

WATER LOGGING AND ITS EFFECT ON CROPPING PATTERN AND CROP PRODUCTIVITY IN SOUTH-WEST PUNJAB : A CASE STUDY OF MUKTSAR DISTRICT

***Sukhdeo Singh**

After the introduction of canal irrigation system mainly in South-West Punjab and poor drainage system give birth to the serious problem of water logging which results socio-economic loss to the rural population. The present study is an attempt to focuses on worrisome issues of water logging that has been dogging the farmers in South-West region of Punjab for a long time. It also reveals that the cropping pattern shifts from wheat-cotton crop rotation to wheat-paddy crop rotation and other commercial crops as sugarcane, sarson, cereals etc totally expressed eliminate due to many reasons. Crop productivity of most crops is adversely affected in this region due to water logging and productivity per acre less than by about fifty per cent in waterlogged land as compare to normal land.

Keywords: Irrigation, Water logging, Cropping Pattern, Crop Productivity.

INTRODUCTION

There are many success stories of agriculture as an engine of growth early in the development process and of agriculture as a major force of poverty reduction. Agriculture growth was the precursor to the acceleration of industrial growth, very much in the way agricultural revolution predated the industrial revolution that spread across the temperate world from England in the mid 18th century to Japan in the late 19th century (World Development Report, 2008). Due to the introduction of modern methods of cultivation during 1970s which is famously known as Green Revolution the agriculture in the State of Punjab has made spectacular progress from the last four-five decades and there seems to be no parallel example anywhere in the world history of agricultural development (Rangi and Sidhu, 1998).

The introduction of new technology has completely replaced the old mode of production in Punjab's agriculture. Traditional agriculture has progressively given way to modern and commercial agriculture and sooner Punjab became the role model for the other States in the country. No doubt, the new technology has provided numerous economic gains to the State and the country as a whole in the form of increase in both production and productivity and irrigation coverage up to 95 per cent of the total cropped area in Punjab. But Punjab has been suffering a lot from the ecological point of view. Due to the new agricultural technology, the demand for water, chemical fertilizers, insecticides and pesticides increased very sharply in the State, which gives birth to the problem of water logging and water depletion, soil degradation and health problems.

Irrigation canals bring farmers the most important input for increased agricultural production. But irrigation has not been an unmixed blessing to the farmers. It also has the potential to turn green fields into water logging. The land in the canal areas is often flat and poorly drained. The application of irrigation water to them results in water logging over a period of time. Poor water management is leading to land degradation in irrigated areas through water logging and salinity. Due to the unplanned canal irrigation system, inadequate drainage system and over irrigation seepage, the problem of water logging becomes an important issue in the different part of Punjab.

Due to water logging, the level of groundwater rise and then it reaches to the crop root zone, it starts to have a serious impact on crop productivity, making the land totally unproductive and rendering the land into wet desert. It is not only adversely affect the cropping pattern, crop productivity and soil fertility, but it also making the bad effect on land, roads, buildings, trees etc.

The present paper is an attempt to examine the problem of water logging and its effect on cropping pattern and crop productivity in the South-West districts of Punjab State. The paper is divided in to three sections. The first section deals with the problem of water logging in South-West districts of Punjab with special emphasis on Muktsar district. In the second section, the effect of water logging on cropping pattern has been examined. Water logging and crop productivity in waterlogged area has been examined in the last section.

METHODOLOGY

This present study is relating to Muktsar district of Punjab. The study is based on primary as well as secondary sources of data. Secondary sources are used to look into the area under water logging in Punjab and Muktsar district and for the selection of villages which are most affected by water logging in each block of the district of Muktsar. Four villages one from each block are to be selected from the district. This includes Husner (Gidderbaha block), Tapa Khera (Lambi block), Ratta Khera (Malout block) and Dodan Wali (Muktsar block). The information in this regard has been collected from the different departments of Government of Punjab. Primary data is collected through a primary field survey for the agricultural year 2010. For the primary analysis, the 10 per cent of the households as sample from the total number of marginal, small, medium and large farmers has been selected to examine the affect of water logging on cropping pattern and crop productivity in the study area.

EXTENT OF WATER LOGGING IN SOUTH-WEST PUNJAB

As far as the Punjab is concerned, before the introduction of canal network water table was very deep in the whole of Punjab. Punjab is one of the first States in India to have set up mighty canal system. In the pre-independence period headwork constructed were Madhopur on Ravi river along with Upper Bari canal, Ropar on Sutlej with Bist doab and Sirhind canals and Hussainiwala on Sutlej with Eastern and Bikhner canals. In the post-independence period Bakhra dam with Nangal headwork on Sutlej with Bhakhra main canal, Harike headwork on Sutlej-Beas with Sirhind feeder and Rajasthan feeder and Pong dam on Beas-Talwara headwork to feed Shah and Kandi canals. As result of canals network in whole Punjab, the ground water table started rising and by 1964 substantial area having shallow water table (Uppal, 1966). From 1964 onward ground water table experienced both fall and rise.

After the introduction of canal irrigation in South-West Punjab, this comprises the districts of Bathinda, Faridkot, Ferozepur Muktsar, Moga and Mansa. The water table has been progressively rising in almost all the districts. The South-Western districts comprises 34 per cent area of Punjab and out of 17.2 lakh hectare areas of the zone, 6.3 lakh hectare areas has a rising water logging problem (Gupta et al., 1995). Another study also estimates that in 1991 about 200,000 hectare of land in Punjab was under the water logging. The most affected districts are Ferozepur, Fridkot, Bathinda and Muktsar (Dharmadhikary, 2005). During the last two decades, water table has risen by more than 10 meters in 30 per cent and 10 per cent of areas of Muktsar and Bathinda districts respectively (Kamra et al., 2007). Ground water up to 15 meter depth is saline and unfit for irrigation in about one fourth of South-Western districts (Kamra, et al., 2007). The rising trend is due to lack of provision of adequate drainage system, excess application of irrigation water and

under exploitation of groundwater resources due to its poor quality. The region, irrigated with Sirhind canal and an extensive distribution network is experiencing extreme instances of water logging and soil salinity problems. As a result, water and salt have been accumulating over the years in this region of Punjab. The water table in South-West Punjab is rising at the rate of 0.5 meter to 1.0 meter per year (Joshi and Tyagi, 1991). The original cotton/bajra/maize-wheat/gram system has been replaced by paddy-wheat crop rotation resulting from leveling of extensive sand dunes and conversion of these to irrigated fields. The area under cotton has been reduced by rising water table and farmers are not keen to grow cotton. Changing cropping pattern, aridity, rise in water in old paleo-channels, use of poor quality irrigation water and canal seepage have compounded the problem critically.

Table 1
Waterlogged Area (up to 1.5 m depth) in Punjab and Muktsar District
(In Hectares)

Years	Waterlogged Area in Punjab	Waterlogged Area in Muktsar District (%age)
1998	104,250	65,200 (62.54)
1999	64,350	35,150 (54.62)
2000	30,300	11,100 (36.63)
2001	39,000	9,200 (23.59)
2002	18,050	11,950 (66.20)
2003	7,100	1,950 (27.46)
2004	10,400	5,800 (55.77)
2005	5,800	2,200 (37.93)
2006	12,000	10,700 (89.17)

Source: Water Resources, Directorate, Punjab, Chandigarh.

Note: Figures in parentheses represent percentages.

Problem of Water Logging in Muktsar District

The problem is wide spread over all blocks of Muktsar. The water table has been rising steadily over the last three decades reaching within 1 meter or less from the surface over large areas (Government of Punjab, 2008). Table 1 highlights that the per cent share of waterlogged area has been increased from 62.54 per cent of total area of water logging of Punjab in 1998 to 89.17 per cent in 2006 in Muktsar district.

The problem is widespread over all blocks (Malout, Lambi, Gidderbaha and Muktsar) of Muktsar district. The water table rises virtually to surface in number of villages during the rainy season causing serious damage to standing crops. Water logging and soil salinity are thus an unavoidable off shoot of irrigation and adversely affect the production and productivity in irrigation command areas of South-West of Punjab resulting in huge economic loss. Therefore, serious doubt has rightly been raised on long term sustenance of irrigated agriculture unless the issue of environment degradation is not addressed appropriately.

Causes of Water Logging in Muktsar District

Initiation of problem of water logging, its extent and degrees are controlled by several factors. The various causes for the development of water logging in Punjab is as under

The huge network of unlined distribution and their field channels recharge ground water body on account of seepage from as well as by returns slow of irrigation into the fields.

Two major lined canals i.e. Rajasthan feeder and Sirhind feeder running parallel to East of Muktsar district. Although lined but on account of cracks in lining of their bed and sides are causing damage to the area and major source of excess inflow into the area.

Poor working of existing surface drainage system is also responsible for water logging. The drains have not been built along with the canal network. Even where drains have been constructed, the maintenance of the drains is of very poor quality.

Very less withdrawal of underground water for irrigation due to poor groundwater quality.

Lateral groundwater flow from North-East to South-West duration the depth of water table contours from North-West Punjab towards Bathinda and Malout towns with average rate of travel of about 0.29 kms/year and cause the water table rise in this tract (Uppal and Mangat, 1981).

WATER LOGGING AND CROPPING PATTERN

Just after independence, the country was in the grip of severe food shortage in spite of heavy imports of food grain. Thus, the priority of nation was to lay more stress on production of cereals. The Punjab state took the lead in making drastic changes in the cropping pattern to push up the productivity of various crops. The cropping pattern of the state changed significantly over the period of time. The wheat being a traditional crop has from the beginning dominated the cropping pattern of the state, but its significance has increased over the period. There was a substantial jump in the proportion of the area under wheat when the new dwarf varieties were introduced in mid-sixties. Table 2 shows the changing pattern of state. It is revealed that over the time period area under wheat, paddy, cotton and sugarcane changed. The area under wheat was 29.59 per cent of total cropped area of the state in 1960-61, but it increased to 44.36 per cent in 2009-10. The area under paddy increased tremendously after the introduction of new dwarf varieties in early seventies. It increased from 4.79 per cent in 1960-61 to 35.29 per cent of the total cropped area

in 2009-10. It is increased by about 8 times during this period. The cotton (American and Desi), sugarcane and other important crops occupied 9.45, 2.81 and 53.36 per cent respectively in 1960-61, but these crops have lost their share in total cropped area in 2009-10 as 6.46 per cent, 0.75 per cent and 13.13 per cent respectively due to relative disadvantages.

Table 2
Shifting Cropping Pattern in Punjab
(Area in 000 Hectares)

Years	Wheat	Paddy	Cotton	Sugarcane	Other crops	Total cropped area
1960-61	1,400 (29.59)	227 (4.79)	447 (9.45)	133 (2.81)	2,525 (53.36)	4,732 (100)
1970-71	2,299 (40.49)	390 (6.87)	397 (6.69)	128 (2.25)	2,464 (43.40)	5,678 (100)
1980-81	2,812 (41.58)	1,183 (17.49)	649 (9.60)	71 (1.05)	2,048 (30.28)	6,763 (100)
1990-91	3,273 (43.63)	2,015 (26.86)	701 (9.34)	101 (1.35)	1,412 (18.81)	7,502 (100)
2000-01	3,408 (42.91)	2,612 (32.89)	474 (5.96)	121 (1.52)	1,326 (16.69)	7,941 (100)
2009-10	3522 (44.36)	2802 (35.29)	513 (6.46)	60 (0.75)	1,043 (13.13)	7,940 (100)

Source: Statistical Abstract of Punjab, Various Issues.

Note: Figures in parentheses represent percentages.

The cropping pattern of the Muktsar district which is the one of the districts of South-West region of Punjab popularly known as cotton belt has also changed. Table 3 reveals that the share of other crops declined from 40.13 per cent in 1995-96 to 10.51 per cent in 2009-10 due to many reason. Wheat, the major food grain always remained quite eco-friendly. It has been the dominant rabi crop in this district from the beginning. In 1995-96, 44.50 per cent of the gross cropped area in this district was under wheat, which slightly increased to 45.65 per cent in 2009-10. Paddy, initially grown in waterlogged area of the district, but now become the second main crop. It was hardly grown on 1.57 per cent of the area in 1995-96 and now, it become the second dominant crop with 22.27 per cent of the total cropped area in 2009-10. Cotton always remained the traditional crop of the district of Muktsar. The area under cotton occupying 15.21 per cent of the gross cropped area in 1995-96 increased to 21.38 per cent in 2009-10. However, the yearly fluctuations in the yield and area under different major crops due to changing climate conditions, multi deceases and price variations.

Table 3
Changing Cropping Pattern in Muktsar District
(Area in 000 Hectare)

Years	Wheat	Paddy	Cotton	Sugarcane	Other crops	Total cropped area
1995-96	170 (44.50)	6 (1.57)	58.1 (15.21)	0.6 (0.16)	153 (40.13)	382 (100)
2000-01	189 (43.85)	93 (21.58)	86.5 (20.07)	3.8 (0.88)	58.7 (13.62)	431 (100)
2005-06	200 (44.94)	77 (17.30)	117 (26.29)	1 (0.23)	50 (11.24)	445 (100)
2009-10	205 (45.65)	100 (22.27)	96 (21.38)	0.8 (0.17)	47.2 (10.51)	449 (100)

Source: Statistical Abstract of Punjab, Various Issues.

Note: Figures in parentheses represent percentages.

Table 4
Cropping Pattern during Water Logging
(In Percentage)

Name of Village	Area under different crops, per cent							
	Rabi Crops				Kharif Crops			
	Wheat	Fodder	Permanent Fallow	Seasonal Fallow	Paddy	Fodder	Permanent Fallow	Seasonal Fallow
Husner	72.19	9.79	10.01	8.01	80.70	9.29	10.01	-
Tapa Khera	75.90	9.01	9.07	6.02	82.33	8.6	9.07	-
Ratta Khera	61.04	8.21	18.70	12.05	74.95	6.35	18.70	-
Dodan Wali	76.04	6.13	12.15	5.02	80.72	7.13	12.15	-
Total	71.46	8.28	12.48	7.78	79.68	7.84	12.48	-

Source: Field Survey, 2010.

The cropping pattern in kharif and rabi season during the water logging in the study area given in Table 4. The primary analysis of the most affected villages by water logging depicts that the area under cotton had decreased and reached to zero in these villages due to stagnant problem of water logging. The wheat-cotton crop rotation is changed into wheat-paddy crop rotation which dominating the cropping pattern in the study area. Cotton is totally replaced by paddy in this area. The cotton is very sensitive crop to water logging and can not tolerant excess water in root zone. As far as sugarcane and sarson is concerned, the area under these crops is totally struck out from the cultivation purposes. The main reason behind struck out these crops from cultivation is that these crops are very sensitive crops to water logging and they can not tolerant excess water in

root zone. The study shows that 12.48 per cent of area of households remained permanent fallow because of water logging and 7.78 per cent is left seasonal fallow during rabi season because, the delay land preparation and cultivation of rabi season crops. The study highlights that the major kharif crop are paddy and fodder with 79.68 per cent and 7.84 per cent respectively. In rabi, wheat the most important crop covering 71.46 per cent of total cropped area during study period and fodder covers only 8.28 per cent of total cropped area.

WATER LOGGING AND CROP PRODUCTIVITY

Productivity is one of the main factors that determine the area under a particular crop in future. Table 5 highlights the area and productivity per hectare in Punjab and South-Western region of Punjab. The productivity of wheat has been continuously improving over the years since sixties. Its yield is 4563 kg per hectare in 2001-02 which covering 3408 thousands hectares area under wheat in the State. But it decreased to 4179 kg per hectare in 2005-6 due to mono-culture of single dominant varieties PBW 343, covering more than 90 per cent of the total area under this variety of wheat in the State. Afterwards, the yield of wheat increased to 4307 kg per hectare in 2009-10. If we look into the South-West region, the conditions are same as well as the State. In the case of paddy, the yield continuously increased from 3506 kg per hectare to 4010 per kg hectare between 2001-02 to 2009-10. Initially, paddy was growing in water logging area in the South-West region, but after that it started substituting paddy in place of cotton due to adverse climate condition and failure of varieties of cotton in the whole region. The growth of cotton productivity is improved with the introduction of new high yielding cotton varieties especially BT cotton. In 2001-02, its yield is 845 kg per hectare, but its yield increased to 1118 kg per hectare with 513 thousand hectares in 2009-10. The main reason behind increased yield under cotton is that the introduction of BT cotton varieties in the state from last one decade. The analysis also shows that area under cotton is decline in the South-West part of Punjab, but productivity is increasing if we compare it with previous years.

Agricultural production and productivity of most crops is direct bearing due to water logging. Both air and water in appropriate proportion are essential for plant growth and a slight disturbance in this delicate balance of plant physiological growth. The extent of the yield reduction is influence by the physiological stage of growth at which water logging occurs, the time and duration of water logging, temperate, the fertility of soil and kind of crop (Gupta et al., 2006). The cotton is very sensitive to water logging and 77 per cent yield reduction due to this, the corresponding figures for paddy, wheat and sugarcane are 42 per cent, 38 per cent and 61 per cent (Joshi, 1994).

The data in Table 6 reveals that average size of area under different crops among all farm-size categories as 8.53 acres for wheat and 3.80 acres for fodder in rabi season. All farm-size holding covers 8.94 acres of paddy and 1.26 acres of fodder in kharif season. The study also depicts that the average productivity of wheat is 11.30 quintal per acre which is less than by about fifty per cent as compare to normal land. In the case of paddy, it also shows that average productivity of paddy in waterlogged area is less as compare to unaffected land. The average productivity of paddy is 22.41 quintal per acre in waterlogged area of the households. The average productivity per acre in the case of marginal and small farm-size holding is low than of medium and large farm-size holding because the marginal and small farmers are not economical strong to consume costly chemical fertilizer to increase productivity. The overall results shows that in waterlogged area, the productivity is less in one side and it increases the cost of production on other side because farmers are keen to use more and more costly chemical fertilizer which result of indebtedness and farmers are committing suicides in Punjab.

Table 5
Area and Yield of Different Major Crops in South-West Districts of Punjab
(Per Hectare)

Name of District	Years																	
	2001-02				2005-06				2008-09									
	Wheat		Paddy		Cotton		Wheat		Paddy		Cotton		Wheat		Paddy		Cotton	
Area	Yield	Area	Yield	Area	Yield	Area	Yield	Area	Yield	Area	Yield	Area	Yield	Area	Yield	Area	Yield	
Ferozepur	383	4336	230	3755	143.1	750	386	4065	236	4049	140	1429	395	4142	262	3680	127	1070
Fridkot	111	4468	70	3823	36.1	645	116	4164	86	3941	26	1330	117	4107	98	4219	18	1031
Muktsar	194	4238	65	3673	125.5	675	200	3936	77	3867	117	1482	205	4633	100	3873	96	1241
Bathinda	243	3905	82	3742	162	677	243	3927	95	4057	151	1280	251	4634	104	4575	150	1340
Mansa	166	4045	68	3562	92.2	653	163	3754	70	4154	91	1170	170	4297	77	4211	89	996
Moga	167	4664	152	3807	14.3	458	174	4609	167	4403	9	1259	177	4401	172	4721	4	968
Punjab	3408	4563	2612	3506	474	845	3468	4179	2642	3858	557	1277	3522	4307	2802	4010	513	1118

Source: Statistical Abstract of Punjab, Various Issues.

Table 6
Average Area and Average Productivity of Important Crops in Study Area

Farm Size	Rabi Crops				Kharif Crops			
	Wheat		Fodder		Paddy		Fodder	
	Average Area (in Acres)	Average Productivity (in Quintal Per Acre)	Average Area (in Acres)	Average Productivity (in Quintal Per Acre)	Average Area (in acres)	Average Productivity (in Quintal Per Acre)	Average Area (in acres)	Average Productivity (in Quintal Per Acre)
MFs	2.15	10.89	0.41	78.10	2.30	21.17	0.30	140.37
SFs	3.97	10.27	0.85	78.53	4.9	21.23	0.50	140.80
MDFs	9.24	12.02	1.68	78.89	9.41	23.05	1.25	147.99
LFs	18.76	12.15	3.42	78.83	19.14	24.20	3.00	150.16
Average size/ total	8.53	11.33	3.80	78.64	8.94	22.41	1.26	144.83

Source: Field Survey, 2010.

Note: MFs (Marginal Farmers), SFs (Small Farmers), MDFs (Medium Farmers) and LFs (Larger Farmers)

CONCLUSION

In Punjab, after the introduction of canal irrigation in South-West region and poor drainage system, the water table is rising at an alarming rate which results water logging in this region. Water logging is adversely affecting the cropping pattern and crop productivity in irrigation command area of South-West part of resulting in huge socio-economic loss. Due to water logging problem, cotton is totally replaced by paddy. Earlier cotton covered 80 per cent of the total area in the region, but now totally struck out from cultivation process. Cotton is very sensitive crop which does not tolerate excess water, so cotton crop is proved total failure in waterlogged areas. Sugarcane, seson and other crops also eliminated from cultivation because of relative disadvantages. The crop productivity of most crops is also affecting in the waterlogged area. The yields of most important crops like wheat and paddy has reduced almost fifty per cent reduce in waterlogged area if we compare it with normal land. This increase the cost of production because farmers are used more pesticides and insecticides to increase productivity of crops. Water logging in a considerable decrease in net returns from crop production and farmers income, thus affecting the well-being of the rural population in the Punjab. Due to low net returns from agriculture, indebtedness and suicides particularly among marginal and small farmers being a burning issue in Punjab economy.

It comes out from the analysis that cropping pattern and crop productivity has adverse affected

by water logging in irrigation command area of the South-West region which resulting in huge socio-economic loss. There is need for development of an appropriate organizational, technical and administrative framework to overcome the problem of water logging and drainage issues at national and state level. Since water logging is a result of accumulation of excess water, the remedial measures are related to drainage system. Broadly, the drainage measures are two types' surface drainage and sub-surface drainage. Both vertical surface and horizontal sub-surface drainage pumped out the excess water from a large area and it can be used for direct irrigation or added to canal water. Surface drainage should be built along with the canal system. Even where the drains have constructed, the maintenance of drains is required so that these can be kept in good conditions. Where the ground water and soil is not saline, the handling of the problem of water logging is easier because the accumulated water can be pumped out and can be used directly for irrigation purposes. Another way to control water logging is by bio-drainage namely planting tree. For this purpose Eucalyptus should be grown in waterlogged areas because it has very high tolerant capacity to water. Water logging adversely affected the crop productivity so there is an urgent need to educate the farmers by promoting rural non-farm activities. Besides this, government should provide loan at very low rate of interest for establishment of various income generating ventures will help the farmers. Last but not the least, to overcome the problem of water logging crop insurance should be provided to the farmers in waterlogged area.

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