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SERIES #121-76

THE EFFECTS OF HIGH YIELDING VARIETIES ON THE REGIONAL, SEASONAL, AND VARIETAL CHANGES IN RICE PRODUCTION IN THE PHILIPPINES

BY

E. C. Lucas, T. T. Williams, & L. B. Sereno

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SOUTHERN UNIVERSITY

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FOREWORD

The Unemployment and Underemployment Institute was created to coordinate all international economic development activities of the 211(d) grant at Southern University.

In 1972, the Agency for International Development (AID) approved a five year grant to Southern University to strengthen and increase its capacity in economic/agricultural economics to enhance Southern's capabilities to contribute to the resolution of problems of rural unemployment and underemployment in developing countries.

The general objectives of the Institute are (a) to develop and coordinate the activities of the University for greater participation in international economic development programs; (b) to make available the capacities and expertise thus developed to public and private agencies involved in industrial development programs; and (c) to conduct research, seminars, and workshops on domestic and international development problems including cooperatives, manpower utilization, small farmers, housing, population, nutrition, leadership training, and community development.

In keeping with objective (a), the University supports several faculty members working towards advanced degrees in the area of economic development and related disciplines, supports undergraduate scholarships to foreign and U. S. nationals in the Department of Agricultural Economics and Economics, provides travel to professional seminars for faculty, foreign exposure to development experiences, and special training on techniques of program design and evaluation.

In keeping with objective (b), the Institute sponsors an International Development Seminar Series, Student-Faculty & Staff Seminar Series, and hosts foreign individuals and groups interested in economic development programs at Southern University.

Results of research projects consistent with the objectives of this program are published under the Institute's Faculty-Staff Research Paper Series. Papers published under this series reflects the diversity of interests and specialties of our faculty and staff.

The above activities of the Institute demonstrate the capacities and expertise of Southern University developed through the 211(d) program. As a result of the 211(d) grant, the Unemployment-Underemployment Institute at Southern University is in a position to offer expert and technical personnel to private and public agencies involved in international economic development programs.

T. T. Williams
Director

THE EFFECTS OF HIGH YIELDING VARIETIES ON THE REGIONAL, SEASONAL, AND VARIETAL CHANGES IN RICE PRODUCTION IN THE PHILIPPINES

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INTRODUCTION:

The introduction of the high yielding varieties (HYV) of rice in the Philippines and wheat in Mexico about a decade ago marked the beginning of a new revolution - a revoloution that promised increased agricultural productivity as well as the hope to improve peasant agriculture in the Third World. This revolution is known popularly as the "Green Revolution" defined by Cleaver (11) as the "rapid growth in Third World grain output associated with the introduction of a new package of tropical agricultural inputs". This package consists of a combination of improved seed grain varieties, heavy fertilizer usage and carefully controlled water supply.

The effects of the Green Revolution have been studied extensively by economists all over the world and results published in every major agricultural, economic, and development journal. While estimates of yield increases vary from one place to another, every investigator reported substantial increases in HYV yields over the traditional varieties. For example, Barker (4) reported over one hundred percent in rice productivity in the Philippines between 1969-1971 due to HYV. Sorkin (28) reported cases where HYV have exceeded production of traditional varieties by about three to four times. Wherever the HYV was introduced the results were the same - the HYV have consistently out produced the traditional varieties. In addition, HYV have also displaced traditional varieties in areas where water supply was controllable.

Because of the increased productivity resulting to widespread adoption of the HYV, economists have become prematurely optimistic about the prospect for development of the Third World countries. Ahmad (1) for example, citing an FAO Indicative World Plan predicted that "by 1985, India and Pakistan will be self-sufficient in rice and will need either to export the surplus or feed it to livestock." Johnston (25) predicted that the HYV will provide developing countries with a tool to feed an increasing population and jobs for increasing labor force. Fisher (18) indicated that yields in some areas have already increased to the point where diversion of land to non-cereal crops is possible, thus promoting export and creating opportunities for further growth and development.

The social impact of the HYV has also been explored by sociologists and economists. Studies have shown that the benefits derived from increased productivity have not been equally shared by the factors of production. Landlords have benefited more than tenants and wages of hired laborers have not increased accordingly. Evictions of tenants have also been reported as a result of active management participation of the traditional absentee landlord, or tenants have been demoted to hired laborers or sharecroppers status, completely depriving them of the management responsibility, benefits and profits provided for in the tenancy arrangement.

Events in the last two years have shown that the anticipated glut of grain in the developing countries has not materialized. Insufficient food supply continues to be a major problem. The tenancy problems associated with increased productivity has continued but not at the scale that constitute grave social problems.

Objectives of the Study:

One area of research that has received little attention from economists and agriculturists is the effects of HYV on the traditional pattern of agriculture of developing countries. A study of this type is important because existing economic and institutional structures revolve around tradit traditional agricultural practices and that alteration of these practices must result to adjustments in the supporting agricultural and economic institutions. For example, changes in the seasonal, varietal and regional system of rice farming necessarily cause adjustments in pricing, marketing channels, transportation and storage, and labor utilization not only in rice but also in non-rice agriculture.

It is the objectives of this study to (1) determine the seasonal and varietal changes in rice production as a result of the adoption of HYV, and (2) to determine the extent of varietal substitution between HYV and traditional varieties.

The data used of objective (1) are rice production estimates for 1956 and 1971 by regions and by seasons. The base year (1956) represents the regional and seasonal production pattern before the introduction of the HYV, while the terminal year (1971) represents seasonal and regional production pattern four years after the formal introduction of HYV. Production data classified by regions and varieties for the years 1970 and 1973 were used for objective (2).

Procedures: Shift Share Analysis (The Model)

Let there be four cropping seasons (i = 1, 2, 3, 4) in a year and nine regions (j = 1, 2, 3...9) in the Philippines. Also, let Y'_{ij} and Y_{ij} be the production of rice in the ith season in the jth region for the terminal year (1971) and the base year (1956), respectively. From these basic variables, the following computational notations are established as follows:

$Y_{i.} = \sum_{j=1}^{9} Y_{ij}$ = national production of rice in the ith season in 1956,

$Y'_{i.} = \sum_{j=1}^{9} Y'_{ij}$ = national production of rice in the ith season in 1971,

$Y_{..} = \sum_{i=1}^{4}\sum_{j=1}^{9} Y_{ij}$ = total rice production in 1956,

$Y'_{..} = \sum_{i=1}^{4}\sum_{j=1}^{9} Y'_{ij}$ = total rice production in 1971,

$r_{ij} = Y'_{ij}/Y_{ij}$ = 1971 to 1956 production ratio for the ith season in the jth region,

$R_{i} = Y'_{i.}/Y_{i.}$ = 1971 to 1956 production ratio for the ith season in the nation,

$R_{n} = Y'_{..}/Y_{..}$ = 1971 to 1956 total production ratio.

Shift share analysis assumes that the change in rice production between 1956 and 1971 can be factored into three components - the national growth component (NG), the seasonal growth component (SG), and the regional growth component (RG). Accordingly, the change in production in the ith season in the jth region is shown in equation (1).

(1) $Y'_{ij} - Y_{ij} = \Delta Y_{ij} = Y_{ij}\ (R\ -1) + Y_{ij}\ (R\ -R) + Y_{ij}\ (r\ -R\ )$, where the first, second, and third terms in the right hand side of equation (1) represent, respectively, national growth component (NG), the seasonal growth component (SG), and the regional growth component (RG). ΔY_{ij} represents the change in production for the ith season in the jth region. Alternatively it can be obtained by subtracting the base year from the terminal year production as in the left hand side of equation 1. If equation (1) is divided by Y_{ij} and the quotient multiplied by one hundred, the percent increase in production from the base to the terminal year is obtained as in equation (2).

(2) $r - 1 = (R_a - 1) + (R_i - R_a)$ where $(r - 1)$ represents the percent increase in production in the ith season in the jth region, and the first, second, and third terms on the right hand side of equation (2) represents respectively, the percent increase in production due to national growth component, seasonal growth component and regional share growth component. The vertical summation (summation over the ith index) yields the change in regional production as in equation (3).

(3) $Y'_{ij} - Y_{ij} = \Delta Y_{ij} = Y_{ij} (R_a - 1) + Y_{ij} (R_i - R_a) + Y_{ij} (r_i - R_i)$

<u>Interpretation of the Model</u>:

Expansion of rice production among regions in the Philippines roughly parallel each other. However, this parallelism is approximate only. There are differences in climate, soil, availability of controllable water supply, differential rates of HYV adoption, and growing conditions inherent in each region. Shift share analysis recognizes these similarities and differences, and accordingly, it identifies the changes in rice production attributable to each growth component.

A region's increase in rice production attributable to the national growth component (NG) reflects a uniform increase in productivity among regions and among seasons. This overall increase may be due to adoption of high yielding varieties, improved cultural practices, general availability of commercial inputs (e.g. fertilizer and insecticide, increased use of machinery, more efficient irrigation systems, and generally improved weather condition). The national growth component is computed by multiplying the region's production in the initial year by the percent increase in national productivity (R_a -1) and the product obtained reflects the change in production due to national growth effect.

The seasonal growth component (SG) arises from the differential productivity of rice at different cropping seasons. It is computed by applying to each regional production in the base year, the difference between the seasonal production growth rate and the national production growth rate $(R_i - R_a)$.[2] If for a particular season $(R - R) < 0$, rice production in that season is below the national norm, and to the extent that a high percentage of a region's production is harvested during that season, the impact on the region's total production is negative. Conversely, if $(R - R) > 0$, rice production for that season is above the national norm, and to the extent that the bulk of a region's production is harvested in that season, the impact on that region's total production is positive.

The regional growth component (RG) arises from the fact that a region's production is expanding or declining more rapidly vis-a-vis(other regions engaged in rice production). The regional difference reflects comparative advantage of the region in rice production, extent of HYV adoption, differences in growing condition, and differences in availability of controllable water supply. The regional growth component is computed by applying to the region's production in the base year, the difference between the regional production growth rate and the seasonal production growth rate $(r_i - R_i)$.[3] If $(r_i - R_i) < 0$, the region has an unfavorable comparative advantage over other regions in the production of rice, and thus, exerts a negative effect in the total productivity of the region. If on the other hand, $(r_i - R_i) > 0$, the region has a comparative advantage over other regions in the production of rice.

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[2] $R_i - R_a = (R_i - 1) - (R_a - 1)$

[3] $r_i - R_i = (r_i - 1) - (R_i - 1)$

Results: Regional Shift in Production

The 50,552,100 sacks increase in production over the four year period represents 67.94% increase over the 1956 production level. However, this increase was not distributed uniformly across the country and throughout the year because of inherent regional differences in growing condition, seasonality of production and availability of controllable water supply and commercial inputs. For example, Southern Tagalog showed the highest production increase with 147.39% above the 1956 production level, followed by Bicol, Southwest Mindanao, Ilocos, Cagayan Valley, Central Luzon, Western Visayas, Northeast Mindanao and Eastern Visayas, in that order.

Perhaps it is more meaningful to compare regional rate of productivity increase by their growth components. Table 1 shows regional production for 1956 and 1970, increase in production over the four year period, and the growth components of production change. Of the 2,771,400 sacks increase in rice production for Ilocos, 1,676,00 was due to national growth component; 333,500 was due to seasonal growth component; and 761,900 was due to regional growth component.

The sum of the regional and seasonal growth components of 1,095,000 represents the net shift and sack/measures, the extent to which productivity increase in Ilocos exceeded the average national increase of 67.94%. In percent, this is equivalent to 44.4.% above the national growth rate. Similarly, Southern Tagalog showed a net shift of 79,45%; 76.55% for Bicol, 64.96% for Southwest Mindanao, and 7.84% for Cagayan. On the other hand, regions with growth rates less than the national average include -44.20% for Western Visayas, -48.61% for Northeast Mindanao, -75.92% for Eastern Visayas, and -18.71% for Central Luzon. The net shift can be determined by inspection of Figure 1 as the vertical distance between the point representing each region and the NG line representing the national growth rate.

Table 1: Regional Changes in Rice Production in the Philippines, 1965-1970

Regions	Production 1956	Production 1970	Change in Production	Components of Change NG	SG	RG	Net Shift
			in 1000 sacks of 44 kgms each				
Ilocos	2466.7	5238.1	2771.4	1676.0	333.5	761.9	1095.4
Cagayan Valley	6639.6	11671.4	5031.8	4511.2	-2338.1	2858.7	520.6
Central Luzon	21499.0	32085.1	10586.1	14607.5	- 897.7	- 3123.7	-4021.4
Southern Tagalog	8077.0	19981.4	11904.4	5487.9	- 257.2	6673.7	6416.5
Bicol	5161.2	12618.8	7457.6	3506.8	- 333.7	4284.5	3950.8
Eastern Visayas	6909.1	6358.2	-550.9	4694.4	4690.7	- 9936.0	-5245.3
Western Visayas	11036.4	13657.0	2620.6	7498.7	- 518.2	- 4359.9	-4878.1
Northeast Mindanao	5308.6	6334.9	1026.3	3607.0	- .2	- 2580.5	-2580.7
Southwest Mindanao	7302.3	17007.1	9704.8	4961.6	- 677.9	5421.1	4743.2
TOTAL[a]	74399.9	124952.0	50552.1	50552.1	0	0	0
				percent of 1956 production			
Ilocos			112.35	67.94	13.52	30.89	44.41
Cagayan Valley			75.78	67.94	-35.21	43.06	7.84
Central Luzon			49.24	67.94	- 4.18	- 14.53	-18.71
Southern Tagalog			147.39	67.94	- 3.18	82.63	79.45
Bicol			144.49	67.94	- 6.47	83.02	76.55
Eastern Visayas			- 7.98	67.94	67.89	-143.81	-75.92
Western Visayas			23.74	67.94	- 4.69	- 39.51	-44.20
Northeast Mindanao			19.33	67.94	00	- 48.61	-48.61
Southwest Mindanao			132.90	67.94	- 9.28	74.24	64.96
TOTAL[a]			67.94	67.94	0	0	0

[a] Details may not add to total due to rounding.

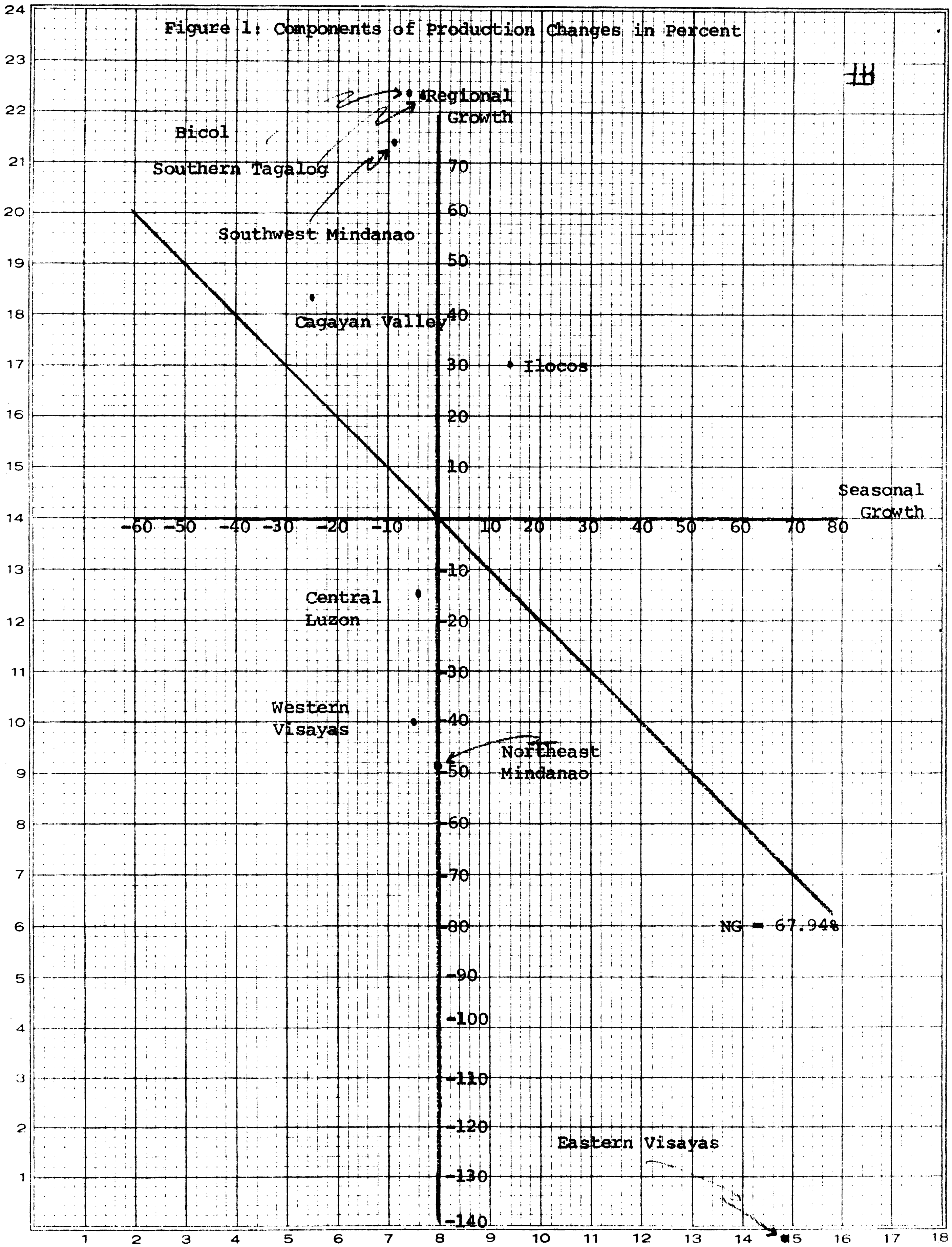
Figure 1 is also a convenient device in determining the sources of productivity change for each region. Depending on the location of a region in the diagram, a region may have (a) positive regional and seasonal growth components as in the case of Ilocos; (b) positive regional and negative seasonal growth components as in the case of Bicol, Southern Tagalog, Southwest Mindanao and Cagayan Valley; (c) negative regional and seasonal growth components as in Central Luzon and Western Visayas; and (d) negative regional growth and positive seasonal growth components as in the case of Northeast Mindanao and Eastern Visayas.

Regions with positive regional growth components (quadrants I and II) have comparative advantage over other regions in the production of rice. This may be due to favorable soil and weather conditions, abundance of controllable water supply, availability of commercial inputs and widespread adoption of the HYV. Regions with positive seasonal growth components (quadrants I and IV) grow the bulk of their rice crops during the October-November-December, and April-May-June cropping periods-periods of favorable rice growing conditions in the Philippines. Six of the nine regions of the country show negative seasonal growth components (quadrants II & III) indicating that a high percentage of their rice crops are harvested during the July-August-September and January-February-March periods. While these periods may not be the most favorable time to plant rice, experience has shown that this cropping pattern proved to be more profitable for the farm unit as a whole, and the more favorable seasons could be used for the production of cash crops, such as tobacco, corn, sugarcane, and vegetables.

Seasonal Shift in Production:

Before the introduction of the certified seeds in the late 1950's and the HYV in the late 1960's, hundreds of rice varieties were used to suit the

Figure 1: Components of Production Changes in Percent



particular growing, climatic, and rainfall characteristics of the region. These varieties had different maturity and photoperiodic characteristics, hence harvest seasons differ from one region to another. The widespread adoption of certified seeds and the HYV has made rice farming more standardized into four distinct seasons.

The seasonal shift in production was estimated from the same set of data that were used earlier in the geographic shift except that, (a) the regional growth component is assumed to be zero, i.e., no regional differences in productivity; and (b) growth rate among all regions is the same as the national growth rate of 67.94%. The result is shown in Table 2.

Table 2 shows the production for 1956 and 1971 classified according to seasons, the change in production for each season, components of change with regional growth component reduced to zero, and the national growth component held at 67.94% for all seasons. Holding these two growth components constant allows the seasonal growth component to vary from one period to another.

The results indicate a shift in production from Season 1 (July-August-September) and Season III (January-February-March), to Season II (Oct.-Nov.-Dec.) and Season IV (April-May-June). Over the four year period from 1966-70, the production in Season I has decreased by 57.08%, while production in Season II has increased by 31.28%. Also, production in Season III has decreased by 101.54%, while production in Season IV had increased by 141.02%.

Varietal Shift in Production:

In 1970, two years after the introduction of HYV, the government started collecting production statistics by regions and varieties. For statistical reporting purposes, five major varietal groups were included: Irrigated High Yielding Variety (HYVI); Rainfed High Yielding Variety (HYVR);

Irrigated Traditional Variety (TVI); Rainfed Traditional Variety (TVR); and Upland Variety (UV).

Using the same procedure to isolate seasonal shift in production (i.e., holding the regional and seasonal growth component constant and allowing for the varietal growth component to vary), and applying it to production and area statistics, the results indicate substantial shifts from traditional to high yielding varieties.

In terms of production, it is evident from Table 3 that the biggest shift occurred from the traditional rainfed variety (TVR) to the high yielding rainfed (HYVR) varieties. Over the three year period from 1970 to 1973, production of the Traditional Rainfed Varieties have declined by 29.01%, while production of the High Yielding Rainfed Varieties has increased by 47.01%. To a lesser extent, similar shift has been observed for the irrigated varieties. While the production of the Traditional Irrigated Varieties has declined by 18.87%, production of the High Yielding Irrigated Varieties has increased by 11.18%. The yield for the Upland Variety has declined slightly by 3.58%.

In terms of area planted, Table 4 shows that the HYV have displaced the traditional varieties. While the area planted with the Traditional Rainfed Varieties has decreased by 23.97%, a corresponding increase of 53.05% was reported for the High Yielding Rainfed Varieties. Also, while the area planted to Traditional Irrigated Varieties has decreased by 18.87%, an increase of 11.18% has occurred for High Yielding Irrigated Varieties. The area planted to Upland Varieties has increased by 5.45%.

A word of explanation about the statistics. In 1971, the Philippines rice production has decreased by 18,608,600 sacks or 15.65% below the 1970 production level, as a result of the devastating typhoons that passed through

Luzon, in 1972, by a severe stemborer infestation. These are shown in the national growth components in Tables 3 & 4.

Within the period of study, the rate of varietal substitution of the irrigated varieties appear to be slower than for the rainfed varieties. This has not been the case in earlier years. By 1970, a higher percentage of irrigated rice lands have already been planted with HYV, and substitution of the irrigated varieties after 1970 were limited to farmers who were either incapable of buying HYV seeds in previous years, or have had no access to supply of HYV.

SUMMARY AND CONCLUSIONS:

In this study, we attempted to determine the impact of the HYV on, (a) the direction and magnitude of regional and seasonal shift in rice production for the period 1956 to 1970; and (b) rate of varietal substitution of traditional for HYV for the period 1970 to 1973. The results are summarized as follows:

1. Over the four year period from 1966 to 1970, an overall national increase in productivity of 67.94% occurred. This increase in production has not been uniformly distributed among regions of the country and throughout the year.
2. Regionally, Southern Tagalog, Bicol, Southwest Mindanao, Ilocos and the Cagayan Valley, in that order, exceed the 67.94% average national growth rate, while Eastern Visayas, Northeast Mindanao, Western Visayas and Central Luzon, in that order, exhibited productivity increases short of the national average.
3. Seasonally, it appears that rice production has been shifting from the July-August-September (Season I) and January-February-March)

Table 2: Components of Production Changes by Seasons

Seasons	Months	Production 1956	Production 1970	Change	Components of Change NG	Components of Change SG	Components of Change RG	Net Shift	Net Shift As Percent of 1956 Prod'n.
		1000 sacks of 44 kgms. each							
I	Jul-Aug-Sept.	9123.8	10115.4	991.2	6199.4	-5208.0	0	- 5208.0	- 57.08
II	Oct-Nov-Dec.	38663.5	77026.9	38363.4	26270.0	12093.4	0	12093.4	31.28
III	Jan-Feb-March	18310.0	12158.8	-6151.2	12440.7	-18592.0	0	-18592.0	-101.54
IV	Apr-May-June	8302.2	25651.0	17348.8	5641.0	11707.9	0	11707.9	141.02
TOTAL		74399.5	124952.1	50552.2	50552.2	0	0	0	

Table 3: Components of Production Changes by Varieties, 1970-1973

Varieties	Production 1970	Production 1973	Change	Components of Change NG	VG	RG	Net Shift	Net Shift As Percent of 1956 Prod'n.
	1000 sacks of 44 kgms each							
High Yielding Variety Irrigated (HYVI)	40497.8	38693.3	- 1807.5	-6335.93	4528.45	0	4528.45	11.18
High Yielding Variety Rainfed (HYVR)	17828.0	23419.8	5591.8	-2789.23	8381.82	0	8381.82	47.01
Traditional Variety Irrigated (TVI)	22252.5	14512.9	- 7679.6	-3481.44	-4198.20	0	-4198.20	-18.87
Traditional Variety Rainfed (TVR)	28749.9	15885.1	-12864.8	-4498.74	-8366.81	0	-8366.81	-29.01
Upland Variety (UV)	9612.9	7764.4	- 1848.5	-1504.51	- 344.54		- 344.54	- 3.58
TOTAL	118941.1	100332.5	-18608.6	-18608.65	0	0	0	

Table 4: Components of Changes in Area Planted by Varieties, 1970-1973

Varieties	Production		Change	Components of Change			Net Shift	Net Shift As Percent of 1956 Hectarage
	1970	1973		NG	VG	RG		
	1000 hectares							
High Yielding Variety Irrigated (HYVI)	826.7	873.0	46.3	-.43	46.73	0	46.73	5.65
High Yielding Variety Rainfed (HYVR)	527.5	807.1	279.6	-.28	279.86	0	279.86	53.05
Traditional Variety Irrigated (TVI)	519.0	368.2	-150.8	-.23	-150.51	0	-150.51	-29.08
Traditional Variety Rainfed (TVR)	828.3	629.3	-199.0	-.41	-198.57	0	-198.57	-23.97
Upland Variety (UV)	412.1	434.4	22.3	-.23	22.50	0	22.50	5.45
TOTAL	3113.6	3112.0	- 1.6	-1.58	0	0	0	

(Season III) production seasons to the October-November-December (Season II) and April-May-June (Season IV) production seasons.

4. Substitution of the traditional varieties (irrigated and rainfed) for the high yielding varieties has been observed for the period, 1970-1973.

5. The biggest source of increased productivity seem to be the national growth component reflecting technological advance in rice agriculture as a result of the adoption of the HYV and the improved practices necessary for its adoption. The regional growth component, also an important source of increased productivity, reflects the comparative advantage of certain regions over other regions in the production of rice.

The above findings showing the overall increase in productivity, and increasing seasonality and regionality of production, have several implications on the economic institutions supporting agriculture. First, increased productivity, generally, should provide increased marketable supply, causing price to go down at a level that the average family can afford. In order for this to occur, economic support institutions including marketing channels, transportation and storage facilities, credit and finance, among others, should be so re-structured as to minimize spatial or regional bunching and seasonal fluctuations of supply. This requires efficient transportation facilities to transport rice from the surplus areas to deficit areas, adequate storage areas at strategic points, and credit availability for middlemen and consumers alike.

Unless companion measures are implemented to minimize the spatial and temporal fluctuations in supply, price differential among regions and seasons will result, price will continue to remain high, and the benefits derived from increased productivity will not be shared equitably among the people.

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