Chapter 6

EFFECTS OF ROAD ACCESSIBILITY ON AGRICULTURAL SECTOR
IN MARATHWADA.

We shall try to investigate the effects of road accessibility on agricultural sector in Marathwada as compared to another region viz: West Maharashtra.

Road accessibility effects on agricultural sector have multiple dimensions. The different dimensions can be mentioned as below:

1) Road accessibility effects on crop pattern.
   i) On the composition of crops this may be termed as crop pattern sensitivity.
   ii) On the interregional crop concentration this may be termed as crop concentration sensitivity.

2) Road accessibility effects on agro-productivity.
   i) On the average physical yield per acre of a particular crop - this may be termed as yield sensitivity per acre.
   ii) On the value gross productivity per acre - this may be termed as gross value sensitivity per acre.

3) Road accessibility effect on marketable surplus - this may be termed as market-surplus sensitivity.
Our analysis refers to two approaches -

1) Inter-crop variation in sensitivity to the same level of change in road accessibility.

2) Sensitivity of particular crop to variation in road accessibility.

The analysis requires the measurement of need of road transportation by agricultural commodities. This may be termed as road transport necessity of a crop.

The road transport necessity of the crop can be stated as a function of the following determinants.

1) Percentage of marketable surplus out of the total production of corresponding agricultural commodity.

2) Average lead of transportation of agricultural crops by carts. This mainly represents transportation from primary centre to assembly centre.

3) Average lead of transportation of agricultural commodity by truck transportation. It mainly represents the transportation from assembling centre to terminating centre.

So, we can say that road transport necessity of crop $Z$, i.e. $RTN_Z = \text{percentage of marketable surplus} \times \text{average lead by cart in Kms.} \times \text{average lead by trucks in kms.}$
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Crop</th>
<th>Percentage of Marketable surplus to total production</th>
<th>Average lead by trucks in kms.</th>
<th>Average lead by carts in kms.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Oil-seeds</td>
<td>69</td>
<td>260</td>
<td>20.66</td>
</tr>
<tr>
<td>2.</td>
<td>Cotton</td>
<td>90</td>
<td>534</td>
<td>22.29</td>
</tr>
<tr>
<td>3.</td>
<td>Sugar and gir</td>
<td>85</td>
<td>269</td>
<td>20.94</td>
</tr>
<tr>
<td>4.</td>
<td>Jowar</td>
<td>24</td>
<td>223</td>
<td>15.23</td>
</tr>
<tr>
<td>5.</td>
<td>Bajra</td>
<td>26</td>
<td>223</td>
<td>15.23</td>
</tr>
<tr>
<td>6.</td>
<td>Rice</td>
<td>31</td>
<td>223</td>
<td>15.23</td>
</tr>
<tr>
<td>7.</td>
<td>Wheat</td>
<td>33</td>
<td>223</td>
<td>15.23</td>
</tr>
</tbody>
</table>
As we are interested in the relative road transport necessity of the crops, we can construct the indices of road transport necessities for the crops, taking arithmetic mean of road transport necessities = 100. The index of road transport necessities of crop for instance, \( z_1 \) can be calculated by the following equation:

\[
RTNI_{z_1} = \frac{RTN_{z_1}}{RTN_m} \times 100.
\]

- \( RTNI_{z_1} \) = Road transport necessity index for crop ' \( z_1 \) '  
- \( RTN_{z_1} \) = Road transport necessity of crop ' \( z_1 \) '  
- \( N \) = Number of the crops.  
- \( RTN_m \) = Mean road transport necessity = \( \frac{\sum RTN_z}{N} \)

We have constructed the road transport necessities and road transport necessity indices of different agricultural commodities on the basis of data shown in Table

The estimated road transport necessities and road transport indices for respective agricultural commodities are given in the following Table

The estimated road transport necessity indices for agro-commodities reveal that the cash crops like oil-seeds, sugar-cane and cotton are highly transport intensive whereas food crops like jowar, bajra, rice and wheat are less transport intensive crops.
TABLE NO. 6.2

<table>
<thead>
<tr>
<th>Agricultural commodity</th>
<th>Road transport necessity (RTN)</th>
<th>Road transport necessity index (RTN₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Jowar</td>
<td>444</td>
<td>24</td>
</tr>
<tr>
<td>2. Bajra</td>
<td>471</td>
<td>26</td>
</tr>
<tr>
<td>3. Rice</td>
<td>559</td>
<td>31</td>
</tr>
<tr>
<td>4. Wheat</td>
<td>595</td>
<td>33</td>
</tr>
<tr>
<td>5. Oil-seeds</td>
<td>1063</td>
<td>108</td>
</tr>
<tr>
<td>6. Sugar-gur</td>
<td>2540</td>
<td>139</td>
</tr>
<tr>
<td>7. Cotton</td>
<td>6182</td>
<td>339</td>
</tr>
</tbody>
</table>

Arithmetic mean of road intensities = 1322 = road transport intensity index = 100.
The analysis needs the quantitative measurement of variation in road accessibility in different regions or in different areas. The road density in the area can be taken as indicator of road accessibility for the crop in the area. The road facilities indices of different areas provide the relative accessibility in respective areas.
6.1
ROAD ACCESSIBILITY EFFECTS ON CROP PATTERN
ANALYSIS ON MARATHMANDA AND WEST MAHARASHTRA

Road Accessibility and Crop Pattern

Normally it is contemplated that there would be a powerful effect of road accessibility on crop pattern. It is theoretically often argued that road accessibility tends to increase marketability of agricultural produce with positive impact on marketing efficiency; nevertheless, the same degree of sensitivity to road accessibility by various crops can be hardly imagined owing to different degrees of road transport necessities of different commodities.

The degree of sensitivity of crop to road accessibility would be a direct function of road transport necessity of the concerned crop. It implies passive accessibility effect on food-crops and powerful influence on cash-crops, as they are less transport intensive and high transport intensive crops respectively.
The corollary that follows is that the crop pattern in the region with paucity of roads would constitute the greater proportion of less transport intensive food-crops and smaller proportion of transport intensive cash-crops as compared to the same in the identical region with efficient and adequate road system.

This corollary suggests that as Marathwada has been efficient in road facilities, there must be lower percentage of acreage under cash-crops in this region as compared to that in West Maharashtra as the latter has relatively higher road density, ignoring, of course, the qualitative variations in the soil and climatic conditions.

It appears that statistical evidence does not substantiate the theoretical corollary as the percentage acreage under cash-crops including cotton, ground-nut and sugar-cane being 22.9 in Marathwada as against 14.95 in West Maharashtra and the percentage acreage, under food-grain crops including jowar, rice, wheat and bajra being 48.9 in Marathwada as against 66.6 in West Maharashtra (1962-63).

The possible explanation lies in better quality of land and more dependable rain which must have brought a larger proportion of cash-crops for Marathwada as compared to West Maharashtra.

1. Table A 6.1
to the other region inspite of the deterrent of low road accessibility.

The above statistical evidence might have failed to reveal the probable adverse effect by inadequacy in road accessibility on the crop pattern in Marathwada, as it cannot separate the influence of inter-regional differences in soil and climatic conditions between two regions. As argued earlier, the superiority in soil and greater degree of dependability of rain in Marathwada might have compensated the probable adverse effect of inadequate road accessibility.

It indicates the need for multiple regression analysis. The multiple regression analysis requires the quantitative measurement of relative superiority of crop pattern of various spatial units like regions and districts. We shall therefore attempt to evolve the method of measuring the relative superiority in crop pattern.

The superiority in crop pattern implies a higher proportion of acreage under high value productivity crops in the region. The value productivity is resultant of the crop pattern average physical yield of the crop and average harvest price for the crop in the corresponding area.

As crop pattern comprises of various crops with different proportions, a single quantitative indicator for relative
superiority of crop pattern can be constructed on the basis of conversion of all crops in one base-crop according to value productivity and the percentage acreage under respective crops in the area.

It would be feasible to take crop having lowest value productivity as base-crop, so that other crops can be expressed according to their value productivity of a crop to value productivity of base-crop will serve the purpose and this may be termed as 'Crop-quotient' for a crop in question. Supposing the base crop is 'A',

Crop-quotient of crop 'B' may be indicated by $B_{cr}$

$$B_{cr} = \frac{\text{Average value productivity of } B \text{ in area } R_l}{\text{Average value productivity of base crop } A \text{ in area } R_l}$$

As the relative superiority of a crop pattern in the area would be the function of crop-quotients and percentage acreage under corresponding crops, the crop pattern indices for the area indicating relative superiority of crop pattern can be calculated as,

Crop pattern index for area $R_l$ indicated by $I_{cr} R_l$ x

$$I_{cr} R_l = B_{cr} \times \text{percentage acreage of crop } B + C_{cr} \times \text{percentage acreage of crop } C + \ldots + \frac{N_{cr}}{cr} \times \text{percentage acreage of crop } N.$$
Estimation of crop pattern indices for Marathwada and West Maharashtra.

As the value productivity of bajra is lowest, bajra is to be taken as base-crop. The regional crop pattern indices are estimated only for non-irrigated cropped area in the region. The acreage under irrigated land is excluded from the analysis to eliminate the effect of variation in irrigated land on the crop pattern.

Though the rank-correlation analysis provides no evidence for positive crop-pattern sensitivity to road accessibility, we cannot have conclusive inference at this analytical stage. It might have failed to reveal the probable adverse effect by inadequacy in road accessibility on the crop-pattern in Marathwada, as it cannot separate the influence of inter-regional differences in soil and climatic conditions between two regions. As argued earlier, the superiority in soil and greater degree of dependability of rain in Marathwada might have compensated the probable adverse effect of inadequate road accessibility. It indicates the need for multiple regression analysis. The multiple regression analysis requires the quantitative measurement of relative superiority of crop-pattern of various spatial units like regions and districts. We shall, therefore, attempt to evolve the methods of measuring the relative superiority in crop pattern.
The superiority in crop-pattern implies the higher proportion of acreage under high value productivity crops in the region. The value productivity is resultant of average physical yield of the crop and average harvest price for the crop in the corresponding area.

As crop-pattern comprises various crops with different proportions, a single quantitative indicator for relative superiority of crop pattern can be the basis of conversion of all crops in one base-crop according to value productivity and the percentage acreage under respective crops in the area. Let us confine our analysis to crops under non-irrigated acreage.

It would be feasible to take crop having lowest value productivity as base-crop, so that other crops can be expressed according to their value productivity in terms of the base crop. The ratio of value productivity of a crop to value productivity of base-crop will serve the purpose and this may be termed as 'Crop-quotient' for a crop in question. Supposing the base crop is 'A',

\[
\text{Crop-quotient of crop'B' } = \frac{\text{Average value productivity of B in area } R_1}{\text{Average value productivity of base-crop 'A' in area } R_1} = K
\]

As the relative superiority of a crop-pattern in the area would be the function of crop-quotients and percentage acreage under corresponding crops, the crop-
pattern indices for the area indicating relative superiority of crop-pattern can be calculated as,

\[ R_1 = \frac{C_r B \times \text{percentage acreage of crop } B}{C_r A \times \text{percentage acreage of crop } C} + \cdots + C_r n \times \text{percentage acreage of crop } N \]

Estimation of crop-pattern indices for Marathwada and West Maharashtra.

As the value productivity of bajra is lowest, bajra is to be taken as base-crop. The regional crop-pattern indices are estimated only for non-irrigated cropped area in the region. The acreage under irrigated land is excluded from the analysis to eliminate the effect of variation in irrigated land on the crop-pattern.

The estimated regional crop-pattern indices for Marathwada and West Maharashtra are 182.86 and 171.68 respectively based on crop-quotients and percentage acreage under crops as shown in Table A 6.2.

In spite of the paucity of roads, the crop-pattern of non-irrigated acreage in Marathwada appears to be slightly superior to that of West Maharashtra as regional crop index for Marathwada is found slightly higher. This necessitates to resort to multiple regression analysis to verify the accessibility effect on crop-pattern eliminating influence of regional factors like superiority in soil and climatic conditions.
Multiple regression analysis:

1. For this multiple regression analysis, cross-section data of districts in Marathwada and in West Maharashtra for the year 1962-63, are considered.

2. The regional crop-quotients are used for districts in the respective regions as inter-district variation in the region with regard to average physical productivity and harvest prices of agro-commodities is not found significant.

3. Road indices of road density per Sq. area for district is taken as indicator of relative accessibility in the district.

4. The dummy variables are used to absorb the probable effects of regional factors like superiority of soil and high dependability of rain in Marathwada and high frequency of famine in districts namely Poona, Sholapur and Ahmadnagar in West Maharashtra.

The linear multiple regression equation is to be estimated taking superiority of crop-pattern indicated by district crop-pattern indices as function of road accessibility and other regional factors like soil and climatic conditions.

\[ Y = aX_1 + b(D_1 X_1) + d(D_1) + C \]

1. A 6:3
\[
Y = \text{Crop-pattern index of the district.}
\]

\[
X = \text{Road index for the district.}
\]

\[
X_1 = \text{Dummy variable for regression coefficient of } X \text{ as}
\]

\[
D = 1 \text{ for } X_1 \text{ in the districts in Marathwada.}
\]

\[
D = 0 \text{ for } X_1 \text{ in districts in West Maharashtra.}
\]

\[
D_1 = 1 \text{ for districts: Poona, Ahamadnagar and Sholapur.}
\]

\[
D_1 = 0 \text{ for all other districts other than Poona, Ahamadnagar and Sholapur.}
\]

\[
\alpha, b, d = \text{regression coefficients}
\]

\[
c = \text{constant term.}
\]

The estimated regression equation is as follows:

\[
Y = 0.0339 X_1 + 0.1620(D_1 X_1) -55.05 D_1 + 244.6
\]

\[
R^2 = 0.2233
\]

The regression co-efficient of road index has a positive sign as expected but it is not found statistically significant even at 0.05 level of significance.

The regression co-efficient of dummy variable for road indices for the districts in Marathwada has a positive sign but it is not found statistically significant at 0.05 level of significance.

The regression coefficients for dummy variable for intercept for the districts having high frequency of famine
emerged with negative sign as expected but it is not statistically significant.

\( R^2 \) is found equal to .2238 and it has not emerged statistically significant even at .05 level of significance.

Thus it indicates very poor goodness of fit. The estimated regression equation separating influence of regional factors like superiority in soil and climatic conditions does not bear out the positive accessibility effect on superiority in crop-pattern.

Non-sensitivity of crop-pattern to road accessibility evident in the analysis may be attributed to often argued risk reducing tendency of the farmer in India; farmers in India tend to reduce the risk by diversifying their crops. The increasing road accessibility may have no risk-reducing influence and thereby non-influence on crop-pattern.

ii) \textbf{ROAD ACCESSIBILITY AND INTER REGIONAL SPECIALIZATION OF CROPS}.

The theoretical considerations prompt us to believe that the region with paucity of roads would have greater inter regional specialization in less road transport intensive products like foodgrains as compared to the region with adequate and efficient road system.

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We may, now, examine inter-regional specialization of different crops in the case of Marathwada, the region with paucity of roads, and West Maharashtra, region with high density of roads in the light of above theoretical consideration.

The inter-regional spatial concentration of different crops can be measured by 'location quotients' of the crops for the respective regions estimated on the basis of following equation.

\[
\text{Location quotient for region} A \text{ of crop} T = \frac{\text{Percentage acreage under crop} \ T \text{ to the total cropped acreage in region} A}{\text{Percentage acreage under crop} \ T \text{ to total cropped acreage in the State}}
\]

The estimated location quotients of different crops for West Maharashtra and Marathwada are shown in the Table 6.4.

It is revealed in the Table 6.4 that Marathwada has relatively more specialization in jowar, wheat, pulses, and cotton, as compared to west Maharashtra. The first three are food crops and last one i.e. cotton is cash-crop.

West Maharashtra has more specialization in the case of rice, bajra, ragi, ground-nut and sugar-cane as compared to Marathwada. First three are food crops and last two
### Table 6.4

LOCATION QUOTIENTS OF DIFFERENT CROPS

<table>
<thead>
<tr>
<th>Crops</th>
<th>West Maharashtra</th>
<th>Marathwada</th>
</tr>
</thead>
<tbody>
<tr>
<td>Howar.</td>
<td>1.10</td>
<td>1.11</td>
</tr>
<tr>
<td>Rice.</td>
<td>0.51</td>
<td>0.26</td>
</tr>
<tr>
<td>Wheat.</td>
<td>0.69</td>
<td>1.20</td>
</tr>
<tr>
<td>Bajra.</td>
<td>1.93</td>
<td>0.61</td>
</tr>
<tr>
<td>Ragi.</td>
<td>0.79</td>
<td>0.03</td>
</tr>
<tr>
<td>Pulses.</td>
<td>0.79</td>
<td>1.42</td>
</tr>
<tr>
<td>Sugar-cane.</td>
<td>1.34</td>
<td>0.52</td>
</tr>
<tr>
<td>Cotton.</td>
<td>0.38</td>
<td>1.09</td>
</tr>
<tr>
<td>Ground-nut.</td>
<td>1.36</td>
<td>1.19</td>
</tr>
<tr>
<td>Fruits &amp; Vegetables</td>
<td>1.23</td>
<td>0.56</td>
</tr>
<tr>
<td>Fodder.</td>
<td>1.69</td>
<td>0.02</td>
</tr>
</tbody>
</table>
Table No. 6.5
RANKING ACCORDING TO VALUE -PRODUCTIVITY PER ACRE.
AND LOCATION QUOTIENTS OF CROPS

<table>
<thead>
<tr>
<th>Crops</th>
<th>West Maharashtra</th>
<th>Marathwada</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rank: value</td>
<td>Rank: value</td>
</tr>
<tr>
<td></td>
<td>productivity</td>
<td>location quotients</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Rice</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Cotton</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Groundnut</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Wheat</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Jowar</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Pulses</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Bajra</td>
<td>8</td>
<td>2</td>
</tr>
</tbody>
</table>
are cash crops. Thus, it creates doubts about the distinctive nature in regard of inter-regional specialization between the two regions. This induces us to resort to rank-correlation analysis to find out whether there exists any distinction between Marathwada and West Maharashtra in regard of inter-regional concentration of crops indicated by location quotients and the relationship between inter-regional concentration of crops and road transport intensity of respective products.

Rank-correlation analysis of location quotients of the crops in the region would reveal whether the regions are significantly different in regard to inter-regional crop concentration of crops. The statistically significant rank correlation coefficient with negative sign would indicate that the two regions are different in the case of inter-regional crop concentration.

The ranking of crops according to location quotients for the two regions is given in the table 6.45. The estimated rank-correlation between the location quotients for the crops in the two regions is found to be $r = 0.33$ with negative sign as expected but not found statistically significant even at 0.05 level of significance. Thus, rank-correlation analysis does not show significant difference between two regions.
It does not allow us to say that in regard to inter-regional crop concentration, Marathwada is significantly different from West Maharashtra.

**Location-quotients of crops under irrigation.**

It would now be interesting to know whether two regions are significantly different in regard to inter-regional concentration of crops exclusively under irrigated land, as allocation of irrigated land is expected to be more market-sensitive; moreover, the irrigated farming requires more investment and out of pocket expenditure for farm inputs. Further, the magnitude of inter-regional difference in quality of land and dependability of rains would be reduced in the case of irrigated land.

The location-quotients of crops under irrigated land and their ranking is given in the table 6.6

Rank-correlation coefficient of location quotients of irrigated crops in the two regions is found equal to -.28. The sign of correlation coefficient is as anticipated but not found statistically significant at .05 level of significance. Thus even in the case of exclusive irrigated crops Marathwada cannot be said distinct in regard to crop concentration as compared to West Maharashtra.
<table>
<thead>
<tr>
<th>Crops</th>
<th>West Maharashtra</th>
<th>Marathvada</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Location quotients</td>
<td>Ranks</td>
</tr>
<tr>
<td>Bajra</td>
<td>1.63</td>
<td>2</td>
</tr>
<tr>
<td>Jowar</td>
<td>1.10</td>
<td>7</td>
</tr>
<tr>
<td>Rice</td>
<td>0.19</td>
<td>8</td>
</tr>
<tr>
<td>Wheat</td>
<td>1.20</td>
<td>6</td>
</tr>
<tr>
<td>Cotton</td>
<td>2.60</td>
<td>1</td>
</tr>
<tr>
<td>Ground-nut</td>
<td>1.60</td>
<td>3</td>
</tr>
<tr>
<td>Sugar-cane</td>
<td>1.40</td>
<td>4</td>
</tr>
<tr>
<td>Pulses</td>
<td>1.22</td>
<td>5</td>
</tr>
</tbody>
</table>
Thus inter-regional concentration of crops in both regions seems to be insensitive to variation in road accessibility between Marathwada and West Maharashtra.

The road transport intensities of the agro-products and inter-regional crop concentration in Marathwada and West Maharashtra:

The road accessibility effect is anticipated on inter-regional crop concentration as a function of road transport intensities of the agro-products, because the greater road accessibility would tend to encourage greater acreage under road transport intensive agro-products, conversely, deficiency in road system would tend to induce farmers to allocate more land to less transport intensive products. This implies accessibility effect with opposite direction in regard to high road transport intensive products and less transport intensive products.

Thus, we can expect that owing to deficiency in road accessibility, Marathwada would have greater inter-regional concentration in the case of less transport intensive agro-products in contrast to West Maharashtra conversely, West Maharashtra with relatively efficient road system, would have greater inter-regional concentration in the case of high road transport intensive agro products.
This can be tested by rank correlation analysis between road transport intensities of agro-products and location quotients of respective crops in the two regions.

If we would get, rank-correlation coefficient with negative sign in the case of Marathwada and with positive sign, in the case of West Maharashtra. We can say that the variation in road transport intensities and difference in road accessibility are effective in the case of crop concentration in two regions, of course, ignoring differences in soil and climatic conditions between the two regions.

The respective ranking is given in the Table 6.7.

Taking total cropped area including irrigated and non-irrigated area, the rank-correlation coefficients between road transport intensity indices and location quotients are found equal to -0.14 and zero(0) in the case of West Maharashtra and Marathwada respectively both are found not significant at .05 level of significance. Thus the analysis does not substantiate the anticipated relationship between road transport intensities and crop concentration, as a result of difference in road accessibility in both regions.

The same kind of analysis is resorted to inter-regional crop-concentration taking into account exclusively irrigated land. The rank correlation coefficient between
<table>
<thead>
<tr>
<th>Crops</th>
<th>Ranking according to road transport intensity indices</th>
<th>Ranking of location quotients.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>WEST MAHARASHTRA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MARATHMAD A</td>
</tr>
<tr>
<td></td>
<td>Total Acreage</td>
<td>Irrigated.</td>
</tr>
<tr>
<td>Cotton</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Sugar-gur.</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Oilseeds</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Wheat</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Rice</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Bajra</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Jowar</td>
<td>7</td>
<td>4</td>
</tr>
</tbody>
</table>
location quotients of irrigated crops and road transport intensity indices are found to be equal to 0.54 and -.21 in the case of West Maharashtra and Marathwada respectively. Both the coefficients emerged with anticipated signs but they are not found statistically significant even at .05 level of significance.

The analysis does not provide convincing evidence for road accessibility effect on crop concentration as function of road transport intensities of agro-products even in the case of exclusively irrigated crops.

ROAD ACCESSIBILITY EFFECT ON ACREAGE UNDER VEGETABLES AND FRUITS

The road accessibility effect on acreage under fruits and vegetables needs separate analytical treatment as road transport service needed for them is qualitatively different as these products are perishable. Speed, frequency of road transport service and road-distance between farm and terminal centres are crucial factors. The data about these components is not readily available, so the road transport intensity index for them could not be constructed.

In Marathwada, acreage under fruits and vegetables was very small as compared to that in West Maharashtra. Only 0.46% of land was under fruits and vegetables in Marathwada as against 1.04% in West Maharashtra. The
inadequacy and deficiency in the road system appears to be the factor responsible for very low percentage of land under fruits and vegetables in this region as the marketing of fruits and vegetables requires quick and extensive road transport system. The speedy transhipment is extremely essential as they are perishable. Terminal centres are mainly big urban centres like Bombay, Poona which are situated at distant places from Marathwada region. The transhipment requires truck transportation with competitive rates. This is possible only when there exists an efficient and adequate road system in the region.

The following region-wise table indicates the probable positive relationship between the relative road densities indicated by road indices and percentage of acreage under fruits and vegetables in the regions.

**Table 6.3 (1962-63)**

<table>
<thead>
<tr>
<th>Region</th>
<th>Percentage acreage under vegetables and fruits in relation to cropped area.</th>
<th>Average of district road indices.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Konkan</td>
<td>1.60</td>
<td>167.4</td>
</tr>
<tr>
<td>West Maharashtra</td>
<td>1.04</td>
<td>149.1</td>
</tr>
<tr>
<td>Nagpur</td>
<td>0.62</td>
<td>68.37</td>
</tr>
<tr>
<td>Marathwada</td>
<td>0.46</td>
<td>45.85</td>
</tr>
</tbody>
</table>

1. Average road indices for regions were estimated on the basis of district road indices estimated by MRTS as variation in inter-regional sq. area is negligible.
It appears that inter-regional variation in percentage acreage under fruits and vegetables is significantly and positively correlated with variation in road facilities in respective regions. It provides the probable statistical evidence for the contention that lower acreage under fruits and vegetables in Marathwada may be explained in the light of lower density of roads in the region.

**ACREAGE UNDER FODDER.**

The percentage acreage under fodder is considerably low in Marathwada. It was only 0.19 percent of total gross cropped area in Marathwada as against 8.23 percent in West Maharashtra in year. It means that the percentage acreage under fodder in Marathwada was 2.3 percent of that in West Maharashtra. Further, the comparison of population of livestock in the two regions as given in the following table, indicates glaring disparity in the availability of fodder per cattle head.

**Availability of fodder per cattle head.**

<table>
<thead>
<tr>
<th>Region</th>
<th>Population of</th>
<th>Acreage under</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>milch cattle +</td>
<td>fodder</td>
<td></td>
</tr>
<tr>
<td></td>
<td>other cattle +</td>
<td>(00) 1962-63</td>
<td></td>
</tr>
<tr>
<td></td>
<td>milch buffaloes +</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>other buffaloes</td>
<td>(00) 1961-62</td>
<td></td>
</tr>
<tr>
<td>West Maharashtra</td>
<td>65616</td>
<td>16558</td>
<td>0.252</td>
</tr>
<tr>
<td>Marathwada</td>
<td>43161</td>
<td>229</td>
<td>.005</td>
</tr>
</tbody>
</table>


2. According to 1961 Cattle-census; the population of milch cattle holds good for 1962-63 as well, as no separate figures could be obtained.
The positive correlation has been revealed in the following table between the percentage acreage under fodder and road indices.

Table 6.10

<table>
<thead>
<tr>
<th>Region</th>
<th>Percentage acreage under fodder</th>
<th>Road indices for the region.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Konkan</td>
<td>26.55</td>
<td>167.4</td>
</tr>
<tr>
<td>West Maharashtra</td>
<td>8123</td>
<td>149.1</td>
</tr>
<tr>
<td>Marathwada</td>
<td>0.19</td>
<td>45.35</td>
</tr>
</tbody>
</table>

The lower percentage of acreage under fodder might have been caused by paucity of roads among other factors, as paucity of good roads nullifies the incentive for rearing milch cattle, as milk does not fetch reasonable price. Milk producer living on bad roads finds it uneconomical to market their surplus because the milk collector, who travels by bicycle, cannot carry enough on a bad road to make the trip pay. He is able to carry atleast twice as much on a good road, and, therefore, avoids farms with poor access. The only recourse for the isolated farmer is to dispose of his milk locally for whatever he can get. 1

The milk-collecting truck or van cannot reach villages with no access to good roads for collecting surplus milk. As a result of this, milk-producers are deprived of big markets like Bombay, Poona, Solapur and Aurangabad. Consequently the potentialities of development of dairy industry have remained unexplored in this region.

6.2

YIELD SENSITIVITY OF CROPS AND ROAD ACCESSIBILITY.

It is elucidated that one of the important factors responsible for low agricultural productivity in Marathwada is lack of transport facilities. Among the other factors, can be mentioned low irrigation facilities and traditional cultivation practices. However, certain factors may be regarded as favourable for the productivity in the region. It has been noted that man land ratio in the region is somewhat better as compared to other regions.

From theoretical point of view, the adverse effect of inaccessibility on average physical yield can be attributed partly to the following factors.

1) It increases the cost of application of agro-inputs.
2) It increases inconvenience to cultivators.
3) It keeps farmers aloof from new methods of cultivation.
4) It depresses harvest-price of surplus agro-products.
   It acts as a disincentive.

---

### TABLE NO. 6.11

Indices of per acre yield of crops in Marathwada, on the basis per acre yield in Poona Division=100.

(1961-63 Average yield)

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Crop</th>
<th>Marathwada yield index</th>
<th>Rank according to yield index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Jowar</td>
<td>130.00</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>Bajra</td>
<td>113.02</td>
<td>2</td>
</tr>
<tr>
<td>3.</td>
<td>Wheat</td>
<td>83.72</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>Total pulses</td>
<td>82.84</td>
<td>4</td>
</tr>
<tr>
<td>5.</td>
<td>Ground nut</td>
<td>76.37</td>
<td>5</td>
</tr>
<tr>
<td>6.</td>
<td>Rice</td>
<td>55.36</td>
<td>6</td>
</tr>
<tr>
<td>7.</td>
<td>Sugar-cane</td>
<td>45.54</td>
<td>7</td>
</tr>
<tr>
<td>8.</td>
<td>Cotton</td>
<td>41.86</td>
<td>8</td>
</tr>
</tbody>
</table>

Based on table A 6.4
Comparative analysis of average yield per acre of the crops in Marathwada and Poona Division is pertinent to verify the impact of deficiency in road accessibility on average physical yield per acre, as the difference in road facilities between the two regions is significantly wider. For reference, the index of road mileage for Poona Division is 142 while that of Marathwada only about 46 on the basis of State average equal to 100. The indices of average physical yield per acre of the crops in Marathwada are constructed on the basis of per acre yield of corresponding crops in Poona Division equal to 100. These indices are shown in the table G.11

**INTERCROP VARIATION IN YIELD SENSITIVITY TO ROAD ACCESSIBILITY**

Yield sensitivity of crop to road accessibility is expected to be direct function of degree of road transport necessity of the crops. This prompts us to believe that the paucity of the roads in Marathwada might have affected per acre yield of road transport intensive cash crops with greater degree as compared to per acre yield of less transport intensive food crops.

This is evidenced by ranking per acre yield indices for the crops in Marathwada on the basis of yield in Poona Division as it shows that higher ranks are received by less
transport intensive crops and lower ranks are received by high transport intensive cash crops.

In spite of paucity of roads in Marathwada the average physical yield per acre of jawar and bajara is found to be relatively higher than the same in Poona Division. This may be attributed to (1) Superior land in Marathwada and (2) Meagre adverse influence of paucity of roads on yield per acre owing to less degree of road transport necessity of jowar and bajra, the latter pertinent to our analysis.

The ranking shows that all other crops have relatively lower per acre yield in Marathwada as compared to that in Poona Division.

On the basis of data in Table 6.12 the rank correlation analysis in regard to yield indices and road transport intensity of the respective crops is attempted. The estimated rank correlation coefficient is -0.89 and found statistically significant at .05 level of significance as anticipated.

It identifies the relatively lower per acre yield of crops in Marathwada as compared to Poona Division in the case of high road transport intensive cash crop in contrast to food crops, probably, as a result of anticipated high yield sensitivity by high transport intensive crops to low road accessibility in the region.
Thus it substantiates the contemplated functional relationship between yield sensitivity and road transport intensity of the crops.

Now we shall resort to rank correlation analysis of average physical yield of individual crops and road density indices of the districts. The purpose of this analysis is to investigate the road accessibility effect on the average physical yield of the individual crops in the district and also to corroborate the earlier findings about intercrop variation in yield sensitivity.

The degree of accessibility is indicated by road indices of the districts in Maharashtra State estimated by the Regional Transport Survey of Maharashtra. Normally the degree of accessibility to the farm would be directly proportional to the road density in the district.

We have included all the districts of Maharashtra State except that of Konkan Region where the soil climatic conditions are very different.

The analysis is not confined to Marathwada region because:

1) Marathwada has only five districts which is too small a number for rank correlation analysis.
ii) The variation in average physical yield between different districts in Marathwada is very low and insignificant but the variation in yield is substantial between districts from Marathwada and districts from other regions of Maharashtra State. In short, inter-regional variation is high as compared to intra-regional variation.

iii) The variation in road densities between districts in Marathwada is also insignificant, but the variation in road densities between districts from Marathwada and districts from other regions of Maharashtra State is substantial.

iv) A comparative analysis of this region would be feasible only if other regions of Maharashtra are also taken for analysis.

We have taken only relevant districts from the Maharashtra State excluding districts of Konkan region.

The rank correlation analysis is attempted for the major crops; jowar, bajra, wheat, rice, groundnut, cotton and sugar-cane.

The estimated rank correlation co-efficients of average physical yield and road indices based on the data at district level is shown in the Table No. 6.13

1 Table A 6.5
2 Table A 6.6
Table 6.13

RANK CORRELATION CO-EFFICIENTS OF AVERAGE PHYSICAL YIELD AND ROAD INDICES.

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Crops</th>
<th>No. of Observations</th>
<th>Rank correlation co-efficient</th>
<th>Significant at .05 level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cotton</td>
<td>21</td>
<td>0.77</td>
<td>Significant</td>
</tr>
<tr>
<td>2</td>
<td>Sugarcane</td>
<td>16</td>
<td>0.50</td>
<td>Significant</td>
</tr>
<tr>
<td>3</td>
<td>Rice</td>
<td>21</td>
<td>0.47</td>
<td>Significant</td>
</tr>
<tr>
<td>4</td>
<td>Groundnut</td>
<td>21</td>
<td>0.39</td>
<td>Not significant</td>
</tr>
<tr>
<td>5</td>
<td>Wheat</td>
<td>22</td>
<td>0.33</td>
<td>Not significant</td>
</tr>
<tr>
<td>6</td>
<td>Bajra</td>
<td>20</td>
<td>0.12</td>
<td>Not significant</td>
</tr>
<tr>
<td>7</td>
<td>Jowar</td>
<td>21</td>
<td>0.31</td>
<td>Not significant</td>
</tr>
</tbody>
</table>
The rank correlation coefficients emerged statistically significant with positive sign in the case of cash crops, Cotton and Sugarcane but was not found significant in the case of groundnut.

The rank correlation coefficients were found statistically significant at .05 level of significance in the case of food grains like Jowar, Wheat and Bajra but not found significant in the case of Rice.

The rank correlation coefficients may be taken as direct indicators of relative level of crop yield sensitivity to road accessibility to corroborate our earlier findings about relationship between yield sensitivity and road transport intensity of the corresponding agro-products.

The following table reveals the ranking of the yield sensitivity of the crops as directly indicated by relative value of rank correlation coefficients and road transport intensity of the corresponding agro-products.

The estimated rank-correlation coefficient between yield sensitivity and road transport necessity of the crops is found to be +0.86. It is with positive sign and found statistically significant at .05 level of significance. It corroborates our earlier inference that inter-crop variation in yield-sensitivity is a direct function of degree of road transport necessity of the crops.
<table>
<thead>
<tr>
<th>Crop</th>
<th>Rank-correlation coefficients of average physical yield and Road indices.</th>
<th>Degree of Road transport necessities of crops.</th>
<th>Value productivity in Marathwada.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jowar</td>
<td>6</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Bajra</td>
<td>7</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Wheat</td>
<td>5</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Groundnut</td>
<td>4</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Rice</td>
<td>3</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Cotton</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>
The analytical superiority of this exercise lies in the fact that it is based upon more disaggregated district data and analysis of crops individually.

Further, the rank-correlation coefficient between yield sensitivity and value productivity in Marathwada is estimated and it is +0.79a and found statistically significant at .05 level of significance. It shows that average physical yield of high value crops is more sensitive to road accessibility. This can be attributed to the fact that they require more transport intensive inputs like fertilizers and extensive and efficient marketing system.

In the context of relative yield of the crops in Marathwada, we may draw the following inferences.

1) The degree of lower average physical yield is found to be wider in the case of those crops whose yield has strong correlation with accessibility by road namely, cotton, sugar-cane and rice.

ii) The crops that have higher yield as compared to Poona division are the crops whose yield is found with no significant correlation with accessibility by road viz., jowar and bajra.

iii) The positive correlation between yield sensitivity and road transport intensity is corroborated.
(iv) It shows the positive correlation between yield sensitivity and value productivity. This enables us to infer that the greater degree in lower yield of high value crops in Marathwada may be due to low accessibility by road in the region.

These inferences are highly tentative, as from econometric point of view, they suffer from some limitations,

i. The analysis ignores the statistical implications of significant test.

ii. The number of observations is not equal for all crops.

iii. The correlation coefficients may have specification bias.

Hence we must resort to regression analysis.

**REGRESSION ANALYSIS OF ROAD ACCESSIBILITY EFFECT ON AVERAGE PHYSICAL YIELD.**

Average physical yield of the crop is the resultant of multiple factors acting simultaneously like irrigation facilities, road accessibility and regional factors. So the major analytical question is one of separating the effect of road accessibility on the yield of crops from that of other influential factors. Obviously this necessitates resort to multiple regression analysis.

We have selected a few important crops like Jowar, Cotton, Ground-nut and Sugar-cane for regression analysis,
as the total acreage under these crops constitutes 61% of the total cropped area in Marathwada.

We have preferred a cross section analysis based on data at district level owing to important reasons in addition to those mentioned earlier.

1. Our interest is mainly restricted to empirical investigation of regionwise variation in agricultural productivity for which variations found at district level would be quite pertinent.

2. The cross section data tends to reduce the seriousness of the problem of multi-collinearity.

3. The problems of separating seasonal and cyclical fluctuations and trends related to time series data could be avoided.

The data used for regression refers to district level average physical yield of the crop, road indices of the district indicating road densities, the proportion of irrigated acreage to non-irrigated acreage under the corresponding crop in the district. Dummy variables are used to catch the regional effects.

Reference Year for the cross section data is 1962-63.

The log-linear form is chosen as there are probabilities of non-linear functional relationship between

1. Table A 6.5
2. Table A 6.7
dependent variable, that is yield per acre and independent variables like accessibility by road, proportion of irrigated area under crop.

The least square method is used to estimate regression coefficients.

**JOWAR**

We shall try to verify the accessibility effect on average physical yield of jowar by regression analysis.

At the outset, let us say that the average yield of jowar is the function of relative accessibility by road indicated by road indices as expressed in the following function.

\[ Y = e^{aX_1} \]

- \( Y \) = average physical yield in Lbs per acre in the District
- \( X_1 \) = Road indices for district
- \( X_2 \) = Percentage of irrigated acreage under jowar to non-irrigated acreage under it
- \( a \) = Exponential coefficient of \( X_1 \)
- \( c \) = Constant term for intercept

\[ \log Y = a \log X_1 + \log c \]

The estimated equation is

\[ \log Y = 0.2392 \log X_1 + \log 2.3312 \]
The regression coefficient of road indices in the log-linear function was found significant at .05 level of significance. The sign of regression coefficient is positive indicating the positive impact, i.e. stimulating impact on average physical yield of jowar. This regression coefficient with positive sign discards our earlier findings by rank correlation analysis that there is no positive influence on yield of per acre jowar.

The weakness of this regression equation is very poor goodness of fit, as \( R^2 = 0.21 \)

The probable objection would be that regression coefficient of road indices might have absorbed the stimulating effect of irrigation on the yield owing to probable co-linearity. To avoid this objection, let us add one more important variable viz the proportion of irrigated acreage under jowar to the non irrigated acreage under it in the district. So,

\[
Y = cx_1^a x_2^b \]

\[
\log Y = a \log x_1 + b \log x_2 + \log c
\]

The estimated multiple regression equation is

\[
\log Y = 0.2964 \log x_1 - 0.197 \log x_2 + \log 2.1435
\]

Even after introducing proportion of irrigated land under jowar in the district, as the additional explanatory
variable the regression coefficient of road index has retained its positive sign with statistical significance at .05 level indicating the stimulating impact of road accessibility on yield of jowar after eliminating the effect of irrigation.

Unexpectedly, the regression coefficient of irrigation has negative sign with no statistical significance at .05 level of significance. This may probably be attributed to weakness of cross-sectional data in regard to revealing the positive irrigation effect on yield owing to allocation of greater proportion of inferior irrigated land to jowar in irrigated area as compared to that in non-irrigated area.

This multiple regression equation has not improved the explanatory power as the value of $R^2$ did not increase to a greater extent. Further the question of high yield of jowar in Marathwada inspite of paucity of roads in the region remains unanswerable. For that, we shall introduce the dummy variable to catch the regional effects. As the effect of irrigation has not emerged statistically significant, the irrigation variable will be dropped.

$$\log Y = a \log X_1 + d(D \log X_3) + \log c.$$  

- $D = 1$ for districts in Marathwada.
- $D = 0$ for non Marathwada districts.
- $d$ = regression coefficient for D dummy variable.
The estimated equation is
\[ \log Y = 0.5999 \log X_1 + 0.1829 \log X_3 + \log 1.4734 \]
\[ R^2 = 0.4566 \]

The regression coefficients of road indices and dummy variable for road indices in the districts of Marathwada are found to be statistically significant at .05 level of significance and also \( R^2 \) is found significant at .01 level of significance.

The coefficient of road indices has retained its positive sign even after introducing dummy variable for regional factors. As anticipated the sign of coefficient of dummy variable for Marathwada emerged with positive sign indicating higher marginal impact of road accessibility on Jowar yield owing to regional factors, probably superior land assured and an adequate rain in the region.

The estimated separate equation for Marathwada is-
\[ \log Y = 0.7828 \log X_1 + \log 1.4737 \]
\[ Y = 29.75 X_1^{0.7828} \]

The following is the estimated regression equation for districts in the regions other than Marathwada.
\[ \log Y = 0.5999 \log X_1 + \log 1.4734 \]
\[ Y = 29.75 \times 1.5999 \]

This equation has explained the probable reason for higher yield of jowar in Marathwada inspite of low road density. The higher yield does not indicate the absence of influence of road accessibility but the comparative superiority of land in Marathwada.

These estimated regression equations substantiate the anticipated stimulating road accessibility effects on average physical yield of jowar, even after eliminating the effects of irrigation and regional factors on yield of jowar.
We find that in Marathwada acreage under cotton a cash crop, is very high but the per acre yield of cotton is very low as compared to that in other regions in the State. This may be attributed to lower percentage of irrigated acreage under the crop and the lower road density in the region.

The regression analysis has been attempted to verify individual road accessibility effect on per acre yield of cotton in the district. Let us take a simple hypothesis that cotton yield at district level has sensitivity to road accessibility indicated by road index. So the regression equation in the non-linear form becomes as

\[ Y = cX_1^a \]

\( Y = \) average physical yield of cotton in the district.

\( X_1 = \) road indices of district.

\( c = \) constant term

\( a = \) exponential coefficient for \( X_1 \).

In the log-linear form

\[ \log Y = a \log X_1 + \log c \]

The estimated regression equation

\[ \log Y = 1.1196 \log X_1 + \log 0.1808 \]

\[ Y = \frac{X_1^{1.1196}}{1.1576} \]

\( R^2 = 0.7232 \)
The estimated regression coefficient of road indices is found statistically significant at .05 level with positive sign. It indicates the positive effect of road accessibility on average physical yield of cotton.

The value of $R^2$ is 0.73 indicating fairly satisfactory goodness of fit. The equation substantiates that the lower average yield of cotton in the districts of Marathwada may be attributed to lower densities of road facilities in the same districts.

The estimated equation with only one explanatory variable of road indices may be statistically significant, but we cannot ignore the possibility of specification error owing to the effect of collinear variable i.e. percentage irrigated acreage under cotton in the district.

We may now attempt multiple regression with additional explanatory variable of percentage of irrigated acreage to non-irrigated acreage under cotton in the district.

$$Y = cX_1^a \times X_2^b$$

$X_2 = \frac{\text{percentage of irrigated acreage under cotton in the district}}{\text{non-irrigated acreage under cotton in the district}}$

$b = \text{exponential coefficient of } X_2$
\[ \log Y = a \log X_1 + b \log X_2 + \log c \]

The estimated equation is as follows.

\[ \log Y = 0.6385 \log X_1 + 0.1086 \log X_2 + \log 0.6617 \]

\[ R^2 = 0.8937 \]

\[ Y = 4.533 X_1^{0.6385} X_2^{0.0825} \]

Both regression coefficients are found statistically significant at .01 level of significance.

We can interpret from the fitted equation that there is a stimulating effect of road accessibility on average yield of cotton with a positive impact of irrigation. This implies that the variation in average yield of cotton is positively related to variation in road accessibility even after eliminating irrigation effect on the yield.

The lower yield in Marathwada of cotton can be attributed to lower level of road accessibility in the region.

The explanatory power of the regression equation has been increased from 72 per cent to 90 per cent as value of \( R^2 \) is found 0.8937.

Analysis of variance indicates that 41 per cent variation in the average physical yield of cotton can be attributed to variation in road density in the districts and 49 per cent variation to variation
in percentage of irrigated acreage under cotton to non-irrigated acreage under the same.
ROAD ACCESSIBILITY EFFECT ON THE YIELD OF GROUNDNUT:

Let us now analyse the effect of road accessibility on the average physical yield of groundnut.

At first, simple regression is to be attempted in non-linear functional form, assuming that average yield of the groundnut is function of road accessibility in the district.

\[ Y = \text{Average physical yield of groundnut in the district} \]
\[ X_1 = \text{Road indices for the district} \]
\[ a = \text{Exponential coefficient of } X_1 \]
\[ c = \text{Constant terms.} \]
\[ X_2 = \text{Percentage of irrigated to non-irrigated acreage under groundnut in the district} \]
\[ b = \text{Exponential coefficient of } X_2. \]

\[ Y = cx^{a_1} \]

In the log-linear form
\[ \log Y = a \log X_1 + \log c \]
The estimated equation is
\[ \log Y = 0.76 \log X_1 + \log 1.2314 \]
\[ Y_2 = 17.04 X_1^{0.76} \]
\[ R^2 = 0.5416 \]
\[ N = 21 \]
\[ \log Y = 0.7063 \log x_1 + 0.3141 \log x_2 + \log 1.2972 \]

\[ R^2 = 0.6930 \quad \text{i.e.} \quad Y = x_1^{0.7063} \cdot x_2^{0.3141} \]

Both regression coefficients emerged significant at .05 level of significance, indicating positive impact of road accessibility and irrigation on the average physical yield of groundnut in the district.

The merit of this equation with two variables lies in the fact that it has separated the effect on the yield.

The explanatory power of the regression function has increased from 54\% to about 70 per cent as \( R^2 \) increased from .54 to 0.6930 by adding the irrigation variable.

Further, it would be interesting to know whether regional factors have exerted influence on the average yield in the districts. The dummy variable is to be introduced to catch and to separate the regional effects on average yield of the groundnut. The dummy variable is used for regression coefficient of road indices in the districts. So the regression equation takes the following form.

\[ \log Y = a \log x_1 + b \log x_2 + d \cdot (D \cdot \log x_1) \]

- \( D = 1 \) for districts in Marathwada
- \( D = 0 \) for non-Marathwada districts
- \( d \) = regression coefficient for dummy variable.
The estimated equation indicates that there is an encouraging impact of accessibility by road upon the average physical yield of groundnut, as the regression coefficient has been found statistically significant at .05 level with positive sign. $R^2$ is also found statistically significant at .05 level.

It reveals the empirical evidence for the contention that interdistrict variation in the average physical yield of the groundnut can be attributed to the variation in road facilities in the districts.

This regression equation has low explanatory power as value of $R^2$ is found only equal to .54.

Further, the regression coefficient for road indices may suffer from specification bias, as we have left out important variable, namely proportion of irrigated acreage under groundnut in the district. So we resort to multiple regression equation explaining that the average physical yield of groundnut is a function of road accessibility and percentage of irrigated acreage to the non-irrigated acreage under groundnut in the districts.

$$Y = cX_1^a X_2^b$$

$$\log Y = a \log X_1 + b \log X_2 + \log c.$$
\[ \log Y = 0.7063 \log x_1 + 0.3141 \log x_2 + \log 1.2972 \]

\[ R^2 = 0.6980 \quad i.e. \quad Y = x_1^{0.7063} \cdot x_2^{0.3141} \]

Both regression coefficients emerged significant at .05 level of significance, indicating positive impact of road accessibility and irrigation on the average physical yield of groundnut in the district.

The merit of this equation with two variables lies in the fact that it has separated the effect on the yield.

The explanatory power of the regression function has increased from 54% to about 70 per cent as \( R^2 \) increased from .54 to 0.6980 by adding the irrigation variable.

Further, it would be interesting to know whether regional factors have exerted influence on the average yield in the districts. The dummy variable is to be introduced to catch and to separate the regional effects on average yield of the groundnut. The dummy variable is used for regression coefficient of road indices in the districts. So the regression equation takes the following form.

\[ \log Y = a \log x_1 + b \log x_2 + d (D \log x_1) \]

- \( D = 1 \) for districts in Marathwada
- \( D = 0 \) for non-Marathwada districts
- \( d = \) regression coefficient for dummy variable.
The estimated regression equation with dummy variable -

\[ \log Y = 1.1173 \log X_1 + 0.3353 \log X_2 + 0.1603 \log X_3 + \log 0.4355 \]

\[ R^2 = 0.9117 \quad (\log X_3 = D \cdot \log X_1) \]

The regression coefficient for dummy variable for districts in Marathwada region has been found statistically significant at level - with positive sign thereby indicating that there would be a higher marginal impact of road accessibility on average yield of groundnut in this region due to regional factors like fertility of land and adequate and assured rain.

So also regression coefficient of proportion of irrigated acreage has retained its positive sign having statistical significance.

The value of coefficient of determination \((R^2)\) has been found 0.9117 indicating highly satisfactory goodness of fit.

Thus, estimated multiple regression equation substantiates the stimulating road accessibility effect on per acre yield of the groundnut even after eliminating effect of irrigation and regional factors.

In the light of this equation, the lower average physical yield in the sdistricts of Marathwada can be explained in the terms of low road density in the region though soil in Marathwada can be regarded superior for groundnut.
We can have two regression equations one for districts in Marathwada and the other for non-Marathwada districts.

The regression equation for districts in Marathwada

$$\log Y = 1.2731 \log X_1 + 0.3853 \log X_2 + \log 0.4255$$

The regression equation for districts in the state other than districts in Marathwada.

$$\log y = 1.1178 \log X_1 + 0.3853 \log X_2 + \log 0.4255$$

It enables us to anticipate the higher per acre yield in the region by providing more and more roads in the region.

**THE IMPACT OF ROAD ACCESSIBILITY ON SUGARCANE YIELD**

The average physical yield of sugarcane has been found relatively lower in the districts in Marathwada. Our purpose is to investigate quantitatively how far the paucity of roads in the districts in Marathwada is responsible for lower yield in this region.

Let us, at the outset, analyse the impact of road accessibility on average yield of sugarcane with only one explanatory variable i.e. road index in the district.

The regression equation is to be taken in the non-linear form as -

$$Y = cX_1^a$$
In the log-linear form

\[ \log Y = \log x_1 + \log c. \]

The estimated equation is

\[ \text{Log } Y = 0.4023 \log x_1 + \log 2.8144 \]

\[ R^2 = 0.2136 \]

\[ N = 21 \]

\( Y \) = Average physical yield of sugarcane in the district.

\( x_1 \) = Road index for the district.

\( a \) = Exponential parameter for \( x_1 \).

\( c \) = Constant.

The regression coefficient of road index has been found statistically significant at .05 level of significance with positive sign indicating encouraging impact on average physical yield of sugarcane in the districts. The lower average yield of sugarcane in Marathwada can be regarded as a result of the inadequate road facilities in the region.

The weakness of this estimated equation is a very poor goodness of fit as \( R^2 \) is found to be equal to only 0.21.

The lower value of \( R^2 \) may be owing to omission of some important explanatory variable. Since the sugarcane is cultivated only when adequate water supply is assured, the
distinction between irrigated and non-irrigated acreage has no analytical relevance. We, therefore, think that the regional factors might have influenced the variation in average physical yield of sugarcane in the districts. It has been reported that the Nagpur Division is not suitable for sugarcane production owing to natural factors like soil conditions¹.

This prior knowledge induces us to use dummy variable for districts in the Nagpur Division anticipating that average yield of sugarcane in the districts of Nagpur Division would be less owing to the deficiency in soil conditions ceteris paribus.

The dummy variable for constant term in the log-linear form has been used with reference to the districts in Nagpur Division, but it has not been found statistically significant even at .05 level of significance. So the dummy variable with reference to the regression coefficient of road index in the districts in Nagpur Division is used to catch the regional influences on yield. Hence our log-linear regression equation becomes,

¹. Besides, the crop patterns under irrigation are apt to differ from region to region depending upon soil conditions. Thus, Deccan has excellent advantages for growing sugarcane wherever water supply is assured, while areas like Chandrapur and Bhandara are better suited for paddy. NCAER - Techno-economic survey of Maharashtra - op. cit. p. 25.
\[ \log Y = a \log x_1 + d (D \log x_1) + \log c. \]

\[ D = 1 \text{ for districts in Nagpur Division} \]
\[ D = 0 \text{ for districts other than those in Nagpur Division} \]

The estimated multiple regression equation is:

\[ \log Y = 0.3044 \log x_1 - 1.459 \log x_3 + \log 3.0367 \]

\[ R^2 = 0.6361 \]

\[ \log x_3 = D \log x_1. \]

\[ sy_{x_1x_3} = 0.1249 \]

The regression coefficient of dummy variable with reference to road indices for districts in the Nagpur Division has been found statistically significant at .01 level of significance with negative sign as anticipated. The negative sign of regression coefficient of dummy variable indicates that the rate at which road accessibility tends to influence average physical yield in the districts of Nagpur Division would be comparatively lower, conversely it indicates higher marginal rate of influence by road accessibility on average physical yield of the sugarcane in Marathwada as well as in West Maharashtra.

We can have separate regression equations for different regions as follows:

Regression equation for Marathwada and West Maharashtra

\[ \log Y = 0.3044 \log x_1 + \log 2.0367 \]
Regression equation for Nagpur Division -

\[ \log Y = 0.1635 \log x_1 + \log 3.0967 \]

Thus, regression coefficient of road index free from regional influences as emerged statistically significant with a positive sign. It substantiates the anticipated positive and encouraging effect of road accessibility on average yield of sugarcane. It also follows that the lower yield in Marathwada can be attributed to paucity of roads in the region. This indicates the ardent need for more and more roads in the region to enhance the yield of sugarcane.

**THE IMPACT OF ROAD ACCESSIBILITY ON PER ACRE VALUE PRODUCTIVITY.**

We have already discussed the positive and stimulating effect of road accessibility on the average physical productivity in the case of jowar, groundnut, cotton and sugarcane. The analysis of the effect of road accessibility on the average physical yield ignores the aspect of value productivity. The average gross value productivity is comprehensive term and is influenced mainly by three factors.

1) Average physical productivity of the crops in the district.

2) Harvest price-level of the crops in the district.

3) The composition of the crops in the district, i.e. crop-pattern.
Theoretically, we can contemplate the interaction of these factors influencing average gross value productivity.

Paucity of roads tends to cause spatially lower prices of surplus produce in the district, which may result in turn into disincentive to apply required inputs like fertilizers to adequate extent, thereby causing lower average physical yield. Moreover paucity of roads in the region increases the cost of transportation, this cost-push effect of road inaccessibility, further, tends to discourage farmers to apply the modern methods of cultivation, as the application of modern methods of cultivation requires quick and timely supply of different inputs to the farm site. This is not possible in the region suffering from paucity of roads. Briefly, cost-push effect and price depressing effect of inadequate road accessibility lead to lower gross value productivity in the region, though prices of agricultural produce to be imported in the region would be high but the proportion of these produce would be negligible and so it would not have any net effect on the gross value productivity.

So far as regions in Maharashtra State, including Marathwada, are concerned, our empirical analysis has indicated that inter-district variation in road accessibility has no influence on the crop pattern. Further, no significant distinction has been revealed in regard to crop pattern between the regions in the state. Hence the lower gross value
productivity may be attributed to lower prices and lower average physical productivity of majority crops in the region.

It may be urged that average gross value productivity would be influenced by two important factors i.e. road accessibility in the district and percentage acreage under sugarcane to total acreage under crops.

For our analysis, the choice of referring to percentage acreage under sugarcane has a special significance because it is mainly a high value cash crop as compared to many other commercial crops, further, it represents the relative magnitude of irrigated land with relatively higher water intensity. Moreover, in all probability, efficient cultivation is likely to be practised in areas concentrating more on sugarcane crop for the simple reason that the financial position of cultivators taking sugarcane crop is much better and as such they can afford better cultivation practices.

There is no necessity of elaborated explanation for probable positive influence of road accessibility on the average value productivity. The regression analysis referring to the average physical yield as a function of road accessibility with other relevant factors bears out the positive effect on average physical yield, further positive encouraging road accessibility effect on the price of the surplus agricultural produce can be anticipated so it enables us to say that there would be a positive impact of road accessibility on gross value productivity.
Owing to co-linearity and interaction, both these effects would be captured by regression coefficient of road indices in the districts.

So our linear regression equation states that average gross value productivity in the districts in Maharashtra is a function of road indices representing degree of road accessibility and index of acreage under sugarcane in the districts the sugarcane index for the district has been calculated on the basis of average sugarcane acreage at district in the State = 100. Data is presented in the table

\[ Y = aX_1 + bX_2 + c \]

\( Y = \text{Average gross value productivity per acre in the districts.} \)

\( X_1 = \text{Road indices in the districts.} \)

\( X_2 = \text{Index of acreage under of sugarcane to total cropped area.} \)

\( c = \text{Constant term} \)

\( a \) and \( b = \text{regression coefficients for road indices and index of sugarcane acreage in the district as explained earlier respectively.} \)

The estimated linear regression equation is as follows.

\[ Y = 0.3003 \ X_1 + 0.3681 \ X_2 + 88.92 \]

\[ R^2 = 0.8860 \]
The regression coefficient of road index has been found positive and statistically significant at .01 level of significance and lends support to the contention that road accessibility tends to exert a positive and stimulating effect on average gross value productivity per acre. Moreover, by taking the important explanatory variable, that is sugar-cane acreage index, with road index in the multiple regression analysis the road accessibility effect has been separated from the effect by other relevant factor like proportion of sugar-cane and irrigated acreage in the district as explained earlier. This has reduced the specification bias in the equation. The value of $R^2$ is found 0.39 indicating a fairly satisfactory goodness of fit. Thus the lower average gross value productivity per acre in Marathwada can be attributed to paucity of road facilities in the region.
6.4

ACREAGE EXTENSION IMPACT OF ROAD ACCESSIBILITY IN MARATHWADA.

As it has been explained that increasing road accessibility would tend to extend acreage under cultivation. During last thirty years, the Marathwada region has experienced extension of the net cropped area. The proportion of net cropped area to the total geographical area was already as high as 71 percent in 1941 and it increased to 75 percent by 1971. It can be attributed to growing pressure of rural population and to increasing road density in the region. This time series data is consistent to theoretically conceived positive acreage extension impact of road accessibility, but the inter-regional comparison does not support it. Hence it necessitates the deeper cross section analysis.

The Cross Section Analysis.

The positive acreage extension impact of road accessibility prompts us to expect that owing to paucity of roads the proportion of cultivated land would be comparatively lower as compared to the same in other high road density region of West Maharashtra; but statistical data contradicts this anticipation
as the proportion of cultivated land to total land area appears to be higher in Marathwada as compared to other regions. The contradictory empirical evidence suggests the possibility of regional factors concealing the positive acreage extension impact of road accessibility. This possibility justifies the regression analysis based on district level data. It would not be necessary to say that positive acreage extension impact of road accessibility implies reduction in cultivable waste in the area. It allows us to formulate the hypothesis that proportion of cultivable waste in the districts would be inverse function of road density in the districts, ceteris paribus

\[ Y = a + bx \]

\( Y = \) Percentage of cultivable waste in the district.
\( X = \) Road density index.
\( b = \) regression coefficient of \( x \)
\( a = \) intercept.

Regression analysis on cross section data-
Regression analysis has been attempted to test the above said hypothesis. On the basis of district data of percentage of cultivable waste in the district in Marathwada, West Maharashtra and Vidarbha.
The inclusion of districts from other two regions, viz. West Maharashtra and Vidarbha has become necessary owing to two reasons; for inter-regional comparisons, and for sufficient number of degrees of freedom.

The cultivable waste in the district is estimated by deducting area under forest, land not available for cultivation, and fallow land from total area.

The road density index for the district has been used to indicate relative level of road accessibility in the given district. The cross sectional data refers to year 1962-63 (Table 1). At the outset, the regression coefficient of road density index (x) has been estimated by taking into consideration districts from Marathwada and West Maharashtra excluding Kolhapur. The Kolhapur district has been eliminated from the analysis owing to its distinctive position; maximum percentage of cultivable waste despite high road density.

The estimated regression coefficient emerged with negative sign as anticipated but not found satisfactorily significant even at 0.05 level of significance.

1 Table A 6.6
This may be owing to weak influence of road density on acreage extension and also owing to smaller number of observation. To increase the degrees of freedom, additional districts from Vidarbha region excluding Chandrapur district are added for analysis. The estimated regression equation is as follows:

\[
Y = 15.6170 - 0.06 x^{1.21}
\]

\[R^2 = 0.21\]

The regression coefficient of road density index emerged with negative sign substantiating the theoretical argument that percentage of cultivable waste in the district would be inverse function of level of road accessibility. The regression coefficient emerged statistically significant at .03 level of significance. Hence inter-district variation in proportion of cultivable waste can be attributed to variation in road density. The goodness of fit is not satisfactory statistically as coefficient of determination \((R^2 = .21)\) is very low. Nevertheless exercise supports the positive acreage extension impact of road accessibility. We can hope that
more and more roads in Marathwada region would encourage additional acreage under cultivation. 

_Acreage extension impact and Marathwada._

It would be highly pertinent to verify the possibility of different intensity of road-accessibility effect on acreage extension in Marathwada as compared to same in other regions i.e. West Maharashatra and Vidarbha owing to regional factors. The dummy variable \( X_1 \) to catch variation in respect of regression coefficient of road density index in district of Marathwada is introduced and the following regression equation is estimated.

\[
Y = a + bX_1 + dX_2
\]

---

1. \( X_1 \) for district in Marathwada.

Where \( X_2 = \)

- 0. \( X_1 \) for district in West Maharashatra and Vidarbha.

Estimated regression equation

\[
Y = -9.934X_1 - 0.008X_2 + 99.3867
\]

\( F \) test indicates that regression coefficient of dummy variable for road density index in the districts of Marathwada is not statistically significant even at .05 level of significance.

It demonstrates no distinct road accessibility effect on acreage extension in Marathwada.
ROAD ACCESSIBILITY EFFECT ON MARKET DENSITY OF AGRO-PRODUCE.

It can be contemplated that relatively greater road accessibility would tend to encourage the yield of high transport intensive agro-products. This has been empirically verified in the context of relationship between the inter-crop yield sensitivity to accessibility and transport intensity of the individual agro-crop. This transport intensity of agro-crop has ignored the relative weights is of the different products. Now, we shall try to identify whether there is any positive impact of the road accessibility upon the products having relatively high weight per square km. This weight intensity per square km, can be regarded as a function of absolute weight, marketable surplus. We can contemplate that this weight intensity would be direct function of road accessibility as it would enhance the average physical productivity of the products having high weightage intensity, and further greater proportion of acreage would be allocated to the products having high weightage intensity. This may be termed as market-density of agro-products per square kilomtare.
On the basis of the proportion of acreage under different crops and its estimated marketable surplus in the district, we can verify the above mentioned effect in the district. The marketable surplus in metric tons per sq.km. of cropped area in the district can be taken as a dependent variable that is expected to be influenced by road accessibility in the district and other relevant and important determinants. So, our regression equation will be as follows.

\[ Y = aX_1 + bX_2 + c \]

\( Y \) = marketable surplus in metric tons per sq.km. of cropped area in the district.

\( X_1 \) = road density in Kms. per 1000 Sq.Kms.

\( X_2 \) = percentage of irrigated acreage to non-irrigated acreage in the district.

\( a \) and \( b \) = regression coefficient for \( X_1 \) and \( X_2 \) respectively.

The estimated regression equation is

\[ Y = 0.0547 \times X_1 + 0.2643 \times X_2 + 8.95 \]

\( R^2 = 0.23 \)

We have estimated the regression equation to verify the impact of road accessibility on the
marketable surplus density by taking into account two important explanatory variables viz. road density and irrigation proportion in the districts of Marathwada and West Maharashtra.

The regression coefficient of \( X_1 \) and \( X_2 \) emerged with positive sign as anticipated but not found statistically significant even at 0.05 level of significance. Thus this equation failed to substantiate our theoretical assertion that road accessibility tends to provide stimulating impact on the marketable surplus density indicating weight intensity of the agro-area.

The observation of data (Table 1) reveals the distinctive position of Kolhapur district in the cross-section series owing to special features like adequate and assured rain, high proportion of acreage under irrigated water by canals, and relatively heavy acreage under sugar-cane. Hence it would be worthwhile to attempt again the regression analysis excluding the Kolhapur district from cross-section data. The estimated regression equation with the same explanatory variables excludes Kolhapur district is as follows.

\[ 1 = Table A 6, II \]
The regression coefficient of road accessibility emerges statistically significant at .05 level substantiating the theoretical assertion. Regression coefficient of irrigation has positive sign but surprisingly not found statistically significant, indicating no influence of irrigation on market surplus density in the district. Thus it indicates the positive impact of road accessibility on the average physical yield of agro-products having relatively higher weight and high degree of market orientation, further it is indirect indication for the higher proportion of acreage under agro-products with heavy weight and greater degree of marketability.

Lower market surplus density in the district of Marathwada can be attributed to lower road accessibility in the region.

Let us, now identify the influence of regional factors on the market surplus density. We shall try to catch the influence of regional factor by introducing dummy variable for the intercept term, differentiating districts in Marathwada and districts in the region other than Marathwada. As the regression coefficient of irrigation has not emerged statistically significant, irrigation variable can be dropped from the analysis.
So now the multiple regression equation contains the two explanatory variable viz. road density and dummy variable. The regression equation to be estimated is -

\[ Y = aX_1 + dX_4 + C \quad \text{dummy variable } X_4 = 1 \text{ for districts in Marathwada} 
\]
\[ X_4 = 0 \text{ for districts in the regions other than Marathwada}. \]

The estimated regression equation is -

\[ Y = 0.0207 X_1 - 1.8995 X_4 + 16.1787 \]

\[ R^2 = .4498 \quad \quad F \text{ for } X_1 = \]

\[ F \text{ for } X_4 = \]

The estimated regression coefficient of dummy variable for intercept is found with negative sign as expected but it is not statistically significant at .05 level. It shows that factors other than road density has no regional impact on the market surplus density.

**Note on data used for the regression analysis of market surplus density:**

The data with some modifications is taken from article published in "Economic and Political Weekly" Vol. VII No. 51, dated 16th December 1972 entitled "Demand for Roads in Maharashtra: A cross Section Study" by M.V. Nadkarni and A.B. Deogirikar.1

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We have modification in the case of marketable surplus. In article mentioned above marketable surplus \( X_3 \) derived as metric tons per sq. km. of area. We have converted these marketable surplus per sq. km. area in districts into marketable surplus per sq. km. cropped area only using conversion ratio based on cropped area in the district to the total area of the district for the year 1963-64 as variation between (63-68) in the cropped area is found negligible.

The figures in the articles of the marketable surplus are based on the estimation of agricultural output and the proportion of marketable surplus as explained in the article, "This (Marketable surplus) is derived from estimates of all-India proportions for selected crops as given by the Directorate of Marketing, Government of India". These estimates (in percentage) are as follows: rice 31.4; wheat 32.7; jowar 23.3; maize 24.3; gram 44.3; groundnut 84.0; cotton 92.0; gur 80.0. For other crops, we had to assume certain proportions based on a reasonable guess in consultation with officials of the Agriculture Department and Directorate of Economics and Statistics. These 'guessedimate' proportions are: other cereals 24.0; other pulses 44.0 other oil seeds 90.90; tobacco 90.0; potatoes 84.0; chillies 84.0; onions 84.0; mangoes 50.0; bananas 70.0. Since proportions of marketed surplus of crops

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can vary from district to district, it would have been ideal to have district-wise proportions. Due to paucity of data, we have used the all-India proportions. The estimated marketable surplus per sq. km. in metric tons is given in Table No. A-6.5.

The road density \( X_1 \) is also taken from the same article as road length in km. per 1000 sq. km. area in 1967-68 excluding municipal roads as given in Table No. A-6.5.
6.6.

**ISSUE OF IDENTIFICATION**

We have verified the stimulating impact of road accessibility indicated by road density on average physical yield of major crops, gross value productivity per acre and marketable surplus density of agro-products. The serious econometric objection can be raised against these inferences as a case of identification issue. It can be questioned on the basis of the possibility that the road density would be the function of agricultural productivity in the region. There may be more roads because the agro-productivity is high. Thus the estimated equation may have simultaneity bias.

Fortunately, we could get the convincing empirical evidence indicating that agricultural productivity has no statistically significant influence on road density in the districts of Maharashtra State. This has been evidenced in the multiple regression analysis which takes the road length in kilometres per 1000 sq. km. of area in the year 1967-68, as dependent variable and population per square kilometre of area \( (X_1) \), railway length in kilometres per 1000 square km. of area \( (X_2) \), total agricultural output in metric tonnes per square km. of area \( (X_3) \), and marketable surplus in metric tonnes per sq. km. of area \( (X_4) \), as explanatory variables with some other additional variables.

While discussing the separate influences of explanatory variable it is stated. We find that density of population
(\(X_1\)) emerges as the statistically significant variable (at 35 percent level) in the equations. Rail length (\(X_4\)) also emerges as equally significant and it has the expected negative sign showing the relationship of substitution with roads. The remaining variables, however, fail to emerge as statistically significant, inspite of the variety of models or equations fitted."

Further it is stated\(^2\) "The influence of agriculture also does not emerge as a separate significant factor, eventhough its influence was tested in several ways. In Equation I, total agricultural output (\(X_3\)) is used; in Equation II, it was split up into two parts foodgrains (\(X_{3A}\)) and the rest (\(X_{3B}\)), both taken as separate variables, while omitting \(X_2\) (which is significantly correlated with \(X_1\)). In Equation III, marketable surplus (\(X_3\)) is used; in Equation IV, the same is used as dummy variable (\(X_{3D}\)) representing districts with higher (or lower) than average marketable surplus; in Equation V, the same model is fitted but omitting (\(X_{2D}\)) which was found to be statistically very insignificant. In Equation VI, presence of non-linearity or second degree relationship is tested for total agricultural output; the hypothesis here was that the curve relating need for road with agricultural output would rise at first, and then tend to fall. Though the expected signs emerged here, the co-efficients were not

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\(^2\) Ibid. pp 2466-67
statistically significant. In Equation VII, total agricultural output is taken as dummy variable \( X_{3D} \). In none of these equations, does the influence of agriculture emerge as a significant factor.¹

Thus there is hardly any need of additional empirical analysis for convincing that road density in the district is not a function of agricultural productivity and market surplus density as total agricultural output in metric tonnes per square km. of area and marketable surplus in metric tonnes per sq. km. of area are positively correlated with average physical yield of individual crops on which the influence of road density in the district is estimated.

Thus our inferences about the accessibility effect value on average physical yield of major crops, gross value. Productivity per acre and market surplus density can be claimed as inferences from identified equations.

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