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Optimal Cropping Pattern for Sustainable Water Use in Canal Command AREA

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Abstract

The different proposed cropping pattern scenario was formulated for Kalwande Minor Irrigation Scheme based on the irrigable command area and volume of water required. The area and total depth of water required for different vegetables, pulses and horticultural crops were considered for proposed cropping pattern. The paddy crop is the dominant crop in the study area and grown in kharif season. Similarly in some of the areas, paddy is grown in rabi season. Therefore in the present study the rabi paddy was considered for developing the different cropping scenarios. The alternate cropping pattern suggested that the rabi paddy should not be encourage in the command area due high demand of water and low net returns. The cropping pattern based on combination of vegetables, horticultural and pulses showed potential in terms of maximum net returns and optimum utilization of available water. The area under only rabi paddy if more than 46 percent (51.06 ha) of irrigable command area, the available water in the reservoir will not meet the demand and the net returns obtained would be less. The study found that the maximum net returns obtained under single crop i.e for vegetables were Rs.143.38 lakh. The maximum net returns obtained under double crop i.e. for horticultural + vegetables were Rs.139.3 lakh. The horticultural + vegetables +pulses cropping pattern on 5.50 ha, 5.50 ha and 100 ha respectively provides maximum returns under available water source. The study concluded that the rabi paddy would not be found feasible in terms of water availability and benefits obtained. The vegetable and horticultural crop showed potential in the command area with the available water source to get maximum net returns.

Keywords: Cropping pattern, command area.

Introduction

Day by day the world's population is increasing at the alarming rate resulting in increasing demand of food and fiber. On the other hand, per capita land and water resources are decreasing at alarming rate. Water is valuable natural resource, which is used for agriculture, recreation and industrial purpose. Due to industrialization and population growth the demand and utilization of water is increased which increased pressure on the water resources. The major portion of the water resource is used in agriculture sector for irrigation purpose to enhance the crop production. Due to growing demand for domestic and industrial purpose the share of the irrigation water is diverted for industries, recreation and drinking purpose. Therefore it is need of the time to utilize the available water resources optimally and judiciously with multipurpose use.

India has made tremendous progress in development of its irrigation potential. However, only about two-third of the created irrigation potential is actually being utilized and overall project irrigation efficiencies are very poor. Applying water to crop through irrigation increases yield and production in agriculture. However, inappropriate management of irrigation schemes might lead to environmental problems such as a high water table and poor drainage and thus salinization and pollution in addition to low quality irrigation water.

One of the most important decisions in agricultural sector is determining optimum cropping pattern. The objective of determining optimum cropping pattern is to select combination of products that shall be produced in a farming unit considering characteristics of cultivation of each crop, market price forecasting, quantity of demand, available soil and water resources, labour, capital, agricultural equipment etc. in order to maximize profit earned by that farming unit[1]. Decision about Development or limitation of cultivation of different crops in different regions shall be made in accordance to resources limitation such as inadequacy of fertile land; this will reveal necessity of designing a comprehensive cropping pattern for agricultural crops.

The proposed cropping pattern for a command of Shahi distributor having area of 11,818 ha at water availability levels of 100, 70 and 50 gave net returns of Rs.185, 146 and 114 million, respectively[2]. It was found that the water available in the command area may support optimally 4981,

3560, 1817, 632, 355, 87 and 3653 ha of wheat, sugarcane, mustard, lentil, potato, chick pea and rice respectively[2].

The proper cropping scenario for arid and semi arid regions at Fars province in the southern part of Iran resulted that, there was trade offs among reduce water use, reduce risk and getting a specific gross margin[3]. Also, the study showed that, wheat tended to increase, causing from price supporting program, indicating the government intervention trace in farmers cropping pattern. Therefore sustainable use of resources was affected by output condition in market[3].

The study on cropping pattern takes paramount advantages of net returns and ensuring significant savings of groundwater. The study found that the area under paddy had reduced from 70.65 per cent of cultivated area at 100 per cent water availability level to 57.34 per cent at 64 per cent water availability level. The area had shifted towards less water-consuming crops like maize, *desi* cotton and Bt cotton. The study revealed that a shift in transplanting dates of paddy from early June to third or fourth week of June could save water without having any adverse impact on the profitability[4].

The optimum cropping pattern will increase the total profit of regions, Babol by 6.8 per cent, Babolsar by 8.9 per cent and Qaemshahr by 5.6 per cent[5].

The study on cpconcluded that optimum cropping pattern skewed towards Potato so to get maximum net return in Mayurakshi command area. In order to cultivate the entire command area a large number of labours were required but it was very difficult to get that huge number of labour at time. So for sustainable agricultural development farmers had to take the advantage of mechanized cultivation system[6].

Methodology

Study area: The command area of Kalwande Minor Irrigation Scheme is selected for study, which is located in coastal belt of Maharashtra state and situated in Konkan region, Ratnagiri.

Details of the project: The dam is earthen type with concrete waste weir. The dam site is located between 17°28'53"N Latitude and 73°29'12.37"E Longitudes at altitude of 108.65 m above mean sea level. The Kalwande Minor Irrigation Scheme has 3.42 km^2 catchment area. The gross capacity of dam is 1.967 Mm^3 with 1.927 Mm^3 of live storage. The loss of water by evaporation and seepage from reservoir was 0.918 Mm^3 which was 47.63 per cent of the live storage. The volume of 0.169 Mm^3 was reserved for lift irrigation to supply the water for drinking and irrigation to horticultural crops grown on ridge line of catchment area. The net available water in the reservoir was 0.840 Mm^3 which was 43.50 per cent of the live storage. The volume of water available in the reservoir per unit of culturable command area was 6,190 m^3 ha^{-1}

Existing cropping pattern: In Kalwande command area in 2013-14 during *kharif* paddy crop was grown while in *rabi* season (October to Jan-Feb) pulses, vegetables, watermelon, groundnut etc. crops were irrigated with canal water. The perennial and horticultural crops like cashew, mango, banana and pineapple were also grown in the command area and irrigated with canal water. Hence at present only 9.06 ha area was irrigated during *rabi* season.

Methodology: In command area in year 2013-14 during *rabi* season only 9.06 ha area was under cultivation. From survey of command area it was observed that the actual area under crops was very less, hence grouping of crops were done into pulses, vegetables, horticultural, oil seeds and watermelon. The main output considered is crop production and major inputs are water and land.

The different proposed cropping pattern scenario was formulated based on the irrigable command area and volume of water required. The area and total depth of water required for different vegetables, pulses and horticultural crops were considered for proposed cropping pattern. The following scenarios were developed.

Proposed cropping pattern scenarios: The paddy crop is the dominant crop in the study area and grown in *kharif* season. Similarly in some of the areas, paddy is grown in *rabi* season. Therefore in the present study the *rabi* paddy was considered for developing the different cropping scenarios. The area under DY-2 was not considered for development of cropping scenarios, due to incomplete pipe network. Hence the cropping scenarios were developed for 96.62 ha irrigable command area. Therefore three scenarios were developed on *rabi* paddy based cropping pattern.

Scenario I- 45 % area under *rabi* paddy, 40% area under vegetable crops, 15% area under horticultural crops.

Scenario II- 30% area under *rabi* paddy, 55% area under vegetable crops, 15% area under horticultural crops.

Scenario III- 15% area under *rabi* paddy, 60 % area under vegetable crops, 25 % area under horticultural crops.

In addition to this further scenarios were also developed based on the gross returns and available land and water source.

Results and Discussion

The different proposed cropping pattern scenario was formulated based on the irrigable command area, volume of water available and net returns obtained from the irrigable

area under different crops. The paddy crop is the dominant crop in the study area and grown in kharif season. Similarly in some of the areas paddy is grown in *rabi* season. Therefore in the present study the *rabi* paddy was considered for developing the different cropping patterns. The following scenarios were developed. To find out the optimum cropping pattern in the command area by considering the water as constraint 140 scenarios were developed. The different area combinations of pulses, vegetables and horticultural crops under water constraint were evaluated and recommended on the basis of net returns obtained.

Scenario-I: In scenario-I 45 percent area under *rabi* paddy, 40 percent area under vegetable crops, 15 percent area under horticultural crops showed that the available water will not be sufficient to full fill the crop demand. The net available water in the reservoir was 0.840 Mm^3 while the water required for irrigation was 1.244 Mm^3. From Table-1 it was observed that there was deficit of 0.404 Mm^3 of water. Based on these results it was observed that *rabi* paddy needs huge amount of water when irrigated on 45 percent area of ICA. Similarly the net returns obtained from *rabi* paddy under recommended package of practices would be very less (Rs.-0.37667 lakh / ha) These results indicated that *rabi* paddy crop was not beneficial.

Scenario-II: In scenario–II 30 percent area under *rabi* paddy, 55 percent area under vegetable crops, 15 percent area under horticultural crops. From table-1, it is observed that, when 33.30 ha under paddy, 61.05 ha area under vegetables and 16.65 ha area under horticultural crops, the available water in the reservoir would not meet the irrigation demand and there was a deficit of 0.225 Mm^3 of water. Similarly the net returns obtained would be less (Rs.85.78 lakh).

Scenario-III: From table-1 it was observed that for scenario–III (15 percent area under *rabi* paddy, 60 percent area vegetable crops, 25 percent area under horticultural crops) then the water required for irrigation was 0.954 Mm^3, which was more by 0.114 Mm^3 than the available capacity. The total net returns obtained from paddy, vegetables and horticultural crops would be Rs.112.20 lakh respectively.

These results indicated that, when *rabi* paddy was considered for cropping pattern in the command the available water in the reservoir will not full fill the irrigation demand. Hence it is suggested that *rabi* paddy would not be encourage for cultivation. The net returns obtained from the *rabi* paddy were very less than other crops.

Scenario-IV: Under scenario IV, the single cropping pattern i.e. only horticultural crops, only pulses and only vegetables was developed. It is observed that the available water for irrigation was 0.840Mm^3, which can irrigate 72.15 ha area under horticultural crop. The total net return obtained from horticultural crop was Rs.84.36 lakh. The available water in the reservoir satisfied the irrigation demand of 111 ha area under pulses and vegetables. The total net returns obtained from 111 ha area under pulses was Rs.4.13 lakh. Similarly the total net returns obtained from 111 ha area under vegetable crops was Rs.143.38 lakh. The vegetables and horticultural crops showed potential in the command area under the available water source to get the maximum net returns. To irrigate 72.15 ha area under horticultural crop the water level of reservoir decreased up to 90 m (11.5 m) at end of season i.e. at end of season the reservoir was empty. Similarly for vegetables and pulses crops the water level of reservoir reduced by 8.57 m (RL 101.50 - 92.93) m and 7.08 m (RL 101.50 m - 94.42 m) at the end of season

Scenario-V: In scenario-V the combination of two crop types i.e. pulses + vegetables, vegetables + horticultural and horticultural + pulses was studied. The area under different crop types, volume of water required and total net returns are obtained. The horticultural and vegetable crops when irrigated on 33.3 ha and 77.7 ha area provides maximum net returns of Rs.139.30 lakh with 0.809 Mm^3 of water. The combination of vegetable (105 ha) and pulses (5.55) needs 0.594 Mm^3 water with net returns of Rs.136.42 lakh. The combination of horticulture plus pulses provides 78.28 lakh total net returns from 66.6 ha (60 percent) area under horticulture and 11.1 ha (10 percent) area under pulses. These results indicated that the combination of vegetables and horticultural crops provides maximum net returns from the available water source. For combination of pulses and vegetables the water level of the reservoir were decreased up to 8.48 m also for combination of horticultural and vegetable crops the water level of the reservoir decline up to 10.75 m at the last part of season. Similarly the combination of horticultural and pulses showed decline water level in reservoir by 10.85 m.

Scenario-VI: Scenario VI consists of the combination of horticultural, pulses and vegetables was tested for different area combinations under available water source to maximize the net returns. From figure-1 it is seen that, the available water source allowed the cultivation of horticultural crop on 5.55 ha (5 percent) area, pulses crop on 5.55 ha (5 percent) area and vegetables crops on 99.9 ha (90 percent) area was Rs.135.74 lakh. For maximizing the net returns in the command area from the available water source the cultivation of vegetable crops or vegetable plus horticultural crops found suitable. For combination of 5 percent horticultural crops, 5 percent pulses and 90 percent vegetable the water level of the reservoir were declined from 101.50 m (11.50 m) to 92.73 m with reduction in water level of reservoir by 8.77 m.

Table-1
Volume of water required and total net benefits for *rabi* based cropping pattern

Sr. No.	Paddy (% area)	Vegetables (% area)	Horticultural crops (% area)	Water required for irrigation (Mm^3)	Deficit supply (Mm^3)	Total net returns(lakh)
Scenario-I	45	40	15	1.244	-0.404	58.01
Scenario-II	30	55	15	1.065	-0.225	85.78
Scenario-III	15	60	25	0.954	-0.114	112.2

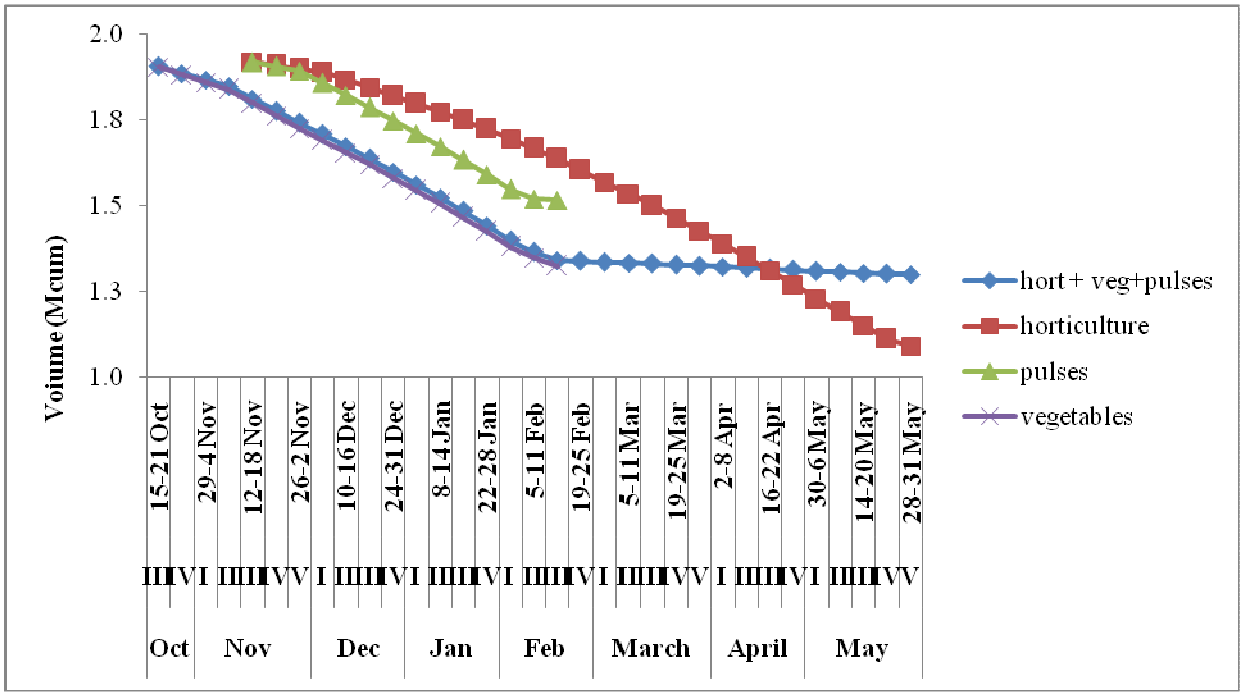

Figure-1
Graph showing volume of water retained in dam after irrigation

Conclusion

The efforts were done to study the alternate cropping pattern for maximizing the net returns per unit of area per unit of available water resources. The study concluded that *rabi* paddy would not be found feasible in terms of water availability and benefits obtained. The vegetable and horticultural crop showed potential in the command area with the available water source to get maximum net returns. The maximum net returns can be obtained by adopting the horticultural plus vegetables plus pulses cropping pattern.

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