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Marketed Surplus Response of Millets: Some Policy Implications

The behaviour of marketed surplus to changes in prices and non-price factors like irrigation, acreage and productivity is of critical importance in formulating agricultural policy. In the case of crops which are wholly or almost wholly marketed, the output and marketed surplus will be almost same. Jowar and ragi *(Eleusine coracana)* are the two most important crops grown in the semi-arid tracts of the country. These millets are grown by the farmers mainly for home consumption.

The marketed surplus realised from these crops, despite the fact that they occupy over half the area under cereals in the state, is meagre owing to the fact that it is grown mainly for home consumption. But there is a need to stimulate the output and marketed surplus of these crops, given its widespread consumption in certain regions and nutritional value. Moreover, these are crops grown in the dryland tracts, which account for a major portion of the area under cultivation. There were attempts to estimate the response of marketed surplus to product price changes, output level and land tenure system as seen in the studies carried out by Bardhan (1970), Behrman (1966), Raj Krishna (1962) and Shah and Pandey (1976). However, most of the studies relating to marketed surplus have been confined to major cereals. Hence, in this study an attempt has been made to quantify the behaviour of the marketed surplus of jowar and ragi, due to changes in the incentive structure.

The advent of new technology in agricultural production ushered in the intensive use of inputs even though jowar and ragi were late in receiving benefits from such a breakthrough. It is an accepted fact that this is bound to have a bearing on the output response and marketed surplus model of foodgrains. The model developed by Janvry and Kumar (1981) measures the effects of both factor and product prices on the marketed surplus. In this paper the marketed surplus has been employed to examine the alternative price policy for securing adequate increases in the supply of millets in Karnataka. The specific objectives of the study are to (a) analyse the impact of price and non-price factors on marketed surplus of jowar and ragi and (b) simulate price and non-price factors to attain specific goals of output. It is also of interest in the study to examine the effect of income on marketed surplus response due to inflation.

ANALYTICAL FRAMEWORK

The model suggested by Bardhan (1970) is as follows:

$$M_1 = Q_1\left(\frac{p_1}{p_2}\right) - C_1\left[p_1, I = p_1Q_1\left(\frac{p_1}{p_2}\right) + p_2Q_2\left(\frac{p_1}{p_2}\right)\right]$$

where M_1 = marketed surplus of foodgrains,
Q_1 = output of foodgrains,
Q_2 = output of crops other than foodgrains,
C_1 = consumption of foodgrains,
p_1 = price of foodgrains,
p_2 = price of crops other than foodgrains,
I = farmers' total income.

The impact of escalation in the price of inputs such as human labour, bullock labour, fertiliser and fixed capital inputs is the main focus of the study. Hence, following Janvry and Kumar (1981), the model can be extended as:

$$M = Q\left[\frac{w}{p}, \frac{r}{p}, \frac{f}{p}, \quad Z_1, Z_2, Z_3, T\right] - C(p, I)$$

$$I = P.\,Q\left[\frac{w}{p}, \frac{r}{p}, \frac{f}{p}, \quad Z_1, Z_2, Z_3\right] = W.X_1\left[\frac{w}{p}, \frac{r}{p}, \frac{f}{p}, \quad Z_1, Z_2, Z_3\right]$$
$$- r.X_2\left[\frac{w}{p}, \frac{r}{p}, \frac{f}{p}, \quad Z_1, Z_2, Z_3\right] - f.X_3\left[\frac{w}{p}, \frac{r}{p}, \frac{f}{p}, \quad Z_1, Z_2, Z_3\right] - Z_1 - Z_2$$

where M = marketed surplus of the crop in quintals,
Q = output of the crop,
X_1 = level of human labour in man-days,
X_2 = level of bullock labour in bullock pairs,
X_3 = level of chemical fertilisers in kg,
p = unit output price (Rs./qtl),
w = wage rate (Rs./man-days),
r = bullock-pair rate (Rs./bullock-pair),
f = unit cost of fertiliser (Rs./kg),
Z_1 = irrigation expenditure,
Z_2 = capital expenditure,
Z_3 = area under the crop,
C = consumption expenditure (Rs./household),
T = time (technological change).

The growth in the marketed surplus can be expressed as:

$$\frac{dM}{M} = E_M^p \frac{dp}{p} + E_M^w \frac{dw}{w} + E_M^r \frac{dr}{r} + E_M^f \frac{df}{f} + E_M^{Z_1} \frac{dZ_1}{Z_1} + E_M^{Z_2} \frac{dZ_2}{Z_2} + E_M^{Z_3} \frac{dZ_3}{Z_3} + E_M^T \frac{dT}{T}$$

where $E_M^p = \frac{dM}{dp} \cdot \frac{p}{M}$. To obtain the other expressions p is substituted respectively by w, r, f, Z_1, Z_2, Z_3 and T.*

The restricted quadratic profit function was estimated separately for jowar and ragi. The form of the profit function is presented below.

$$\pi^* = a_0 + \sum_{i=1}^{3} a_i q_i + \frac{1}{2}\sum_{i=1}^{3}\sum_{j=1}^{3} a_{ij} q_i q_j + \sum_{i=1}^{3}\sum_{k=1}^{3} r_{ik} q_i z_k + \sum_{k=1}^{3} b_k Z_k + \frac{1}{2}\sum_{h=1}^{3}\sum_{k=1}^{3} b_{hk} Z_h Z_k$$

* The individual expressions of elasticities are not presented here to save space, which are available from the authors.

where π^* is the normalised profit, p is a vector of unit output prices and Z is a vector of fixed inputs, q_i = normalised unit prices of inputs such as labour, bullock and fertiliser. a_o, a_i, a_{ij}, r_{ik}, b_k and b_{hk} are coefficients to be estimated from the profit function. Factor demand and output supply elasticities were also derived from the estimated profit function using the equations given below.

The human labour demand function is:

$$\frac{d\pi^*}{dq_1} = X_1 = -[a_1 + a_{11}\, q_1 + a_{12}\, q_2 + a_{13}\, q_3 + r_{11}\, Z_1 + r_{12}\, Z_2 + r_{13}\, Z_3]$$

Bullock labour demand function is:

$$\frac{d\pi^*}{dq_2} = X_2 = [a_2 + a_{22}\, q_2 + a_{12}\, q_2 + a_{23}\, q_3 + r_{21}\, Z_1 + r_{22}\, Z_2 + r_{23}\, Z_3]$$

Fertiliser demand function is:

$$\frac{d\pi^*}{dq_3} = X_3 = [a_3 + a_{33}\, q_3 + a_{13}\, q_1 + a_{23}\, q_2 + r_{31}\, Z_1 + r_{32}\, Z_2 + r_{33}\, Z_3]$$

Output supply function is:

$$\frac{d\pi^*}{dp} = Q = a_0 - \frac{1}{2}\,[a_{11}\, q_1^2 + a_{22}\, q_2^2 + a_{33}\, q_3^2] - [a_{12}\, q_1\, q_2 + a_{13}\, q_1\, q_3 + a_{23}\, q_2\, q_3]$$

$$+ b_1\, Z_1 + b_2\, Z_2 + b_3\, Z_3 + \frac{1}{2}\,[b_1\, Z_1^2 + b_2\, Z_2^2 + b_3\, Z_3^2] + b_{12}\, Z_1\, Z_2 + b_{13}\, Z_1\, Z_3 + b_{23}\, Z_2\, Z_3$$

Household data on cost of cultivation of principal crops in Karnataka for the period 1982-83 to 1986-87 were used for the present study. The survey on cost of cultivation of principal crops is undertaken by the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India. The data for the present study were obtained from the comprehensive scheme for cost of cultivation of principal crops located at University of Agricultural Sciences, Bangalore. The share of gross returns and factor bill in crop income and the share of marketed surplus to gross output were derived from the data (Appendix 1) and used in calculating the elasticities of jowar and ragi (Appendix 2).

EFFECTS OF PRICE AND NON-PRICE FACTORS ON MARKETED SURPLUS AND CROP INCOME

The elasticities of output supply, marketed surplus and crop income were estimated separately for jowar (J) and ragi (R) and the results are as follows.

Output supply equations

$$Q_J = 0.028\, \dot{P}_J + 0.002\, \dot{w} + 0.013\, \dot{f} - 0.043\, \dot{t} + 0.0513\, \dot{Z}_1 + 0.641\, \dot{Z}_2 + E^T_{QJ}$$

$$Q_R = -0.51\, \dot{P}_R - 0.108\, \dot{w} + 0.046\, \dot{f} - 0.213\, \dot{t} + 0.122\, \dot{Z}_1 + 0.263\, \dot{Z}_2 + E^T_{QR}$$

Marketed surplus

$$\dot{M}_J = 0.393\,\dot{P}_J + 0.053\,\dot{w} + 0.045\,\dot{f} + 0.026\,\dot{r} + 0.012\,\dot{Z}_1 + 0.870\,\dot{Z}_2 + 0.548\,\dot{Z}_3 + E^T_{MJ}$$

$$E^T_{MJ} = 0.8584\,E^T_{QJ} + 0.0476\,E^T_{X_1J} + 0.0572\,E^T_{X_2J} + 0.02185\,E^T_{X_3J}$$

$$\dot{M}_R = -0.870\,\dot{P}_R - 0.020\,\dot{w} + 0.098\,\dot{f} + 0.320\,\dot{r} + 0.090\,\dot{Z}_1 + 0.460\,\dot{Z}_2 + 0.670\,\dot{Z}_3 + E^T_{MR}$$

$$E^T_{MR} = 0.5267\,E^T_{QR} + 0.1334\,E^T_{X_1R} + 0.1743\,E^T_{X_2R} + 0.0454\,E^T_{X_3R}$$

Crop income

$$\dot{I}_J = 5.5135\,\dot{P}_J - 1.3876\,\dot{w} - 0.1746\,\dot{r} + 0.0154\,\dot{f} - 0.2319\,\dot{Z}_1 + 1.2860\,\dot{Z}_2 - 1.4040\,\dot{Z}_3 + E^T_{IJ}$$

$$E^T_{IJ} = 4.455\,E^T_{QJ} - 0.3811\,E^T_{X_1J} + 0.2795\,E^T_{X_2J} + 0.1068\,E^T_{X_3J}$$

$$\dot{I}_R = 5.1729\,\dot{P}_R - 0.2843\,\dot{w} - 1.7456\,\dot{r} - 1.520\,\dot{f} - 0.5720\,\dot{Z}_1 - 0.9885\,\dot{Z}_2 + 0.3496\,\dot{Z}_3 + E^T_{IR}$$

$$E^T_{IR} = 4.8408\,E^T_{QR} - 0.3656\,E^T_{X_1R} - 0.6596\,E^T_{X_2R} - 0.2176\,E^T_{X_3R}$$

Jowar output exhibited a positive response to its own price, whereas ragi output tended to decrease with an increase in its own price. This relationship was observed in regard to marketed surplus as well. Ragi crop is normally grown under poor soil conditions in scanty rainfall areas and grown mainly for home consumption with little of marketed surplus. On the other hand, there is more marketed surplus in jowar and the positive response seen in jowar is understandable. Ragi being mainly grown for home consumption seems to be responding in a perverse manner to its own price mainly due to its nature of cultivation and its susceptibility to weather conditions as a dryland crop. A perusal of the marketed surplus equations reveals a distinct tendency among the farmers growing jowar and ragi to alter their marketable surplus to earn a target net income. This is evidenced by the fact that when the input prices increase, the quantity marketed also increases, perhaps to cover the additional cost of cultivation. Further, the output price was found to have an overwhelming impact on the income. A one per cent increase in prices resulted in a 5.5 per cent increase in income in jowar and a 5.7 per cent rise in ragi.

Using the estimated equations of marketed surplus the effect of a notional 10 per cent increase in factor price was studied. The results of the simulation are presented in Table I.

TABLE I. EFFECTS OF PURE INFLATION ON MARKETED SURPLUS OF JOWAR AND RAGI

(per cent)

Factors	Crops	
	Jowar	Ragi
(1)	(2)	(3)
Product price	3.93	-6.70
Wage	0.53	-0.20
Bullock price	0.45	0.96
Fertiliser price	0.26	3.20
All factors	5.17	-2.74

It is clear from Table I that pure inflation has a negative effect on the marketed surplus of ragi. The marketed surplus decreased by 2.74 per cent for every 10 per cent inflation in both product and factor prices. This clearly indicates the subsistence nature of this crop. However, the same is not true in jowar under similar set of circumstances, the marketed surplus rises by 5.17 per cent, induced mainly by a 3.93 per cent increase in crop output.

POLICY ANALYSIS

The changes in the unit price of output on factor price such as human labour, bullock labour and fertiliser have a bearing on the marketed surplus, consumer demand and income. The impact of inflation in these factors was assessed by making use of marketed surplus, income and output supply equations estimated earlier.

It was observed that the marketed surplus can be maintained at a constant level at the observed rate of factor price inflation ($w = 0.013$, $r = 0.068$, $f = 0.033$) without any change in non-price factors, namely, acreage, irrigation and productivity only if the output price were to increase by 2.2 per cent in jowar and 5.6 per cent in ragi. This would lead to an increase of crop income by 1.2 per cent in jowar and 4.5 per cent in ragi. Further, it is observed that the non-farm consumer demand will increase by 8 per cent in jowar and by 1.5 per cent in the case of ragi.

In case a growth in crop income equivalent to the rate of inflation in factor prices is envisaged to maintain parity between input and output prices, an increase in the prices of jowar and ragi by 2.1 per cent and 3.8 per cent respectively would be needed.

The quantification of the responses of the farmers with regard to their marketing behaviour reveals that the farming community will adapt to inflation by reducing their consumption and releasing a larger quantity for sale in the market; consequently, the net income of the producer will fall. In the case of jowar for a 10 per cent increase in factor prices there will be a fall in net income by 20 per cent. Besides, the farmers will reduce their consumption in order to make good the loss in cash income.

The growth in marketed surplus and crop income is decomposed into different constituents at the existing growth rate of both price and non-price factors. The results presented in Table II indicate that the growth in marketed surplus due to all factors is at 0.204 per cent for jowar and 0.033 per cent for ragi.

TABLE II. SOURCES OF GROWTH OF MARKETED SURPLUS AND CROP INCOME

(per cent)

Sources of growth (1)	Growth of marketed surplus		Growth in crop income	
	Jowar (2)	Ragi (3)	Jowar (4)	Ragi (5)
Factor price	0.040	0.021	-0.030	-0.173
Product price	0.006	-0.026	0.083	0.171
Acreage	0.151	0.013	-0.386	0.007
Irrigation	-0.016	0.022	0.305	-0.142
Capital input	0.066	0.010	0.098	0.022
Productivity	-0.007	-0.007	0.836	0.010
All sources	0.204	0.033	0.906	-0.105

The growth in marketed surplus is much lower than the growth in population. The effects of non-price factors were found to be significant for both jowar and ragi. Among the non-price factors, the expansion of area under crop had a substantial effect on the marketed surplus of jowar along with increase in capital input use. In the case of ragi, increasing the area under irrigation and area under the crop resulted in augmenting the marketed surplus. The contribution of productivity to marketed surplus is negligible. Hence, in both the crops a mixed strategy involving efforts to increase the productivity through varietal improvements, irrigation and expansion of area under the crop can be adopted to meet the demand from an ever increasing population. The policy options for ragi from both the production and welfare angle is confounded by the fact that they conflict with each other. While favourable price helps to increase incomes, it does not help in increasing the output or marketed surplus. From this perverse behaviour of output it is apparent that the allocation of resources in ragi is decided by tradition rather than by incentives, which is perhaps due to the poor yields and low level of technology adoption. In order to make policy intervention more effective, the production of these major millets grown in the state will have to be made more remunerative through a breakthrough in technology, which will facilitate a market orientation, thereby improving the efficiency of resource use.

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APPENDIX 1

BASIC DATA FOR CALCULATING ELASTICITIES OF MARKETED SURPLUS

Particulars (1)	Jowar (2)	*Ragi* (3)
1. Ratio of gross output to net income	2.1920	2.4800
2. Share of wage bill in crop net income	0.1144	0.1656
3. Share of bullock wage bill in crop net income	0.1375	0.3380
4. Share of fertiliser expenditure in crop net income	0.0525	0.0880
5. Share of irrigation charges in crop net income	0.0410	0.0095
6. Share of capital expenditure in crop net income	0.7490	0.7300
7. Share of land rent in crop net income	0.0967	0.0790
8. Marketed surplus-output ratio	0.5647	0.5534
9. Consumption-marketed surplus ratio	0.7708	0.8060
10. Price elasticity of demand	-0.6300	-0.6300
11. Income elasticity of demand	0.5400	0.6400

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APPENDIX 2

ELASTICITIES OF FACTOR DEMAND AND OUTPUT SUPPLY FOR JOWAR AND RAGI

Particulars	Crop price	Wage	Animal wage	Fertiliser price	Irrigation	Capital	Land
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Factor demand: Jowar							
Human labour	-0.1600	-0.0007	-0.0245	0.0878	-0.0011	0.0236	0.5869
Bullock labour	0.1438	-0.0430	-0.0418	0.0196	-0.0080	0.0709	0.8057
Fertiliser	-1.3980	0.2905	0.0374	0.3216	0.0759	-0.1573	0.0457
Output supply	0.0277	0.0023	-0.0430	0.0130	-0.0507	0.6412	0.4934
Factor demand: *Ragi*							
Human labour	-0.9880	-0.2840	0.0524	0.0198	0.0129	-0.0342	0.6101
Bullock labour	0.2540	0.0839	0.0876	0.0437	0.0443	-0.2383	0.7203
Fertiliser	1.1880	0.0742	0.1024	0.4476	0.2037	-0.8252	1.3658
Output supply	-0.1511	-0.1080	0.2131	0.0460	0.1221	0.2625	0.7210

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