Influence of Irrigation Schedules on Economics of Winter Wheat in Eastern Uttar Pradesh

Abstract

In this study, the cost of production and benefits cost ratios of wheat crop per hectare are examined using pooled data from two cropping years (2020-21 and 2021-22) in Prayagraj, Uttar Pradesh, India. Estimation of economic returns considering the influenced by limiting soil water conditions, climatological factor, and factor of energy balance. Significantly, Due to limiting soil water conditions, the maximum cost of wheat production was 46702.14 Rs/ha in treatment T_1(396 mm) and the lowest cost was 38052.68 Rs/ha in treatment T_5(79.2mm), the maximum gross return was 88566.67 Rs/ha in treatment T_1(396mm) while the lowest gross return was 49766.67 Rs/ha in treatment T_5(79.2mm), the highest net return was 41864.53 Rs/ha in treatment T_1(396mm) while the lowest net return was 11731.99 Rs/ha in treatment T_5(79.2mm), the maximum B:C ratio was 1.93 in treatment T_2(316.8mm) whereas the lowest B:C ratio in treatment T_5(79.2mm) was 1.30. Because of the climatological factor, highest wheat production cost was 46702.14 Rs/ha in treatment T_1(396mm) and lowest was 39494.25 Rs/ha in T_5(132mm), the maximum gross return was 92833.33 Rs/ha in treatment T_2(330mm) and lowest was 56833.33 Rs/ha in treatment T_5(132mm), the highest net return was 47933.17 Rs/ha in treatment T_2(330mm), while the lowest was 17339.08 Rs/ha in treatment T_5(132mm), the maximum B:C ratio was 2.07 in treatment T_2(330mm), and lowest was 1.44 in treatment T_5(132mm). Due to factor of energy balance, maximum wheat production cost was 50306.08 Rs/ha in treatment T_5(528mm) and lowest was 41296.22 Rs/ha in T_1(198mm), the maximum gross return was 102333.33 Rs/ha in treatment T_4(396mm) and lowest was 71000.00 Rs/ha in treatment T_1(198mm), the maximum net return was 55631.20 Rs/ha in treatment T_4(396mm) and lowest was 29703.78 Rs/ha in treatment T_1(198mm), the greatest B:C ratio was 2.19 in treatment T_4(396mm) and lowest was 1.72 in treatment T_1(198mm).

Keywords: Costs, Wheat Production, Water, Climate, Energy.

1. Introduction

In India, the agricultural sector is regarded as the driving force behind economic growth and expansion (World Bank, 2004). Due to the fact that in developing nations like India, this

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sector satisfies the need for food grains while also employing a large percentage of the total population. In India, wheat was grown on 29.9 million acres, producing 107 million metric tonnes at a yield of 3,430 kg per hectare (Government of India, 2019-20). Greater than 25% of India's entire wheat production comes from only Uttar Pradesh. According to a recent study conducted by the state's agricultural department, the total wheat output in Uttar Pradesh in 2022 is projected to be 359 million metric tonnes, which is 16 million metric tonnes less than in 2021 (U.P., Government). Water scarcity is the primary barrier to expanding crop varieties and yields (Caparas et al., 2021). Water for irrigation is increasingly limited and expensive as a result of the rapid depletion of surface and subsurface water supplies caused by irregular rainfall (Turral et al., 2011). Thus, the proper quantity and frequency of irrigation is critical for making the most use of water resources for agricultural production (Levidow et al., 2014). The rising demand for wheat has led to an annual expansion of the global wheat market (Enghiad et al., 2017). Grain yields decline steadily for every day when sowing is delayed after the third week of November (Fazily, 2021). Farmers have begun using resource-saving techniques, such as zero-till and surface seeding in wheat crop, to save costs and plant earlier (Gupta and Seth, 2007). To provide optimal soil moisture condition for optimal plant growth and development, optimal yield, water usage efficiency, and economic advantages, irrigation timing is a crucial management input (Hatfield and Dold, 2019). Microclimate is the most influential of many complicated parameters that determine when and how much water to apply during irrigation (Saher et al., 2022). Scheduled irrigation that replenishes moisture content to the desired level while conserving water and energy helps maximise irrigation efficiency (Koech and Langat, 2018). Every kind of irrigation system has its own unique combination of fixed costs, operating expenses, and the cost of initial investment. Costs associated with capital investments include those for the installation and maintenance of essential irrigation facilities and machinery (Dalton et al., 2002). The water distribution network, the design of the irrigation system, and the automation of water management are all part of this. Investments in capital result in recurring expenses known as fixed yearly costs (Parween et al., 2021). Depreciation, interests, taxes, and maintenance are all part of these costs. Electricity used for activities such pumping water and removing and cleansing channel is a recurring cost (Sachs et al., 2012). The total cost of operations consists of human labour, land, seeds, fertiliser, chemicals, and repairs and maintenance.

2. MATERIALS AND METHODS

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In this research to examine the economies of wheat by comparing the production cost and benefits cost ratios of wheat on pooled data of wheat crop for two cropping years (2020-21 and 2021-22) at Prayagraj, Uttar Pradesh India. Experiments in the field were carried out at the Sam Higginbottom University of Agriculture, Technology, and Sciences Irrigation Research Farm in Prayagraj, Uttar Pradesh, India. Prayagraj is situated at 25.45 degrees North latitude and 81.84 degrees East longitude, and it is situated at the confluence of the Yamuna and Ganga rivers. The experimental design was a randomized complete block with three replication and five levels of irrigation included.

2.1.1 Total available water: Total available water refers to the quantity of water that may be used by plants. Actually, it's the soil moisture differential between the field capacity and the permanent wilting point. The total available water was determined using the formula below.

$$TAW = 1000 \, [(\theta_{FC} - \theta_{PWP})] \times Zr \qquad (1)$$

Where, TAW is the total available water (mm), θ_{FC} is the moisture content at field capacity (%), θ_{PWP} is the moisture content at permanent wilting point (%), and Zr is the effective root zone depth in meters (Allen et al., 1998).

2.1.2 Readily available water: The readily available water is the fraction of TAW that a crop may take from the root zone without suffering from water stress (Allen et al., 1998).

$$RAW = p \, TAW \qquad (2)$$

Where, RAW is the readily available soil water in the root zone (mm), p is the average fraction of total Available Water.

2.1.3 Calculate the net depth of irrigation: After the calculating of total available water (TAW), the maximum permissible depletion (p) in percentage was used in the following equation to determine the net depth of irrigation:

$$IW = p \times TAW \qquad (3)$$

Where, IW is the net depth of irrigation to be used for a single irrigation (mm), p is the maximum allowable depletion (%) and TAW is the total available water (mm). Using data from FAO-56, maximum allowable depletion (p) for wheat crop is equal to 0.55.

2.1.4 Weather data

The weather data, which prevailed during the two wheat crop growing seasons, November 2020 to April 2021 and November 2021 to April 2022, are presented in table 1.

Table 1. Average monthly weather data during crop growing season (2020-21 and 2021-22)

Weather data 2020-21

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Month	T. max (^{0}C)	T. min (^{0}C)	Mean RH (%)	Sunshine (hour)	Wind speed (Km/h)	Rainfall (mm)
November	32.21	13.59	74.35	8.41	1.11	0.80
December	26.76	9.56	80.90	7.91	1.01	18.40
January	22.29	9.15	78.90	2.99	0.98	7.00
February	30.13	11.26	67.70	8.18	1.03	5.20
March	36.21	19.52	60.40	9.21	1.17	2.80
April	41.99	20.08	52.30	9.15	1.53	0.00
Weather data 2021-22						
Month	**T. max (^{0}C)**	**T. min (^{0}C)**	**Mean RH (%)**	**Sunshine (hour)**	**Wind speed (Km/h)**	**Rainfall (mm)**
November	29.62	15.14	74.76	8.69	1.03	0.00
December	24.76	11.12	81.22	5.22	1.03	1.20
January	20.49	9.08	85.77	3.36	1.04	57.20
February	27.91	13.20	68.19	8.27	1.37	0.00
March	35.44	19.46	59.18	8.97	1.32	0.00
April	42.15	23.73	59.03	8.75	1.53	0.00

Source: Department of Forestry and Environment at Prayagraj, Uttar Pradesh

2.2 Irrigation scheduling based upon limiting soil water conditions

Irrigation was scheduled on the basis of limiting soil water conditions. This approach applies to the laboratory assessment of soil moisture content as a percentage of its oven-dried weight. The moisture content of the soil was calculated as a percentage of the dry soil weight using the following formula:

$$MC(\%) = \frac{(W2-W3)}{(W3-W1)} \times 100 \quad (4)$$

Where, MC is the soil moisture content (%), W1 is the weight of tin (g), W2 is the weight of moist soil + tin (g), and W3 is the weight of dry soil + tin (g).

The depth of irrigation was applied at different levels for approaches of limiting soil water conditions; the different irrigation levels are 1, 0.8, 0.6, 0.4, and 0.2. Apply irrigation depths of 66 mm at irrigation level 1, 52.8 mm at irrigation level 0.8, 39.6 mm at irrigation level 0.6, 26.4 mm at irrigation level 0.4, and 13.2 mm at irrigation level 0.2. When the soil moisture level is between 16 and 18%, irrigation water is applied. The highest total water applied to wheat was 396 mm in the treatment T_1, followed by 316.8 mm in the treatment T_2, 237.6 mm in the treatment T_3, 158.4 mm in the treatment T_4, and 79.2 mm in the treatment T_5.

Table 2. Irrigation details as influenced by limiting soil water conditions

Treatments	Level of Irrigation	Depletion (%)	Depth of Irrigation (mm)	No. of Irrigation	Total Water Applied (mm)
T_1	1	0	66	6	396
T_2	0.8	20	52.8	6	316.8
T_3	0.6	40	39.6	6	237.6
T_4	0.4	60	26.4	6	158.4
T_5	0.2	80	13.2	6	79.2

2.3 Irrigation scheduling based upon climatological approaches

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This method schedules irrigation based on climatological factors and applies a specified quantity of water when pan evaporation reaches a predetermined level. Using predefined IW and ratio values, the objective of cumulative pan evaporation was derived using the following equation.

$$CPE = \frac{\text{IW}}{\text{Ratio}} \quad (5)$$

Where, CPE is the cumulative pan evaporation (mm/day) and IW is the net depth of irrigation water (mm). The net depth of irrigation (IW) is 66 mm. Thus, irrigation was scheduled at 37.71 mm cumulative pan evaporation (CPE) in treatment T_1 (IW/CPE=1.75), at 44 mm cumulative pan evaporation (CPE) in treatment T_2 (IW/CPE=1.5), at 66 mm cumulative pan evaporation (CPE) in treatment T_3 (IW/CPE=1.0), at 88 mm cumulative pan evaporation (CPE) in treatment T_4 (IW/CPE=0.75) and at 132 mm cumulative pan evaporation (CPE) in treatment T_5 (IW/CPE=0.5). The total water applied for wheat was recorded to be highest amount of water applied in treatment T_1 396 mm under the irrigation level at (IW/CPE=1.75), followed by treatment T_2 (IW/CPE=1.5) 330 mm, treatment T_3 (IW/CPE=1.0) 264 mm and treatment T_4 (IW/CPE=0.75) 198 mm while minimum amount of water applied in treatment T_5 (IW/CPE=0.5) 132 mm.

Table 3. Irrigation details as influenced by climatological factors

Treatments	Level of Irrigation	Depth of Irrigation (mm)	Irrigation Frequency	Total Water Applied (mm)
T_1	IW/CPE = 1.75	66	6	396
T_2	IW/CPE = 1.5	66	5	330
T_3	IW/CPE = 1	66	4	264
T_4	IW/CPE = 0.75	66	3	198
T_5	IW/CPE = 0.5	66	2	132

2.4 Irrigation scheduling based upon approaches of energy balance

The energy refers to the amount of heat or energy necessary to evaporate free water. Evapotranspiration is determined by energy exchange at the plant surface and is limited by the amount of available energy. To maintain equilibrium, the energy entering the surface must be equal to the energy leaving it during the same period. When developing an energy balance equation, all energy flows should be included (Allen et al., 1998). The equation for an evaporating surface is as follows:

$$Rn - G - \lambda ET - H = 0 \quad (6)$$

Where Rn is the net radiation, measured in $MJm^{-2}day^{-1}$, H is the sensible heat measured in $MJm^{-2}day^{-1}$, G is the soil heat flux measured in $MJm^{-2}day^{-1}$, and λET is the latent heat flux measured in $MJm^{-2}day^{-1}$.

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The field experiment is conducted in randomised block design, with three replications and five treatments. The net depth of irrigation is 66 mm and water depths can also be expressed in terms of energy received per unit area. The latent heat of vaporization, a kind of energy, depends on the temperature of the water. Evaporation of water requires relatively large amounts of energy, either in the form of sensible heat or radiant energy. Irrigation was scheduled at 115.5 mm water vaporized from soil (λET) in treatment T_1 (EB=1.75), at 99 water vaporized from soil (λET) in treatment T_2 (EB=1.5), at 66 mm water vaporized from soil (λET) in treatment T_3 (EB=1.0), at 49.5 mm water vaporized from soil (λET) in treatment T_4 (EB=0.75) and at 33 mm water vaporized from soil (λET) in treatment T_5 (EB=0.5). Total amount of water used for wheat was recorded to be highest amount of water in treatment T_5 528 mm under the irrigation level at (EB=0.50), followed by T_4 396 mm under the irrigation level at (EB=0.75), T_3 330 mm under the irrigation level at (EB=1) and T_2 264 mm under the irrigation level at (EB=1.5) while minimum amount of water T_1 198 mm under the irrigation level at (E.B=1.75).

Table 4. Irrigation details as influenced by factors of energy balance

Treatments	Level of Irrigation	Depth of irrigation (mm)	Irrigation Frequency	Total Water Applied (mm)
T_1	E.B. = 1.75	66	3	198
T_2	E.B. = 1.5	66	4	264
T_3	E.B. = 1	66	5	330
T_4	E.B. = 0.75	66	6	396
T_5	E.B. = 0.50	66	8	528

2.5 Economic Analysis

Economic analyses were performed for all irrigation scheduling options as well as various treatments. To examine the economic feasibility of all irrigation scheduling approaches under variable quantity of irrigation for wheat crop yield, both fixed and operational costs are considered. The total cost of crop production, gross return, net return, and benefit cost ratio of all irrigation scheduling systems were evaluated using the following assumptions:

The salvage value of the component is 0. The tube well, pumps motor, and pump house have a usable life of 25 years. An open channel conveyance system has a useful life of 5 years. Weeding and spraying equipment has a useful life of 7 years. The interest rate is 10% and 7.5% for repairs and maintenance. Three crops are planted each year.

2.5.1 Fixed cost

The following methods were used to determine the fixed costs of water development, irrigation equipment, spraying and weeding equipment (James and Lee 197);

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$$\text{Capital Recovery Factor (CRF)} = \frac{i(1-i)^n}{(1-i)^n - 1} \quad (7)$$

Where, i is the interest rate (fraction), n is the useful life of components (years)

$$\text{Annual fixed cost/ha} = \text{CRF} \times \text{Fixed Cost/ha} \quad (8)$$

$$\text{Annual fixed cost/ha/season} = \frac{\text{Anual Fixed Cost/ha}}{\text{Number of Crop Per Year}} \quad (9)$$

2.5.2 Operating cost

The operating costs for labour charges (Irrigation, Planning, Weeding, Cultivation, Fertilizer and Chemical application, harvesting, threshing, etc.), land preparation, land rent, seeds, fertilisers, chemicals, water pumping repair and maintenance were estimated.

2.6 Total cost of crop production

The overall cost of crop production is the sum of fixed and operational costs.

$$\text{Total cost of crop production} = \text{fixed cost} + \text{operating cost/ha} \quad (10)$$

2.7 Gross return

The gross return was calculated taking into consideration the grain yield and current wholesale price of wheat.

$$\text{Gross return (Rs/ha)} = \text{Grain yield (t/ha)} \times \text{wholesale price of wheat (Rs/t)} \quad (11)$$

2.8 Net return

The net return was calculated by deducting the various costs of cultivation from the gross return as follows:

$$\text{Net return (Rs/ha)} = \text{gross return (Rs/ha)} - \text{total cost of crop production (Rs/ha} \quad (12)$$

2.9 Benefit cost ratio

The benefit cost ratio was established by dividing gross returns by total cultivation costs.

$$\text{Benefit cost ratio} = \frac{\text{Gross return(Rs/ha)}}{\text{Total cost of crop production(Rs/ha)}} \quad (13)$$

3. Result and Discussion

The pooled data (2020-21 and 2021-22) of economics return for wheat as influenced by limiting soil water conditions, climatological factor and factor of energy balance under different irrigation scheduling are presented in Table 5. According to a statistical calculation of the data, differences in grain yield related to changes in the various amounts of irrigation treatments were considered to be statistically significant. Results showed that the treatment T_1(396mm) had the highest grain yield due to limited soil water conditions 4.43 ton/ha, while the treatment T_5(79.2mm) had the lowest 2.49 ton/ha. Significantly, treatment T_2(330mm) had the greatest grain yield as impacted by climatological factor 4.64 ton/ha, whereas

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treatment T_5(132mm) had the lowest grain yield 2.84 ton/ha. Significantly, treatment T_4(396mm) had the greatest grain yield as impacted by the factor of energy balance 5.12 ton/ha, whereas treatment T_1(198mm) had the lowest grain yield 3.55 ton/ha.

Table 5. Pooled data of Economic return of wheat crop as influenced by different irrigation scheduling

Economic return of wheat crop as influenced by limiting soil water condition					
Treatment	**Grain Yield (t/ha)**	**Cost of Production (Rs/ha)**	**Gross Return (Rs/ha)**	**Net Return (Rs/ha)**	**B/C Ratio**
$T_{1(396mm)}$	4.43	46702.14	88566.67	41864.53	1.89
$T_{2(316.8mm)}$	4.29	44539.77	85766.67	41226.90	1.93
$T_{3(237.6mm)}$	3.28	42377.41	65666.67	23289.26	1.55
$T_{4(158.4mm)}$	2.95	40215.04	58966.67	18751.63	1.46
$T_{5(79.2mm)}$	2.49	38052.68	49766.67	11713.99	1.30
Economic return of wheat crop as influenced by climatological factors					
Treatment	**Grain Yield (t/ha)**	**Cost of Production (Rs/ha)**	**Gross Return (Rs/ha)**	**Net Return (Rs/ha)**	**B/C Ratio**
$T_{1(396mm)}$	4.29	46702.14	85766.67	39064.53	1.84
$T_{2(330mm)}$	4.64	44900.16	92833.33	47933.17	2.07
$T_{3(264mm)}$	4.11	43098.19	82133.33	39035.14	1.91
$T_{4(198mm)}$	3.14	41296.22	62766.67	21470.44	1.52
$T_{5(132mm)}$	2.84	39494.25	56833.33	17339.08	1.44
Economic return of wheat crop as influenced by factors of energy balance					
Treatment	**Grain Yield (t/ha)**	**Cost of Production (Rs/ha)**	**Gross Return (Rs/ha)**	**Net Return (Rs/ha)**	**B/C Ratio**
$T_{1(198mm)}$	3.55	41296.22	71000.00	29703.78	1.72
$T_{2(264mm)}$	3.82	43098.19	76333.33	33235.14	1.77
$T_{3(330mm)}$	4.22	44900.16	84333.33	39433.17	1.88
$T_{4(396mm)}$	5.12	46702.14	102333.33	55631.20	2.19
$T_{5(528mm)}$	4.80	50306.08	95900.00	45593.92	1.91

3.1 Cost of wheat production

The highest cost of wheat production as impacted by restricting soil water conditions was 46702.14 Rs/ha in treatment T_1(396mm), while the lowest cost of wheat production was 38052.68 Rs/ha in treatment T_5(79.2mm). Highest cost of production of wheat as influenced by climatological factor was 46702.14 Rs/ha recorded in treatment T_1(396mm) while minimum cost of production of wheat in treatment T_5(132mm) 39494.25 Rs/ha. The highest cost of wheat production as influenced by energy balance factors was 50306.08 Rs/ha in treatment T_5(528mm), while the lowest cost of wheat production was 41296.22 Rs/ha in treatment T_1(198mm). These findings are consistent with those of other scientist (Tasal and Pawar, 2013, Khan et al., 2019, Mukherjee et al., 2019).

3.2 Gross return

The maximum gross return of wheat as impacted by soil water limiting conditions was 88566.67 Rs/ha in treatment T_1(396mm), while the lowest gross return of wheat was

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49766.67 Rs/ha in treatment T_5(79.2mm). The maximum gross return of wheat as affected by climatological factors was 92833.33 Rs/ha in treatment T_2(330mm), while the smallest gross return of wheat was 56833.33 Rs/ha in treatment T_5(132mm). The maximum gross return of wheat as influenced by energy balance factors was 102333.33 Rs/ha in treatment T_4(396 mm), while the lowest gross return of wheat was 71000.00 Rs/ha in treatment T_1(198 mm). These findings are consistent with those of other scientist (Tasal and Pawar, 2013, Khan et al., 2019, Mukherjee et al., 2019).

3.3 Net return

The highest net return of wheat as impacted by limiting soil water conditions was 41864.53 Rs/ha in treatment T_1(396mm), while the lowest net return of wheat was 11731.99 Rs/ha in treatment T_5(79.2mm). The maximum net return of wheat as influenced by climatological factors was 47933.17 Rs/ha in treatment T_2(330mm), while the lowest net return of wheat in treatment T_5(132mm) was 17339.08 Rs/ha. The maximum net return of wheat as impacted by energy balance variables was 55631.20 Rs/ha in treatment T_4(396mm), while the lowest net return of wheat was 29703.78 Rs/ha in treatment T_1(198mm). These findings are consistent with those of other scientist (Tasal and Pawar, 2013, Khan et al., 2019, Mukherjee et al., 2019).

3.4 B:C Ratio

The maximum B:C ratio of wheat as impacted by soil water limiting conditions was 1.93 in treatment T_2(316.8mm), whereas the lowest B:C ratio of wheat in treatment T_5(79.2mm) was 1.30. The maximum B:C ratio of wheat as influenced by climatological factor was 2.07 in treatment T_2(330mm), while the lowest B:C ratio of wheat in treatment T_5(132mm) was 1.44. The greatest B:C ratio of wheat as impacted by factor of energy balance was 2.19 in treatment T_4(396mm), while the lowest B:C ratio of wheat was 1.72 in treatment T_1(198mm). These findings are consistent with those of other scientist (Tasal and Pawar, 2013, Khan et al., 2019, Mukherjee et al., 2019).

3.5 Relationship between total water used and economic return

3.5.1 Relationship between total water applied and gross return

The relationship between total water applied and gross return of wheat as influenced by different irrigation scheduling are shown in figures 1 to 3. Because of the limited soil water condition, the total water applied and gross return of wheat showed a quadratic relationship R^2=0.95. R^2=0.89 for the quadratic relationship between total water applied and gross return of wheat as impacted by climatological factors. Total water applied and wheat gross return as impacted by energy balance factor have a quadratic relationship with R^2=0.85.

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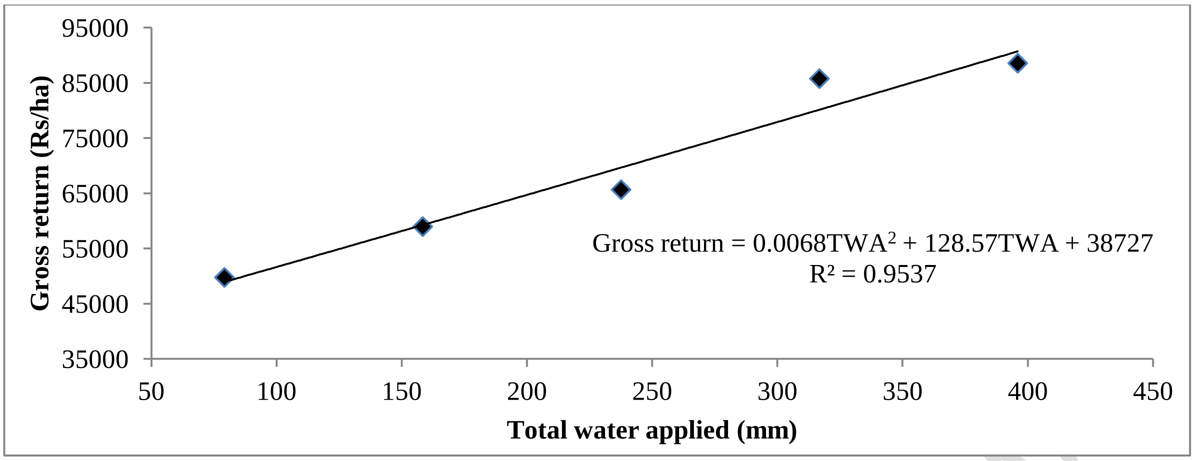

Fig. 1. Relationship between total water applied and gross return as influenced by limiting soil water conditions

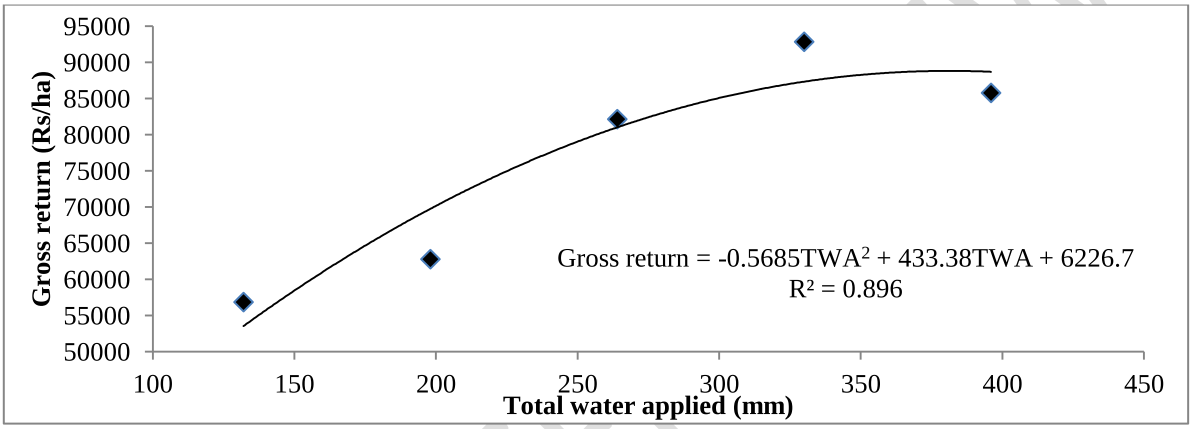

Fig. 2. Relationship between total water applied and gross return influenced by climatological factor

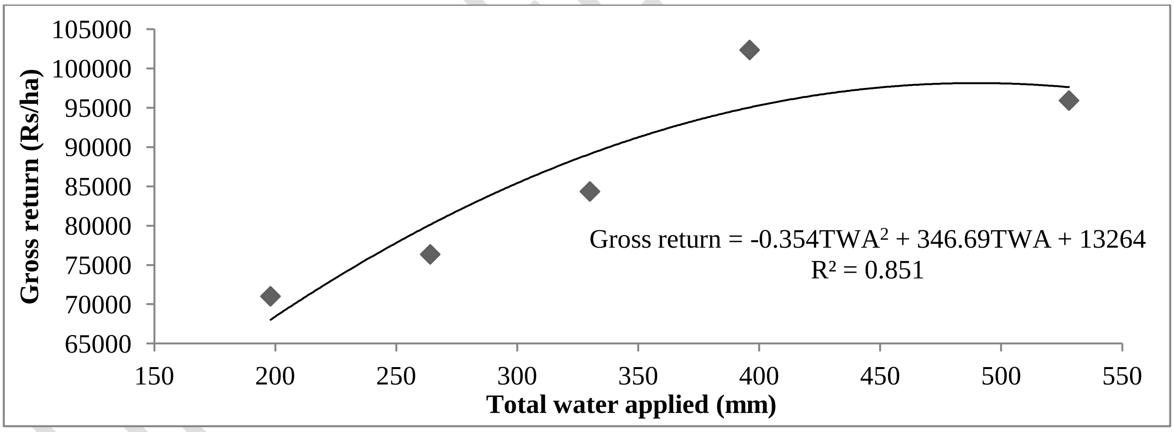

Fig. 3. Relationship between total water applied and gross return as influenced by factor of energy balance

3.5.2 Relationship between total water applied and net return

The relationship between total water applied and gross return of wheat as influenced by different approaches of irrigation scheduling are shown in figures 4 to 6. The total water applied and net return of wheat impacted by limiting soil water conditions demonstrated a quadratic relationship R^2=0.92. The total water used and net return of wheat affected by climatological factors revealed a quadratic relationship R^2=0.85. The total water applied and net return of wheat as influenced by the factor of energy balance have a quadratic relationship R^2=0.75.

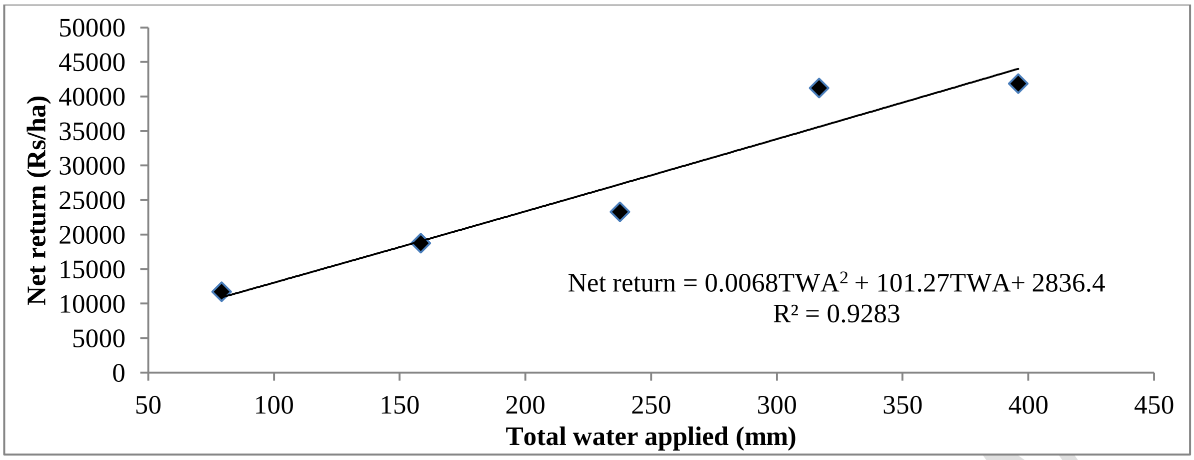

Fig. 4. **Relationship between total water applied and net return as influenced by limiting soil water conditions**

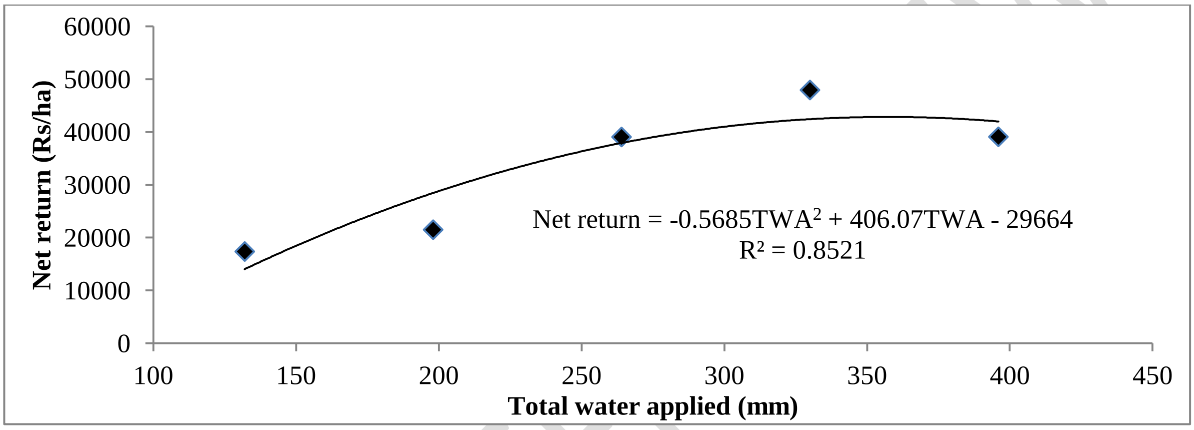

Fig. 5. **Relationship between total water applied and net return as influenced by climatological factor**

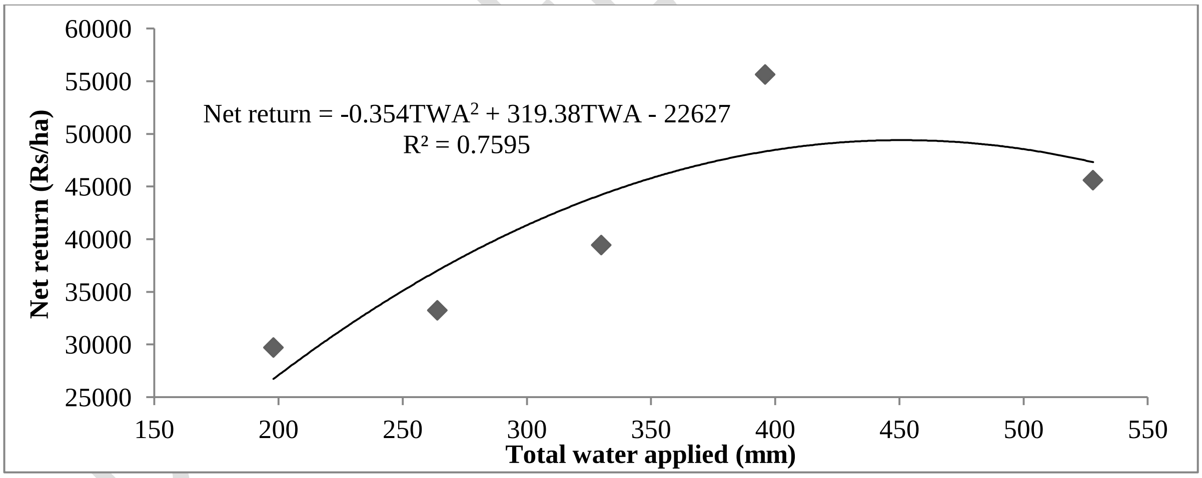

Fig. 6. **Relationship between total water applied and net return as influenced by factor of energy balance**

3.5.3 Relationship between total water applied and B:C ratio

The relationship between total water applied and B:C ratios of wheat are shown in figures 7 to 9. The total water applied and B:C ratio of wheat impacted by limiting soil water conditions demonstrated a quadratic relationship R^2=0.90. The total water applied and B:C ratio of wheat as influenced by climatological factors revealed a quadratic relationship R^2=0.82. The total water applied and B:C ratio of wheat as impacted by the factor of energy balance revealed a quadratic relationship R^2=0.65.

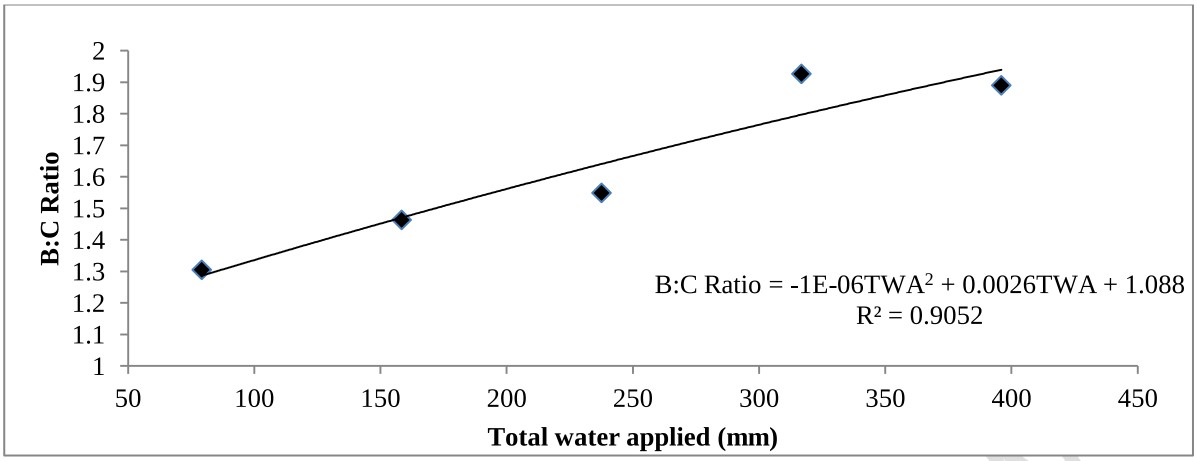

Fig. 7. Relationship between total water applied and B:C ratio as influenced by limiting soil water conditions

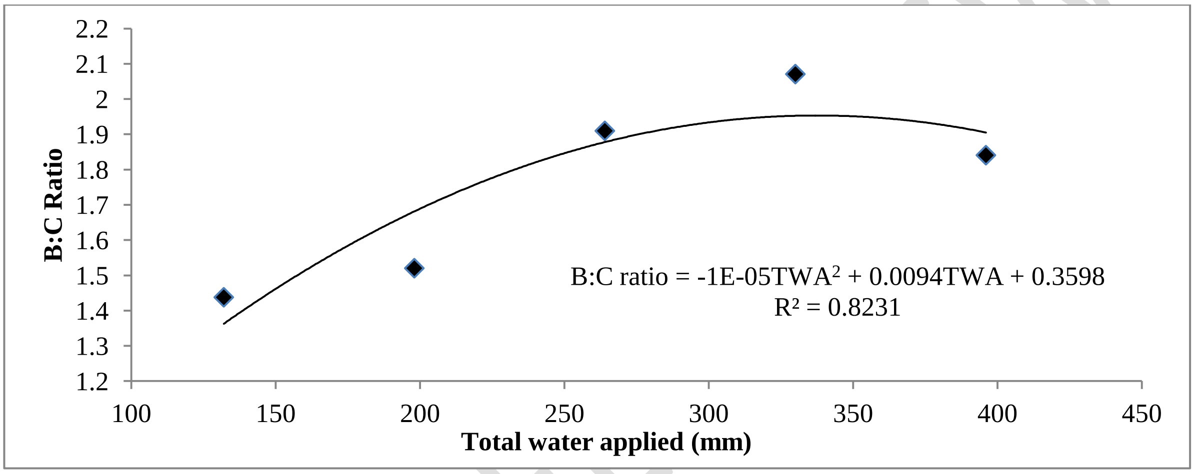

Fig. 8. Relationship between total water applied and B:C ratio as influenced by climatological factor

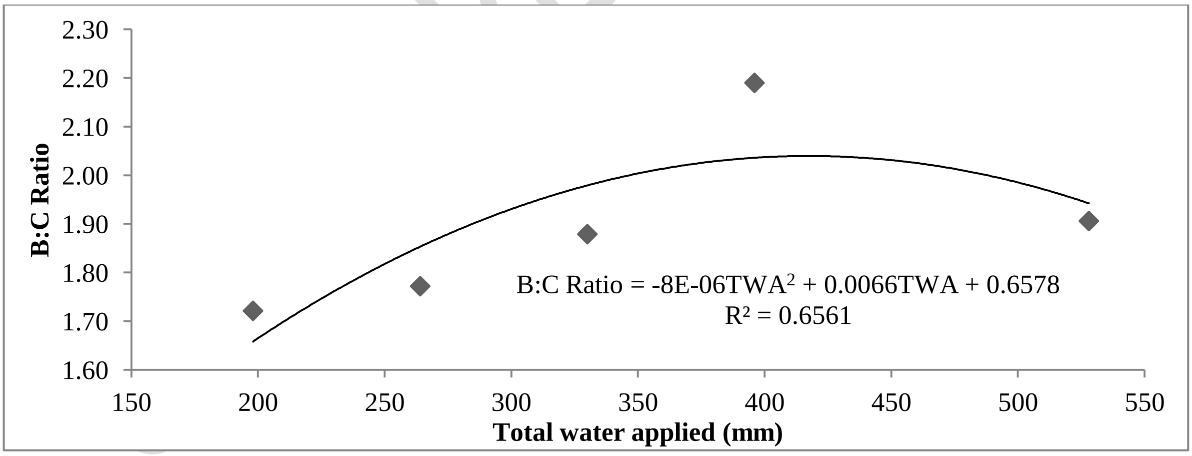

Fig. 9. Relationship between total water applied and B:C ratio as influenced by factor of energy balance

Conclusion:

The most expensive aspects of the process of producing wheat are the expenditures associated with irrigating the land, preparing the soil, and harvesting the wheat. The important variables reducing the production of the crop are unfavourable meteorological conditions, bad agricultural methods, and a deficit of irrigation. The productivity of wheat crops may be greatly improved, and it is necessary to make it easier to use production inputs, particularly irrigation water inputs. Irrigation was scheduled as influenced by limiting soil water conditions and the maximum benefit cost ratio 1.93 was found with 316.8 mm of total water applied at irrigation level 20 % soil moisture depletion. Irrigation was scheduled as influenced by climatological factor, the maximum benefit cost ratio 2.07 was found with 330 mm of total water applied at irrigation level (IW/CPE=1.5). Irrigation was scheduled as influenced by factors of energy balance, the maximum benefit cost ratio 2.19 was found with 396 mm of total water applied at irrigation level (EB=0.75). In most cases, a decrease in a farmer's returns may be attributed to the absence of official financing, the restricted availability of informal financing, and the high cost of producing wheat. The government should update and stabilise the support prices of major crops annually to help the agricultural community and prices are publicised before to planting. The farmers then make plans for when and how much irrigation, how much land, how much fertiliser, and how many other resources will be dedicated to each crop.

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