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A Study of Crop Combination in North-East Ahmednagar District using Weaver Technique and GIS Approach

Bhagwat Rashinkar
Department of Geography, Late Abasaheb Kakade College, Bodhegaon, Maharashtra, India

Digambar Samarth
Department of Geography, Taywade College, Koradi, Nagpur, Maharashtra, India

Pramod Wadate
Department of Geography, Bar. Sheshrao Wankhede Mahavidyalaya, Mohapa, Kalmeshwar, India

ABSTRACT
The analysis of crop combination founds a significant feature in agricultural geography. It provides quantitative approach for agricultural regionalization to the agriculture planner and decision maker. Crops grown in combinations where specific crop is occupies a position of total isolation remaining crops in a specific area at a given time. The maps of individual crops have been by prepared using statistical manner and Geographical Information System (GIS) software which are interesting and simplified for planners for decision making process. The study calculated the crop combination for Newasa, Shevgaon and Pathardi tehsils of eastern Ahmednagar district in Maharashtra using Weaver's technique and prepared maps in GIS software. Agricultural crops data (2010) were obtained from District Agricultural Department, Ahemadnagar. The data were classified for these three tehsils and calculated the crop combination using Weaver's technique (1954). Thematic maps were prepared in GIS software for obtaining crop combination results in three tehsils. It was found that there are two and four crop combinations in the rainy, winter and summer seasons in the 2010 year. This region has been dominated by Sunflower, Foodgrain, Groundnut, Maize, Cotton and Sugarcane crops. It was also observed the spatio-temporal variations in crop combinations. Geographical factors, like rainfall, physiography, transportation, socio-economic development are influencing the regional agriculture pattern. Using statistical methods and its integration in GIS environment presentation are more accurate for visualization of crop combination with thematic maps. Suggested approach is easier than the traditional approach for further decision making in agricultural environment.

Keywords
Crop combination, GIS, Agricultural Regionalization, Rainfall, Physiography, Socio-Economic factors

1. INTRODUCTION
Agricultural regionalization has been attracting the consideration of many reserch communities, academic scholars, scientists, planners etc. in the field of agricultural geography. Planner is interested in the overall agricultural region. Agriculture still forms the backbone of Indian economy, despite of concentrated efforts towards industrialization and urbanization in last three decades [1]. Agriculture is the base for the overall world's population and livelihood. In India, nearby 68% of the population is settled in rural area and it contributes approximately 22% of gross domestic product (GDP) where 60 to 70 percent population is dependent on agriculture [2]. Moreover, 60% of net sown area (NSA) in the country is rainfed. Due to variation in rainfall, the production of agriculture is uncertain spatially and temporally in the world [3].

The primary production is generated from land resource plays the vital role in shaping the fabric of life and the economy which also establishes the pace of development and progress of the community. Therefore, these situations are leading much attention on the regional scenario of agriculture like as crop combination, crop intensity, crop concentration and crop diversification. Hence, the spatio-temporal change in cropping pattern in particular time of span clearly shows the changes that have taken place in the agricultural development [4]. These spatio-temporal changes are brought by physical, climatological, socio-economic and technological factors in any area of world. In India, developing state like Utter Pradesh, Maharashtra, Gujarat, etc. are the major source of economy and livelihood of the working population which also influenced by the local physical factors.

The agriculture and allied environment has a multi-dimensional correlation with other factors of the earth surface and sub-surface environment. The role of space based input like satellite derived data is growing in the regional environmental and agriculture study [5]. As compare to conventional method of preparing maps GIS technique is most useful for aerial mapping, monitoring and tracing the spatial entities information with thematic maps at precise level [5, 6]. Using conventional methods, study of crop combination, somewhat called time consuming, required more human resources, and less accuracy oriented [6]. Today, the trends of crop combination have been changed and having a more statistical scientific base and its integration in Geographical Information System (GIS) software [7,8]. It is probably most used in spatial or agricultural planning with monitoring, mapping, and analysis of environmental parameters. Similarly, the Remote Sensing (RS) data help to generate the digital relief or digital elevation information of the earth surface at higher resolution with more scientific and visual manner [9]. Such relief information can be helpful to correlate the physiography and agricultural crops [10].

Ahmednagar district of Maharashtra entirely depends on rainfed and irrigation based agriculture. There is huge variation in agriculture cropping pattern in various tehsil. These trends of spatio-temporal changes can be analysed properly with statistical computations of crop combinations and its integrations in GIS software for preparations of thematic base maps [14,15]. It is useful and resourceful for the earth scientists, researchers, regional planners, spatial planners in several decisions making and agricultural regionalization related planning process. In view of this, present investigation mainly relies on the secondary data of

Newasa, Shevgaon and Pathardi tahsils collected from the Agricultural Department of Ahmednagar district, Maharashtra, India. It was observed that, there is a seasonal variation in cropping pattern due to local physiographical, climatological and dam-feed irrigation system. Moreover, based on this crop combination analysis, it was revealed that, there is a spatio-temporal variation in crop combination due to diverse physical and developed artificial irrigation system in the southern part of the study area.

2. THE STUDY AREA

Present study area covers Newasa, Pathardi and Shevgaon tehsils which are parts of the north-east Ahmednagar district, located in Maharashtra state of India (Figure. 1). This study area is selected as a study area to understand the crop combination and its correlations with physical and cultural environment. The extent of the selected study area is 18° 56' 42.05" to 19° 42' 49.31" N latitude and 74° 45' 3.35" to 75° 34' 5.97" E longitude. It covers around 3,589.38 km2 area with diverse hilly, plateau and plain area. The mean temperature of the area recorded around the 25 to 29 degree in the area. The maximum elevation of the study area is 906 M. which is observed in the southern part of the study area (Pathardi Tahsil) while minimum elevation is 423 m which is observed in the northern direction of the study area (Shevgaon Tahsil). There is uneven distribution of physiography, population and agriculture and water resources in the area. Brander and Schuyt (2010) stated that, rivers and streams hold enormous ecological values that provide very essential ecological services [11,13]. The intensity of precipitation, temperature, evapotranspiration, soil moisture, groundwater, vegetation canopy, cropping pattern etc. drought parameters are determined drought nature [9]. The present area suffers from drought characteristic as an influence of drought parameters. Godavari is the significant east flowing river which is flowing from the northern part of the study area. The average rainfall of the study area is around 400-550 mm which has great spatial and temporal variations. There is variation in physiographic and climatic aspects in the study area. Therefore, it is observed the spatio-temporal variations in crop combinations are an effect of rainfed and developed dam-fed irrigation system in the study area.

3. DATABASE AND METHODOLOGY

The present study mainly focused on the secondary data collected from the Agricultural Department of Ahmednagar District, Maharashtra. This collected data were classified for Newasa, Shevgaon and Pathardi tehsils study area considering the objective crop combination calculation and thematic maps preparations in GIS environment. Initially, for calculation of crop combination Weaver's method [12] was admirably selected. This method was applied in the selected study area of Ahmednagar district to compute the crop combination of selected study area region. The percentage of crops for each tahsils was calculated and identified the crop combinations. Calculated crop combinations results were incorporated in GIS software and thematic maps were prepared for rainy, winter and summer seasons of 2010 year.

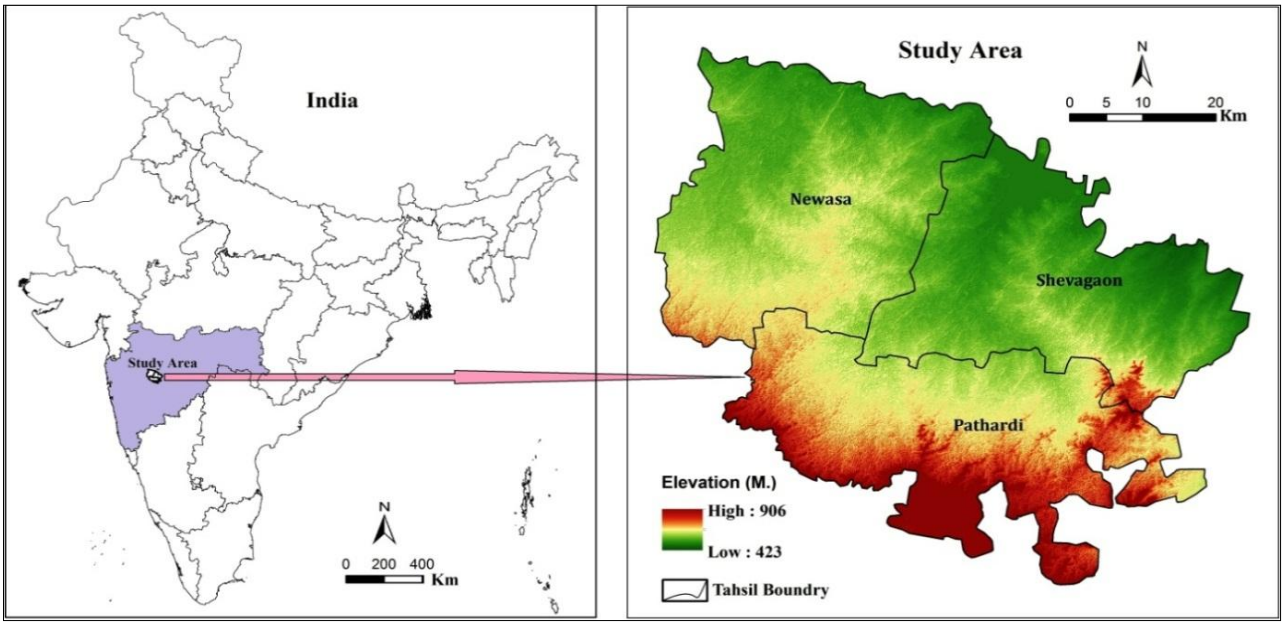

Figure 1: Location map of the study area

4. ANALYSIS AND RESULTS

4.1 Crop Combination: Rainy Season 2010

The impact of rainfall in 2010 year was observed on the cropping system. In this season, it is observed that Bajara, Cereal, Maize, Tur, Moong, Udid, Pulses, Foodgrain, Groundnut, Sesame, Sunflower, Soyabeen, Oilseed, Cotton etc. crops with variation in ratio (Table 1). According to data, Cotton, Foodgrain, Cereal and Bajara are observed with dominant crops in this area in same seasons. In the Shevgaon tehsils observed the percentage, i.e. Cotton (40.94%), Foodgrain (19.42 %), Cereal (15%) and Bajara (15.30%). Likewise, in the Pathardi tehsils observed the situation i.e. Foodgrain (25%), Cotton (22.61%), Cereal (21%) and Bajara (21%). In the Newasa tehsils the sequence of crops were observed with Foodgrain (25%), Cereal (19%), Cotton (15%) and Bajara (14.74%). From this data, it was observed that, the ratio of Foodgrain crop were higher in the Pathardi and Newasa tahsils of the study area.

Table 1: Tahsil wise crops (%) in Rainy Season 2010

	Crop	Shevgaon	Pathardi	Newasa
1	Bajara	15.30	21.25	14.74
2	Cereal	15.38	91.86	18.44
3	Maize	0.08	0.60	3.69
4	Tur	3.39	2.84	6.84
5	Moong	0.17	0.71	0.46
6	Udid	0.03	0.30	0.01
7	Pulses	4.04	3.88	7.33
8	Foodgrain	19.42	25.73	25.77
9	Groundnut	0.07	0.04	0.26
10	Sesame	0.06	0.01	0.01
11	Sunflower	0.02	0.06	0.02
12	Soyabeen	0.09	0.04	2.76
13	Oilseed	0.26	0.11	3.07
14	Cotton	40.94	22.61	15.93
15	Sugarcane	0.46	0	0.66

Table 2: Crop Combination for Rainy Season in 2010

Tahsil	Crop Combination	Crops Combination
Shevgaon	Four Crop Combination	Sunflower, Foodgrain, Cereal, Bajara
Pathardi	Four Crop Combination	Foodgrain, Cotton, Cereal, Bajara
Newasa	Four Crop Combination	Foodgrain, Cereal, Cotton, Bajara

According to results, it was observed that four crop combination in the Shevgaon, Pathardi and Newasa tahsil in rainy seasons of 2010 year (Table 2, Map 2). It was the strong influence of homogenous rainfall in the study area. It was observed that, the area under crops is increasing in these three tahsils. The policy of government and changing technology leads to increasing the area under crops especially cotton crop. As a result, homogenous regionalization was seen in the rainy seasons of 2010 year in the study area (Figure 2).

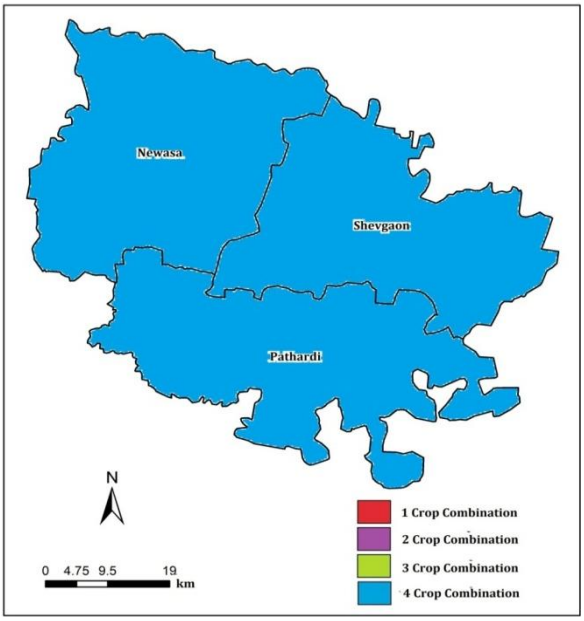

Figure 2: Crop Combination for Rainy Season 2010

4.2 Crop Combination: Winter Season 2010

In the winter season of 2000 year observed the changing cropping patter which is mostly influenced by rainfall. The sequence of crops according to their area is changing in same study area in 2000. According to tehsil wise crops (%) data for Winter Season in 2010 (Table 3). It was observed from the data there were spatio-temporal changes in the cropping pattern in the selected study area. In the winter seasons of 2000 year, observed the crops, i.e. Jawar, Wheat, Maize, Cereal, Gram, Pulse, Foodgrain, Sesame, Safflower, Sunflower, Jaws and Oilseed.

Table 3: Tahsil wise crops (%) for Winter Season in 2010

	Crop	Shevgaon	Pathardi	Newasa
1	Jawar	18.60	19.42	14.88
2	Wheat	2.3	6.79	8.27
3	Maize	0.60	0.44	0.40
4	Cereal	25.59	26.67	23.55
5	Gram	7.06	6.27	8.70
6	Pulse	7.11	6.27	8.70
7	Foodgrain	32.94	32.94	32.26
8	Sesame	0	0	0
9	Safflower	1.09	0.20	1.44
10	Sunflower	0	0.24	0.18
11	Jaws	0.06	0.14	0
12	Oilseed	1.15	0.60	1.62

Table 4: Crop Combination for Winter Seasons in 2010

Tahsil	Crop Combination	Crops in Crop Combination
Shevgaon	Four Crop Combination	Foodgrain, Cereal, Jawar, Pulse
Pathardi	Four Crop Combination	Foodgrain, Cereal, Jawar, Wheat
Newasa	Four Crop Combination	Foodgrain, Cereal, Pulse, Jawar

According to obtained results, it was observed that, in winter seasons of 2010 year Foodgrain, Cereal, Jawar, Pulse, Jawar etc. crops ration were higher in the study area (Table 3). Out of that, in the Shevgaon tehsil were seen the sequence of Foodgrain (32.71%), Cereal (25.59%), Jawar (18.60%) and Pulse (7.11) crops (Table 4). In the Pathardi tehsil, also seen the sequence with Foodgrain (32.94%), Cereal (26.37%), Jawar (19.42%) and Wheat (6.79%) crops. In these three tehsils were seen the Foodgrain at highest production. After that, Cereal, Jawar were seen at highest ratio in the overall study area. From the above Table 4 it was found the four crop combination in this selected study area (Figure 3). I this crop combination the sequence of Foodgrain, Cereal and Jowar crops are similar in these three tahsils. According to that, there was found the similar agricultural regionalization in this study area. This might happen due to similar government policy and unique physical situation in the study area.

Table 5: Crop Combination for Summer Seasons in 2010

Crop	Shevgaon	Pathardi	Newasa
Groundnut	38.20	32.23	40.17
Sunflower	0	6.16	3.17

Oilseeds	36.20	38.39	43.34
Moong	0.43	1.42	0.42
Bajara	0	4.74	0
Maize	23.18	17.056	12.90

From Table 5 it is observed that in Shevgaon tehsil net area under crops like Groundnut (38.20%), Oilseeds (36.20%), Maize (23.18%) and Moong (0.43%) crops. In Pathardi tehsil Oilseeds (38.39%), Groundnut (32.23%), Maize (17.06%) and Sunflower (6.16%) crops were observed dominantly. Similarly, in Newasa tehsil Oilseeds (43.34%) and Groundnut (40.17%), were at highest ratio (Table 5). As a conclusion, there is dominance of Oilseeds, Groundnut and Sunflower crops in the study area in summer seasons of 2010. In Shevgaon and Pathardi to observed the four crop combination whereas in Nevasa tehsil, it observed only two crop combination. The situations of summer crops are depend on the rainfall pattern of rainy seasons. In the summer season of 2010, it observed the similar crops in Shevgaon and Pathardi tehsils (Figure 3). Similarly, in Newasa tehsil it observed the two crop combinations. There was rapid growth of area under Groundnut and Oilseeds in the study area which is the main characteristic of the study area.

Table 6: Crop Combination for Summer Seasons in 2010

Tehsil	Crop Combination	Crops in Crop Combination
Shevgaon	Four Crop Combination	Groundnut, Oilseeds, Maize, Moong
Pathardi	Four Crop Combination	Oilseeds, Groundnut, Maize, Sunflower
Newasa	Two Crop Combination	Oilseeds, Groundnut

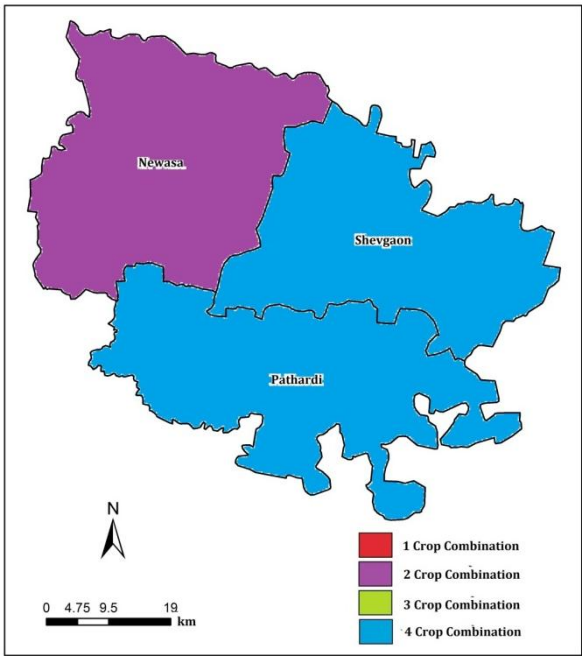

Figure 4: Crop Combination for Summer Season 2010

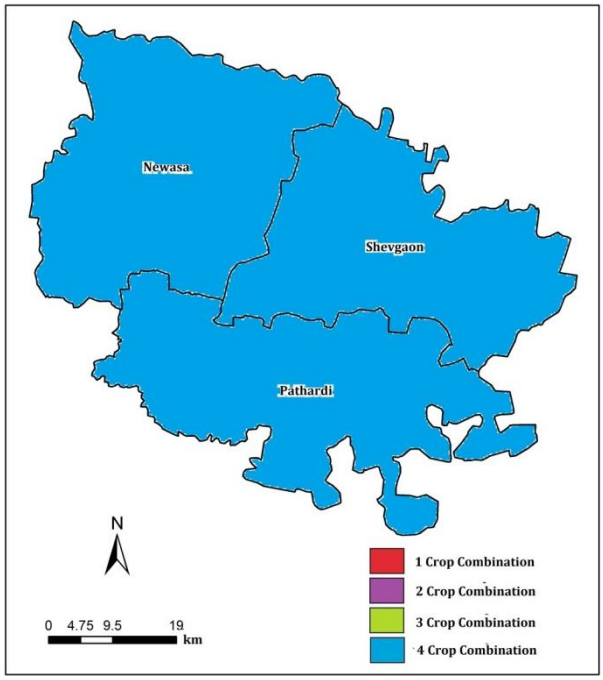

Figure 3: Crop Combination for Winter Season 2010

4.3 Crop Combination: Summer 2010

In this research, it is found that main reasons of crop combination changes are due to the physical nature of the study area. Moreover, factors, like rainfall, physiography, transportation, socio-economic development influencing the regional agriculture pattern, changing agricultural policy, weather etc. facts are also responsible for changing agricultural crop combination. In the summer seasons of the 2010 year found the dominance of Groundnut, Sunflower, Oilseeds, Moong, Bajara and Maize crops in the study area (Table 5).

5. CONCLUSION

The changes in the crop combinations during the rainy, winter and Summer seasons are due to rainfall pattern, changing agricultural product rate, government policies, agricultural technology, literacy, etc. factors were found clearly in the study area. It is observed that the strong correlation in between physical factors and agricultural products are in the study area. The physiographic situation of the study area is determined by two main river systems passing through middle part of the study area which also influenced the agricultural crop combination. The southern part of the study area is consisted with the hilly region with a more than 900 meter height from mean sea level. Thus, the agricultural productivity was noticed lower and depends on rainfall pattern. At the same time the northern part of the study area is less than the 400 meter from mean sea level. Therefore, cropping system is developed in this area. The parts of Shevgaon tehsil and Newasa tehsil is consisted with plain area. Therefore, there is a favorable situation for agricultural cropping system in this area. According to the physiographic situation it can be viewed that the agricultural and other economic development is strongly associated with Newasa and Shevgaon Tehsil area as compared to Pathardi area. The part of Shevgaon tehsil is connected with the Jayakwadi reservoir water body. Therefore, it is observed that minimum slope in this area are good conditions for agricultural development. Geographical factors, like rainfall, physiography, transportation, socio-

economic development influencing the regional agriculture pattern in the study area. In this attempt, used statistical methods and its integration in GIS software is more accurate for crop combination scenario presentations with thematic maps manner. Suggested approach is easier than the traditional approach for further decision making in agricultural environment.

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