NOTES

THE RELATIONSHIP BETWEEN GRAIN AND STALKS PRODUCTION

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I

Among the steps necessary for raising the productivity of the agricultural sector in the country, the cultivation of high-yielding fodder crops assumes great importance. Crop and animal husbandry are followed by a large section of the Indian cultivators. A full integration of both these activities is essential to step up the availability of manurial inputs to the soil to supplement the fertility as well as to meet the feed and fodder requirements of the livestock.

India accounts for nearly 56 per cent of the total livestock population of the world and for one-quarter of the total world population of cattle and buffaloes. However, the animals are under-fed and under-nourished. Although India is the third largest producer of total quantity of milk, the quantity produced per milch animal or per head of human population is consequently very low. The annual average milk yield of the cow is 382 lbs., the buffalo 1,117 lbs., and the goat (per lactation) 127 lbs. It is imperative, therefore, that milk-yields are considerably increased. The proper nourishment of animals for stepping up milk supplies as well as efficient traction power for farming can be ensured inter alia by providing adequate feeding which in turn can be achieved by increasing the production of natural grass-lands, cultivated fodder crops and stalks yielding crops.

In view of the limited area under grass lands and fodder crops, the major source of livestock feed is the stalks, a resultant by-product of grain production. Yet, the availability of data on stalks production (and

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1. The statistical assistance and comments given by Shri. V. S. Dharap, Statistical Assistant, Agro-Economic Research Centre, and the computation work done by Miss Usha Sharma, Shri H. M. Raval and Shri T. K. Mehta of the Farm Management Centre are acknowledged with thanks.

2. Cost of Production of Milk in Delhi—I. C. A. R.
productivity) is severely limited. Several studies have been made to find out the input-output relationship of grain production as well as to estimate the output of grain in the country. Hardly any studies, however, seem to have been made to estimate the quantity of stalks production. Admittedly, the estimation of stalks production at a macro level poses a variety of problems. Nonetheless, it is possible to find out a definite ratio of relationship between grain and stalks production for a particular region showing homogeneous characteristics in respect of soil-climate complexes, cropping pattern, irrigation, cultural practices, etc. A particular variety of crop will display similar impact of different factors (e.g., use-levels of seeds, manures and fertilisers) on both the output of grain as well as stalks. Any variations in the production of stalks can, therefore, be explained by the variations in the output of grain.

OBJECTIVES OF THE STUDY

Against this background, the present study is attempted which seeks
(i) to find out the productivity of various by-products per unit of land;
(ii) to ascertain the relationship between grain production and stalks production; and
(iii) to study this relationship between grain production per unit of land and stalks production per unit of land.

SCOPE OF THE STUDY

The crops studied to establish the above relationship are Paddy and Jowar. The data required for the study were collected for 24 plots in respect of Paddy (Z-31 variety) and 18 plots in respect of Jowar (BP. 53) from among the 50 sample holdings in the 5 selected villages of Bulsar district. The plots were selected at random while the villages and cultivators have been selected on the basis of multi-stage stratified random sampling method by the Farm Management Centre. The information about area and production of main and by-products was gathered by personal interrogation of the sample farmers (the latter at the time of harvesting of the respective crops). The output of grain and stalks of these sample plots was actually weighed after the harvesting was done.

3. Farm Management Centre, Sardar Patel University, Vallabh Vidyanagar.
CHARACTERISTICS OF THE AREA UNDER STUDY

Soil in 5 selected villages consists mostly of Kyari lands suitable for paddy cultivation and medium black type of soil on which inferior cereals such as jowar, kodra or Rabi crops like wheat, gram etc. are grown. Although improved agricultural practices are not wholly absent, the rate of their adoption, inspite of the Package Programme, appears to be rather slow. The application of chemical fertilisers is the only improved input which seems to have caught the imagination of a cross-section of the cultivators. In other words, improved implements, use of insecticides and pesticides etc. are yet to make any considerable head-way in this tract. Most of the farms in these villages are not irrigated as yet; an inconsiderable area which is irrigated is irrigated by private wells. The average rainfall in this tract is, however, very high ranging from 60” to 80”. The cropping pattern of the 50 holdings shows that more than two-fifths of the cropped area is under paddy followed by mango, a fruit crop and Jowar, an inferior cereal accounting for 19.6 per cent and 14.3 per cent respectively. The sowing and harvesting of Paddy was done in June-July and September-October respectively while that of Kharif Jowar was carried out in June-July and December-January respectively. The average farm size of the 50 holdings is 2.85 hectares which, when compared to the 4.25 hectares average holding for the total sample of 150 farmers in the I.A. D. P. districts of Surat and Bulsar, indicates the comparative preponderance of small farms in this Zone. Consequently, the co-efficient of variation is as high as 92.63 per cent for the selected farms of the Paddy Zone as against 79.06 per cent for the total Sample.

II

PADDY (A)

The randomly selected 24 plots of paddy comprised the total area of 14.37 acres giving the average size of the plot of 0.60 acres. The aggregate output of paddy on these plots was 9390 Kgs. of paddy which means the average yield was 653.22 Kgs. per acre. The average yield of paddy straw worked out to 973.69 Kgs. per acre. The yield-level of paddy thus compared favourably with the average yield of 526.37 Kgs. in Surat District calculated on the basis of the output data of the last three years, 1963-64 to 1965-66. Thus the productivity of paddy on the sample plots was higher by 24.10 per cent than the district average.
It is well-known that information about the production of paddy straw is not available. It can be seen from Table 1 below that an acre of land under paddy would yield 973.69 Kgs. of straw. Furthermore, a crude relationship between the production of grain and that of stalks on the basis of the total output data shows that 100 Kgs. of paddy would yield 149 Kgs. of straw. The details of plots, area and output of grain and Stalks by size of holding groups are set out in Table 1.

PADDY (B)

An attempt is made in this section to find out the relationship between (i) Stalks production and grain production, and (ii) Stalks production and area devoted to paddy. A second degree equation

\[ Y = a + bx + cx^2 \]

is fitted to the data, results of which are summarised below. Stalks production and grain production:

\[ Y = 0.41 + 1.40x - 0.0015x^2 \]  \hspace{1cm} (1)

Per Acre Stalks production and

Per Acre Grain Production

\[ Y = 5.28 + 3.39x - 0.14x^2 \]  \hspace{1cm} (2)

Stalks production and Area under Paddy:

\[ Y = 0.15 + 7.17x^2 + 1.47x^2 \]  \hspace{1cm} (3)

Where \( Y \) = Production of stalks in quintals for all the equations (1) (2) and (3).

\[ X = \begin{align*} (i) & \text{ Production of grain in quintals for equations} \\
(1) & \text{ and (2)} \\
(\text{ii}) & \text{ area under paddy for equation (3).} \end{align*} \]

The co-efficients of quadratic term \( X^2 \) comes out to be insignificant in the case of all the equations (1), (2) and (3).

The equations are fitted after eliminating the quadratic terms and the linear relationships are

Stalks Production and grain Production:

\[ Y = 0.43 + 1.38x \]  \hspace{1cm} (4)

\( r = 0.98 \)

Per Acre Stalks Production and per Acre Grain production:

\[ Y = 0.10 + 1.54x \]  \hspace{1cm} (5)

\( r = 0.77 \)

Stalks production and Area under paddy:

\[ Y = 0.03 + 9.83x \]  \hspace{1cm} (6)

\( r = 0.97 \)

The regression co-efficients of the equations (4), (5) and (6) are significant at 5 per cent level. Again, the high correlation between the variables included in the model indicates the adequacy of the fit. Thus, the linear equations (4), (5) and (6) are better fit than the quadratic types of equations (1), (2) and (3).

(i) The respective values of \( F_{1,21} \) for equations (1), (2) and (3) are 1.52, 1.59 and 3.92.

Now, \( Pr \left\{ F_{1,21} > 4.325 \right\} = 0.05 \)

hence, all the observed F values are not significant at 5 per cent level of significance.
### TABLE 1

**YIELD-LEVELS OF GRAIN AND STALKS OF PADDY BY FARM-SIZE GROUPS**

<table>
<thead>
<tr>
<th>Size-group (Hect)</th>
<th>No. of Plots</th>
<th>Area (Acres)</th>
<th><strong>MAIN PRODUCT</strong></th>
<th></th>
<th><strong>BY-PRODUCT</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Production (Kgs)</strong></td>
<td><strong>Average (Kgs/Acre)</strong></td>
<td><strong>Production (Kgs)</strong></td>
<td><strong>Average (Kgs/Acre)</strong></td>
</tr>
<tr>
<td>Below 2.50</td>
<td>11</td>
<td>2.400</td>
<td>1753.81</td>
<td>730.75</td>
<td>2417.55</td>
<td>1007.31</td>
</tr>
<tr>
<td>2.51-5.00</td>
<td>8</td>
<td>6.950</td>
<td>3759.12</td>
<td>540.88</td>
<td>6076.70</td>
<td>874.35</td>
</tr>
<tr>
<td>5.01-7.50</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>7.51-10.00</td>
<td>5</td>
<td>5.025</td>
<td>3877.16</td>
<td>771.57</td>
<td>5502.48</td>
<td>1095.02</td>
</tr>
<tr>
<td>10.01 and above</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>24</td>
<td>14.375</td>
<td>9390.09</td>
<td>653.22</td>
<td>13996.73</td>
<td>973.69</td>
</tr>
</tbody>
</table>
GRAIN PRODUCTION AND STALKS PRODUCTION

From equation (4) it can be said that after a certain level (after 0.43 quintals – which on an average, may be the level of production of stalks even in the extremeties like complete failure of grain production) an increase in production of grain by one quintal will result in an increase of 1.38 quintals of production of stalks. Equation (5) suggests that on an acre of land, if production of grain increases by one quintal, the production of stalks will increase by 1.54 quintals. The minimum production of stalks even in the extreme cases of failure of grain production is on an average 0.10 quintals per acre. However, equation (4) having a correlation co-efficient of 0.98 between the grain production and stalks production, can be regarded as a more reliable estimate than the equation (5) with correlation co-efficient of 0.77 between the two said variables. Major part of the variation in stalks output is explained by the variation in grain output which implicitly means all the inputs that lead to changes in output levels of grain are responsible for changes in the output levels of stalks.

Area and Stalks production

Equation (6) suggests that with the existing input-mix and at the prevailing input-levels, an increase of one acre in land devoted to paddy will yield additional 9.83 quintals of stalks. In other words, the productivity rate of paddy-straw per acre is 9.83 quintals.

III

JOWAR (A)

In respect of Jowar, 18 randomly selected plots accounted for the total area of 32.15 acres revealing the average size of plot of 1.79 acres. The output of Jowar on these plots was 5938.32 Kgs. or 184.71 Kgs. per acre, while the production of stalks was 9089.71 Kgs. It is found that based on these data there exists a relationship between grain and stalks production of 152.90 Kgs. of stalks to 100 Kgs. of grain. In Table 2 below are provided the details of grain and stalks production and productivity.
<table>
<thead>
<tr>
<th>Size-group (Hect.)</th>
<th>No. of Plots</th>
<th>Area (Acres)</th>
<th>MAIN PRODUCT</th>
<th>BY-PRODUCT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Production (Kgs.)</td>
<td>Average (Kgs./Acre)</td>
</tr>
<tr>
<td>Below 2.50</td>
<td>7</td>
<td>8.225</td>
<td>1363.00</td>
<td>165.71</td>
</tr>
<tr>
<td>2.51-5.00</td>
<td>6</td>
<td>11.700</td>
<td>2760.32</td>
<td>235.92</td>
</tr>
<tr>
<td>5.01-7.50</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>7.51-10.00</td>
<td>5</td>
<td>12.225</td>
<td>1815.00</td>
<td>148.47</td>
</tr>
<tr>
<td>10.01 and above.</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>TOTAL</td>
<td>18</td>
<td>32.150</td>
<td>5938.32</td>
<td>184.71</td>
</tr>
</tbody>
</table>
The most intriguing fact that emerges from the data given in this table is that productivity of grain on the small farms was less than both the average for all the plots taken together as well as the productivity on the middle-sized farms; the productivity of stalks, on the other hand, was considerably higher on the plots operated by small farmers than on those operated by the middle farmers. This may be attributable to variations in the use-level of chemical fertilisers, type of seeds, or some other factors. It is also possible that since Jowar is grown mostly for providing staple food to the livestock, the small farmers in particular might be taking relatively larger production of fodder than that of grain to maintain livestock. The factors to which these differences can be attributed can, however, be more thoroughly studied as a separate subject.

A comparison between the yield-levels of Jowar on the selected plots (184.72 Kgs./acre) and the three-years’ (1963–64 to 1965–66) average for the district as a whole (251.49 Kgs/acre) shows that the productivity of Jowar lagged behind on the sample plots. Only the middle farmers with the yield of 235.92 Kgs/acre seem to be somewhat favourably placed while the big farmers (148.47 Kgs/acre) were worse off.

**JOWAR (B)**

As in the case of paddy, the quadratic equation

\[ Y = a + bx + cx^2 \]

is fitted to the data and the results are

Stalks production and grain: \[ Y = 0.88 + 1.22x + 0.0090x^2 \] ............(7)

Per Acre Stalks Production and grain Production: \[ Y = -0.06 + 1.73x - 0.0268x^2 \] ............(8)

Stalks Production and area under Jowar: \[ Y = -1.63 + 8.48x - 2.02x^2 \] ............(9)

where \( Y \) = Production of Stalks in quintals in case of all the equations (7), (8) and (9).

\[ X = (i) \] Production of grain in quintals in case of equations (7) and (8).
and (ii) area under Jowar in equation (9).

As the regression co-efficients of the equations (7), (8) and (9) are insignificant at 5 per cent level, linear equations are fitted to the data. These functional forms are

Stalks Production and Grain Production.

\[ Y = 0.76 + 1.30X \ldots \ldots \ldots \text{(10)} \]

\[ r = 0.80 \]

Per acre Stalks Production

\[ Y = 0.37 + 1.43X \ldots \ldots \ldots \text{(11)} \]

Per acre Grain Production

\[ r = 0.93 \]

Stalks Production and Area

\[ Y = 2.41 + 1.48X \ldots \ldots \ldots \text{(12)} \]

\[ r = 0.36 \]

The regression co-efficients of equations (10) and (11) are significant at 5 per cent level, while that of equation (12) is insignificant at 5 per cent level. The estimates of stalks production derived from equations (10) and (11), due to high correlation between stalks production and grain production, may be quite reliable. Model of equation (12), indicating the relationship between area and stalks production does not explain adequate variation in the stalks production. The correlation coefficient 0.36 suggests that variables other than area at the present level of input-structure tend to influence the stalks production to a considerable extent.

GRAIN PRODUCTION AND STALKS PRODUCTION

Equation (10) suggests that an increase of one quintal in production of grain results in an increase of 1.30 quintals in the production of stalks. Equation (11), on the other hand, indicates that the quantum of stalks production per acre is 1.43 times the grain production per acre, the minimum stalks production on an average being 0.37 quintals. It may be mentioned here that the estimates of stalks production given by equation (11) may be more reliable than those given by equation (10)\(^5\)

\[ 4. \text{ The respective values of } F_{1, 15} \text{ for equations (7), (8) and (9) are } \angle 1.00 \angle 1.00 \text{ and } 3.59 \]

\[ \begin{align*}
F_{1, 15} & \geq 4.543 = 0.05 \\
\end{align*} \]

hence, all the observed F values are not significant at 5 per cent level of significance.

\[ 5. \text{ The adequacy of estimates is more in the case of equation (11) due to high correlation of 0.93.} \]
SUMMARY AND CONCLUSIONS

Study of relationship between grain production and stalks production is helpful for predicting production of stalks for a given output of grain. It has added significance in periods of scarcity such as at present to enable planners to meet inter-district or inter-regional demands for fodder to maintain livestock. In order to find out this ratio of relationship, two cereal crops viz. Paddy and Jowar were studied on the basis of cost accounting data of 24 and 18 randomly selected plots growing the respective crops. It is found that, in respect of Paddy, the linear equations provided a closer fit than the second degree equation. The co-efficient of correlation between stalks production and grain production was found to be quite high (0.98) suggesting greater reliability of estimates provided by the linear equation based on these two variables. To recapitulate the results; after attaining the level of 0.43 quintals of stalks production, every additional unit increase in the paddy production is likely to increase the straw production by 1.38 units. On the basis of the linear relationship between stalks production and area devoted to Paddy, it is seen that with the existing input-mix and at the prevailing input-levels, an increase of one acre in the area is likely to yield additional 9.83 quintals of straw. Similarly, in respect of Jowar also, the regression co-efficients of the quadratic from of equations turned out to be insignificant at 5 per cent level. The linear equations consequently fitted to the data under study show that the quantum of stalks production is related to that of grain production in the ratio of 1.43:1, the minimum stalks production being 0.37 quintals. The insignificant co-efficient of correlation (0.36) between stalks production and area devoted to Jowar suggests that variables other than area at the present level of input-structure tend to influence the stalks production to a considerable extent.
উপরেরক ভাবনায় দৃষ্টি সমক রাখায়, আ লেখক পেটা উত্যাপানিত আচ্ছাদনের-productivity-তেমন মূল্য পাক অনে তেনা পেটা উত্যাপানী অনুপাত-ratio-দিয়ে আব্যাস করোনা প্রায় করোনা আলেম ছে। আ মাত্র আঁকো অনে নিচুয়, গে মূল্য ধান্য পাকনালারি অনুসারি ২৪ অনে ১৪ পেটা (plots) না অনলারি মাইল ইনিত "করোনায় আলেম ছে। ইরান ঐক্যনেট এন্টার, বলবাননায়গাতিরি আধিকাচার অনে পাকানী পোস্ট আইনামক্যার-আই.এ.ডি.পি. districts-ছে। Multi Stage stratified random sampling পদ্ধতি সংষ্টায় করোনা আবুল আ খল্লামানী ১৪ আনে অনে ১৫০ পিডুতলা ছাড়া, বলবাননার পাং গাভোনা অনুষ্টানে ওপর নতায়ক প্রভাবী আঁকো অনে নিচুয় প্লেটস আক্ষরিক নমুনাধিকরণীর (Random sampling Method) প্রায় করোনা আলেম ছে। লেখ নোয়া প্রভাবী নতুন ইতিহাসে পল্লু রাস্কনী তেয়ার করোনায় আলেম ছে।

(১) পাকনা পেটা উত্যাপানী অকর দৃষ্টি উত্যাপানী শুধুমাত্র।

(২) মূল্য অনে পেটা উত্যাপান বজ্রস্বর স্বয়ং ছে কে কে তে স্থাপিত করুক।

(৩) তন্ত্রনী অকর দৃষ্টি উত্যাপানী বজ্রস্বর স্বয়ং (ratio of relationship) তে আব্যাস করোন। আ আব্যাস মাত্র আন্তরকমানী নিয়ন্ত্রণ গেরিয়ান বিদ্যমান (Regression Analysis) না সৈনিক পদ্ধতিবিদ্যায় উপস্থাপনা করোন তে পিকামাস তৃতীয় শাখায় ছে তে না দেয়া প্রভাবী ছে।

ংংগনা পাকনা আন্তরক আঁকো অনে তেনা পেটা উত্যাপান বজ্রস্যামী সর্বসম্ভাব্যগুলো Coefficient of correlation ০.৮৪ জেনে বেন ছে। নে আন্তরকমানী বিদ্যমানী দৃষ্টিতে বেন ছে। পাক সা১ নিলিপো জন্য তারী পাক পরাজপ্ত উত্যাপান সরাসরি ০.৫৩ অনন্তর অতুল ওরাইয়ে জেম করন্ত থাক ছে। আঁকো উত্যাপন সা০ পাকু যে আঁকো উত্যাপন মায় অধিকনী অধিকনী অংশনালারি ব্যাখ্যায় থাক তে তেনা বুঝাও উত্যাপনামী ১.৩৭ অধিকনী ব্যাখ্যায় থাক তে আ আব্যাস পর্যায় নানা শাখায় ছে। আঁকো পুনরায় উত্যাপন অনে আঁকো প্রায় উত্যাপন অনে আঁকো প্রায় বাংলারি হেকানী ঵িস্তার অনে অনে বজ্রস্যামী স্বয়ং অনে স্থাপিত করুন ছে কে অয়মর বর্তু (inputs) না উপায়গুলো ইস্তার করোনা ন আলো তে আঁকো হেকানী বিস্তারী অকর অকর ব্যাখ্যায় চতুর্থ পরাজপ্ত উত্যাপনামী ৮.৫৩ করিন্তু ব্যাখ্যায় ব্যাখ্যায় বর্তু ছে।

নিচুয় পাকনা আন্তরক মূল্য পাকনা অনে পেটা-উত্যাপনী তেমন অনে অকর দৃষ্টি উত্যাপনী বজ্রস্যামী কর্মদীক নিয়ন্ত্রণ সমীক্ষকনী নিয়ন্ত্রণ সমান্তরাং (Regression-Co-efficient) স্বয়ং ছে। নয়ারী পেটা উত্যাপন অনে পাকনী হেকানী বিস্তার বজ্রস্যামী অনে সম্ভাব্যক সত্য নথি। অহী নিচুয় পাকনা পেটা উত্যাপন অনে মূল্য উত্যাপন
વૃષ્ણિક પ્રમાણમાં 1.43 મિટિનું છે. વર્ષાની સરીયારે નિમિત્તે પાણી પેટા ઉત્પાદન સરસરી 0.37 ક્રીટલ કેટલા થયા હતી કુવારતા ઉત્પાદનની હર ઓકે ઓખમો વધારે થયા છે. તેથી તંત્ર પેટા ઉત્પાદન એને તેના વાચતર હેકરું વિસ્તાર વધીને સહજાયોને ખાંદું 0.35 છે. છે સમાયે તથી એ અબ્યાસ પરથી ઉત્સ્પન થયે છે કે તે વાત સાધ્યના (inputs) તે ઉપયોગ થાય પ્રથી રહે તે વાત હેકરું વિસ્તાર સ્થિરપણા અન્ય સાધનના (inputs) તે ઉપયોગ કરીને પેટા ઉત્પાદન પર નાંખવાના અસર કરે છે. ]