Farm Management Notes for Asia and the Far East **(FAO, Bangkok), 12 (1), 1977 : 22-29.**

Land redistribution, technological improvement, employment generation: an analysis with Bangladesh data*

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In 1972, the Bangladesh government ordered all farm families owning more than 33.3 acres of land to surrender the excess land for redistribution among families owning less than 1.5 acres of land. The basis of choosing these figures are not known. Since there are very few farms above the declared maximum size, the redistributive effect of these measures are not likely to be more than marginal.

In a sample of 300 farms studied by Jabbar in three districts – Mymensingh, Rangpur, Dinajpur- major maladjustment exists between land and labour: some farms owned more land per unit of available labour than they could cultivate themselves thereby opening the way for making sharecropping arrangements; others owned less land per man-unit than was necessary to provide full employment.[1] The need for land redistribution arises because of the necessity to alleviate the adverse effects of this maladjustment on production efficiency, income distribution and technological improvement. The findings of the study mentioned above suggested that redistributive measures aimed at abolishing sharecropping and promoting owner-operatorship are likely to help achieve those objectives.

A committee appointed by the Indian Planning Commission once recommended that in view of the extremely limited supply of land in India, there should be an absolute ceiling on land holdings of each family and the holding should ensure minimum income necessary for supporting the family.[2] Following this recommendation, Mitra[3] has tried, by applying linear programming, to determine minimum land resources and combination of other resources required to attain a farm income equal to: (1) income of unskilled

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* Derived from a section of the PhD thesis of the author.

[1] M A Jabbar, An investigation into the effect of farm structure on resource productivity in selected areas of Bangladesh. Unpublished PhD thesis, University of Wales, UK, 1976.

[2] Government of India, *Report of the Committee on Size of Holdings* (Faridabad: Government of India Press, 1959), p.100.

[3] A.K. Mitra, "Influence of Specific Agricultural Resource Adjustments on the Growth and Development of the Rural Sector in the District of Burdwan, India", *Farm Management Notes for Asia and the Far East,* IV, 1 (January 1968), 19-30.

labourers in industry, (2) income of semi-skilled labourers in industry, and (3) average income of the upper third of the farms which he studied.

There are limitations to using minimum family income as a criteria for land redistribution : (1) One has to specify as many minimum income levels as there are sizes of families. (2) Interpretation of minimum income for a given family size will differ between potential losers and gainers of land on the one hand and the policy makers or researchers on the other. (3) Factors determining income change, sometimes violently. Therefore, any determined income level will remain valid for a short time period. (4) The quantity of land required to achieve any acceptable minimum income in relation to any of the three stated criteria will vary even within the bounds of a small region.

Creating productive work opportunities in agriculture is one of the major policy objectives enunciated by the Bangladesh government in the first five year plan. One possible way to achieve this objective is to redistribute land in such a manner that each farm family has enough land to employ fully its labour. (This does not preclude the possibility of hiring some labour in peak seasons.) Income generated by a farm providing full employment will be assumed adequate to maintain the family under given conditions. This measure will be unfavourable toward large families with comparatively smaller numbers of working men. This problem can be overcome by allowing a certain minimum amount of land per family member with a downward adjustment for those families having non-farm employment. Land redistributed on this basis will automatically put a limit on the size of family holdings which will be smaller than the ceiling suggested by the government. The resulting distribution of resources and income will be more egalitarian than the existing one. In combination with other reform measures including introduction of cooperative farming, provision of inputs and services, redistribution will create both incentive and environment for raising resource productivity and for accelerating the rate of technological improvement.

According to the samples in Jabbar's study, per caput availability of land in Mymensingh, Rangpur and Dinajpur averaged 0.47 acres, 0.41 acres and 1.27 acres respectively.[1] Assume that the total land owned by all farms in each sample is to be redistributed among themselves (since information about landless labourers was not

[1] Dinajpur figure has an upward bias because smaller farms were not adequately represented in the sample.

available, they are not considered as potential gainers of land) on the basis of the sample average per caput availability of land. Distributions of farms and farm area according to acres owned after suggested redistribution are shown in Table 1. None of the farms in Mymensingh owned more than 10 acres of land, none in Rangpur owned more than 15 acres and 15 percent of the farms in Dinajpur owned more than 20 acres. The maximum size of family holdings in Dinajpur will reduce further if more smaller farms and landless workers are considered potential gainers of land.

Table 1: Distribution of farms and farm area according to acres owned after suggested land redistribution for the selected regions

Size class in acres	Distribution of farms and farm area by selected regions					
	Mymensingh		Rangpur		Dinajpur	
	Farms	Farm area	Farms	Farm area	Farms	Farm area
	.....Percent.....					
Less than 1.00	2	0.6	2	0.5	a	a
1.00 – 2.49	29	17.0	44	29.0	a	a
2.50 – 4.99	50	50.9	49	56.7	7	1.7
5.00 – 7.49	18	28.9	3	5.8	14	6.8
7.50 – 9.99	1	2.6	1	3.1	31	43.1
10.00 – 14.99	a	a	1	4.9	42	40.3
15.00 – 19.99	a	a	a	a	6	8.1
All farms	100	100.0	100	100.0	100	100.0

a. none.

Most of the present part-operators and about 40 percent of all farms will lose land as a result of suggested redistribution (Table 2). Number of owner-operators losing land will be reduced substantially if marginal cases are excluded. In political terms, excluding marginal farmers are likely to reduce potential resistance to change.

After land redistribution, the relative share of land, fixed labour and fixed capital becomes consistent with all farmers being owner-operators (Table 3). Part-operators will possibly disinvest their slightly excess capital and part-tenants should be the ones to acquire them. Credit facilities should be extended to that end.

Table 2: Number of farms gaining and losing land as a result of suggested land redistribution by tenure for the selected regions.

Tenure class	Farms gaining and losing land by selected regions					
	Mymensingh		Rangpur		Dinajpur	
	Gainer	Loser	Gainer	Loser	Gainer	Loser
	.....number of farms.....					
Part-operators	1	4	2	13	10	36
Owner-operators	35	37	23	19	15	3
Part-tenants	20	3	38	5	29	1
Tenants	a	a	a	a	6	a
All farms	56	44	63	37	60	40

a. none.

Table 3: Relative share of land, fixed labour and fixed capital by tenure classes after suggested land redistribution for the selected regions

Region and tenure class	Proportion of indicated factor			
	Farms	Land area	Fixed labour	Fixed capital
	.....percent.....			
Mymensingh:				
Part-operators	5	4.2	4.1	6.9
Owner-operators	72	76.1	77.4	78.0
Part-tenants	23	19.7	18.5	15.1
All farms	100	100.0	100.0	100.0
Rangpur:				
Part-operators	15	15.2	17.3	22.2
Owner-operators	42	46.9	44.3	46.0
Part-tenants	43	37.9	38.4	31.8
All farms	100	100.0	100.0	100.0
Dinajpur:				
Part-operators	46	49.2	53.7	56.8
Owner-operators	18	16.8	16.9	14.6
Part-tenants	30	29.5	25.2	25.5
Tenants	6	4.5	4.2	3.1
All farms	100	100.0	100.0	100.0

The immediate effect of land redistribution will be to reduce income inequality. Maximizing employment, raising output and income will necessitate changes in cropping patterns and technological improvement as indicated by solutions of linear programming models constructed for a 2 man-unit farm for each of the three regions.

The linear programme model to maximize employment was constructed thus:

$$\text{Maximize} \qquad Z = \sum_{j=1}^{n} C_j X_j ;$$

$$\text{Subject to} \qquad \sum_{j=1}^{n} a_{ji} X_j \leq b_i ; \qquad i = 1, \ldots , m;$$

$$X_j \geq 0;$$

where Z is the number of man-days of employment during one year,

C is an n component row vector of total man-days of labour required per unit of each activity or process,[1]

X is an n component row vector of activities,

a is an nxm matrix of technical coefficients,

b is an m component column vector of resource limitations.

The operational models involved introducing appropriate slack variables for transforming inequalities into equalities and the following assumptions:

1. The farm was assumed to be owner-operated. Participation in cooperative was assumed for using mechanical irrigation.
2. The following enterprises (real activities) were assumed for the three regions:

Mymemsingh: *aman* rice, *aus* rice, IRRI rice, jute.

Rangpur: *aman* rice, *aus* rice, IRRI rice, jute, tobacco.

Dinajpur: *aman* rice, *aus* rice, IRRI rice, sugarcane, wheat.

3. Only labour was assumed a constraint. All other resources were either available or would be available as and when necessary.
4. The following alternative labour supply situations were assumed:

[1] For definition of activity or process, see Earl O. Heady and W. Candler, *Linear programming* Methods (Ames, Iowa: The Iowa State University Press, 1958), p.11.

a. 30 man-days per man-unit per month; no hiring possible.
b. 30 man-days per man-unit per month; 100 man-days casual hired labour during the year as and when necessary.
c. 30 man-days per man-unit per month with a maximum of 255 man-days per man-unit per year; 100 man-days casual hired labour during the year as and when necessary.

5. Monthly labour requirements per acre are shown for each enterprise in Table 4. An enterprise producible in all three regions was assumed to have the same labour requirement in each region.
6. Labour requirement data was prepared on the implicit assumption of existing human labour, animal power-based technology and farm practices. Irrigation was assumed to be provided by hired mechanical source(s). The possibility of using tractor and power tiller for cultivation operations was not considered. Theoretically, tractor mechanization may be advocated on the basis of potential advantages in relation to (a) more timely sowing and better preparation of fields leading to increased yields, (b) substitution of crops designed for human consumption for fodder crops thereby increasing total food availabilities, (c) more rapid field preparation permitting increased crop intensities. Lawrence has discounted the potential advantages of mechanization under existing conditions in relation to all three criteria and has shown that animal power was more economic than tractor or power tiller from the point of view of both individual producers and the society.[1] However, selective mechanization might be beneficial and economic within a cooperative structure not considered in this model.

The general structure of the basic matrix is shown in Table 5. Optimal solutions for Mymensingh, Rangpur and Dinajpur are shown in Table 6, 7 and 8 respectively. IRRI acreage seems to be an important determinant for raising employment and output in all three regions. In reality, the cropping patterns are likely to be slightly different because

[1] Roger Lawrence, S*ome Economic Aspects of Farm Mechanization in Pakistan* (Islamabad: United States Agency for International Development, 1970), (mimeographed).

Mymensingh and Rangpur being major jute and tobacco producing regions, farmers are likely to produce certain minimum amount of these crops. The programmes may be adjusted accordingly by introducing minimum or maximum amount of a particular crop as a constraint.

Table 4: Average monthly labour requirement for major crops

Month	Average labour requirement for indicated crops							
	Aman	*Aus*	Boro	IRRI	Jute	Tobacco	Sugarcane	Wheat
	.....man-days per acre.....							
January	10	a	23	20	a	30	5	5
February	a	a	a	20	10	20	15	5
March	a	18	12	16	10	15	20	15
April	a	17	12	20	20	a	a	a
May	a	17	a	a	15	a	a	a
June	a	12	a	a	10	a	a	a
July	23	12	a	a	20	a	a	a
August	20	a	a	a	15	a	10	a
September	20	a	a	a	a	a	10	a
October	a	a	10	10	a	10	30	5
November	7	a	10	17	a	15	30	5
December	10	a	15	15	a	30	40	20
Total	90	76	82	118	100	120	160	55

a. none.

The amount of land actually required for producing the crop areas given by each programme solution will depend on the intensity of cropping, i.e. the number of times each piece of land may be used during one year. Assuming 150-200 percent intensity of cropping, 3-4 acres of land will be enough to produce 5-7 acres of crops as given by the programme solutions, i.e. a 2 man-unit, 3-4 acre farm may be regarded as optimal under given conditions. Mymensingh and Rangpur each have about this size of average farm. The size of Dinajpur farms may not be lowered to this level unless substantial improvement in technology and cropping intensity are contemplated.

Table 5: Basic matrix for a two-men-unit-owner-operated farm

Employment per acre	0	90	76	118	100	120	0	0	.	.	0	0	0	0	.	.	0	0
Resource or activity	Supply	Real activities											Disposal activities					
		.....Enterprises.....					…….. Casual hired labour…….											
		Aman rice	*Aus* rice	IRRI	Jute	Tobacco	January	February	.	.	November	December						
		P_1	P_2	P_3	P_4	P_5	P_6	P_7	.	.	P_{16}	P_{17}	P_{18}	P_{19}	.	.	P_{42}	P_{43}
P_{18} Fixed labour: Jan	60	10	0	20	0	30	-1	0	.	.	0	0	1	0	.	.	0	0
P_{19} February	60	0	0	20	10	20	0	-1	.	.	0	0	0	1	.	.	0	0
P_{28} November	60	7	0	17	0	15	0	0	.	.	-1	0						
P_{29} December	60	10	0	15	0	30	0	0	.	.	0	-1						
P_{30} Total	510	90	76	118	100	120	-1	-1	.	.	-1	-1						
Casual labour tie:																		
P_{31} January	0	-100	-100	-100	-100	-100	1	0	.	.	0	0						
P_{32} February	0	-100	-100	-100	-100	-100	0	1	.	.	0	0						
P_{41} November	0	-100	-100	-100	-100	-100	0	0	.	.	1	0						
P_{42} December	0	-100	-100	-100	-100	-100	0	0	.	.	0	1	0	0	.	.	0	0
P_{43} Total casual labour	100	0	0	0	0	0	1	1	.	.	1	1	0	0	.	.	1	0
													0	0	.	.	0	1

Table 6: Optimal enterprise combinations for maximizing employment of a two man-unit owner-operated farm in Mymensingh under alternative constraints

Constraints	Crops					Employment per man-unit	Estimated gross output[a]
	Aman	*Aus*	IRRI	Jute	Total		
	.....acres.....					Man-days	Taka
1. (a) 30 man-days per man-unit per month (b) No hired labour	2.00	1.17	2.00	0.00	5.17	252	8,237
2. (a) as above (b) casual hire, 100 man-days per year	3.00	2.74	2.00	0.00	7.74	315	10,860
3. (a) as above with maximum of 255 days per year (b) as 2 (b)	3.00	4.10	0.24	0.00	7.34	255	7,839

a. assuming all farm average yield and prices.

Table 7: Optimal enterprise combinations for maximizing employment of a two man-unit owner-operated farm in Rangpur under alternative constraints

Constraints	Crops						Employment per man-unit	Estimated gross output[a]
	Aman	*Aus*	IRRI	Jute	Tobacco	Total		
	.....acres.....						Man-days	Taka
1. (a) 30 man-days per man-unit per month (b) No hired labour	0.57	0.52	2.03	2.03	1.46	5.11	265	8,373
2. (a) as above (b) casual hire, 100 man-days per year	2.25	1.61	2.50	1.00	0.00	7.36	310	11,290
3. (a) as above with maximum of 255 days per year (b) as 2 (b)	2.10	0.94	1.95	1.20	0.00	6.19	255	9,278

a. Assuming all farm average yield and prices.

Table 8: Optimal enterprise combinations for maximizing employment of a two man-unit owner-operated farm in Dinajpur under alternative constraints

Constraints	Crops						Employment per man-units	Estimated gross Output[a]
	Aman	*Aus*	IRRI	Sugar cane	Wheat	Total		
	Crops						Man-days	Taka
1. (a) 30 man-days per man-unit per month	1.92	1.31	1.89	0.31	0.00	5.43	272	8,693
(b) No hired labour								
2. (a) as above								
(b) casual hire, 100 man-days/yr	2.42	1.76	1.50	1.15	0.00	6.83	306	10,479
3. (a) as above with maximum of 255 days per year	1.23	2.65	2.36	0.13	0.00	6.37	255	10,201
(b) as 2 (b)								

a. Assuming all farm average yield and prices .

The above findings of linear programming models should not be interpreted too rigidly because of the inherent assumptions under lying linear programming[1] and also because of the insufficiency of data in some respects. Labour requirements were assumed constant for all the regions. Practically, there is no general optimal way of growing crops; there are only differential optimal for different crops in different regions.[2] The models were constructed for demonstrating the procedure, in a simple manner, of handling the problem under consideration rather than finding a unique solution of the problem.

[1] For assumptions underlying linear programming in general, see Heady and Candler, *op.cit*., pp. 17-18.
[2] Attributed to Chayanov by Peter Worsley, *Two Blades of Grass* : Rural cooperatives in agricultural modernization. Manchester University press, Manchester, UK. p.39.