PN-AAT-987 42559

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The Philippine Journal of Crop Science, Vol. 9, No. 2, 1984
Published by the Crop Science Society of the Philippines

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Reprint No. 70

Philipp. J. Crop Sci., 1984, 9(2):89-100
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0115-463x/84 $1.25

An Economic Perspective of Crop Diversification in Rainfed Areas: Implications to National and Regional Planning†

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With the heavy burden imposed by the foreign exchange constraint, the Philippines has no choice but to develop a plan of promoting agricultural production alternatives that are efficient earners/savers of foreign exchange. This paper suggested a generalized sectoral framework in approaching a Philippine agricultural diversification strategy. It further attempted to operationalize the framework to selected crops at the commodity, farmer, regional and national levels. Likewise the economics of crop diversification was assessed at the regional and national levels using the domestic resource cost (DRC) approach.

On the average, most of the crops studied at the national level (except mungbeans) were efficient earners/savers of foreign exchange. Differences, however, existed in terms of the levels of private (financial) and social (economic) profitability as disaggregated analyses were done at the regional and individual commodity production system levels. Sensitivity analyses were done to determine the ranges of border (export-import) prices and technology (yield) upon which selected Philippine crops can maintain international comparative advantage. The border price and technology ranges varied from one crop to another but implied far reaching effects in technology generation and input/output pricing policies.

The research findings cited above present only a partial overview of the crop sub-sector of Philippine agriculture. It would be desirable to expand the economic analysis to other crops and to the other production sub-sectors (livestock, fishery, agro-forestry) to have a more complete picture of the potentials of Philippine agricultural diversification.

The growth in rice production in the Philippines over the past several years has created a potential second generation problem involving surpluses beyond domestic requirements and thus, depressing palay prices received by farmers. Lower rice prices mean lower farm incomes to rice producers. Although there is a government procurement policy of maintaining a floor price, availability of resources limits government intervention into rice trade.

Continued rice surpluses, can be reduced in at least three ways: distribution of rice to target groups in direct food intervention program, exports, and diversification. This paper examines the potential of the third alternative of agricultural diversification. Because efficient earning/saving of foreign exchange is important to the Philippines this paper focuses on the analysis of crops with significant potentials for exports and/or import substitution. This paper presents a general framework in approaching an agricultural diversification strategy and examines the comparative advantage of commodities at the regional and national levels to assess the potentials for an efficient crop diversification.

AGRICULTURAL DIVERSIFICATION: A SUGGESTED APPROACH

Crop diversification is a subset of a larger matrix of production alternatives in the agricultural sector. Hence, it should not be viewed in isolation. In attempting to devise an agricultural diversification strategy for the Philippines, the interface of several interrelated factors should be considered. These general factors are schematically shown in Fig. 1. A two way level of planning, that is, one at the farmers' level and the other, at the regional-national level is suggested in the framework. These two levels should have continuous feedback mechanisms because whatever diversification strategy/policy decisions taken at any one level will inevitably affect the other. Emphasis should be given to the set of variances in resource endowments by region, by agricultural production alternatives and the terms of trade. These factors affect the relative comparative advantage of the different production systems.

Resources endowments consist of land (soils) capability, delineated into texture, slope and elevation, rainfall patterns and physical cropping suitability and emerging technologies which are potential shifters of supply of a production alternative.

In agricultural diversification, production alternatives can be subdivided into crops, livestock, fishery and agroforestry. Each of these sub-sectoral production activities has its own set of input requirements and therefore would have different implications to resource allocation. These can be further disaggregated to the different production systems of individual commodities. By this we mean speci-

†Paper presented at the Plenary Session of the 15th Annual Scientific Meeting of the Crop Science Society of the Philippines (CSSP), MMSU, Batac, Ilocos Norte, May 16-18, 1984.

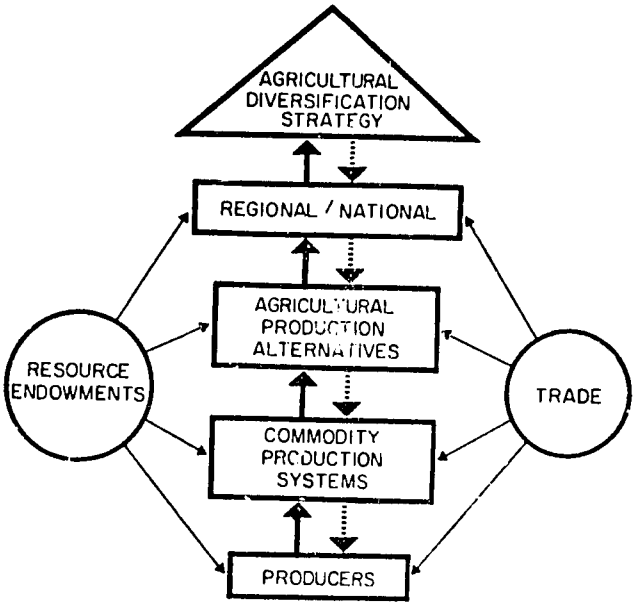

Fig. 1. Suggested framework in approaching agricultural diversification.

fic production technologies for each commodity. At this level of disaggregation, variety/breed, land type, water regime, levels of mechanization, and other technical delineations are taken into account in defining a particular production system of an individual commodity.

Trade is a very important factor when devising an agricultural diversification strategy. Two general levels of trade, domestic and international, through price signals, determine simultaneously the financial and economic viability of the different production alternatives. Actual domestic (market) prices determine the financial feasibility of a commodity enterprise at the farmers' level. On the other hand, export-import prices provided by international trade determine the economic viability of agricultural production activities at the national level.

The economics of crop diversification as it interfaces with resource endowments, trade, agricultural production alternatives and commodity production systems at the farmers level and at the regional-national levels is discussed in the succeeding section.

THE ECONOMICS OF CROP DIVERSIFICATION – A DOMESTIC RESOURCE COST ANALYSIS

This paper approaches the problem of crop diversification within the context of the theory of comparative advantage. This theory dates back to the time of the classical economists who postulated that given variances in technology levels and resource endowments among production alternatives, there would be greater gains in economic efficiency among trading countries if each country would specialize in the production of commodities in which she has a relative comparative advantage. Over the years this economic concept has been operationalized by the use of a measure called domestic resource cost (DRC). DRC can be formally stated as the ratio of domestic costs and border price of output minus foreign cost.

$$(1)\ \text{DRC} = \frac{\text{domestic costs in shadow prices per unit of output}}{\text{border price of output minus foreign cost per unit in border prices}}$$

The numerator is in local currency while the denominator is in foreign currency. The result is the "own exchange rate" for the activity (Medalla and Power, 1979). Medalla and Power further argued that the rationale for using DRC as a measure of relative efficiency is the importance of the foreign exchange constraint on Philippine economic development.

The DRC as a measure of comparative advantage can be compared with the shadow exchange rate (SER) of foreign exchange as in investment criterion of benefit cost analysis. Bruno (1972) postulated that depending on the ratio of DRC/SER, the relative comparative advantage of an economic activity can be determined for a country. Thus if,

$$(a)\ \frac{\text{DRC}}{\text{SER}} < 1 \text{ comparative advantage}$$

$$(b)\ \frac{\text{DRC}}{\text{SER}} = 1 \text{ neutral advantage/disadvantage}$$

$$(c)\ \frac{\text{DRC}}{\text{SER}} > 1 \text{ comparative disadvantage}$$

In contrast to the society's capability in generating foreign exchange from a given production activity, we can also calculate the private cost ratio (PCR) which is the cost of domestic resources valued in market prices, required for every unit of value added, also in market prices.

$$(2)\ \text{PCR} = \frac{\text{cost of domestic factors}}{\text{total revenue minus cost of tradable inputs}}$$

Both numerator and denominator are expressed in market prices or prices actually faced by private producers.

To standardize comparison among different production systems, the private and social profitability indices of these two measures can also be computed. These indices are represented by the following:

$$(3) \quad PP = \frac{\text{net private profit}}{\text{gross private returns}} \times 100$$

where PP = private profitability or simply private net profit as a percentage of gross revenues in actual market prices.

$$(4) \quad SP = \frac{\text{net social profit}}{\text{domestic factor costs}} \times 100$$

where SP = social profitability, a measure of social profit as a percentage of the social value of scarce domestic factors used in production.

In the Philippines, the DRC measures have been utilized as a major component in the study of industrial promotion policies of the Philippines (Bautista et al., 1979) and more recently on the analysis of economic policies and Philippine agriculture (David, 1983). Specifically, studies on the comparative advantage were likewise undertaken for livestock (Cabanilla, 1983); and forestry (Power and Tumaneng, 1983) and some of the major crops such as rice (Unnevehr and Balisacan, 1982), corn (Rodriguez and Rodriguez, 1983), coconut (Clarete and Roumasset, 1983), cotton (Balisacan, 1982), sugar (Nelson and Agcaoili, 1983), and tobacco (Abad, 1982).

Generally the above mentioned commodity studies analyzed the relative comparative advantage at the national level but failed to provide spatial guidelines on where such particular enterprises be undertaken among the different regions of the country. This present study therefore attempts to supplement the past national studies on comparative advantage by extending the analysis among selected agricultural production activities at the regional levels.

General Assumptions. There are several requirements in the calculations of DRC. First is an adequate knowledge of the costs of different production systems and be able to value these costs at their opportunity costs. Second, is the allocation of these costs into domestic and foreign components. Finally, the value of output should be adjusted into their border price equivalents. Table 1 summarizes the percentage used in allocating the foreign and domestic cost components in the production of the different crop enterprises. Generally, this paper utilizes the historical method of allocation in contrast to the "fully tradable assumption". The historical approach assumes that with the expansion of a production activity, the historical proportion of domestic and foreign sources would prevail.

Another crucial aspect in the DRC calculations is the choice of shadow prices to be used in costing the different inputs. In this analysis, there were several resource factors where shadow price calculations were crucial. Among them were: land, labor, costs of capital (interest) and of foreign exchange. Generally, however, this study followed the basic guidelines developed by Medalla and Power (1979), but with slight modifications, when not applicable.

Regarding the land used in production, land rent was costed equal to the value of the existing sharing arrangements in the different production systems for each region. The rationale in adopting this valuation instead of a fixed land value across region was that different regions have different resource endowments. Therefore, the opportunity cost of land for each region should reflect the differences in land quality, productivity, and relative scarcity. For example, the land rents in Ilocos, Cagayan Valley, Central Luzon and Southern Mindanao were relatively higher than in the rest of the regions.

The opportunity costs for labor, both for hired and family were computed as equal to their market wage rate prevailing in the regions. Again, the assumption was that the wage differentials among regions should reflect the relative scarcity and skills of the labor force across regions.

The shadow price of capital (interest) used was 15% which is the usual rate used by the NEDA in evaluating projects. For foreign exchange, the shadow exchange rate (SER) was calculated at OER = SER, and at 20% and 50% higher than the official exchange rate. The official exchange rate used in all the calculations was $1:₱14. The border prices for crops used in the analysis are shown in Table 2. The prices of the potential export commodities such as rice, white potato, cassava, sorghum, garlic and peanuts were FOB, Manila except for sorghum. On the other hand, the import prices for corn, soybeans and cotton were average CIF, Manila (Table 2).

Sources of Data. A major portion of the data used in this analysis came from the crop-livestock-fishery diversifi-

Table 1. Allocation of agricultural input costs into domestic and foreign components and implicit taxes, 1983, historical assumptions.

		Cost components		Implicit
		Domestic	Foreign	taxes
1.	Seeds (hybrid corn)	75	25	–
2.	Fertilizer			
	Urea (implicit tariff IT = 44%)	21	50	29
	Mixed (IT = 42%)	21	49	30
3.	Chemicals	24	46	30
4.	Labor	100	–	–
5.	Animal power	100	–	–
6.	Machine (tractor) (IT = 10%)	37	44	19
7.	Fuel and oil (IT = 25%)	33	27	40
8.	Interest	100	–	–
9.	Depreciation	100	–	–
10.	Land	100	–	–
11.	Irrigation (IT = -86%)	214	500	-614

Sources: Cabanilla (1983); Power and Medalla (1983); Unnevehr and Balisacan (1983); Rodriguez (1982); David and Balisacan (1981);

cation farm management survey launched from July to October 1983. In addition these primary data were supplemented by studies done at the Philippine Institute of Development Studies (PIDS), The Policy Analysis Staff (PAS), Bureau of Agricultural Economics, Ministry of Agriculture, the Central Luzon State University, the University of the Philippines at Los Baños (UPLB), the private sector, and other government and non-government sources.

Table 2. Border prices used for DRC calculations.

Commodity	Nature of trade	$/mt
Rice	Export	283 (FOB, Manila)[a]
Corn	Import	157 (CIF, Manila)[b]
Cotton	Import	1,636 (CIF, Manila)[c]
Soybean	Import	287 (CIF, Manila)[d]
Mungbeans	Import	249 (CIF, Manila)[e]
White potato	Export	285 (FOB, Manila)[f]
Cassava	Export	462 (FOB, Manila)[g]
Sorghum	Export	111 (FOB, U.S.)[h]
Garlic	Export	767 (FOB, Manila)[i]
Peanuts	Export	800 (FOB, Manila)[j]

[a] Average export price of Philippine rice from 1977 to 1981.
[b] Foreign Trade Statistics, average CIF value of corn imports from both U.S. and Thailand from 1978 to 1982.
[c] Foreign Trade Statistics, 1982. Average import prices of raw cotton adjusted for quality by 14%.
[d] Foreign Trade Statistics, 1978-1982. Five-year moving average of import prices for soya beans.
[e] Foreign Trade Statistics. Average import price of green or yellow mungbean, 1978-1982.
[f] Foreign Trade Statistics. Average export price of fresh potatoes, 1978-1982.
[g] Foreign Trade Statistics. Average export price of fresh or dried cassava, 1978-1982.
[h] NFA. Average price (FOB, U.S.) of sorghum, 1982.
[i] Foreign Trade Statistics. Average export price of fresh or chilled garlic, 1978-1982.
[j] Foreign Trade Statistics. Average export price, 1980 (most recent year of exportation of green peanuts).

RESULTS AND DISCUSSION

Four distinct but interrelated results relevant to crop diversification are presented. They are: (a) delineations of the physical factors (resource endowments and cropping suitability) at the regional-national levels; (b) comparative advantage of selected crops at the regional level, particularly, the Ilocos Region; (c) comparative advantage of selected crops at the national level; and (d) sensitivity analysis of the competitiveness of selected crops at the international level.

Crop Diversification and Interactions with the Physical Factors. The physical factors or resource endowments are vital in determining the comparative advantage of a production activity. We attempted to interface existing rainfall distribution, land use and cropping patterns with the physical characteristics (texture, slope, elevation) of soils for the different regions in the Philippines.

Rainfall distribution was delineated into 13 possible patterns, categorized according to the length and nature of dry and wet months over the year (Table 3). On the other hand, soils were classified into 6 categories based on texture (Table 4). Based on possible cropping patterns devised by the UPLB Multiple Cropping Source Book (1977), the rainfall distribution, soil texture, slope and elevation were mapped together (Table 5) to form cropping pattern by physical suitability and by region. Results of this physical mapping are found in Table 6. Based on the above physical characteristics of soil and rainfall distribution and possible combinations of one or two cropping patterns, the possible physical cropping hectarage of the Philippines was estima-

Table 3. Rainfall distribution characteristics, Philippines.

Code	Rainfall Description	Dry Months	Wet Months	Transition Months
1.1	– Less than 2 dry mo, greater than 9 wet mo	April	May-Feb.	March
1.2	– Less than 2 dry mo, 7-9 wet mo	April	July-Mar.	May, June
1.3	– Less than 2 dry mo, 5-6 wet mo	Feb.	May-Oct.	Jan., April
1.4	– Less than 2 dry mo, 3-4 wet mo	Feb.	Oct.-Jan.	Mar.-Sept.
1.5	– Less than 2 dry mo, less than 3 wet mo	Feb.	May, June	Jan., Mar., Apr., Jul.-Dec.
2.2	– 2-4 dry mo, 7-9 wet mo	Mar.-May	June-Dec.	Jan., Feb.
2.3	– 2-4 dry mo, 5-6 wet mo	Jan.-Apr.	July-Oct.	May, June, Nov., Dec.
2.4	– 2-4 dry mo, 3-4 wet mo	Jan.-Apr.	July-Oct.	May, June, Nov., Dec.
2.5	– 2-4 dry mo, less than 3 wet mo	Feb.-Apr.	Sept., Oct.	May-Aug., Nov.-Jan.
3.3	– 5-7 dry mo, 5-6 wet mo	Dec.-Apr.	June-Oct.	May, Nov.
3-4	– 5-6 dry mo, 3-4 wet mo	Dec.-Apr.	June-Sept.	May, Oct., Nov.
3.5	– 5-6 dry mo, less than 3 wet mo	Jan.-Apr.	Sept., Oct.	May-Aug., Nov., Dec.
4.5	– Greater than 6 dry mo, less than 3 wet mo	Oct.-Apr.	May, June	July-Sept.

Note: Dry months – rainfall is less than 100 mm/mo.
Wet months – rainfall is more than 200 mm/mo.
Months with rainfall ranging from 100-200 mm/mo would be the transition months.
Source: Bruce (1984).

Table 4. Soil characteristics, Philippines.

Code	Soil description
1	Soil with less than 40% clay-silt fraction on the surface; light textured soil which includes fine sands and sandy loams
2	Soil with 40-60% clay-silt fraction on the surface; includes silt loams, sandy clay loams, silty clay loams
3	Soil with 60-80% clay-silt fraction on the surface; includes clay loams, silty clays
4	Soil with greater than 80% clay-silt fraction on the surface; includes clays
Hy	Hydrosol; soils on swamps and marshes and other water logged areas
Ms	Unclassified soils on the mountains

Source: Bruce (1984).

ted at 10.564 million hectares (Table 6).

By using further the criteria of suitability of soil, slope, elevation and rainfall distribution across regions, the study roughly estimated the land areas feasible for corn, soybeans and cotton production from across existing land use. Within the irrigated, rainfed and upland areas, the physical areas suitable to corn, soybeans and cotton were estimated at 1.413, 1.608 and 0.583 million hectares, respectively (Table 7). Significant hectarages of these suitable physical areas are found within rainfed areas. The area for soybeans is probably overstated because the classification does not account for solar radiation, which can be limiting to soybean production.

Crop Diversification at the Regional Level (The Ilocos Region). Before assessing simultaneously the relative comparative advantage of several commodities at the regional or national levels, individual crops were first evaluated at the farmer's production systems (technology) level. Two standard measures, the private profitability (PP) and social profitability (SP) indices were used to rank the financial and social viability of these individual crops at the produc-

Table 5. Possible cropping pattern suitability, Philippines.

Cropping pattern code		Agro-climate† (mo) WM	DM	TM	Texture of surface soil	Slope (% Steepness)	Elevation (m above sea level)
1.	R-DTC	3-4	1-4	5- 7	Silt loam, sandy clay loam, silty clayloam, clayloam, silty clay, clay	0- 9	0- 50
2.	R-R-DTC	5-6	1-4	3- 5	Silt loam, sandy clayloam, silty clayloam, clayloam, silty clay, clay	0- 9	0- 50
3.	R-R-UC	7-9	1-4	1- 3	Silt loam, sandy loam, clayloam, silty clayloam, loam, silty clay, clay	0- 9	0- 50
4.	UC-DTC	5-7	3-5	1- 3	Fine sand, sandy loam, silt loam, silty clayloam, clayloam, sandy clayloam	0-30	50-200
5.	UC-UC-DTC	3-6	1-3	4- 7	Fine sand, sandy loam, silt loam sandy clayloam, silty clayloam	0-30	50-200
6.	UC-UC-UC	2-4	1-3	8-10	Fine sand, sandy loam, netloam, sandy clayloam, silty clayloam	0-30	50-200
7.	R-R-R	Irrigated areas					

Hy, Waterlogged areas
X, not classified for cropping pattern suitability; elevation greater than 200 m., slope more than 18% and soils either too shallow or too stony
R, Lowland rice
UC, Upland crop, mainly corn and upland rice
DTC, Drought-tolerant crops such as mungbean, cowpea, sorghum, cassava

†Based on agroclimatic maps, IRRI.

WM, months with rainfall greater than 200 mm/mo.
DM, months with rainfall less than 100 mm/mo.
TM, months with rainfall ranging from 100-200 mm/mo.

Note: 1. Where one agroclimate is suitable to 2 cropping patterns, a combination of 2 pattern is shown, as 1-4, 1-5, 1-6, 2-4, 2-5, and 3-4.
2. Cropping pattern design taken from Multiple Cropping Source Book, 1977, UPLB.

Source: Bruce, 1984.

Table 6. Possible cropping pattern by suitability, by region, Philippines.

Region/ Suitability	1	1-4	1-5	1-6	2	2-4	2-5	3	3-4	4	5	6	7	hy	x	Total (hectares)
I	6,928	161,768			28,612	25,702			1,317	59,400			196,648		1,676,465	2,156,840
II		573	11,043		98,402	278,250		88,588		243,900			195,519		2,724,025	3,640,300
III		186,707			143,391	125,812			2,259	90,900			318,306	49,500	906,205	1,823,080
IV					416,767	701,933		65,710	10,080	6,300			91,610	28,575	1,945,405	3,266,380
IV A	78,492		30,938		204,620	77,592	4,868						8,040	26,775	1,058,305	1,489,630
V	79,412		43,756	40,253	249,174	123,068	166,163	95,751	210,818			19,800	109,630	38,700	586,725	1,763,250
VI	18,629		6,612		264,845	260,931	8,415	146,102					115,966	72,675	1,128,145	2,022,320
VII	28,511		61,828		34,966	16,357					325,800	44,100	14,938	15,750	952,900	1,495,150
VIII	33,676		44,191		97,711	13,828		269,972	251,927		47,700	25,200	28,495	26,775	1,303,675	2,143,150
IX	A 13,500										264,475			41,625	81,900	401,500
IX				B	42,112	133,540		43,014	214,166	27,900			28,868	41,625	935,785	1,467,010
X					141,248		23,976	216,127	152,215	105,300	116,100		115,559	64,125	1,898,130	2,832,780
XI	93,440		25,025	130,348	122,606	24,662	130,348	98,840	101,882	71,100	10,800		35,849	15,975	2,308,415	3,169,290
XII	305,288		7,358		98,553	27,946	26,889	22,231		93,600	122,400	43,200	74,235	88,500	1,419,120	2,329,320
Total (has)	657,876	349,048	230,751	170,601	1,943,007	1,809,621	360,659	1,046,335	944,664	698,400	887,275	132,300	1,333,663	510,600	18,925,200	30,000,000

Suitability Codes:

1 = Lowland Rice (R) – Drought Tolerant Crops (DTC) such as mungbean, cowpea, sorghum and cassava
2 = Lowland Rice – Rice-DTC
3 = R-R- Upland Crop (UC) mainly corn and upland rice
4 = UC-DTC
5 = UC-UC-DTC
6 = UC-UC-UC
7 = R-R-R
hy = Waterlogged areas
x = Not classified for cropping pattern suitability; elevation greater than 200 m; slope greater than 18%; and soils either too shallow or stony.

Source: Bruce (1984).

Table 7. Hectarages of areas suited to corn, soybeans and cotton production within the rainfed and irrigated rice areas and upland crop areas, (by regions) based on soil and topographic characteristics.†

Crop Area	R I	R II	R III	E IV	G IVA	G V	I VI	I VII	O VIII	O IXA	O IXB	N X	S XI	S XII	Total area in hectares
Within rainfed rice area															
Corn	129,825	177,525	176,512	51,525	675	67,275	130,969	33,525	72,000	0	37,350	4,950	33,300	19,400	934,831
Soybeans	100,817	117,056	171,865	35,807	–	14,709	34,875	38,404	52,518	225	5,216	1,303	–	26,300	599,095
Cotton	55,007	65,590	74,412	8,068	450	562	26,925	3,641	10,696	–	2,146	612	96	2,701	250,906
Within irrigated rice area															
Corn	89,550	55,575	44,550	2,475	0	21,375	9,000	0	0	0	0	45,225	0	0	267,750
Soybeans	141,586	180,954	246,590	26,566	3,182	78,979	81,977	7,469	16,194	–	4,751	1,477	17,806	69,781	877,312
Cotton	53,094	6,745	36,701	17,516	804	2,302	23,193	–	903	–	4,385	7,767	8,517	–	161,927
Within upland crop area															
Corn	34,875	52,425	7,200	17,325	0	0	0	16,025	4,500	0	0	11,250	19,125	47,925	210,650
Soybeans	18,956	19,908	27,122	20,196	–	–	5,387	10,944	–	–	–	–	16,682	12,420	131,615
Cotton	18,900	19,620	27,121	20,196	–	–	5,386	49,429	–	–	–	–	17,399	12,690	170,741
Total area															
Corn	254,250	285,525	228,262	71,325	675	88,650	139,969	49,550	76,500	0	37,350	61,425	52,425	67,325	1,513,231
Soybeans	261,359	317,918	445,577	82,569	3,182	93,688	122,239	56,817	68,712	225	9,967	2,780	34,488	108,501	1,608,022
Cotton	127,001	91,955	138,234	45,780	1,254	2,864	55,504	53,070	11,599	–	6,531	8,379	26,012	15,391	583,574

†Criteria for area selection:

(a) **Corn**: soil should have texture ranging from sandy loam to silty clay loam; rainfall includes the major patterns except those with less 3 wet mo; slope should range from 0 to 3%; elevation not greater than 50 m above sea level.

(b) **Soybeans**: rainfall condition includes those areas with 3 to 6 wet mo and not more than 6 dry mo; slope not steeper than 3%, elevation not higher than 200 m above sea level; soil with wide range of soil texture from fine sand to clays.

(c) **Cotton**: abundant but not excessive rainfall, with elevation not higher than 50 m above sea level; slope not steeper than 9%, soil texture ranging from fine sand to sandy loams.

Source: Bruce (1984).

Table 8. Ranking of private profitability (PP) of corn production by type of system, by region, Philippines, 1983 (%).

Production systems	R I PP	R I Rank	R II PP	R II Rank	R III PP	R III Rank	E IV PP	E IV Rank	G V PP	G V Rank	I VI PP	I VI Rank	I VII PP	I VII Rank	O VIII PP	O VIII Rank	N IX PP	N IX Rank	N X PP	N X Rank	S XI PP	S XI Rank	S XII PP	S XII Rank
PS I : WTVI	37	3			8																			
PS II : WTVNI	33	4	5	14	-33		23	8	-1		7	13	-39		-72		-30		-22		-14		-26	
PS III : WIVI					-0.8																			
PS IV : WIVNI					-224						-39				-174		28	7	-10		-143			
PS V : YTVNI	-7		-65						-15		-231								31	6				
PS VI : YIVI	10	12																						
PS VII : YIVNI	12	11	42	2	-24		-36	18	10		0.6		-18		-167		-96						-31	
PS VIII : YHVNI	-28										49	1							1	15	32	5	20	9

Table 9. Domestic Resource Cost (DRC) and comparative advantage of corn production, by type of system, by region, Philippines, 1983.

	R I DRC	R I DRC/SER	R II DRC	R II DRC/SER	R III DRC	R III DRC/SER	E IV DRC	E IV DRC/SER	G V DRC	G V DRC/SER	I VI DRC	I VI DRC/SER	I VII DRC	I VII DRC/SER	O VIII DRC	O VIII DRC/SER	N IX DRC	N IX DRC/SER	N X DRC	N X DRC/SER	S XI DRC	S XI DRC/SER	S XII DRC	S XII DRC/SER
PS1 : WTVI	5.5	0.33			4.5	0.27																		
PS2 : WTVNI	6.2	0.37	6.9	0.41	9.3	0.55	5.9	0.35	8.6	0.51	7.0	0.42	9.5	0.56	14.2	0.85	9.6	0.57	9.3	0.55	8.3	0.49	7.9	0.47
PS3 : WIVI					7.8	0.47																		
PS4 : WIVNI					7.5	0.45					11.2	0.67			22.9	1.36	4.4	0.26	6.8	0.41	18.8	1.12		
PS5 : YTVNI	9.7	0.58	11.9	0.7					9.5	0.56	25.9	1.54								0.28				
PS6 : YIVI	7.9	0.47																						
PS7 : YIVNI	8.2	0.49	3.8	0.22	8.7	0.52	11.4	0.68	6.4	0.38	7.8	0.47	7.8	0.47	22.0	1.31	15.6	0.93					8.3	0.50
PS8 : 12.3 0.73											3.0	0.18							5.9	0.35	4.2	0.25	4.8	0.29

Table 10. Ranking of Social Profitability (%) of corn production systems, by region, Philippines, 1983.

	R I SP	R I Rank	R II SP	R II Rank	R III SP	R III Rank	E IV SP	E IV Rank	G V SP	G V Rank	I VI SP	I VI Rank	I VII SP	I VII Rank	O VIII SP	O VIII Rank	N IX SP	N IX Rank	N X SP	N X Rank	S XI SP	S XI Rank	S XII SP	S XII Rank
PS1 : WTVI	154	8			208	5																		
PS2 : WTVNI	126		102		50		135	10	64		99		48		- 1.5		45		51		69		76	
PS3 : WIVI					78																			
PS4 : WIVNI					85						24				-39		215	4	105		-26			
PS5 : YTVNI	44		17						48		-46								192	6				
PS6 : YIVI	79																							
PS7 : YIVNI	71		272	2	60		22		119		79		79		-37		-10						68	
PS8 : YHVNI	13										354	1							136	9	231	3	189	7

tion systems level before they were compared with the other crops at the regional-national levels.

This procedure is best illustrated by taking corn as an example. Corn was delineated into 8 production systems distributed across 12 regions. The production systems for corn were:

PS1 :	White Traditional Variety, Irrigated	(PS1: WTVI)
PS2 :	White Traditional Variety, Non-irrigated	(PS2: WTVNI)
PS3 :	White Improved Variety, Irrigated	(PS3: WIVI)
PS4 :	White Improved Variety, Non-irrigated	(PS4: WIVNI)
PS5 :	Yellow Traditional Variety, Non-irrigated	(PS5: YTVNI)
PS6 :	Yellow Improved Variety, Irrigated	(PS6: YIVI)
PS7 :	Yellow Improved Variety, Non-irrigated	(PS7: YIVNI)
PS8 :	Yellow Hybrid Variety, Non-irrigated	(PS8: YHVNI)

The PP, DRC, comparative advantage (DRC/SER) and SP were then calculated for each of the production systems across regions where samples were available. The evaluation of the relative comparative advantage of these systems was done in the form of ranking based on the magnitude of their computed PP and SP. Two types of evaluation were possible. One was by comparing corn production systems across regions. With this method one could pinpoint the specific production system highly suitable to a specific region. This procedure was used in comparing average production systems at the national level. Tables 8, 9, and 10 illustrate the first method of evaluation. For example PS8: Yellow Hybrid Non-irrigated corn produced in Region VI topped the other corn production systems across regions in terms of the magnitude of its PP (49%) and SP (354%)'

The other method was to rank the production systems within the confines of a single region. The procedure can be illustrated for the Ilocos Region in Table 11. In this procedure, PS1: WTVI and PS2: WTVNI, ranked first and second, respectively in both the PP and SP criteria. PS8: YHVNI ranked last in the Ilocos Region. The above procedure was also done for the analysis of the other crops in the Ilocos Region.

The same procedures used for corn were used for other crops. Then an average crop production system was calculated for each crop before it was compared with the average production systems of the other crops at the regional and national levels.

Following the above procedures, the private profitability of 16 crops was analyzed for the Ilocos region. Of the 15 crops studied, onion was the most financially viable crop for Ilocos, exhibiting a PP of 85% (Table 12). Watermelon, sweet peas, baguio beans and cabbage also had high positive private profitabilities. However, hybrid corn (in contrast to open-pollinated corn), peanuts and tomatoes on the average, exhibited negative private profitability (Table 12).

Of the eight crops whose DRCs were calculated for the Ilocos region, cassava ranked first with a PP of 322%. It was followed by cotton, peanuts, rainfed lowland rice and open-pollinated corn for the second to the fifth positions with SP ranging from 94 to 143%. The other crops (garlic, white potato, mungbeans, hybrid corn and irrigated rice) likewise showed positive social profitability (Table 13).

Crop Diversification at the National Level. If we aggregate the analysis to the national level, the PP and SP ranking would exhibit a different pattern. Among the 10 crops assessed on the basis of national average, irrigated rice ranked number one with 23% PP. Hybrid corn and cotton were ranked number two and three, respectively, in private

Table 11. Ranking of Private Profitability (PP) and Social Profitability (SP) of corn production systems, Ilocos, Region, Philippines, 1983.

	PP (%)	Rank	SP (%)	Rank
PS1 : WTVI	37	1	154	1
PS2 : WTVNI	33	2	126	2
PS3 : WIVI				
PS4 : WIVNI				
PS5 : YTVNI	-7	5	44	5
PS6 : YIVI	10	4	79	3
PS7 : YIVNI	12	3	71	4
PS8 : YHVNI	-28	6	13	6

Table 12. Summary of Private Profitability (PP) of agricultural crops in the Ilocos region.

Crop	Private Profitability Percentage	Ranking
Rice, rainfed lowland	20.0	8
Rice, irrigated	25.0	7
Corn, open-pollinated	17.0	12
Corn, hybrid	-28.3	19
Cotton	8.3	14
Mungbeans	19.3	10
White potato	14.1	13
Cassava	17.4	11
Peanuts	-22.5	18
Garlic	0.5	16
Tobacco, Virginia	1.0	15
Tobacco, native	19.6	9
Tomatoes	-9.3	17
Cabbage	32.6	6
Watermelon, lowland	61.4	2
Watermelon, upland	50.9	4
Baguio beans	47.0	5
Sweet peas	58.0	3
Onions	85.0	1

profitability. Garlic, soybeans and rainfed lowland rice had almost identical PPs of around 21%. Only open-pollinated corn had negative private profitability of 4% (Table 14).

In terms of social profitability, cassava on the national average had the highest percentage of 342. Cotton was also impressive with a high SP of 184%. Hybrid corn and peanuts had SP of 177 and 143%, respectively. The others with the exception of mungbeans (-38%) had SP ranging from 24 to 97% (Table (14).

Sustainability of Comparative Advantage in Philippine Crops. Except for mungbeans, the DRC analysis of crops at the national level calls for optimism. The question however is: Under what set of international prices and technology (yield) levels can the Philippines sustain her relative advantage? A sensitivity analysis was done to answer this question. Because the 10 crops analyzed at the national level were facing a different set of trade, technology and cost structures, the answer would therefore vary by commodity.

In general, however, corn production (open-pollinated and hybrid) seemed to have the most optimistic ranges of sustainability. Given the current observed yields ranging from 1.67 to 3.57 mt/ha, Philippine corn production would be able to sustain its competitiveness in trade as long as the border price of corn would not go lower than the range of $55 to $87/mt. Similarly, given the current border price of $157/mt, as long as corn yields would not go lower than 0.90 mt/ha (open-pollinated corn) to 1.51 mt/ha (hybrid corn), the production of corn would still be an efficient method of earning/saving foreign exchange (Table 15).

For rice, given current yield levels, rainfed lowland rice had the lowest breakeven border price ($126/mt) among three national average rice production systems. However, rainfed upland rice had the lowest breakeven yield (1.26 mt/ha) (Table 15).

On the other hand, cotton production can lower its current import price level of $[illegible],636/mt to 30% and yield to as low as 0.21 mt/ha of cotton seed and still be an effi-

Table 13. Summary of Domestic Resource Cost (DRC), Comparative Advantage, and Social Profitability of agricultural crops in the Ilocos Region.

Crop	DRC	Comparative Advantage	Social Profitability Percentage	Social Profitability Ranking
Rice, rainfed lowland	7.1	0.42	98.0	4
Rice, irrigated	7.6	0.45	85.1	6
Corn, open-pollinated	7.5	0.49	94.3	5
Corn, hybrid	12.3	0.73	13.5	10
Cotton	5.8	0.35	142.9	2
Mungbeans	15.2	0.90	14.2	9
White potatoe	7.9	0.47	79.4	7
Cassava	3.4	0.20	322.4	1
Peanuts	5.9	0.35	135.1	3
Garlic	9.3	0.56	49.9	8

Table 14. Summary on Private Profitability (PP), Domestic Resource Cost (DRC), Comparative Advantage and Social Profitability (SP) of Philippine Agricultural Systems, 1983.

System†	Private Profitability Percentage	Private Profitability Ranking	DRC	Comparative Advantage‡	Social Profitability Percentage	Social Profitability Ranking
Rice, rainfed upland	12.2	9	8.13	0.49	74.8	10
Rice, rainfed lowland	19.8	6	7.12	0.43	96.7	5
Rice, irrigated	24.8	1	7.60	0.46	83.9	6
Corn, open pollinated	-4.4	13	8.70	0.52	75.0	9
Corn, hybrid	24.5	2	5.10	0.30	177.0	3
Cotton	24.2	3	4.87	0.29	184.4	2
Soybeans	22.0	5	10.40	0.62	36.0	11
Mungbeans	6.5	11	23.7	1.41	-38.1	13
White potato	14.1	7	7.9	0.47	79.4	8
Cassava	3.5	12	3.6	0.22	341.97	1
Sorghum	13.4	8	8.2	0.49	81.3	7
Peanuts	11.5	10	5.78	0.34	142.63	4
Garlic	23.2	4	11.3	0.67	23.57	12

† Average technology across production systems and regions.
‡ At shadow exchange rate (SER) = 1.2 of official exchange rate (OER).

Table 15. Average breakeven border prices and yields levels of the different crop production systems, Philippines, 1983.

	Breakeven border price at average observed yields	Breakeven yields at given border price
	($/mt)	(mt/ha)
Rice, rainfed, upland	142.13[a]	1.26[n]
Rice, rainfed, lowland	126.06[b]	1.44[n]
Rice, irrigated	139.52[c]	2.07[n]
Corn, open-pollinated	87.43[d]	0.90[o]
Corn, hybrid	55.24[e]	1.51[o]
Cotton	562.39[f]	0.21[p]
Soybeans	218.47[g]	0.84[q]
Mungbeans	307.20[h]	0.45[r]
White potato	142.50[i]	6.75[s]
Cassava	101.21[j]	0.31[t]
Sorghum	57.67[k]	1.22[u]
Peanuts	282.35[l]	0.29[v]
Garlic	529.35[m]	1.42[w]

[a] At average observed yields of 2.86 mt/ha (palay).
[b] At average observed yields of 3.51 mt/ha (palay).
[c] At average observed yields of 4.14 mt/ha (palay).
[d] At average observed yields of 1.67 mt/ha (shelled corn).
[e] At average observed yields of 3.67 mt/ha (shelled corn).
[f] At average observed yields of 1.74 mt/ha (seed cotton).
[g] At average observed yields of 1.30 mt/ha (beans).
[h] At average observed yields of 0.36 mt/ha (beans).
[i] At average observed yields of 13.6 mt/ha (fresh potato).
[j] At average observed yields of 2.10 mt/ha (dried cassava).
[k] At average observed yields of 2.45 mt/ha (grain).
[l] At average observed yields of 0.85 mt/ha (shelled peanuts).
[m] At average observed yields of 2.22 mt/ha (dried cloves).
[n] At border price of $283/mt, FOB, Manila (milled rice), yields in palay equivalent; to convert them to rice, the milling recovery rate used was 0.65.
[o] At border price of $157/mt, CIF, Manila.
[p] At border price of $1,636/mt of lint (CIF, Manila), adjusted for quality by 14%.
[q] At border price of $287/mt (CIF, Manila).
[r] At border price of $248/mt (CIF, Manila).
[s] At border price of $285/mt (CIF, Manila).
[t] At border price of $462/mt (FOB, Manila).
[u] At border price of $111/mt (FOB, U.S.).
[v] At border price of $800/mt (FOB, Manila).
[w] At border price of $767/mt (FOB, Manila).

cient saver of foreign exchange (Table 15).

The range of breakeven border prices and yields for the remaining crops (soybeans, mungbeans, white potato, sorghum, peanuts and garlic), as shown in Table 15, can be interpreted in the same manner as rice, corn and cotton.

SUMMARY AND CONCLUSIONS

Agricultural diversification research is relatively a new area in the Philippines. Most of the researches done in the past were on a location-commodity specific basis and failed to consider the interactions of the major factors (physical, technology, socio-economic) that affect agricultural production alternatives in the regional, national and international (trade) levels. With the present foreign exchange constraint, the Philippines has no choice but to develop a strategy of promoting agricultural production alternatives that are efficient earners/savers of foreign exchange.

From the study, the following conclusions were deduced:

(1) Agricultural diversification problem should be approved as an integrated strategy, taking into account simultaneously, the interfaces of the physical, technological and socio-economic factors at the sector level.

(2) Crop diversification planning should not be viewed in isolation at the individual commodity production systems level but simultaneously with other commodities/agricultural production possibilities at the regional, national and even at the international levels.

(3) Because of the foreign exchange constraint being faced by the Philippines today, a strong economic argument of efficiency exists in the domestic production of currently imported commodities (cotton, corn and soybeans) and potential export crops (rice, white potato, cassava, sorghum, garlic and peanuts). This finding has a tremendous implications to resource allocation and technology generation in the agricultural sector, in particular, and the Philippine economy in general.

(4) The economic analysis in selected crops should be expanded to other crops and the other production sub-sectors (livestock, fishery, agro-forestry) in the agricultural sector to have a more complete picture of the production alternatives. Also, there is a need to study the potential international markets for non-traditional exportable commodities which are efficient earners of foreign exchange.

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