Vol XXXVI
No. 2

APRIL-
JUNE
1981

ISSN 0019-5014

INDIAN JOURNAL OF AGRICULTURAL ECONOMICS

INDIAN SOCIETY OF
AGRICULTURAL ECONOMICS,
BOMBAY

INCOME AND EMPLOYMENT EFFECTS OF THE NEW DRY LAND FARM TECHNOLOGY IN HARYANA*

Since the inception of planned economic development in India, Government has been striving to raise agricultural production and employment through a multiplicity of devices. Evolutionary changes in the development strategy are being effected with a view to achieving growth with social justice. It is felt that this goal cannot be obtained only by maximizing per capita output. There is a need to maximize income based on productive absorption of surplus labour in agriculture which is the dominant sector.

In fact, it was optimistically believed that the introduction of new technology would create more employment and provide additional income to the surplus labour. However, there are conflicting views about the effect of new technology on employment. Some[1] hold the view that the adoption of new technology will substantially increase total agricultural employment, while others[2] have argued that the green revolution may not help in raising agricultural employment.

In India, rural income and employment data are scarce and at times non-existing particularly for the dry land tracts. As a matter of fact, there are very few systematic, scientific and empirical studies concerning the effects of new dry land agricultural production technology on income and employment. This paper, therefore, attempts to study the income and employment effects of new (improved) dry land technology in agriculture.

METHODOLOGY

Hissar, Sirsa, Bhiwani and Mohindergarh districts of Haryana State where Dry Land Agricultural Development and Drought-Prone Areas Development Projects are in operation, were selected to represent the dry land tract. Stratified two-stage random sampling design was used for data collection and the dry land tract was divided into two zones, *viz.*, Hissar and Narnaul based on average yearly rainfall. The Hissar zone had 350 mm. annual rainfall, whereas the Narnaul zone had more than 350 mm. annual rainfall. Village was the lowest unit for the demarcation of the zones. The total number of villages in Hissar and Narnaul zone was 1,007 and 630 respectively. One per cent villages from each zone making a total number of 16 villages, 10 from Hissar and 6 from Narnaul zone, were selected. The holding size-groups, *viz.*, small, medium and large were formed by dividing the cumulative frequency of the households into three parts in each zone. From each holding size-group, 10 per cent of the households were selected

* The authors are grateful to an anonymous referee of this Journal for his valuable suggestions.

1. I. R. Wills, "Green Revolution and Agricultural Employment and Income in Western Uttar Pradesh", *Economic and Political Weekly*, Vol. VI, No. 13, March 27, 1971, pp. A-5-A-10.

2. Pranab Bardhan, "'Green Revolution' and Agricultural Labourers", *Economic and Political Weekly*, Vol. V, Nos. 29, 30 and 31, Special Number, July 1970, pp. 1239-1246.

for this study. Accordingly, 150 farmers* comprising 70 small, 42 medium and 38 large holding size were selected from Hissar zone. From Narnaul zone a total number of 90 farmers** consisting of 52 small, 23 medium and 15 large holding size was selected. The total number of farmers selected for this study was 240.

The Data

Detailed primary data on the resource structure, land use classification, resource inventory, input-output details, crops and cropping pattern, livestock, labour force, financial position, borrowing capacity, sources of finance, family composition, literacy, consumption pattern, marketing facilities, farmer's attitude regarding different dry land technologies, etc., were collected from the selected farmers of the study area. Data were collected for the normal year of 1976-77 by personal interview on the schedules specially designed for the study.

THE MODEL

Linear programming was used for measuring the impact of the new dry land farm technology on income and employment of the farm families. Six models for Hissar as well as for Narnaul zones were fitted. The models are:

Model I — existing technology, existing capital;
Model II — intermediate technology, existing capital;
Model III — improved technology, existing capital;
Model IV — existing technology, relaxed capital;
Model V — intermediate technology, relaxed capital; and
Model VI — improved technology, relaxed capital.

The objective function (Z) to be optimized was stated as a linear function of the independent variables subject to the linear inequalities stated in terms of these variables. Symbolically, the profit maximizing linear programming model is defined as follows:

$$\text{Maximize } Z = CX$$
$$\text{Subject to } = AX \leqslant b$$
$$X \geqslant 0$$

where C = vector of per hectare net income from crop activity,
X = vector of optimal level of activities,
A = input-output coefficient matrix,
b = input availability vector.

The number of resource constraints, their level and number vary according to farm sizes and crop zones.

The Activities

Fifteen crop activities, *viz.*, jowar, *desi* bajra, hybrid bajra, bajra mixed with *moong* and *guar*, *guar*, *moong*, groundnut, *desi* cotton, American cotton, *desi* wheat, Mexican wheat, barley, gram, mustard and *massar* were included in the model. In addition, capital borrowing was also included in the model.

* Hissar Zone
Small .. 3·50 ha.
Medium .. 7·50 ha.
Large .. 15·40 ha.

** Narnaul Zone
Small .. 3·20 ha.
Medium .. 6·50 ha.
Large .. 14·00 ha.

The Constraints

Land was included as one of the constraints in the model. Considering irrigation restriction and crop seasons, four land constraints, *viz.*, irrigated *kharif* and *rabi* lands and unirrigated *kharif* and *rabi* lands were identified and included in the model. With regard to labour, three labour restrictive periods (July-August, October-November and April-May) for human labour were identified. Since the available human labour on the selected farms exceeded the requirement, labour hiring was not included in the model. As a majority of the farmers maintain either a pair of bullocks or a camel, draught power was not considered as a limiting factor. Capital (credit) was considered as one of the major constraints for development of dry land farms. Hence, it was included as a constraint in the model. Optimum plans were also worked out by relaxing this capital (past savings and some borrowings) constraint. Minimum restriction on fodder acreage was included as a constraint to meet the feed requirements of farm animals.

Coefficients

Three types of input-output coefficients[3] were used in the programming model. First set of the input-output coefficients of the existing level of technology was developed on the basis of the inputs used and output produced for different enterprises on the sample farms of the respective zones. Second set of input-output coefficients representing intermediate level of technology was derived on the basis of the inputs used and output produced for different enterprises on the progressive farms of the respective zones. A farmer adopting 50 per cent of the recommended package of practices[4] for dry land farms was termed as a progressive farmer. The third set of input-output coefficients representing improved level of technology was developed on the basis of the input-output coefficients given in the package of practices for the dry land farms.

EMPIRICAL FINDINGS

The main thrust in this paper was to work out income and employment effects of new dry land farm technology on small, medium and large holdings in the Hissar and Narnaul zones of Haryana arid agriculture. Thus, to highlight the effects of new dry land farm technology on farm incomes and employment, the irrigated crops have been excluded while presenting the results.

A. Effects of New Dry Land Farm Technology on Farm Income and Employment

The per farm net income at the existing, intermediate and improved levels of technologies, capital used, land utilization, crop plans, human and bullock labour employment at the existing, intermediate and improved levels of technologies are presented in Tables I and II and Appendix Table 1.

3. Input (resource) coefficients were computed as average quantities of various restrictive resources required per unit of a process or activity.

4. Package of practices means use of improved seeds, fertilizers, plant protection measures and cultural practices together in the crop production process.

TABLE I—EFFECT OF TECHNOLOGY ON FARM INCOME

(*Rs.*)

Study zone	Technology level	Capital level	Incomes on		
			Small farms	Medium farms	Large farms
Hissar	Existing	Existing	1,717	3,476	8,785
		Relaxed	1,855	4,287	11,431
	Intermediate	Existing	2,385	4,305	9,611
		Relaxed	2,627	5,530	12,406
	Improved	Existing	3,233	5,036	9,815
		Relaxed	5,259	6,558	14,522
Narnaul	Existing	Existing	3,050	7,040	13,189
		Relaxed	3,290	7,667	14,147
	Intermediate	Existing	3,393	7,750	15,066
		Relaxed	3,922	8,975	16,977
	Improved	Existing	3,432	7,558	11,373
		Relaxed	5,907	13,392	24,058

TABLE II—EFFECT OF TECHNOLOGY ON FARM EMPLOYMENT

(*Days*)

Study zone	Technology level	Capital level	Employment on		
			Small farms	Medium farms	Large farms
Hissar	Existing	Existing	165	294	470
		Relaxed	183	306	567
	Intermediate	Existing	195	303	505
		Relaxed	224	324	641
	Improved	Existing	190	310	510
		Relaxed	366	466	780
Narnaul	Existing	Existing	193	418	740
		Relaxed	193	438	845
	Intermediate	Existing	198	430	801
		Relaxed	209	465	881
	Improved	Existing	118	280	445
		Relaxed	223	538	909

(*i*) *Effects on farm income*

An increase in the per farm net income was observed on each of the three size-groups of holdings at the intermediate as well as improved levels of technologies in Hissar and Narnaul zones except for the improved level of tech-

nology on large holdings in Narnaul zone. In Hissar zone the increase in net farm income at the intermediate technology level over the existing one was the highest, being 38 per cent on small holdings followed by 23 per cent on medium holdings (Table I). It was the lowest, being 9 per cent on large holdings. At the improved level of technology, the net increase in income over the existing level of technology was 88, 44 and 11 per cent on small, medium and large holdings respectively.

In Narnaul zone, the percentage increase in per farm net income at the intermediate level of technology over the existing one was 11, 10 and 3 per cent on small, medium and large holdings respectively. However, on the large size holdings, the net farm income decreased at the improved level of technology over the existing level due to the shortage of capital. On the other hand, on small and medium holdings the adoption of the improved technology led to 12 and 7 per cent increase in net farm income (Table I).

(ii) Effects on labour employment

Table II shows that there was higher use of labour (both human and bullock) in the optimum plans at the intermediate level of technology as compared to the optimum plans at the existing level of technology. This was mainly due to higher human and bullock labour requirement by the new dry land production technology recommended for the region. A similar trend was observed for the improved level of technology in the Hissar zone. In contrast to this, in Narnaul zone, the use of both human and bullock labour decreased at the improved level of technology. The plausible reasons for this situation may be the substitution of less labour intensive crops like *guar* for more labour intensive crops like bajra in addition to the less intensive use of land due to capital limitation.

The above findings, thus, reveal the scope for increasing farm incomes of the dry farming areas of Haryana through the adoption of the new dry land farm technology. This also shows that the new dry land farm technology is labour intensive[5] and needs to be further extended through an aggressive extension programme.

B. Effects of Unrestricted Capital on Farm Income and Employment

The effect of relaxing the capital constraint on net returns and labour employment is presented in Tables I and II and Appendix Table 2.

(i) Effects on farm income

The relaxation of capital constraint increased net farm incomes on all farm size-groups (Table I). For example, in Hissar zone it increased by Rs. 138, Rs. 811 and Rs. 2,646 on small, medium and large farm holdings respectively. Similarly, the relaxation of capital constraint in Narnaul zone increased net farm income by Rs. 240, Rs. 627 and Rs. 953 on small, medium and large holdings respectively.

5. Wills, *op. cit.*

(ii) Effects on labour employment

A comparison of optimum plans at the existing level of technology with the restrictive use of capital with the optimum plans obtained with the unrestricted use of capital at the existing technology level shows increased use of human labour on each holding size-group in both the zones except for small holdings in Narnaul zone (Table II). This shows that the dry land farms are very much capital starved. The implication of this finding is that the increased use of capital has the potential of increasing net farm incomes and employment in the dry land agriculture.

C. Effects of Unrestricted Capital and New Dry Land Farm Technology on Farm Income and Employment

The interaction effect of relaxing the capital constraint and use of the new dry land farm technology increased farm incomes substantially on all holding size-groups (Table I). For example, the net income increased by 206, 89 and 65 per cent on small, medium and large farm holdings respectively in Hissar zone. Similarly, in Narnaul zone it increased by 94, 90 and 82 per cent on small, medium and large farm holdings respectively. The human labour employment increased by 122, 58 and 66 per cent on small, medium and large size holdings respectively in Hissar zone. In Narnaul zone human labour employment increased by 16, 29 and 23 per cent on small, medium and large farm holdings respectively. These findings, thus, further show that the use of new dry land farm technology coupled with the increased supply of capital has greater potential to increase farm incomes and employment as compared to the use of new dry land farm technology alone.[6]

D. Decomposition of Total Change in Farm Income and Employment

The decomposition of total change in farm income in Table III shows a mixed trend. In Hissar zone, for example, the contribution of pure technology component in increasing incomes on small and medium farm holdings was more as compared to the contribution of pure capital component. However, on large size holdings the contribution of pure capital component was the highest. In Narnaul zone the contribution of pure capital component was more as compared to the pure technology component except on small size holdings. Table III further shows that it is the interaction effect of capital and technology which increased farm income substantially in both the zones. Decomposition analysis shows that in the case of human labour employment also, the contribution of pure technology in increasing human labour employment was the highest on small and medium size holdings in Hissar zone. On large size holdings the contribution of capital component in increasing the human labour employment was more. As a result of capital shortage, the contribution of pure technology component was negative on

6. Mruthyunjaya and A. S. Sirohi, "Enterprise Systems for Stability and Growth on Drought-Prone Farms: An Application of Parametric Linear Programming", *Indian Journal of Agricultural Economics*, Vol. XXXIV, No. 1, January-March 1979, p. 37.

all size-groups of holdings in Narnaul zone. Similar to Hissar zone, in Narnaul zone also the interaction effect of capital and technology contributed more in increasing income and employment than a single component (Tables III and IV).

TABLE III—DECOMPOSITION OF TOTAL CHANGE IN FARM INCOME

(*Rs.*)

Study zone	Component	Change in income on		
		Small farms	Medium farms	Large farms
Hissar	Pure technology	1,516	1,560	1,030
	Pure capital	138	811	2,646
	Technology × capital	3,542	3,082	5,737
Narnaul	Pure technology	382	518	—1,816
	Pure capital	240	627	953
	Technology × capital	2,857	6,352	10,869

TABLE IV—DECOMPOSITION OF TOTAL CHANGE IN FARM EMPLOYMENT

(*Days*)

Study zone	Component	Change in employment on		
		Small farms	Medium farms	Large farms
Hissar	Pure technology	25	16	40
	Pure capital	18	12	97
	Technology × capital	201	172	310
Narnaul	Pure technology	— 75	— 213	— 295
	Pure capital	—	20	105
	Technology × capital	30	120	169

Conclusion

The findings presented in this paper show that when the new dry land farm technology is used at the existing resource level, capital shortage limits its full exploitation (Appendix Tables 1 and 2). Thus, for full exploitation of the new dry land farm technology, provision of liberal credit facilities is a pre-requisite.

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APPENDIX TABLE 1

OPTIMAL PLANS WITH EXISTING LEVEL (EXLT), INTERMEDIATE LEVEL (IMLT) AND IMPROVED LEVEL (IPLT) OF TECHNOLOGY WITH EXISTING CAPITAL, HARYANA: 1976-77

Sr. No.	Cropping plan	Small			Medium			Large		
		EXLT	IMLT	IPLT	EXLT	IMLT	IPLT	EXLT	IMLT	IPLT
					Location—Hissar					
1.	Net income (Rs.) ..	1,717	2,385	3,233	3,476	4,305	5,036	8,785	9,611	9,815
2.	Capital used (Rs.) ..	421	613	944	985	1,075	1,472	2,138	2,448	2,796
3.	Land used (ha.) ..	3·07	3·90	3·90	6·00	6·00	6·00	12·80	12·80	12·80
	(*i*) Bajra (HYV) ..	1·00	1·00	1·00	1·50	1·50	1·50	3·00	3·00	3·00
	(*ii*) *Moong*	—	—	—	1·84	—	—	—	—	—
	(*iii*) *Guar*	1·50	1·50	1·50	1·76	3·60	3·60	9·80	9·80	9·80
	(*iv*) Gram	0·57	1·40	1·40	0·90	0·90	0·90	—	—	—
	(*v*) Mustard	—	—	—	—	—	—	—	—	—
4.	Human labour (days) ..	165	195	190	294	303	310	470	505	510
5.	Bullock labour (days) ..	30	35	31	51	55	55	95	97	100
					Location—Narnaul					
1.	Net income (Rs.) ..	3,050	3,393	3,432	7,040	7,750	7,558	13,189	15,066	11,373
2.	Capital used (Rs.) ..	732	753	849	1,492	1,505	1,879	2,458	3,001	2,967
3.	Land used (ha.) ..	4·60	4·60	3·20	10·50	10·60	7·10	21·80	20·80	11·27
	(*i*) Bajra (HYV) ..	—	—	—	—	—	—	—	—	—
	(*ii*) Mixed crop ..	2·30	—	—	2·72	—	—	—	—	—
	(*iii*) *Guar*	—	2·30	2·30	—	5·30	5·30	—	10·90	10·90
	(*iv*) *Massar*	—	—	—	2·58	—	—	10·90	—	—
	(*v*) Gram	—	—	0·56	—	—	1·20	0·77	—	0·37
	(*vi*) Mustard	2·30	2·30	0·40	5·30	5·30	0·60	9·13	9·90	—
4.	Human labour (days) ..	193	198	118	418	430	280	740	801	445
5.	Bullock labour (days) ..	35	38	32	62	66	31	125	131	69

APPENDIX TABLE 2

OPTIMAL PLANS WITH EXISTING LEVEL (EXLT), INTERMEDIATE LEVEL (IMLT) AND IMPROVED (IPLT) OF TECHNOLOGY WITH UNRESTRICTED CAPITAL, HARYANA: 1976-77

Sr. No.	Cropping plan	Small			Medium			Large		
		EXLT	IMLT	IPLT	EXLT	IMLT	IPLT	EXLT	IMLT	IPLT
					Location—Hissar					
1.	Net income (Rs.) ..	1,855	2,627	5,259	4,287	5,530	6,558	11,431	12,406	14,522
2.	Capital used (Rs.) ..	795	878	2,387	1,595	1,793	2,922	4,176	4,338	6,250
3.	Land used (ha.) ..	2·50	2·50	5·00	6·00	6·00	6·00	12·80	12·80	12·08
	(*i*) Bajra (HYV) ..	1·00	1·00	1·00	1·50	1·50	1·50	3·00	3·00	3·00
	(*ii*) *Moong*	1·50	1·50	1·50	3·60	3·60	3·60	9·80	9·80	9·80
	(*iii*) *Guar*	—	—	—	—	—	—	—	—	—
	(*iv*) Gram	—	—	2·50	0·90	0·90	—	—	—	—
	(*v*) Mustard	—	—	—	—	—	0·90	—	—	—
4.	Human labour (days) ..	183	224	366	306	324	466	567	641	780
5.	Bullock labour (days) ..	38	43	51	61	72	76	145	149	150
					Location—Narnaul					
1.	Net income (Rs.) ..	3,290	3,922	5,907	7,667	8,975	13,392	14,142	16,977	24,058
2.	Capital used (Rs.) ..	989	1,291	2,675	2,180	2,828	6,164	3,508	4,963	12,013
3.	Land used (ha.) ..	4·60	4·60	4·60	10·60	10·60	10·60	20·80	20·80	20·80
	(*i*) Bajra (HYV) ..	—	—	—	—	—	—	—	—	—
	(*ii*) Mixed crop ..	2·30	2·30	—	5·30	5·30	—	10·90	10·90	—
	(*iii*) *Guar*	—	—	—	—	—	—	—	—	—
	(*iv*) *Moong*	—	—	2·30	—	—	5·30	—	—	10·90
	(*v*) Gram	—	—	—	—	—	—	—	—	—
	(*vi*) Mustard	2·30	2·30	2·30	5·30	5·30	5·30	9·90	9·90	9·90
4.	Human labour (days) ..	193	209	223	438	465	538	845	881	909
5.	Bullock labour (days) ..	36	40	41	64	67	70	140	151	160