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Irrigation based community development through community irrigation scheme: A case study of Khanapur village, Ajara Tehsil, Kolhapur district, Maharashtra

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Abstract
The major goal of community-based micro irrigation systems is to increase access to irrigation and increase agricultural land under the irrigation condition and boost up agricultural output, with a focus on marginal and small-land holding farmers who currently have limited access to irrigation. The existing cropping scenario were worked out by conducting survey of farmers and discussion sessions with respective village authorities in Khanapur study area during February 2022 to March 2022. For community micro irrigation the design of lift cum micro irrigation system was prepared as per standard steps and norms of designs. The comparison between existing and proposed crops productivity and net returns were completed by analyzing the parameters required for study such as yield, gross returns, and cost of cultivation of respective crops. It was concluded from studies that, the cropping pattern of the study area is typical and it is patient to state that the agricultural economy that is only minimally developed. From the results it was observed that, in study region the cashew, mango, watermelon gives better performance and watermelon gives best performance under small area as 5.2 ha. The community micro irrigation project prepared for 218 ha area with 12 proposed crops and the entire area is divided in to 12 zones. From the result of design rising main of 508 mm (20 inch) and pump of 340 HP is required for the 218 ha community irrigation system. Due to community micro irrigation the total cultivable area is possible to take under irrigation along with a diversified cropping pattern. Therefore, because of lift cum micro irrigation system the proper application of the irrigation and fertigation schedule is possible and it results in increasing irrigation efficiency, cropping intensity and ultimately the yield, productivity and net returns of crops in multiple times than the existing. It is concluded that, the community micro irrigation is one of the important way to double the farmers net returns and give satisfaction to farmers from their small land of field.

Keywords: Cropping pattern, source of irrigation and irrigation system, productivity, net returns, community micro irrigation

1. Introduction
Agriculture is a source of great pride and it is a major part of the Indian economy and one of the main sources of national income. Small and marginal farmers comprise the majority of farmers in India (Kumar *et al*. 2018) [18]. In Maharashtra state, 70% of the population works in agriculture. The distribution of land across various groups of farmer households in rural Maharashtra indicates that there is an unequal allocation of land. In the state of Maharashtra, marginal farmers comprise around 50% of the land. From 2006 to 2011, the average land holdings of farmers declined from 1.46 ha to 1.44 ha (Pawar and More 2018) [32].
The small land-holding farmers are core of the India. But the farming on small scale is not affordable to small land holders because farmers have to invest costs in implements and tools, machinery, work animals, sowing seeds, fertilizers, irrigation, labour, etc and even they restrict to cultivate number of crops on the same land. This results in their inability to promote modern agriculture. Small and marginal farmers are facing many drawbacks, problems, and challenges during their journey of life such as lack of proper human resources, smaller value realization due to imperfect market for produce, less access to public irrigations, electricity grids, and command area development, unaware of contingency situations and consequences of poor quality of land and water management. Therefore, income is also less, so the farmer cannot buy modern machines for farming and overall results in they are failed to recover the capital money invested in fixed and variable costs and practically they do not generate a financial yield from small land.

From the above overview, there is a great need to increase the income of small land holding farmers. There are several ways that can boost the income of farmers such as community irrigation with micro-irrigation, canal irrigation, fertility management, fertigation scheduling, and crop rotation strategies. Community irrigation is one of the important ways in which a greater number of farmers and the government can come together and possible to irrigate the maximum area under irrigation with proper cropping patterns. It will be possible to extend education financial assistance, and mechanization up to the small farmer. Micro irrigation plays a vital role in farmer's income and can increase the water use efficiency and provide appropriate water to the root zone of the plant. It minimizes weed problems and farmers can apply fertilizer in soluble form through fertigation equipment in definite schedule ultimately, results in raise of income of farmer and gives financial stability in farmer's life. Community micro irrigation convenience the farmer through higher production, higher yields, and lower risk of crop failure, and enables smallholders to adopt more diversified cropping patterns, and to switch from low-value subsistence production to high-value market-oriented production.

2. Materials and Methodology

2.1 Study Area

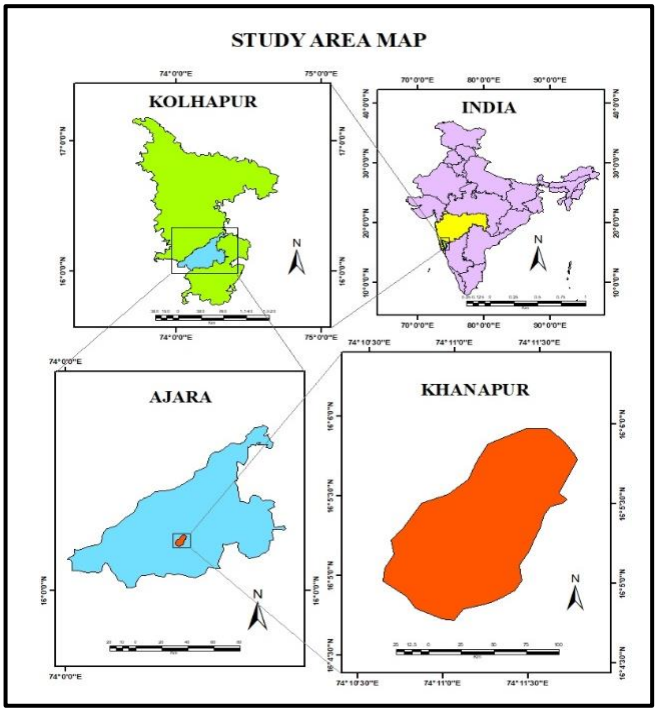


Fig 1: Study area

The Khanapur village is located in the Ajara tehsil of the Kolhapur district of Maharashtra, India. It is located between 16°06'14.27" in the north and 74°12'19.49" in the east. Khanapur village experiences a minimum average temperature of 21.1 degrees and a maximum average temperature of 34.4 degrees during summer time. The minimum average temperature is 16.6 degrees and the maximum average temperature is 28.3 degrees during the winter season (Anonymous 2021) [1]. Khanapur had a high rainfall i.e total of 1900 mm. The population of the village is 781 out of which approximately the male population is 394 and the female population is 387 as per the 2011 census. There are about 172 houses in the Khanapur village. The total geographical area of the village is 355.72 ha. Out of which 218.19 ha area is suitable for cultivation of crops. In the study region, there are 296 farmers whose annual income depends upon agriculture and belongs to small and marginal land holding category (Anonymous 2021) [2]. The large area of the region is covered by medium black soil. The area has a steep topography and rich lateritic soils suited for the excellent growth of Ghansal rice.

2.2 Data Base

2.2.1 Primary Data

The primary data was collected by conducting a sample survey questionnaire interview in village. For interview 10 farmers were selected. For conducting interview questionnaire each farmer required 30 to 50 minutes. For primary data collection 8 different points are considered such as Farmer's personal information, existing allocation of the area for different crops, available water resources, water application method which is used by the farmer, pumping system details, crop-wise farmer's irrigation and fertigation scheduling, information about advanced irrigation system, and market availability.

2.2.2 Secondary Data

Secondary data was collected by conducting discussion sessions with respective authority such as Talathi Mrs. Vandana Shinde madam and Gramsevak Mr. Vishal Dundgekar sir of village and Taluka Agriculture Officer of Ajara Tehsil. The 16 points are considered for discussion such as, total geographical area of village, climatic condition and population distribution of village, number of farmers, total cultivable area, total irrigable area, different types of soil, different water resources, area under micro irrigation, cropping intensity, crops are to be grown, area allotted to different crops, total water availability, pumps used to irrigate, energy source: electrical, solar, fuel, electricity available, and mechanization used in agriculture.

3. Results and Discussion

3.1 Existing cropping pattern of village

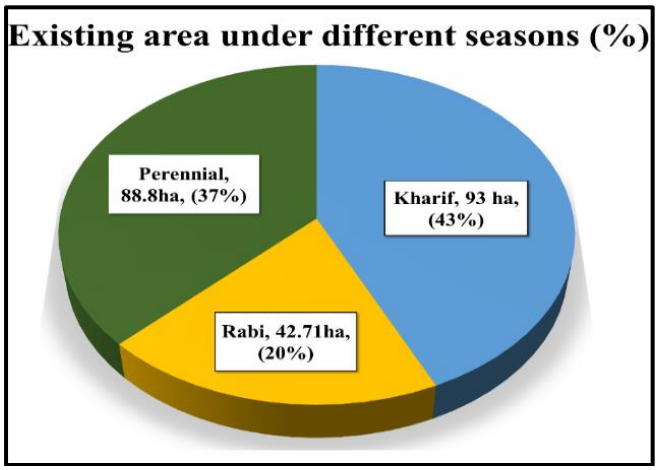


Fig 2: Existing area under different seasons

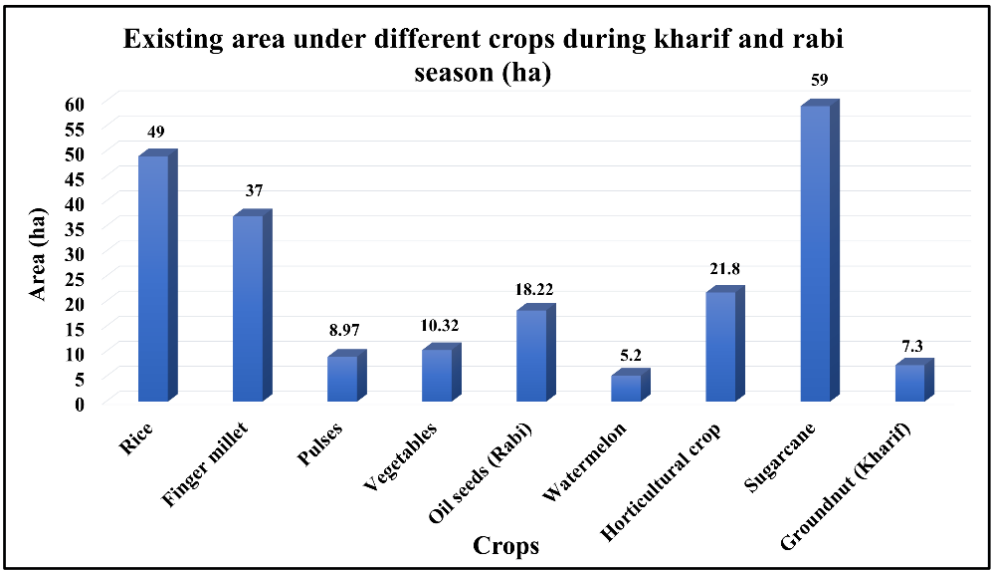


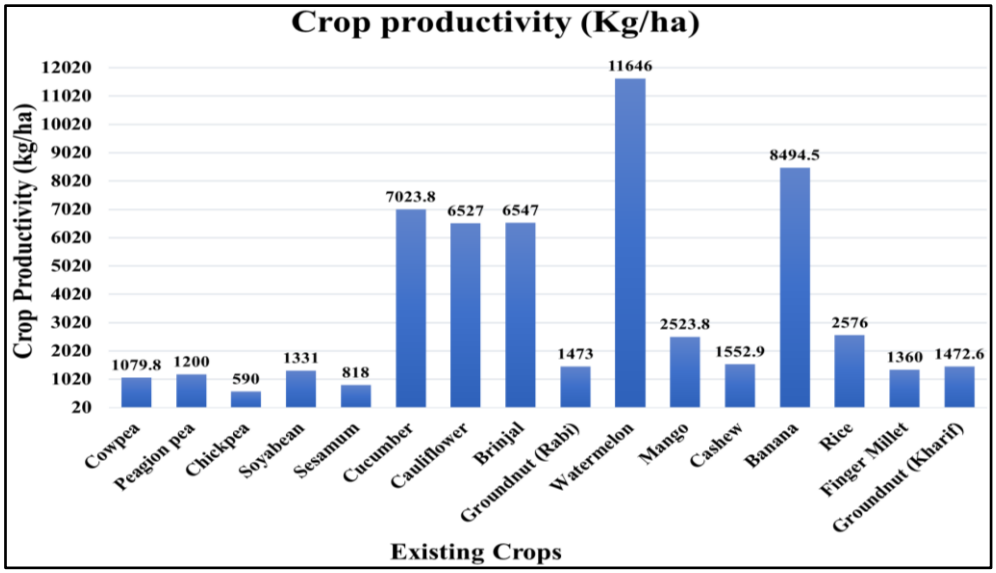
Fig 3: Existing cropping pattern of village

From this survey it was observed that, the total geographical area of village is 355.72 ha. The total geographical area 218.19 ha land is suitable for cultivation. The remaining 137.53 ha area is non cultivable because of hilly region, forest etc. Out of the total cultivable area farmers only cultivate 174.1 ha of mostly land which actual cultivable area. In a command area during kharif season, dominant crops grown by farmers were rice 49 ha followed by finger millet 37 ha and groundnut 7.3 ha. In a study region it was observed that, most dominant crop grown in the study area was sugarcane which holds area about 59 ha. It also analysed that, pulses crop like cowpea, pigeon pea and chickpea were cultivated during rabi season on 8.97 ha. Under vegetable crops cucumber, brinjal, cauliflower were taken on 10.32 ha. Mainly three oilseed crops like sesamum, groundnut and soyabean were grown on 18.22 ha. The horticultural crops such as mango, cashew, banana were cultivated on 21.8 ha, and watermelon crop which was grown between rabi and summer season on 5.2 ha.

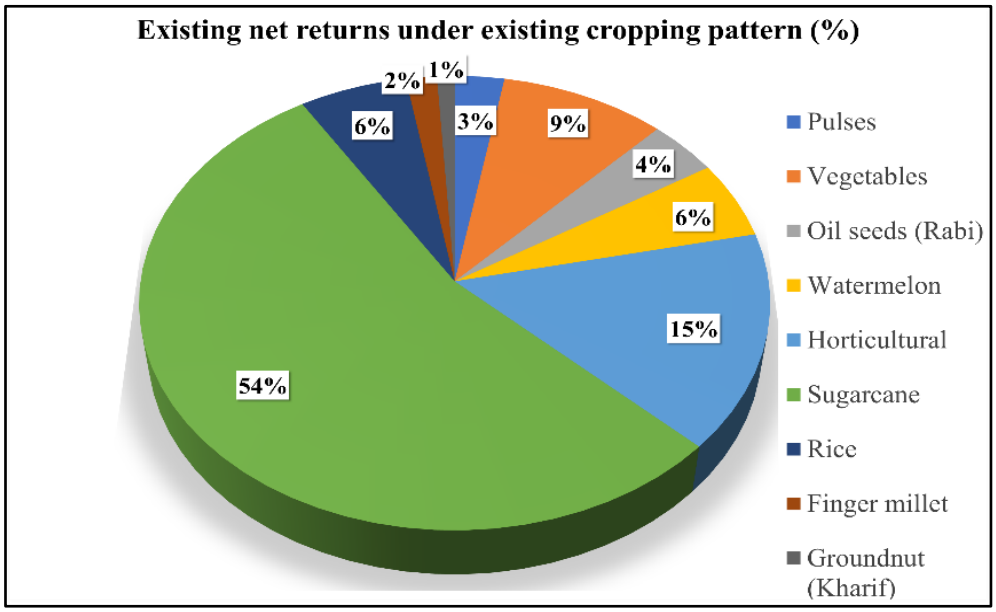
3.2 Sources of irrigation and existing irrigation methods

The area cultivated under kharif season was 93.3 ha, rabi season was 42.71 ha and area under perennial crops was 80.8 ha which occupies 43%, 20% and 37% of actual cultivable command area respectively. In the study region, 110.81 ha area was under the irrigated condition which is 68.6% of the actual cultivable area. Most of the farmers used furrow irrigation, and uncontrolled flooding irrigation method, and the least of the farmers used micro irrigation systems. Farmers used furrow irrigation for sugarcane, banana, watermelon, brinjal, cabbage, and cauliflower, etc and uncontrolled flooding was used for pulses, groundnut, sesamum etc. Due to a lack of awareness of micro irrigation only 3.4 ha area was observed under drip irrigation system which is only 3% of the total irrigable area.

3.3 Existing productivity and net returns of different crops in the village



(a)



(b)

Fig 4: Existing crop productivity and net returns of different crops in the study area

In village it was observed that, maximum productivity obtained from watermelon followed by banana and vegetables. The pulses show relatively low performance. In case of net returns highest net returns obtained from sugarcane because due to lack of knowledge of high valued crops every farmer grown sugarcane on large area even though the benefit cost ratio of sugarcane is low. Though the watermelon cultivated on less area, the net returns under watermelon is relatively high. Horticultural and vegetables crops give medium net returns. From overall study, it was concluded that there is great need to introduce high valued crops such as vegetables watermelon and banana in village under large area which will increase the yield and income of farmers in village.

3.4 Community Micro Irrigation along with cropping pattern

In present study, we focused on cropping pattern and the method of irrigation because these are the important factors which has impact upon net returns of farmer. The suggested cropping pattern plays vital key role in doubling the farmers income. In this research water will be lifted from river to irrigate cultivable village area via network of distribution pipes and drip and sprinkler irrigation system installed at farm along with diversified cropping pattern. The proposal is prepared to irrigate 218 ha area. The total area is divided in to 12 number of zones with average zone area is 18.16 ha. There are 12 high valued crops introduced in study region based on benefit cost ratio of respective crops which helps in maximize the farmers income. The selected crops were strawberry, watermelon, banana and vegetables such as broccoli, cabbage, brinjal, and cauliflower which are high yielding crops. From the existing crops, five crops were selected from the village which have good and best performance in the study region which includes cashew, mango, sesamum, cowpea, and sugarcane etc. These 15 crops were proposed in the allotted zone with advance micro irrigation system during rabi season. From the survey details it is need to design pump to irrigate 218 ha area in 12 hrs. The end point of the boundary area has length 1293 m with elevation RL 703 m. The start point of the river consists elevation RL as 655 m. In present community irrigation project, the convenient point is selected up to the water has to be lifted is taken as 1077 m length with RL 683 m. To design pump the static head up to which water is to be lifted is 28 m. For calculation total head filtration, fitting, fertigation losses considered as 5 m each and operating head considered as 15 m each.

Table 1: Basic data for design of drip irrigation and sprinkler irrigation system

Sr. No.	Parameters	Total	Zone
1	Area (ha)	218	18.16
2	Crop	Mixed	Mixed
Drip irrigation system			
3	Emitter	PC inline, PC online	PC inline, PC online
4	Emitter discharge (lph)	4 lph, 8 lph	4 lph, 8 lph
5	Emitter spacing (m)	0.3 m, 0.5 m, and 0.6 m	0.3 m, 0.5 m, and 0.6 m
7	Lateral spacing (m)	1.2 m, 1.75m, 7 m, and 4m	1.2 m, 1.75m, 7 m, and 4m
8	Shift duration (hr)	1	1
9	Available operational (hrs/day)	12	12
10	Number of shifts per day	12	12
11	Actual operating (hrs/day)	12	12
12	Average shift area (ha)	18.16	18.16
13	Average shift flow (m^3/hr)	81.66	81.66
14	Total Number of zones	12	1

15	Maximum discharge variation (%)	10	10
16	Water Source	River	River
Sprinkler irrigation system			
1	Crop	Groundnut	Groundnut
2	Area (ha)	10.9	0.90
3	Sprinkler	Twin nozzle sprinkler (4 mm × 2.5 mm)	Twin nozzle sprinkler (4 mm × 2.5 mm)
4	Sprinkler spacing (m)	12 m	12 m
5	Sprinkler individual discharge (lit/sec)	0.53	0.53
6	Application rate (mm/day)	20	20
7	Lateral spacing (m)	8	8
8	Percent of overlapping	50	50
9	Radius of coverage (m)	8	8

3.5 Cost economics of project

Table 2: Cost economics of drip irrigation and sprinkler irrigation

Sr. No.	Season	Crop	Cost per ha (Rs)	Allotted area per zone (ha)	Cost per zone (Rs)	No of zones	Total cost (Rs)
1	Rabi	Broccoli	142846.78	2.906	415207.97	12	4982495.686
2		Cabbage	142846.78	3.633	519009.96	12	6228119.608
3		Strawberry	167442.14	1.816	304186.55	12	3650238.652
4		Brinjal	142846.78	1.453	207603.98	12	2491247.843
5		Cauliflower	142846.78	1.09	155702.99	12	1868435.882
6		Cowpea	139732.8	0.908	126923.96	12	1523087.52
7		Sesamum	139732.8	0.545	76154.376	12	913852.512
					Total		21657477.7
8	Summer	Groundnut	27906.56	0.908	25348.45	12	304181.504
					Total		304181.504
9	Rabi and summer (Perennial crops)	Banana	102674.72	2.543	261136.03	12	3133632.454
10		Sugarcane	136773.18	1.816	248471.27	12	2981655.324
11		Cashew	37421.8	1.635	61184.64	12	734215.716
12		Mango	70247.86	1.271	89331.86	12	1071982.344
					Total		7921485.838
Drip Trenching							
Sr. No.	**Bill of Quantity**		**Unit**	**Quantity**	**Rate (Rs)**		**Cost (Rs)**
1	Drip irrigation installation along with trenching		Ha	218	3000		6543000
Control Unit							
2	Sand filter, 100 m3		No.	11	90000		990000
3	Screen filter, 100 m3		No.	11	10000		110000
4	Fertigation injection pump		No.	1	15000		15000
5	Fitting accessories		No.	1	20000		20000
					Total		1135000
					Grand Total		37561145

The estimated cost of lift irrigation i.e the cost required for HDPE pipe and pump installation and their accessories is Rs. 1976316.2 and the estimated cost of drip irrigation system is Rs. 37561145. The total cost of Community Micro Irrigation is Rs. 39537461.24

3.6 Comparative study of productivity and net returns of different crops under existing and proposed cropping pattern

Table 3: Productivity and net returns of different crops under existing and proposed cropping pattern

Existing cropping pattern						Proposed cropping pattern					
Sr. No.	**Season**	**Crop**	**Area (ha)**	**Productivity (Kg/Ha)**	**Net returns (Rs)**	**Sr. No.**	**Season**	**Crop**	**Area (ha)**	**Productivity (Kg/Ha)**	**Net returns (Rs)**
1	Rabi	Cowpea	3.47	1079.8	113780	1	Rabi	Broccoli	34.88	13300	78638215.6
2		Pigeon pea	3	1200	94092	2		Cabbage	26.16	25000	16597593.4
3		Chickpea	2.5	590	29300	3		Strawberry	21.8	14500	24677447.4
4		Cucumber	4.2	7023.8	280750	4		Brinjal	17.44	20000	14577939.0
5		Cauliflower	3.6	6527.8	261100	5		Cauliflower	13.08	15000	7287652.8
6		Brinjal	2.52	6547.6	253500	6		Cowpea	10.9	1100	414961.91
7		Soyabean	3.5	1331	81657	7		Sesamum	6.54	1320	222621.6
8		Sesamum	2.42	818	54762	Total			130.8		142416431.7
9		Groundnut	12.3	1473	200400	8	Summer	Watermelon	32.7	25000	10686098.4

10		Watermelon	5.2	11646	466720	9		Cabbage	43.6	25000	6915663.922
Total			42.71		1836061	10		Capsicum	26.16	28000	25283313
11	Rabi and summer (Perennial crops)	Mango	4.2	2523.8	204800	11		Cucumber	17.44	2500	6495371.04
12		Cashew	8.5	1552.9	692500	12		Groundnut	10.9	25000	520721.4272
13		Banana	9.1	8494.51	418000	Total			130.8		49901167.79
14		Sugarcane	59	59153	4610031	13	Rabi and summer (Perennial crops)	Banana	30.52	40000	5642171.36
Total			80.8		5925331	14		Sugarcane	21.8	113000	2155184.18
15	Kharif	Rice	49	2576	515382	15		Cashew	19.62	4000	1103232.6
16		Finger millet	37	1360.27	148250	16		Mango	15.26	16000	583130.38
17		Groundnut	7.3	1472.6	84250	Total			87.2		9483718.52
Total			93.3		747882	17	Kharif	Rice	87.2	2576	917169.6
Grand Total					8509274	18		Finger millet	43.6	1360.27	568544
						Total			130.8		1485713.6
						Grand Total					203287031.6

As compared to existing due to proper application of water to the crops and proper maintain of irrigation and fertigation schedule the productivity of crops increased by multiple times. Highest productivity obtained from vegetable crops followed by horticultural crops, watermelon and cucumber crop. Therefore, by preparing the design of community micro irrigation productivity of crops increases and help to doubles the farmers income. The farmers in the village cultivate 174.1 ha area with total net returns under kharif, rabi and perennial crops as Rs. 747882, Rs. 1836061 and Rs. 5925331 respectively. By introducing community micro irrigation, the income of the framers is doubled by multiple times than the existing. In proposed cropping pattern the highest net returns obtained under rabi season as Rs. 142416431.7 followed by summer season Rs. 49901167.79 and kharif season Rs. 1485713.6 respectively. The perennial crops give maximum net returns under 87.2 ha area is Rs. 9483718.52.

4. Conclusion

The average land holding of each farmer in village is 0.74 ha. Area under kharif, rabi and perennial season, is 93.3 ha, 42.71 ha and 80.8 ha respectively. n. From the results it was concluded that, in study region the cashew, mango, watermelon gives better performance and watermelon gives best performance under small area as 5.2 ha. The soil in the study region is medium black soil. From the survey details the area selected for community irrigation is 218 ha. The total area is divided into 12 zones each zone will contribute 18.16 ha. 15 crops are proposed for 218 ha area. From the result, as compared to existing, it was found that in vegetables highest productivity obtained from cabbage (74350 Kg/ha) followed by cauliflower (29690 Kg/ha), brinjal (25000 Kg/ha) and broccoli (13300 Kg/ha). As compared to existing due to community micro irrigation it was concluded that, in rabi season broccoli provided high net returns due to its high commodity and medicinal value as (Rs. 78638215.6). In vegetables cabbage, brinjal, cauliflower has net returns as (Rs. 16597593.4), (Rs. 14577939.0) and (Rs. 7287652.8) respectively. Strawberry has relatively largest net returns under medium area as (Rs. 24677447.4). It also found that, cowpea and sesamum contributes net returns under relatively low area as (Rs. 414961.91) and (Rs. 222621.6) respectively. In summer season due to high benefit cost ratio and under largest area cabbage gives high net returns as (Rs. 16597593.4) followed by capsicum (Rs. 9278280), watermelon (Rs. 3676410) and cucumber (Rs. 1986352). Groundnut crop contributes relatively low net returns under less area as (Rs. 149289.4). From perennial crops, banana holds rank first as (Rs. 5642171.36) followed by sugarcane, cashew, mango as (Rs. 2155184.18), (Rs. 1103232.6), (Rs. 1103232.6), and (Rs. 583130.38) respectively. In comparison to existing by using sprinkler irrigation method net returns of groundnut crop is increased by two times than the existing. The total net returns from 174.1 ha area is Rs. 8509274 and by introducing community micro irrigation the net returns from 218 ha is Rs. 203287031.6

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