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STABILISATION OF PRICES, SUPPLY AND INCOME FOR PADDY AND WHEAT IN PUNJAB: A UNIFIED APPROACH

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Rising costs discourage input use and hence reduce output supply. The decline in output supply raises food prices and causes hardship to the consumers. The rise in food prices should be sufficiently high not only to counteract the rising costs but also to leave a rate of profit conducive to investment in agriculture. Otherwise, there will be setback in productivity. Now the question arises as to how to contain the rising costs, maintain the rate of profit and correct the setback in productivity. The situation can be corrected through price and non-price adjustments like factor prices, technological change, irrigation, capital inputs, acreage and procurement. An attempt is made in this paper to develop a policy model for Punjab agriculture and use it to *(i)* evaluate the effects of price and non-price factors on factor demand, output supply and crop net income and *(ii)* simulate the model to suggest the adjustments needed in the price and non-price factors to attain the specific goals of prices, production, crop income and consumer welfare.

I

THE MODEL

The model used in the study is a simplified version of the unified approach described by Quizon and Binswanger.[1] The elements of the model are the producer core consisting of factor demand and output supply, output demand and crop net income equations.

Producer Core System

The theory of profit function[2] provides a set of factor demand and output supply equations as :

Factor demand : $X = X(P, p, Z, T)$

Output supply : $Q = Q(P, p, Z, T)$

where X is a vector of k variable inputs, P is a vector of crop output prices, p is a vector of variable input prices, Z is a vector of fixed inputs, T is technology, Q is a vector of crop output supply. The producer core system in rates of change is :

$$\dot{Q}_i = E^{P}_{Q_i}\,\dot{P} + \sum E^{p_j}_{Q_i}\,\dot{p}_j + \sum E^{Z_j}_{Q_i}\,\dot{Z}_j + E^{T}_{Q_i}\,\dot{T} \qquad (i = 1, 2, \ldots\ldots n)$$

$$\dot{X}_{k_i} = E^{P}_{X_i}\,\dot{P} + \sum E^{p_j}_{X_i}\,\dot{p}_j + \sum E^{Z_j}_{X_i}\,\dot{Z}_j + E^{T}_{X_i}\,\dot{T} \qquad (k = 1, 2, \ldots\ldots k)$$

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1. James B. Quizon and Hans P. Binswanger, "Income Distribution in Agriculture: A Unified Approach", *American Journal of Agricultural Economics*, Vol.65, No.3, August 1983, pp. 526–538.

2. Lawrence J. Lau, "Applications of Profit Functions in Production Economics", in Melwyn Fuss and Daniel McFadden (Eds.): Production Economics: A Dual Approach to Theory and Applications, Vol. I, North-Holland Publishing Co., Amsterdam, 1978, pp. 183-215. Also see Lawrence J. Lau and P. A. Yotopoulos, "Profit, Supply, and Factor Demand Functions", *American Journal of Agricultural Economics*, Vol. 54, No. 1, February 1972, pp. 11-18 and S.L. Bapna, H.P. Binswanger and J.B. Quizon, "Systems of Output Supply and Factor Demand Equations for Semi-Arid Tropical India", *Indian Journal of Agricultural Economics*, Vol. XXXIX, No. 2, April-June 1984, pp. 179-202.

The dot on the varibale indicates the rate of change, *i.e.*, $\dot{X}_i = \frac{dX}{dt} \cdot \frac{1}{X}$; 'E' parameters are the elasticities of output supply and factor demand, *i.e.*, $E_X^P = \frac{dX}{dP} \cdot \frac{P}{X}$, subscripts k and i indicate 'k' inputs and 'n' crops respectively.

Output Demand System

Following the consumer demand theory, the output demand equations in rates of change are :

Per capita consumer demand: $\dot{d}_i = E_{d_i}^{P_i} \dot{P}_i + E_{d_i}^{P_j} \dot{P}_j + E_{d_i}^{I_c} \dot{I}_c \quad (i = 1 \ldots . n)$

Consumer demand: $\dot{d}_i^* = \dot{d}_i + \dot{POP}$

Internal demand: $\dot{D}_i^* = s_1 \dot{d}_i^* + s_2 (\dot{SEED}_i + \dot{L}_i) + (1 - s_1 - s_2) \dot{OU}_i$

Total demand: $\dot{D}_i = \lambda_i \cdot \dot{D}_i^* + (1 - \lambda_i) \dot{PROC}_i$

where d_i, d_i^*, D_i^* and D_i are per capita consumer demand, consumer demand, internal demand and total demand for ith crop output respectively, P_i and P_j are the prices of own and substitute crops, I_c is consumer income, POP is population, SEED is the seed rate, L is crop area, OU is other uses of the crop, s_1 and s_2 are the shares of consumer demand and seed use in internal demand, PROC is the crop output surplus available for other States which includes the procurement for central pool and private trade to other States, and λ is the share of internal demand in total demand.

The equilibrium product prices are determined by equating output supply to its demand for each crop ($Q_i = D_i$; i = 1, ... n), which have their own effects on factor demand, output supply and also on crop net income.

Crop Net Income

Net income (I) from crop is,

$$I = P.Q(P, p, Z, T) - p.X(P, p, Z, T) - g.Z - f^*.F$$

where g is a vector of fixed factors (included in production) prices, f^* is a vector of prices of fixed factors (F) which are independent of the output. The growth in net income in terms of elasticities can be measured as

$$\dot{I} = E_I^P \dot{P} + \sum E_I^{p_i} \dot{p}_i + \sum E_I^{g_i} \dot{g}_i + E_I^{Z_i} \dot{Z}_i + E_i^T \dot{T} + \sum E_I^{f^*} \dot{f}^* + \sum E_I^{F_i} \dot{F}_i$$

The elasticities of the income model can easily be computed using the elasticities of the pro-producer core system with the formulae developed by de Janvry and Kumar.[3]

The Data

The data generated under the "Comprehensive Scheme for Studying the Cost of Cultivation of Principal Crops" for Punjab by the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India were used for paddy and wheat crop for the period 1977-78 to 1979-80. In each year, the sample covered about 200 farmers spread over the

3. Alain de Janvry and P. Kumar, "The Transmission of Cost Inflation in Agriculture with Subsistence Production : A Case Study in Northern India", *Indian Journal of Agricultural Economics*, Vol. XXXVI, No. 3, July-September 1981, pp. 4-5.

zones.[4]

II

MEASUREMENT OF FACTOR DEMAND, OUTPUT SUPPLY, OUTPUT DEMAND AND INCOME

Consider the case of the three variable factors, human labour (N), fertilizer (X), bullock labour (B) with prices w, f, and b respectively, three fixed factors – irrigation expenditure per farm (IRR), capital inputs per farm (K), land (L) with two outputs – paddy (Q_P) and wheat (Q_W) – with prices P_P, P_W respectively for Punjab farmers. The subscripts P and W stand for paddy and wheat crops respectively. The normalized quadratic (NQ) profit function and demand functions for N, X and B were jointly estimated for paddy and wheat separately for each zone by imposing the symmetry and other linear restrictions on the structural parameters of the equations.[5] Using the estimated parameters of NQ profit equation which were statistically consistent, the elasticities for output supply and factor demand are worked out for each zone and thereafter these elasticities are aggregated.[6]

The factor demand and output supply equations for paddy and wheat are as follows.[7]

Factor Demand

$$\dot{N}_P = 0.2870\dot{P}_P - 0.3794\dot{w} + 0.1039\dot{f} - 0.0115\dot{b} + 0.1072\,\dot{IRR}^*_P - 0.0076\,\dot{K}^*_P + 0.6268\,\dot{L}_P$$

$$\dot{X}_P = 0.4908\,\dot{P}_P + 0.1433\dot{w} - 0.6499\dot{f} + 0.0158\dot{b} + 0.2414\,\dot{IRR}^*_P - 0.0510\dot{K}^*_P + 1.0265\dot{L}_P$$

$$\dot{B}_P = 0.4161\,\dot{P}_P - 0.0749\dot{w} + 0.0903\dot{f} - 0.4315\dot{b} + 0.0565\,\dot{IRR}^*_P - 0.4890\dot{K}^*_P + 0.0137\dot{L}_P$$

$$\dot{N}_W = 0.3949\dot{P}_W - 0.3255\dot{w} - 0.0063\dot{f} - 0.0631\dot{b} + 0.1157\,\dot{IRR}^*_W - 0.0978\dot{K}^*_W + 0.7129\dot{L}_W$$

$$\dot{X}_W = 0.6453\dot{P}_W - 0.0035\dot{w} - 0.6319\dot{f} - 0.0099\dot{b} + 0.0285\,\dot{IRR}^*_W + 0.1877\dot{K}^*_W + 1.0528\dot{L}_W$$

$$\dot{B}_W = 0.8550\dot{P}_W - 0.2869\dot{w} - 0.0519\dot{f} - 0.5162\dot{b} + 0.0351\,\dot{IRR}^*_W - 0.9054\dot{K}^*_W - 0.0894\,\dot{L}_W$$

Output Supply

$$\dot{Q}_P = 0.1326\dot{P}_P - 0.0556\dot{w} - 0.0676\dot{f} - 0.0094\dot{b} + 0.1604\,\dot{IRR}^*_P + 0.2375\dot{K}^*_P + 1.2081\dot{L}_P + T_P$$

$$\dot{Q}_W = 0.1809\dot{P}_W - 0.0530\dot{w} - 0.1023\dot{f} - 0.0256\dot{b} - 0.0115\,\dot{IRR}^*_W + 0.0602\dot{K}^*_W + 0.6735\dot{L}_W + T_W$$

where $T_P = F^{T\dot{T}}_{Q_P}$ and $T_W = E^{T\dot{T}}_{Q_W}$ are the shifts in the productivity through technological change.

Output Demand

Expenditure and compensated own and cross price elasticities of demand estimated by Swamy and Binswanger[8] based on transcendental logarithmic consumer demand equations are used here. The demand equations for rice and wheat are :

4. For sampling purpose, Punjab State is divided into three zones based on soil type, agro-climatic conditions and cropping pattern.

5. For estimation procedure and econometric results of the estimated NQ profit function and factor demand functions, see, Ramesh Chand : Effects of Factor and Product Prices on Factor Demand, Output Supply and Marketed Surplus of Major Crops in Punjab, Ph. D. Thesis, Division of Agricultural Economics, IARI, New Delhi, 1984 (unpublished).

6. Based on pooled data of all the zones, the estimated coefficients of the NQ profit equations will not be free of specification error since the model does not take into account variations in agro-climatic and soil factors and therefore, zonewise analysis was done and then aggregated.

7. Defining $IRR = IRR^*.L$, $K = K^*.L$ where IRR^* and K^* are per hectare irrigation and capital inputs respectively. Since $\dot{IRR} = \dot{IRR}^* + \dot{L}$ and $\dot{K} = \dot{K}^* + \dot{L}$, the $\dot{IRR}$ and $\dot{K}$ in factor demand and output supply equations are replaced by $\dot{IRR}^*$ and $\dot{K}^*$.

8. G. Swamy and H.P. Binswanger, "Flexible Consumer Demand Systems with Linear Estimation Equations : Food Demand in India", *American Journal of Agricultural Economics*, Vol. 65, No. 4, November 1983, p. 681.

Per capita consumer demand

$$\dot{d}_P = -0.5815\dot{P}_P + 0.1275\dot{P}_W + 0.873\dot{I}_c$$

$$\dot{d}_W = 0.2266\dot{P}_P - 0.2259\dot{P}_W + 1.2451\dot{I}_c$$

Consumer demand

$$\dot{d}^*_P = -0.5815\dot{P}_P + 0.1275\dot{P}_W + 0.873\dot{I}_c + \dot{POP}$$

$$\dot{d}^*_W = 0.2266\dot{P}_P - 0.2259\dot{P}_W + 1.2451\dot{I}_c + \dot{POP}$$

Internal demand

$$\dot{D}^*_P = -0.1229\dot{P}_P + 0.0270\dot{P}_W + 0.1846\dot{I}_c + 0.2114\,\dot{POP} + 0.1776\,\dot{SEED}_P + 0.1776\dot{L}_P + 0.6110\,\dot{OU}_P$$

$$\dot{D}^*_W = 0.1154\dot{P}_P - 0.1150\dot{P}_W + 0.6340\,\dot{I}_c + 0.5092\,\dot{POP} + 0.1080\,\dot{SEED}_W + 0.1080\,\dot{L}_W + 0.3828\,\dot{OU}_W$$

Total demand

$$\dot{D}_P = -0.0238\dot{P}_P + 0.0052\dot{P}_W + 0.0358\dot{I}_c + 0.0410\,\dot{POP} + 0.0344\,\dot{SEED}_P + 0.0344\dot{L}_P + 0.1185\,\dot{OU}_P + 0.8061\,\dot{PROC}_P$$

$$\dot{D}_W = 0.0575\dot{P}_P - 0.0573\,\dot{P}_W + 0.3160\,\dot{I}_c + 0.2538\,\dot{POP} + 0.0538\,\dot{SEED}_W + 0.0538\,\dot{L}_W + 0.1908\,\dot{OU}_W + 0.5015\,\dot{PROC}_W$$

Crop Net Income

The elasticities of the producer core system and Annexure provide the basic data to work out the numerical parameters of crop net income equations. The equations in rates of change for paddy and wheat are :

$$\dot{I}_P = 4.1082\dot{P}_P - 0.7667\dot{w} - 0.5632\dot{f} - 0.0873\dot{b} - 0.2120\dot{g}_1 - 0.0561\dot{g}_2 - 0.9290\,\dot{r} + 0.2220\,\dot{IRR}^*_P + 0.7522\,\dot{K}^*_P + 2.4543\dot{L}_P + 4.1004\,T_P$$

$$\dot{I}_W = 5.6712\dot{P}_W - 0.7568\dot{w} - 0.9029\dot{f} - 0.1734\dot{b} - 0.1330\dot{g}_1 - 1.4090\dot{g}_2 - 1.2650\,\dot{r} - 0.3178\,\dot{IRR}^*_W + 1.0078\,\dot{K}^*_W - 0.4651\dot{L}_W + 5.722\,T_W$$

where I is crop net income (Rs./ha.), g_1 and g_2 are the prices of irrigation and capital inputs respectively and r is the rental value of land.

III

EFFECTS OF PRICE AND NON-PRICE FACTORS

In this study, the exogenous variables in the model are classified as price and non-price factors. The price factors include factor price, irrigation, capital inputs and acreage. The non-price factors include the growth in productivity through technology, consumer income, population, procurement and seed and other uses. The estimated model provides the elasticities of price and non-price factors indicating the direct partial effects of each one of them on factor demand, output supply and demand and crop net income. At equilibrium, $\dot{D}_P = \dot{O}_P$ and $\dot{D}_W = \dot{Q}_W$. The price determination equations are :

$$\dot{P}_P = 0.3658\dot{w} + 0.4501\dot{f} + 0.0651\dot{b} - 1.0309\,\dot{IRR}^*_P + 0.0016\,\dot{IRR}^*_W - 1.5308\dot{K}^*_P - 0.0085\dot{K}^*_W - 7.5652\dot{L}_P - 0.0872\dot{L}_W - 6.4456T_P - 0.1407T_W + 0.2752\dot{I}_c + 0.3000\dot{POP} + 0.2217\dot{SEED}_P + 0.0076\dot{SEED}_W + 0.7638\,\dot{OU}_P + 0.0268\,\dot{OU}_W + 5.1958\,\dot{PROC}_P + 0.0706\,\dot{PROC}_W$$

$$\dot{P}_W = 0.3158\dot{w} + 0.5381\dot{f} + 0.1204\dot{b} - 0.2496\ \dot{IRR}^*_P + 0.0487\ \dot{IRR}^*_W - 0.3696\dot{K}^*_P - 0.2548\dot{K}^*_W - 1.8262\dot{L}_P - 2.6227\dot{L}_W - 1.5559\dot{T}_P - 4.2321\dot{T}_W + 1.3930\dot{I}_c + 1.1379\dot{POP} + 0.0535\ \dot{SEED}_P + 0.2277\ \dot{SEED}_W + 0.1844\ \dot{OU}_p + 0.8075\ \dot{OU}_W + 1.2542\ \dot{PROC}_P + 2.1224\dot{PROC}_W$$

By substituting the equilibrium product price in the above equations the net effects[9] of price and non-price factors on factor demand, output supply and crop net income are computed and presented in Table I. Factor prices, namely, wages, fertilizer prices and bullock labour prices have positive effects on equilibrium product price for both the crops. The net effects of these price factors on their own demand and output supply were negative as expected. But the factor prices have positive effects on crop net income. This is because the increase in product price has more than compensated the loss due to decline in productivity as a result of reduced input use. There is a possibility to substitute irrigation for fertilizer in paddy production. Capital inputs[10] substitute human and bullock labour. The intensive use of irrigation and capital inputs have very mild effects on output supply and negative effects on crop income. Further growth in these inputs is thus undesirable. As the acreage increases output supply increases, output price decreases and factor demand falls. Unlike other price factors, acreage has stronger effects on factor demand, output supply, product price and crop profitability. Similarly, technology has negative but stronger effects on product prices, crop income and on factor demand. Own productivity effects are positive on output supply whereas the cross productivity effects are observed to be negative on account of consumer substitution between rice and wheat.

The demand shifters, namely, procurement. consumer income, population, seed and other uses have positive impact on product prices, factor demand, output supply and crop net income. As the demand increases, output prices, input demand and output supply increases with a rise in profitability. Among the demand shifters, the effects of procurement is much stronger than the rest.

Thus, procurement, technology and acreage are identified as the most powerful instruments which need to be manipulated for attaining growth and stability in production, prices and income at desired levels.

IV

POLICY ANALYSIS

The model is simulated to analyse the required adjustments in price and non-price factors in order to reach specific goals of prices, production, income and consumer demand under the assumption that the factor price inflation will continue at the rate as was observed during 1974-83 (*i.e.*, $\dot{w}$=0.1, $\dot{f}$=0.08, $\dot{b}$=0.13, $\dot{g}_1$=0.10, $\dot{g}_2$=0.10, and $\dot{r}$=0.10), no change in the use of irrigation, capital inputs, and seed rate for both the crops ($\dot{IRR}^*$=0, $\dot{K}$=0, $\dot{SEED}$=0), population will grow at the rate observed in the past ($\dot{POP}$=0.023), consumer income will increase at rate of 5 per cent $\dot{I}_c$=0.05), the use of crop output for other purposes within the Punjab will continue at the same level as in the past ($\dot{OU}$=0), Some of the scenarios are illustrated in Table II.

9. The net effect is the total of direct and indirect effects. The indirect effects of price and non-price factors are being contributed by demand and supply forces through prices.

10. Capital inputs include mainly tractor and agricultural machinery charges.

TABLE I. ELASTICITIES OF FACTOR DEMAND, OUTPUT SUPPLY, CROP INCOME AND PRODUCT PRICES FOR PADDY AND WHEAT, PUNJAB

Exogeneous variables		Factor demand						Output supply		Crop income		Product price	
		Paddy			Wheat			Paddy	Wheat	Paddy	Wheat	Paddy	Wheat
		N_P	X_P	B_P	N_W	X_W	B_W	Q_P	Q_W	I_P	I_W	P_P	P_W
Price factors													
Wage (Rs./day)	w	-0.274	0.323	0.077	-0.203	0.197	-0.021	-0.007	0.003	0.736	1.005	0.366	0.311
Fertilizer price (Rs./N+P+K)	f	0.233	-0.429	0.278	-0.113	-0.285	0.408	-0.008	-0.008	1.286	2.149	0.450	0.538
Bullock labour price (Rs./pair day)	b	0.007	0.047	-0.405	-0.016	0.070	-0.413	-0.001	-0.004	0.176	0.509	0.064	0.124
Irrigation expenditure (Rs./ha.)													
Paddy	IRR^*_P	-0.189	-0.265	-0.372	-0.099	-0.161	-0.213	0.024	-0.045	-4.013	-1.416	-1.031	-0.249
Wheat	IRR^*_W	0	0.001	0.001	0.135	0.060	0.077	0	-0.003	0.007	-0.042	0.002	0.049
Capital inputs (Rs./ha.)													
Paddy	K^*_P	-0.447	-0.802	-1.126	-0.146	-0.238	-0.316	0.035	-0.067	-5.540	-2.096	-1.531	-0.369
Wheat	K^*_W	-0.002	-0.004	0.004	-0.198	0.023	-1.123	-0.001	0.014	-0.035	-2.453	-0.009	-0.255
Area under crop (ha.)													
Paddy	L_P	-1.540	-2.687	-3.134	-0.721	-1.178	-1.561	0.025	-0.330	-28.630	-10.357	-7.565	-1.826
Wheat	L_W	-0.025	-0.043	-0.036	-0.323	-1.782	-2.332	-0.012	0.199	-0.358	-15.340	-0.007	-2.623
Non-price factors Technology													
Paddy	T_P	-1.250	-3.164	-2.682	-0.614	-1.004	-1.330	0.145	-0.281	-22.380	-8.824	-6.446	-1.555
Wheat	T_W	-0.048	-0.069	-0.059	-1.671	-2.731	-3.618	-0.019	0.234	-0.578	-18.279	-0.141	-4.232
SEED (kg./ha.)													
Paddy	$SEED_P$	0.064	0.109	0.092	0.021	0.035	0.046	0.029	0.010	0.911	0.303	0.223	0.053
Wheat	$SEED_W$	0.002	0.004	0.003	0.090	0.147	0.195	0.001	0.041	0.031	1.291	0.008	0.227
Other uses (qtl.)													
Paddy	OU_P	0.219	0.375	0.318	0.073	0.119	0.158	0.101	0.033	3.130	1.046	0.764	0.184
Wheat	OU_W	0.008	0.013	0.011	0.319	0.521	0.690	0.004	0.146	0.110	4.579	0.027	0.807
Procurement (qtl.)													
Paddy	$PROC_P$	1.491	2.550	2.160	0.495	0.809	1.072	0.689	0.227	21.340	7.113	5.195	1.254
Wheat	$PROC_W$	0.020	0.035	0.029	0.838	1.370	1.815	0.009	0.384	0.290	12.037	0.071	2.122
Consumer income	I_C	0.079	0.135	0.115	0.550	0.899	1.191	0.036	0.252	1.131	7.900	0.275	1.393
Population	POP	0.086	0.147	0.125	0.449	0.734	0.973	0.040	0.206	1.230	6.453	0.300	1.138

N=Human labour, X=Fertilizer and B=Bullock labour.

In the last decade, the acreage under paddy and wheat in the Punjab grew at the compound annual growth rate of 10.51 and 2.76 per cent respectively. The growth in productivity was observed to be 1.05 per cent for paddy and 2.83 per cent for wheat. The observed growth in procurement price fixed by the Agricultural Prices Commission (APC) also grew at the annual rate of 8.2 per cent for paddy and 4.86 per cent for wheat. With the same acreage and productivity growth continuing in the future, the procurement prices can only be maintained in the market provided the foodgrain procurement for other States grow at the annual rate of 17.6 per cent for paddy and 2.57 per cent for wheat. The supply of paddy and wheat will grow at the rate of 14.21 per cent and 3.29 per cent respectively (S–1). The farmers' income from paddy will increase at the rate of 41 per cent whereas the income from wheat will decrease by 2.6 per cent. The higher returns to investment in paddy will induce the acreage under paddy by a shift of area from other less profitable crops. Such acreage response in the absence of adequate demand from other States will result in excessive welfare costs to the procurement system in order to maintain the prices fixed by the APC. Without adequate procurement support and private trading to other States, the product prices will crash resulting in unfavourable input-output price ratios which will lead to low productivity and income (S–2). Now the question arises : what should be the growth in the acreage and in procurement to maintain the prices fixed by the APC and also assure supply of output from both the crops at the rate of 5 per cent? The scenario (S–3) revealed that the acreage response of 2.9 per cent in place of 10.51 per cent for paddy and 4 per cent in place of 2.8 per cent for wheat will be enough to assure the growth in output supply. The surplus of foodgrains from Punjab can be absorbed by increasing the procurement by 6 per cent in place of 17 per cent for paddy and by 4.8 per cent for wheat in place of 2.56 per cent. This policy package will assure again high returns to paddy growers (22 per cent) whereas the profitability from wheat will decline at the rate of 3 per cent. This scenario thus suggests that there is a need for downward revision of paddy prices and upward revision of the wheat prices to maintain parity in crop income. Therefore, in order to stabilise the crop income and output supply at the rate of 10 per cent and 5 per cent respectively for both the crops, there is a need to revise the paddy price only by 5 per cent per annum in place of 8.2 per cent and wheat prices to be revised upward at the rate of 7.2 per cent per year (S–4). For this, the acreage response needed will be 3.2 per cent for paddy and 3.8 per cent for wheat. This will enable Punjab to increase its surplus available to other States at the rate of 5.83 per cent per year for paddy and 5.5 per cent per year for wheat. This price policy will ensure growth in domestic consumer demand of 2.3 per cent for paddy and 5.7 per cent for wheat and also have positive impact on the use of crucial inputs like fertilizers whose demand will grow at the rate of 2 to 3 per cent per annum. Similarly, other rational policy packages can be worked out to attain specific welfare goals.

V

CONCLUSION

The paper demonstrates the power of the policy model in reassuring the direct and net effects of price and non-price factors on factor demand, output supply and net crop income. Punjab farmers are close to irrigation and capital inputs use ceilings in paddy and wheat crops. Hence, productivity gains via irrigation and capital inputs use have to come from other crops and regions. Procurement, technology and acreage are the most powerful instruments which need to be manipulated not only to neutralise factor price inflation but also to attain desired growth and stability in production, prices and income as illustrated in the study.

TABLE II. POLICY SCENARIOS ON STABILISATION OF PRICES, SUPPLY AND INCOME, PUNJAB

Scenarios	Maintained assumption	Policy goals	Actions needed	Implications
S-1	$\dot{L}_P = 0.1051$ $\dot{L}_W = 0.0276$ $T_P = 0.0165$ $T_W = 0.0283$	$\dot{P}_P = 0.0820$ $\dot{P}_W = 0.0486$	$\dot{PROC}_P = 0.1706$ $\dot{PROC}_W = 0.0256$	$\dot{Q}_P = 0.1421$ $\dot{Q}_W = 0.0389$ $\dot{I}_P = 0.4097$ $\dot{I}_W = -0.0265$ $= 0.0022$ $\dot{d}_w = 0.0703$ $= 0.0560$ $\dot{N}_w = -0.0020$ $\dot{X}_P = 0.1130$ $\dot{X}_W = 0.0080$ $\dot{B}_P = -0.0210$ $\dot{B}_W = -0.0610$
S-2	$\dot{L}_P = 0.1051$ $\dot{L}_W = 0.0276$ $T_P = 0.0165$ $T_W = 0.0283$	$\dot{Q}_P = 0.05$ $\dot{Q}_W = 0.05$	$\dot{PROC}_P = 0.035$ $\dot{PROC}_W = 0.136$ $\dot{d}_p$ $\dot{N}_P$	$\dot{P}_P = -0.6130$ $\dot{P}_W = 0.1100$ $\dot{I}_P = -2.4460$ $\dot{I}_W = 0.3220$ $\dot{N}_P = -0.1130$ $\dot{N}_W = 0.0220$ $\dot{X}_P = -0.2290$ $\dot{X}_W = 0.0480$ $\dot{B}_P = -0.31$ $\dot{B}_W = 0.008$
S-3	$T_P = 0.0165$ $T_W = 0.0283$	$\dot{P}_P = 0.0820$ $\dot{P}_W = 0.0486$ $\dot{Q}_P = 0.05$ $\dot{Q}_W = 0.05$	$\dot{L}_P = 0.0290$ $\dot{L}_W = 0.040$ $\dot{PROC}_P = 0.0600$ $\dot{PROC}_W = 0.048$	$\dot{I}_P = 0.223$ $\dot{I}_W = -0.032$ $\dot{d}_P = 0.002$ $\dot{d}_W = 0.07$ $\dot{N}_P = 0.009$ $\dot{N}_W = 0.006$ $\dot{X}_P = 0.034$ $\dot{X}_W = 0.021$ $\dot{B}_P = -0.022$ $\dot{B}_W = -0.062$
S-4	$T_P = 0.0165$ $T_W = 0.0283$	$\dot{I}_P = 0.10$ $\dot{I}_W = 0.10$ $\dot{Q}_P = 0.05$ $\dot{Q}_W = 0.05$	$\dot{P}_P = 0.0502$ $\dot{P}_W = 0.0717$ $\dot{L}_P = 0.0322$ $\dot{L}_W = 0.0379$ $\dot{PROC}_P = 0.0583$ $\dot{PROC}_W = 0.0550$	$\dot{d}_P = 0.0235$ $\dot{d}_W = 0.0574$ $\dot{N}_P = 0.001$ $\dot{N}_W = 0.014$ $\dot{X}_P = 0.022$ $\dot{X}_W = 0.034$ $\dot{B}_P = -0.035$ $\dot{B}_W = -0.042$

ANNEXURE

COST AND RETURN STRUCTURE OF WHEAT AND PADDY, PUNJAB, 1977-80

Items		Wheat	Paddy
Yield (qtl./ha.)	(Q)	31	53
Price of yield (Rs./qtl.)	(P)	115	94
Human labour (Rs./ha.)	(w.N)	474	907
Fertilizer (Rs./ha.)	(f.X)	573	697
Bullock labour (Rs./ha.)	(b.B)	110	103
Irrigation (Rs./ha.)	(g_1.IRR)	84	258
Capital (Rs./ha.)	(g_2.K)	885	682
Land rent (Rs./ha.)	(r)	816	1,120
Cost of cultivation (Rs./ha.)	C	2,942	3,767
Net income (Rs./ha.)	I	623	1,215