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A STUDY ON MICRO IRRIGATION TECHNOLOGY ADOPTION WITH SPECIAL REFERENCE TO DINDIGUL DISTRICT

A. Archana [1], Dr. V. Suthacini [2]

[1] Part- Time Research Scholar, School of Economics, Madurai Kamaraj University, Madurai, India
[2] Assistant Professor & Head, Department of Agricultural Economics, School of Economics, Madurai Kamaraj University, Madurai, India

Corresponding Author
A. Archana, archraj92@gmail.com

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ABSTRACT

In India, micro irrigation technology was introduced in the 1970's to overcome the severe depletion of ground water in many areas of India due to overexploitation of ground water in irrigating crops. Tamil Nadu is one of the key implementing states for the micro irrigation system in India. Nowadays, micro irrigation is known as the most precise, efficient, and practical method of delivering water and nutrients to crops. The adoption of micro-irrigation technologies (MIT) has emerged as a critical solution for enhancing water use efficiency in agriculture, particularly in water-scarce regions. This study focuses on the adoption patterns of micro irrigation systems in Dindigul District, Tamil Nadu. This study based on secondary data obtained from various government reports, agricultural surveys, and research publications. Dindigul, a predominantly agricultural district, faces challenges related to water scarcity and erratic rainfall, making it an ideal location to analyze the impact and diffusion of MIT.The research aims to assess the extent of adoption of micro irrigation practices such as drip irrigation and sprinkler systems.

Keywords: Micro Irrigation, Technology Adoption, Drip Irrigation, Sprinkler Systems

1. INTRODUCTION

Agriculture remains the cornerstone of India's economy, contributing significantly to livelihood, food security, and rural development. However, agriculture in India faces numerous challenges such as water scarcity, declining soil fertility, unpredictable weather patterns, and inefficient water management systems. Among these, water scarcity is particularly critical, especially in regions like Tamil Nadu, where droughts and irregular rainfall patterns are prevalent. In response to these challenges, the adoption of modern irrigation techniques has become a priority.

Micro irrigation, a water-efficient method, is increasingly recognized as an effective solution for addressing water management issues in agriculture. Micro irrigation techniques, such as drip irrigation and sprinkler systems, deliver water directly to the plant root zone, minimizing water wastage and optimizing crop yield. This technology not only conserves water but also promotes sustainable agricultural practices, ensuring long-term productivity and environmental sustainability.

Dindigul District, located in the southern part of Tamil Nadu, is predominantly an agrarian region where the cultivation of crops such as bananas, groundnuts, and vegetables is widespread. However, the district faces challenges related to water scarcity, low rainfall, and the over-exploitation of groundwater resources. In such a context, the adoption of micro irrigation technologies has gained momentum as a viable solution to improve water use efficiency and enhance agricultural productivity.

1.1. OBJECTIVES OF THE STUDY

This study is based on following objectives.

1) To determine how widespread the adoption of micro irrigation technologies, such as drip irrigation and sprinkler systems in the Study area.
2) To identify the trends and changes in adoption rates over time.

2. REVIEW OF LITERATURE

Suresh et.al (2020)[1]had explores the potential of micro-irrigation (MI), specifically drip and sprinkler systems, as a solution to address water scarcity, greenhouse gas emissions, and inefficiencies in agriculture in India, especially under the pressures of climate change. Despite heavy government subsidies, MI adoption in India remains low, covering less than 15% of its potential. This study discussed for expanding MI, such as emphasizing low-cost technologies suitable for small farmers, which make up the majority of Indian agriculture, integrating water management systems that reduce dependency on groundwater and enhance surface water use in canal irrigation systems, targeting regions with over-exploited groundwater and unsustainable water extraction, prioritizing MI where it's most needed, using solar-powered pumps alongside MI to reduce energy use and carbon emissions and encouraging wastewater reuse for irrigation and linking it to MI for sustainable water management. Financial innovations, such as hybrid annuity models and subsidies linked to water harvesting initiatives, are also suggested to overcome financial barriers. The study underscores the need for effective policy frameworks and institutional mechanisms to manage water resources sustainably and boost MI adoption, contributing to both adaptation and mitigation strategies against climate change.

Padmavathi (2023)[2]had explores the adoption of Micro Irrigation Technology (MIT) in India, focusing on Drip and Sprinkler Irrigation Methods (DMI and SMI). In 2020-21, India's adoption of DMI was 5.96% of total irrigated area, with Karnataka leading, followed by Tamil Nadu, Andhra Pradesh, and Gujarat. Globally, countries like Ukraine and Finland have achieved nearly 100% adoption of micro irrigation. The study reveals that while DMI adoption is increasing in some Indian states, it is declining in others, such as Tamil Nadu and Andhra Pradesh. It also highlights the importance of spreading the benefits of MIT among farmers, particularly small and marginal ones. To promote sustainable agricultural development, it recommends expanding MIT usage, with government support through subsidies and incentives.

Yaminivaddula et.al (2023)[3] has examined "Progression of drip irrigation and fertigation in cotton across the globe and its future perspectives for sustainable agriculture" explores the global use and future potential of drip irrigation and fertigation for cotton farming, focusing on water and fertilizer efficiency. The agriculture sector, consuming 70% of global freshwater, faces challenges in water management, with cotton alone using 11% of this water. Drip irrigation, a method introduced in the 1960s, has evolved into a widely adopted technique, yet drip fertigation in cotton remains underexplored.The study synthesizes data from 124 studies across both developed and developing nations, highlighting significant benefits of drip fertigation in cotton farming. It shows that this method can reduce water usage by 50–60% and fertilizer use by 20–30%, while also improving cotton yield. Despite these advantages, its adoption is limited in developing countries, primarily due to the high initial costs. The study suggests that increasing the area under drip irrigation in countries like India could significantly conserve water and fertilizer, benefiting farmers in the long term. Policy interventions, such as farmer-friendly policies, are recommended to encourage wider adoption of this technology.

Maria Sabbagh et.al (2023)[4] their study investigates the determinants influencing potato farmers' adoption of micro-irrigation systems in the Bekaa region of Lebanon. The findings reveal that farmers' willingness to adopt micro-irrigation systems is influenced by performance expectancy, effort expectancy, and facilitating conditions. Key barriers to adoption include a lack of knowledge, financial limitations, and insufficient extension services. Despite enthusiasm for the technology, socio-economic instability and financial constraints hinder its adoption. The study concludes that factors such as age, experience, and voluntariness of use affect the adoption decision, and provides recommendations for agricultural policies.

3. RESEARCH METHODOLOGY

Dindigul is a district located in the southern part of Tamil Nadu, India. It is known for its picturesque hill stations, particularly the Dindigul hills, and its proximity to the Western Ghats. The district is an important agricultural hub, producing crops like bananas, guava, groundnut, and cotton. Dindigul is also famous for its traditional metal products, especially the Dindigul locks. The economy is largely driven by agriculture, trade, and industries such as textile and manufacturing. The district has a rich cultural heritage, with several temples and historical landmarks.This study is based only on secondary data. The researcher analyses the study period as the financial year from 2015–16 to 2022–23. Secondary data were collected from the Pradhan Mantri Krishi Sinchayee Yojana, the Department of Agriculture, and Farmers' Welfare. Statistical methods such as trend analysis and compound annual growth rate are employed for the study's analysis.

3.1. TREND ANALYSIS

The trend function is calculating a new y-value using the simple straight -line equation:

$$y = a + bx$$

Where

$$a = \bar{y} - b\bar{x}$$

And:

$$b = \frac{\sum(x-\bar{x})(y-\bar{y})}{\sum(x-\bar{x})^2}$$

3.2. COMPOUND GROWTH RATE

The compound growth rate is the rate at which an initial sum would have to grow to achieve the final sum over a set number of periods. To find the compound growth rate, three data points are needed

- The initial sum, or the value of something at time t=0
- The value of that same something at the end of the period concern
- And, finally, the number of periods that are concerned with

The compound growth rate model is

CGR = (Antilog b-1) x 100

Y = $a+b^t$

Y = Selected Variable

T = Time Period

4. RESULTS AND DISCUSSIONS

Table 1 State wise adoption of Micro irrigation System in India (Area in '000hec)

S. No	States	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	CGR (In %)
1	Karnataka	64220	139406	236108	234853	250590	321178	336053	166841	13

2	TamilNadu	32287	44778	105696	172445	263492	214147	102329	70856	10
3	AndhraPradesh	94104	141098	186441	200257	121712	118161	14645	90775	0
4	Gujarat	142681	165948	143129	140778	107649	101329	78690	106109	-4
5	Maharashtra	35671	106172	132829	159959	171097	49878	113479	168390	21
6	Rajasthan	56346	47651	48207	53982	59573	69191	78232	191004	16
7	Telangana	39864	61980	90018	42186	8195	13441	35538	40711	0
8	UttarPradesh	1597	35512	28235	55074	56953	58104	33931	65226	59
9	Madhya Pradesh	57397	54324	39759	35195	15882	17717	69890	46568	-3
10	Chhattisgarh	8068	19287	13088	19212	27688	19032	18640	23885	15
	others	19351	23808	25364	44392	91224	55584	133647	131780	0.27
	Total	551586	839964	1048874	1158333	1174055	937762	1015074	11021415	0.09

Source: PMSKY, Department of Agriculture and Farmers Welfare

The table 1 represents on the adoption of micro irrigation systems in India from 2015-16 to 2022-23 reveals significant variations in state-wise progress. Karnataka showed substantial growth, reaching 336,053 hectares in 2021-22, but saw a sharp decline to 166,841 hectares in 2022-23, with a 13% compound growth rate (CGR). Tamil Nadu's adoption grew steadily until 2019-20, peaking at 263,492 hectares, before declining in subsequent years, showing a 10% CGR. Andhra Pradesh's adoption was volatile, peaking at 200,257 hectares in 2018-19 but declining significantly after that, with no growth (0% CGR). Gujarat's adoption remained largely stagnant, declining from 142,681 hectares in 2015-16 to 106,109 hectares in 2022-23, reflecting a negative CGR of -4%. Maharashtra, however, showed impressive growth, increasing to 168,390 hectares by 2022-23, with the highest growth rate at 21%. Rajasthan exhibited consistent growth, reaching 191,004 hectares by 2022-23, with a 16% CGR. Telangana's adoption was minimal, with no growth (0% CGR), reaching only 40,711 hectares by 2022-23. Uttar Pradesh experienced a remarkable rise, growing by 59% to 65,226 hectares by 2022-23. Madhya Pradesh's adoption declined, falling from 57,397 hectares in 2015-16 to 46,568 hectares in 2022-23, with a -3% CGR. Chhattisgarh's adoption grew from 8,068 hectares to 23,885 hectares, showing a 15% growth rate. The 'Others' category showed a slight increase with a minimal 0.27% CGR. Overall, the total adoption across India saw moderate growth with a 0.09% CGR, reaching 11,021,415 hectares by 2022-23.

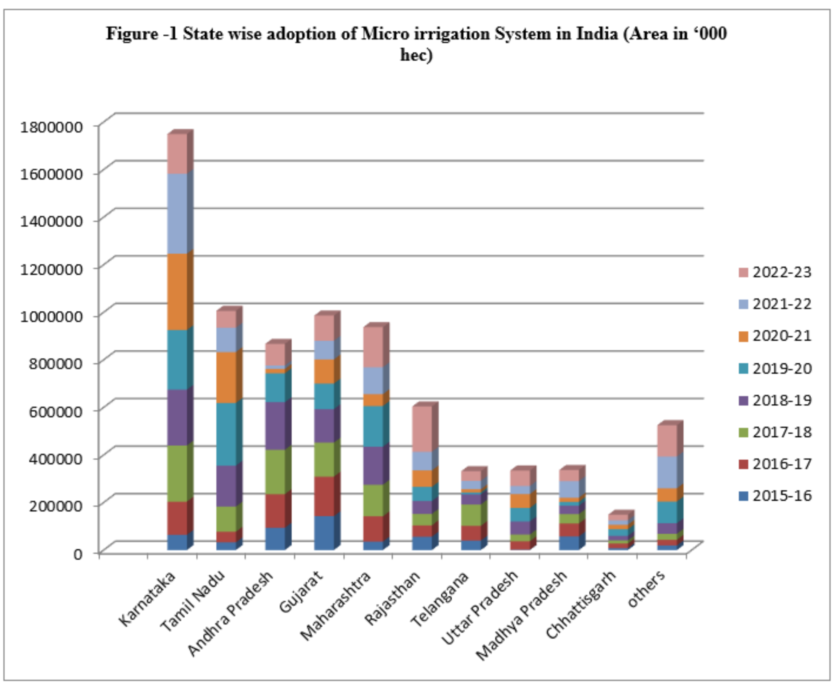

Figure 1 represents state wise adoption of micro irrigation system in India.

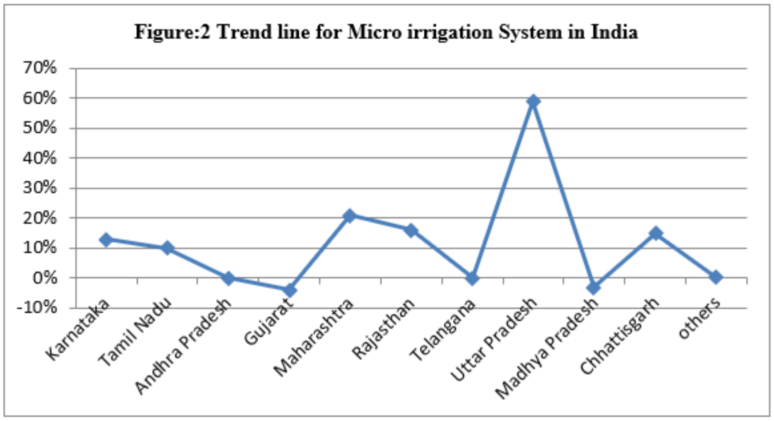

Figure 2 represents state wise adoption of micro irrigation system in India.

Table 2 District wise adoption of Micro irrigation System in Tamilnadu (Area in '000 hec)

S. No	Districts	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	CGR
1	Villupuram	2,622	3,283	12,972	19,515	18,381	15,696	3635	3075	0.02
2	Dharmapuri	3,509	3,409	5,642	8,561	32,286	14,399	6667	5321	0.05
3	Salem	3,936	4,215	7,144	11,521	19,458	11,183	5178	4621	0.02
4	Erode	2,254	2,882	5,786	7,532	24,339	10,784	5240	4459	0.09
5	Tiruvannamalai	1,648	1,813	6,913	12,745	11,212	16,439	6622	3483	0.10
6	Krishnagiri	1,845	2,838	4,157	7,278	16,007	10,903	7076	4956	0.13
7	Namakkal	2,046	1,949	4,243	6,776	12,410	9,890	3328	2925	0.05
8	Coimbatore	1,078	1,465	3,112	5,220	11,186	9,551	4531	3168	0.14
9	Dindigul	1426	2120	3952	6569	13463	6978	4946	3260	0.11
10	Theni	1,020	868	3,269	4,574	10,958	7,218	3314	2380	0.11
	others	10903	19936	48506	82154	93792	101106	51792	33208	0.15
	Total	32287	44778	105696	172445	263492	214147	102329	70856	0.10

Source PMSKY, Department of Agriculture and Farmers Welfare

The table 2 represents district-wise adoption of micro irrigation systems in Tamil Nadu from 2015-16 to 2022-23 reveals varying rates of growth across regions. Villupuram showed a modest increase in adoption, peaking at 19,515 hectares in 2018-19 but declining to 3,075 hectares by 2022-23, with a very low 0.02% compound growth rate (CGR). Dharmapuri experienced significant fluctuations, with a substantial rise to 32,286 hectares in 2019-20 but saw a decline in later years, resulting in a 0.05% CGR. Salem's adoption also grew steadily, reaching 11,521 hectares in 2018-19, but like others, experienced a decline to 4,621 hectares by 2022-23, showing a 0.02% CGR. Erode saw a notable rise, with the area under micro irrigation increasing to 24,339 hectares in 2019-20, before tapering off to 4,459 hectares in 2022-23, and a 0.09% CGR. Tiruvannamalai's adoption grew from 1,648 hectares in 2015-16 to 16,439 hectares in 2020-21, but by 2022-23, it dropped to 3,483 hectares, with a 0.10% CGR. Krishnagiri exhibited the highest growth rate in the district-wise data, reaching 16,007 hectares in 2019-20 but dropping to 4,956 hectares by 2022-23, with a 0.13% CGR. Namakkal had a modest increase, peaking at 12,410 hectares in 2019-20 and decreasing to 2,925 hectares by 2022-23, showing a 0.05% CGR. Coimbatore saw steady growth, reaching 11,186 hectares in 2019-20 and declining to 3,168 hectares by 2022-23, with a higher 0.14% CGR. Dindigul's adoption rose to 13,463 hectares in 2019-20 but fell to 3,260 hectares in 2022-23, showing a 0.11% CGR. Theni followed a similar pattern, increasing to 10,958 hectares in 2019-20 and dropping to 2,380 hectares by 2022-23, also with a 0.11% CGR. The "Others" category, representing various districts, saw a significant rise, with a 0.15% CGR, reaching 33,208 hectares by 2022-23. Overall, Tamil Nadu's total adoption of micro irrigation systems increased from 32,287 hectares in 2015-16 to 70,856 hectares in 2022-23, reflecting a modest 0.10% CGR.

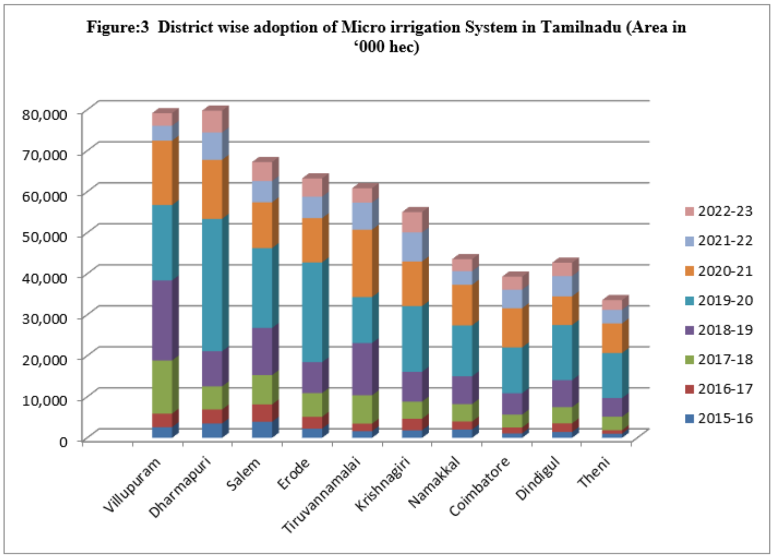

Figure 3 represents district wise adoption of micro irrigation system in Tamil Nadu.

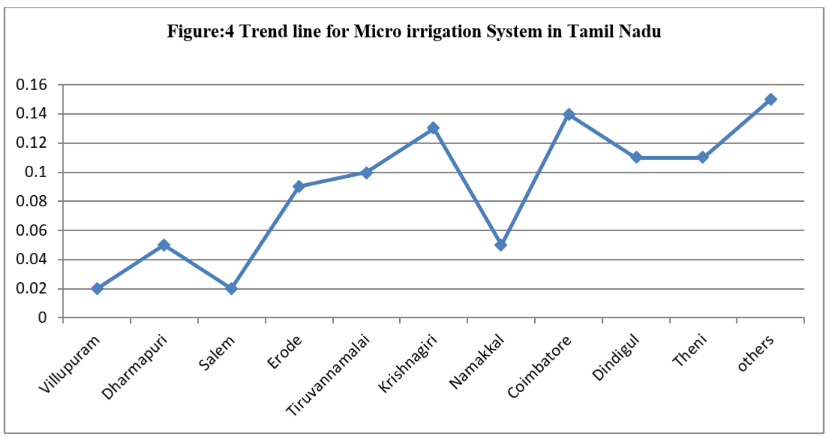

Figure 4 represents district wise adoption of micro irrigation system in Tamil Nadu.

Table 3 Block wise adoption of Micro irrigation System in Dindigul district (Area in '000 hec)

No	Blocks	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	CGR (In %)
1	Athoor	118	140	178	268	569	432	384	258	0.10
2	Nilakottai	60	110	157	249	671	531	454	360	0.25
3	Batlagundu	143	164	263	327	782	491	346	257	0.08
4	Oddanchatram	79	114	196	285	542	340	291	217	0.13
5	Reddiarchatram	292	309	381	492	831	473	385	328	0.01
6	Thoppampatti	182	210	294	386	572	280	163	190	0.01
7	Palani	160	205	252	391	582	631	498	417	0.14

8	Vedasandur	134	153	239	328	643	347	196	164	0.03
9	Dindigul	57	170	231	375	756	381	159	98	0.07
10	Natham	152	258	379	492	893	294	160	168	0.09
	others	49	287	1382	2976	6622	2778	1910	803	0.42
	Total	1426	2120	3952	6569	13463	6978	4946	3260	0.11

Source: PMSKY, Department of Agriculture and Farmers Welfare

The table 3 represents adoption of Micro Irrigation Systems in Dindigul district from 2015 to 2023 shows both growth and decline across various blocks. The total area under micro irrigation peaked at 13,463 hectares in 2019-20, followed by a sharp decrease to 3,260 hectares in 2022-23. Nilakottai exhibited the highest growth, reaching 671 hectares in 2019-20, with a CGR of 0.25%. Palani also showed significant adoption, peaking at 631 hectares in 2020-21, with a CGR of 0.14%. Other blocks like Athoor, Oddanchatram, and Batlagundu saw growth until 2019-20, followed by a decline, reflecting a slowing down of adoption after the peak year. Reddiarchatram, Thoppampatti, and Vedasandur had minimal growth, with CGRs of 0.01% and 0.03%, respectively. Dindigul experienced a rise to 756 hectares in 2019-20 but fell drastically to 98 hectares by 2022-23. Natham peaked at 893 hectares in 2019-20 before its decline to 168 hectares. The "others" category showed the highest growth with a CGR of 0.42%, reaching 6,622 hectares in 2019-20, followed by a decline. Overall, the district saw an initial surge in adoption, but the growth slowed significantly after 2019-20.

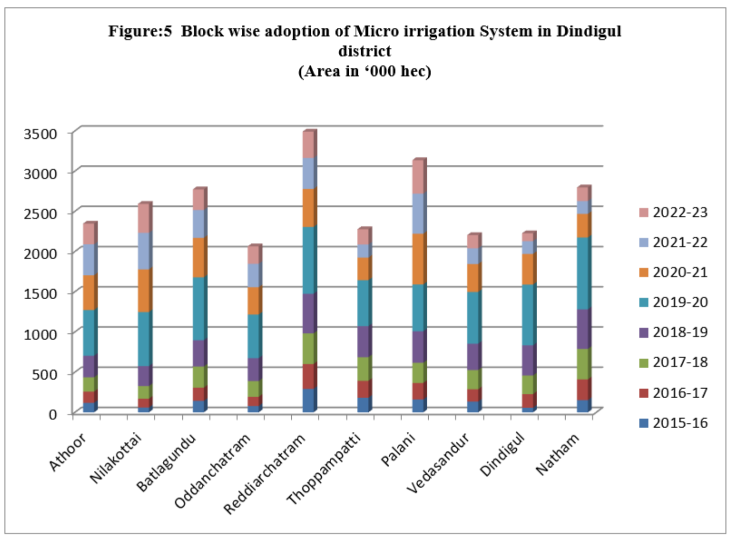

Figure 5 represents block wise adoption of micro irrigation system in Dindigul district.

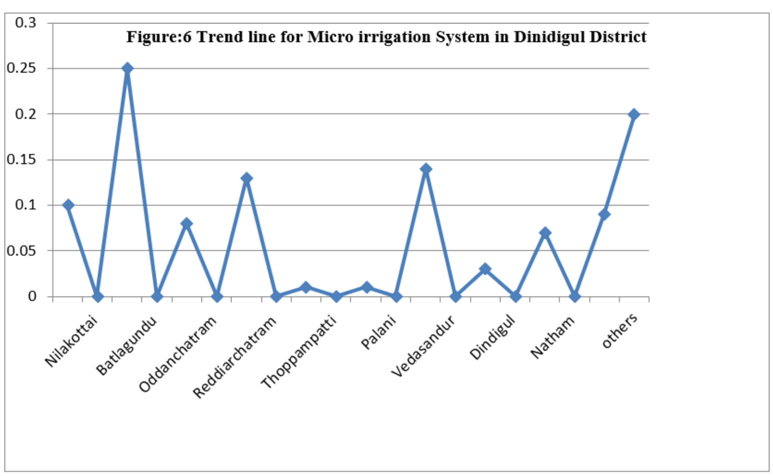

Figure 6 represents block wise adoption of micro irrigation system in Dindigul district.

5. FINDINGS OF THE STUDY

- Karnataka experienced substantial growth until 2021-22 but saw a sharp decline in 2022-23, with a 13% compound growth rate (CGR).
- Tamil Nadu saw steady growth until 2019-20, peaking at 263,492 hectares, but then experienced a decline, with a 10% CGR.
- Gujarat remained largely stagnant, decreasing from 142,681 hectares to 106,109 hectares, with a negative CGR of -4%.
- Maharashtra showed impressive growth, reaching 168,390 hectares by 2022-23, with the highest growth rate of 21%.
- Overall, India's total adoption of micro irrigation systems showed moderate growth, with a 0.09% CGR, reaching 11,021,415 hectares by 2022-23.
- Villupuram showed a modest increase, peaking at 19,515 hectares in 2018-19, but then declining to 3,075 hectares by 2022-23, with a very low 0.02% compound growth rate (CGR).
- Dharmapuri experienced significant fluctuations, rising to 32,286 hectares in 2019-20, but then declining in later years, resulting in a 0.05% CGR.
- Salem saw steady growth, reaching 11,521 hectares in 2018-19 but declining to 4,621 hectares by 2022-23, with a 0.02% CGR.
- Dindigul rose to 13,463 hectares in 2019-20 but fell to 3,260 hectares by 2022-23, showing a 0.11% CGR.
- Overall, Tamil Nadu's total adoption of micro irrigation systems increased from 32,287 hectares in 2015-16 to 70,856 hectares in 2022-23, reflecting a modest 0.10% CGR.
- Nilakottai showed the highest growth, reaching 671 hectares in 2019-20, with a 0.25% compound growth rate (CGR).
- Palani also saw significant adoption, peaking at 631 hectares in 2020-21, with a 0.14% CGR.
- Other blocks like Athoor, Oddanchatram, and Batlagundu experienced growth until 2019-20, followed by a decline, reflecting a slowdown in adoption after the peak year.
- Reddiarchatram, Thoppampatti, and Vedasandur showed minimal growth, with CGRs of 0.01% and 0.03%.
- Dindigul rose to 756 hectares in 2019-20 but dropped drastically to 98 hectares by 2022-23.
- Natham peaked at 893 hectares in 2019-20 before declining to 168 hectares by 2022-23.
- The "others" category showed the highest growth with a 0.42% CGR, reaching 6,622 hectares in 2019-20 before its decline.
- Overall, the district saw an initial surge in adoption, but growth slowed significantly after 2019-20.

6. SUGGESTIONS

- Increase **subsidies and financial support** for small and marginal farmers to reduce the initial investment burden.
- Implement **training and extension services** to increase awareness and technical skills related to micro-irrigation systems.
- Promote **solar-powered pumps** in conjunction with micro-irrigation to enhance sustainability and reduce energy costs.
- Encourage the use of **wastewater for irrigation** to further conserve water resources and promote sustainable farming practices.

7. CONCLUSION

The adoption of micro-irrigation technologies has been uneven across different regions, with areas like Maharashtra and Nilakottai making notable progress, while others such as Salem have experienced stagnation or even a decline. Several factors contribute to this disparity, including financial constraints, lack of adequate extension services, and limited awareness among farmers. To overcome these challenges, government support in the form of subsidies and incentives for micro-irrigation systems is crucial, particularly in regions facing water scarcity and irregular rainfall. The findings highlight the need for targeted policy interventions, such as providing financial assistance and implementing awareness programs, to address the barriers of high initial costs and limited access to technical knowledge, thereby accelerating the adoption of micro-irrigation technologies.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

None.

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