

## SPATIAL ORGANIZATION OF AGRICULTURE IN A NORTH INDIAN VILLAGE A DEDUCTIVE MODEL

JHUJAR SINGH, Chandigarh

**ABSTRACT:** Spatial reality can be expressed more explicitly and meaningfully through models. This paper develops a deductive model of the spatial organization of crops in a north Indian village. Descriptive modelling of the spatial location of agricultural activity in selected villages have been attempted earlier too. But the deductive logic on which the present model has been based is a special feature of this study. Since north India is characterized with two distinct crop seasons; a separate model for each season has been formulated. Finally, both have been integrated into a modified model which has been tested by taking a case study of a village.

Theory is the soul of a subject. It is the light of a discipline. Its development is of vital significance for the promotion of any branch of scientific knowledge dealing with reality. Unfortunately, geography trailed behind in comparison with other social sciences, such as economics, sociology and psychology in this regard. The geographers of the developed world realized this fact earlier and oriented their researches towards theory building since the middle of this century. Most of the Indian geographers, however, are still engaged in the description and interpretation of naive geographic patterns emanating from the mapping of secondary data. Theory building seems to be their remote concern. In the context of a short history of Indian Geography, such a state of the subject is understandable. But the sooner this phase ends the better it is. There is an urgent need to orient geographic research in India towards the development of theory in the Indian context (Raza, 1981; Sopher, 1973). The present paper is a

modest attempt in this direction. The purpose of this study is to propose a deductive model of the spatial organization of agriculture in a north Indian village.

The economic location theory, to a large extent is based on the distance-cost relationship. The classical model postulated by Von Thunen in the context of city and its surrounding area has also been based on the same economic principle (Thunen, 1826). Distance plays a prominent role in the spatial organization of crops in a village too (Blaikie, 1971; Chisholm, 1966; Prothero, 1957; Singh and Singh, 1979; Singh, 1976; Stevens and Lee, 1979; Symons, 1972). In this case, among other factors, the distance from the settlement, the source of water and the approach road, and the associated cost of movement of men and materials determine the location of crops. The deductive theory forwarded in this paper has been based on the aforesaid findings and empirical observations in the area.

### The Theory

The crops grown in a north Indian village will organize themselves in an order of zones around its settlement provided it fulfils the following conditions:

1. The settlement (nucleated type) is located in the centre of the village from where the land gradually slopes down in all directions.

2. The soil is homogeneous in inherent properties but decline in manageable fertility with increase in distance from the settlement.

3. It has inadequate, unreliable and seasonally concentrated rainfall. Therefore, the performance of a crop depends upon irrigation.

4. The landholdings in the village are of the same size and extend in the form of sectors from the settlement up to the periphery.

5. The village roads run radially along the boundaries of each landholding.

6. The tubewells are the only source of irrigation. All of them have been installed within the settlement from where water flows to the fields through open and unlined channels under the force of gravity.

7. With the available knowledge, experience and ability at their command, the farmers try to use their resources rationally.

Under these assumptions, all those crops which require more water, are intensive in nature, bring higher net revenue and need greater time and energy in transportation from the fields to the settlement after harvest, will occupy the inner zones.

(i) The greater are the water requirements of a crop the closer it will be located to the source of water. Every time water is taken from a tubewell to the field through an unlined and open channel, some of it is lost in transit by way of seepage, evaporation and leakage. The farther is a field from the source of water the greater will be the loss. In order to reduce its wastage, the farmers will grow more water demanding crops

near the source. (ii) The higher are the capital and labour needs of a crop the closer it will be raised to the settlement. Various inputs, such as fertilizers, manures, insecticides, pesticides and seeds are stored in the settlement and are carried to the fields whenever required. People travel from the settlement daily to the fields for work. Thus, the farther is a field the greater will be the cost of transporting inputs and the travel time. Expenditure on movement multiplies in case an intensive crop is raised far from home. For reducing wasteful expenditure on movement, the farmers will grow more intensive crops near the settlement. (iii) The higher is the net income derived from a crop the closer it will be grown to the settlement. A remunerative crop will preferably be raised on superior soils for increasing income. As richer soils are assumed to be located at the outskirts of the settlement, naturally more lucrative crop will concentrate there. This apart, the farmers will like to grow more paying crops near their homes to keep them under constant vigil. (iv) The greater is the transport cost involved in bringing a harvested crop from a field to the settlement the closer it will be located to it for obvious reasons. This will be more true of subsistence farming. Such a relationship, however, will be weaker in the case of commercial agriculture where most of the agricultural produce is transported directly from the fields to the market.

A specific set of crops is raised in north India. According to the deductive logic stated above, they will organize themselves in an order of zones around the settlement. By taking irrigation needs, capital and labour (human and bullock) inputs, and net income the zonal position of each crop has been worked out with the help of Kendall's ranking coefficient method (Kendall, 1939). A crop with lowest value of the coefficient has the highest rank in the locational hierarchy and thus will be grown adjacent to the settlement. Other crops will

follow in order of their locational positions. Input costs and net returns used for computing ranking coefficients of various crops have been taken from "Comparative Economics of Crops : 1980-81" A report compiled by the Department of Economics and Sociology of Agricultural University, Ludhiana. These figures relate to Punjab and are the recommendations of the University for realizing potential returns under normal weather conditions. The inputs in the case of sugarcane have been reduced to one-half for making them comparable to the seasonal crops.

Winter and summer are the two distinct seasons of north India. Accordingly, it has two crop seasons. The one associated with winter is known as *rabi* and the other coincident with summer is termed as *Kharif*. Thus, a separate model for each crop season has been proposed.

**Rabi Model**

During *rabi* (winter) season, wheat, barley, gram, lentil, oilseeds (mustard, rapeseed, linseed, etc.), clover and vegetables are largely grown in north India. According to their ranking coefficients, they will organize themselves in the following order of zones around the settlement (Table I and Figure 1) :

1. Vegetables
2. Clover
3. Wheat
4. Barley
5. Lentil
6. Oilseeds
7. Gram

Because of their intensive and more profitable nature, vegetables will be grown adjacent to the settlement where soil is comparatively fertile. They may be grown for subsistence or for cash. If vegetables are grown for domestic consumption, this zone will be narrower. If their cultivation is oriented towards the market, this zone will be wider. In the later case, its width will be governed by: (i) the accessibility and connectivity of the village with the market; (ii) frequency and fastness of the transport and; (iii) their demand. This zone will buldge outward along roads for convenience of transport as vegetables are taken to the market generally at the time when other crops stand in the fields. Clover comes next to vegetables in locational position. It may be raised for subsistence or for cash. In latter case, it may be sold directly as such or indirectly through dairy products. If fodder is marketed through dairy products, its association with the settlement will be stronger. The width and shape characteristics of this zone will be guided by the same set of forces as that of the vegetable zone. Wheat will occupy third position in the locational hierarchy. Besides being a prefe-

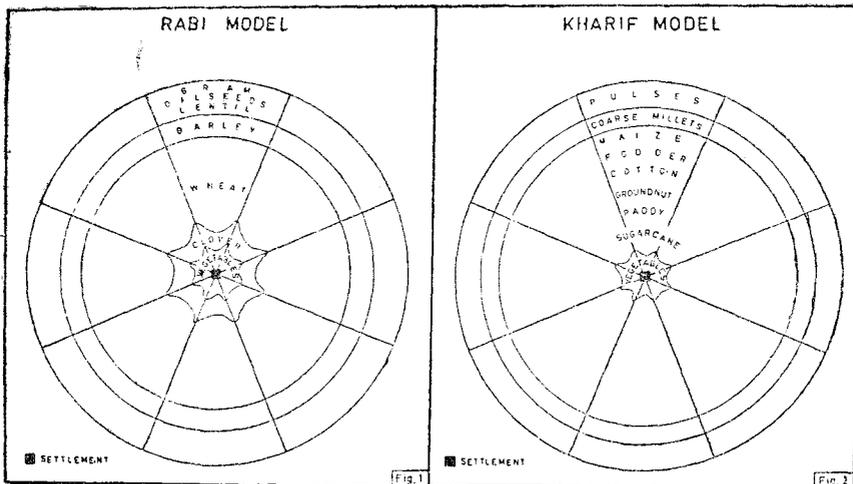


Table I  
Locational Position of Rabi Crops

( Inputs and net returns per hectare )

Crops	Irrigation inputs (in diesel engine hours)	Rank	Capital inputs (in rupees)	Rank	Human labour inputs (in hours)	Rank	Bullock labour inputs (in hours)	Rank	Net Returns (in rupees)	Rank	Ranking coefficient	Locational position
Vegetables	138	2	3887	1	3786	1	420	1	9973	1	1.2	1
Clover	247	1	1616	3	1319	2	366	2	2513	2	2.0	2
Wheat	74	3	1900	2	993	3	227	4	1905	5	3.4	3
Barley	57	4	722	5	487	4	208	5	1641	7	5.0	4
Lentil	25	5	539	7	358	6	326	3	2157	4	5.0	4
Oilseeds	25	5	820	4	452	5	138	7	1804	6	5.4	5
Gram	17	6	699	6	336	7	148	6	2221	3	5.6	6

red cereal it is an outstanding cash crop of winter season. A larger proportion of rabi cropland of north India is devoted to this crop. As a result, wheat zone will be the widest. Barley is a minor crop. It will occupy an intermediate position between more water demanding crops of inner zones and draught resistant crops of the outer zones. Lentil, oilseeds and gram are less intensive, less profitable and have lower water needs than the other crops of the season. Therefore, they will be grown in the peripheral zones. These crops are generally raised for domestic consumption. The situation in semi-dry tracts of north India however, is different. In these areas where physical set up is more favourable, these crops are grown for subsistence as well as for cash.

#### Kharif Model

Paddy, cotton, maize, groundnut, sugarcane, vegetables, pulses, pearl millet, cluster bean and sorghum vulgare are the major crops grown in north India during the *Kharif* season. They will arrange themselves in the following zonal order around the settlement (Table II and Figure 2) :

1. Vegetables
2. Sugarcane
3. Paddy
4. Groundnut
5. Cotton
6. Fodder
7. Maize
8. Pearl millet and cluster bean
9. Pulses.

*Kharif* vegetable zone, like its *rabi* counterpart, will come out next to the settlement. Its width and shape characteristics will also be determined by the same forces. Sugarcane, paddy, groundnut, cotton, fodder and maize, in case all of these are grown, will follow in order. Depending upon the physical, economic and social set up of a village, the area devoted to each one of them will vary. The fodder, which falls at the sixth position, is likely to shift towards the settlement in case it is raised for sale through dairy products. Pearl millet, cluster bean and pulses will be cultivated in the outer zones. These are draught resistant and are less intensive in nature. The net

income generated by them is also comparatively low. Generally, they are grown for domestic consumption. However, they become partly commercial in semi-dry areas where their zones will broaden and those of more water demanding crops will shrink.

The order and width of zones projected in the proposed model may change with time. Due to the change in price structure and demand and the development of high yielding seeds, less remunerative and extensive crops of today may become comparatively more rewarding and intensive tomorrow. This will change the width and reshuffle the order of zones. The boundaries of various crop zones have been drawn arbitrarily. Their objective demarcation is a problem in itself.

#### Modified Model

The validity of a deductive theory depends upon the authenticity of its assumptions. The more its stipulated conditions corroborate reality the greater will be its applicability. In order to assess the authenticity of the proposed theory, a brief review of its assumptions vis-à-vis facts is imperative. Secondly, their scrutiny is fundamental to the modification of the model.

North India is characterized with nucleated type of rural settlements. Most of them are located in the near centre of their respective villages. Rainfall in this part of the country is inadequate, unreliable and seasonally concentrated. As a result, irrigation is essential for uninterrupted growth of plants. The farmers are fairly rational in their location decisions (selection of a field for a crop) as no sensible person would deliberately opt for uneconomic locations. Thus, first, third and seventh assumption of the theory corroborate reality to a great extent. However, others depart notably from the prevailing facts. Landholdings in north India are neither uniform in size nor extend in sectors. Invariably, they are frag-

Table II.  
Locational Position of Kharif Crops

Crops	Irrigation inputs (in diesel engine hours)	Rank	Capital inputs (in rupees)	Rank	Human labour inputs (in hours)	Rank	Bullock labour inputs (in hours)	Rank	Net returns (in rupees)	Rank	Ranking coefficient	Locational position	( Inputs and net returns per hectare )	
													Rank	Rank
Vegetables	185	1	1097	4	2518	1	260	2	12664	1	1.8	1		
Sugarcane	131	2	1325	3	1265	3	274	1	2155	4	2.6	2		
Paddy	185	1	1532	1	1717	2	183	4	2056	5	2.8	3		
Groundnut	74	3	1475	2	1005	5	106	5	2592	2	3.4	4		
Cotton	49	5	1048	5	1062	4	106	5	2582	3	4.4	5		
Fodder	62	4	855	7	796	6	260	2	12	9	5.6	6		
Maize	37	6	751	8	667	7	193	3	1740	7	6.2	7		
Pearl millet and cluster bean	31	7	865	6	657	8	89	7	1221	8	7.2	8		
Pulses	30	8	514	9	598	9	99	6	1883	6	7.6	9		

Table III  
 Cropping Pattern of Village Devinagar  
 Hirasingshwa : 1979-80

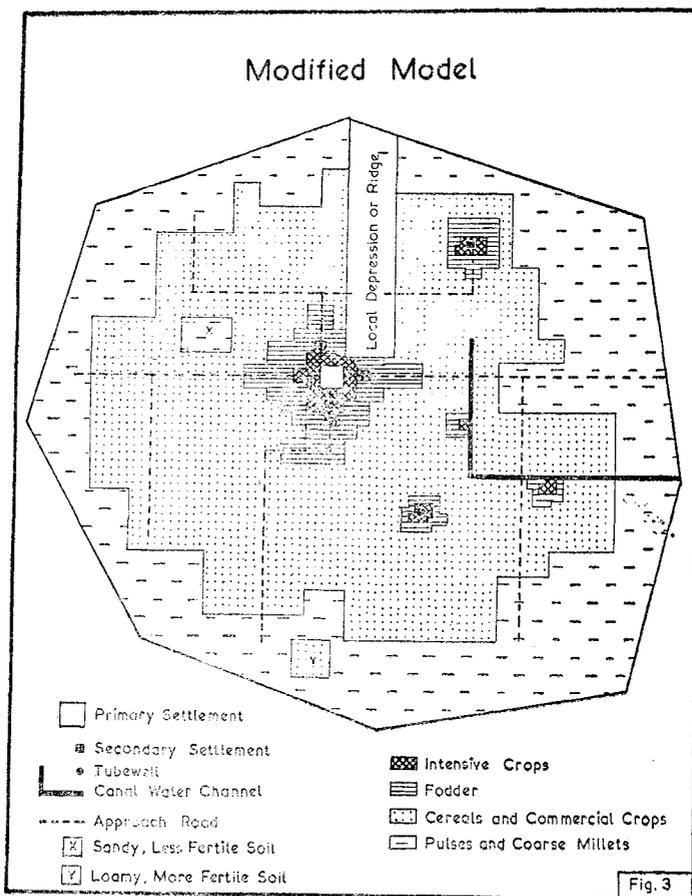
Crops	Percentage area	Crops	Percentage area
<b>Rabi</b>		<b>Kharif</b>	
Wheat	88.0	Paddy	92.2
Clover	4.2	Sorghum	6.2
		vulgare (jowar)	
Lentil	2.7	Vegetables	0.4
Gram	2.2	Catton	0.3
Vegetables	1.0	Sugarcane	0.3
Linseed	0.7	Others	0.6
Sugarcane	0.5		
Others	0.7		

mented into unequal blocks located far and near from the settlement. The farmers install tubewells / pumping sets over their isolated blocks of land. It results in dispersing the sources of water. Thus, irrigation water does not flow from the settlement as stipulated. In a number of villages, canals or both canals and tubewells, provide water for irrigation. The channels of water, of course, are open and unlined. The approach roads circumvent rectangular fields and are not radial. The decline in soil fertility with increase in distance from the settlement is more true of the rainfed villages with unconsolidated landholdings. In this situation, a farmer is likely to hold some fragments of his landholding near the settlement and others far from it. In accordance with the distance-decay principle, he manures the nearer blocks of his land more intensively and manage them more carefully (Ishida, 1972). The situation, however, is different in those villages where landholdings have been consolidated into one or two blocks and irrigation, especially through tubewells, has been adequately developed. In such villages, a farmer who happens to hold land at the periphery, manures and fertilizes it with almost the same intensity as is done by another whose land is located near the sett-

lement. It resulted in equalizing the built up fertility of the soil in all parts of the village to a great extent.

The preceding discussion clearly reveals that some of the assumptions of the theory are far from reality. In the light of prevailing facts, the proposed model needs modification. Under the existing situation, the postulated zonation of agriculture will be true only in the case of larger, less tracterized, rainfed and unconsolidated villages. It will be either very weak and broken or will be missing altogether in smaller, mechanized, consolidated and irrigated villages. In the latter case the source of water will play a critical role in the location of agriculture. A tubewell is a prized location of a farmer. Invariably, it has a small structure for protecting the installation. The same is temporarily used for storing some of the farm inputs and implements. A few shady trees planted at the site provide protection against the summer sun. A chaff-cutter and a thresher may also be associated with it. Generally, a farmer operates from here when out in the fields, for work. Besides being a locale from where water flows, it operates as a nodal point of movement for men and materials. Therefore, it will develop an agricultural zonation of its own. If the irrigation water is furnished by a canal, the zonation of crops will develop along the channel carrying canal water with clusterst at points where it opens to a farm (Fig. 3).

Although settlements in north India are of nucleated type yet a secondary settlement within a village is possible. It may be the result of : (i) the shifting of residence permanently by a farm family from the main settlement to their distant farm for the convenience of work and space, and (ii) the construction of a farm house on the purchased land by an in-migrant family. A tubewell/pumping set may also be associated with it. This type of isolated farm house will act as a node and will develop zonal order of its own.



In certain villages, the soil may not be homogeneous in inherent properties and the land may not slope down in all directions from the settlement. Both these facts will disturb the deducted zonal order.

The greater a model corresponds with the reality the higher is its validity. The applicability of the proposed model may be established by testing it against a real situation. The following village has been randomly selected as a test case for this purpose.

#### The Village

Devinagar Hirasingshwala (hadbast No. 265, Tahsil and District Patiala, Punjab, India), the village under study, is located in the flood plain of the Ghaggar at 30°-7' N and 76°-31' E. The settlement of this village

is located ulmost in the centre. None of its field falls at a distance of more than 1.2 kilometres from the settlement. It receives an annual average rainfall of about 63 centimetres out of which 80 per cent (50 cms.) comes during the rainy season (July, August and September). Besides being seasonally concentrated, the rainfall is variable and inadequate. The village has fertile clay-loam soils and a rich reservoir of underground water. The southern one-third of the village is flooded by the Tangri rivulet (a tributary of the Ghaggar) during the rainy season. Patiala, the nearest market city, is located at a distance of 28 kilometres from the village. Inhabited by 261 persons (1971), Devinagar Hirasingshwala has an area of 198 hectares out of which 186 hectares are

under net cultivation. Almost the whole of its cultivated area is irrigated. Nearly three-fourths of its irrigation water is provided by tubewells/pumping sets and the remaining one-fourth by the canals. Under inadequate and unreliable rainfall, the performance of a crop in the village depends upon irrigation. It has 37 farm families. Out of these 33 live in the village. The remaining 4 dwell in the neighbouring villages. On an average, each cultivating household owns 5.3 hectares of farm-land. The actual size of the landholdings, however, varies from 2 to 18 hectares. It is an owner-cultivated, highly commercial, progressive and fairly mechanized village. It has 14 tractors along with necessary implements and threshers. Because of its distant location from the city market, intensive farming activities, such as poultry, dairy, piggery and vegetable-raising could not come up on a commercial scale. Its economy is based on cereals. Wheat and paddy are the most important commercial crops of the village (Table III). Other crops are raised mostly to cater to the domestic needs.

#### The Mapping and Measurements

The study is based on the cropping pattern of 1979-80. First of all, an outline field map of the village was obtained from the village revenue official (*patwari*). The location of tubewells/pumping sets and individual landholdings were marked on this map by visiting the fields and consulting the concerned farmers. The field-wise location of each crop of both the seasons was brought on it by surveying the village at the time of standing crops. The reference map thus prepared was used to measure the distances. The average distance at which each crop of the village is located with respect to the source of water, the settlement and the approach road is taken as an index of location (Table IV). The distances were measured straight from the centre of each field in which a crop is grown up to the source (tubewell / pumping set / canal course) from where it draws water, up to the centre

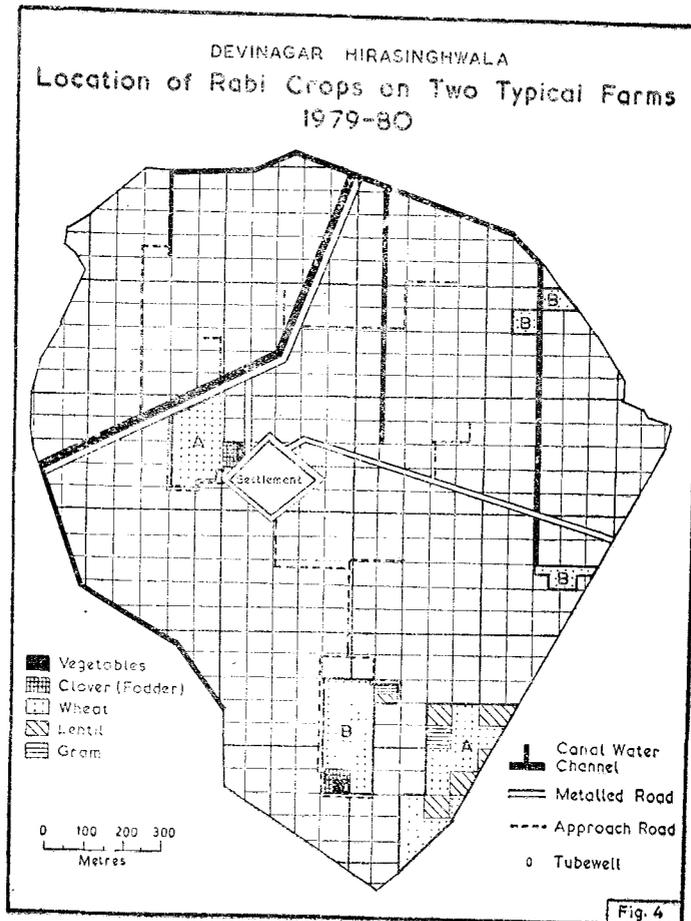
Table IV  
Location Distance of Various Crops in  
Village Devinagar Hirasingshwala : 1979-80

Crops	Average distance (in metres) from the		
	Source of water	Village settlement	Village road
<b>Rabi</b>			
Vegetables	35	402	115
Clover	62	504	107
Wheat	125	574	117
Gram	134	592	111
Lentil	148	628	153
<b>Kharif</b>			
Vegetables	35	386	71
Sorghum	97	510	106
Paddy	113	542	107

of the settlement and up to the road used to approach it.

#### Description

The average distance at which each crop of the village has been grown with respect to the settlement, the source of water and the road as shown in table VI clearly validate the deductive logic portrayed in the proposed theory. More water, labour and capital intensive crops of the village have been raised closer to the source of water and the settlement. Cereals and pulses followed in order. Fodder has been grown near the settlement as well as near the roads. The water requirements of various crops of the village bear a strong negative correlation ( $-0.82$ ) with the average distance at which they are located from the source of water. The capital and labour inputs of different crops show a strong negative correlation ( $-0.86$ ) with the average distance at which each crop is located with respect to the settlement. For further investigation of the spatial organization of crops in the village, the following two typical farms have been taken up for detailed discussion (Figures 4 and 5).



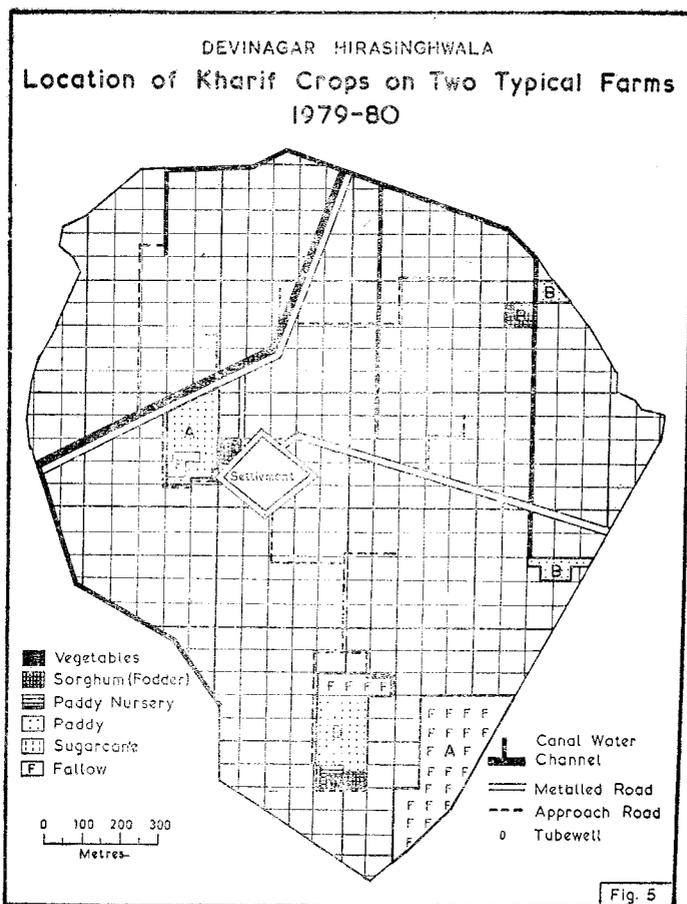
#### Farm A

This farm is owned and cultivated by Shiv Das. It is 13.6 hectares in size and is fragmented into two blocks of unequal size. The smaller block covering 4.8 hectares adjoins the settlement and the larger (8.8 hectares) falls at an average distance of about 750 metres in the southeastern peripheral part of the village. The nearer piece of land has a tubewell while the farther one has a pumping set without structure. Due to the locational advantage and assured supply of irrigation water, the nearer block is cultivated more intensively and is managed more carefully. It was cropped during both the seasons while the distant block was subjected to cropping only during the *rabi*

season. Apart from cereals, the required amount of vegetables and fodder were raised over the nearer block. The farther fragment was exclusively devoted to cereals and pulses. The location of crops by the side of the tubewell on the adjoining block is worth noting. Intensive crops and fodder concentrate adjacent to the tubewell. Cereals occupy the remaining fields.

#### Farm B

This farm belongs to Wattan Singh. It is 10.2 hectares in size and is fragmented into 5 blocks. The largest block of this farm is 7.5 hectares in size and is located at an average distance of about 700 metres in the southeastern peripheral part of the village. It has a tubewell with structure. Because of



its larger size and assured water-supply, it is better managed and more intensively cultivated piece of the farm. Distance from the source of water has been critical in determining the spatial organization of crops on this block. During *rabi* season, vegetables encircle the pumping set. Clover, wheat, and pulses follow in order. Wheat occupies maximum area. During *kharif* season, vegetables, paddy nursery and sorghum concentrate near the tubewell. Paddy occupies the largest share of this block and is grown next to them. Fodder has been grown by the side of the road for the convenience of transportation. Other blocks of this farm, where irrigation water is either hired from the neighbouring

farmers or is drawn from the distant canal are largely devoted to cereals during both the seasons.

Reality is complex. No model, however perfect, can portray facts in life size. The structuring of reality in total through a model is only an ideal which might be strived for. The model proposed in this study, in fact, is a beginning towards that end.

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*Address of the author*

Dr. Jhujar Singh, Deptt. of Geography, Panjab University. Chandigarh-160014