Crop Productivity in The Riparian Zone of Ghaggar Basin, Rajasthan

Abstract

Rivers, and more so their coastal or riparian zones, are amongst the greatest agricultural producers of the world. It applies even more to the rain-deprived arid and semi-arid regions. In such regions, even seasonal, intermittent or ephemeral rivers and streams contribute highly to the agricultural economy. The Ghaggar is a seasonal river flowing through Rajasthan State of India. Whenever in spate, it brings fertile silt and recharges the ground water of the riverbed and floodplains. Arguably, these soil and water are unequally distributed, and have greater benefits for the upstream riparian zone, than in the downstream. This paper is a comparative, longitudinal study of crop productivity in the upstream and downstream riparian zones of Ghaggar, falling in the Hanumangarh and Ganganagar districts of Rajasthan, respectively.

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Introduction

Rivers are symbols of productivity and sustain large human masses by providing them food through agricultural and related activities. Rivers and streams in the arid and semi-arid regions have played similarly significant role in the development and sustenance of economies and societies there. The streams of the desert regions are not generally perennial, but mostly seasonal, in nature since flow of surface water in these streams is temporary and short lived. However, the riverbeds, and more occasionally flood plains, of these streams get recharged with groundwater, which can be used for irrigation and other purposes. The silt, coming during times of flood, provides fertile soil while recharge of groundwater offers opportunities of raising some crops. The river coasts, or the riparian zones, of such seasonal or perennial rivers in the arid regions provide better opportunities for agrarian activities and settlement of population.

The present study is focused on Ghaggar, the seasonal stream of the state of Rajasthan. This stream arises in the foothills of Himalayas and flows near the inter-state boundary of Punjab and Haryana States, before entering Rajasthan in Tibbi tehsil of Hanumangarh district. The downstream portion of Ghaggar flows through Ganganagar district of Rajasthan, before petering out in the desert sands of Anupgarh tehsil near international boundary of India and Pakistan. The study aims to analyse the agriculture in the riparian zone of Ghaggar river in Rajasthan state by looking at some aspects of crop productivity longitudinally along the river.

1. **Review of Literature**

Ali & Shalaby (2012) used remote sensing and geographic information system to establish an appropriate cropping pattern, and to assess the water needs of crops in the dry desert region west of Nile river. It was presumed that appropriate crop and water management are major pillars of sustainable agriculture in such dry region. The authors recommended appropriate crops, recognising three physiographic units of ancient deltaic plains, aeolian plains, and lowlands of alluvial deposits. These recommendations were made according to the conditions of soil, water and climate.

Shiva (2015) assessed the historically unparalleled political and technological achievement of man, i.e., Green Revolution in reference to agriculture, ecology and politics of the Third World. She alleges that this so-called non-violent revolution has caused violence and ecological poverty on the land. Showing the impacts of Green Revolution in India, she makes an assessment of the ill-effects of mono-cropping and commercial farming, while revealing close relations of ecological destruction and poverty.

Srivastava & Raghubanshi (2016) emphasized the present-day imperative of thinking in holistic dimensions, in order to establish sustainable agro-ecosystem in India. In the soils of agroecosystem, complex networks of dynamic interactions are found in spatio-temporal dimensions. During the years of Green Revolution, due to myopic and inefficient agro-management, the interactions of agricultural soils were harmed, the ill-effects of which are being seen in decreasing efficiency, productivity and multifunctionality. The Green Revolution has endangered the internal regulation in functionality of our agro-ecosystem by obstructing the efficiency-making interactions of biotic and abiotic components of this system.

Herrero and Havlik (2017) analysed global farming, and production of nutrition, according to size of farms. They also studied the interrelations of farm size, cultural diversity and production of nutrition. In Sub-Saharan Africa, South East Asia and South Asia very small farms (lesser than two hectares) are significant and produce about 30 percent of food and nutrition. It was found that diversity of production of agricultural and nutrition elements increases globally with size of the farm. However, areas of agricultural diversity generate more elements of nutrition.

Sonwa et al. (2017) worked by keeping it in mind that climatic conditions in varied agro-ecosystems of whole of Africa are changing, which are not only affecting the populations but also forcing them to respond. They also described the different factors that affect the climate change hazards in African agriculture. Included in these factors are availability of physical resources, policy references and role of culture etc. The process of adaptation to climate change should be supplemented by such research which can generate appropriate information for the measures, policies and strategies of adaptation.

Pellegrini & Fernandez (2018) analysed crop production, physical inputs and land use at country level, in order to assess the technological changes behind three times increase in global crop production between 1961 and 2014. In order to develop a measure for agricultural intensification, they converted machinery, fuels and fertilizers in terms of energy units contained in them. They found that, at global level, there was an increase of 137 percent in use of inputs per hectare, whereas increase in land use was only 10 percent.

Qureshi (2018) opined that uncontrolled and unregulated exploitation of water resource in Pakistan has put question mark on the ability of available groundwater resources to sustain the increasing population. The groundwater economy can be increased by encouraging water conservation, starting micro irrigation techniques and by growing high value crops by use of groundwater. Looking at the food needs and sustainable supply of groundwater in the country it is also necessary to rationalize the cropping patterns.

Carlson, et al. (2019) have put forward the view that man has intensely changed the natural hydrological processes that generate, and maintain, the diversity of aquatic and riparian habitats near streams and rivers. Diversion of surface water for agricultural production in arid and semi-arid regions has degraded riverine ecosystems. However, new, potential, artificial riverine systems have also been created along, and within, the canals constructed for transportation of water.

Objectives of the Study

This study aims to analyse patterns of crop productivity in the upstream and downstream riparian zones of Ghaggar river of Rajasthan by unravelling longitudinal productivity patterns along the stream. The upstream zone in Rajasthan falls in Hanumangarh district, while the downstream zone lies in Ganganagar district of the State.

Hypothesis

It was presumed that crop productivity in the upstream riparian zone of Hanumangarh district would be higher than in the downstream riparian zone of Ghaggar river lying in Ganganagar district.

Methodology & Sources of Information

This study is based on the fieldwork, carried out amongst the riverside or riparian farmers of Hanumangarh and Ganganagar districts of Rajasthan during May- June 2018. A comprehensive list of villages, lying on or near Ghaggar river, in upstream and downstream sections of Ghaggar was prepared. Out of these, twelve villages from Hanumangarh and nine villages from Ganganagar district were selected. These villages included Kalibangan, Rampura Rangmahal (Pilibangan tehsil), Chak Budh Singh, Gaadu, Dhaliya, Jawala Chak, Satipura, Amarpura Theri (Hanumangarh tehsil), Talwara Jheel, Tibbi, Thehar Khodawala and Peer Kamadia (Tibbi tehsil) in Hanumangarh district. The villages from Ganganagar district were Rangmahal Jogiya, Amarpura Jatan, Manaksar, Bhairupura Silwani, Sadak Wali Dhani, 11SD and 1 PPM (Suratgarh tehsil), 5 GB and 6GB (Vijaynagar tehsil). From these villages, lists of such farmers was prepared, who carried out farming on river bed and floodplains of Ghaggar river. Information about agricultural practices and productivity of crops was gathered from 116 farmers of Hanumangarh, and 146 farmers of Ganganagar district. Results on relevant aspects are presented in the tables below. In order to assess the characteristics of productivity, some measures were used and calculated. These measures included irrigation intensity, cropping intensity, crop yield index and crop productivity.

Irrigation Intensity was calculated for Rabi and Kharif seasons as proportion of irrigated area to the cropped area. Cropping Intensity was calculated by totalling the cropped areas of Rabi, Kharif and Jayad (i.e., Gross Cropped Area) and dividing it by the available used arable land (i.e., Net Cropped Area). Crop Yield Indices for various crops were also worked out by dividing productivity of the crop in a particular region (i.e., upstream or downstream riparian zone of Hanumangarh or Ganganagar district) by the average yield of the crop in the whole riparian zone of Ghaggar stream in both the districts of Rajasthan. Both Cropping Intensity and Crop Yield Index have been presented in percentages.

Results & Discussion

Details of land cultivated in the riverbed and floodplains of Ghaggar river, in the upstream areas of Hanumangarh district and downstream areas of Ganganagar district, are shown in the Table 1 below. The average land cultivated per household in Hanumangarh district areas was 5.34 hectares, while it was 3.97 hectares in Ganganagar district. Cultivation in Ganganagar district may be lower due to lesser availability of water in downstream areas of Ghaggar. The floodwaters don't often reach the downstream areas of Ganganagar which may reflect in lesser cultivation of such areas. It may be mentioned that rivers are public resources, and any cultivation of the riverbeds and nearby areas is not legally recognised. However, people resort to cultivating such areas because of their better fertility and productivity, which result from silts and fresh water brought by the river, whenever it is in spate.

Table 1: Average Land Cultivated in Ghaggar Basin of Rajasthan

Riparian Zone District	Total Arable Land (Hect)	Number of Households	Average Arable Land/Household (Hect)
Hanumangarh	619.66	116	5.34
Ganganagar	579.16	146	3.97
Overall Basin	1198.82	262	4.58

The proportion of irrigated area, or Irrigation Intensity, indicates the potential of agricultural and crop productivity in an area. Lying in the command area of Gang canal, Indira Gandhi Canal and Bhakhra canal, the study area is one of the highly irrigated areas of the country, not to speak of Rajasthan. Average irrigation intensity for the whole riparian zone was 99.58 percent for Kharif season, while it was 98.80 percent for Rabi season (Table 2). In the upstream riparian zone of Hanumangarh district, the ground water of the riverbed and nearby floodplains has been exploited and utilised for irrigation through tubewells, although this practice is also not legal in nature.

Table 2: Irrigation Intensity in Ghaggar Basin of Rajasthan

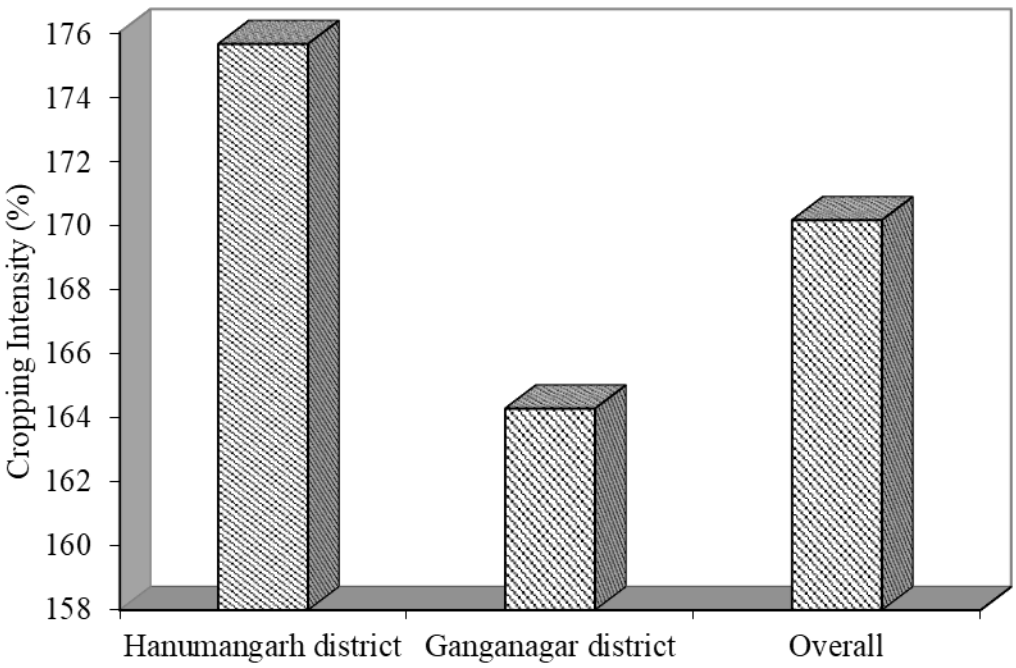
Riparian Zone District	Area Under Crops (Hec)	Area Under Irrigation (Hec)	Irrigation Intensity (%)
RABI CROP			
Hanumangarh	2078.56	2078.05	99.97
Ganganagar	1866.22	1850.10	99.14
Overall Basin	3944.78	3928.15	99.58
KHARIF CROP			
Hanumangarh	2159.28	2144.14	99.30
Ganganagar	1797.41	1765.17	98.21
Overall Basin	3956.69	3909.31	98.80

Cropping intensity is a significant indicator of agricultural and crop productivity. It is enabled by assured supply of irrigation water, which allows multiple use of same cropland in a calendar year. Cropping intensity in the riparian belt of Ghaggar river of Rajasthan desert is comparatively high, as it falls at a level of 170.15 percent. Cropping intensity is higher in the upstream zone of Hanumangarh district (175.64 percent). In comparison, the intensity of cropping is lower in downstream zone of river falling in Ganganagar district, which is only at 164.28 percent (Table 3 & Fig. 1).

Table 3: Cropping Intensity in Ghaggar Basin

Riparian Zone District	Net Cropped Area (Hect)	Gross Cropped Area (Hect)	Cropping Intensity (%)
Hanumangarh	2450.24	4303.61	175.64
Ganganagar	2290.08	3762.20	164.28
Overall Basin	4740.32	8065.81	170.15

Fig. 1: Cropping Intensity in Ghaggar Basin of Rajasthan



Productivity of some Rabi and Kharif crops in the upstream and downstream riparian zones of Ghaggar river have been presented in Table 4 & 5 and Fig. 2. Average productivities of food grains like wheat and rice in Ghaggar river basin are at higher levels in the upstream areas of Hanumangarh district. On the other hand, average productivity of oilseed, i.e., mustard and fibre crop of cotton are higher in the downstream riparian belt of Ganganagar district. This may also be due to the fact that riparian zone of Ghaggar in Ganganagar district is comparatively drier, as compared to upstream zone of Hanumangarh district. As a result, it is more productive to grow mustard and cotton in drier, more sandy parts of Ganganagar area.

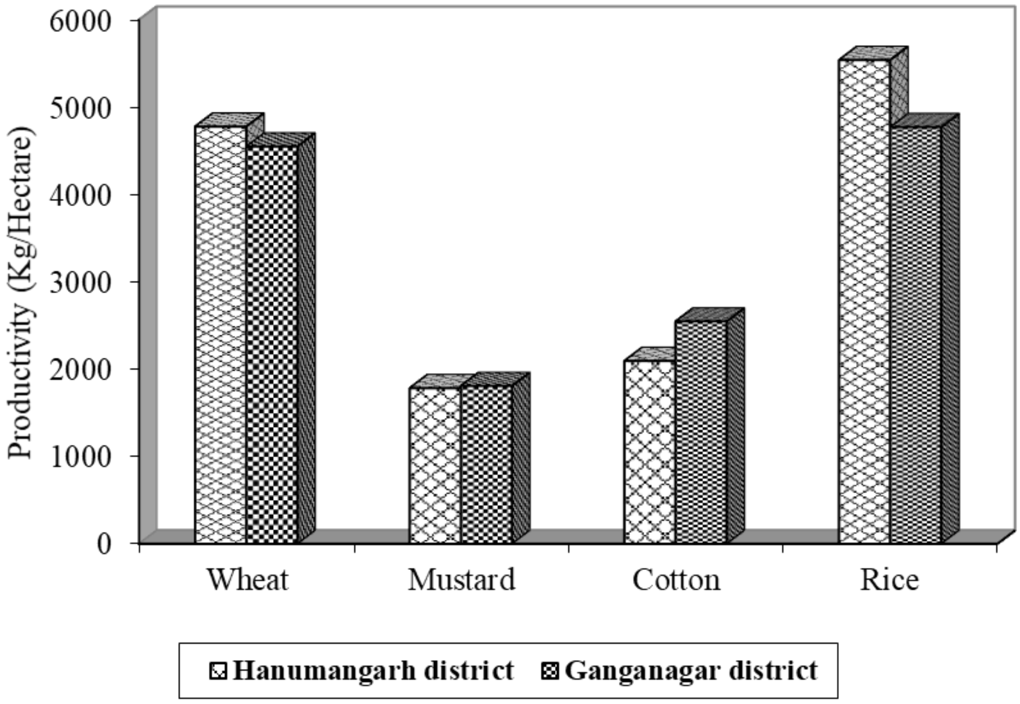
Table 4: Productivity of Some Rabi Crops in Ghaggar Basin of Rajasthan

Riparian Zone District	Production (Quintals)	Area (Hect)	Productivity (Kg/Hect)
WHEAT			
Hanumangarh	23023	481.95	4777
Ganganagar	14140	310.85	4549
Overall Basin	37163	792.80	4687
MUSTARD			
Hanumangarh	266	14.92	1783
Ganganagar	1291.5	71.45	1807
Overall Basin	1557.5	86.37	1803

Table 5: Productivity of Some Kharif Crops in Ghaggar Basin

Riparian Zone District	Production (Quintals)	Area (Hect)	Productivity (Kg/Hect)
COTTON			
Hanumangarh	2105.5	100.54	2094
Ganganagar	3464	136.07	2546
Overall Basin	5569.5	236.61	2354
RICE			
Hanumangarh	22345	403.42	5539
Ganganagar	11591	242.94	4771
Overall Basin	33936	646.36	5250

Fig. 2: Productivity of Some Crops in Ghaggar Basin of Hanumangarh and Ganganagar Districts

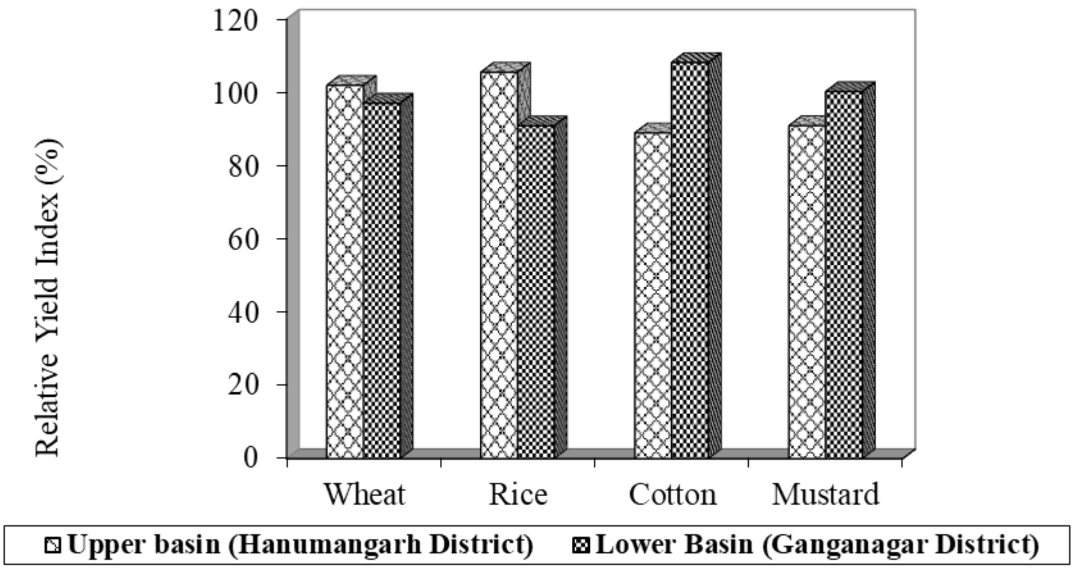


The Relative Yield Indices of the above-mentioned crops have also been calculated for the riparian zones of both the upstream and downstream areas of Hanumangarh and Ganganagar districts, respectively. These indices have been used to compare the yield of a particular crop in upstream Hanumangarh, and downstream Ganganagar, riparian zones of Ghaggar river, with the yield of that crop in the whole riparian belt of Ghaggar river, i.e., both Hanumangarh and Ganganagar districts combined. The results shown in Table 6 indicate that relative yield indices of food grains like wheat and rice are higher in the upstream riparian zone of Hanumangarh district. On the other hand, relative yield indices of non foodgrain, cash crops of mustard and cotton are higher in downstream riparian zone of Ghaggar river lying in Ganganagar district (Table 6 & Fig. 3).

Table 6: Relative Yield Indices of Some Crops in Upstream & Downstream Riparian Zones of Ghaggar (Percent)

Riparian Zone	Wheat	Rice	Cotton	Mustard
Upstream (Hanumangarh District)	101.92	105.50	88.95	90.90
Downstream (Ganganagar District)	97.06	90.88	108.16	100.22

Fig.3: Relative Yield Indices of Some Crops in Ghaggar Basin of Rajasthan



Since highly productive agricultural regions are able to produce more than the local consumer needs of the producing farmers, these areas become areas of commercialisation of agriculture. Some crops like cotton, sugarcane, vegetables are meant almost cent percent for the market. Foodgrains and oilseeds, on the other hand, may be consumed locally, to the extent of supplying household needs, by the households producing them. Wheat is the major food grain of the study area, while rice is used only as a secondary food grain. The level of commercialization for wheat in the study area is 85 percent of the production, while the level of commercialization in case of rice production is 98 percent of the produce (Table 7). This may also have something to do with the fact that per unit area productivity of rice is much higher than wheat.

Table 7: Commercialization of Wheat & Rice Production in Ghaggar Basin

Riparian Zone District	Production (Quintals)	Sold in Market	Level of Commercialization (%)
WHEAT			
Hanumangarh	23023	19626	85.25
Ganganagar	14140	12092	85.52
Overall Basin	37163	31718	85.35
RICE			
Hanumangarh	22345	22055	98.70
Ganganagar	11591	11259	97.14
Overall Basin	33936	33314	98.17

Conclusion

The study shows that cultivation of riverbed and floodplain land in the riparian zone of upstream Hanumangarh district is greater than in downstream Ganganagar district. Greater availability of moisture in the riverbed and floodplain of upstream areas may account for the same. Irrigation intensity is on the higher side in both the districts, either due to ground water resources of Ghaggar riverbed, or from irrigation from extensive canal network in the region. The overall crop intensity is higher in upstream riparian Hanumangarh, again due to higher availability of water both in the canals and in the fertile riverbed and floodplain of Ghaggar there. Crop productivity and relative yield indices of moisture loving crops, thus, seems to be higher in upstream Hanumangarh, while those of lesser hydrophilic or sunlight loving crops are higher in downstream Ganganagar. Commercialization of foodgrains seems to vary according to cultural food choice and domestic consumption levels.

More such studies may be carried out for riparian and non-riparian (lateral) zones of the rivers.

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