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How elastic is the profit to prices of output and the variable inputs? Some insights from paddy cultivation in India

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Abstract One of the strategies that seems to be convenient to the government, farmers and policymakers is the increase output price to double the farmers' income. But how much will be the increase in the profit as a result of increase in output price depends on the profit elasticities. Profit received by the farmers is a function of output supply as well as demand of inputs used in the production process, which, in turn, depends on their respective prices. The present study estimated normalised restricted translog profit function and used duality approach to determine profit elasticities with respect to output and input prices in paddy cultivation. The study found that the profit in paddy is more elastic (-1.7108) to the decrease in input prices than the increase in output price (1.6001). On the basis of elasticities, it can be calculated that the doubling of profit from paddy requires more than 62% increase in output price and more than 58% decrease in input prices in real terms. On the demand side, the increase in profit from this crop put heavy pressure on input market which needs to be taken care to have desired effect.

Keywords Profit elasticity, restricted translog profit function, output supply elasticity, input demand elasticity, paddy

JEL codes C4, C5, O1, Q12

Indian government pledged to double farmers' income by 2022. This led many to contemplate as what is it and how to do it? The various dimensions of the income speculated were whether it is doubling of output, gross revenue or profit; doubling of nominal income or real income; or doubling of income from farm activities alone or also from non-farm activities. To be rational, there is no doubt in deciding that the government's intention seems to be to doubling income of the farmers from farming in real terms (Chand 2017). Various approaches being put forth for doubling farmers' income encompass both on-farm and off-farm strategies. The on-farm strategies include increasing of productivity and input use efficiency by adopting improved technologies in seed, fertilizer and irrigation (Saxena et al. 2017). The shifting of cropping pattern in favour of high value crops and taking advantage of

vertical and horizontal integration of farm enterprises viz. cropping-poultry-fishery, processing, etc., are some of the options available to the farmers to get additional returns. Chandrasekhar and Mehrotra (2016) observed that net income from farming of animals increased by 3.21 times in 2013 over the average monthly income in 2003 and can prove to be the key driver in increasing net income of agricultural households. The off-farm strategies suggested are the development of agriculture supporting infrastructure (roads, markets, storage and processing) (Meena et al. 2017) and institutional arrangements for linking farms to the market (cooperatives, contract farming and producer companies) (Venkatesh et al. 2017). All these are age-old strategies but could not get much of the needed momentum in the past due to the presence of numerous factors desisting farmers to divert from traditional

practices. The policies targeted at prices, procurement, subsidy and consumption or distribution have favored cultivation of the selected crops especially foodgrains in the country and proved detrimental to diversification (Despande and Naika 2002; Parik and Singh 2007; Devineni et al. 2022). The cultivation of many fruits and vegetables which are generally considered as high value crops, would appear risky to a vast majority of small and marginal farmers, unless there are provisions of effective technology, price, marketing and insurance support (Haque 2006).

One of the strategies in increasing of farmers' income that is being seriously pursued by the government, the farmers and the economists alike is the increase of output price. The strong support it draws from one of the important recommendations of National Commission on Farmers (NCF) (GOI 2006) to fix minimum support prices (MSP) at least 50% more than the weighted average cost of production. The government's commitment in the recommendation is evident from the decision taken in the Union Budget, 2018 (GOI 2018) to fix MSP of kharif crops at 50% higher than the cost of variable inputs and labour. Besides the other apprehensions raised about this recommendation of NCF, how much will be the increase in profit with an increase in output price depends on profit elasticity. The amount of profit realised by a farmer in any crop is an interaction of changes in the output supply and the demand of inputs used in production of the output. In turn, the change in output supply and input demand takes place on account of changes in their prices. An econometric estimation of profit, output supply and input demand functions helps us in determining the profit elasticity with respect to output and input prices. Another related aspect which is implicit in this analysis is that, if profit doubles, what is going to happen to output supply and inputs' demand. Since, the increase in output supply does not stand in isolation; the policy makers have to think as what to do with the increased supply and the inputs' demand so that it does not result into an ultimate decline in the price of output and increase in the prices of inputs.

The present paper dwells on above mentioned aspects using dual function approach in paddy cultivation in India as the crop constitutes about 35% of area and 40% of production of food grains in the country. The profit in this case is defined as the income over cost incurred on selected inputs used in the crop. The paddy

crop was selected for the study keeping in view its wide spread cultivation in the country. The study assumes that doubling of farm income is evenly distributed across all crops cultivated by the farmer and thereby, doubling of farmer's income means doubling of income per unit of each crop cultivated.

Methodology

The state wise time series data on output produced and inputs used in paddy cultivation were taken from various reports of Comprehensive Scheme for cost of cultivation of Principal crops, prepared by the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India. A balanced panel having time series observations for five years from 2015 to 2019 across seventeen major paddy growing states were used to estimate profit, output supply and input demand functions simultaneously by applying seemingly unrelated regression (SURE) model. Only those states were kept in the model which were having information on cost of cultivation of paddy throughout five years of duration (2015-19). The major sources of other information consulted have been cited at the same place where used.

SURE model framework

How the producer is going to respond is determined by prevailing technological relationship that exists between inputs used and the resulting output, and the choice of inputs at given market prices for both commodity and the inputs in the presence of fixed factors. Integration of these two elements in duality leads to the profit function that determines the optimum decision on output supply and input demand. The paper applied same approach to derive output supply and input demand functions using normalised restricted translog profit function of the following form:

$$\begin{aligned} \ln \pi^{*'} = & \alpha_0 + \sum_{j=1}^5 \alpha_j \ln r_j + \frac{1}{2} \sum_{i=1}^5 \sum_{j=1}^5 \gamma_{ij} \ln r_i \ln r_j + \\ & \sum_{k=1}^3 \beta_k \ln Z_k + \frac{1}{2} \sum_{k=1}^3 \sum_{l=1}^3 \theta_{kl} \ln Z_k \ln Z_l + \\ & \sum_{i=1}^5 \sum_{k=1}^3 \delta_{ik} \ln r_i \ln Z_k + \xi_i \end{aligned} \quad (1)$$

Translog functional form was chosen because of its advantage over the limitations of Cobb Douglas functional form as cited by Sidhu and Baanante (1981) and Chand (1986). The former is considered to be a flexible model with variable elasticities and at the same time giving second-order approximation of the variables. In the function, π^* is the restricted profit normalised by output price and was estimated by deducting cost of variable inputs from the gross revenue. The gross revenue was the sum of main and by-product values. The inputs included in the study were seed, fertilizer, manure, human labour and animal labour. The prices of inputs were normalised (r_i) by the output price. The normalisation reduced the function by one variable and the homogeneity constraint was automatically satisfied in this formulation. There were one fixed factor i.e. working capital (Z_1) and two state shifters i.e. proportion of gross cropped area under rice (Z_2) and irrigated area (Z_3). Since the input-output data on paddy cultivation was taken per hectare basis for each state, the inclusion of latter two variables i.e. proportion of gross cropped area under rice (Z_2) and irrigated area (Z_3), besides the prices was necessary to scale up the estimation of parameters at aggregate level or the state level. All the values were taken in natural logarithmic form except the working capital and state shifters. There ξ_i was the error term. The parameters α_0 , α_i , γ_{ij} , δ_{ik} , β_k and θ_{kl} were estimated and subscripts 'i' & 'j' stands for prices of inputs ($i=1..5$), 'z_k' stands for fixed factors and the shifters when $k=1$, it is the working capital and $k=2$ and 3 are the state shifters Z_2 and Z_3 , respectively.

The partial derivatives of the log linear translog profit function, as defined earlier, with respect to log value of normalised input price yields the input share equations as given below:

$$S_i = \frac{\partial \ln \pi^*}{\partial \ln r_i} = -\frac{P_i X_i}{\pi^*} = -s_i = \alpha_i + \sum_{j=1}^5 \gamma_{ij} \ln r_j + \sum_{k=1}^3 \delta_{ik} \ln Z_k \quad (2)$$

$$S_y = \frac{P_y Y}{\pi^*} = 1 + \sum \frac{\partial \ln \pi^*}{\partial \ln r_i} = 1 - \alpha_i - \sum_{j=1}^5 \gamma_{ij} \ln r_j - \sum_{k=1}^3 \delta_{ik} \ln Z_k \quad (3)$$

where S_i is the negative share value of the i-th input and S_y is the positive share value of output in the profit. Since the input and output shares form a singular system of equations (by definition $S_y - \sum S_i = 1$), one of the share equations i.e. the output share equation, was dropped. The remaining variable input share equations

and the profit function were estimated jointly using Zellner's Seemingly Unrelated Regression Equation (SURE) procedure (Zellner 1962). Since the five input share equations were derived from the same normalised translog profit function, 45 linear equality parametric restrictions were imposed along with 10 symmetry constraints. The validity of imposed fifty-five joint null hypotheses was tested using F-value statistic with asymptotic properties as suggested by Theil (1971) at 55 number of restrictions (m) and 420 (n-k) degrees of freedom where 'n' is the total number of observations and 'k' is the number of parameters estimated in unrestricted function including the intercept.

The computed $F_{(55,420)}$ value (14.3487) was found to be higher than the critical value 1.3645 at $F_{(0.05,55,420)}$ and hence, the null hypotheses was rejected. This implies that among other things, the profit was not maximised with respect to normalised prices of the variable inputs which may be specific to the Indian conditions as were found by other authors (Junankar, 1982; Kumar, 2005) and more so, paddy being a staple food in many states. Nevertheless, the further analysis was conducted using restricted profit function so that supply and demand functions meet the properties of homogeneity ($\epsilon_{y,py} + \sum \epsilon_{y,pxi} = 0$ and $\tau_{i,py} + \sum \tau_{i,pj} = 0$) and symmetry ($\tau_{i,pj}/\tau_{j,pi} = S_j/S_i$). It was also observed that estimation of profit elasticities with respect to output and inputs' prices, which was the main objective of the study, were not sensitive to the estimated parameters of restricted or unrestricted translog profit function.

Before proceeding further with the estimation of output supply and input demand functions, the fitted functions were tested to be monotonic as the predicted output and the factor shares calculated by using the estimated parameters of demand equations at average levels of variable input prices and fixed factors were found to be positive and negative, respectively.

Following Hotelling's Lemma, the negative of the first order partial derivative of the normalised profit function with respect to normalised input prices gives a system of demand functions for variable inputs as given below:

$$-\frac{\partial \pi^*}{\partial r_i} = X_i \quad (4)$$

Factor Demand Function

$$X_i = -\frac{\pi^*}{s_i} \left[\alpha_i + \sum_{j=1}^5 \gamma_{ij} \ln r_j + \sum_{k=1}^3 \delta_{ik} \ln Z_k \right] \quad (5)$$

Output Supply Function

$$Y = \pi * \left[1 - \sum (\alpha_i + \sum_{j=1}^5 \gamma_{ij} \ln r_j + \sum_{k=1}^3 \delta_{ik} \ln Z_k) \right] \quad (6)$$

From factor demand and output supply functions, different elasticities were computed as follows:

Output supply elasticities

Output supply elasticities with respect to output price, variable input prices and the fixed factors were estimated at average value of S_i and at given level of parameters estimated from the above-mentioned demand and supply functions.

The supply elasticity with respect to output price ($\epsilon_{y,py}$) is given by

$$\epsilon_{y,py} = -\sum S_i + \sum \sum \gamma_{ij} / (1 - \sum S_i) \quad (7)$$

The supply elasticity with respect to i th input price (ϵ_{y,px_i}) was estimated as follows

$$\epsilon_{y,px_i} = S_i - \sum \gamma_{ij} / (1 - \sum S_i) \quad (8)$$

The supply elasticity with respect to fixed factors/ shifters was calculated as follows:

$$\epsilon_{y,Z_k} = \frac{\partial \ln Y}{\partial \ln Z_i} = \frac{\partial \ln \pi^*}{\partial \ln Z_i} + \frac{\partial \ln (1 - \sum_{i=0}^n S_i)}{\partial \ln Z_i} = (\beta_k + \sum \delta_{ik} \ln r_i + \sum_{l=1}^3 \theta_{kl} \ln Z_l) - \frac{\sum \delta_{ik}}{(1 - \sum S_i)} \quad (9)$$

Input demand elasticities

From the factor demand equations estimated for seed, fertilizer, manure, human labour and animal labour, the input demand own and cross elasticities were estimated. The own price elasticity of demand for i th input (τ_{i,px_i}) derived from its input share function was calculated as given below:

$$\tau_{i,px_i} = \frac{\partial \ln X_i}{\partial \ln r_i} \cdot \frac{\partial r_i}{\partial P_{x_i}} = S_i + \frac{\gamma_{ii}}{S_i} - 1 \quad (10)$$

where $S_i = -\frac{P_{x_i} X_i}{\pi^*} = -s_i$, $r_i = \frac{P_{x_i}}{P_y}$ and γ_{ii} = coefficient of i -th input share for with respect to normalised price of i -th factor.

Similarly, the cross price elasticity of demand of i th input with respect to price of j th input (τ_{i,px_j}) was

obtained by

$$\tau_{i,px_j} = \frac{\partial \ln X_i}{\partial \ln r_j} \cdot \frac{\partial r_j}{\partial P_{x_i}} = S_j + \frac{\gamma_{ij}}{S_i} \quad (11)$$

where γ_{ij} = coefficient of i -th input share function with respect to normalised price of j -th factor.

The elasticity of demand for i -th input with respect to output price, P_y ($\tau_{i,py}$) was derived from following formula:

$$\tau_{i,py} = \frac{\partial \ln X_i}{\partial \ln P_y} = -\sum_{i=1}^5 S_i + 1 - \frac{\sum_{i=1}^5 \gamma_{ij}}{S_i} \quad (12)$$

Finally, the elasticity of demand of i -th input with respect to the k -th fixed/ shift factor ($\tau_{i,k}$) was obtained from following equation.

$$\tau_{i,k} = \frac{\partial \ln X_i}{\partial \ln Z_k} = \frac{\partial \ln \pi^*}{\partial \ln Z_k} + \frac{\delta_{ik}}{S_i} = \beta_k + \sum_{i=1}^5 \delta_{ik} \ln r_i + \sum_{k=1}^3 \theta_{kl} \ln Z_l + \frac{\delta_{ik}}{S_i} \quad (13)$$

where δ_{ik} coefficient of i -th input share function with respect to k -th factor

Profit elasticities

It estimates the percentage change in profit with respect to prices of output and variable inputs used in paddy production. The major concerns of the government addressed by the profit elasticities were that how the profit responded to the changes in prices of output and inputs used in its production. In this, we used profit function (π^*) not normalised which can be written in the form of factor share functions as shown below:

$$\pi^* = P_y \cdot Y + \sum \frac{\partial \ln \pi^*}{\partial \ln r_i} \cdot \pi^* \quad (14)$$

The various profit elasticity estimates can be derived from this equation. The elasticity of profit with respect to output price ($E_{\pi,py}$) is

$$E_{\pi,py} = \frac{\partial \pi^*}{\partial P_y} \cdot \frac{P_y}{\pi^*} = 1 - \sum \frac{\gamma_{ij}}{S_y} \quad (15)$$

where ' s_y ' is share of value of output in profit and $\sum \gamma_{ij}$ is the sum of coefficients of all factor share equations with respect to normalized prices of all variable inputs.

The elasticity of profit with respect to prices of i -th variable input is given by

$$E_{\pi,px_i} = \frac{\partial \pi^*}{\partial P_{x_i}} \cdot \frac{P_{x_i}}{\pi^*} = \epsilon_{y,px_i} + \sum \frac{\gamma_{ij}}{s_y} \quad (16)$$

where $\epsilon_{y,P_{x_i}}$ is the output supply elasticity with respect to price of i th input and $\Sigma \gamma_{ij}$ is the sum of coefficients of all factor shares equations with respect to normalized price to i -th input.

Finally, the output supply elasticity of profit ($\eta_{y,\pi}$) and the inputs' demand elasticity of profit ($\eta_{x_i,\pi}$) were estimated to know the proportionate change in output supply and the inputs' demand with respect to profit. The output supply elasticity of profit ($\eta_{y,\pi}$) was taken as the ratio of output supply elasticity (ϵ_{y,P_y}) and the profit elasticity (E_{π,P_y}) with respect to output price i.e. $\epsilon_{y,P_y}/E_{\pi,P_y}$; which is elaborated below:

$$\eta_{y,\pi} = \frac{\partial Y}{\partial \pi} \cdot \frac{\pi}{Y} = \frac{\partial Y}{\partial P_y} \cdot \frac{\partial P_y}{\partial \pi} \cdot \frac{\pi}{Y} \cdot \frac{P_y}{P_y} = \frac{\partial Y}{\partial P_y} \cdot \frac{P_y}{Y} \cdot \frac{\partial P_y}{\partial \pi} \cdot \frac{\pi}{P_y} = \frac{\epsilon_{y,P_y}}{E_{\pi,P_y}} \quad (17)$$

While the input demand elasticity of profit ($\eta_{x_i,\pi}$) for the i th input was taken as the ratio of input demand elasticity ($\epsilon_{x_i,P_{x_i}}$) for the same input and the profit elasticity ($E_{\pi,P_{x_i}}$) with respect to input prices i.e. $\epsilon_{x_i,P_{x_i}}/E_{\pi,P_{x_i}}$ as show below:

$$\eta_{x_i,\pi} = \frac{\partial x_i}{\partial \pi} \cdot \frac{\pi}{x_i} = \frac{\partial x_i}{\partial P_{x_i}} \cdot \frac{\partial P_{x_i}}{\partial \pi} \cdot \frac{\pi}{x_i} \cdot \frac{P_{x_i}}{P_{x_i}} = \frac{\partial x_i}{\partial P_{x_i}} \cdot \frac{P_{x_i}}{x_i} \cdot \frac{\partial P_{x_i}}{\partial \pi} \cdot \frac{\pi}{P_{x_i}} = \frac{\epsilon_{x_i,P_{x_i}}}{E_{\pi,P_{x_i}}} \quad (18)$$

Results and discussion

Price elasticities of input demand and paddy supply

Any policy intervention of price change does not end

with it but has a rippling effect in the market in terms of effecting the supply, demand of inputs and the profit. In the process, estimates of own and cross price elasticities of paddy supply and the variable input demands for seed, fertilizer, manure, human and animal labour (Table 1) have been derived from input share function so that the sensitivity of the output supply and the input demand to the market prices may be understood. Table 1, also, shows the estimates of elasticities of paddy supply and the demand of variable inputs with respect to capital as a fixed factor and the percentages of gross cropped area under paddy and irrigation as shifter of the function.

As expected, the elasticities of paddy supply and the factors' demand were positive with respect to paddy price and negative with respect input prices except for fertilizer where own price elasticity was found to be positive but close to zero. Both paddy supply and the inputs' demand were elastic to paddy price but what is notable was that the demands of inputs were more elastic to paddy price. The results of demand and supply elasticities to paddy price convey that the increase in paddy price raise demand for inputs more than the increase in supply of its output being input intensive nature of the crop. The demand elasticity of manure to paddy price was as high as 2.845. It was followed by demand elasticity of animal labour (1.906), human labour (1.755) and seed (1.490). The demand elasticity of fertilizer with respect to paddy price was 1.206 which means 1% increase in paddy price results into 1.206%

Table 1 Price elasticity estimates for paddy supply and demand for its variable inputs, 2015-19

Crop and factor prices	Paddy	Seed	Fertilizer	Manure	HL	AL
1. Output price						
Paddy	1.110	1.490	1.206	2.845	1.755	1.906
2. Input prices						
Seed	-0.059	-0.868	-0.125	-0.087	-0.025	-0.065
Fertilizer	-0.058	-0.151	0.008	-0.118	-0.066	-0.226
Manure	-0.066	-0.051	-0.057	-1.033	-0.073	-0.068
Human labour	-0.747	-0.265	-0.586	-1.331	-1.456	-0.609
Animal labour	-0.181	-0.155	-0.446	-0.276	-0.136	-0.938
3. Fixed variable						
Capital (Rs)	1.240	0.571	1.234	1.763	0.875	0.951
4. Aggregate variables						
%GCA under paddy	0.031	-0.055	-0.441	-0.139	0.162	0.363
%GCA irrigated	-0.433	-0.236	0.231	-0.683	-0.587	-1.170

Source Authors' calculations

increase in fertilizer demand while it raises output by only 1.110%. If the government wishes to double paddy farmers' income by increasing paddy prices, this requires extensive arrangements to meet demand of the farmers for the inputs at cheaper rate keeping in view the highly elastic demand of the inputs for paddy prices.

With respect to input prices, the elasticity of paddy supply was negative, confirming, thereby, that the paddy output supply decreases with the increase of input prices. Nevertheless, paddy supply elasticities with respect to input prices were found to be inelastic which means that the output supply decreases by less than 1% with 1% increase in input prices. The increase in human and animal labour wage rates adversely affect the output supply of paddy substantially as is evident from the highest value of output supply elasticity for human labour wage rate (-0.747) followed by for animal labour wage rate (-0.181). The paddy supply was highly elastic (1.240) to fixed capital on the farm. Since percentage of gross cropped area under paddy and under irrigation were used as state shifters, the elasticity estimates of these variables indicate the effect of these variables on paddy supply and input demand in the state. In contradiction to the belief, the supply of paddy in a state reduces by 0.433% for every 1% increase in proportionate area under irrigation. On the other side, the supply elasticity of 1% increase in proportionate area under paddy was positive (0.031).

The own price elasticities for all the inputs' demand were negative except for fertilizer indicating that input prices has least effect on use of fertilizer in paddy. This may be due to the fact that the fertilizer prices do not vary much across states and over time due to subsidy. The own price elasticities of manure (-1.033) and human labour (-1.456) were found to be elastic while it was inelastic in other inputs but high enough to be close to one. This indicates that inputs' demand especially that of human labour in paddy (Mailena et al. 2013) was highly sensitive to their prices/ wage rates. The cross price elasticity of all the inputs were found to be negative revealing complementarity between the inputs as the use of one input is directly related to the use of another input. For instance, increased demand for seed require higher use of rest of the inputs namely, fertilizer, manure, human and animal labour. The cross price elasticities of all the inputs were inelastic except that of manure to the

human labour wage rate (-1.331) which was even higher than the own price elasticity of manure. This may be due to the fact that collection of manure and applying them in the fields is a labour intensive work and is done only by those farms where labour is available.

The capital has significantly positive demand elasticities for all inputs which were elastic for fertilizer (1.234) and manure (1.763) but were inelastic for other inputs but high enough in case of human and animal labour. The percentage increase in demand of seed was 0.571 for 1% raise in capital availability. The proportionate area under paddy was having positive effect on the demand of human and animal labour while it was negative in rest of the inputs which may be because of the reason that paddy cultivation in the states having higher percentage of area under paddy is less input intensive to seed, fertilizer and manure. The input demand elasticities were negative to the proportionate area under irrigation for all inputs except for fertilizer because the fertilizer use increases with irrigation. The input demand elasticities of area under irrigation were inelastic for all inputs except animal labour where 1% raise in the proportionate area under irrigation reduced the demand for animal labour by 1.170%. These two estimates implicate that higher proportion of area under irrigation in a state leads to mechanisation and the demand for animal labour reduces faster in paddy cultivation. As the percentage area under irrigation increases, the demand of inputs in paddy reduced because of shifting of farmers away from paddy cultivation.

Profit elasticities with respect to output and input prices

In the present context, it is pertinent to determine how the profit from paddy cultivation changes with the change in output and input prices. In this process, this section of the paper estimates the percentage change in profit from paddy for 1% change in input and output prices including fixed factors. Table 2 indicates the estimated profit elasticities with respect to output and input price in paddy cultivation.

As expected, the increase in output price results into increase in profit while the increase in input prices lead to decrease in the profit. The value of profit elasticity to output price was estimated to be 1.6004 confirming, thereby, increase in output prices have substantial

Table 2 Estimated profit elasticities with respect to output and input prices in paddy cultivation

Crop and factor prices	Profit elasticities	Change in prices/ variables (%) to double the profit
1. Output price		
Paddy	1.6004	62.49
2. Input prices	-1.7108	-58.45
Seed	-0.1078	
Fertilizer	-0.1302	
Manure	-0.0628	
Human labour	-1.1531	
Animal labour	-0.2568	
3. Fixed variable		
Capital (Rs)	1.7765	56.29
4. Aggregate variables		
%GCA under Paddy	-0.1238	Not calculated
%GCA irrigated	-0.1592	Not calculated

Source Authors' calculations

positive effect on profit and there is nothing wrong if the policy makers are targeting raise in profit by increasing the minimum support prices. If the elasticity of profit to output price is 1.60%, 62.49% increase in paddy prices will double the profit.

On the other hand, the profit elasticity with respect to all variable input prices taken together was found to be highly elastic and reduces profit by 1.71% for 1% increase in the variable input prices. It amounts to about 58% reduction in input prices to double the profit. Thus, the reduction in input prices contributes more than the increase in output price to double the profit from paddy. Which can be further simplified to understand that if profit is to be doubled by 2022, output price should compound at the rate of 6.26% per annum and input prices should reduce at the rate of 10.28% per annum in real terms from the 2014 as base. By using scenario analysis, Balaji et al. (2017) found that letting the MSP and FHPs to increase by 10% a year will double real gross income from *arhar* (pigeon pea). Ali et al. (2012) observed that MSP for paddy (fine) experienced an annual growth rate of 6.76% over the period 1990-2009.

The availability of fixed capital has positive effect on profit. The elasticity of profit to capital was observed to be 1.77% requiring 56% increase in capital to double the profit. The role of capital in increasing the profit

from crop cultivation has been advocated by various studies in the past also (Narayanamoorthy 2013). The capital available in the hands of farmers may be enhanced by various banking products like Kisan Credit Card (KCC), crop and term loans, micro-financing systems, etc. The additional capital available may be directed towards purchase in machinery, adoption of modern technology and improved skill in crop cultivation and the latter is perhaps more desired in paddy cultivation. It may be noted here that the profit elasticities of proportionate area under irrigation and rice were negative showing clearly that profitability of paddy production was lesser in states with higher proportion of area under irrigation and rice. The results demonstrate that the technological breakthroughs and other related supports are not enough to improve the productivity and profitability of the crop in these states. This can be one of the strategies towards doubling the farmers' income from paddy in those states.

State wise effect on profit from output price increase

As observed above, the doubling of profit required 62.49% increase in an average output price. Since the output price differ from state to state, the stated increase in output price is not likely to have the same effect on profit in all the states. To find out the effect on paddy profit from the increase in existing output price, state

Table 3 State wise percentage increase in profit

Change in profit (%)	States
< 50%	Haryana, Punjab, Karnataka, Gujarat and Madhya Pradesh (MP)
≥ 50% and < 80%	Andhra Pradesh (AP) , Uttar Pradesh (UP)
≥ 80% and < 100%	Maharashtra and Uttrakhand
≥ 100%	Assam, Bihar, Chattisgarh, Himachal Pradesh (HP), Kerala, odisha, Tamil Nadu (TN) and West Bengal (WB)

Source Authors' calculations

wise profit and inputs' demand equations were estimated using the estimated parameters of restricted normalised translog profit and input share functions given in Table A1 of Appendix. The changes in profit so recorded in different states at 62.49% increase in average output price are given in Table 3.

The effect of increase in output price on paddy profit was found to be the maximum in those states which were having low per hectare profit but high percentage area under rice e.g. Assam, Kerala, Chattisgarh, TN, WB, etc. The states like Punjab and Haryana, which are already getting higher profit per hectare, has less effect of output price on profit. This may be because paddy production in these states heavily depends on input use and the little gain in profit was realised by decrease in demand for inputs.

Output supply and inputs demand elasticities with respect to profit

Another question that needs to be answered is what will happen to the supply of paddy and the input

demand if profit increases i.e. the elasticity of paddy supply and input demand to profit. Table 4 shows the estimated elasticity of paddy supply and major variable input demand to profit in paddy cultivation. The perusal of results clearly indicates that paddy supply is inelastic to profit i.e. if profit increase by 1%, the output supply will increase by only 0.69% and a 100% increase in profit is going to increase paddy supply by about 69.40% on an average.

However, input intensive nature of the paddy cultivation for that matter was clearly reflected by the elastic input demand to profit for most of the variable inputs except for fertilizer which was observed to be negative. The elasticity of fertilizer demand to paddy profit (-0.064%) indicated that efficiency in fertilizer use pay more in terms of greater profit rather than increase in demand for quantity of fertilizer. The elastic demand for rest of the inputs clearly indicates that the doubling of profit from paddy per hectare is likely to put higher pressure on their demand.

Table 4 Estimated elasticity of paddy supply and major variable input demand with respect to profit in paddy cultivation

Output supply and input demand	Output supply and input demand elasticity w.r.t. profit	Change in paddy supply and input demand (%) to double the profit
1. Output supply		
Paddy	0.694	69.40
2. Input demand		
Seed	8.048	804.80
Fertilizer	-0.064	-6.40
Manure	16.442	1644.29
Human Labour	1.263	126.30
Animal labour	3.654	365.40

Source Authors' calculations

The elasticities of demand for inputs other than fertilizer were 8.048, 16.442, 1.263 and 3.654 for seed, manure, human labour and animal labour, respectively. The high value of elasticity of manure demand to profit may be due to overestimation to some extent, because the quantity of manure used in paddy cultivation is abysmally low but it results into higher profit when applied by improving the soil condition. Any increase in profit from paddy is likely to cause 16 folds increase in demand of manure. A number of studies have recorded that the use of organic manure in paddy and other crops has enhanced efficiency and have reduced the requirement of chemical fertilizers (Khan et al. 2002; Singh and Gangawar 2000). The doubling of profit is likely to increase demand for seed by more than eight times, the demand for human labour by a hundred and quarter per cent (126%) and the demand of animal labour by more than three folds (365%). The results of the study succinctly indicate that raise in the profit from paddy will put greater pressure on variable input demand side rather than on output supply side.

Conclusions

Profit from paddy cultivation was found directly elastic to output price (1.6004) and inversely elastic to variable input prices (-1.7108). Representing an average situation, more than 62% increase in output price is required to double the profit while more than 58% decrease in input prices is required in real terms to attain the same level of profit. For 62% increase, the output price should compound at the rate of 6.26% per annum keeping the input prices same. An increase in profit has inelastic effect on output supply (0.694%) while it is highly elastic for the demand of major inputs. The doubling of profit is going to increase the demand for seed by more than eight times, the demand for human labour by a hundred and quarter (126%) and the demand of animal labour by more than three folds (365%) while the demand of manure is likely to increase 16 folds. Thus, the policy issues that need to be addressed is the availability of these inputs at lower rate in order to increase the profit of the farmers per hectare in case of paddy crop which account of 27% of the gross farmers' income from crop cultivation. Among non-price factors like fixed capital was the major contributor to increase in profit. The ensured use of quality seed and manure will enable the farmers to increase their profit. Since, the higher profit was

attained with lesser fertilizer demand, indicating, taking advantage of efficient use of fertilizer and promoting use of organic fertilizer or manure are some of the strategies to be adopted. The higher value of elasticity of profit to human labour wage rates (-1.1531%) demands mechanization especially in those states allocating larger area to paddy which would reduce the adverse effect of human labour wages on profit.

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