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Research Article

Study of Cropping Pattern, Crop Ranking and Crop Combination in Somb River Basin at Lower Shiwalik Hills

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Abstract The studies related to agriculture become more pertinent for those areas, where agriculture contributes more than 80 percent of net income, either through its direct cultivation or through its allied occupations. The aim of present study is to assess the cropping pattern, crop combination, and crop ranking in the Somb river basin using geospatial techniques and secondary data. Here, agriculture is single primary occupation and the basic source of economy. As well as more than 50 percent of total workers are engaged in agriculture and smallholders farmers, who grow crops using low intensity practices of land. Hence, a scientific and systematic study is highly required to assessing and mapping the cropping pattern in the watershed.
Keywords: *Crop combination; Crop pattern; Crop ranking; Irrigation*

1. Introduction

Agriculture is one of the leading occupation in India and it plays a vital role in shaping the economic condition of the farmers as well as the whole country. It contributes about 16 per cent of total GDP and 10 per cent of total export. Over 60 per cent of total land of the country is arable making it the second largest country in term of total arable land. Agriculture provides food to the masses, green fodder for livestock and supplies raw material to various agro-based industries. Hence, systematic, scientific, and proper cropping pattern and crop combinations are the most important aspect for better out-put in agriculture. Cropping pattern indicates the proportion of area under various crops at a point of time where as the crop combination indicates to grow different types of crops under the same agriculture field. Both Cropping pattern and combinations area dynamic concept as it changes over space and time. Terrain, topography, slope, temperature, amount and reliability of rainfall, soil and availability of water for irrigation are some factors responsible for the cropping pattern and combination in any area (Husain, 2010). Cropping pattern and combination are also the part of behavioral approach in geography, because it reflects the performance of the farmer for various crops sown in an agricultural field. Hence, by considering the facts related to better cropping pattern, the present research has been attempted to analyzing the irrigation facilities, cropping pattern, crop ranking and crop combination in the Somb river basin.

1.1. Study Area

The Somb river is a tributary of Yamuna river, arise from the outer slope of the lower part of Shiwaliks range in the district Sirmaur (Himachal Pradesh, India) and takes a southerly course, which drains in

the plain land of district Yamunanagar (Haryana, India). The extension of Somb drainage basin lies between $77^0$18/E to $77^0$34/E longitude and $30^0$9/N to $30^0$29/N latitude and total calculated area is 492 kms^2 (Figure 1). The northern part or the area falls in Himachal Pradesh is a dissected hilly track and not more useful for agriculture, whereas the southern part is plane and favorable for agriculture.

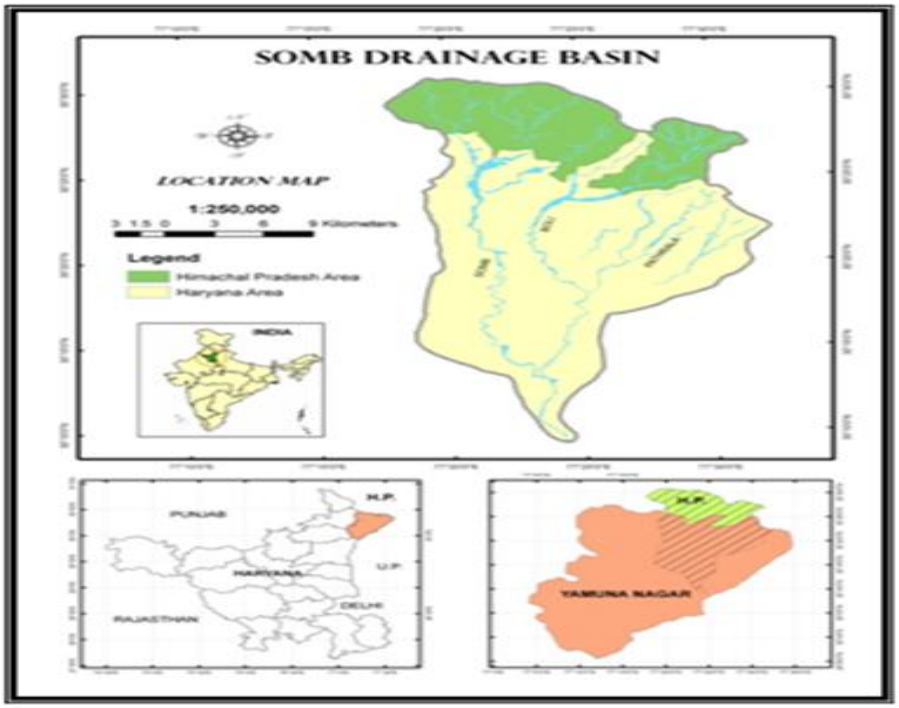

Figure 1: *Somb Drainage Basin*

1.2. Climate

The watershed has a sub-tropical continental monsoon climate, where we find great variation in climatic elements. Normally, the period from November to February is cold, this is followed by the summer season from March to the end of June. The south-west monsoon mostly breaks in the last week of June or first week of July and continues up to about the middle of September. The period from mid September to the mid of November is the post monsoon or transition season. In winters, frost sometimes occurs during December and January. The watershed also gets occasional winter rains from cyclones or western disturbances. The rainfall is mostly restricted to rainy season. The study area is characterised by the high velocity hot winds and dust storms during the summer months of May and June. The temperature for the last ten years varies from 3^0C in January to 36^0C in June.

1.3. Soil

The study area has occupied the outer most range of Shiwaliks lying west of Yamuna River. The soils, due to the variation in topography, intensity of erosion, parent material, and other factors, exhibit variations in many characteristics like texture, depth, colour, drainage, moisture status etc. The soil analysis of the soil samples taken by various agencies suggest that P_H value varies from 6.7 to 8.1. On the steep slopes, the soil is dry and tends to support xerophytic vegetation. The plain area is formed by alluvial deposits of the Somb River and its tributaries and the main river Yamuna and its other tributaries.

1.4. Objectives

The major objectives of the study are:

a. To assess and mapping of the cropping pattern
b. To assess the crop ranking
c. To study the crop combination

2. Data Source and Methodology

The present study is carried out basically with the help of Geo-coded IRS- P6 FCC merged LISS-III with 23.5 m spatial resolution, data of March, 2005. The area of watershed has been delineated on the bases of topographical sheets no. 53 F/6, F/7, F/8 and F/11 on 1:50,000 scales, obtained from Survey of India. Some secondary data has been collected from the following departments of Haryana and Himachal Pradesh government:

- Department of Agriculture, Sirmaur (Himachal Pradesh) and Yamunanagar (Haryana)
- Department of Irrigation, Sirmaur (Himachal Pradesh) and Yamunanagar (Haryana)
- Krishi Vigan Kainder (KVK), Yamunanagar (Haryana)
- Division Soil Conservation Officer (DSCO), Department of Agriculture, Yamunanagar (Haryana)
- Haryana Remote Sensing Application Centre (HARSAC), HAU-Campus, Hissar

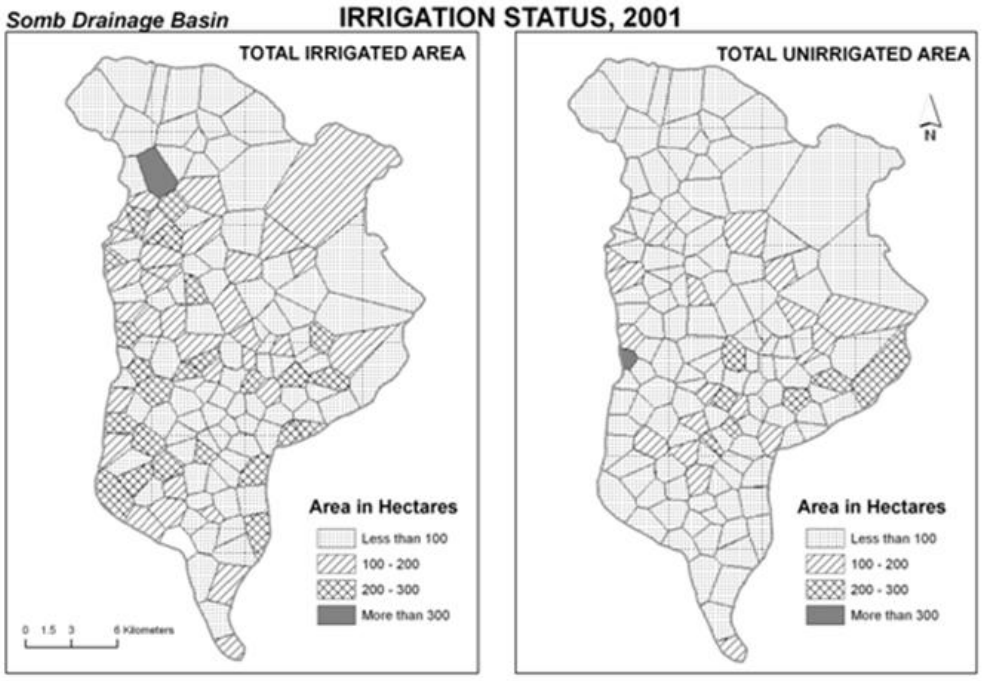

Figure 2: *Somb Drainage Basin: Irrigation Status 2001*

On the basis of data collected from irrigation department, agriculture department and primary survey, the irrigated and non irrigated areas has been identified. The study is based on the proportion of cropland under ten major crops, which are divided into two categories- Kharif crops and Rabi crops. To study the cropping pattern, a comparison of the relative strength of various crops is made by ranking them according to the percentage of net shown area occupied by each.

Crop combination analysis has been done by using the Weavers method modified by Doi after substituting $\sum d^2/ n$ with $\sum d^2$ i.e. the sum of squared differences. In this method, the minimum value of deviation decides the number of crops to be included in crop combination. The Weaver formula is as:

$$\Gamma^2 = \sum d^2/n \text{ or } \Gamma = \sqrt{\sum d^2/n}$$

Where Γ = value of crop combination, d is the difference of the actual crop percentage from the theoretical norm and 'n' is the number of crops in the given combination.

Finally, ArcGIS (version 9.2) software has been used to prepare the maps.

3. Results and Discussion

3.1. Area under Irrigation Facilities

Irrigation facilities play a vital role for the development of agriculture as well as vegetation cover. According to irrigation department of Yamunanagar, Haryana, tube-well (with electricity and without electricity) are the main sources of irrigation, beside this government canal and river water is used for this purpose at some agriculture lands. Approximately 160 square kilo meters (16000 ha.) agriculture land is irrigated by tube-wells. Irrigation facilities are poor in hilly areas (Figure 2). Water harvesting earthen dams are also constructed in Kathgarh, Rampur Gainda, Bhagwanpur, Darpur, Bagpat, Khillanwala, Ibrahimpur, Dhanoura and Salempur villages.

Table 1: *Somb Drainage Basin - major crops and there characteristics*

Crop	Time	Time harvesting	Climate	popular verities	Soil required	More suitable areas
Paddy	Nursery sown in June and transplanted in July -August	Sep. to Nov.	Hot-Wet	IR-8, IR-106, Pusa-2.21,Jaya, jhona-349 & 351, Basmati-217 & 370	Clay to Clay loam	Cultivated at all agricultural land but more yield in flood areas of streams
Maize	June-July	Oct. Nov.	Hot-Wet	Ganga 5, Ganga I, Vijay, Sona	Loam (well drained)	Pedimount Areas
Bajra	July-Aug	15th Sep. to 15thOct	Hot	Hybrid Bajra No.1, No. 4 and B.J. 104	Sandy or Sandy loam (Well drained)	Southern plain areas of low land
Wheat	Oct. to Dec.	March to April	Cold	Kalyana, Sona (K-227), Sonalika (S-308), H.D. 2004, P.N.18, HDM-1553 and C-306	Well drained loam soil	All over the agricultural land
Gram	Oct. to Dec.	March to April	Cold	PB-7, G 104, C-164	All types but Sandy loam, clay loam with well drained are more favorable	Southern plain areas of low land
Sugarcane	Mid. Feb. to Mid. April	Nov to Dec.	Hot-Wet	Co. 1148, Co. 975, Co. 453, Co. 212 Co. 124, Co. 158.	Loam and Clay	Pedimount and plain areas

Ground nut	March	Aug-Sep	Hot-Wet	…….	Well drained sandy soil	Selected villages
Barley	Oct.- Nov.	March to April	Cold	…….	Sandy loam and loam with well drained texture	Areas situated near streams
Pules	July- Aug	Oct. Nov.	Hot	Mash48, Mash I-1, T-9, Moong No.54, shining Moog No. 1, Massar No. 9-12	Sandy or Sandy loam(Well drained)	Selected Areas (Subsidiary Crop)
Vegetable	Oct.-Nov.	March to April	Cold	…….	All area with high organic Carbon in soil	Selected Areas (Subsidiary Crop)
Oil seed	Early September	Early December	Average	……..	Sandy or Sandy loam(Well drained)	Pedimount and Plain areas.
Vegetable and green fodder	Early March	Early June	Average	……..	Well drained sandy soil	Mostly all areas for green fodder and Stream banks have Melon

Department of Agriculture, Yamunanagar, Haryana, India.

Table 2: *Somb Drainage Basin - area under various crops*

Crop	Area under crop ($km^{2)}$	Percentage of total agricultural land	Percentage of total area
Kharif	1.478	0.6	0.30
Rabi	0.487	0.2	0.10
Kharif + Rabi (Double Cropped)	253.964	99.1	51.60
Current Fallow	0.239	0.1	0.05
Total	**256.168**	**100.0**	**52.05**

Satellite image interpretation, March, 2005.

3.2. Copping Patterns

The crops of the watershed area are divided into two main categories viz. Kharif and Rabi locally known as *Sawani* and *Sadhi* respectively. The former one is the summer season harvest and the latter is the winter season harvest. Any crop, which does not strictly fall within these two categories, is known as zaid crop and its harvest is called the zaid-Rabi or zaid-Kharif, according to the harvest with which it is assessed. *Toria* (an oilseed) is cultivated as zaid Kharif and vegetables, melon and green fodder as zaid Rabi. A brief account of various crops sown in watershed is given in Table 1.

According to the field study and the data collected from Agriculture Departments of district Yamunanagar, Haryana and district Sirmaur, Himachal Pradesh, total agriculture land in watershed is approximately more than 50% of the whole area. The result is a low yield per hectare, but the increase in the adaptation of new technology and use of inputs has substantially increased the agriculture production.

In the present watershed, more than 99 percent of total agriculture land is double cropped area, which is cultivated in both Kharif and Rabi season. Only one percent of agriculture land is single cropped and

follow land area. Some crops have also harvested in hilly areas of watershed, but its area is negligible (Table 2).

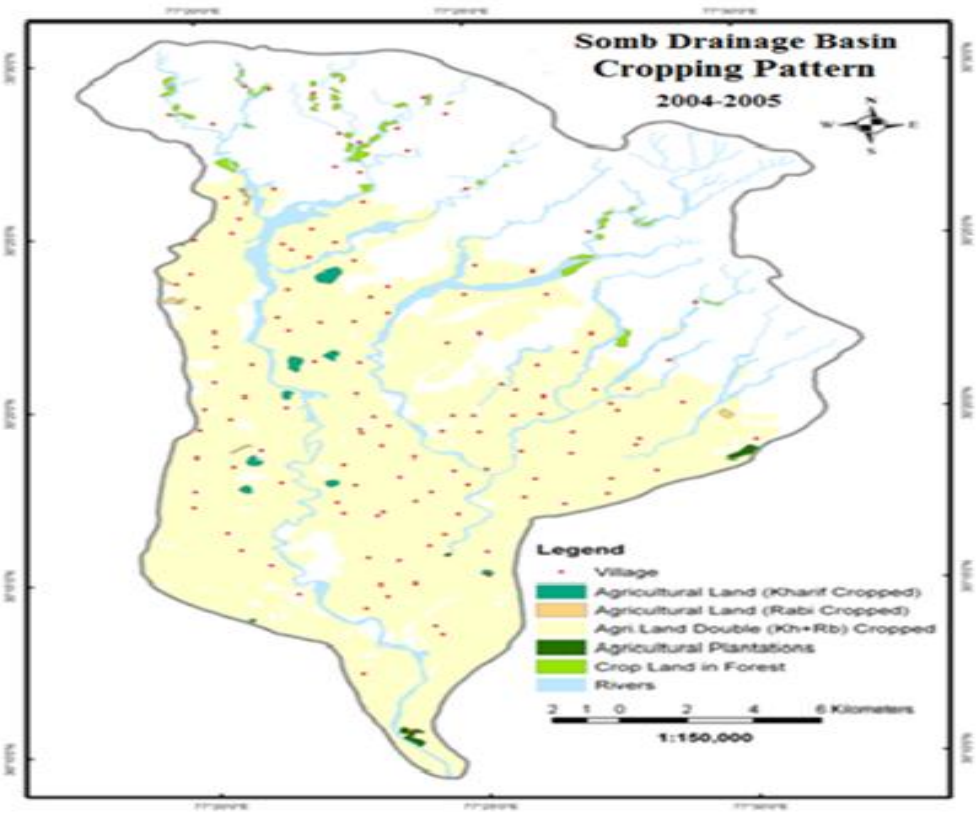

Figure 3: *Somb Drainage Basin: Cropping Pattern (2004-2005)*

The present cropping pattern has pre-dominance of cereals, where wheat, sugarcane, and paddy occupy more than one third area. There has been a big spurt in area under these croups (especially wheat and paddy) after green revolution of 1960-61 due to increasing growth in irrigation facilities.

3.3. Crop of Kharif Season

Kharif is a very important cropping season during June to October. It occupies more than Rabi cropped area in the watershed. Paddy and Sugarcane are very common crops of this season and both occupy more than 88 percent of total sown area (Table 3).

3.4. Crop of Rabi Season

The Rabi crops are cultivated with the advent of the winter season, generally from the end of October to beginning of November. The main Rabi crops are Wheat, Gram, Barley, Pulses and the commercial crops are Groundnut, Oilseeds, and Cotton. In the study area, only Wheat is predominated Rabi crop on whole agriculture land (Table 3).

3.5. Crop Ranking

The study of agriculture region is of great importance in geographical studies. The regional dominance of various crops can be determined by comparing the relatively a real strength of various crops. This can be obtained by ranking them, for each paragon, according to the percentage of the total harvested cropland occupied by each crop (Porwal, 1994).

Table 3: *Somb Drainage Basin - percentage of area, production, and average yield of Kharif and Rabi crops*

Kharif crops				Rabi crops			
Crop	**Areal distribution (% to net sown area)**	**Production (%)**	**Av. yield in kgs/hact.**	**Crop**	**Areal distribution (% to net sown area)**	**Production (%)**	**Av. yield in kgs/ hact.**
Maize	5.90	2.71	1685.00	Wheat	89.4	96.5	3674.9
Paddy	55.24	44.76	2957.00	Gram	3.0	0.7	934.5
Sugarcane	33.40	49.30	5380.90	Cotton	3.0	0.5	604.9
Sunflower	1.40	1.90	5000.00	Groundnut	0.6	0.3	1671.6
Pulse	1.55	0.32	753.03	Sirson	1.3	0.7	1914.7
Other	2.51	1.01	1470.00	Other	3.4	1.3	1257.3
Total	100.00	100.00	3650.93	**Total**	**100.0**	**100.0**	**3402.8**

Based on sample analysis in the watershed area (2004-2005).

Table 4: *Somb Drainage Basin - crop ranking*

Crop	% of net sown area	Rank	% of total production	Rank	Av. yield in kgs/hact.	Rank	Compound rank	Final rank
Maize	3.01	5.00	1.44	4.00	1685.00	6.00	5.00	5.00
Paddy	28.25	2.00	23.75	3.00	2957.00	4.00	3.00	3.00
Sugarcane	17.10	3.00	26.15	2.00	5380.90	1.00	2.00	2.00
Sunflower	10.70	4.00	1.00	5.00	5000.00	2.00	3.60	4.00
Pulse	0.79	8.00	0.17	9.00	753.03	11.00	9.30	10.00
Wheat	43.60	1.00	45.60	1.00	3674.86	3.00	1.60	1.00
Gram	1.28	7.00	0.34	7.00	934.48	10.00	8.00	7.00
Cotton	1.31	6.00	0.22	8.00	604.86	12.00	8.60	8.00
Groundnut	0.28	10.00	0.13	10.00	1671.56	7.00	9.00	9.00
Sirson	0.65	9.00	0.35	6.00	1914.70	5.00	6.66	6.00

Based on sample analysis in Somb Drainage Basin.

The simplest form of the agricultural regionalization of first order is based on either the dominating crop (first ranking crop) or a specific indicator used to define an area. On the basis of crop dominance and ranking device, regions like Corn Belt, Cotton Belt were defined for the United States by American geographers (Singh and Dhillon, 1994). The crop ranking has been done on the basis of dominance of area under specific crops. As far as crop ranking is concerned, Wheat is the first ranking crop, which covers an area of more than 43 percent of net sown area. The crop Paddy covers 28.25 percent and Sugarcane 17.10 percent, and comes at second and third place respectively. The crops Sunflower, Maize, Cotton, Gram and Pulses are placed on fourth to eighth ranks respectively. The crop Mustard and Groundnut are insignificant crops as they occupy less than one percent area of net sown area (Table 4).

The crop ranking is also measured on the basis of three elements i.e. percentage of net sown area, percentage of total production, and average yield per hectare. It is observed that the Wheat crop has first ranked where as the Sugarcane has second and due to high yield. The crop Paddy has got third position. The crops Sunflower, Maize, Mustard, Gram and Cotton have lied at fourth to eighth rank respectively. The yield of various crops affects the ranking of this section as compared to the previous. But, it is better rather than first.

Table 5: *Somb Drainage Basin - crop combination*

Category	Crop combination	Percentage of crop land (a)	Percent theoretical base (b)	Difference squared $(b-a)^2$	Crop Combination Index
Monoculture	Wheat	43.60	100.00	3180.96	3180.96
Bi-Combination	Wheat	43.60	50.00	40.96	251.60
	Paddy	28.50	50.00	462.25	
Tri-Combination	Wheat	43.60	33.33	106.10	130.10
	Paddy	28.50	33.33	23.32	
	Sugarcane	17.10	33.33	263.41	
Tetra-Combination	Wheat	43.60	25.00	345.10	226.04
	Paddy	28.50	25.00	12.25	
	Sugarcane	17.10	25.00	62.41	
	Maize	3.01	25.00	483.56	
Penta-Combinaion	Wheat	43.60	20.00	556.96	255.11
	Paddy	28.50	20.00	72.25	
	Sugarcane	17.10	20.00	8.41	
	Maize	3.01	20.00	288.66	
	Cotton	1.31	20.00	349.31	
Hexa-Combination	Wheat	43.60	16.66	729.00	254.00
	Paddy	28.50	16.66	141.60	
	Sugarcane	17.10	16.66	0.25	
	Maize	3.01	16.66	184.68	
	Cotton	1.31	16.66	233.78	
	Gram	1.28	16.66	234.70	

Based on sample analysis in Somb drainage Basin.

3.6. Crop Combination

The crop combination reflects the variable position of the individual crops within themselves. It can also be helpful in interpreting some aspects of economic and social geography (Mohammad, 1978). A number of statistical methods have been applied by the geographers to study the crop combination.

For the analysis of crop combination, first the percentage of different crops, during the Kharif and Rabi season, to the total cropped area has been calculated. The crops having a real coverage of less than one percent are not included in the analysis of crop combination as they are insignificant as compared to dominated crops. The table 5 shows that minimum combination index i.e. 130.1 for a combination of Wheat, Sugarcane and Paddy indicate that the watershed area is a tri-crop combination region.

4. Conclusion

The indices of cropping pattern, crop ranking and crop combination indicate the complexities of crop distribution in quantitative manner. About 52 percent of total area of the basin is under cultivation with a wide variety of Kharif and Rubi crops like Maize, Paddy, Sugarcane, Sunflower, Pulse (Kharif crops) and Wheat, Gram, Cotton, Groundnut, Sirson (Rabi crops) and more than 99 percent of the total agriculture land is double cropped area. The crop Wheat is the first ranking crop, which covers an area of more than 43 percent of net sown area and Paddy covers 28.25 percent and Sugarcane 17.10 percent, and comes at second and third place respectively. The pattern of crops and crop combination are mostly controlled by topography, soil and irrigation facilities. The spatial variations of cropping pattern identified in the basin area are highly useful not only for watershed development planning but also for the economic development of the farmers lives in basin area.

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