VOL. 11, NO. 6, JUNE 2016 ISSN 1990-6145
ARPN Journal of Agricultural and Biological Science

www.arpnjournals.com

IMPACTS OF WATER LOGGING AND SALINITY ON CROPS PRODUCTION OF VILLAGE ADINA, DISTRICT SWABI

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ABSTRACT

This study was conducted to investigate the impacts of water logging and salinity on crop production in village Adina, District Swabi of Khyber Pakhtunkhwa. Questionnaire survey was used for data collection about underlying causes of water logging and salinity in the area, comparative assessment of yield production in water logged and non-water logged soil and vulnerability of different crops to water logging and salinity. Soil was also analyzed for pH and Electrical Conductivity. Study findings indicated that yield of crops was comparatively low approximately (88%) in water logged and saline areas. The major causes contributing to water logging and salinity were seepage from canals and Terbala Dam (48%) and poor irrigation practices of farmers (28%). Rice crop was resistant to water logging while maize and wheat were most effected crops. Results of analysis indicated that pH and electrical conductivity of water logged soil samples was high. It is suggested on the basis of results that modern scientific methods should be used for irrigation and cultivation in the affected area. Salinity Control and Reclamation Project (SCARP) was launched in the area that proved effective but still there is a need to upgrade the existing project to reclaim important agricultural land.

Keywords: Water logging, Salinity, Village Adina, Rice, SCARP.

INTRODUCTION

Waterlogging and salinity reduce plant growth and resultantly reduce crop production. Pakistan is mainly dependent on agriculture sector and thus loss of agricultural production poses serious threats to the economy (Zaman and Ahmad, 2009). About 75% of the total population is directly or indirectly dependent upon the agricultural sector. The agricultural sector is mainly dependent on the irrigation system of and almost 80% of agricultural production comes from the lands which are cultivated though irrigation channels and the remaining 20% are rain dependent lands (Chaudhry *et al*., 2002 and Azhar *et al.*, 2004a). Due to the poor drainage facilities in the irrigation system not only the agricultural lands have suffered but also agricultural production has suffered from the twin menace of water logging and salinity. Thus water logging and salinity act as severe constraints to the agricultural production in Pakistan. It has been identified as a biotic environmental factor which has been eroding the agricultural production for more than three decades and thus causing threat to our future survival. The lands which are severely affected by water logging and salinity have gone out of production while much decreased has been caused to the agricultural production of lands which are slightly or moderately affected (Federal bureau of statistics, 1987). It has been estimated that water logging and salinity affects 25% of irrigated land in Pakistan, reducing crop yields (Chambers, 1988 and Yudelman, 1989). Moreover, 48% of the soils in Sindh, 18% in Punjab are strongly affected by salinity and water logging (Khan, 1991). Similarly in Khyber Pakhtunkhwa 0.472 Mha of land is affected by salinity (Qureshi and Lennard, 1998). Approximately 40,000 hectare of arable land in Pakistan is lost annually to cultivation due to salinity, and it is suggested that two tons of salt are added to each irrigated hectare per year (Stoner, 1988). While worldwide, Oldeman *et al* (1991) estimated that 10.5 Mha are affected by waterlogging and 76.6 Mha are affected by human-induced salinization, but they did not differentiate salinity in the irrigated and non-irrigated rain- fed areas. Similarly Ghassemi *et al* (1995) carried out a survey on selected countries that represent about 70 percent of global irrigated land, estimate the total world-wide salt-affected lands in the irrigated area to be 45.4 Mha. The two major environmental impacts of waterlogging and salt-affected soils are the decline in crop productivity and loss of arable land.

Water logging (hypoxia) and salinity have a range of effects. Firstly, they rapidly decrease the initial growth of roots and shoots (Barrett-Lennard, 1986a and Drew *et al*., 1988). Secondly, affect the processes associated with solute movement across membranes, such as nutrients uptake e.g. nitrogen, and increase the availability of nutrients, e.g. iron and manganese (Ponnamperuma 1977; Trought and Drew, 1980 and Buwalda *et al.,* 1988a), the regulation of cytoplasmic pH and membrane potentials (Greenway and Gibbs, 2003), and thirdly, effect the stomatal conductance i.e. it causes to decrease the stomatal conductance or leaf water potential (Bradford and Hsiao, 1982; Huang *et al*., 1995a and Else *et al*., 2001). Thus all these factors contribute to the reduction of yields and loss of arable lands. The aim of this study is to identify the causes of water logging and salinity in the area, comparative assessment of yield production and soil and vulnerability of different crops to water logging and salinity. Although, the SCARP is working effectively but still water logging and salinity are major problems of the area, therefore, the emphasis would be primarily on the technical aspects of reclamation.

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STUDY AREA

Swabi lies between the Indus River and Kabul River, in the Khyber Pakhtunkhwa Province of Pakistan. It is the fourth most populous district of the KP. It lies between 33°-55 and34°-23 north latitudes and 72°-13 and 72°-49 east longitudes. The total Area of District Swabi is 1543Km^2. Swabi is blessed with fertile agricultural land therefore most of the people are associated with agriculture. There are about 100 Villages in Distt Swabi but this study is focused on Village Adina having total land of 3500 acres (Figure-1), out of which 1500 acres are covered by mountains and approximately 800 acres of land is water logged and saline. The crops mostly grown in the study area include wheat, maize, tobacco, rice, sugarcane etc. Kharif Crops includes maize, rice, and sugarcane and ground nut. Rabi Crops include wheat, barley, rape and mustard.

Figure-1. Map of the study area.

MATERIALS AND METHODS

Both questionnaire survey and lab work was used as a tool for data collection. The study area was divided into two sections, water logged and saline area and non-water logged and non-saline area. The questionnaire was mainly focused on local farmers and it covered various aspects like the growth of various crops, causes of water logging and salinity, impacts of water logging and salinity, crops resistant and vulnerable to water logging and salinity, average production of crops and land reclaimed due to SCARP project. Both the soils water-logged and saline and non-water logged and non-saline soils were also analyzed for studying the impacts of water logging and salinity. Ten soil samples were taken from both water-logged and saline and non-water logged and non-saline soils in which 5 samples were taken from each soil which was then analyzed for pH and EC. Soil water suspension of 1:5 was sued to measure pH and EC of the soil with the help of (inoLab) pH meter and EC meter (McLean, 1982 and US salinity laboratory staff, 1954).

RESULTS AND DISCUSSIONS

Study findings showed that most of the farmers are uneducated and are mostly growing wheat, maize, tobacco and rice crops. It was noticed that rice is the most resistant crop as compared to the other crops grown in the study area. According to the view of 90% of people rice is more resistant to the water logging and salinity as compared to the other crops while maize and wheat were also analyzed as resistant crops by 2% and 8% of the surveyed farmers respectively. Further, it was also noted that tobacco crop was mostly affected as compared to the wheat, maize and rice. Data analysis revealed that tobacco is the most effected crop and according to 82% of the people views tobacco is vulnerable to water logging and salinity while maize is 10% affected and wheat is 8% effected due to water logging and salinity in the study area (Figure-2). These results are in accordance with Ahmad *et al* (2007). He found in his study that rice showed much resistance to water logging and salinity as compared to the wheat, cotton and sunflower. The resistance of rice crop to water logging and salinity is due to the aerenchyma tissues in the root cells which are prominent air spaces in the root cortex induced by water logging. These spaces provide an internal pathway for oxygen transport between roots and the aerial environment, O_2 is supplied to the roots and rhizosphere, while carbon dioxide, ethylene etc. move from the soil to the shoot and the atmosphere.

It was noted that water logged and saline lands have a decreasing trend of crops production as compared to the non-water logged and non-saline lands. Mohamedin *et al* (2010) also reported that crops production of water logged and non-water logged soil greatly decreased as compared to the non-water logged and non-saline. In the study area the major causes of water logging and salinity were noted to be seepage from the canals, Terbela Dam and agricultural methods. According to 48% of the population, seepage from canals causes water logging and salinity while according to the 28% of the total population poor irrigation and 24% unscientific agricultural practices are responsible for water logging and salinity (Figure-3). Khan (1997) also reported that water logging and salinity in general were mainly caused due to high water tables,

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seepage from canal, deep percolation and absence of inadequate and poor drainage system.

It was also found that the crops production ranging from 400-1200 kg/ acre in water logged and saline lands were found to be 6% while in non-water logged and non-saline land was 88%. Similarly the crops production ranging from 1200 -2400 kg/acre in water logged and saline lands were found to be 10% while 64% in non-water logged and non-saline. Further the crops production ranging from 2400-3600 kg/ acre was 2% in water logged and saline while 30% in non-water logged and non-saline lands (Figure-4). Overall reduction trend in crop yield is found 88%. The average production of wheat, maize, tobacco and rice per acre were found to be 1000kg, 800 kg, 400 kg and 2400 kg for water logged and saline land while production of non-water logged and non-saline lands of these crops were found to be 2400 kg, 2000kg, 1600 kg and 2400 kg respectively (Figure-5). Ahmad (2002) also noted that the maize production was reduced in water logged and saline areas while Kahlown and Azam (2002) proved that water logging and salinity has not much significant effects on the production of rice.

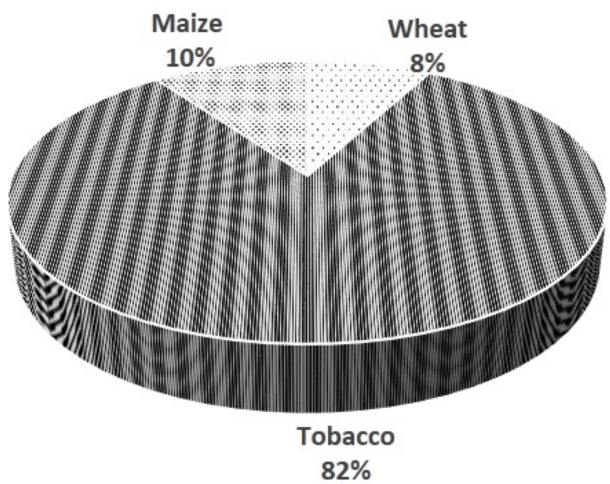

Figure-2. Crops affected due to water logging and salinity in the study area.

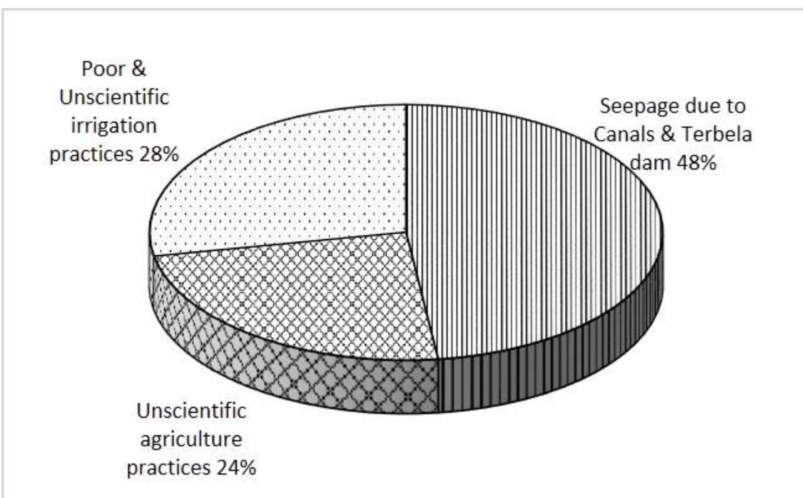

Figure-3. Major causes of water logging and salinity in the study area.

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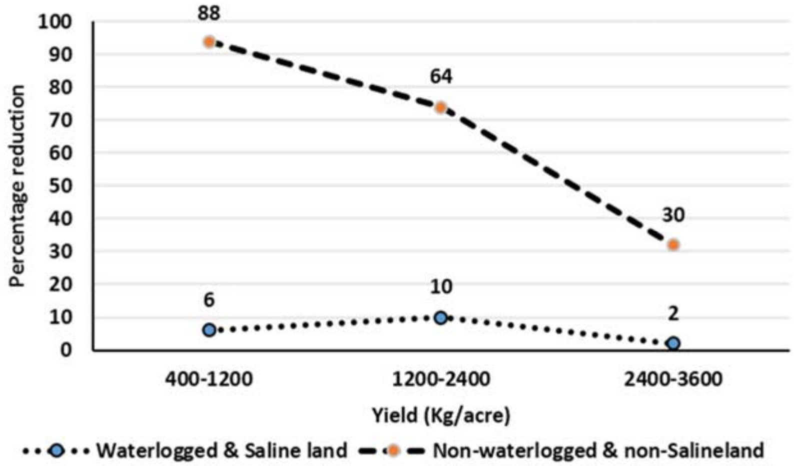

Figure-4. Percentage reduction in the crops yield.

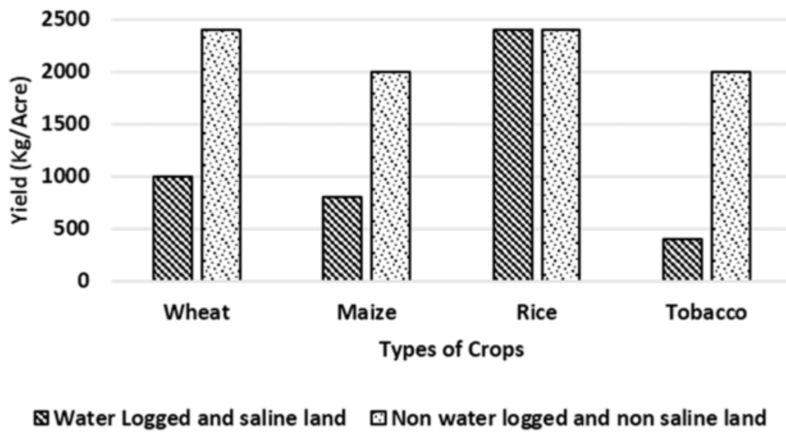

Figure-5. Reduction in the yield of crops (kg/ Acre) of the study area.

Current status and efficacy of the SCARP Project

It was noticed from the study findings that 78% of land has been reclaimed due to the implementation of the SCARP project but yet the problem exists and according to the 22% of the total population the water logging and salinity problem still occur and the efficiency of the SCARP project is not satisfactory. In reference to the current study findings Khan *et al* (1997) and Sarwar *et al* (2002) reported that water logging and salinity problems has reduced up to 50% due to the implementation of Mardan Swabi SCARP project. Similarly Tariq *et al* (2002) also concluded that SCARP project has reduced the water logging and salinity problems up to greater level.

For studying the impacts of water logging and salinity on crops production, soil salinity is measured as the concentration of soil solution in terms of EC in dSm^{-1}.Soil analysis showed that the water logged and saline soil has high electric conductivity as compared to the non-water logged and non-saline soil (Table-1). Results have been compared with US Department of Agriculture handbook standards which are saline>4; slightly saline 4<8; moderately saline 8<16; severely saline >16 (Richards, 1954). High electric conductivity causes to change the water up take. Electrical conductivity increase directly when the salt concentration increases, plants will up take more amounts of salts especially sodium and less amount of water which causes the wilting of leaves and reduce the growth of crops. In other words high EC also caused to change the osmotic effect and specific ion effect which caused to reduce the growth as well as production of crops. Li *et al* (2008) also reported that soil with high level of electric conductivity has adverse effects on the growth of crops due to which the crops yield was reduced as compared to the normal level of electric conductivity. The results of pH for saline and non-saline soil (Table-2). Results have been compared with US Department of Agriculture handbook standards which are slightly alkaline 7.4-7.8; moderately alkaline 7.9–8.4; strongly alkaline 8.5-9.0; very strongly alkaline> 9.0 (Soil survey manual, 1993). Soil pH significantly effects the availability of soil nutrients like phosphorous, zinc, manganese, iron etc., except boron, molybdenum, solubility of the toxic nutrient elements in the soil, physical breakdown of root cells and biological activities related to pH. Thus greatly affect the growth and

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development of the crops which in turn effects the crops production. Bange *et al.* (2004) carried out experiments from which he concluded that high pH of soil causes to decrease the availability of nutrients which in turn adversely effects the average crop production.

Table-1. EC (dsm^{-1}) values for non -water logged and non-saline and water logged and saline soil.

		Study sampling sites			
Soil type	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**
Non water logged and non-saline	3.2	2.9	2.5	1.2	1.5
Water logged and saline	23.9	7.1	18.7	5.2	9.1

Table-2. pH for non -water logged and non-saline and water logged and saline soil.

		Study sampling sites			
Soil type	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**
Non water logged and non-saline	7.8	8.2	8.3	7.9	8 .0
Water logged and saline	10.1	8.6	9.1	10.7	11.5

CONCLUSIONS

The present study revealed that water logging and salinity is a major problem to the crops and causes great amount of reduction in crops production. It was found that the water logged and saline lands have a decreasing trend of crops production approximately 88% as compared to the non-water logged and non-saline lands. Tobacco and maize is mostly affected due to water logging and salinity as compared to the wheat while rice was greatly tolerant to water logging and salinity. The major causes responsible for water logging and salinity were found seepage from canals, Terbela Dam and poor and unscientific irrigation and agricultural practices but the major contributor to water logging and salinity was seepage from canal (48%) reported by the local farmers. Soil analysis also revealed that the pH and EC of the water logged and saline lands were high as compared to the non- water logged and non-saline soil. This high pH caused to decrease the nutrients up take due to which the growth of crops retards and thus reduced production occurred while high electric conductivity caused to increase the concentration of salt amount and its solubility due to which the salts up take is increased and water up take declines. The high EC caused to increase the accumulation of salts due to which the crops growth is effected and thus the crops production is reduced.

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