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Fertilizing Taro in the Lowlands of Papua New Guinea

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General

Taro *Colocasia esculenta* (L.) Schott is grown worldwide and has been a crop of major importance as a staple in many place: the Pacific Islands, Egypt, part of India, Brazil, the Philippines and the Caribbean. It is an efficient producer of calories (4.2 to 4.4 Cal/g), compared to sweet potato (3.4 Cal/g), rice (3.5 to 4.0 Cal/g) and Cassaba (1.3 to 1.5 Cal/g).

It is commonly boiled, fried or made into *krupuk* (thin chips) in Indonesia. Taro can, however, be converted to stable intermediate products such as taro flour and dried slices. These can be further processed into ready-to-use products such as taro rice, noodles and macaroni. Several other taro products such as taro chips, canned or prozen taro chunks, cereal and infant foods, might also have commercial potential.

Taro is grown as a semi-subsistence crop in Papua New Guinea, generally on newly cleared forest lands by shifting cultivation. The crop is very sensitive to soil fertility conditions. Recently, taro yield has declined in some localized areas due to increased intensity of cultivation and shorter fallows as a result of rising population pressure on land. Thus, there appears to be a scope for the use of chemical fertilizers. Inorganic fertilizers however, are rarely used on the semi-subsistence farms, especially for a bulky and staple crop like taro.

Recent indications are that with declining yields and rising prices for taro, farmers may tend to use chemical fertilizers. Increasing labour wages and land values are also likely to encourage farmers to use fertilizers. This would obviously depend on the technical response of taro to fertilizer use, farmer' fields the economics of fertilizer use, farmer perceptions, factor price relationships, access to markets, and cash available to farmers.

Many researchers have studied the response of taro to inorganic fertilizers under research station environments. However, as not much information on such responses is available under farmers' field conditions, it was decided to carry out an on-farm trial under location specific conditions.

On-Farm Trial

An on-farm trial under researcher manage-ment was carried out in 1988-1989 (two experiments) in a farmer's field in Tikeling village near Lae in the lowlands of PNG. The main objective was to understand and quality the response of production and quality of taro to various levels and combinations of nitrogen, phosphorus and potassium.

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A randomized complete block design (RCBD) with four blocks and 18 treatments was used: two levels of nitrogen (0 and 100 kg/ha), three levels of phosphorus (0, 50 and 100 kg/ha) and three levels of potassium (0, 50 and 100 kg/ha), were applied in the form of Urea, Triple Superphosphate, and Murate of Potash, respectively. Fertilizers were applied in one basal dose during the establishment stage of the crop. The first experiment was carried out during October 1988 and May 1989 and the second was done during June and December 1989. The second experiment was planted at the same site but in another plot. The soil was alluvial sandy loam, the site itself having been cleared from secondary forest dominated by the Piper adunca tree species.

The common local taro variety Numkoi was planted. The co-operating farmer prcvided labour, planting material, and other inputs. Metalaxyl was applied at a rate of 0.2% (a.i.) to control taro leaf blight (Phytopthora colocasiae). Harvest data included corm yield, number of corms, taro beetle (Papuana spp.) damaged and undamaged corms, number of beetle holes, number of suckers, number of cormlets etc. The data were subjected to statistical and economic analyses, both separately for individual experiments and in combination for .the two experiments. These analyses enabled us to work out the technical response and economic viability of fertilizer use for taro.

Statistical Analysis

Results from analysis of variance (F values) for factorial design (three factors) are presented for each experiment (Table 1). Blocking was not significant for the first experiment but was effective for the second and it improved precision in the range of 10 to 48 per cent. There was a systematic variation in taro beetle damage between the blocks. The highest was 28 beetle holes per plot in the first block, which declined to 9 holes in the fourth block.

Nitrogen showed a positive and significant effect on corm yield and number of suckers in both reasons, while potassium significantly affected the number of suckers during the second season. The number of holes caused by the taro beetle was not affected by levels or combinations of any of these nutrients. The amount of variation from coefficient of variation, was less than 30% for corm yield, but was very high for number of suckers and for number of beetle damaged holes.

The test of homogeneity (F test) indicated that data on corm yield and number of beetle damaged holes could be combined for two seasons, but data on number of suckers could not be combined. The results of analysis for combined data are presented in Table 2. Not a single factor including season showed any significant effect on number of beetle holes, while corm yield was affected significantly by the level of nitrogen and

Table 1 Analysis of variance (F values) for taro fertilizer experiments: Tikeling 1988-1989

Source of Variation	Degree of freedom	Corm yield (kg/plot)*		No. of suckers per plot		No of beetle holes in taro per plot	
		First season	Second season	First season	Second season	First season	Second season
Block	3	1.09	4.73***	1.46	3.49**	0.56	12.58***
Nitrogen (N)	1	7.01***	12.15***	5.11***	27.73***	0.19	0.00
Phosphorus (P)	2	0.52	0.69	0.14	0.75	0.07	0.34
N* P	2	1.88	0.75	1.17	1.76	0.24	0.08
Potassium (K)	2	1.94	2.42	1.55	3.20**	0.89	1.21
N* K	2	5.63	0.87	0.37	0.69	0.08	1.26
P • K	4	0.27	0.51	1.62	0.18	1.26	0.29
N • P * K	4	2.59	1.54	0.91	0.74	0.44	0.28
Error	51						
Grand mean		6.05	5.36	18.6	42.65	11.50	16.80
Coefficient of variation (%)		22.1	28.6	52.5	36.8	84.9	54.8
Error mean square		1.8	2.4	95.0	246.1	94.8	84.8

••• Significant at 1% level.
•• Significant at 5% level.
• Net plot is of 4.32 m2.

Editorial

Current Patterns in Consumption and Use of Root and Tuber Crops

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Root and tuber crops are a group of the mandate crops of the CGPRT Centre. Like other groups, botanically different families are included in the group-cassava, sweet potato, irish potato, yam and taro.

A remarkable feature taking place in these crops, at least in a' few, is that, contrary to the general conception of them as the poor people's crops, the consumption of the crops has been increasing, as well as production. Take cassava as an example. Its consumption has been rising, not as a direct food - though this use is still predominant particularly in rural areas - but as processed food, livestock feed and industrial materials. Cassava flour is mixed with wheat flour, or used exclusively for making bread and cakes; dried chips are widely used as the material for processed foods. Even sweet potato, once regarded as a disappearing species, now attracts increasing attention as a source of processed food such as chips, starch and liquor. The sweet potato market is getting larger in Viet Nam and the Philippines. In many other countries, irish potato is replacing sweet potato as consumption patterns change.

We should however, avoid drawing a too optimistic picture of the prospects for root and tuber crops as concerns their future development. According to a study undertaken by the Centre, demand for yam and taro in the Pacific has definitely been declining, while that for sweet potato and cassava has been expanding, though moderately. Yet a bright potential exists for the further expansion of these crops if these emerging uses are supported by a concerted and sustained effort to increase market exploitation together with other suitable actions.

Thus marketing, processing and trade become important areas subject to research and development, in which the Centre has already gained considerable knowledge and expertise. Since these crops have been and will continue to be grown by small farmers, it is also necessary to perform research of farming systems and household economy, and the interlinkage between production and markets, so as to integrate their production in a beneficial manner for the farmers.

Table 2 Analysis of variance (F values) for data combined over two experiments: 1988-1989

Source of variation	Degree of freedom	Corm yield (kg/plot)	No. of beetle holes on taro per plot
Block	3	4.43	1.60
Season (S)	1	7.15	2.36
Error (a)	3	-	-
Nitrogen (N)	1	19.08"*	0.12
S • N	1	0.79	0.08
Phosphorus (P)	2	1.19	0.04
S • P	2	0.04	0.35
N * P	2	0.62	0.18
S • N • P	2	1.86	0.16
Potassium (K)	2	0.31	0.03
S • K	2	4.11**	2.05
N • K	2	4.61**	0.33
s * N K	2	1.23	0.94
P * K	4	0.46	0.50
S P • K	4	0.36	1.11
N • P • K	4	2.03	0.20
S • N " P * K	4	1.96	0.52
Error (b)	102		

***Significant at 1% level.
**Significant at 5% level.
Significant at 5% level.

Table 3 Significant results from comparison of means using least significant difference (LSD) test

Season	Factor	Means	Difference from lowest mean	LSD value
Corm yield (tonnes/ha)				
Combined	0 Nitrogen	12.0		
over two seasons	100 kg Nitrogen	14.4	2.44***	1.097
No. of suckers (.000)				
First season				
	0 Nitrogen	37.04		
	100 kg Nitrogen	49.07	12.0e'	10.69
Second season				
	0 Nitrogen	76.16		
	100 kg Nitrogen	121.30	45.14"	17.21
	50 kg Potassium	83.43		
	0 Potassium	106.67	23.24"	21.08
	100 kg Potassium	106.09	22.66"	

***Significant at 1% level.
**Significant at 5% level.

interactions of potassium with season and nitrogen.

Relevant means are compared by applying the least significant difference (LSD) test (Table 3). A hundred kilogram of nitrogen gives a significantly higher corm yield than without added nitrogen, with a high increase in the number of suckers. Sucker numbers appeared to have declined significantly at 50 kg potassium and then increased at 100 kg potassium, a relationship that cannot be explained easily. A similar relationship was revealed between corm yield and potassium at 100 kg of nitrogen, during the second season. This probably was the result of significant interactions of potash with nitrogen during this season (as seen in Table 2).

Soil Analysis Results

Results from analysis of plot soil samples taken before planting show that the phosphorus level in both plots was higher than the critical value, although much higher in the first. Levels of magnesium as well as potassium were very low and their ratio was extremely high. Carbon and nitrogen levels were also much below the critical minimum values.

In general, the corm yield and number of suckers responded positively and significantly at 100 kg of nitrogen/ha. The corm yield increased by 20% from 12.0 tonnes/ha (at no added nitrogen) to 14.4 tonnes/ha (at 100 kg N/ha) while the sucker number went up by 32 and 59% during the first and second seasons, respectively. The low level of nitrogen in the soil before the applications of fertilizers has allowed this response. Phosphorus did not appear to have a significant effect on any of these variables. This is quite consistent with the higher level and lower retention of basic phosphorus in these soils.

Although the soil potassium level was very low, the added potassium did not have any significant effect on corm yield. This could be because of the relatively higher levels of magnesium and abnormally higher ratio of magnesium to potassium (about 100). The added potassium might not have been enough to balance this ratio or it might indicate the biological yield potential of taro (Numkoi variety), which could not be influenced any further by the added potassium. This requires further investigation. The corm yield or beetle damage did not show any significant variation across seasons. However, the sucker number was significantly higher (more than double) during the second season, possibly because the low level of phosphorus during the second season allowed nitrogen to influence the vegetative growth. This relationship has an important implication for the generation of planting material.

Economic Analysis

Detailed cost benefit calculations were made by giving due consideration to: moisture loss of harvested taro; level of farmer management; market demand; quality loss due to beetle damage as reflected in market prices; transport and marketing costs of both inputs and outputs, and labour cost for fertilizer application and for harvesting (Perrin et al. 1979).

Net Benefit Curve

Figure 1 shows the net benefit curve as plotted against variable cost for using various levels of fertilizers. The undominated alternatives are those that give higher net benefit at the same or lower variable cost compared to other alternatives. The line joining undominated alternatives forms the net benefit curve and all alternatives to the right and below that curve are dominated alternatives. As shown in the figure, six undominated alternatives appear on the net benefit curve. The curve is linear with higher slope between 0 and 100 kg nitrogen and flattens to the level of 100 kg N and 100 kg P, showing that a much smaller additional benefit (Kina 240/ha) is obtained from the additional variable cost of Kina 480/ha (1 Kina = 1.06 US$).

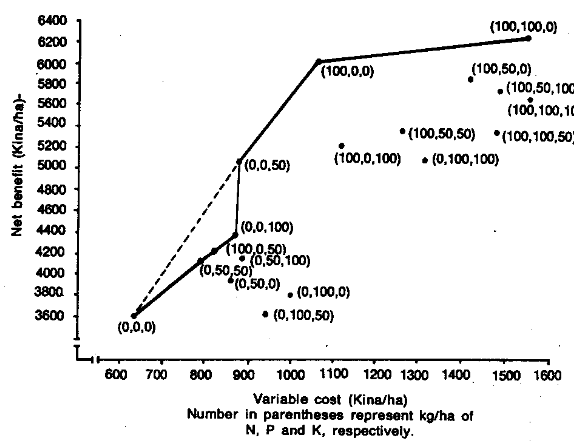

Figure 1 Net benefit curve for taro fertilizer trial: Tikeling 1988-1989

Dominance Analysis

A similar picture can be deduced from the dominance analysis. In this case, dominated alternative is that which has variable cost equal to or higher than that for the treatment above it.

The undominated alternatives are subjected to further economic (marginal) analysis (Table 4). The alternative with 100 kg of nitrogen and 100 kg of phosphorus per hectare, gives the highest net benefit (k6270/ha) among the undominated treatments. The marginal rate of return is 50% which is not enough to cover an expected marginal rate of return of 100%. The expected rate is derived by considering a 15% interest on the variable cost for a period of 9 months, with a 15% service charge to acquire a loan and a 70% risk premium to allow for variability in output and prices.

The next treatment (100 kg of Nitrogen), though the second best in terms of net benefit, is encouraging in terms of marginal rate of return to investment. It gives a very attractive rate of return of more than 500%, which safely covers the expected rate of return of 100%. It would need about K1100/ha to meet the expenses on fertilizer use (including cost of harvesting) and given a net benefit of about K6000. This option would also be promising for farmers with limited cash and sufficient family labour, as it would need only K82/ha for the actual purchase and application of fertilizer while the major variable cost would be on labour for harvesting.

Minimum Returns Analysis

A minimum returns analysis was done to cover the relative risk of disaster by looking at the worst 25% of the outcomes of each treatment. Out of 8 replications over two experiments, those two replications (considered separately for each treatment) which gave the lowest and the second lowest net benefits were looked at. A comparison of these worst results gives an idea of the relative riskiness of various treatments. For the worst set, the alternative, which we chose using marginal analysis (100 kg N), had ranked 7th while for the second worst set, it ranked 3rd. On the basis of averages of two worst outcomes, the chosen alternative gave a net benefit of K4200, about K1000 less than the alternative (100 kg N and 100 kg P) giving the highest benefit. Thus, even on the basis of minimum returns analysis, the treatment with 100 kg N per hectare seemed to be reasonably stable and profitable.

Sensitivity Analysis

Prices of fertilizers, taro, suckers, and labour vary considerably and have implications for the level of fertilizer use. Higher fertilizer prices may reduce use, while higher taro prices may increase its use and vice versa. A sensitivity analysis was done by varying the prices of fertilizers, labour and taro output (corm and sucker), in the range of lower 30% and higher 30%. In general, the ranking of alternatives (on the basis of net benefits) did not change, while undominated alternatives remained almost unchanged. The marginal analysis of the top two alternatives (100 kg N, 100 kg N and 100 kg P) for the price variations, is shown in Table 5.

Table 5 Price sensitivity analysis

Price variation	Marginal rate of return (%) from the	
	100 kg N	100 kg N and 100 kg P
Current prices	517	50
30% lower fertilizer price	564	80
30% higher fertilizer price	477	28
30% lower labour wages	698	71
30% higher labour wages	402	33
30% lower output prices	291	5
30% higher output prices	744	94

In all cases of price variation, 100 kg N shows a much higher rate of return than the expected rate of 100%. While the alternative, with 100 kg N kg and 100 kg P, gives in general, a

Table 4 Economic analysis of the undominated alternatives

Alternative N	P (Kg/ha)	K	Corn yield (tonnes/ha)	Net benefit (K/ha)	Variable cost (K/ha)	Change from the next highest: Marginal increase in net benefit (Kg/ha)	Marginal Increase in variable cost (K/ha)	Marginal rate of return (%)
100	100	0		6270	1550	240	484	50
100	0	0		6030	1066	962	186	517
0	0	50		5068	880	692	7	9886
0	0	10		4376	873	255	82	311
0	50	50		4121	7910	521	160	326
0	0	0		3600	631		-	

much lower rate of return which fails to cover the expected rate. Thus 100 kg N appeared to be quite consistent and robust to price changes within a reasonable range and could safely be considered for recommendations to the farmers in the Lae area and similar areas in the lowlands of PNG.

A Partial Budget

A partial budget for using 100 kg of Nitrogen as a prospective option is shown in Table 6. The suggested improved option gives a corm yield of 12.7 t/ha, about 65% higher than that obtained without fertilizer use (7.7 t/ha). The variable cost due to fertilizer use would be Kina 1066/ha; K436 more than the variable cost (K630) for no fertilizer use. This results in an additional net benefit of K2430/ha; giving an average rate of return of 55%, which is very attractive in considering possible alternate investment opportunities for the farmers.

Table 6 Partial budget for fertilizer use on taro

Item	Treatment	
	No fertilizer	100 kg of N/ha
Average corm yield' (t/ha)	7.7	12.7
Gross field benefit[2] (K/ha)	4230	7096
Variable cost[a] (K/ha)	630	1066
Nat benefit (K/ha)	3600	6030
Additional net benefit (K/ha)		2430
Additional variable cost (K/ha)		436
Average rate of return (%)		557

[1] Experimental corm yield is adjusted to allow for 4% moisture loss and 20% lower yield under farmer management.
[2] Gross field benefit is worked out by considering 60% demand for output, reduced prices for corms due to beetle damage, and transport and marketing costs of inputs and outputs.
Variable cost for fertilizer technology includes value of fertilizer (K74). cost of fertilizer transport (K 2), cost of labour for fertilizer application (K6), and cost of labour for harvesting of taro (K984).

The use of fertilizers could have been still more beneficial, had there been higher demand for taro output, lower marketing costs, and less variation in prices of inputs and outputs. Current analysis is based on 60% effective demand for taro corms. This implies a need for an appropriate government policy (designed and implemented) to provide assured and increased demand for output and reduced and stable costs of marketing for a bulky crop such as taro. That would encourage farmers to use chemical fertilizers and thus help reduce pressure on land and labour.

Limitations

One major weakness of this study is that the highest level of nitrogen included in the trial was only 100 kg/ha while past studies had showna positive response up to and more than 200 kg N/ha. As only two nitrogen levels (0 and 100 kg) were included, this did not allow an estimation of non-linear relationship (orthogonal polynomials). Generally, one would expect a quadratic response to nitrogen. Such a relationship would permit the determination of physical maxima and economic optima.

Although, information from one farmer's field at one site is useful, it has only limited value. A good number of such trials would be necessary to cover a range of agro-physical and socio-economic environments to get a general picture on fertilizer response.

Another set of soil samples taken at the time of harvesting would have given an additional insight about the changes in soil fertility levels because of fertilizer applications and taro cultivation.

This trial was carried out in a village about 10 km away from the Lae urban market which gave good market access to the farmer, making fertilizer use for taro an economically attractive proposition. Similar trials need to be carried out at other places away from town areas to validate and confirm these results.

Being a diagnostic trial, it was managed by the researchers and farmer involvement was limited. This did not allow a full expression of farmer perceptions, knowledge and attitudes, which are essential in designing recommendations.

Conclusion

A positive and significant response by taro to nitrogen was found on the basis of the results of this on-farm trial. Seasonal variation in response was not significant, suggesting uniform recommendation across seasons. Taro production showed no response to phosphorus. Potassium did not show any consistent relationship with the corm yield, thus requiring further investigation. Statistical and economic analyses have suggested that the use of 100 kg of nitrogen per hectare can give a very attractive rate of return to farmers in the Lae area. To arrive at a broad spectrum of doses, trials with more levels and higher doses of nutrients need to be carried out at various locations on farmers fields, preferably under their management. Inclusion of fields with varying levels of soil fertility and at different distances from urban markets would help delineate recommendation domains and recommendation rates. There is also a need for the government to design and implement policies that will minimize risk and uncertainties related to the marketing of a bulky crop such as taro.

It would appear that taro could be made into a more commercial crop in South East Asian countries as well as in Papua New Guinea and the Pacific Islands. Such. a situation would be dependent upon a high input of fertilizer and the development of taro-processing industries.

A Note on Supply and Demand Modeling

Klaus Altemeier*

A. Introduction

Recent analysis of agricultural commodity markets in Indonesia has shown that supply and demand modeling requires a multi-market approach rather than a single market approach to produce appropriate policy recommendations (Ministry of Agriculture 1988). This gave rise to several studies producing a variety of elasticities indicating the effects of price and income changes on aggregate food crops supply and demand (CARD 1987, IFPRI 1987, World Bank 1987, CWFS 1988, Ministry of Agriculture 1988, Stanford 1988). One of the main objectives of these studies was to learn more about the cross relationships between different food crops. But almost none of the reports set up an analytical framework which could be used to produce up to date recommendations for policy makers.[1]

Only one study, which was conducted by the Ministry of Agriculture in 1988, produced a simulation spreadsheet which combined the full system of supply and demand equations of the analytical work. However, this model spreadsheet was complicated and thus did not readily lend itself to easy application. This gave reason to investigate a simpler modeling system.

Recently a simplified, linearized version of the earlier MOA supply and demand model was produced. Although simpler, this model has the disadvantage that the imposed linearization violates the aggregation conditions of neoclassical demand and supply theory. This requires periodic review of elasticity values, especially when simulations lead to drastic changes in supply and demand patterns or relative prices. This is not viewed as too great a disadvantage, however, since - with the exception of the Ministry of Agriculture study and the CARD demand system work - all other research has not considered theoretical consistency as an important guideline for model building. Moreover, the advantages of the simplified demand and supply model version are great, as it allows analysts to set up an elasticity based multi-market model almost instantly on a Lotus spreadsheet which can produce simultaneous multi-market endogenous price solutions. The logic of the model is also very easy to understand and it can be used for a broad range of multi-market analyses.

This paper is intended as a user's manual for national level market analysts. The basic model, which consists of a number of model equations and basic data set, is introduced in the first section. The basic model represents a further simplified version of the original model since it does not incorporate a linkage between the food crops' economy and the . macro economy as a whole, which can be done also in a simplified form (Altemeier and Tabor 1989). For the sake of simplicity, this practical guide refers only to partial equilibrium analysis, which is considered to be sufficient for most applications. The Lotus spreadsheet implementation of the model is described in the second section of this paper and the third section demonstrates how the model spreadsheet can be used for market analysis.

B. The Basic Model

Model Equations

The basic model consists of 3 sets of equations (equ 1 to 3). The first set comprises area price relationships:

equ. (1) $\ln A_i = a_a(t) + \sum_{j=1}^{m} bij . \ln pl.$

The second set of equations is yield price relationships:

equ. (2) $\ln y_i = a_y(t) + c_i \ln p_l + \sum_{j=l}^{r} d_{ij} \ln qj.$

The third set of equations is commodity demand functions:

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* SFCDP/AED

[1] A summary of study results can be found in F. Ellis, “Report on a Meeting to Review Agricultural Policy Models”, World Bank and Bulo’g Integrated Planning Unit, Jakarta, September 1988.

$$\text{equ. (3)} \ln x_{di} = a_d(t) + e_i \ln TEXPC + \sum_{j=1}^{m} f_{ij}; \ln p_j$$

and factor demand functions:

$$\text{equ. (4)} \ln r_{ij} = a_{rj}(t) + \sum_{k=l}^{m} U_{ijk} \ln q_k + n_{ij} \ln pi.$$

All equations are written in double log form to allow for the explicit use of elasticity values as model parameters. In this basic form, input and output prices and total expenditures are exogenous variables. Technological progress, weather conditions, population growth and other influencing factors can be incorporated by changing the equation intercepts. Endogenous variables are demand, areas, and yields. The model can be summarized in the form of self-sufficiency ratio equations, which refer to imposed price regimes:

$$\text{equ. (5)} \ln \Phi_i = a^*(t) + \Theta_{ij} \ln p_j.$$

One interesting feature of the model is that its price equations can be solved by considering self-sufficiency ratios to be policy targets:

$$\text{equ. (6)} \ln p_j = \Theta_{ij}^{-1} . [\ln \Phi_i - a^*(t)].$$

Total expenditures and input price effects are included in the intercepts. The model solution equation (equ. 6) is useful for many real world applications when elasticity estimates are available from different studies and the impacts of protectionism are being investigated. It should be noted again that a sound set of elasticity values is needed for analysis and that drastic changes in prices involve consistency problems, since double log models violate the aggregation conditions of supply and demand theory.

Data Requirements

As seen from the model equations discussed above, data requirements are very small relative to the aggregation level of the model. Data requirements are shown in Tables 2 and 3. A base year data set, consisting of prices, harvested areas, net yields, aggregate consumption levels and per hectare use of inputs such as fertilizer and labour, is needed to run the model. In addition, supply and demand elasticities for each commodity are also required. To make projections, non-price induced (i.e. exogenous) trends for area extension, yield increases, and total expenditures on consumption must be included, as well as an assumption about population growth.

C. Spreadsheet Implementation

The spreadsheet model structure is summarized in Appendix 1. The spreadsheet implementation of the model is straight forward. The top of the model spreadsheet corresponds exactly to Table 2. It begins with an *n x n* matrix of area response elasticities, followed below in succession by matrices of area response elasticities, yield response elasticities, and factor demand elasticities. Each of these matrices has *n .x (m* + 1) elements. Below the yield response elasticities is a matrix of demand elasticities, which consists of *n x n* price elasticities and *1 x n* expenditure elasticities[2]

The next matrix refers to market surpluses or deficits, represented in terms of. quotas (In xs - In xd). The elements of this matrix are calculated by adding the area and yield response commodity price elasticities and subtracting the corresponding demand elasticities. Since there are no cross price elasticities for yield responses in this version of the model, the cross price elements of the new matrix are simply the differences between area response, cross price elasticities, and demand cross price elasticities.

In order to endogenize prices with reference to given market surplus targets, the calculated market balance elasticities matrix has to be inverted. The elements of the inverse matrix are then used to calculate a (so-called) dual solution at the bottom of the simulation spreadsheet.

The next matrix in the simulation spreadsheet corresponds to the baseyear data set of Table. 2. The first row consists of commodity prices. For convenience, the factor prices are added to the far right columns of this row. Note that the model does not include factor market price determination and thus considers factor prices to be exogenous. The second row of the baseyear data matrix refers to planted areas and the third to net yields. For simplicity, net yields are defined as gross yields minus waste, seed use and non-food related industrial use. In simulations, the percentage relationship between gross and net yields is assumed constant. The fourth row of the baseyear data matrix refers to supply for human consumption, defined as the product of areas and

[2] *n* refers to the number of commodities, *m* refers to the number of inputs.

net yields, and the fifth row to total domestic human consumption. The next two rows refer to trade gaps, firstly as the difference between availability minus consumption and secondly as the quotient of availability and consumption. Finally, there are two rows referring to baseyear application rates of factor inputs per commodity and hectare. In this Indonesian case, yield response and input demands refer to labour use and fertilizer application rates only.

With a set of elasticities and baseyear data, it is then possible to calculate baseyear intercepts for the double log behavioural equations of the model. The calculation procedures are presented in Appendix 1. In the model spreadsheet these intercept calculations are done below the baseyear data set.

The next portion of the spreadsheet, moving downward, contains assumptions about exogenous variables for simulation purposes. The first row contains price assumptions as percentages of the baseyear price. For convenience, factor price increases are attached to the right end of this row, as they are in the baseyear data set. The next row contains market surplus targets - for example, in the Indonesian case a 1 or^{-} 100% for rice which indicates that rice self-sufficiency is targeted. Market surplus targets are not used in the primal solution of the model, but rather in the price endogenous dual solution of the model at the bottom of the model spreadsheet. The third row reflects exogenous, non-price induced shifts in areas between simulation periods, while the fourth row refers to exogenous shifts in yields. Finally, two cells in this part of the spreadsheet refer to exogenous demand growth which is caused by population and real per capita income growth.

All exogenous shifts are factored into the corresponding intercepts of the demand and supply equations. This procedure results in a new Matrix of intercepts which is placed below the exogenous variable changes in the model spreadsheet. Formulas for the new intercepts are presented in Appendix 1.

The next step is to include a matrix of simulation results in the model spreadsheet. The format of the simulation results matrix is the same as the baseyear data matrix. But all solution entries are calculated from formulas linked to the new intercepts and prices. The supply and demand formulas are shown in Appendix 1.

In the matrix of simulation results, new surplus/deficit quotas are calculated for each commodity market. At this stage the user could use the surplus/deficit targets to produce shadow prices with respect to the trade restrictions imposed on the system. The shadow price solution, which is also referred to as the dual solution, uses the calculated inverse of the price elasticity matrix described above. The shadow price calculation is illustrated in Appendix 1. The formulas refer to the ratio targets and the new intercepts, as well as the elements of the inverse elasticity matrix.

With the calculation of new commodity. surplusses and deficits, the model spreadsheet routine is completed and provides a framework for partial equilibrium multi-market analysis. The primal solution is applied for quantities with prices, income, population, and area and yield trends as exogenous variables. The dual solution gives prices with market surplus/deficit targets, income, population, and area and yield trends as exogenous variables.

D. Model Simulation

It is useful to demonstrate how the model works using a specific data set. The user is advised to test the model by comparing his outcomes with the simulation results found below. Tables 2 and 3 refer to the baseyear data set. To simulate a new solution, the following assumptions are made with respect to exogenous variable changes:

Table 1 Exogenous Variables' Change Assumptions

	Real Price	Area Growth	Yield Growth	Surplus Target
Rice	-3%	1.00%	1.26%	100%
Maize	-3%	-0.33%	2.37%	110%
Cassava	-3%	-0.77%	1.85%	115%
Soybean	-3%	0.78%	1.36%	85%
Groundnut	-3%	1.12%	1.68%	100%
Mungbean	-3%	2.00%	3.00%	100%
Sugar	-3%	1.00%	2.00%	90%
Real Fertilizer Price:	10%			
Real Wage Rate:	1%			
Real Income:	3%			
Population:	2%			

The primal solution is summarized in Table 4a and the dual solution in Table 4b. The dual solution requires that prior exogenous commodity price changes be reset to zero. The percentage changes between baseyear prices and shadow prices can then be copied into the row which refers to exogenous price changes between the two periods. This procedure produces the targeted market surplus ratios in the simulation matrix.

Table 2 Aggregate Supply and Demand Elasticities (Base-year 1986)

Area Response (Mid term) [b_{ij}] in equ. (1)

Prices	Rice	Maize	Cassava	Soybean	Groundnut	Mungbean	Sugar
Rice	0.194						-0.162
Maize	-0.057	1.126	-0.023	-0.201	-0.142	-1.600	
Cassava	-0.004	-0.064	0.237	-0.187			
Soybean	-0.022	-0.367	-0.238	1.409	-0.599		
Groundnut			-0.387	-0.146	1.412		
Mungbean	-0.011					1.340	
Sugar	-0.100			-0.070		-0.199	0.580

Yield Response and Factor Demands

Prices	Rice	Maize	Cassava	Soybean	Groundnut	Mungbean	Sugar
Per ha. yield w.r.t. [c_i] and [d_{ij}] in equ. (2)							
- Commodity	0.324	0.606	0.314	0.365	0.312	0.248	
- Fertilizer	-0.029	-0.066	-0.025	-0.018	-0.019	-0.014	
- Labour	-0.295	-0.540	-0.289	-0.347	-0.293	-0.234	
Fertilizer Demand w.r.t. [n_{ij}] and [u_{ik}] in equ. (4)							
- Commodity	0.557	0.766	0.766	0.949	0.769	0.865	
- Fertilizer	-0.358	-0.356	-0.479	-0.472	-0.918	-0.544	
- Labour	-0.200	-0.410	-0.287	-0.477	-0.149	-0.321	
Labour Demand w.r.t. [n_{ij}] and [u_{ik}] in equ. (4)							
- Commodity	0.931	1.518	1.194	1.332	1.135	1.336	
- Fertilizer	-0.032	-0.100	-0.039	-0.035	0.014	-0.030	
- Labour	-0.899	-1.419	-1.156	-1.297	-1.149	-1.306	

Commodity Demands [f_{ij}] and [e_i] in equ. (3)

Prices	Rice	Maize	Cassava	Soybean	Groundnut	Mungbean	Sugar
Rice	-0.159	0.387	0.429	0.214	0.413	0.406	0.157
Maize	0.045	-0.261	0.056	0.027	-0.119	-0.170	-0.081
Cassava	0.036	0.040	-0.390	-0.029	-0.102	0.080	-0.001
Soybean	0.023	0.025	-0.037	-0.779	0.483	-0.139	0.226
Groundnut	0.025	-0.061	-0.074	0.269	-0.738	0.403	-0.020
Mungbean	0.007	-0.025	0.018	-0.022	0.114	-0.680	0.010
Sugar	0.024	-0.105	-0.001	0.319	-0.050	0.090	-0.292
Total Expenditures	0.294	0.388	0.261	0.458	0.642	0.614	0.519

Source: Based on BINUS/SFCDP, Supply and Demand Study Parameter Estimates. Ministry of Agriculture, (1988).

See also: Altemeier K., Tabor S., Supply Parameters for Indonesian Agricultural Policy analysis. **Ekonomi dan Keuangan di Indonesia**, Vol. XXXVI, No. I, 1988.

Tabor S., Altemeier K., Demand Parameters for Food Policy analysis in Indonesia. **Bulletin of Indonesian Economic Studies.** Accepted for publication in 1989.

Table 3 Baseyear Figures for an Aggregate Supply and Demand Modal (Base-Year 1996)

		Unit	Rice	Maize	Cassava	Soybean	Groundnut	Mungbean	Sugar
Wholesale Prices	[p]	Rp/kg	336	166	70	582	1,161	816	622
Area	[A]	Tsd.Ha	9,966	3,030	1,194	1,170	588	287	316
Post Harvest Losses		%	14.0	16.7	18.0	17.5	24.1	15.4	
Yield per Ha	[y]	Ton/ha	3.978*)	1.867	11.278	0.977	1.063	0.721	6.236
Net Production	[x_s]	'000 mt	23,183	4,711	11,042	943	470	175	1,734
Total Demand	[x_d]	'000 mt	23,124	4,367	10,149	1,296	409	172	1,908
Dom. Surplus	[Z]	'000 mt	59	344	893	-353	61	3	-174
Labour	[r_1]	Md./ha.	163	72	86	108	106	60	
Fertilizer Use	[r_2]	Kg/ha	275	182	120	83	103	59	

Note: Wage Rate [q_1] = Rp. 1,300 per man-day
Fertilizer Price [q_2] = Rp. 125 per Kg
• Paddy, rice/paddy conversion 68%

Source: Prices refer to Jakarta wholesale prices. Ministry of Agriculture, Market Information Service. Sugar price from Bulog. Area and yield figures from CBS (Central Bureau of Statistics). Factor Input figures from MOA Farm Management Surveys. Post harvest losses and demands from revised food balance sheets, Supply and Demand Study, MOA (1988).

The multi-market supply and demand worksheet can be extended or used for other purposes or commodity groups by changing the baseyear data set and the elasticity values. It should be noted that each time the elasticity matrices are changed, the surplus elasticity matrix must be inverted again.

E. Summary

This paper is intended as a practical guide to multi-market analysis. It shows in detail how to use a set of constant supply and demand elasticities and baseyear data for multi-market analysis on a Lotus spreadsheet. The analytical results refer to a set of exogenous variables such as prices, area trends, yield trends, and income and population growth. Further model development has lead to a formulation in which prices are related to market surplus/deficit targets. This feature allows researchers to analyze question such as price fluctuations resulting from the trade policies.

Although the example in this paper relates to data sets and analysis from Indonesia, and to the food crops sub-sector, the basic model could be adapted for other applications and commodities in different countries. The model seems also to be an effective pedagogical tool.

The version of the model described in this paper represents the simplest version of a more complex, demand and supply model developed in Indonesia's Ministry of Agriculture. The earlier model included a link between the food crops economy and the macro-economy and distinguished between crop production on and off Java. The macro-link can be incorporated in this simplified version, but this complicates the solving of prices in the dual solution of the model. Future work with the model will include the extent to which it can be modified for application to regional planning issues.

Table 4a Primary Solution for an Aggregate Supply and Demand Model (Base-Year 1998)

		Unit	Rice	Maize	Cassava	Soybean	Groundnut	Mungbean	Sugar
Wholesale Prices	[p]	Rp/kg	326	161	68	565	1,126	792	603
Area	[A]	Tsd.Ha	10,066	2,957	1,200	1,151	583	297	315
Post Harvest Losses			14.0	16.7	18.0	17.5	24.1	15.4	
Yield per Ha	[y]	Ton/ha	3.965*)	1.854	11.295	0.975	1.055	0.734	5.597
Net Production	[x_s]	'000 mt	23.344	4.566	11.112	925	467	184.	1,764
Total Demand	[x_d]	'000 mt	23,647	4,474	10,373	1,330	422	177	1,962
Dom. Surplus	[Z]	'000 mt	-304	92	739	-405	44	7	-198
Self-Sufficiency Ratio		%	0.99	1.02	1.07	0.69	1.11	1.04	0.90
Labour	[r_1]	Md./ha.	155	68	80	100	95	55	
Fertilizer Use	[r_2]	Kg/ha	264	170	114	78	99	56	

Table 4b Dual Solution tor an Aggregate Supply and Demand Model (Base-Year 1986)

		Unit	Rice	Maize	Cassava	Soybean	Groundnut	Mungbean	Sugar
Wholesale Prices	[p]	Rp/kg	344	173	78	628	1,139	828	629
Area	[A]	Tsd.Ha	10,054	3,061	1,200	1,278	560	278	320
Post Harvest Losses		%	14.0	16.7	18.0	17.5	24.1	15.4	
Yield per Ha	[y]	Ton/ha	4.0361	2.227	11.778	1.012	1.050	0.742	5.597
Net Production	[x_s]	'000 mt	23,728	4,940	11,591	1.088	442	175	1,791
Total Demand	[x_d]	'000 mt	23,728	4,491	10,079	1,258	442	175	1,990
Dom. Surplus	[Z]	'000 mt	0	449	1,512	-188	0	0	-199
Self-Sufficiency Ratio		%	1.00	1.10	1.15	0.85	1.00	1.00	0.90
Labour	[r_1]	Md./ha.	159	72	89	110	96	57	
Fertilizer Use,	[r_2]	Kg/ha	278	190	134	90	100	.59	

Note: Wage Rate [q_1] = Rp. 1,313 per man-day
Fertilizer Price [q_2] = Rp. 137.5 per Kg
•) Paddy, rice/paddy conversion = 68%

APPENDIX 1

SUPPLY AND DEMAND MODEL: SPREADSHEET IMPLEMENTATION

|b|

|c|

|u|

|f| and |e|

Surplus |Θ|

Invers

$|\Theta|^{-1} = |\Omega|$

Baseyear Data

Intercepts t

Exogenous Variables'

Incercepts (t + 1)

Simulation Results

Equilibrium Prices

NOTE:

b = Area Response Elasticities [n·n elements]

c = Yield Response Elasticities [(m + l) · n elements]

u = Factor Demand Elasticities [(m + l) · n elements]

f = Demand Price Elasticities [n · n elements]
e = Expenditure Elasticities [1 · n elements]

Θ = defined as { = b + c − f for own price terms (elements on the diagonal); = b − f for others }

n = number of commodities
m = number of inputs

BASEYEAR DATA:
- Commodity Prices and Input Prices
- Harvested Areas
- Net Yields
- Net Supply (calculated as Harvested Areas and Yields)
- Commodity Demand
- Trade Gaps
(calculated as SUPPLY-DEMAND)
- Input Demand (Fertilizer and Labour)

EXOGENOUS VARIABLES' CHANGES:
- Commodity and Factor Price Increase (%) [T_p, T_q]
- Trade Gap Targets (Supply/Demand Ratios)
- Area Trends (%) [T_A]
- Yield Trends (%) [T_y]
- Total Expenditure Trends (%) [T_{EXP}]
- Increase of Pupulation (%) [T_{pop}]

CALCULATIONS:

Intercepts (t):

- Areas: $a_{ai}(t) = \ln A_i - \sum_{j=1}^{n} b_{ij} \ln p_j$
- Yields: $a_{ay}(t) = \ln y_i - c_i \ln p_i - \sum_{j=1}^{2} d_{ij}$
- Commodity Demands: $a_{di}(t) = \ln x_{di} - \sum_{j=1}^{n} f_{ij} \ln p_j$
- Fertilizer Demands: $a_{ril}(t) = \ln r_{i1} - n_{i1} \ln p_i - \sum_{k=1}^{2} u_{ik1} \ln q_k$
- Labour Demands: $a_{ri2}(t) = \ln r_{i2} - n_{i2} \ln p_i - \sum_{k=1}^{2} u_{ik2} \ln q_k$

Intercepts (t + 1):

- Areas: $a_{ai}(t + l) = a_{ai}(t) + \ln(1 + T_A)$
- Yields: $a_{yi}(t + l) = a_{yi}(t) + \ln(l + T_y)$
- Commodity Demands: $a_{di}(t + l) = a_{di}(t) + \ln(1 + T_{pop}) + \ln(1 + e_i T_{EXP})$
- Fertilizer Demands: $a_{ril}(t + l) = a_{ril}(t)$
- labour Demands: $a_{ri2}(t + l) = a_{ri2}(t)$

SIMULATION RESULTS:

The Simulation Results Matrix has the same structure as the baseyear data matrix:

- New Prices: $p(t + l) = p(t) \cdot (l + T_p)$
  $q(t + l) = q(t) \cdot (l + T_q)$
- New Areas: $A_i(t + l) = \exp[a_{ai}(t + l) + \sum_{j=1}^{n} b_{ij} \ln p_j(t + l)]$
- New Yields: $y_i(t + l) = \exp[a_{ay}(t + l) + c_i \ln p_i(t + l) + \sum_{j=1}^{2} d_{ij} \ln(t + l)]$

– New Net Supplies: $x_{si}(t+l) = A_i(t+l) \cdot y_i(t+l)$

– New Comm. Demands: $x_{di}(t+l) = \exp[a_{di}(t+l) + \sum_{j=1}^{n} f_{ij} \ln p_j(t+l)]$

– New Gaps: $Z_i = x_{si}(t+l) - x_{di}(t+l)$

– New Ratios: $\Phi_i(t+l) = x_{si}(t+l) / x_{di}(t+l)$

– New Fertl. Demands: $r_{i1}(t+l) = \exp[a_{ri1}(t+l) + n_{i1} \ln p_i(t+l) + \sum_{k=1}^{2} u_{ik1} \ln q_k(t+l)]$

– New Labour Demands: $r_{i2}(t+l) = \exp[a_{ri2}(t+l) + n_{i2} \ln p_i(t+l) + \sum_{k=1}^{2} u_{ik2} \ln q_k(t+l)]$

Shadow prices are calculated as follows:

$$p_j = \sum_{i=1}^{n} [\ln \Phi_i(t+l) - a_{ai}(t+l) - a_{yi}(t+l) + a_{di}(t+l)] \cdot \Omega_{ij} \text{ with } \Omega_{ij} \equiv \Theta^{-1}$$

APPENDIX 2

Symbols in Model Equations:

p	Single food crop commodity wholesale prices in real terms (Rp/Kg).
q	Variable input prices in real terms (Rp/Kg).
x_s	Supply of food crops (tsd. tons).
x_d	Demand for food crops (tsd. tons).
A	Area in food crop production (tsd. ha).
r_1	Demand for Labour per ha. (man-days).
r_2	Demand for Fertilizer per ha. (kg).
y	Yield per ha (tons).
TEXPC	Total real expenditures for consumption in constant prices (Rp/cap/year)
Z_i	Trade balance for single food crops (tsd. tons).
Φ	Trade quotas for single food crops (%).
a	Intercepts.
b	Area response own price and cross price elasticities.
c	Yield response own price elasticities.
d	Yield response factor price elasticities.
u	Factor demand own and cross factor price elasticities.
n	Factor demand commodity price elasticities.
e	Commodity demand expenditure elasticities.
f	Compensated commodity demand own price and crops price elasticities.
Θ_{ij}	Elements of the Surplus/Deficit Elasticity Matrix.
Ω_{ij}	Elements of the inverse of the Surplus/Deficit Elasticity Matrix.
t	Time.
T	Trend variables.

CGPRT Centre News and Activities

Regional Statistical Database System for CGPRT Crops: Second Regional Workshop

Within the context of this Newsletter, it is hardly necessary to stress the importance that CGPRT crops play in the economies of most Asian and Pacific countries. Yet in spite of this importance, lack of reliable readily available data has frequently hampered planning, research and development of the CGPRT crops and upland agriculture in general. Researchers, extension workers, planners and policy makers have for a long time strongly felt the need to improve this situation.

To fill this gap, the CGPRT Centre initiated in 1987, the establishment of a regional statistical database system of CGPRT crops (RSDS). The RSDS for CGPRT crops covers the entire process from production and marketing up to utilization as well as selected general statistical data relevant for the above group of users. Software was developed in 1988-1989 and distributed among collaborating institutes throughout the region. Ultimately the RSDS will cover all ESCAP member countries.

A first regional workshop on RSDS was held in September 1989 and was attended by representatives of institutes from Indonesia, Nepal, the Philippines, Sri Lanka, Thailand and Viet Nam. To date, information for Indonesia, Thailand and The Philippines has been entered and data entry has started or will start in the near future on Bangladesh, the Republic of Korea, Myanmar, Nepal, Pakistan, Sri Lanka and Viet Nam.

The second workshop has just been concluded in February of this year. Ten countries were invited to attend: Bangladesh, Indonesia, Korea, Myanmar, Nepal, Pakistan, the Philippines, Sri Lanka, Thailand and Viet Nam. The objectives of the workshop were:

a) To present and discuss progress made in institutes where a storage and retrieval system, RSDS II (folllowing RSDS I) has been introduced.

b) To discuss institutional and technical issues regarding institutes where RSDS II is not yet established and has only recently been introduced.

c) To reconfirm the willingness of each country to participate, and to further specify programme direction and the future needs.

A practical component of the meeting was to familiarize participants with the second generation software, RSDS II, and a newly developed interface programme.

Dr. Seiji Shindo, the Director of the CGPRT Centre welcomed the participants and reported the major achievements of the RSDS programme during 1989/1991:

i) The approval for funding of the regional component by the Government of the Netherlands, for a three year period, 1991-1993.

ii) The finalization of the much improved second version of software, RSDS II, and its distribution to a large number of institutes throughout the region.

iii) The finalization of country profiles on Indonesia, Thailand and the Philippines.

The workshop provided a forum for an extensive exchange of information and experience. It pointed out areas of special concern for individual countries, and supplied a practical evaluation and discussion of the attributes of the RSDS II programme.

It was concluded in the discussion preceding the familiarization with software, that strengthening user service and data use in general would need linkage between RSDS II and expert systems, which could cover

i) Econometric and statistical processing.

ii) Simple geographical information systems (GIS).

Participants submitted that the mandates of participating institutes in most cases were not sub-sectoral, only covering foodcrops, but were infact sectoral or even multi-sectoral in nature. While the participants acknowledged the use of RSDS II in the specific field of CGPRT crops, it was underlined that the need for a standardized database approach, involving user friendly software based on personal computers, was also very urgent in other areas of interest.

The participants informed the Centre of general features of RSDS II and the manual, which could be further improved. They particularly felt that the manual needs improvement, while an extended on-screen menu and aid facilities would be regarded as most helpful. The Centre's staff was highly commended for the development of RSDS II, which was found to be versatile and user-friendly.

With regard to the adoption of RSDS II and the varying needs of "country correspondents" from institutes in their home countries, it was suggested and agreed that the lead institutes will monitor the specific adoption of RSDS II, and if necessary, co-ordinate between the Centre and national institutes. This approach would lead to a "uni-list" of RSDS II users, to be based on reports of the country correspondents, and the CGPRT Centre would circulate this list among the users on a periodical basis.

As well, a list of themes was drawn up for the third regional meeting planned for 1992. The meeting was closed by the chairperson, Dr. Cynthia R. Mamon, who expressed her warmest appreciation for the active and creative participation of all representatives and extended the thanks of all participants to the secretariat for their organization of the second RSDS meeting.

New Publications

Role of Secondary Crops In Employment Generation: A Study In a Rain-fed Lowland Village In Java

Kawagoe, Toshihiko, et al. 1991. 88 p. ISBN 979-8059-38-7. Price Rp 11.000. US$ 12.50. US$ 9,00 (developing countries).

This study identifies the role of secondary crops in employment generation in peasant economies. It focuses on how peasants utilize their labour in the production of rice, CGPRT crops (secondary crops) and vegetables, in conjunction with their farming systems. The study also investigates farmers' off-farm activities at the village level, especially marketing activities of farm produce. It is found that labour absorption in post-harvest activities concerning CGPRT crops and vegetables is substantial.

Upland Economy in Java: A Perspective of a Soybean-based Farming System

Morooka, Yoshinori and Mayrowani, Henny. 1991. 183 p. ISBN 979-8059-37-9. Price Rp 16.500. US$ 17.50. US$ 13.50 (developing countries).

This study investigates crop cultivation in a typical upland village with a complicated intercropping system in Java, Indonesia. As well, it examines how production is related to the whole village economy. The study combines a farming systems approach with a formal economic analysis and presents a wealth of accumulated data on upland agriculture.

Marketing of Rice, Cassava and Coffee in Lampung, Indonesia

Mougeot, Eric. 1991. 123 p. ISBN 979-8059-39-5. Price Rp 16.500. US$ 17.50. US$ 13.80 (developing countries).

The theme of this study is the commercialization of agricultural production in Lampung Province. It covers three crops destined for national consumption as well as export , rice, cassava, and coffee. The study was carried out under a bilateral co-operation agreement between ORSTOM (Institut Francais de Recherche Scientifique pour le Developpement en Cooperation) and the Ministry of Transmigration. Ethnic participation in trade is analyzed in detail. It was found that small producers are not in a strong bargaining position.

Newly Available Publications from IRRI, CIAT, and APO

The following IRRI, CIAT, and APO publications are available for purchase in Indonesia from the Publications Section of the Centre and its Indonesian's distribution network as well.

Review of Advances in Plant Biotechnology, 1985-1988. IRRI 1989. 329 p. Rp 12.500.

Gene Banks and the World's Foods. Plucknett, Donald L.; Smith, Nigel J.H.; Williams, J.T.; Anishetty, N. Murthi. IRRI 1989. 248 p. Rp 15.000.

Bacterial Blight of Rice. IRRI 1989. 235 p. Rp 12.000.

Progress in Irrigated Rice Research. IRRI 1989. 390 p. Rp 12.750.

International Deepwater Rice Workshop (1987). IRRI 1989. 633p. Rp 24.000.

Seeds and Seedlings of Weeds in Rice in South and Southeast Asia. Zimdahl, ill.; Moody, K.M.; Lubigan, R.T.; and Mabbayad, M.O. IRRI 1989. 63 p. Rp 7.750.

Dibble Sticks, Donkeys, and Diesels: Machines in Crop Production. Campbell, J.K. IRRI 1990. 329 p. Rp 16.500.

Simulation of Ecophysiological Processes of Growth in Several Annual Crops. Vries, F.W.T. Penning de; Jansen, D.M.; Berge, H.F.M. ten; and Bakema, A. IRRI 1989. 271 p. Rp 21.000.

Publications of the International Agricultural Research and Development Centers: 1989 Edition. IRRI 1989. 730 p. Rp 25.000.

Publications of the International Agricultural Research and Development Centers: 1990 Supplement. IRRI 1990. 332 p. Rp 15.000.

Completing the Food Chain. Hirschoff, Paula M. and Kotler, Neil G. (eds.). IRRI 1989. 193 p. Rp 21.000.

IRRI 1989: Planning for the 1990's. 1990. 72 p. Rp 10.000.

IRRI Annual Report for 1988. 1989. 646 p. Rp 28.750.

Acceptability and Nutritional Quality of Common Beans. A Bibliography. Lareo, L.R. and Gonzales, F. (Compilers). CIAT 1989. 268 p. Rp 15.000.

Bean Common Mosaic: Screening for Disease Resistance. Morales, F.J. CIAT 1989. 26 p. Rp 15.750.

Bean Production Problems in the Tropics. Schwartz, H.F. and Pastor Corrales, M.A. (eds.). CIAT 1989. 654 p. Rp 60.000.

Cassava Breeding and Agronomy Research in Asia. Howeler, R.H. and Kawano K. (eds.). CIAT 1988. 350 p. Rp 60.000.

Marketing Systems for Farm Products in Asia and the Pacific. APO 1990. 276 p. Rp 7.500.

Top Management Forum: Originality in Management - Effective Vehicle for Creating Markets. APO 1990. 115 p. Rp 7.500.

Animal Feed Resources in Asia and the Pacific. APO 1990. 430 p. Rp 10.000.

Biotechnology in Asia: Development Strategies Applications and Potentials. APO 1990. 412 p. Rp 10.000.

Foreign Direct Investment in Asia. Chen, Edward K.Y. (ed.). APO 1990. 270 p. Rp 7.500.

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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