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The Comparative Advantage of Maize and Poultry Feed Production in Lampung and West Java, Indonesia[1]

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Introduction

Maize is the second major food after rice in Indonesia. Although it is consistently decreasing, the maize contribution to the total food consumption has been dominant in the last 17 years (Directorate General of Food Crops, in Djatiharti and Rusastra, 1990). In 1970 the maize contribution to total food consumption reached 70 percent of maize production and then fell to 56 percent in 1986. In the same period, the amount of maize used for feed increased sharply from 15' percent in 1970 to 37 percent in 1986. At the end of Repelita V (1993) the amount of maize needed for feed is projected to reach 1411 thousand tons, 66 percent of which would be used for poultry feed (CARD and Ministry of Agriculture, 1990).

To meet the drastic increase in the domestic demand for maize due to the rapid expansion of the domestic poultry industry, Indonesia has had to import maize since 1976. Nevertheless, the amount of maize import has been small, on average, 33.6 thousand tons/year during the 1976-1987 period which was about 0.8 percent of the total national production. During this period Indonesia was also exporting some maize, but exports fluctuated with production levels. Fulfilling domestic demand (self sufficiency) has been the main objective of the national maize production policy.

In attempting to increase domestic production the immediate question would be "is domestic maize production efficient in resources used"?. This short paper is intended to answer the question. Specifically, this paper evaluates the comparative advantage of domestic feed production under three trade regimes: import substitution, interregional trade and export promotion. In addition the analysis is also conducted under two raw material regimes, namely, imported maize and domestic maize. The discussion begins with a brief review of maize production at national level.

Methods

A study was conducted in West Java and Lampung using the 1988 data. The two locations were chosen based on the following considerations:

(1) West Java is a major feed-producing and using area. Of the total 91 feed factories in

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Indonesia in 1987, 35 of them were located in West Java which contributed 30 percent to the total domestic feed production. But maize production in West Java was only 3.90 percent of the total national production.

(2) Lampung is one of the major maize producers but with a very small feed industry. Lampung contributed 6.12 percent to the total national maize production in 1986, but only had 4 feed factories which produced 2.67 percent of the national feed production.

The data for comparative advantage analysis were obtained from two feed factories in each location. The average production capacity of the Bogor factories was 38,700 tons/year with capacity utilization of 72 percent. In Lampung, the average production capacity was 44.000 tons/year with capacity utilization 87 percent. The types of feed analyzed were for layer and broiler-finisher. The data for maize production costs were obtained from the CBS Farming Cost Structure.

The comparative advantage will be analysed under three trade regimes:

(1) import substitution (IS), which is evaluated at the wholesaler;
(2) inter-regional trade (IR) which is evaluated at the regional port of destination; and
(3) export promotion (EP), which is evaluated at the nearest port of exportation.

The comparative advantage is analyzed using various criteria, namely: domestic resource cost ratio (DRCR) and net economic benefit (NEB). In addition to the comparative advantage indicators, some incentive indicators are also computed namely: effective protection rate (EPR and implicit tariff (IT). The formula for computing those indicators are as follows:

$$DRCR = \frac{DC - DB}{TB - TC} \quad \text{(1)}$$

DRCR = domestic resource cost ratio
DC = domestic cost (non-tradeable resource cost)
DB = domestic benefit
TB = tradeable benefit
TC = tradeable cost

The production process is efficient in domestic resource use if DRCR <1. But if DRCR> 1, then the production process is not efficient.

$$NEB – TGB – TCPM \quad \text{(2)}$$

NEB = net economic benefit
TGB = total gross benefit
TCPM = total cost of production and marketing

All prices used to compute DRC and NEB are the shadow (economic) prices. We should note that DRCR <1 implies NEB >0 and DRCR >1 implies NEB <0.

$$IT = \left(\frac{FIIC\ FI}{EIIC} - 1 \right) \times 100\% \quad \text{(3)}$$

IT = implicit tariff
FIIC = financial intermediate input cost
EIIC = economic intermediate input cost

It should be clear that II < 0 indicates that the economic activity receives subsidy, whereas IT > 0 indicates that the economic activity does not receive subsidy through its inputs.

$$EPR = \left(\frac{FVA}{EVA} - 1 \right) \times 100\% \quad \text{(4)}$$

EPR = effective protection rate
FVA = financial value added
EVA = economic value added

IF EPR > 0 then we may say that the economic activity receives incentives, whereas if EPR < 0 then the economic activity is burdened by disincentives.

National Maize Production Situation

National maize production increased from 2.3 million tons in 1969 to 5.2 million tons in 1987 or an increase on average of 4.6 percent/year. Although increasing, the national maize production, however, has fluctuated. Production growth has been mainly due to the rapid increase in productivity. Productivity increased from 0.94 ton/ha in 1969 to 1.96 ton/ha in 1987 or an average growth rate of 4.2 percent/year. The harvested area was growing at an average of 0.3 percent/year or from 2.4 million hectare in 1969 to 2.6 million hectare in 1987. By the end of Pelita V (1993) the total national maize production is projected to reach 8044 thousand ton which arises from 3573 thousand hectare of harvested area with a productivity 2.25 ton/ha (CARD and MOA, 1989).

Editorial

The process and actions of transformation: some implications

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One often hears of "transition of economies". It has recently acquired a special meaning, that is, the adjustment of efforts or the process of making a transition from a centrally planned to a market-oriented economy.

In the past, a number of economies in the Asian region pursued the ideals of socialism and egalitarian growth policies, which achieved, in most cases, mixed or limited success. In order to rekindle an economy, particularly those plagued by civil unrest, many centrally planned economies are now switching their basic principle of economic management to market-orientation, in which, as it describes, market forces play the eminent role in combination with personal motivation and built-in mechanisms of efficiency.

In an effort of transforming an economy, attention has been focussed on macro-economic management and restoration of equilibrium through privatization and reduction of public interventions. Liberalization in price setting, finance and trade has been introduced through lifting of price prescription and institutional monopolies and monopsonies.

Agriculture is not excluded from these efforts, and sometimes even constitutes the pivot of the transition. Already, privatization of farming units has been practiced in several countries in the region such as China, Laos, Mongolia, Myanmar, and Viet Nam. Now Cambodia and Afghanistan would join. The degree of market orientation varies by country. Also in sectors where small enterprises dominate, there remains a need including production for government intervention, especially in inducing production to demand level through limited price policies.

The modalities and tools needed in these actions are different from those in a centrally planned economy, however. Different kinds of information and statistics are indispensable to make any policy decisions, and new methods of analysis are called for.

The CGPRT Centre has engaged in assisting researchers and policy makers to acquire effective and practical means and tools of economic analysis. Several training courses and workshops have been carried out every year in this regard. The statistical databases on CGPRT crops could help in this process. In gradually expanding the geographical coverage, the Centre is now prepared to assist the transitional process in agriculture.

Java contributed 67 percent of the total 6.2 million ton of the national maize production in 1989. In harvested area, Java contributed 69 percent of the total national maize harvest area. Maize productivity in Java was about 22 percent higher than off-Java. The maize productivity in Java was 2.26 ton/ha whereas off-Java was only 1.85 ton/ha. But the maize productivity differential between West Java and Lampung is quite small. In 1989 the maize productivity in West Java was 2.24 ton/ha whereas in Lampung it was 2.19 ton/ha (Indonesian Statistics, 1990, CBS).

One of the main problems in increasing the domestic maize production is the fact that the maize harvest area in Java has been decreasing since 1969, whereas the area expansion outside Java has been slowly increasing. The slow expansion of the maize harvested area may be due to its lower profitability compared to rice or other secondary crops. For example, during the 1979-1985 period the average national profit from maize was only Rp 121 thousand/ha, wheras from rice it was Rp 352 thousand/ha, soybean was Rp 210 thousand/ha and groundnut was Rp 335 thousand/ha. During the same period, the maize farming profit was Rp 118 thousand/ha in Lampung and Rp 96 thousand/ha in West Java (Rusastra et al., 1990). In addition to the lower profitability, the lack of Government price support, especially during the harvest season, also contributes to a low growth rate and unstable maize production in Indonesia.

Comparative Advantage of Maize Production

As mentioned, the comparative advantage analysis will be conducted under various trade regimes. The trade destinations for West Java are Jakarta for EP, and Bandung for IS. Since West Java is still deficient in maize then the IR trade regime is not applicable for West Java (Rosegrant, 1987). Whereas the trade destinations for Lampung are Medan for EP, Metro Lampung for IS and Jakarta for IR.

The analysis shows that maize production in Lampung is more efficient than in West Java in terms of domestic resource use (Table 1). Under the IS trade regime the DRCR for Lampung is 0.47

whereas for West Java it is 0.85. This indicates that maize production in West Java requires more domestic resources in order to save one unit of foreign exchange. Maize production in West Java is not feasible economically for exportation as shown by the DRCR larger than one (1.10) under the EP trade regime. If we look at the DRCR by trade regimes we will see that the lowest one is under the IS trade regimes, then the IR and the largest one is under the EP trade regime. We may say therefore that the domestic maize production would be more beneficial economically if used primarily to meet local demand. Only the surplus should be used for inter-regional trade or export.

Table 1. Comparative Advantage Criteria and Economic Incentive of maize in West Java and Lampung, 1986.

Region	Trade regime	DRC ratio	NEB (Rp/kg)	EPR (%)	IT (%)
West Java	IS	0.85	20.64	3.10	-32.71
	EP	1.10	-49.47	4.72	-23.01
Lampung	IS	0.47	82.96	10.49	-31.35
	IR	0.55	59.72	33.30	-26.33
	EP	0.71	1.62	6.08	-26.35

The input subsidies enjoyed by the maize producer are not significantly different between regions as shown by the implicit tariff. The implicit tariff varies between 23-32 percent of the total economic intermediate inputs cost. But as a whole, the maize producers in Lampung enjoy a higher protection than in West Java as shown by the higher EPR for Lampung. As we can see from Table 1, the EPR under the IS trade regime is 3.10 percent in West Java and 10.49 percent in Lampung. The higher EPR for Lampung is due to the higher price support as indicated by the higher NPR. The NPR in the two regions vary between 4.1 - 1.0 percent.

The economic break-even (DRCR = 1) price for Lampung is Rp 86.04/kg under the IS trade regime and Rp 121.68/kg under the EP trade regimes. This indicates that maize production in Lampung would still be feasible economically even if the international price fell by 23.95 percent under the EP trade regime and by 46.23 percent under the IS trade regime. For West Java the break-even prices are Rp 139.36/kg and Rp 172.72/kg under the IS and EP trade regimes respectively. This indicates that maize production in West Java would be feasible economically for exportation if the international price increased by 7.40 percent (Table 2). Accordingly, we may say that the economic feasibility of maize production in West Java is more sensitive to price changes than in Lampung.

Table 2. Maize Break-Even Border Price (DRCR = 1) by Trade Regimes in West Java and Lampung, 1986.

Region	Trade regime	DRCR	Price for DRCR = 1 (Rp/kg)	Change of Price[1]) (%)
West Java	IS	0.85	139.36	-12.90
	EP	1.10	172.77	+ 7.98
Lampung	IS	0.47	86.04	-46.23
	IR	0.55	100.28	-37.33
	EP	0.71	121.68	-23.95

1) The base year economic price of maize is Rp 160/kg.

The DRCR sensitivity to productivity change is presented in Table 3. If maize productivity in West Java increased by 12 percent, that is from 1879 kg/ha to 2100 kg/ha, maize farming would be feasible economically for exportation. Conversely, if the productivity decreased by 15 percent (from 1879 kg/ha to 1600 kg/ha) then maize farming in this area would not be feasible economically even for local consumption. This indicates how important it is to increase maize productivity in West Java in order to enhance its economic efficiency.

Table 3. Sensitivity Analysis of Maize Comparative Advantage by Productivity in West Java and Lampung, 1986.

Region	Trade regime	DRCR by Maize Productivity			
West Java		**1100**	**1600**	**1879***	**2100**
	IS	1.61	1.03	0.85	0.76
	EP	1.96	1.29	1.10	0.98
Lampung		**1100**	**1600**	**1925***	**2100**
	IS	0.89	0.57	0.47	0.53
	IR	1.00	0.66	0.55	0.51
	EP	1.18	0.82	0.71	0.66

*Actual maize productivity in West Java and Lampung is 1879 kg/ha and 1925 kg/ha, respectively.

For Lampung, even if productivity decreased by 17 percent (from 1925 kg/ha to 1600 kg/ha) maize farming would still be feasible economically under all trade regimes. If the productivity decreased even more, up to about 43 percent, then the export orientation would not be feasible economically but the interregional trade would be at its economic break-even point. Accordingly, maize productivity in Lampung should be maintained to at least 1100 kg/ha to be efficient economically.

Comparative Advantage of Feed Production

Before discussing the comparative advantage of feed production let us look at its financial characteristics. In general the major component of the feed production cost is raw materials. The raw material cost comprises 75.4 percent for Bogor, and 82.0 percent for Lampung of the total production costs. (Table 4). Maize is the major component of the raw material cost. In Bogor maize as the feed ingredient for layers and broilers reaches 35 percent and 42 percent respectively. Whereas in Lampung maize as a feed ingredient is 40 percent for layer feed and 48 percent for broiler feed. The maize contribution to the total feed production costs is 21.0 percent for Bogor and 25.4 percent for Lampung.

Table 4. Summary of Poultry Feed Industry Indicator in Bogor and Lampung, 1988

Description	Revenue (Rp/100 kg)	Financial cost* (Rp/100 kg)		Profit (Rp/100 kg)	Profit-ability (%)
Bogor					
- Layer	45,200	42,013	(74.6)	3,187	7.60
- Broiler	55,100	46,888	(76.2)	8,212	17.50
Lampung					
- Layer	39,600	38,363	(81.6)	1,237	3,10
- Broiler	47,100	42,928	(82.4)	4,172	8,90

* Figure in parenthesis is the proportion of feed ingredient financial cost (%).

Financial profitability of feed production is low in these two regions. The average feed production profitability is only 12.6 percent in Bogor and 6.0 percent in Lampung (Table 4). These profitabilities are much lower that the market interest rate which reaches over 25 percent/year. This very low financial profitability is partly due to the low factory capacity utilization rate. We expect feed profitability to increase in the future with the increase in factory capacity utilization as the poultry industry expands due to the deregulation policy.

As mentioned, maize contributes a significant amount to the feed cost. Accordingly, it is important to conduct an economic analysis of the feed production under two scenarios:

(a) the maize used for the feed raw material obtained from domestic production,

(b) the maize used for the feed raw material imported from abroad. The first scenario may be considered as an integrated maize-feed domestic production. Whereas the second scenario is a separate economic analysis of the maize and feed productions.

In the first scenario the unit cost of obtaining maize for the feed production is the unit cost of maize production plus transportation cost from the farm level to the factory level. For the second scenario, the unit cost of obtaining maize for the feed production is the CIF imported price plus transporation cost from port to the factory. The computation shows that the production, handling and marketing economic cost of maize in West Java in 1988 was Rp 196/kg, whereas in Lampung it was Rp 123/kg. The import parity price of maize at the factory level was Rp 229/kg. The tradeable component of maize production cost was 21 percent, whereas that of imported maize was 98 percent.

The analysis shows that if the feed mills use the imported maize for feed raw material (separated production scenario) then the feed production is only feasible under the IS trade regime in Bogor. In Lampung, the feed production is not feasible economically under any of the trade regimes (Table 5). But if the mills use domestically produced maize (integrated scenario) then the feed production would be feasible economically in both regions under all trade regimes except under the export promotion in Lampung (Table 6). However the DRCR is lower under the integrated scenario. Under the separated production scenario (imported maize) the DRCR varies between 2.06 (for broiler feed) and 3.32 (layer feed) whereas under the integrated scenario (domestic produced corn) the DRCR varies between 1.04 and 1.20. In short the integrated scenario is more efficient than the separated scenario.

That the integrated feed production scenario is more efficient than the separated feed production scenario is due to the gain in maize procurement efficiency. The integration strategy has been commonly practiced by the feed industry in Indonesia. This integrated feed production practice has been encouraged by the 1990 poultry industry deregulation policy. The 1990 poultry deregulation policy permits vertical integration with a larger size for export orientation of a single interprise or management cooperation with poultry farmers.

Although not feasible economically except under the IS trade regime in Bogor, the feed production using imported maize (separated production scenario) is very sensitive to price changes. Feed production in Bogor would be feasible economically under all trade regimes if the international feed price increased by 5.48

percent. Feed production in Lampung would be feasible under all trade regimes if the international feed price increased by 5.65 percent. Accordingly, it is very risky for Indonesia to rely on imported processed feed.

Table 5. Comparative Advantages and Economic incentive of Poultry Feed Using Imported Maize In Bogor and Lampung, 1988.

Description	Trade regime	DRCR	NEB (Rp/100 kg)	Change of price for DRCR = 1 (%)	IT (%)	EPR (%)
Bogor						
Layer	IS	0.83	912	-2.33	3.68	53
	IR	1.09	- 362	0.69	3.59	75
	EP	1.97	-2250	5.48	3.55	198
Broiler	IS	0.85	723	-1.73	5.96	161
	IR	1.15	- 551	1.04	5.83	219
	EP	2.25	-2439	5.44	5.77	502
Lampung						
Layer	IS	1.60	-1080	2.71	6.78	113
	IR	1.60	-1080	2.40	6.41	49
	EP	3.32	-2038	5.65	6.77	335
Broiler	IS	1.17	- 362	0.79	14.54	196
	IR	1.17	- 362	0.51	13.80	95
	EP	2.06	-1318	3.28	14.50	415

Table 6. Comparative Advantages and Economic incentive of Poultry Feed Using Domestic Maize in Bogor and Lampung, 1988.

Description	Trade regime	DRCR	NEB (Rp/100 kg)	Change of price for DRCR = 1 (%)	IT (%)	EPR (%)
Bogor						
Layer	IS	0.53	5397	-14.12	6.62	-30.9
	IR	0.94	398	- 1.18	4.18	-32.8
	EP	0.88	1029	- 2.85	4.63	-22.1
Broiler	IS	0.48	6974	-16.43	15.11	+ 1.2
	IR	0.79	1861	- 4.63	12.81	+ 1.5
	EP	0.77	2362	- 5.88	16.08	+ 4.6
Lampung						
Layer	IS	0.85	1829	- 4.47	20.16	-66.8
	IR	0.97	373	- 1.07	17.25	-59.8
	EP	1.20	-1806	4.40	16.11	-54.2
Broiler	IS	0.86	1870	- 4.19	30.59	-52.3
	IR	0.98	283	- 0.78	26.79	-50.3
	EP	1.04	- 470	1.05	25.66	-37.0

In general we may say that Indonesia should develop the feed industry to meet its domestic demand. In addition, this analysis shows that domestic feed production is feasible economically using domestically produced maize. Hence, to increase feed production efficiency, the development of feed mills should be directed toward the maize producing regions.

If it uses imported maize then the feed industry does not receive any subsidy through domestic maize production. Table 5 shows that the financial cost of feed production is higher than the economic cost by the amount of the impllcit tariff rate (IT) times the economic cost (EIIC). But if it uses domestically produced maize then the IT will be higher. This is due to the lower economic cost, especially the EIIC. Reduction in the economic cost further reduces economic value added (EVA), and hence the feed industry that uses domestically produced maize faces disincentives which are shown by the negative EPF (Table 6)

Conclusions

1. More than 95 percent of total domestic maize consumption is obtained through domestic production. In 1986 about 37 percent of the total domestic maize consumption was for feed. By the end of Pelita V (1993) the domestic demand for maize is projected to reach 1411 thousand tons, 66 percent of which is for commercial poultry feed. The amount of maize in the poultry feed composition is about 35-48 percent which is one of the dominant items (21-25 percent) in the feed production cost. More dynamic and wider analyses are needed to evaluate the comparative advantage of an integrated feed industry.
2. Maize production in the two regions (West Java and Lampung) is efficient economically, except under the export promotion trade regime in West Java. But maize production would be feasible in both areas under all trade regimes if productivity increases by 12 percent or the international price of maize increases by 8 percent. Based of the DRCR values, we suggest that the domestic maize production should be used to meet local needs. Only the surplus should be exported.
3. Integrating maize production and the feed processing industry using domestically produced maize could improve the efficiency of the feed processing industry. The increase in the feed production efficiency would not be due to subsidies or government protection, but it would be real gain in efficiency. According to the DRCR values, the feed industry should be located near the major maize producing areas and domestically produced maize should be used to support the poultry industry in these areas. In other words, the integration of

feedstuff production, the feed industry and livestock farming is an effective way to increase comparative advantage and economic efficiency.

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Productivity and Production of Coarse Grains, Pulses, Roots and Tuber Crops

Moe Hein[*]*

Introduction

The Union of Myanmar lies between 9°58'-28°29' north latitude and 92°10'-101°10' east longitude. The coast line stretches for 1350 miles from north to south. The central plain is surrounded lengthwise by hilly regions, 400-2500 meter in height. There are three seasons, summer, monsoon and winter. In summer the temperature ranges from 27°-30°C in the lower regions, to more than 38oC in the central and 15°-25°C in the hilly regions. In the cool season it drops to 20°C in the low regions, 15°C in the central region and -4°C in the hilly regions. The precipitation ranges from 250-750 mm in the central area to 2500-5000 mm in the other part of the country. The navigable Ayeyarwady river flows centrally from the northernmost region to the south giving fertile alluvial soil along its banks. Two to three crops are grown annually with the water from weirs and dams built in the central dry zone.

Various crops are grown yearly in different parts of the country with rice as the major crop. The cropping pattern depends on the climate, the adaptability of the crop and the economic return for farm produce. About 50-75% of coarse grains, pulses and root crops are sown in central and the lower Myanmar. We need it understand the advantages and disadvantages of each crop in order to boost productivity and eventually raise the farmer's net income.

Comparison of Crop Productivity

Yield per Unit Area

The productivity of various crops can be expressed in either potential or relative productivity. The potential productivity is the maximum yield when the plants are given the most favourable environment, that is climate, soil fertility and care.

For example, the potential dry matter yield of maize is 71 gm^{-2} day^{-l}. However, it is controlled

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by the efficient use of solar energy and becomes a relative measure under the influence of environmental conditions.

Crop productivity in term of yield per unit area differs with crop species due to the difference in physical condition and chemical composition of farm produce. Higher output of root or tuber crops than grain crops is solely because the yield is expressed in fresh eight (Table 1).

Table 1. Comparison between the world's average yield and the highest yield of particular country (FAO, 1979)

Crop	World's Average Yield (t/ha)	Highest Yield (t/ha)	Country	Ratio of World's Yield to Highest Yield
Maize	2.96	7.44	(New Zealand)	0.40
Sorghum	1.30	4.79	(Spain)	0.27
Soybean	1.51	3.36	(Italy)	0.45
Groundnut	0.98	3.79	(Malaysia)	0.26
Field beans	0.57	2.43	(Egypt)	0.23
Potato	14.50	34.40	(Netherlands)	0.42
Cassava	9.10	32.30	(Cook Islands)	0.28
Sugar beet	32.30	50.00	(Belgium)	0.65

Growth Duration and Harvest Index

The growth duration of sugarcane and cassava is longer and hence the yield is higher than other crops. Potato and sweet potato have a higher harvest index and higher yield than any other crops (Table 2).

Table 2. The relationship of yield, growth duration and harvest index of field crops (After Tanaka, 1983).

Crop	Max. Dry Matter Yield (t/ha)	Growth Duration (days)	Harvest Index
Maize	13	130	0.50
Soybean	7	120	0.45
Field beans	5	90	0.45
Groundnut	5	140	0.40
Potato	18	168	0.80
Sweet potato	17	180	0.80
Cassava	28	365	0.60

Equivalent Yield

The chemical composition of economic yield or harvested organ varies with crop species and the yield is therefore different. The efficient use of primary photosynthesis (glucose) or the conversion efficiency of the end product varies with the chemical composition of the harvested organ. A unit of glucose can be converted into 0.84, 0.38 and 0.31 unit of starch, protein and lipid, respectively Comparison of yields of various crops can therefore be made equally and logically on the basis of equivalent yield (Table 3).

Table 3. Chemical composition and equivalent yield of various crop (After Tanaka, 1983).

Crop	Chemical Composition (%)			Equivalent Yield (g glucose)
	Protein	Lipid	Carbo-hydrate	
Maize	9.5	5.3	83.7	1.42
Sorghum	8.3	3.1	86.7	1.35
Soybean	39.0	19.9	35.4	2.09
Field beans	24.1	2.6	69.0	1.54
Groundnut	27.1	50.4	19.6	2.59
Potato	9.3	0.5	86.3	1.29
Sweet potato	4.2	0.7	92.3	1.24

Adaptability of Crops

Coarse grains are widely adapted to warm and less humid environments. Maize is grown as a monsoon crop in the temperate Shan and Chin states. However, it is grown in the monsoon and in winter in the central plain area. Sorghum and pearl millet occupy the areas with low rainfall and low fertility, especially on the east and west bank of Ayeyarwady river in central Myanmar.

Pulses are quite adaptable to a wide range of climatic conditions though the yield may be poor in the rainy season. They have many culinary uses, and are consumed in various forms. They are sown as a cash crop, contingent crops, forage crops or green manure. The area under pulses is increasing especially as a substitute for rice when the land is flooded or as a relay crop with rice. Cassava is adaptable to marginal or poor soil in lower Myanmar. Sweet potato is grown near the cities for use as dessert. It is given intensive care and the area fluctuates with demand and weather conditions. Potato is widely grown in the rainy season and winter in Shan state.

Resistance to Biotic or Abiotic Stress

Maize is sensitive to excess water, drought, temperatures over 35°C, poor fertility and pests and diseases. It is also prone to fungal attacks when the kernels are stored with high moisture content. The most serious problem is aflatoxin produced by *Aspergillus flavus* and *A. glaucus,* which can be fatal to man and animals. Poor drainage and unbalanced lack of fertilizer can lower kernel yield.

Sorghum and pearl millet are tolerant to drought, poor fertility, high temperature, and pests and diseases. Therefore they occupy the areas with 250-500 mm rainfall in the central dry zone. Pulses are intolerant to a wide range of stresses, especially insects and diseases. Foliar feeders, pod borers and seed borers usually infest the standing crop and the stored crop. Chickpea does not grow well under pH 5. Fusarium wilt, dry root rot and pod borers are major constraints in chickpea production. Late blight caused by Phytophthora infestans is a major problem in potato cultivation and large sums of money are often spent on fungicidal sprays. Bacterial wilt caused by *Pseudomonas* solanacearum is now becoming serious, aggravated by the nematode, *Meloidogyne* spp., infestation of the major area in Shan state. The crop does not produce well on soils with low fertilizer application. Seed potato germination is reduced if the tubers are subject to direct light. The uncovered tubers in the field are easily attacked by tuber moth, and they will rot rapidly due to fungal infection when wounded mechanically at harvest or in storage. Sweet potato and cassava seem quite tolerant to insects and diseases.

Plant Care

Timely thinning, ie. 1-2 weeks after emergence, of maize is essential and influences the yield. Weeding also plays an important role in upgrading the quality and quantity of kernels. Good drainage systems should be provided in the rainy season, otherwise the crop will be poor or die. Optimum plant population is also quite influential in yield. Timely harvest and dehulling or storing at low (13%) moisture content prevent aflatoxin production under storage. Sorghum and pearl millet, however, thrive well with little or moderate care. Timely spraying and weeding are necessary in pulse production.

Seed potato treatment with fungicide, and planting depth are important for good germination. Timely weeding and depth of cover of the tubers are also yield determinants. Frequent fungidical sprays by forecasting are given to control late blight. Drainage must good in the rainy season to maximize the yields of potato, sweet potato and cassava.

Cropping Pattern

A proper cropping pattern increases crop yields through improving soil fertility and supressing insect pests and diseases. Maize and other crops are very often intercropped or rotated with pulses in order to minimize soil nutrient exhaustion. Pulses are effective and efficient atmospheric nitrogen fixers and eventually the income per unit area is increased (Table 4).

Table 4. Economic return by rotating pulses with other crops. (Ann. Rept. of ARI for 1989-90)

Township	Cropping Pattern		Benefit Cost Ratio
Pyinmana	Groundnut	- rice	3.86
	Rice	- black gram	3.66
	Rice	- chickpea	3.64
Kyaukpadaung	Rice	- chickpea	3.37
	Green gram - rice		2.48
Daik-U	Rice	- chickpea	4.30
	Rice	- black gram	5.03
Patheingyi	Rice	- chickpea	2.91
	Groundnut	- rice	2.53

Nitrogen fixation is enhanced by using rhizobium inoculant. About 7-14% of the major pulse areas use rhizobium, and nitrogenous fertilizer is diverted to other crops. The cropping intensity is also increased as areas with mono crops of wheat and rice are now shifted to double cropping with early maturing green gram, black gram or chickpea.

The yield of crops intercropped or rotated with pigeonpea, Cajanus indicus, is greatly improve as the latter makes phosphate available for other crops. Maize, sesame, groundnut or short staple cotton is often used as an intercrop.

Cost of Cultivation and Net Income

Maize, potato and sweet potato demand great care and the cost of cultivation is usually high. The availability of labour, pesticides and sprayers and handling charges for farm produce determine expenditure in farming. Timely and proper harvest, careful processing and handling are prerequisites in preventing post-harvest damage by pathogens. Frequent sprays on pulses and potato increase the cost of production, which is low in sorghum and cassava (Table 5).

The prices of farm products vary with time. Maize, potato, sweet potato and some pulses are, however, in great demand and prices are often higher than for the other crops. The farmer chooses the crop based on the amount of profit gained per unit of land area and time (Table 6).

Table 5. Economic return (In kyats) per hectare of rice, coarse grains, pulses, root and tuber crops In Myanmar in 1990-1991.

Sr. No.	Crop	Cost (Kyats)	Yield (ton)	Income (Kyats)	Net Income (Kyat)
1.	Rice	4955.47	2.58	8802.34	3846.87
2.	Maize	3770.75	1.49	6798.95	3028.20
3.	Sorghum	2802.11	0.75	3505.23	703.12
4.	Chick pea	2313.67	0.66	9770.33	7456.66
5.	Black gram	2184.36	.74	9640.61	7456.25
6.	Green gram	2365.56	0.58	6707.43	4341.87
7.	Pigeon pea	1174.60	0.62	10020.99	8246.39
8.	Lima bean	2498.41	1.06	7191.84	4713.43
9.	Soybean	2057.11	0.81	5615.27	3558.16
10.	Cowpea	1774.60	.50	10509.78	8735.18
11.	Field pea	2944.20	0.54	8702.29	5758.09
12.	Potato	6177.50	9.96	24581.50	18404.00
13.	Cassava	2965.20	10.16	12009.06	9043.86

1 US $ = 6.3962 Kyats 1990-1991.

Economic Importance

Maize is of great importance in Chin State, Shan State and Sagaing, Magway and Mandalay Divisions. Sorghum is widely sown and used in the central dry zone in Magway, Mandalay and Sagaing Divisions, whereas pearl millet is confined to Magway Division. Pulses are given third priority after rice and oilseed crops. Chickpea, pigeonpea and limabean predominate in Sagaing, Mandalay and Magway Divisions, while soybean is common in Shan State. Black gram and green gram are mostly sown in Sagaig, Bago and Ayeyarwady Divisions.

Potato is a prominent cash crop in Shan State, while cassava is important in Ayeyarwady, Bago and Tanintharyi Divisions. The areas near the cities of Yangon, Bago, Magway and Mandalay are occupied by sweet potato in Sagaing, Bago and Ayeyarwady Divisions.

Demand from the foreign market is an important factor on the crop production in Myanmar. Maize, black gram, limabean, kidney bean, chickpea and pigeonpea are priced high as they are export items. Lentil may become important due to high demand from the external consumer.

Conclusions

It is of utmost importance to raise the living conditions of the majority of the population, that is, farmers. The cultivation practices and socio-economics of the local farmers should be analysed comparatively so that improvements or changes can be made. Researchers in various fields of interest and technical assistants in the agriculture division should collaborate to meet the national objectives. Co-ordination and co-operation with the international agricultural institutions will probably play an important role in improving farm products in both quality and quantity.

Table 6. Man and cattle power used in cultivation of 1 acre (0.41 ha) of particular crop in Myanmar

Particular	Rice	Maize	Sorghum	Chickpea	Black Gram	Green Gram	Pigeonpea	Lima Bean	Potato	Cassava
Land preparation										
Cattle day (CD)	11.8	16.0	12.0	10.0	10.0	12.6	11.4	11.0	40.0	8.0
Man. day (MD)	6.0	-	1.0	2.0	3.0	-	-	-	-	16.0
Sowing & care										
Planting	3.0	4.0	2.0	2.0	2.0	2.0	2.0	4.0	4.0	-
Thinning/weeding	12.0	8.0	2.0	5.0	5.0	-	-	6.0	20.0	-
Irrigation/apply fertilizer	8.0	1.0	1.0	-	-	-	-	-	8.0	-
Intercultivation (CD)	-	2.0	6.0	-	-	-	2.0	5.0	-	-
Harvesting & Processing										
Cattle day	10.0	3.0	5.0	6.0	2.0	2.0	0.6	4.0	6.0	-
Man day	95.0	16.0	10.0	11.0	9.0	11.0	4.0	11.0	4.0	9.0
Inputs										
FYM (kg)	60.0	30.0	15.0	-	-	25.0	-	25.0	60.0	-
Urea (kg)	150.0	25.0	25.0	-	-	-	-	-	150.0	25.0
TSP (kg)	100.0	-	-	-	-	-	-	50.0	10.0	-
Seed (kg)	30.8	25.0	6.9	46.2	48.2	34.2	32.1	61.6	-	-
Pest (lt)	2.0	-	-	1.0	-	-	-	-	4.0	-
Total Cost (K)	2005.45	1526.00	1134.00	936.00	884.00	957.33	718.17	1003.00	2500.00	1200.00

CGPRT Centre News and Activities

Newly Available Publications from APO

Improving Quality of Life In Rural Areas In Asia and the Pacific.
1991. 329 p. Rp 10.000
Low-Cost Farming Practices In Asia and the Pacific.
1991. 233 p. Rp 12.500
Top Management Forum Enterpreneurship for Business Alliances.
1992. 119 p. Rp 7.500
Rural Poverty Alleviation Program in Asia and the Pacific.
1992. 292 p. Rp 7.500

Healthy Harvest, A Global Directory of Sustainable Agriculture Now Available

The call for greater access to sustainable agriculture information has now been answered with the publication of the **Healthy Harvest** directory. The new and expanded edition of **Healthy Harvest: A Global Directory of Sustainable Agriculture and Horticulture Organizations,** is now available from the publisher, **agAccess,** in Davis California. This update of **Healthy Harvest** contains four times as many listings as the original edition.

The 1,400-entry directory provides full descriptions of agriculture & horticulture training institutes, research centers, development programs, advocacy groups, university programs, and business involved in all aspects of sustainable agriculture. The listings are well organized with a complete cross indexing including a geographic index, a subject index, full descriptions, and contact names and phone numbers.

Healthy Harvest's international listings represent the most complete reference anywhere to the sustainable agriculture movement worldwide. European organic farming organizations, south-east Asian research centers, and South American reforestation projects are just a few of the many listings detailed in the new edition.

"The **Healthy Harvest** directory is a useful reference tool for anyone interested in sustainable agriculture," states Jeffrey Harpain, agAccess information specialist. "This book is used by students, writers, reference centers, librarians, and others who want to find information on internships, farm stays, advocacy groups and the whole spectrum of activities around sustainable agriculture."

An added plus throughout the book are the hundreds of beautiful line drawings and sketches by artist Janet Trowbridge Francoeur that complement the wealth of information found on each page.

The 212 page softcover book sells for $19.95 plus $3.00 shipping and handling (CA residents add $1.45 sales tax) and can be ordered by calling **agAccess** at (916) 756-7177 or by writing agAccess at 603 Fourth St., Davis, CA 95616.

The Cultivated Plants of the Tropics and Subtropics

CTA has supported the translation into English of **The Cultivated Plants of the Tropics and Subtropics** by Sigmund Rehm and Gustav Espig. This is both a reference handbook for those working in this field and a textbook for students of agriculture and related subjects.

Originally published in German in 1984, it describes over 1,000 cultivated crops. An introduction to each of the main plant groups looks at the economics, production trends, nutritional value and uses of the group. The major crops are then discussed in more detail and information provided on production figures and distribution, breeding of cultivars, ecophysiology, cultivation, pests and diseases, and harvesting and processing.

Much of the information on individual species, and on the less widely-grown crops, is presented in clear tables which include columns for specific points of interest.

Food crops are divided into main groups; cereals, root and tuber crops, sugar, oil, vegetables, fruits and nuts. There is a section on beverages and stimulants, which includes tobacco, and section on spices, medicinal plants, essential oils, fibre plants, elastomers, dyes and tanning material etc. Fodder grasses and fodder legumes are also included, as are crops which are used for ancillary purposes such as windbreaks and soil stabilizers.

The book sells for US$ 38.00 and can be ordered by writing Verlag Josef Margraf, P.O. Box 105, 6992 Weikersheim, Germany. It is also available from CTA, Postbus 380, 6700 AJ Wageningen, The Netherlands.

CGPRT Centre

The Regional Co-ordination Centre for Research and Development of Coarse Grains, Pulses, Roots and Tuber Crops in the Humid Tropics of Asia and the Pacific (CGPRT Centre) was established in 1981 as a subsidiary body of UN/ESCAP.

Objectives

In co-operation with ESCAP member countries, the Centre will initiate and promote research, training and dissemination of information on socio-economic and related aspects of CGPRT crops in Asia and the Pacific. In its activities, the Centre aims to serve the needs of institutions concerned with planning, research, extension and development in relation to CGPRT crop production, marketing and use.

Programmes

In pursuit of its objectives, the Centre has three programmes which are mutually supportive:

1. Research, which entails the preparation and implementation of studies covering production, utilization and trade of CGPRT crops in the countries of Asia and the South Pacific;
2. Training of national research and extension workers;
3. Information and documentation which encompasses the collection, processing and dissemination of relevant information for use by researchers, policy makers, and extension workers.

Palawija News

Contributors are invited to submit concise summaries of significant social research related to CGPRT crops for publication. Submissions should be limited to two to four double-spaced typewritten text. Two figures (graphs or tables) may accompany the article. Include only references cited. All articles are subject to editing to meet space limitations.

Please send all queries relating to articles in *Palawija News* to Head Publications Section, CGPRT Centre, Jalan Merdeka 145, Bogor 16111, Indonesia.

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