

Changing Spatial Patterns of Agriculture in the Punjab Province and the Food Sustainability

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Abstract: Pakistan is essentially an agricultural country as most of the population is still living in the rural areas and depending on agriculture for their livelihood. Increasing population is putting more and more pressure on the agricultural lands of the country to fulfill the food requirement. Forty four percent of the labor force of the country is alone shared by agriculture sector. Its importance increases as the most of the industries are also dependent on the agricultural products as their raw material. The province of Punjab is the agricultural hub of the country and playing a vital role in supplying the food grain and other agricultural products not only to the population within the province but to all other parts of the country. The districts in the province are producing the major grain crops, which is quite sufficient for showing the level of sustainability for the population within their limits. Only few districts in the Punjab with highly populated urban centers such as Lahore, Rawalpindi and Islamabad are showing somewhat lower shares of agricultural contribution.

Keywords: Crop combinations, food security, sustainability.

INTRODUCTION

Pakistan is an agricultural state thus agriculture gains are of more importance than any other sector. Importance of this sector is manifold as it feeds people, provides raw material for industry and is a base for foreign trade. Foreign exchange earned by the export food products and Textiles with cotton as raw material is about 76% of total exports of Pakistan [1]. Agriculture contributes 21.56% of GDP in 2009 and 21.62% in 2011. About 63% of the total populace is getting their livelihood from it.

According to economic survey report 2009-10, the growth of agriculture of the country was 6.5% in 2004-05 and 4% in 2008-09. Major and minor crops also show the same declining trend of their growth. During the outgoing year 2009, the overall performance of agriculture sector has been weaker than target. Against a target of 3.8 percent, and previous year's performance of 4.0 percent, agriculture is estimated to have grown by 0.20 percent. Major crops, accounting for 31.1 percent of agricultural value added, registered a negative growth of 4.0 percent for second year in a row mainly because of decrease in production of rice and cotton by 29.9 and 11.3 percent, respectively. Minor crops accounting for 10.9 percent of overall agriculture value addition, grew by 4.8 percent as against negative growth of last two years. Fishery and Forestry contributes 16.6% and 8.8% respectively. Though the agricultural sector is facing problems in

Pakistan yet the major chunk of money comes from this sector [2].

In geographical sense the agricultural activity is portrayed by showing the cropping patterns. There are various ways to show the areal extent of cropping pattern prevailing in an area. Generally the top ranking crops are used to show cropping pattern and the other methods are through crop combinations, i.e., the single crop dominance, the two-crop combination then three and four-crop combinations [3].

PUNJAB

The Punjab is the largest province of the country with population of 73.62 million, more than half of the country's population, while it ranked second in terms of area i.e., 205,344 km² about 26% of the country after Baluchistan. It is located at the northwestern edge of the Indian plate in South Asia. The historical capital Lahore is the largest city in the Punjab region. Other important cities include Multan, Faisalabad, Sheikhpura, Sialkot, Gujranwala, Jhelum and Rawalpindi along with federal capital city, Islamabad.

The province is inundated by five perennial rivers namely Indus, Chenab, Jhelum, Ravi and Sutlej which form the backbone of the country's agriculture by supporting a huge irrigation system in the Punjab. According to the Land uses the Punjab has 49% of its area as agricultural land with class I loamy soil to moderate loamy sandy soil. Desert soil with poor drains is marked in the south and north western parts of the province. Furthermore it has 26% of range land 8% of open land/fallow and 4% under forest cover, which is more or less scrubland forest. About 9% is covered by desert located in the south and northwest (Figure 1).

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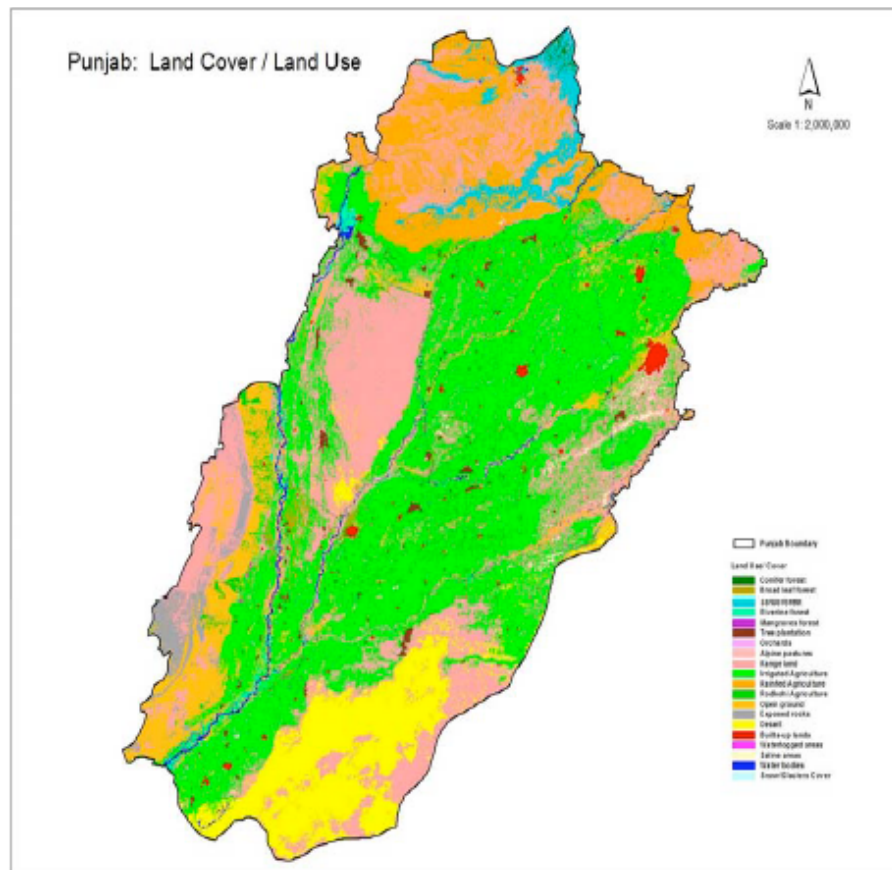


Figure 1: Source: Land use Atlas of Pakistan 2009 [4].

Weather extremes are notable from the hot and barren south to the cool hills of the north. The foothills of the Himalayas are found in the extreme north as well. The Punjab's region temperature ranges from -2° to 45°C , but can reach 47°C (117°F) in summer and can touch down to -5°C in winter.

Climatically, Punjab has three major seasons

- Hot weather (April to June) when temperature rises as high as 110°F .
- Rainy season (July to September). Average rainfall annual ranges between 96 cm sub-mountain region and 46 cm in the plains.
- Mild weather (October to March). Temperature goes down as low as 40°F .

Agricultural Sustainability

For agriculture, the issue of sustainability is linked to that of food security, i.e. the sustained ability of agriculture to provide adequate food supplies. It was included in the report of World Commission on Environment and Development also known as

Brundtland report [5]. The concern about food security stems from the fear that as population increases, our ability to meet increasing food needs will be limited by the natural resource base [6].

“However, the achievement may hectareve come at the expense of long-term sustainability of land resources and development. Sustainable development is consistent with increasing environmental assets or development without destroying the future of natural capital stock” [7].

The term "sustainable agriculture" (U.S. Code Title 7, Section 3103) means an integrated system of plant and animal production practices having a site-specific application that will over the long-term:

- Satisfy human food and fiber needs.
- Enhance environmental quality and the natural resource base upon which the agriculture economy depends.
- Make the most efficient use of nonrenewable resources and on-farm resources and integrate,

where appropriate, natural biological cycles and controls.

- Sustain the economic viability of farm operations.
- Enhance the quality of life for farmers and society as a whole [8].

That definition is a central element of the legislation of the Sustainable Agriculture Research and Education (SARE) program of NIFA (National Institute of Food and Agriculture) USDA.

According to the checklist given by FAO one of components of sustainability is food security or self sufficiency beside various other factors [9].

“Providing a wholesome and adequate food supply is the most basic tenet of agricultural sustainability. However, sharp increases in global food prices have occurred in the past 2 years, bringing the real price of food to the highest level seen in 30 years (FAO, 2008). This dramatic shift is a fundamental concern. The role of ‘local food’ in contributing to the solution of underlying problems is currently being debated” [10].

Crop Combinations

Individual crops may be studied in geography for their own sake. But all crops studied individually cannot convey the realities of the agricultural complex of an area. The areal dominance of certain crops in their varied combinations can best be studied by attempting some kind of synthesis. Rarely do we find a crop growing in complete isolation. Even in areas where a single crop predominates, minor crops do have a role to play. The identification of a crop, with its spatial relationship represents the salient features of the crop complex in an area, is not an easy task. Yet, without such a step, detailed exposition of the agricultural scene, particularly crop patterns, does not seem possible. With our concept of the region it hardly seems possible at present to arrive at a satisfactory synthesis towards agricultural regions [11].

However, with the present methodology a generalization of crop regions may be possible. It has been pointed out first by Weaver, that the generalization and identification of crop regions on the basis of single crops is far from satisfactory. The concept of crop combination region came from J.C.Weaver in 1954 and then modified by Thomas, Coppock, Jasbir Singh and Others [12]. Obviously, the search for generalization of patterns of areal

dominance of crops leads to the identification of crop combination regions. The concept of crop combination regions appears to be valid, as it makes possible the establishment of areas differentiated on the basis of the areal dominance of crops that are spatially related and occur together in varying strengths. It may also be pointed out here, that the delimitation of crop combination regions is merely to facilitate description and comprehension of the agricultural complexities of the area. The delimitation is not an end in itself but only a tool towards a better understanding of the agricultural situation.

In this study the identification of major crop combination is done by using Thomas model, based on the values of variance and hence portrayed in through maps. The application of the model helps to divide the data into two groups i.e., major and minor crops. Major crops are covering 67-100 % of the land, characterized as forming a crop-combination. The model was applied to the data of years 2004-05 and 2008-09 and expressed in Table 1 and the two maps, showing the crop combination of the Punjab i.e. in Figures 1 and 2 respectively.

Three crops, out of 33 crops, are identified as the major crops for the year 2004-05 and the remaining minor crops are also grouped by applying the Thomas model again on them for further grouping. The three crops are wheat, cotton and rice. The next minor crops are gram, sugarcane and maize. The three major crops are covering about 72% of the total cultivated land of the Punjab, which quite significant, showing the hold of two grain crops and one commercial crop. The same results are for the year 2008-09 but with one exception i.e., a slight increase in the area given to the all grain crops represented in Tables 1 and 2. The combinations identified across the districts are shown in the maps, i.e. in Figures 2 and 3.

Area under wheat exceeds six million hectares, while for cotton and rice it is 2.5 million and 1.7 million hectares respectively. This extensiveness of the crop area is in sharp contrast to the individual crop area in other provinces where they remain under one million hectares. Cotton and rice together account for a very substantial crop area, contributing substantially to economic potential of the Punjab. Among the twenty nine minor crops identified eight crops following in the crop category II, occupy 21.83 percent of the provincial cropped area [13].

Of this gram, sugarcane, maize and bajra are the important crops. In 2009 the major crops according to

Table 1: Punjab: Major Crops and Sub Groups of Minor Crops, 2004-05 (Thomas Model)

S. No.	Crops	Area in			Groups	
		Thousand Hectares	%	Variance	Category	%
Major Crops						
1	Wheat	6378.90	43.22	113.46	I	72.17
2	Cotton	2518.30	17.06	41.21		
3	Rice	1754.30	11.89	27.58		
Minor Crops						
1	Gram	956.40	6.48	28.96	II	21.83
2	Sugarcane	644.70	4.37	32.35		
3	Maize	475.00	3.22	35.77		
4	Bajra	331.70	2.25	39.05		
5	Other Oil Seeds	216.71	1.47	42.10		
6	Jowar	216.70	1.47	44.47		
7	Mung	206.64	1.40	46.41		
8	Citrus	173.94	1.18	48.12		
9	Vegetables	139.46	0.94	49.67	III	4.75
10	Guarseed	110.23	0.75	51.06		
11	Mango	100.60	0.68	52.29		
12	Potato	98.76	0.67	53.36		
13	Groundnut	94.70	0.64	54.30		
14	Other Fruits	94.38	0.64	55.14		
15	Sesamum	63.47	0.43	55.95		
16	Barley	35.90	0.24	56.74	IV	0.97
17	Mash	33.22	0.23	57.45		
18	Masoor	27.97	0.19	58.11		
19	Onion	27.67	0.19	58.70		
20	Mattar	17.89	0.12	59.26		
21	Tobacco	16.62	0.11	59.78		
22	Other Condiments	6.84	0.05	60.27	V	0.17
23	Dates	5.79	0.04	60.73		
24	Chillies	5.22	0.04	61.15		
25	Other Kharif Pulses	2.91	0.02	61.55		
26	Banana	1.88	0.01	61.92		
27	Sunhemp	1.67	0.01	62.27		
28	Other Rabi Pulses	0.48	0.00	62.59		
29	Apple	0.39	0.00	62.90		
30	Sugarbeet	0.00	0.00	63.18		
	Total	14759.33	100.00			

Thomas model were found to be five crops namely, wheat, cotton, sugarcane, rice and maize shown in Table 2 below.

For the crop of wheat Jhang is the major district covers more than 400 thousand hectares and producing more than a million ton alone. The other

Table 2: Punjab: Major Crops of the Punjab 2008-09 [14]

Sr. No	Name of District	Wheat		Rice		Cotton	
		Area	Production	Area	Production	Area	Production
		2008-09	2008-09	2008-09	2008-09	2008-09	2008-09
1	Attock	161.1	274.5	0	0	0	0
2	Rawalpindi	115	207.8	0	0	0	0
3	Islamabad	13	21.5	0	0	0	0
4	Jhelum	48.6	99.1	1.6	3.4	0.4	0.5
5	Chakwal	129.1	169.2	0	0	0	0
6	Sargodha	223.4	595.9	51	83.2	6.9	14.9
7	Khusab	83.3	148.6	21.4	37.4	0.4	0.6
8	Mianwali	175.7	332.8	4.9	9.1	13.4	57.1
9	Bhakkar	168.7	383.5	1.2	2.1	8.1	26.7
10	Faisalabad	289.3	846	38.9	61.8	39.3	144.7
11	Toba Tek Singh	163.1	490.4	35.2	59.5	43.3	165.2
12	Jhang	401	1122.9	102.8	182	55.4	206.5
13	Gujrat	158.2	294	59.1	109.3	0	0
14	M.B.Din	131.9	357	95.9	163.1	2	3.1
15	Sialkot	211.3	543.6	190.5	341	0	0
16	Narowal	159.1	311.5	102.8	143	0	0
17	Gujranwala	236.3	755	249.2	494.9	0	0
18	Hafizabad	161.5	464.8	130.3	245.7	0	0
19	Sheikhupura	185.7	496.1	184.5	310.1	0	0
20	Nankana Sahib	166.3	493.7	114.6	210.7	0	0
21	Lahore	62.3	155.7	43.8	83.3	0	0
22	Kasur	194.2	577.4	90.2	179.8	13	32.8
23	Okara	218.9	746.7	119.8	272.6	25.1	85.3
24	Sahiwal	149.3	460.2	30	52.3	71.2	309.9
25	Pakpattan	150.9	516.4	54.3	112.9	46.1	212.5
26	Multan	199.9	590.3	17	27.3	167.1	670.8
27	Lodhran	186.6	600.3	4.9	7.8	197.5	635.6
28	Khanewal	229.5	714.3	30.4	57.5	165.5	754.1
29	Vehari	261	752.8	29.1	53.8	182.1	691
30	Muzzafar garh	315.7	854.7	23.9	48.9	182.1	505
31	Layyah	198.7	503.8	4.8	9.8	38.4	131
32	D.G.Khan	167.1	388.4	36.4	80.2	95.1	343.2
33	Rajanpur	158.6	406.3	8.5	16.9	126.7	436.3
34	Bahawalpur	295.4	885	6.4	11	279.2	1220.6
35	Rahim Yar Khan	320.5	870.2	24.2	46.7	254.1	1184.1
36	Bahawalnagar	346	989.6	70	125.9	211.2	919.8
Punjab		6836	18420	1977.6	3643	2223.6	8751.3

Punjab: Crop Combnations 2004-05

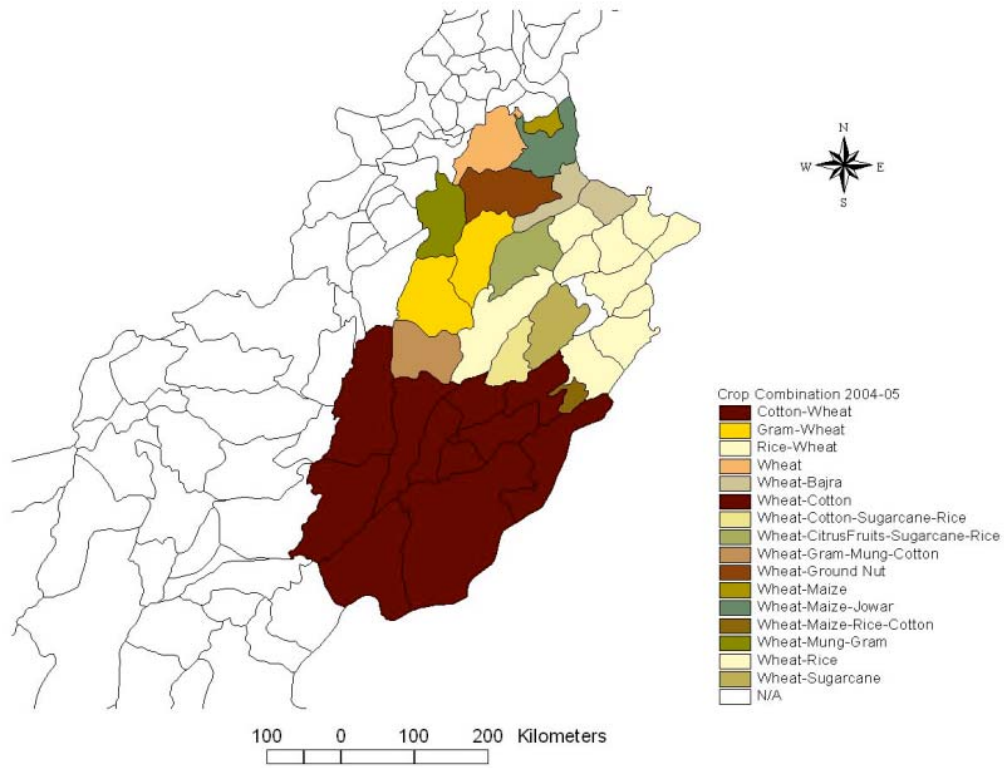


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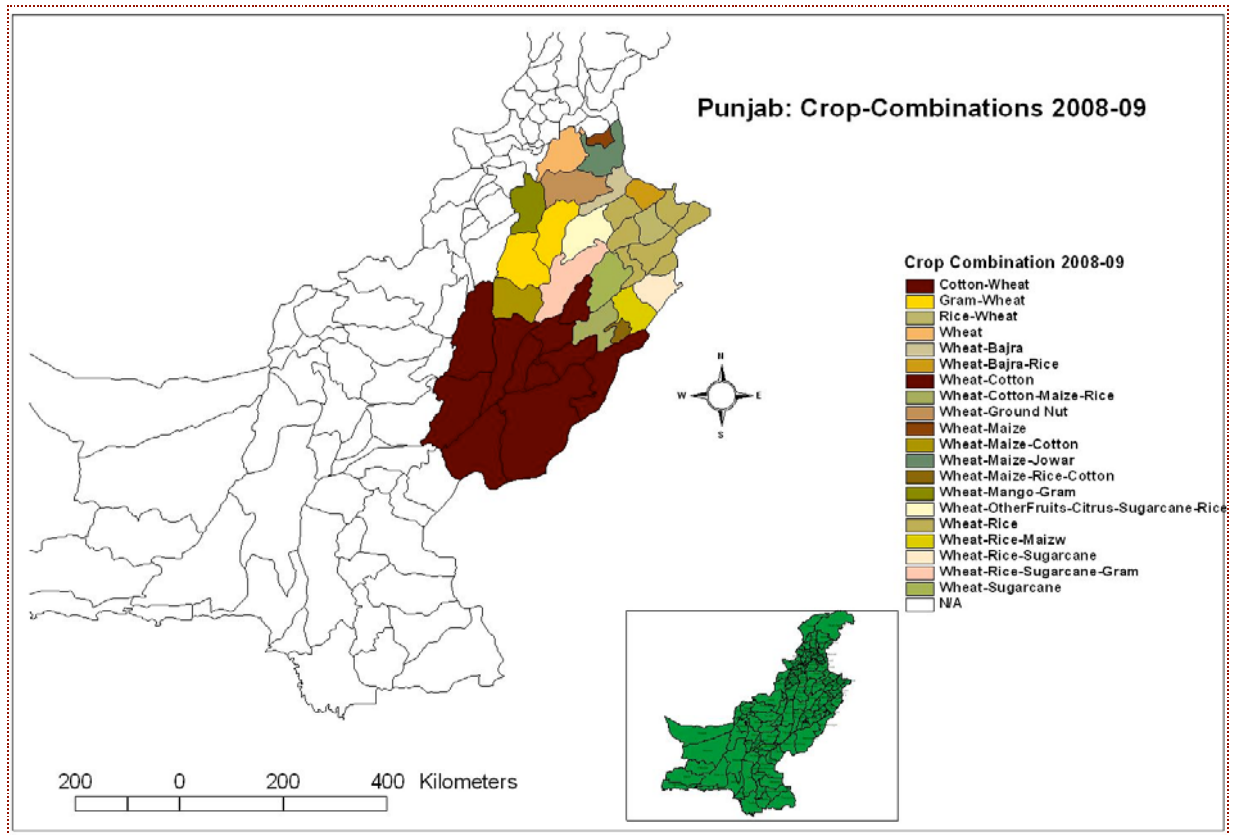


Figure 3:

dominant districts are Bahawalpur, Rahim Yar Khan and Muzaffar Garh. These districts are also producing more than 800 thousand tons of wheat annually. Rice is the next major grain in the Punjab. The major districts are Gujranwala, Sialkot and Sheikhpura, the north eastern districts of the Punjab, covers 249.2 hectares of land and producing about half million tons of rice, while Sialkot and Sheikhpura are producing more than 300 thousand tons of rice. This entire situation is sufficient for food security matters in the Punjab.

The above maps (Figures 2 & 3) are showing various crop combinations the dominant combination in both of the maps, i.e. in 2005 and 2009 is cotton and wheat or wheat and cotton dominating the southern districts of the Punjab. Rahim Yar Khan, Bahawalpur, Muzaffar Garh and Multan are marked for wheat-cotton combination. Other important combination is wheat with rice dominates in the north eastern districts, which are Gujranwala, Sheikhpura and Sialkot respectively and the third major combination is wheat with gram, marked on the western districts i.e. in the districts of Bhakkar, Layyah and Mianwali.

Comparison of Major Crops of the Punjab

In the Punjab it is apparent from the tables given that among all the major crops the Punjab has the largest share in both the years except for maize where KPK is leading by about two percent in 2005, but the Punjab out beat KPK for maize in 2009, in Table 3.

Table 3: Percent Share of Major Crops in the Punjab 2005

	Wheat	Rice	Cotton
Punjab	76.32	69.63	78.88
Sindh	10.62	21.59	19.89
KPK	8.96	2.38	0.07
Balochistan	4.11	6.41	1.16

Table 4: Percent Share of Major Crops in the Punjab 2009

	Wheat	Rice	Cotton
Punjab	75.57	66.75	78.86
Sindh	11.40	24.76	19.91
KPK	8.51	2.07	0.01
Balochistan	4.52	6.42	1.22

All the above data related to major crops shown the tremendous pressure on the land of the Punjab to support the rest of Pakistan as the area under all the major crops in the Punjab has shown a slight decline in percent share but it is supported by the province of Sind up to some extent, where an increase in the contribution of all the principle crops observed.

Population Change

The population of Pakistan is increasing still at a faster pace but as the results of current census have not arrived the population for the years considered is projected, in Figures 4 and 5, with only a little difference, as it is for five years. Slight accumulation of population can be observed around urban centers, in Figure 5.

If one compares the population change the rate of growth are much higher in the urban areas i.e. 3.5% in comparison with 2.3% in the rural areas of the Punjab and 2.5% for the province. Still the urban areas in the Punjab do not exert much pressure on the rural land of the province, but greater pressure is observed from districts other than the Punjab and up to some extent from outside the country specially from Afghanistan, where it is either exported or smuggled for better prices and hence creating an artificial shortfall.

Changes in the Area under Major Crops

The comparison of the major crops of 2005 and 2009 shows that there is considerable area change under the major crops. Out of 35 districts 21 districts has shown a positive change in the area under major crops but 14 districts have a negative trend. It means that these are the districts where there is a shift from the major to some minor crops for increasing food grains or some commercial gain. The results are shown in the Table 5.

The districts with positive and negative changes are shown in the Figure 6. The districts which are showing a positive trend is seem to have relatively uniform character of the factors related to agriculture in the region than those which may have variable characteristics.

Grain Crop Consumption

Food security is expressed by the production of grain crops. In the Punjab it is observed that the districts of Punjab in individual capacity are far apart from the rest of the districts of the country. Few districts

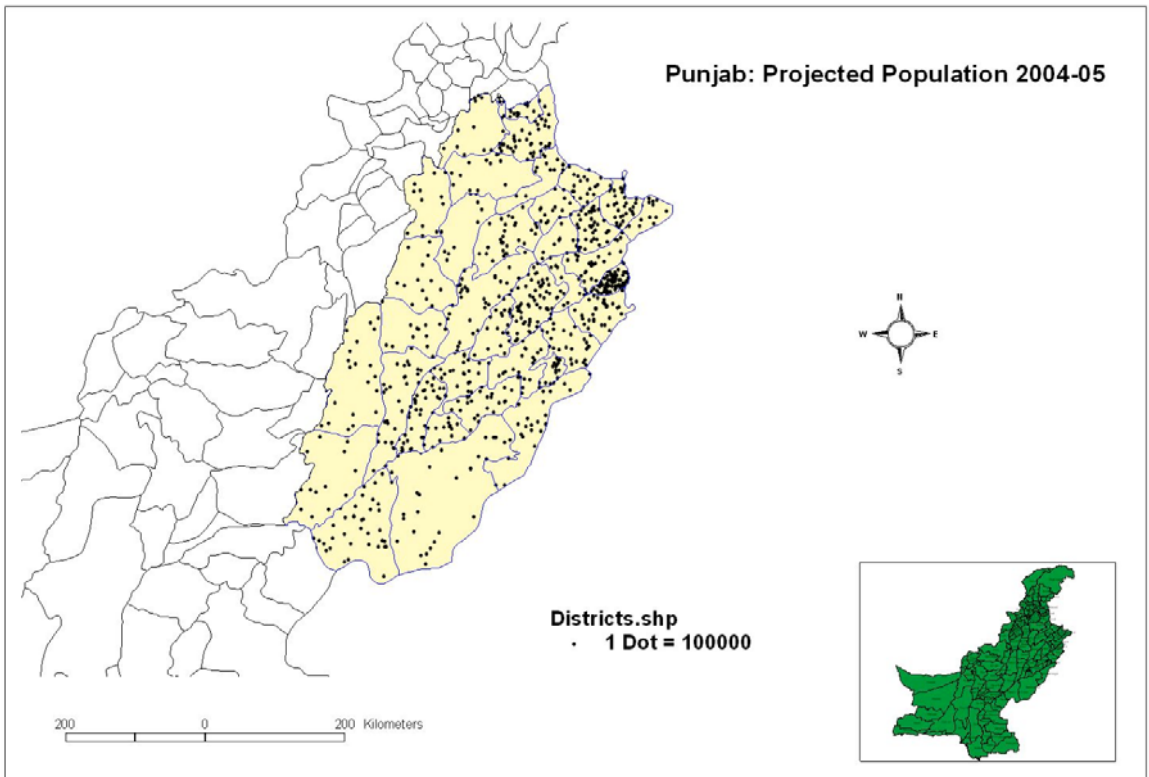


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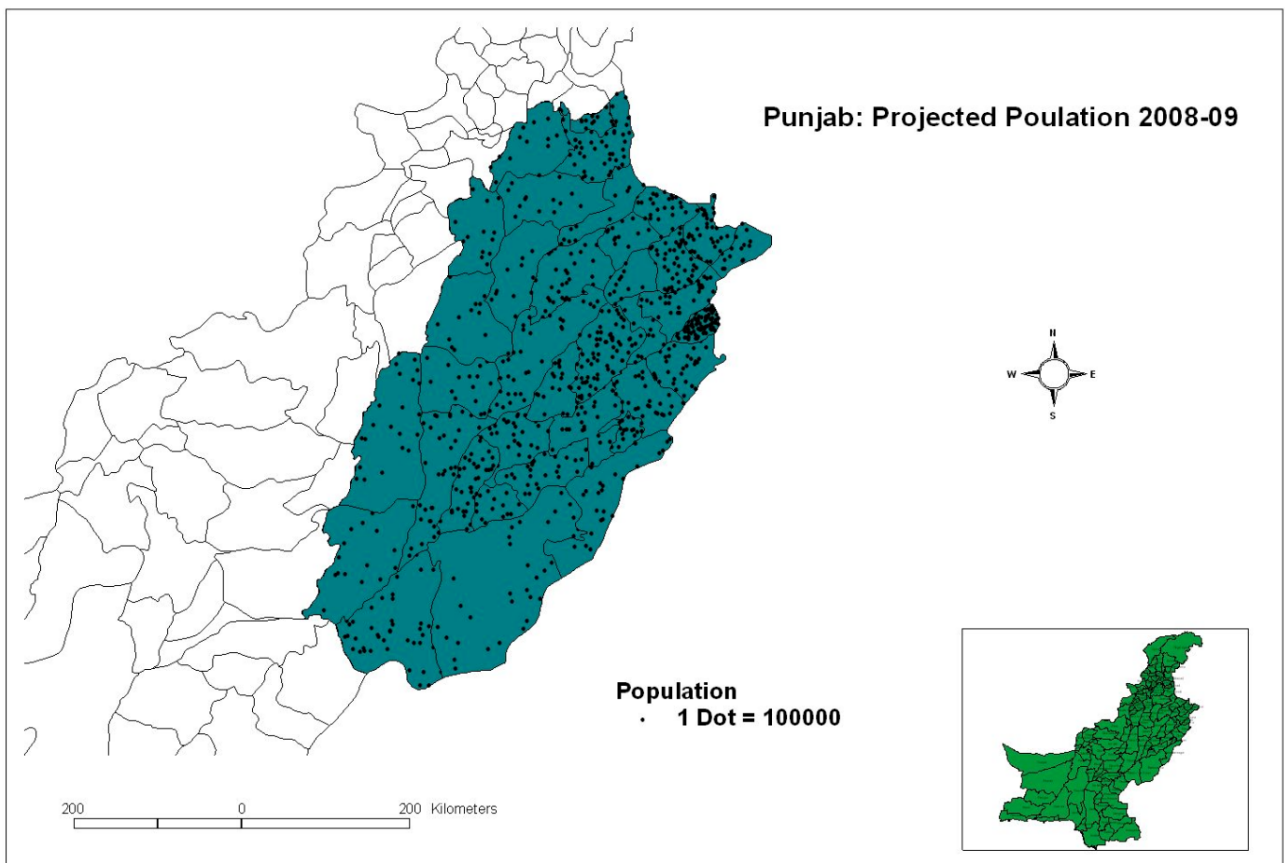


Figure 5:

Table 5: Punjab: Trends of Change in Major Crops Area

Districts	PN Trends of MJsCs	%Change	Crop Combination
Attock	13.80	9.37	W
Rawalpindi	-8.80	-4.37	WMJ
Islamabad	-1.90	-7.57	WM
Jhelum	0.90	1.22	WBj
Chakwal	-7.25	-4.06	WGn
Sargodha	123.05	31.25	WOfCSR
Khushab	-10.10	-2.96	GW
Mianwali	14.57	6.10	WMuG
Bhakkar	50.50	8.71	GW
Faisalabad	11.30	2.95	WS
Toba Tek Singh	-42.10	-16.94	WC
Jhang	180.70	37.15	WRSG
Gujrat	82.80	42.55	WBjR
Sialkot	28.70	7.69	WR
Gujranwala	15.30	3.25	RW
Narowal	44.20	20.30	WR
Mandibahauddin	22.60	11.01	WR
Hafizabad	38.00	14.97	WR
Sheikhupura	-211.80	-36.39	WR
Lahore	13.10	14.09	WR
Kasur	81.70	33.82	WRS
Okara	79.90	22.72	WRM
Sahiwal	50.60	20.47	WCMR
Multan	-22.30	-5.73	WC
Khanewal	-19.30	-4.66	WC
Vehari	-47.40	-9.66	WC
Lodhran	1.30	0.34	CW
Pakpattan	9.80	3.03	WMRC
Muzaffargarh	-10.10	-1.99	WC
Layyah	-68.26	-18.04	WMC
Der Ghazi Khan	-7.70	-2.85	WC
Rajanpur	-21.90	-7.13	WC
Bahawalpur	21.40	3.87	WC
Rahimyar Khan	-46.20	-7.44	WC
Bahawalnagar	48.90	9.62	WC
Nankana Sahib	280.90	0.00	WR

W-Wheat, C-Cotton, R-Rice, G-Gram, S-Sugarcane, M-Maize, J-Jowar, Gn-Ground nut, Bj-Bajra, Of-Other fruits, Cf-Citrus fruits and Mu-Mung.

from Sindh are seem to compete with some of the districts of the Punjab and similarly KPK has shown a good potential of producing maize which is an important grain crop after wheat and rice. Within the

Punjab districts food security is reflected from the production of food grains in the districts. Only three districts, namely Lahore, Rawalpindi and Islamabad, the federal capital, which have a large concentration of

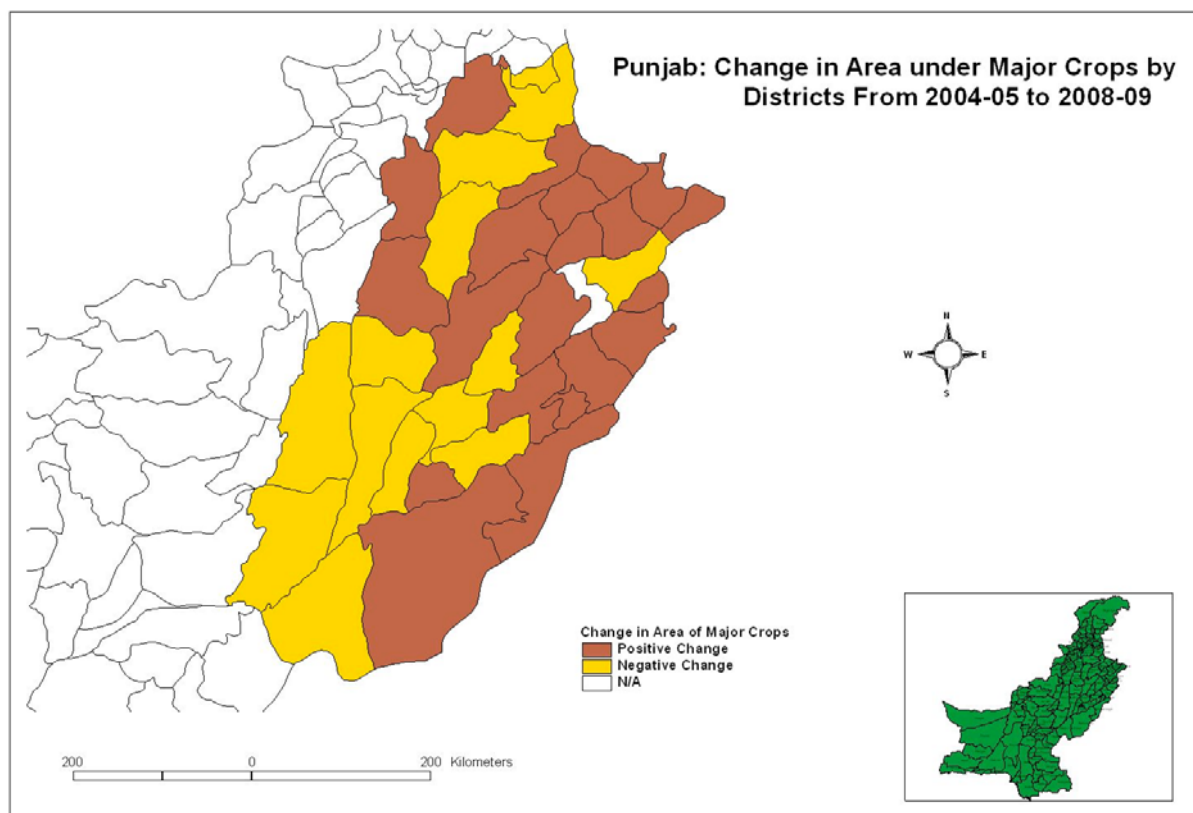


Figure 6:

Table 6: Punjab: Availability of Wheat in Kgs. per Person for Consumption 2004-05 and 2008-09

Districts	WhCn/capita09	WhCn/capita05	Absolute Change
Attock	176.77	188.54	-11.77
Rawalpindi	48.53	56.33	-7.80
Islamabad	17.62	23.27	-5.65
Jhelum	87.63	79.28	8.35
Chakwal	131.75	176.49	-44.74
Sargodha	187.05	188.72	-1.68
Khushab	137.53	169.31	-31.79
Mianwali	257.33	275.61	-18.29
Bhakkar	287.64	287.57	0.08
Faisalabad	125.66	144.55	-18.89
T.T.Singh	252.02	255.75	-3.74
Jhang	330.12	340.41	-10.29
Gujrat	118.44	130.60	-12.15
Sialkot	161.23	160.97	0.26
Gujranwala	173.44	176.33	-2.89
Narawal	207.26	240.58	-33.32
MandiBahauddin	261.58	256.00	5.58
Hafizabad	457.37	393.38	64.00
Sheikhupura	169.83	166.87	2.96

(Table 6). Continued.

Districts	WhCn/capita09	WhCn/capita05	Absolute Change
Lahore	18.46	21.06	-2.60
Kasur	193.49	184.35	9.15
Okara	271.42	293.23	-21.80
Sahiwal	206.51	218.91	-12.40
Multan	149.48	146.12	3.36
Khanewal	279.16	284.07	-4.91
Vehari	286.49	292.90	-6.41
Lodhran	403.69	332.41	71.29
Pakpattan	322.36	344.12	-21.76
Muzaffargarh	244.72	244.30	0.42
Layyah	345.46	381.31	-35.85
D.G.Khan	178.13	200.04	-21.91
Rajanpur	279.75	285.76	-6.01
Bahawalpur	279.37	252.59	26.78
Rahim Yar Khan	212.13	230.38	-18.25
Bahawalnagar	389.34	339.59	49.74
Nankana Sahib	398.13	394.99	3.14

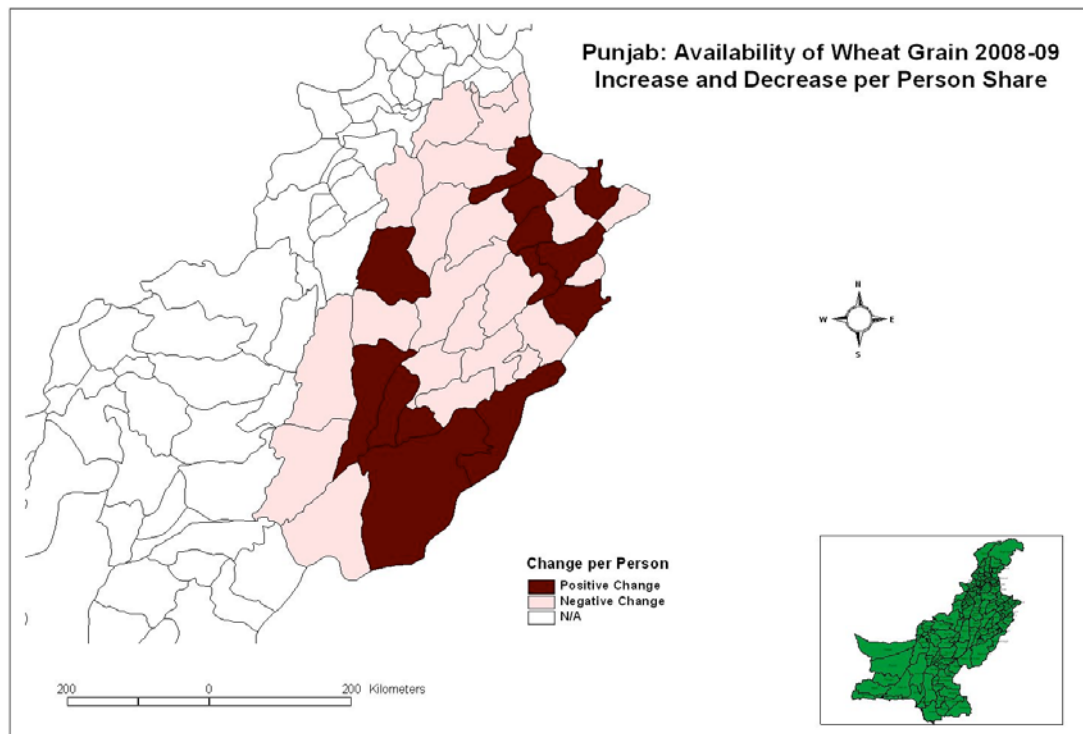


Figure 7:

urban population are not self sufficient on their own, but off course providing some other services to the other districts of the Punjab, which is also very important. For that matter they can be easily supported by other districts.

The districts which have improved per capita consumption of wheat from 2005 to 2009 are some southern districts like Lodhran 21.45%, Bahawalpur 10.6% and Bahawalnagar 14.65%, some wheat-rice districts, namely Hafizabad 16.27%, Mandi

Bahuddin 2.18% and Sheikhpura 1.77% and Bhakkar 0.03% with wheat-gram combination (Figure 7). The percentages are showing the increase in per capita consumption of wheat means the higher availability of wheat as principle grain crop.

There are number of districts which are showing decrease in the production in comparison with the population growth hence having a negative trend. There are 21 such districts, while 13 districts have shown a positive trend towards availability of wheat, leading to strengthen the food security and hence food sustainability in the region.

CONCLUSION

Pakistan is an agricultural country. Its economy depends on agricultural activities. The Punjab is the largest province of the country by population and economy. For food sustainability in the country this province is supporting to a greater extent by supplying its surplus food to other parts of the country. Major crop combinations are wheat-cotton, wheat-rice, and wheat gram and wheat maize giving boost to grain crop availability with in the province. Substantial number districts have shown an increase in the availability of wheat grain for their consumption. The area under wheat which is principle crop of the province has shown slightly higher percentage, comparing it with the production at present it may be fine but this is the point to ponder that this practice is not legible to continue in future as the land cannot be extended unlimited. Farmers have to think about using high yielding varieties and better ways of crop management. Apart from that on the whole, better population control and improved education specifically for farmers are also very essential to improve the productivity level and hence the sustainability. It is apparent from the analysis

that any grain shortage within the province may be artificial or may be a result of mismanagement from the concerned bodies.

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Received on 20-04-2013

Accepted on 25-04-2013

Published on 08-05-2013

<http://dx.doi.org/10.6000/1927-5129.2013.09.50>

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