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Impact of farm pond on yield of chickpea (*Cicer arietinum* L.) through sprinkler irrigation and fish yield, in Bundelkhand

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Abstract
A field demonstration was conducted in drought prone NICRA village of Chitrakoot (UP) in order to find out the impact of farm pond on yield of chickpea (*Cicer arietinum* L.) and fish production & income/ha of three farmers i.e., T-1 Renu, T-2 Avaneesh and compared with T-3 Suman singh, a farmer practice (no irrigation + farm pond), the demo was conducted during Year 2020 -21 and 2021 -22. The pond constructed in 0.1 ha area which was within one ha cultivated area of chick pea and pond. Pods per plant, grains per plant, 100 grains weight, grain yield was affected at different stages of irrigation through sprinkler system. T-1 was a best grower in terms of grains per pod, 100 grain weight, grain yield when sprinkler irrigation given before flowering stage. The system (Chick pea+ Fish) income was also 32.72% higher and T-2 gives 24.14% higher as compared to T-3 (No irrigation + fish pond) income. The production of T-1 in terms of grain yield was found 32.04% higher yield when irrigation given before flowering stage and T-2 gives 19.05% higher yield when irrigation given at grain filling stage as compared to T-3 Suman Singh (No irrigation) yield of grains per pod, 100 grains weight, grain yield was found lowest. Therefore, yield and yield components of chickpea may be reduced under water stress condition, depending on the extent of stress. The system net income was found higher when available pond used for fish cultivation.

Keywords: Chickpea, grain yield, pod per plant, water stress, fish yield

Introduction
In Bundelkhand agroclimatic zone of Uttar Pradesh Chick pea is an important pulse crop. India is one of the important chickpeas growing countries in the total world cultivated area under pulses is about 93.18 (Mha) with production of 89.82 (Mt) at 964 kg/ha yields level. India, with >28 Mha pulses cultivation area, is the largest pulse producing country in the world. It ranks first in area i.e., 31 percent and production with 28 percent in the world. During 2020-21 our productivity was at 885 kg/ha, has also increased significantly over last 05 year (Annual report 21-22) [1]. The Chitrakoot is a rocky district and have small hillocks. Major soils types are silty clay (Kabar) sandy loam (Parwa), and sandy (Rakar) with an area of 70.00, 79.34 and 34 thousand ha, respectively. It was observed that number of rainy days declining from 60 days/ year to 31 days in last 4 decades. The annual normal rainfall (1950-80) of the district is 980.1 mm. The maximum rainfall occurs during monsoon period is June to September having normal value of 876.8 mm. which is 89.46% of the annual rainfall. The average 20 years data shows that the average rainfall varies between 939.5 mm (Mau) and 1059.2 mm. (Karvi).
Water stress is one of the major abiotic components responsible for limiting productivity and growth of chick pea during *rabi* season. Water stress is a major problem in Chitrakoot area of Uttar Pradesh, because rainfall is rarely observed over the growing season and chickpea is traditionally grown in *rabi* season and generally grown in rainfed areas in residual soil moisture. Photosynthesis and cell growth are the primary processes which are affected by water stress (Munns *et al*., 2006) [2]. Chick pea is mostly cultivated as a rainfed crop. Pre-sowing irrigation gave better response in terms of yield. It will help in good germination and better crop growth. If winter rains not occurs, irrigation at pod development stage or pre-flowering stage may give better result. Heavy irrigation is harmful to chick pea crop so, sprinkler irrigation is beneficial. The irrigation at flowering and grain filling stages is very effective in terms of yield and growth of chick pea.

The flowering and pod setting stages is to be the most sensitive stages to drought (Nayyar *et al*., 2006) [3]. The chick pea yield was very low because water stress condition arises at critical growth stages. Water stress during flowering and grain filling caused 50-80% reductions in grain yield due to restrictions in photosynthesis (Leport *et al*., 1999) [4]. Water stress is a major limitation in chickpea production in many rainfed and semi-irrigated regions. The chick pea yield would be affected by water stress at developmental stage. Chickpea is more sensitive to water stress during reproductive stages and consequently experiences substantial yield loss (Turner *et al*., 2001) [5]. Saxena reported that when chick pea given irrigation during the pre-flowering period and at early pod fill resulted in increased yield at several locations in India (Saxena, 1980) [6]. The 722 KVK all over the country disseminating technology, played a greater role in skill development and technology demonstration based on local agro ecological situations. The state agriculture extension system and Krishi Vigyan Kendra linkages strengthening farmers to get meaningful solutions. It will empower farmers to act on ecologically sound and marketable options to increase their incomes. Present study will help and motivate the farmer to harvest rain water at own field and utilize it in life saving irrigation of crops and remaining water can be used to get extra income by adopting fish farming.

Materials and Methods

A field demo were conducted during 2020-21 and 2021-22 at three farmers field of Titihara village adopted under NICRA project by Deendayal Research Institute Tulsi Krishi Vigyan Kendra, Chitrakoot situated at longitude 25.2' N and latitude 81.1'E to find out the effects of sprinkler irrigation (T-1 Renu- irrigation Before flowering stage,T-2 Avaneesh irrigation at grain filling stage,T-3 No irrigation) on performance of yield and yield components of three chickpea (*Cicer arietinum* L.) growers (Renu, Avaneesh and Suman singh). The climate of the district is sub-tropical. The annual temperature varied between 04^0C to 48^0C with annual rainfall of 980.1 mm of last 10 years. The demo were conducted at three farmers field having black cotton soil. In T-1 (Renu) irrigation given before flowering stage, T-2 (Avaneesh) irrigation given at grain filling stage and compared with control plots T-3 (Suman) with no Irrigation, The plots were irrigated with sprinkler system with one hour running period. Each plot covered an area of 0.32 ha. All three farmer having farm pond of 0.1 ha. The field preparation was done by one ploughing before and one ploughing after pre sowing irrigation The seed rate was @ 80 kg /ha treated with PSB and Rhizobium bio agents. The crop was sown with spacing 45 cm x 20 cm. The recommended dose of fertilizer 25 kg N, 50 kg P_2O_5 and 50 kg K_2O per ha was applied at the time of sowing. The sowing was done with tractor drawn seed drill. Data from each plot were collected and pods per plant, grains per pod, 100 grain weight, grain yield were determined. The mean value of each parameter of both of year recorded and presented as per ha. The fish pond included in cultivated area. No rainfall observed during cropping period of both the year. The water in excavated pond stored during rainy season which insure to check soil erosion and water runoff.

Results and Discussion

The result of two-year study of field demonstration conducted at three different farmers field having 0.1 ha farm pond presented in table 1 and 2. Two farmer T-1 and T-2 gave sprinkler irrigation at different crop stage where as T-3 did not irrigate his crop at any stage but all of them are having farm pond and doing fish cultivation. The yield and yield attributes of chick pea revealed that the crop performance was good in terms of Pods per plant, grains per plant, 100 grains weight, grain yield when it is irrigated with sprinkler before flowering stage of chickpea (T-1) and the grain yield was found 1906.3 kg/ha. Whereas T-2 (Irrigation at grain filling stage) chick pea farmer Pods per plant, grains per plant, 100 grains weight, grain yield was lower than T-1 that is 1718.8 Kg/h. The Chick pea yield and Yield parameter of control farmer T-3 (No irrigation) shows less number of Pods per plant, grains per plant, 100 grains weight, grain yield i.e. 1443.75 kg /ha. Chick pea crop faces terminal drought during seed development stage as it is cultivated on residual soil moisture after a preceding rainy crop, thereby making the terminal moisture stress as the major constraint in achieving potential productivity of chickpea (Singh *et al*, 2010) [8]. The data is presented in table-1. The highest yield of Chick pea was found higher in T-1 plots that is 32.04% higher than control (T-3) plots whereas T-2 gave 19.05% more yield from T-3. High increase in annual income was due to introduction of more remunerative crops, more intensive farming and increased yield of crops and milk as a result of increase of water availability and protection of land from water erosion (Singh *et al*., 2018) [7] similar finding shows in table 2 the maximum total cost (Rs. 32750/ ha), Gross return (Rs. 91665/ha), Net return (Rs. 58915/ha) and BC ratio (2.80) recorded by plot (T-1) irrigation given before flowering stage and the net income was 36.72% higher than T-3 plots. The B:C ratio was also found maximum i.e., 2.80 in T-1 plots. Irrigation at grain filling stage (T-2) plots revealed that the total cost of chick pea crop + fish yield (31330/ha), Gross return (Rs. 83230/ha), Net return (Rs. 51900/ha) with BC ratio (2.66). The Net return was 24.14% higher over T-3 unirrigated chickpea. Unirrigated (chickpea + Fish) T-3 plot recorded total cultivation cost (Rs. 27970/ha), Gross return (Rs. 67045/ha), Net return (Rs. 39075/ha) and BC ratio (2.40). TS Kushwaha *et al*., 2020 [9], Study revealed that the drastic change was noted in cropping intensity, agricultural production, annual income and employment. The rainwater conservation in check dams, tanks, gully plugs and khet talab had a great impact on the changes in area of irrigation with stored water and recharges of ground water. The increase in yield was 21 to 59% of rainy season crops, like wise 12 to 60% of winter season crops in Chambal division. After full storage of ponds, the total water level was 3 Meter in height. Irrigation was made at flowering and grain filling stages and the farmers motivated from the traditional cropping with Sesame-Chickpea+ Fish farming as a system approach for better utilization of available resources.

Manjunath *et al*., 2014 [10], told that a holistic approach is the need of the hour in order to sustain a positive growth rate in agriculture. Pods per plant, grains per plant, 100 grains weight, grain yield decreased when irrigation given at grain filling stage. Irrigation disruption at pod filling can decrease grain filling duration (Ghassemi-Golezani *et al*., 2009) and photosynthate mobilization to grains, thereby decreasing grain weight (Sadeghipour, 2008) [11]. Reduction in grain number was due to a decrease in pod formation and an increase in pod abortion (Fang *et al*., 2009; Ghassemi-Golezani *et al*., 2012) [12].

Table 1: Effect of irrigation on Grain yield of chickpea

Farmer Name	Treatment	Grain weight /plant (g)	Number of pods /plant-	Grain yield (kg /ha)	Percent Yield increase	Fish Yield (kg /1000m^2)
Renu (T-1)	Irrigation at flowering stage (40 DAS)+ Pond fish (0.1ha)	12.32	36.5	1906.3	32.04	145
Avaneesh(T-2)	Irrigation at grain filling stage (60 DAS)+ Pond fish (0.1ha)	10.56	32.6	1718.8	19.05	138
Saman singh (T-3)	Rainfed (Control) + Pond fish	8.88	30.11	1443.75	-	-

Table 2: Economics of chickpea + pond fish in different treatment as affected by different stages of irrigation and System approach

Farmer Name	Treatment	Total cost (Rs /ha)	Gross return (Rs/ ha)	Net return (Rs /ha)	BC ratio	% Income increase
Renu (T-1)	Irrigation at flowering stage (40 DAS)+ Pond fish (0.1ha)	32750	91665	58915	2.80	36.72
Avaneesh(T-2)	Irrigation at grain filling stage (60 DAS)+ Pond fish (0.1ha)	31330	83230	51900	2.66	24.14
Saman singh (T-3)	Rainfed (Control) + Pond fish	27970	67045	39075	2.40	-

Conclusion

It is concluded that assured irrigation in sub-tropical area can enhance yield of chick pea and the cropping intensity may be increased with appropriate diversification with fishery enterprise. Adoption of crop diversification system will help in doubling the farmer income. By enhancing system productivity doubling of farm income can be achieved. Water harvesting structure at farm site is the only option in dryland farming system under the changing climatic scenario for increasing cropping intensity, production and income. This study clearly indicating that adoption of this technology is viable option for the farmers to get more benefits because water stress reduces grain yield in chickpea due to reductions in grains per plant and grain weight. Pods per plant, grains per plant, 100 grains weight, grain yield

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