PRODUCTION FUNCTION FOR A SAMPLE OF FARMS IN AFAWA VILLAGE

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An attempt is made in this paper to study the response of production to the changes in individual inputs. For this, the well known Cobb–Douglas power function

\[ Y = A x_1^{b_1} x_2^{b_2} \cdots x_k^{b_k} \]

where \( Y \) = independent variable
\( x_i \) = dependent variables \( i = 1, 2, \ldots, k \)
\( A \) and \( b_i \) are constants is fitted.

It is implicit in the Production Function (Equation (i)) that

(i) \( b_i \) is the elasticity of production of the factor \( x_i \) \( (i=1, 2, \ldots, k) \)

(ii) \( b_i \frac{Y}{x_i} \) is the marginal productivity of the factor \( x_i \)

+ The data used in the paper was collected during the comprehensive Socio Economic survey of Afawa village in Surat district, Gujarat, by the Agro Economic Research Centre for the States of Gujarat and Rajasthan, Vallabh Vidyanagar, as a part of its programme of continuous village surveys. The information pertains to the agricultural year 1961-62. The information collected by the survey method is not so precise or exact as one would like to have. Therefore, the results discussed in this article have to be accepted with some caution.

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After determining the values of the elasticities of production (i.e. $b_i s$) marginal productivities of all the factors can be computed. Since the marginal productivity of $x_i$ is $b_i \frac{Y}{x_i}$ it, i.e. marginal productivity, should be evaluated at the particular values of $x_i$. As we have fitted the Cobb-Douglas function we have evaluated them at the Geometric Mean of the sample values.

Further if $x_1, \ldots, x_k$ are the only relevant inputs in this functional form the sum $(b_1 + b_2 + \ldots + b_k)$ indicates the nature of returns to scale. If for instance $\Sigma b_i = 1$, it means that a given percentage increase in all $k$ inputs will result in an equal percentage increase in output, or in other words the law of constant returns to scale will operate. On the other hand if the sum is greater than 1 or less than 1 the laws of 'increasing marginal returns to scale' or 'decreasing marginal returns to scale' will respectively operate.

**SELECTION OF THE SAMPLE:** The table No. 1 gives the distribution of farmers pursuing cultivation as the main occupation in the village Afsa by the size of operational holding and income groups.

For selecting the sample we have divided the farmers into 3 classes, the criterion of division being the size of land holding. The farmers operating land up to 10 acres were designated as small farmers, those operating land from 10 acres to 25 acres as the medium farmers and those operating more than 25 acres of land were designated as big farmers. 28 medium farmers were selected as sample. This group of farmers usually represents the more important section of farmers in villages. In many cases small farmers are not exclusively dependent on agriculture, as the medium farmers usually are; production efforts of the latter are therefore more important for the development of agriculture. The following table also shows the representativeness of our sample from the criterion of the proportion of various crops grown.
### Table No. 1

**DISTRIBUTION OF FARMERS BY SIZE OF OPERATIONAL HOLDING AND INCOME GROUPS**

<table>
<thead>
<tr>
<th>Size of holding groups (in acres)</th>
<th>Net income groups (in Rs.)</th>
<th>Less than 250</th>
<th>250 to 500</th>
<th>500 to 750</th>
<th>750 to 1000</th>
<th>1000 to 1500</th>
<th>1500 to 2500</th>
<th>2500 to 5000</th>
<th>5000 to 10000 and over</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>below 1</td>
<td>Small farmers</td>
<td>--</td>
<td>1</td>
<td>1</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>2</td>
</tr>
<tr>
<td>1.0-2.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5-5.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.0-10.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>10.0-15.0</td>
<td>Medium farmers</td>
<td>--</td>
<td>1</td>
<td>--</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>--</td>
<td>8</td>
</tr>
<tr>
<td>15.0-20.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.0-25.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>25.0-35.0</td>
<td>Big farmers</td>
<td>--</td>
<td>--</td>
<td>1</td>
<td>2</td>
<td>--</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>35.0-50.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>50.0- &amp; above</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>3</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>9</td>
<td>13</td>
<td>12</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

**Note:**

- The table categorizes farmers based on the size of their operational holdings and their net income groups.

**Production Function for a Sample of Farms in AFWA Village**

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Table No. 2
CROPPING PATTERN OF THE VILLAGE AFAWA AND THE SAMPLE

<table>
<thead>
<tr>
<th>Crops</th>
<th>% of land under the crop</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Village</td>
</tr>
<tr>
<td>Cotton</td>
<td>37</td>
</tr>
<tr>
<td>Paddy</td>
<td>16</td>
</tr>
<tr>
<td>Bean</td>
<td>14</td>
</tr>
<tr>
<td>Juwar</td>
<td>11</td>
</tr>
<tr>
<td>Groundnut</td>
<td>7</td>
</tr>
<tr>
<td>Sugar-cane</td>
<td>5</td>
</tr>
<tr>
<td>Wheat</td>
<td>4</td>
</tr>
<tr>
<td>Other (vegetables, fruits, etc.)</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

The farmers included in the sample had the following common characteristics:

(1) All of them had irrigation facilities.

(2) All used cow-dung manure, fertilisers and/or oil cakes and improved seeds.

(3) All except one possessed necessary agricultural tools and implements.

(4) All possessed at least one bullock. In fact all except two had more than one bullock with them.

(5) Only 5 farmers leased in land. Others have neither leased in nor leased out any land.

(6) Only 5 farmers had attached labourers.

**NATURE OF VARIABLES:** Five input factors are considered to be responsible for the gross agricultural production denoted by $Y$ in
equation (2) given below: \[ Y = A x_1 x_2 x_3 x_4 x_5 \ldots \ldots \ldots (2) \]

where \( A \) & \( b_i \) (i = 1, 2, ... 5) are constants.

and \( x_1, x_2, \ldots x_5 \) are respectively land, agricultural implements, improved inputs (these include manure, fertilisers and improved seeds), water charges and hired labour. These inputs were measured in suitable units discussed below:

\( x_1 \): Land in standardised acres:

The standardisation of the land is based on the land revenue criterion, the underlying assumption being that more revenue is charged on better yielding land and vice versa.

Thus \( x_1 = \frac{a r}{R} \)

where,

\( a \) = acres of land operated by the farmer
\( r \) = per acre revenue paid by the farmer
\( R \) = average per acre revenue at village level.

It is to be noted that a standardised acre can be compared with another in respect of quality.

\( x_2 \): Depreciation of the agricultural tools and implements:

This was done by considering the price paid by the farmer for the implement divided by the expected life (in years) of the implement. The expected life of implements was determined by field investigators who had collected data from the village.

Thus, \( x_2 = \sum_{i=1}^{n} \frac{p_i}{e_i} \)

\( i = 1, 2, \ldots \ldots \ldots n \)

where, \( p_i \) = price of the \( i \)th implement
\( e_i \) = expected life of the \( i \)th implement.

Of course, the value of \( n \) varies from farmer to farmer. Thus under certain assumption \( x_2 \) represents the estimated value of the annual factor - service by the implements.

\( x_3 \): Improved Inputs:

This represents the total charges paid by the farmers for their consumption of chemical fertilisers, oil cakes, cow dung manure and improved seeds.
The reason for taking these three inputs combined was that many crops have been considered together for which farmers used different types of fertilisers (chemical fertilisers, manure and oil-cakes) and improved seeds in different proportions. 

$x_4$: Annual water charges paid by the farmer:

$x_5$: Cash payment to agricultural labourers, (excluding family labour), and imputed value of payment in kind.

**NUMERICAL VALUES**: The following table (table No. 3) gives the values of $A, b_i$ ($i = 1, 2, \ldots, 5$) geometric means of the variables, marginal productivities and adjusted coefficient of multiple determination $\bar{R}^2$.

**Table No. 3**

VALUES OF THE GEOMETRIC MEANS, ELASTICITIES OF PRODUCTION AND MARGINAL VALUE PRODUCTIVITY OF FIVE INPUT FACTORS.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unit</th>
<th>G. M.</th>
<th>Elasticity coefficient $b_i$</th>
<th>S. E. of $b_i$</th>
<th>M. V. P. at G. M.</th>
<th>$t$ Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td>Acres</td>
<td>18</td>
<td>0.010</td>
<td>0.136</td>
<td>1.516</td>
<td>$&lt; 1$</td>
</tr>
<tr>
<td>Agricultural tools and implements</td>
<td>Rs.</td>
<td>93</td>
<td>0.070</td>
<td>0.098</td>
<td>2.054</td>
<td>$&lt; 1$</td>
</tr>
<tr>
<td>Improved practices</td>
<td>Rs.</td>
<td>512</td>
<td>0.295*</td>
<td>0.112</td>
<td>1.572</td>
<td>2.634</td>
</tr>
<tr>
<td>Water charges</td>
<td>Rs.</td>
<td>61</td>
<td>0.211**</td>
<td>0.064</td>
<td>9.440</td>
<td>3.297</td>
</tr>
<tr>
<td>Hired labour charges</td>
<td>Rs.</td>
<td>51</td>
<td>0.032</td>
<td>0.107</td>
<td>1.712</td>
<td>$&lt; 1$</td>
</tr>
<tr>
<td>Total gross output</td>
<td>Rs.</td>
<td>2729</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\Sigma b_i = 0.618$

$A = 105 \quad \bar{R}^2 = 0.7144 \quad \text{Where } \bar{R} : \text{Adjusted coefficient of multiple determination.}$
The elasticity coefficients $b_i$ were tested by student's 't' test. The values of $t$ at 5% and 1% level of significance at 22 degrees of freedom are 2.074 and 2.819 respectively.

Note: The values marked with (*) and (**) are significant at 5% and 1% level of significance respectively.

RELATIVE EFFICIENCY AND MARGINAL PRODUCTIVITIES
OF DIFFERENT ITEMS OF INPUT:

As already noted, the coefficients $b_i$ ($i = 1, 2, ... 5$) measure the elasticities of production with respect to each variable and the sum ($b_1 + b_2 + ... + b_5$) indicate the nature of returns to scale for the relevant inputs $x_1, x_2, ..., x_5$. The adjusted coefficient of multiple determination means that when the number of degrees of freedom is taken into consideration, they show the percentage of the variance in the dependent variable which on an average can be explained by the independent variables. Thus it is an indicator of the adequacy of the data for the purpose of a production function study. The value of $\bar{R}^2 = 0.7144$ meant that nearly 1 per cent of the variations are explained by such a function.

The value of ($b_1 + b_2 + ... + b_5$) is equal to 0.618 which is nowhere near unit. This indicates decreasing returns to scale.

From the statistical viewpoint, the following is the order in which reliance can be put on the conclusions derived from the elasticity coefficients for different inputs.

1. Water charges
2. Improved practices
3. Agricultural tools and implements
4. Hired labour
5. Land.

It is clear from the Table No. 3 that the elasticity of production is next to highest for the water charges. We can say that one per cent increase in water charges results in 0.211 per cent increase in gross agricultural output. This is in agreement with the fact that cotton and paddy which are dominating crops in Afaawa, gave good response to irrigation.
The elasticity of Improved Inputs which is highest is 0.295, which means that one percent increase in this input results in 0.295 per cent increase in gross output. Similarly one per cent increase in ‘agricultural implements’ will result in 0.070 per cent more of gross production. Also one per cent increase in hired labour will increase the gross output by 0.032 per cent, and one per cent increase in land output will increase the gross output by 0.016 per cent only. Although the elasticity for this factor is the lowest and quite insignificant, it should not be understood that this factor is unimportant. The probable reason for getting the lowest value for this factor is that, considering the limitations of the other factors, the farmers under study were operating more than sufficient land, so addition of one more unit won't be of any use to them. Or otherwise the method of standardisation may be defective one.

Finally let us consider the marginal productivities of various input factors. What is the return of an additional unit of a particular factor if the other factors are held constant at their respective geometric means? Since we have fitted the Cobb-Douglass function which is a multiplicative model geometric means have been taken. There is no objection, however, in making any desired levels of independent factors.

Considering first the water charges, it can be seen from Table No. 3 that the marginal value productivity of this input is 9.44. This means that the return of an additional rupee spent as ‘water charges’ is as high as Rs. 9.44. There are in all 48 wells and 10 tanks in Asawa village. But since 1957 Kakrapar canal has been providing water, use of tank water and wells had therefore decreased to a substantial extent. Tanks are being converted into fields. When all farmers of Asawa village will get water from Kakrapar canal the gross agricultural production will increase substantially.

As far as ‘improved inputs’ are concerned, the marginal productivity for this is 1.57. This means that if an additional rupee is spent on this input, the return is Rs. 1.57 only. The reason for such low return may be that here we have considered three factors viz. manures, fertilisers and improved seeds, some of which might not have been used in a proper way. As far as improved seeds are
concerned it may be noted that the farmers under consideration were aware of the advantages of the improved seeds. The total quantity of improved seeds used by the farmers under study was 358 maunds worth Rs. 1195 to cover the area of 231 acres. While only 126 maunds of ordinary seeds costing Rs. 1088 were used by these very farmers to cover the area of 142 acres. The farmers included in the sample were already aware of the use of manures and fertilisers. As a matter of fact the use of this was quite common in Afawa village. But the combination in which manure, fertilisers and oil cakes are used might be unscientific.

Thirdly, the marginal productivity of a unit of ‘depreciation of implements’ is 2.05. Thus the return of an additional rupee spent in the form of agricultural implements is highly fruitful.

Fourthly, considering the ‘hired labour’ input, it is observed that the marginal productivity for this factor is 1.71. Thus the return of an additional rupee is as good as Rs. 1.71. It may be noted that the average daily wage of casual/labourer in Afawa was about one rupee. Thus the marginal productivity is more than the average daily wage of a labourer. Thus keeping the hired labour is fruitful.

We have excluded the family labour. But it has not affected the results, because the proportion of family labour for families under consideration is insignificant. There were 36 active members of the medium class group who supervised agricultural operations; very few were actual participants in the operations. Per acre availability of active adult family members for supervision work was 0.06 persons; average number of persons available per farm being 1.4 which suggests that the exclusion has not vitiated our results.

Since the elasticity of production of ‘land’ input is quite insignificant it is probable that the observed value may have arisen by chance and hence the marginal value productivity of this unit is not interpreted.

SUMMARY AND CONCLUSIONS:

An attempt is made in this paper to fit a Cobb-Douglass production function, on medium class farmers of Afawa village of Surat
District. Our study reveals the following interesting points. Because of the difficulty inherent in the survey method of the collection of data, these conclusions should be treated more as tentative than final.

(i) The water charges paid by the farmers turns out to be the factor with the elasticity next to highest i.e., 0.211. The marginal productivity of a rupee invested in this resource is also as high as Rs.9.44. Thus the farmers could have profitably invested more, in this input.

(ii) The ‘improved inputs’ turns out to be the factor with highest elasticity i.e. 0.295. Our investigation supports the usual hypothesis that more and more use of the improved seeds should be made for increasing the gross agricultural production. There is an immediate need for guiding farmers in making proper use of manures and fertilisers. Further it is necessary to examine whether the combination in which the farmers use manures, chemical fertilisers and oil cakes is a scientific one.

(iii) Though the farmers possessed requisite implements, there is very good scope for investing in implements; of course, the nature of the desirable investment cannot be indicated precisely, since the term ‘implements’ includes a wide variety of tools and implements.

(iv) The wage paid to the agricultural labourers is lower than the marginal productivity of the wage paid labour.

(v) The class of the farmers under study possessed sufficient land. The increase in land is not profitable for them.
(2) સુધારી સાધના એ સંબંધ છે કયાંની સિદ્ધાંતિતરથાંકતા ગુણાંધ છે. તા. ત. ૦-૬માં, સુધારી શીખરનું બદલ ન થયું ઉપયોગથી પેટીયા કૂલ ઉપયોગમાં સંભવણી શક્તી છે તેના અડનના અભારા સ્થાયકનથી વધુ ભાગ છે. જેટલોને આશીષ આંતર તથા સામાજિક આંતરનું ઉપયોગ કરવા રીતી કરવા. તેમાંથી સૌથી હેઠળનું આપવાની તઓડાવી વધુ છે. જધુમાં મે પછુ તપાસો જવારી છે કે પેટીયા ને પ્રમાણણા આશીષ આંતર, સામાજિક આંતર અને આંતરનું ઉપયોગ કરવા છે તે વિદાનિક છે ક નહીં.

(3) તે ને ને પેટીયા પસં પુરૂષા પેટીયાની ઊગાની છે. અંતદ્ય તેમાં રહ્યું કરવાની વધુ અને કાણી છે. અન્યાય ખાસ રીતે કભુ કાયું પદાર્થ કાય શક્તિ કાય તેમાંના ઊગાના છે ક આંતરની ઊગાની છે. પણ કોઇ જ પદાર્થની અંતરના વધુ હાલ વધુ પ્રકૃતિ પણ સાધનો અને આંતરની સમાવેશ કરવી છે.

(4) પેટીયાને આપવામા આંતર મધુરીના હર એ તેમની સંદર્ભે જાપાવતાના મધુરીના હર કરતા આવો છે.

(5) આપવામા આંતરીક વેદામા આંતર પેટીયાની પસં પુરૂષી બેલાભાગાંક કર્મની છે તેમાં પસં કરવા તે તેમના માત્ર કાય કાય તે તે.