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Crop combination regions in India: Special reference of Maharashtra

Dr. Nitin Vinayak Gaikwad
Assistant Professor, Head Department of Geography, Bharati Vidyapeeth's
Dr. Patangrao Kadam Mahavidyalaya, Sangli (Maharashtra)
Email- nitinhira31@gmail.com

Abstract

Maharashtra state has been divided into 9 Agro-climatic zones based on rainfall, soil type and vegetation. Crops are cultivated in Maharashtra mainly in two seasons i.e. Kharif and rabi as a sole crop, mixed cropping, rotational cropping or relay cropping. Cropping system in a locality is based on experience, tradition, expected profit, personal preferences, resources, social and political pressure. Monoculture of rice in some parts of Konkan region and Jowar in some parts of scarcity zone in kharif season is predominant. In different crop combination regions, rice, Jowar, bajara, maize, soybean and cotton are the base crops for kharif season, while wheat, chickpea and rabi jowar are the base crops for rabi season. Other crops like sugarcane and sunflower; fruit crops like grapes, banana, pomegranate, coconut and sapota and vegetables such as brinjal, tomato, potato, onion, turmeric and ginger are also the base crops in different crop combination regions. Intensive land utilization and resource management may use cultivation of two or more than two crops either in succession or in combination with base crops.

Key Words: Agro-climatic Zones, Crop Combination Regions of Maharashtra

Introduction:

Cropping activities go on all round the year in Maharashtra provided water is available for crops. In Maharashtra there are two distinct seasons, rainy/Kharif (July to October) and winter/rabi (October to March). These crops are grown sole or mixed (mixed cropping), or during a definite sequence (rotational cropping). The land may be occupied by one crop during one season (mono cropping), or by two crops (double-cropping), which may be grown in a year in a sequence. These intensive cropping patterns may be taken either in sequence or may be even as relay cropping in which next crop are sown in a standing wide-rowed, slow-growing previous crops; companion crops may be grown. There are various ways of utilizing the land intensively. In any locality, the prevalent cropping systems are the cumulative results of the past and present decisions by individuals, communities or government and their agencies. These decisions are usually based on experience, tradition, expected profit, personal preferences and resources, social and political pressure.

Agro-climatic Zones:

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India has been divided into 15 resource development zones of which 14 fall in the main land and remaining one in the islands of Bay of Bengal and the Arabian Sea. Maharashtra falls within the 9th zone referred to as the Western Plateau and hills region. The aim is regionalization of the Indian agricultural economy and to bring integration of plans of the agro-climatic regions with the State and national plans. The final goal is to organize agricultural planning systems for the 15 Agro-climatic zones and develop policies for faster agricultural development on regional basis.Maharashtra is the 3rd largest state of India located between 16 N to 22 N latitudes and 72 E to 80 E longitudes. On the idea of geographical features, the state is split into 3 natural regions viz., Konkan comprising the coastal area, Sahyadri hill ranges referred to as Western Ghats and therefore the Deccan plateau. Major portion of the state is semi-arid with three distinct seasons of which rainy season starts from July to September. There are large variations in the quantity of rainfall within different parts of the state. Ghat and coastal districts receive an annual rainfall of 2000 mm but most a part of the state lies within the area belt of the ghat with a mean of 600 to 700 mm. The rainfall variations from 500 to 5000 mm are recorded with a mean of 1000 mm distributed over 60-70 days. The state has been divided into 9 Agro-climatic zones based on rainfall, soil type and the vegetation as mentioned

Crop Combination Regions:

In India 68 per cent of population resides in rural area and it contributes nearly 22 percent of Gross Domestic Product. Sixty to seventy per cent population is dependent on agriculture for their livelihood. In India 60 per cent net sown area is rainfed. Due to variation in rainfall, the production is uncertain hence crop combinations attract much attention. Agriculture depends on physical and socio- economic conditions. Agriculture in a way is the result of human efforts applied in the exploitation of land resources towards the satisfaction of one of man's basic needs for food.There had been a substantial investment in major irrigation projects in the colonial days. The post –independence era saw many multipurpose irrigation projects. Lately, interest in medium and minor irrigation works has increased, especially after the drought of 1966. Irrigation, especially the minor projects, has provided a base for multiple-cropping. The All India Co-ordinated Projects run co-operatively by the Indian Council of Agricultural Research and State Agricultural Universities have generated short season, photo-insensitive, high-yielding varieties of various crops suitable for high intensity cropping.

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Table 1. Agro-climatic zones of Maharashtra

I.	**SOUTH KOKAN COASTAL ZONE (**Very high rainfall zone with lateritic soils**).**				
Geographical location	**Geographical spread of the zone**	**Climatic conditions**	**Average annual rainfall**	**Soil type**	**Crop and cropping pattern**
1530 to 1850 N Latitude 72 45to74 50 E Longitude	Comprises mainly Ratnagiri and Sindhudurg districts. Total area of the zone is 13.20 lakh ha. Area under cultivation 3.5 lakh ha.	Daily temperature above 20^0C. throughout the year. May is hottest above 33^0C. Rainfall due to SW monsoon from June to Sept.	3105 mm in 101 days	Laterite. pH-5.5-6.5 acidic, poor in phosphorous, Rich in nitrogen and potassium	Rice is the major crop i.e. 39% of cultivated area. Ragi is 2nd important crop (0.45 lakh ha). Vari is minor hill millet grown on the slopes, pulses like horse gram grown on residual moisture. Oilseeds Niger/Sesamum. Area under Summer Ground nut, Jowar and Tur is likely to increase with irrigation. Horticultural crops-Mango, Coconut, Areca nut, Cashew nut, Jackfruit, Banana and Pineapple. Spices-Clove, Nutmeg, Black pepper.
II.	**NORTH KOKAN COASTAL ZONE (**Very high rainfall zone with non- lateritic soils**).**				
17 52 to 20 N Latitude 70 70to7348E Longitude.	Comprises Thane and Raigad districts. Total area 16.59 lakh ha. Net sown area 4.69 lakh ha with forest zone about 3%, 32% of the land is under forest.	Average daily temperature 22 to 30^0 C. Minimum temperature 17 to 27^0C. Humidity 98%in rainy season and in winter 60%.	2607mm in 87 days.Maximum rain received in July i.e.41 %.	Coarse and shallow. The pH is 5to 6.5, acidic. Rich in nitrogen, poor in phosphorous and potash.	Rice is the major crop (40,600 lakh ha). Vari(19,600 ha). Pulses –Udid andTur. Vegetables-Brinjal andTomato. Oilseeds- Sesamum and Niger. Fruits- Banana andChicku.
III.	**WESTERN GHAT ZONE (**Western Ghat Zone / Ghat Zone**).**				
Narrow strip extending from north to south along the crest of Sahyadri ranges.	It includes hilly high lying terrains of Kolhapur, Satara,Pune, Ahmedanagarand Nashik districts and small area of Sindhudurg district. Altitude varies from 1000-1900 m.	Maximum temperature ranges from 29-39^0C. Minimum temperature ranges from 13-20^0C.	Rainfall 3000 to 6000 mm recorded in different places of the zone viz., Igatpuri, Lonawala, Mahabaleshwar	'Warkas'i.e. light laterite reddish brown. Distinctly acidic,poor fertility, low phosphorous	25% area is under forest. Principal crops are rice, ragi, kodraand other cereals like*Rabi* Jowar, Gram, Groundnut and Niger. Sugarcane is major crop. Area under spices is 353 haand fruits and vegetables are 2933 ha. Well suited conditions for rain fed crops. Fruits crops-Mango, Cashew, Jackfruit, Jamun and Karwanda.
IV.	**TRANSITION ZONE-1 (**Sub-Mountain Zone)				
Geographical location	**Geographical spread of the zone**	**Climatic conditions**	**Average annual rainfall**	**Soil type**	**Crop and cropping pattern**

Located on eastern slopes of Sahyadri ranges	Spreads over 19 tahsils of five districts viz., Nashik, Pune, Satara, Sangli and Kolhapur. The area of the zone measures 10, 289 Sq Km.	Average maximum temperature is between 28-35^{0}C andminimum is 14-19^{0}C.	Rainfall 700-2500 mm received mostly from SWmonsoon.	Soils are reddish brown to black (laterite).The pH is 6-7. Soils are well supplied in nitrogen but low in phosphorous and potash.	Mainly dominated by *kharif* cereals, groundnut and sugarcane. Rabi crops are taken where there are deep soils with high moisture holding capacity. Vegetables-Potato, Onion, Chillies, Tomato and Brinjal. Fruits-Mango, Banana, Guava, Pomegranate and Grapes.
V.	**TRANSITION ZONE-2 (**Western Maharashtra Plain Zone**)**				
It is the a wider strip running parallel to eastern side of Sub Mountain Zone	This zone includes tahsils of Dhule, Ahmednagar, Sangli & central tahsils of Nashik, Pune, Satara, Kolhapur districts. Geographicalarea is 17.91 lakh ha. Net area sown is 8.86 lakh ha.	Water availability ranges from 120-150 days. Maximum temperature 40^{0}C and minimum 5^{0}C	Well distributed rainfall 700 to 1200 mm.	Topography is plain. Soils grayish black. Moderately alkaline with pH- 7.4- 8.4, lowest layer is Murum strata, fair in NPK content, well drainedand good for irrigation.	The zone is predominantly a *Kharif* tract suitable for single rainfed crop. Principal crops grown in*Kharif*and*rabi*are Jowar, Bajra, Groundnut, Wheat, Sugarcane, Udid, Tur, Gram andRagi.
VI.	**SCARCITY ZONE (**Western Maharashtra Plain Zone**)**				
--	This zone covers geographical area of 73.23 lakh ha. The gross and net cultivated area is 58.42 and 53.0 lakh ha, respectively	Suffers from very low rainfall with uncertaintyand ill distribution. Occurrence of drought is noted once in three years. Dry spell varies from 2-10 weeks. Water availability 60-140 days which is affected due todelayed onsets of monsoon and early cessation of monsoon. Maximum temperature 41^{0}C and minimum 14-15^0 C	Less than 750 mm in 45 days with two peaks of rainfall i.e. June-July and September. Bimodal pattern of rainfall	General Topography having slope between 1-2%. Infiltration rate is 6-7mm/hr. The soils arevertisol. Soils have Montmorilonite clay. Poor in nitrogen, low to medium in phosphate and well supplied in potash.	Based on bimodal distribution of rainfall, two cropping systems are noticed. During *kharif* shallow and poor moisture retentive soils are cultivated. Medium deep, moisture holding capacity soils are diverted to *rabi* cropping.In *Kharif* cropping 25-30% crops are Bajra, Jowar, Groundnut, Safflower, Pulses, etc. Productivity is rather low in both the seasons
VII.	**ASSURED RAINFALL ZONE (**Central Maharashtra Plateau Zone)				
Geographical location	**Geographical spread of the zone**	**Climatic conditions**	**Average annual rainfall**	**Soil type**	**Crop and cropping pattern**
--	Comprises parts of Aurangabad,Jalna, Beed and Osmanabad districts. Major parts of Parbhaniand Nanded and	Maximum temperature 41^{0}C and minimum 21^{0}C	700 to 900 mm. 75 % rains received in all districts	Soil colour ranges from black to red. Type of soils are vertisol,	Jowar is a predominant crop occupying 33% of gross cropped area. Area under Cotton-22.55 %, Oilseeds-5.17%, Pulses-7.63%. Kharif Jowar/Bajra

	complete Latur,Buldhanaandsome parts of Akola, Amravati, Yavatmal, Jalgaon, Dhule and Solapur. Geographical area accounts 75 lakh ha. Gross cropped area is 67.8 lakh ha. Forest accounts 9.90% of geographical area.		of the zone	entisolsand inceptisols.The pH is 7-7.5.	followed by gram and safflower. Area under paddy is increasing. Pulses like Udid, Tur, Gram, Mung and lentils are grown. Oilseeds-Groundnut, Sesamum, Safflower and Niger. Sugarcane and summer crops are taken on availability of irrigation.
VIII.	**MODERATE RAINFALL ZONE (**Central Vidarbha zone**)**				
There are five sub zones of central Vidarbha zone based on climate, soil and cropping pattern.	The zone includes entire Wardha, major parts of Nagpur,Yavatmal 2 tahsils of Chandrapur and parts of Aurangabad,Jalna, Parbhaniand Nanded districts. Largest agro-climatic zone encompassing 49.88 lakh ha geographical area and 35.73 lakh ha net cropped area.	Maximum temperature 33-38^{0}C and minimum temperature 16-29^{0}C Average daily humidity 72 % in rainy season, 53% in winter and 35% in summer.	1130mm	Black soils derived from basalt rock. Medium to heavy in texture, alkaline in reaction and low lying areas are rich and fertile	Cropping patterns involves Cotton,*Kharif* Jowar, Tur, Wheat, other pulses and oilseeds.
IX.	**EASTERN VIDARBHA ZONE (**High Rainfall zone).				
-	Includes entire BhandaraandGadchiroli and parts of Chandrapur and Nagpur.Geographical area is 32.7 lakh ha and with almost 50% under forest. Gross cropped area is 10.8 lakh ha.	Mean maximum temperature varies from 32 to 37^{0}C and minimum temperature from 15 to 24^{0}C. Daily humidity is 73% for rainy season, 62% in winter and 35% in summer.	950 to 1250 mm on western side. 1700mm on extreme east side. Rainy days - 59	Soils derive from parent rock granite, gneisses, and schist's. Brown to Red in colour. PH 6 - 7	Paddy is predominant crop in BhandaraRb. Pulses Gram, Lathyrus. Paddy is followed by Rb. Jowar Pulses and Oilseeds.

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The various developmental and educative programmes, especially the High Yielding Varieties Programme, have also resulted in newer cropping patterns involving intensive cropping. In spite of the rapid growth of industries and service sectors in India, agriculture still is an important economic activity, employing 58 per cent of total workers in 2011 (Maharashtra 64 percent in 2011). As compared to India, Maharashtra occupies 9.4 per cent of the area , 9.3 per cent population, 12.6 per cent NSA and 11.4 per cent of the gross irrigated area. Among the major crops grown Maharashtra accounts for about half of the acreage under Jowar and 1/3rd under cotton. Bajara is another important crop, which accounts 18 per cent of area while sugarcane occupies 12.7 per cent of the harvested area under that crop in India. Even then, the method of agricultural growth has not been properly channelized thanks to imbalance in allocation of resources, basic infrastructure and uneven rainfall.

Crops are generally grown in combinations (Weaver, 1954). The study of crop combination of any region has gained importance in geographical study. It gives us the relative position of crops on regional scale. A number of quantitative and qualitative methods have been developed for determination of crop combination regions. In qualitative methods, crop combination regions are arranged or ranked in hierarchical order and then crop combinations are determined. The case of these methods is the simplicity in calculation. Quantitative techniques are more precise, accurate and scientific than qualitative methods. First attempt for delineation of agricultural regions was made by Weaver in 1954. He studied crop combination for Middle East counties.

Rafiullah (1965) modified Weavers method and introduced a new method known as "Maximum Positive Deviation Method" by applying same statistical procedure with altogether different format. According to this method per cent of all crops have arranged in descending order for fifteen villages. The crops having area less than 5 percent were omitted from the calculation and maximum deviation of variance was obtained. For monoculture middle value was considered at 50 per cent, for two crop combination it is 25 per cent, for three crop combination the value is 16.7 per cent, for four it is 12.5 and for five it is 10 per cent and so on.

Crop Combination Regions in Maharashtra:

In crop combination regions, monoculture (one crop combination) is observed eg. Rice (kharif) crop combination in some parts of Konkan region and jowar in some parts of Scarcity zone of Maharashtra. Two or many crop combination regions are noticed in well irrigated areas of Kolhapur, Sangli, Satara, Pune, Nasik and other many districts. A broad position of the crop combination regions in Maharashtra can be presented by taking the major crops into consideration. They include rice, sorghum (in kharif), pearl millet (bajara), maize, finger millet (ragi), soybean, groundnut, and cotton. Among the post-monsoon crops (in rabi), wheat, sorghum (rabi) and chick pea (gram) can also be considered to be the base crops. Other crops such as sugarcane, sunflower, pigeonpea (tur), fruit crops like grape, banana, pomegranate,

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coconut, sapota, sweet orange, kagzi lime, mandarin, cashew nut, etc., and vegetable crops such as tomato, potato, brinjal, onion, turmeric, ginger, etc. may also be considered.

Table 2. Crop combinations in different Agro-climatic zones:

Sr. No.	Agro-climatic zones	Crop combinations
1	Sothern Konkan Coastal Zone.	Rice, Ragi, Vari, Horse gram, Niger, Sesamum, Groundnut, Jowar, Tur, Mango, Coconut, Nut meg, Back paper.
2	North Konkan Coastal Zone	Rice, Vari, Udid, Tur, Sesamum, Brinjal, Tomato, Banana, Chicku.
3	Western Ghat Zone.	Rice, Ragi, Jowar (*rabi*), Gram, Groundnut, Niger, Sugarcane, Wal, Cucurbits, Mango, Cashew, Jackfruit, Jamun, Karwanda.
4	Transition Zone-I.	Rice, Jowar, Ragi, Groundnut, Sugarcane, Potato, Onion, Cillies,Tomato, Brinjal, Mango, Banana, Guava, Cashew nut, Grapes.
5	Transition Zone-II.	Jowar (*Kharif* and *rabi*), Bajara, Soybean, Groundnut, Wheat, Sugarcane,Udid, Tur, Gram, Ragi, Tomato, Brinjal,Cillies, Grapes, Pomegranate, Sweet orange, Kagzi lime.
6	Western Maharashtra Scarcity Zone.	Bajara, Jowar, Groundnut, Safflower, Tur, Udid, Soybean, Sunflower, Pomegranate, Kagzi lime, Grapes Tomato, Chillies, Onion.
7	Central Maharashtra Platean Zone / Assured Rainfall Zone	Cotton, Soybean, Sunflower, Groundnut, Jowar,Bajara, Gram, Safflower, Rice, Sugarcane, Wheat, Onion, Tomato, Chillies, Brinjal, Sweet orange, Grapes, Pomegranate, Guava.
8	Central Vidarbha Zone / Zone of Moderate Rainfall.	Cotton, Jowar (kharif), Wheat, Tur,Udid,Soybean,Groundnut,Sunflower, Safflower, Lathyrus, Onion, Tomato, Brinjal, Sweet orange, Santra, Kagzi lime.
9	Eastern Vidarbha Zone / High Rainfall Zone.	Rice,Lathyrus, Jowar (*rabi*),Udid,Tur,Sunflower, Groundnut, Soybean,Brinjal,Onion, Tomato, Sweet orange, Santra, Kagzi lime.

Conclusions:

The pattern of crop combination gives rise to spatial predominance of certain crops or combination resulting the emergence of crop regions. Such analysis would ultimately minimize the change of oversimplified generalization (Ali, 1978). Crop combination study in geography is trustful in many ways; firstly it provides an adequate understanding of an individual crop. Secondly, combination itself is an integrative reality that demands definition and distribution analysis and finally crop combination regions are essential for the construction of more complex structure of vivid agricultural region (Weaver, 1954). The study of combination thus forms an integral part of agricultural geography and such study is greatly helpful for regional agricultural planning.

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