0.789	0.547	0.226	0.226
IX	11.271	1.663	0.520	9.596	0.737	1.163	3.566	0.341	1.267	1	0.692	0.286	0.287
X	16.279	2.403	0.751	13.860	1.064	1.679	5.151	0.492	1.830	1.444	1	0.413	0.414
XI	39.388	5.813	1.818	33.534	2.575	4.063	12.462	1.190	4.427	3.495	2.419	1	1.002
XII	39.294	5.799	1.813	33.454	2.569	4.053	12.432	1.187	4.416	3.486	2.414	0.998	1
PAASCHE													
CAR	1	0.163	0.051	0.947	0.071	0.111	0.341	0.032	0.115	0.093	0.065	0.027	0.027
I	6.032	1	0.313	5.830	0.435	0.669	2.049	0.194	0.685	0.556	0.394	0.163	0.164
II	19.287	3.211	1	18.665	1.386	2.143	6.527	0.628	2.198	1.776	1.259	0.520	0.525
III	1.048	0.173	0.054	1	0.074	0.117	0.354	0.034	0.121	0.097	0.068	0.028	0.028
IV	13.909	2.316	0.722	13.479	1	1.547	4.703	0.454	1.585	1.280	0.908	0.376	0.379
V	9.014	1.454	0.465	8.582	0.649	1	3.074	0.288	1.030	0.835	0.592	0.245	0.245
VI	2.933	0.476	0.150	2.761	0.208	0.326	1	0.094	0.338	0.273	0.192	0.079	0.079
VII	30.595	4.972	1.559	28.735	2.152	3.423	10.373	1	3.557	2.843	1.998	0.827	0.829
VIII	8.544	1.368	0.431	7.886	0.596	0.956	2.913	0.276	1	0.799	0.558	0.231	0.230
IX	10.763	1.748	0.549	10.128	0.760	1.202	3.655	0.350	1.247	1	0.703	0.291	0.291
X	15.298	2.471	0.778	14.300	1.078	1.707	5.210	0.493	1.775	1.425	1	0.413	0.413
XI	37.128	6.133	1.909	35.447	2.642	4.132	12.594	1.204	4.263	3.434	2.422	1	1.007
XII	36.908	5.982	1.890	34.883	2.629	4.104	12.575	1.185	4.245	3.427	2.417	0.998	1

	CAR	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	LASPEYRES												
CAR	1	0.166	0.052	0.954	0.072	0.111	0.341	0.033	0.117	0.093	0.065	0.027	0.027
I	6.122	1	0.311	5.770	0.432	0.688	2.102	0.201	0.731	0.572	0.405	0.163	0.167
II	19.533	3.198	1	18.568	1.385	2.152	6.677	0.641	2.320	1.820	1.286	0.524	0.529
III	1.056	0.172	0.054	1	0.074	0.117	0.362	0.035	0.127	0.099	0.070	0.028	0.029
IV	14.037	2.299	0.722	13.457	1	1.540	4.804	0.465	1.677	1.315	0.928	0.378	0.380
V	9.016	1.496	0.467	8.546	0.647	1	3.066	0.292	1.046	0.832	0.586	0.242	0.244
VI	2.930	0.488	0.153	2.821	0.213	0.325	1	0.096	0.343	0.274	0.192	0.079	0.080
VII	31.395	5.150	1.593	29.114	2.203	3.467	10.645	1	3.628	2.861	2.027	0.831	0.844
VIII	8.720	1.459	0.455	8.275	0.631	0.971	2.959	0.281	1	0.802	0.563	0.235	0.236
IX	10.770	1.798	0.563	10.319	0.781	1.197	3.668	0.352	1.251	1	0.702	0.291	0.292
X	15.306	2.536	0.794	14.636	1.101	1.688	5.214	0.500	1.791	1.422	1	0.413	0.414
XI	37.140	6.144	1.922	35.395	2.663	4.082	12.634	1.210	4.338	3.438	2.421	1	1.002
XII	37.012	6.094	1.904	35.133	2.637	4.079	12.613	1.207	4.346	3.431	2.420	0.993	1
	FISHER												
CAR	1	0.165	0.052	0.950	0.072	0.111	0.341	0.032	0.116	0.093	0.065	0.027	0.027
I	6.077	1	0.312	5.800	0.433	0.678	2.075	0.198	0.708	0.564	0.399	0.163	0.166
II	19.409	3.204	1	18.617	1.386	2.148	6.602	0.634	2.258	1.798	1.272	0.522	0.527
III	1.052	0.172	0.054	1	0.074	0.117	0.358	0.035	0.124	0.098	0.069	0.028	0.029
IV	13.973	2.308	0.722	13.468	1	1.543	4.753	0.459	1.631	1.298	0.918	0.377	0.380
V	9.015	1.475	0.466	8.564	0.648	1	3.070	0.290	1.038	0.834	0.589	0.243	0.244
VI	2.931	0.482	0.151	2.791	0.210	0.326	1	0.095	0.341	0.273	0.192	0.079	0.079
VII	30.993	5.060	1.576	28.924	2.178	3.445	10.508	1	3.592	2.852	2.013	0.829	0.836
VIII	8.632	1.413	0.443	8.078	0.613	0.963	2.936	0.278	1	0.801	0.561	0.233	0.233
IX	10.766	1.773	0.556	10.223	0.771	1.199	3.661	0.351	1.249	1	0.703	0.291	0.292
X	15.302	2.503	0.786	14.467	1.089	1.697	5.212	0.497	1.783	1.423	1	0.413	0.413
XI	37.134	6.138	1.915	35.421	2.653	4.107	12.614	1.207	4.300	3.436	2.422	1	1.004
XII	36.960	6.038	1.897	35.008	2.633	4.092	12.594	1.196	4.296	3.429	2.419	0.996	1

Appendix 8
AGGREGATE OUTPUT INDICES

	CAR	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	DIVISIA												
CAR	1	0.198	0.146	0.122	0.131	0.189	0.141	0.232	0.252	0.293	0.223	0.135	0.134
I	5.057	1	0.741	0.618	0.665	0.954	0.715	1.174	1.276	1.483	1.127	0.683	0.676
II	6.828	1.350	1	0.834	0.897	1.289	0.965	1.586	1.723	2.003	1.522	0.923	0.913
III	8.184	1.618	1.198	1	1.076	1.544	1.157	1.900	2.065	2.400	1.824	1.106	1.094
IV	7.608	1.505	1.114	0.930	1	1.436	1.076	1.767	1.920	2.232	1.696	1.028	1.017
V	5.299	1.048	0.776	0.648	0.696	1	0.749	1.231	1.337	1.554	1.181	0.716	0.708
VI	7.073	1.399	1.036	0.864	0.93	1.335	1	1.642	1.785	2.074	1.576	0.956	0.945
VII	4.306	0.852	0.631	0.526	0.566	0.813	0.609	1	1.087	1.263	0.960	0.582	0.575
VIII	3.962	0.784	0.580	0.484	0.521	0.748	0.560	0.920	1	1.162	0.883	0.535	0.529
IX	3.409	0.674	0.499	0.417	0.448	0.643	0.482	0.792	0.861	1	0.760	0.461	0.456
X	4.487	0.887	0.657	0.548	0.590	0.847	0.634	1.042	1.132	1.316	1	0.606	0.600
XI	7.400	1.463	1.084	0.904	0.973	1.396	1.046	1.718	1.868	2.170	1.649	1	0.989
XII	7.483	1.480	1.096	0.914	0.984	1.412	1.058	1.738	1.889	2.195	1.668	1.011	1
	PAASCHE												
CAR	1	0.198	0.146	0.12	0.13	0.185	0.142	0.232	0.252	0.293	0.211	0.127	0.134
I	5.037	1	0.743	0.602	0.658	0.937	0.709	1.174	1.276	1.483	1.078	0.651	0.676
II	6.880	1.358	1	0.825	0.892	1.272	0.974	1.586	1.723	2.003	1.445	0.864	0.913
III	8.172	1.611	1.177	1	1.059	1.504	1.171	1.900	2.065	2.400	1.680	0.992	1.094
IV	7.692	1.512	1.120	0.922	1	1.429	1.096	1.767	1.920	2.232	1.619	0.972	1.017
V	5.389	1.057	0.783	0.634	0.694	1	0.747	1.231	1.337	1.554	1.142	0.690	0.708
VI	7.154	1.404	1.032	0.849	0.920	1.321	1	1.642	1.785	2.074	1.497	0.895	0.945
VII	4.463	0.865	0.641	0.510	0.567	0.828	0.614	1	1.087	1.263	0.949	0.577	0.575
VIII	4.146	0.807	0.599	0.479	0.530	0.770	0.572	0.920	1	1.162	0.881	0.534	0.529
IX	3.569	0.700	0.521	0.421	0.462	0.665	0.497	0.792	0.861	1	0.760	0.461	0.456
X	4.662	0.917	0.683	0.548	0.603	0.869	0.647	1.042	1.132	1.316	1	0.608	0.600
XI	7.743	1.530	1.135	0.916	1.004	1.438	1.078	1.718	1.868	2.170	1.654	1	0.989
XII	7.812	1.537	1.141	0.917	1.008	1.453	1.078	1.738	1.889	2.195	1.669	1.013	1

	CAR	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
LASPEYRES													
CAR	1	0.199	0.145	0.122	0.13	0.186	0.14	0.224	0.241	0.28	0.214	0.129	0.128
I	5.054	1	0.737	0.621	0.661	0.946	0.712	1.156	1.239	1.429	1.09	0.654	0.651
II	6.838	1.346	1	0.85	0.893	1.278	0.969	1.56	1.671	1.919	1.463	0.881	0.876
III	8.317	1.662	1.212	1	1.084	1.578	1.178	1.96	2.086	2.376	1.826	1.092	1.09
IV	7.678	1.52	1.121	0.944	1	1.442	1.087	1.763	1.887	2.166	1.657	0.996	0.992
V	5.393	1.067	0.786	0.665	0.7	1	0.757	1.208	1.299	1.503	1.151	0.695	0.688
VI	7.065	1.41	1.027	0.854	0.912	1.339	1	1.63	1.749	2.01	1.546	0.928	0.927
VII	4.659	0.907	0.682	0.596	0.606	0.847	0.654	1	1.085	1.269	0.962	0.587	0.577
VIII	4.243	0.837	0.618	0.528	0.548	0.778	0.593	0.923	1	1.169	0.894	0.543	0.535
IX	3.622	0.71	0.529	0.456	0.47	0.667	0.51	0.794	0.859	1	0.761	0.462	0.457
X	4.733	0.927	0.692	0.595	0.617	0.876	0.668	1.054	1.136	1.316	1	0.605	0.599
XI	7.892	1.535	1.158	1.009	1.029	1.45	1.117	1.734	1.872	2.17	1.645	1	0.988
XII	7.922	1.549	1.16	1.001	1.034	1.464	1.12	1.762	1.899	2.197	1.668	1.01	1
FISHER													
CAR	1	0.198	0.146	0.121	0.13	0.186	0.141	0.219	0.238	0.278	0.213	0.128	0.127
I	5.046	1	0.74	0.611	0.66	0.942	0.711	1.129	1.217	1.419	1.084	0.652	0.648
II	6.859	1.352	1	0.837	0.893	1.275	0.971	1.512	1.644	1.904	1.454	0.872	0.869
III	8.244	1.636	1.194	1	1.072	1.54	1.175	1.813	1.987	2.282	1.752	1.04	1.043
IV	7.685	1.516	1.12	0.933	1	1.435	1.091	1.706	1.855	2.147	1.638	0.984	0.979
V	5.391	1.062	0.784	0.649	0.697	1	0.752	1.194	1.292	1.501	1.146	0.692	0.686
VI	7.11	1.407	1.03	0.851	0.916	1.33	1	1.578	1.718	1.985	1.521	0.911	0.91
VII	4.56	0.886	0.661	0.552	0.586	0.837	0.634	1	1.084	1.264	0.956	0.582	0.572
VIII	4.194	0.822	0.608	0.503	0.539	0.774	0.582	0.922	1	1.166	0.887	0.538	0.531
IX	3.595	0.705	0.525	0.438	0.466	0.666	0.504	0.791	0.857	1	0.761	0.461	0.456
X	4.698	0.922	0.688	0.571	0.61	0.872	0.657	1.046	1.127	1.315	1	0.606	0.599
XI	7.818	1.533	1.146	0.961	1.017	1.444	1.097	1.718	1.857	2.167	1.649	1	0.989
XII	7.867	1.543	1.151	0.958	1.021	1.458	1.099	1.747	1.883	2.193	1.669	1.011	1

Appendix 9

AGGREGATE OUTPUT INDICES

	CAR	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
DIVISIA													
CAR	1	0.174	0.116	0.117	0.154	0.229	0.168	0.393	0.282	0.269	0.176	0.094	0.1
I	5.755	1	0.668	0.675	0.886	1.319	0.969	2.26	1.624	1.547	1.011	0.538	0.575
II	8.619	1.498	1	1.01	1.327	1.975	1.451	3.385	2.432	2.317	1.514	0.806	0.861
III	8.531	1.482	0.99	1	1.313	1.955	1.436	3.35	2.407	2.293	1.499	0.798	0.852
IV	6.496	1.129	0.754	0.761	1	1.489	1.093	2.551	1.833	1.746	1.141	0.607	0.649
V	4.363	0.758	0.506	0.511	0.672	1	0.734	1.714	1.231	1.173	0.767	0.408	0.436
VI	5.942	1.032	0.689	0.696	0.915	1.362	1	2.333	1.677	1.597	1.044	0.556	0.593
VII	2.546	0.442	0.295	0.298	0.392	0.584	0.429	1	0.719	0.684	0.447	0.238	0.254
VIII	3.544	0.616	0.411	0.415	0.546	0.812	0.596	1.392	1	0.952	0.623	0.331	0.354
IX	3.721	0.647	0.432	0.436	0.573	0.853	0.626	1.461	1.05	1	0.654	0.348	0.372
X	5.692	0.989	0.66	0.667	0.876	1.304	0.958	2.235	1.606	1.53	1	0.532	0.569
XI	10.694	1.858	1.241	1.254	1.646	2.451	1.8	4.2	3.018	2.874	1.879	1	1.068
XII	10.012	1.74	1.162	1.174	1.541	2.294	1.685	3.932	2.825	2.691	1.759	0.936	1
PAASCHE													
CAR	1	0.174	0.118	0.097	0.131	0.195	0.140	0.405	0.296	0.281	0.181	0.094	0.100
I	5.755	1	0.678	0.558	0.753	1.120	0.808	2.333	1.703	1.619	1.044	0.542	0.575
II	8.421	1.462	1	0.813	1.104	1.642	1.178	3.478	2.518	2.395	1.551	0.812	0.863
III	10.393	1.803	1.243	1	1.364	2.030	1.449	4.360	3.135	2.984	1.938	1.022	1.088
IV	7.570	1.308	0.934	0.716	1	1.490	1.041	3.416	2.378	2.268	1.497	0.819	0.879
V	5.127	0.890	0.609	0.495	0.672	1	0.717	2.123	1.535	1.460	0.946	0.496	0.527
VI	7.177	1.245	0.860	0.690	0.943	1.402	1	3.022	2.170	2.065	1.342	0.709	0.756
VII	2.368	0.411	0.284	0.227	0.311	0.463	0.330	1	0.717	0.682	0.444	0.235	0.250
VIII	3.310	0.574	0.396	0.318	0.435	0.647	0.461	1.392	1	0.952	0.619	0.327	0.348
IX	3.383	0.585	0.413	0.322	0.446	0.664	0.467	1.491	1.049	1	0.657	0.355	0.380
X	5.311	0.921	0.638	0.510	0.698	1.039	0.739	2.255	1.613	1.535	1	0.530	0.565
XI	9.826	1.702	1.189	0.940	1.293	1.925	1.363	4.232	3.008	2.865	1.872	1	1.068
XII	9.118	1.579	1.106	0.871	1.200	1.787	1.263	3.953	2.802	2.669	1.746	0.936	1

	CAR	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	LASPEYRES												
CAR	1	0.174	0.119	0.096	0.132	0.195	0.139	0.422	0.302	0.296	0.188	0.102	0.11
I	5.755	1	0.684	0.555	0.764	1.124	0.803	2.436	1.742	1.709	1.086	0.587	0.633
II	8.491	1.475	1	0.805	1.07	1.641	1.163	3.522	2.524	2.419	1.566	0.841	0.904
III	10.307	1.791	1.23	1	1.396	2.021	1.449	4.397	3.142	3.108	1.962	1.064	1.149
IV	7.641	1.328	0.906	0.733	1	1.487	1.061	3.215	2.301	2.242	1.433	0.773	0.833
V	5.139	0.893	0.609	0.493	0.671	1	0.713	2.161	1.546	1.505	0.963	0.52	0.56
VI	7.125	1.238	0.849	0.69	0.96	1.395	1	3.033	2.168	2.14	1.353	0.734	0.792
VII	2.466	0.429	0.288	0.229	0.293	0.471	0.331	1	0.718	0.671	0.444	0.236	0.253
VIII	3.38	0.587	0.397	0.319	0.42	0.651	0.461	1.395	1	0.953	0.62	0.332	0.357
IX	3.555	0.618	0.417	0.335	0.441	0.685	0.484	1.465	1.051	1	0.651	0.349	0.375
X	5.514	0.958	0.645	0.516	0.668	1.057	0.745	2.252	1.617	1.523	1	0.534	0.573
XI	10.624	1.846	1.232	0.978	1.221	2.017	1.41	4.257	3.061	2.817	1.885	1	1.068
XII	10.01	1.739	1.159	0.919	1.138	1.897	1.324	3.995	2.874	2.632	1.768	0.937	1
	FISHER												
CAR	1	0.174	0.118	0.097	0.131	0.195	0.140	0.414	0.299	0.288	0.185	0.098	0.105
I	5.755	1	0.681	0.557	0.759	1.122	0.806	2.384	1.722	1.663	1.065	0.564	0.603
II	8.456	1.469	1	0.809	1.087	1.641	1.170	3.500	2.521	2.407	1.559	0.826	0.883
III	10.350	1.797	1.236	1	1.380	2.025	1.449	4.378	3.139	3.045	1.950	1.043	1.118
IV	7.605	1.318	0.920	0.725	1	1.489	1.051	3.314	2.339	2.255	1.465	0.796	0.856
V	5.133	0.891	0.609	0.494	0.672	1	0.715	2.142	1.541	1.483	0.954	0.507	0.543
VI	7.151	1.241	0.854	0.690	0.951	1.399	1	3.028	2.169	2.102	1.348	0.721	0.773
VII	2.416	0.419	0.286	0.228	0.302	0.467	0.330	1	0.718	0.676	0.444	0.236	0.252
VIII	3.345	0.581	0.397	0.319	0.427	0.649	0.461	1.394	1	0.952	0.619	0.330	0.352
IX	3.468	0.601	0.415	0.328	0.443	0.674	0.476	1.478	1.050	1	0.654	0.352	0.377
X	5.412	0.939	0.642	0.513	0.683	1.048	0.742	2.253	1.615	1.529	1	0.532	0.569
XI	10.218	1.773	1.210	0.959	1.256	1.970	1.386	4.244	3.035	2.841	1.879	1	1.068
XII	9.553	1.657	1.132	0.894	1.169	1.841	1.293	3.974	2.837	2.650	1.757	0.936	1

Appendix 10
RICE INPUT INDICES
Distance Matrix

	CAR	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
CAR	0	0.0090	0.0065	0.0095	0.0130	0.0090	0.0235	0.0230	0.0035	0.0095	0.0060	0.0060	0.0130
I	0.0090	0	0.0080	0.0165	0.0165	0.0035	0.0145	0.0360	0.0215	0.0020	0.0020	0.0095	0.0055
II	0.0065	0.0080	0	0.0060	0.0005	0.0045	0.0130	0.0535	0.0215	0.0085	0.0100	0.0015	0.0030
III	0.0095	0.0165	0.0060	0	0.0095	0.0260	0.0010	0.1030	0.0555	0.0125	0.0180	0.0090	0.0055
IV	0.0130	0.0165	0.0005	0.0095	0	0.0145	0.0170	0.0570	0.0350	0.0085	0.0195	0.0125	0.0095
V	0.0090	0.0035	0.0045	0.0260	0.0145	0	0.0015	0.0200	0.0060	0.0030	0.0015	0.0055	0.0010
VI	0.0235	0.0145	0.0130	0.0010	0.0170	0.0015	0	0.0265	0.0140	0.0010	0.0005	0.0015	0.0015
VII	0.0230	0.0360	0.0535	0.1030	0.0570	0.0200	0.0265	0	0.0020	0.0185	0.0260	0.0490	0.0475
VIII	0.0035	0.0215	0.0215	0.0555	0.0350	0.0060	0.0140	0.0020	0	0.0085	0.0140	0.0240	0.0170
IX	0.0095	0.0020	0.0085	0.0125	0.0085	0.0030	0.0010	0.0185	0.0085	0	0.0015	0.0010	0.0010
X	0.0060	0.0020	0.0100	0.0180	0.0195	0.0015	0.0005	0.0260	0.0140	0.0015	0	0.0075	0.0035
XI	0.0060	0.0095	0.0015	0.0090	0.0125	0.0055	0.0015	0.0490	0.0240	0.0010	0.0075	0	0.0015
XII	0.0130	0.0055	0.0030	0.0055	0.0095	0.0010	0.0015	0.0475	0.0170	0.0010	0.0035	0.0015	0

Appendix 11
CORN INPUT INDICES
Distance Matrix

	CAR	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
CAR	0	0.0165	0.0160	0.0075	0.0115	0.0000	0.0005	0.0285	0.0185	0.0005	0.0005	0.0000	0.0015
I	0.0165	0	0.0050	0.0080	0.0070	0.0280	0.0255	0.0350	0.0645	0.0280	0.0270	0.0010	0.0185
II	0.0160	0.0050	0	0.0025	0.0005	0.0040	0.0215	0.0210	0.0540	0.0245	0.0205	0.0075	0.0075
III	0.0075	0.0080	0.0025	0	0.0010	0.0020	0.0215	0.0210	0.0480	0.0195	0.0260	0.0005	0.0210
IV	0.0115	0.0070	0.0005	0.0010	0	0.0040	0.0225	0.0235	0.0565	0.0270	0.0215	0.0065	0.0030
V	0.0000	0.0280	0.0040	0.0020	0.0040	0	0.0030	0.0135	0.0155	0.0040	0.0105	0.0120	0.0050
VI	0.0005	0.0255	0.0215	0.0215	0.0225	0.0030	0	0.0235	0.0155	0.0040	0.0005	0.0015	0.0080
VII	0.0285	0.0350	0.0210	0.0210	0.0235	0.0135	0.0235	0	0.0190	0.0060	0.0140	0.0050	0.0180
VIII	0.0185	0.0645	0.0540	0.0480	0.0565	0.0155	0.0155	0.0190	0	0.0035	0.0090	0.0170	0.0250
IX	0.0005	0.0280	0.0245	0.0195	0.0270	0.0040	0.0040	0.0060	0.0035	0	0.0015	0.0005	0.0020
X	0.0005	0.0270	0.0205	0.0260	0.0215	0.0105	0.0005	0.0140	0.0090	0.0015	0	0.0000	0.0015
XI	0.0000	0.0010	0.0075	0.0005	0.0065	0.0120	0.0015	0.0050	0.0170	0.0005	0.0000	0	0.0050
XII	0.0015	0.0185	0.0075	0.0210	0.0030	0.0050	0.0080	0.0180	0.0250	0.0020	0.0015	0.0050	0