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A REVIEW OF TAMILNADU'S CROPPING INTENSITY

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Abstract: 90% of freshwater used worldwide is used for agriculture, primarily in India. The efficiency of water usage is reduced by Indian flood irrigation. Tamil Nadu has distinct agricultural and agroclimatic patterns when compared to other Indian states, which have raised several concerns over food security and the environment. The purpose of the study is to examine Tamilnadu's farming and irrigation practices. A total of 38 recent review papers are cited to investigate the state's irrigation and farming practices. The report provides guidance for further investigations of Tamilnadu's cropping intensity.

Keywords: *agroclimate, cropping patterns, cropping intensity, irrigation, and food security*

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OVERVIEW

Wheat and rice production in India is ranked second. From 104.4 million tonnes (mt) in 2015–16 to 117.9 mt in 2019–20, the amount of rice produced on 45 million hectares throughout the kharif and rabi seasons increased. Rabi wheat yields on 30 million hectares increased from 92.3 mt to 107.2 mt in 2019–20. Increases in the annual minimum support price as well as the FCI open-ended purchase have increased public inventories and harvest size of these two superior grains. For twenty to thirty years, Punjab and Haryana have been monocropping rice and wheat, which has resulted in significant hidden costs. Soil is improved by scientific crop rotation. Unsafe groundwater irrigation has been brought on by free power. The cultivation methods, soil conditions, and temperature of food and non-food crops differ. On the other hand, food and non-food crops are produced by varying soil types, temperatures, and growing techniques.

Agriculture generates 13% of Tamil Nadu's income. 4.74 million hectares are farmed there. TN seasonal crop report, 2020 states that 57% of the land is irrigated. Agroclimatic zones unique to seven crops exist. Agricultural intensification appears to be the only viable option for increasing agricultural production in a society with finite natural resources, rising food consumption, and enhanced food security as a result of population growth. Crop diversification improves land and water use, income, food security, jobs, and sustainable agriculture. preservation. Crop diversity boosts income, employment, and revenue.

Irrigation covers 45% of the 141 million net-sown hectares in the country. Unirrigated farming that depends on rainfall is risky and ineffective. The growing use of synthetic pesticides and fertilisers has resulted in a significant alteration in cropping patterns. We get sick from poisonous fruits and veggies all the time. Second, pesticide-resistant bugs evolve. High-yield hybrids: The healthiest seeds are native. Use hybrid seeds from the post-green revolution. Because they lack nutrients, organic farming is becoming more significant, although it doesn't lower output. A new system has to combine old and new scientific approaches to maximise benefits and minimise problems. India uses a lot of watering. Following the Green Revolution, India used more groundwater and for irrigation. Projections for the climate could lead to more frequent irrigation, requiring more water. Spatially explicit irrigated area data are necessary for agriculture water resources planning and management for varying crops and growing seasons. More water is used in new production processes. Over ten percent of our water is used for intensive agriculture. reduced groundwater levels. More government irrigation initiatives contaminate and exploit farmland for uses other than farming. A 33% forest cover is necessary for ecological balance. Deforestation gets worse due to cropping. Forest cover has been preserved through afforestation and reserve management. This natural balance has been disturbed by agriculture in many areas, and this needs to be fixed.

Irrigation Trends in Tamilnadu: The current government is thinking of taking measures to support the farm sector because agriculture is the engine of economic growth. Give state-wide irrigation first priority. In India, Tamil Nadu was the dominant irrigation state in the 1960s and 1970s. In 1960–1963 Tamil Nadu irrigated 11% of India's total land area. Poor development of irrigation reduced the State's share to 3.40 percent in 2014–17. From 1960–61 to 2016–17, Tamil Nadu has the only negative gross irrigated area growth. More land cannot be irrigated by Tamil Nadu. Groundwater and canals are used in most northern states. Groundwater, canals, and tanks all provide irrigation water to Tamil Nadu in equal amounts.

The State's canal-irrigated area and tank area decreased. From 1960–1963 to 2014–17, canal irrigation decreased from 9.03 lha to 6.22 lha. The area covered by tanks decreased from 9.41 to 3.69 lha. 6.02 lha of groundwater irrigation increased to 16.53 lha. The land lost to tank and canal irrigation could not be made up for by the massive increase in groundwater irrigation. In Karnataka and Andhra Pradesh, groundwater and canal irrigation areas increased while tank irrigation areas shrank.

Tamil Nadu's net cultivated area fell from 61.69 lha in 1970–71 to 45.82 lha in 2018–19 due to tank and canal irrigation. In 48 years, the state lost 15.87 lha of agricultural land. into 29.78 lha of barren land (15.38 lha). 108.66% increase outpaces the 36.38 percent growth for all of India. Farmers in Tamil Nadu, who have lost inexpensive irrigation supplies, now rely on expensive groundwater to grow crops. According to NABARD, agricultural households in Tamil Nadu made $9,975 between 2016 and 2017. The Central Water Commission states that of its 55.32 lha irrigation capacity, 32.71 lha is used by Tamil Nadu. Find out why there isn't more use of irrigation potential and make adjustments. Secondly, the combined capacity of Tamil Nadu's 41,127 tanks is 347 tmc (thousand million cubic feet), surpassing that of all its dams. In 54 years, the tank-irrigated area decreased by 5.72 lha. Tank area reduction cannot be explained by low rainfall. In its 16th report, the Standing Committee on Water Resources reported that the area irrigated by tanks had decreased due to significant encroachments and poor maintenance.

In the process of removing encroachments, the State ought to take PWD tanks. Tanks may be managed by a "Tank Management Board". Third, 17 out of 32 districts consume more than 80% of groundwater, according to the Central Groundwater Board. less area used for groundwater. Strict groundwater regulations are necessary. Water is conserved in overused blocks by drip irrigation. To prevent groundwater exploitation, stop providing free electricity to large farms larger than 10 hectares. Fourth, all canal command zones should use a "water accounting system" to increase water efficiency. Fifth, a "Water Regulatory Authority" headed by a specialist in water management may be formed. Development of irrigation is necessary for growth in Tamil Nadu.

Tamil Nadu's unpredictable interannual rainfall has led to frequent and substantial changes in land use, even with rapid groundwater irrigation. To minimise crop losses, identify areas that are water-stressed. In order to offer sustainable agriculture for food security and livelihoods, remote sensing can detect areas that are prone to recurring land use changes as well as major target areas for drought-tolerant cultivars, alternative water management techniques, and novel cropping patterns.

II. ASSESSMENT OF LITERATURE

From field preparation to harvesting, agricultural activity is influenced by climate. Climate is determined by temperature, humidity, precipitation, wind, air pressure, and other meteorological factors. Crop patterns have changed due to recent weather. Yields and irrigation are impacted by climate change. The literature review illustrates the trends in agriculture and irrigation in Tamilnadu.

S. Gokula Preetha et al. (2020) looked at crop planning and the sustainability of the Coimbatore District irrigation system. Comparisons were made between dry land, groundwater, canal irrigation, and canal-ground water. viability in rural areas. Irrigation with groundwater and canals was sustainable. In contrast to the other three methods, which only achieved the ecological and economic goals in the optimum planning assessments, groundwater irrigation achieved all three goals: social, ecological, and economic. By increasing profit by Rs.9980.76, the optimal ground water irrigation approach achieved the economic goal of maximum profit. The most effective method decreased potash and phosphorus. The optimal method fulfilled the social objective of employment by increasing the labour consumption of both men and women in ground water irrigation. Optimising ground water and canal irrigation schemes resulted in a profit margin of Rs. 23967. The optimal technique lowered phosphate and nitrogen. By increasing profit by Rs. 17837.67, optimal canal irrigation design achieved the economic objective of maximum profit. The optimal plan reduced plant protection and potash expenses. By increasing dry land profit by Rs. 2673.23, optimal design achieved the economic objective of maximising profit. The most effective method decreased potash and phosphorus. Technology for irrigation using canals and groundwater was more sustainable than others. Using the lexicographic goal programming methodology, the optimum farm plan for ground water, canal, canal irrigation, and dry land systems achieved economic, ecological, and social goals. While the other three methods satisfied the objectives of ecology and economy, ground water irrigation satisfied the aims of social, ecological, and economic aspects.

Global multicropping systems and their potential for intensification were studied by Katharina Waha et al. (2020). The physical area of more than 200 systems, the worldwide multiple cropping area, and the possibility of intensifying cropping were all quantified in the first global gridded data collection of multiple cropping systems. Monthly data pertaining to a crop is used. Finding sequential cropping systems comprising two or three crops with non-overlapping seasons requires taking into account the world's agricultural extent, the growing areas for 26 crop groupings circa 2000 (1998–2002), and the crop harvested areas. 135 million hectares, or 12% of the global cropland, are covered by multicropping systems, of which 85 million are irrigated. 34%, 13%, and 10% of the production of rice, wheat, and maize, respectively, is attributed to multiple cropping. Reharvesting single-cropped land could result in an 87–395 million hectare increase in harvested areas worldwide, 45% less than anticipated. Certain intensification scenarios might let cropland stay cropland, depending on the local environment, crop yields in the second cycle, and costs associated with those changes. Using crop-specific and area representation, global cropping systems have been mapped for assessments of land use and food production. In addition to describing average cropping intensity, this study also describes a number of cropping systems by sequence, growing season, and physical area. Since most nations do not have sub-national production zones, cropping intensity in certain places might be higher than what the global crop calendar indicates. Short-duration crops like legumes and pulses may only be planted as cover crops or pasture crops, overestimating the potential for intensification. This is the case in Indonesia, Brazil, India, China, Argentina, Australia, and the United States.

R. The economic effects of sand mining on groundwater irrigation in Cuddalore were assessed by Selvakumar et al. (2008). The water productivity of blocks with and without sand mining was evaluated based on farm size. Crop diversification, irrigation schedule, intensity, investment pattern in tubewells, and sequence. Examined blocks included in sand mining and non-sand mining, HP-motors, etc. The study found that farmers increased motor horsepower as a result of the sand mining externality that lowered the watertable. Investment in sand mining on a farm-scale has increased. It increased the annual cost of irrigation units and sand mining blocks. Recharging groundwater and restricting sand mining are recommended in the article. Limits on sand mining could enhance Malattar flow.

Sustainable agriculture depends on irrigation efficiency, according to RBI Bulletin (2022), as both the agricultural and non-farm sectors use greater ground water. Technical and area-weighted irrigation expenses were calculated. technological effectiveness for 19 Indian States with significant agricultural areas. In most jurisdictions, the areaweighted cost of irrigation is declining due to reduced irrigation efficiency and subsidised power. Price of agricultural energy and the depth of groundwater can influence irrigation efficiency. Rethinking irrigation laws and promoting improved technical solutions are necessary to address interstate irrigation inequities. Food and agriculture are under threat from non-farm demand and groundwater depletion. This article uses Data Envelopment Analysis to estimate and analyse the State-wise technical efficiency of irrigation, calculates and analyses the State-wise area-weighted average cost of irrigation, and uses random panel Tobit regression to identify the irrigation efficiency drivers based on crop- and State-specific data. It's possible that state-weighted average irrigation costs were reduced due to subsidised power. Some states have high costs. The majority of India's agriculturally significant states have declining irrigation technology efficiency. Random panel Tobit regression models show that the efficiency of the agriculture sector is influenced by the availability of energy and groundwater. Agricultural imbalances may be made worse by inefficient water management, rural electrification, and high agricultural electricity costs. In states with declining efficiency, microirrigation and crop diversification away from water-intensive crops should be given priority.

R. Evolving Optimal Cropping Patterns in Groundwater Over-exploited Region of Perambalur were studied by Mahendran et al. (2006). optimise agricultural designs for groundwater irrigation. The idea was inspired by the Perambalur area's groundwater irrigation. Crop planning was optimised by linear programming. The main obstacles were money, irrigation water, and agricultural land. Six representative farms were selected: one for open wells, one for tubewell-irrigated farms in critical and overexploited groundwater regimes, one for wells in tank command regions, and one for semi-critical and safe regimes. In critical and overexploited groundwater regime sample farms with conventional wells, tank command area wells, and tubewell-irrigated farms, the optimal crop plans decreased the essential irrigation water use by 24.30, 4.54, and 51.71 hours.

Optimal crop plans reduced the essential irrigation water use in semi-critical and safe groundwater regime sample farms by 4.61, 3.99, and 4.73 hours of pumping in conventional wells, tank command area wells, and tubewell-irrigated farms, respectively. Paddy and sugarcane were lowered in all ideal crop plans. Groundnut, gingelly, and tapioca are low-water-intensive crops that were improved by all perfect crop plans. The optimum crop designs that benefited from the necessary and overused groundwater regime either somewhat or significantly raised the net revenue of the sample farms.

A. Cropping patterns and irrigation in the Salem district were investigated by Bharatharathna et al. (2019). Cropping patterns show agricultural productivity and resource endowments. The farm becomes wealthy via commercial crops, and vice versa. Cropping is affected by location. It depends on the time and place. Cropping patterns were altered by policy-induced factors (such as fertiliser and irrigation subsidy, procurement costs, etc.), technological advancements (such as better seeds and irrigation), institutional factors (such as market, road density, and loan availability), and economic effects (such as input and product pricing). Farming is shaped by irrigation. Irrigation has the biggest impact on the farming practices of the communities studied in the Salem district. Water is a component of land, an economic factor. The assumption that "crop selection in study villages in Salem district is heavily influenced by irrigation" is accepted. Maize, gingelly, tapioca, and jower are somewhat irrigated; sugarcane, turmeric, seed cotton, and paddy are fully irrigated. More well and borewell space are needed for previous crops. In the study communities, high irrigation intensity increases cropping intensity and variety.

2015 saw an investigation of Indian agriculture diversification towards high-value crops by Sanjeev Kumar and Sakshi Gupta. From 1990 to 2011, panel regression and SID analyses were employed. The research states that while state-level farming is shifting from foodgrains to high-value crops, state/regional transitions differ. SID data displays crop trends, including food and non-food, in the agricultural economies of all states. Crop diversification according to crop intensity, gross irrigated area, and average annual rainfall is predicted using the Fixed Effect Model. According to the study, farmers require policy assistance for agricultural research, education, technology, insurance, cropping intensity, and gross irrigated area. Crop areas of high value increased by 1.99%. Thus, the production of agriculture is now dominated by high-value crops. Indian agriculture is transitioning from subsistence to high-value, as indicated by area and SID values. This shift does not affect food crops, non-food crops, and total crops equally. The states with the lowest SID in the overall crops subsector are Himachal Pradesh, Bihar, Uttar Pradesh, Jammu & Kashmir, Odisha, Punjab, West Bengal, Madhya Pradesh, Assam, Haryana, Tamil Nadu, Karnataka, Maharashtra, Andhra Pradesh, Rajasthan, Kerala, and Gujarat. Crop diversification at the state level is boosted by farming intensity and yearly rainfall, according to FEM data. Crop variety is increased by gross irrigated area.

Jasim H.R et al. (2018) found a correlation between cropping intensities and irrigation in the Kongu Uplands of Tamil Nadu. The agricultural and irrigation intensities were examined in the Kongu Uplands research conducted in 2015–16. In order to calculate irrigation-cropping intensity, Karl Pearson used the correlation coefficient product moment approach. Block-level G-return data for 2015–16 were provided by the District Economic and Statistics Departments. maps created with ArcGIS. This approach can be used in future research to support decision makers. The lands to the west, northwest, southwest, and even parts of the centre were heavily irrigated. Highlands. Northern and northeastern areas produce the most. In the Uplands, cropping intensity is not affected by irrigation intensity. Three parameters are used in the study to categorise irrigation and agricultural intensity. Elevated, tempered, and centred. Irrigation blocks that are high, moderate, and low. The blocks with the most cropping are 21, 59, and 1. In blocks in the Uplands, the intensity of irrigation and agriculture is marginally negative. In the region under investigation, agricultural intensity is influenced by irrigation as well as environmental, sociocultural, economic, political, technological, and infrastructure aspects.

C. Velavan together with p. Crop diversification in Tamil Nadu was studied by Balaji (2022). The report stated that the state's production of jowar, peanuts, and rice decreased. Minor crops that increased in value were fruits, vegetables, coconut, black and green grammes, and maize. The state is altering its crop base. Primary crops like rice, groundnuts, and jowar have decreased while least share crops like maize, sugarcane, coconut, and green gramme have increased, according to the agricultural area's compound annual growth rate. Diversification in agriculture has decreased. The study illustrated crop diversity throughout the state.

U. Madhurima et al.'s (2022) study looked at Andhra Pradesh's structural modifications to agricultural and irrigation practices. Systems that are dynamic change. Subsystems are impacted by structural changes in the global economy. India is built by states. This study examines the economic relationships between irrigation and changes in dynamic cropping patterns in the primary sector of Andhra Pradesh (including data from Telangana). Eco-friendly surface water irrigation tanks saw a twofold reduction, while groundwater extraction climbed fivefold. Cropping patterns changed to rice, cash crops, and pulse crops under groundwater and canal irrigation, resulting in a decrease in net farmed area. With irrigation, 93% of the coarse wheat has been replaced by chilli. Over the decades, net irrigated fodder crop area increased to 50.61 percent, highlighting the state's cattle business. Net irrigated area is increased by state-wide groundwater and canal irrigation systems. To preserve the infrastructure for tank irrigation, encourage pressurised irrigation. Nutrients are guaranteed by coarse cereal cultivation. reclaiming surface water for irrigation from groundwater.

B. The impact of integrated watershed management programmes on farming in rainfed Tamil Nadu was studied by Kavitha et al. in 2022. The Thoothukudi, Krishnagiri, and Perambalur districts of Tamil Nadu's watershed development programmes were evaluated based on biological, physical, social, and economic factors. Research was improved by watershed development structures. Crop productivity, storage capacity, rising water tables, and extended water availability all contributed to increases in gross cultivated area, crop production, and irrigation and cropping intensity. Investment from the private sector is needed for percolation ponds, farm check dams and other water gathering projects. Maintenance responsibilities for watershed assets by stakeholders provide the community more influence.

The irrigation investment and returns in Tamilnadu were studied by Upali A. Amarasinghe et al. (2008). The research claims that Tamil Nadu's main, medium, and minor irrigation zones are not increasing agricultural productivity. These three industries have likely spent more than $1 billion on irrigation, project rehabilitation, and operations and maintenance since 1970. In spite of these expenditures, between 1970 and 2000, the net surface-water irrigated area under canal and tank irrigation programmes decreased by 10% and 50%, respectively.

Seventy percent of net irrigated land was covered by tanks and canals in the 1970s. Increasing water efficiency has the potential to boost agricultural output. A 24% decrease in irrigation demand might be achieved by raising surface and groundwater irrigation efficiency to 50% and 65% from 35% and 50%, respectively. Using the water savings from paddy cultivation to cultivate more paddy, rice output might surpass population growth. The state's most water-intensive crop, sugarcane, may increase output. Fruits, vegetables, and livestock feed can only be irrigated with a portion of the water saved. The demand for these crops is growing due to dietary changes. Irrigation is reduced when existing land is cropped. Demand for rice will increase by 6% to 14% as consumption patterns shift. The population of Tamil Nadu reaches the mid-2030s. Food could be produced on existing land without irrigation if crop yields were increased. Investments in tank irrigation require fresh perspectives. Whether a tank supplies water for surface water, concurrent irrigation, or recharges groundwater for full groundwater irrigation in command zones, tank maintenance is crucial. The selection of tanks solely for groundwater recharging is based on hydrogeology, number of fillings, interconnection of cascade systems, and water demand in nearby settlements. Examine cutoff points. The groundwater irrigation environment in Tamil Nadu is being overused. Groundwater restoration should be funded by public funds to deliver water. Dig wells to artificially replenish overfished watersheds. Investing in drip and sprinkler irrigation should lessen overabstraction. Less than 20% of Tamil Nadu's irrigation is by drip or sprinkler systems. Crop area is increased via water-saving techniques.

K.R. Karunakaran together with K. Palanisami (1998) looked at Tamil Nadu's crop intensity in relation to irrigation. Large and small irrigation projects are heavily funded by the Five Year Plans in order to support agricultural productivity. Land output and agricultural intensity are impacted by irrigation. This research, therefore, evaluates investment patterns in major and minor irrigation projects and maximises resource benefits by examining how irrigation, particularly diverse sources of irrigation, influences cropping intensity using secondary data from 1969–70 to 1993–94 in Tamil Nadu. State-level agricultural intensity and irrigation development were highly correlated, according to linear regression models. These findings are confirmed by cross-section regression using different irrigation sources. Up until 1979–1980, irrigation from dug wells increased agriculture intensity similarly to that from canals and tanks. Later, cultivation was intensified by irrigation using tubewells and dug wells. Although the area covered by tank irrigation is decreasing, its beneficial impact on cropping intensity necessitates a prompt repair. Crop intensity was increased by minor irrigation (tube and dug well), but more money will need to be spent in the future. The least expensive per acre irrigation projects are major and minor ones.

K. According to Palanisami (2022), tanks are century-old gravity irrigation devices that rely on rainwater to function in arid and semi-arid locations. 0.25 million tanks in India. Between 1953 and 2018, tank-irrigation fell from 3.3 m.ha to 1.67 m.ha. 60% of the lands with tanks are watered. Tank productivity and efficiency have suffered from neglect and inaction. Tank storage capacity was reduced by approximately 30% in most places due to years of poor land use upstream, encroachment into the tank catchment, and tank water siltation, which left most areas with insufficient tank irrigation. Irrigation tanks are the ideal substitute for extensive (protective) irrigation in the semi-arid tropics. There is little groundwater development and canal irrigation. Tanks aid in the climate change adaptation of small farms. Another inexpensive irrigation investment is a tank. Interest funders for tank modernization and refurbishment. Irrigation and tank revival? Bright spots and hot spots could aid in the tanks' long-term revival. Most of these are covered in this report. In the early 1980s, institutional development, upkeep, and administration were neglected in favour of physical rehabilitation to boost agricultural productivity. The goals of tank rehabilitation, the sources of funding, the physical elements chosen for restoration, the method of implementation, and the institutional architecture have all evolved. Future tank rehabilitation repair projects should promote rural livelihoods by enhancing the advantages from diverse tank usage, based on past restoration outcomes and anticipated requests. This report offers six effective modernization strategies. such as desilting the water spread region in a selective tank. Usually between 20% and 30%. desilting of the tank water spread area. closing the sluices to convert tanks into percolation ponds when the average water storage in the tanks during a five-year period is less than 40%. filling tanks from adjacent canals, anaicuts, or rivers a couple of times a season. Groundwater draft annually to determine the ideal well count in the tank command area for groundwater development. 20% more wells could be added by tank commands. During the farming season, use tank and ground water by rotating the sluice.

J.S. Miss Amarnath and Mr. S. Saranya (2014) evaluated farmer livelihood security and created ideal farm plans in both agro-ecological systems using farm-level indicators and the Sustainable Rural Livelihood (SRL) framework. Irrigated agro-ecological systems are sustained by high soil fertility and integrated pest management. Agro-ecological systems that are irrigated have higher output-input ratios, net returns, and value. Higher input self-sufficiency, labour requirements for producing a single crop, and food expenditure were found in irrigated agro-ecological systems. The evaluations of the SRL framework looked at social, financial, physical, and natural capital. Irrigated agro-ecological systems are more sustainable, according to farm-level data. Kenya's CARE model examined the security of farmers' livelihoods under both systems. It demonstrated the economic, ecological, and social safety of irrigated agroecological farmers. Using multi-objective goal programming, the study developed sustainable farm plans with social, ecological, and economic objectives. Lastly, the government ought to support rain-fed farmers through agricultural development and welfare initiatives, and irrigated farmers through financing and extension policies.

Ga and V. Geethalakshmi. Dheebakaran (2021) studied Tamilnadu agriculture and climate change. According to their findings, agriculture can adjust to modest climatic change with the aid of technology and agronomic modifications. Regional capacities vary widely. Find places that are vulnerable to climate change. Determining this adaptability and the key rates of climate change to which agriculture can locally adjust is crucial. Research on how agriculture may adapt to yearly, seasonal, and intra-seasonal climate variability in the nation's many agroclimatic zones is required to comprehend climatic change and its effects on agriculture and people. Crop productivity, soil erosion, salinization, nutrient depletion, insects, illnesses, and hydrology are all impacted by climate change. Crucial factors include fertilisation, planting time, crop selection, irrigation, and more. Management strategies should be modified to raise critical crop yields in changing climate scenarios, taking into account population growth, the demand for food grains, and changes in productivity brought on by climate change. It is important to research cultivars and climate change management. There are several projections from climate change models, but in order to assess the effects, more intricate scenarios with greater spatial resolution are required.

In 2017, Shinde Varsha Tanaji and Deshmukh MS conducted an analysis of the irrigation intensity and the Indian cropping intensity index. India: A study on irrigation intensity and agriculture. Cropping intensity is increased by the variations in land use, irrigation intensity, cropping pattern, and cropping intensity among all states. In 1950–51, cropping intensity increased by 28% to 139%. While agricultural intensity increased from 111% to 139%, the net sown area increased by 18% from 118.75 million hectares in 1950–51 to 139.93 million hectares in 2012–13. There were 60.10 million hectares of net irrigated land, and irrigation intensity increased from 17.56 percent in 1950–1951 to 47.24 percent in 2012–2013. India has higher intensities of irrigation and agriculture. The compound growth rate is 0.47 gross cropped area and 0.13 net sown area. 73.41% of cropping intensity varies. The intensity and dispersion of agriculture were impacted by irrigation. Crop intensity and production are increased by irrigation. Net area cropped twice a year is increased by cropping intensity. The productivity of an agricultural acre per year rises. The efficiency, labour, and cropping intensity of modern agriculture techniques are all improved. When different winter crops were planted with conserved water, cropping intensity rose with net irrigated area and effective irrigation potential. According to this study, agriculture and irrigation intensity rose with irrigation infrastructure. Manipur grows 100 and Punjab 190 crops.

S.R. Verma (2016) investigated the effects of agricultural mechanisation on labour, income, cropping intensity, productivity, and labour force. Agricultural mechanisation decreases human and animal drudgery, improves cropping intensity, precision, and input utilisation, and lowers crop yield losses by utilising a variety of power sources and improved agricultural tools and equipment. Mechanising farms increases output while saving money. Production has increased due to mechanisation, irrigation, high-yielding seed varieties' biological and chemical inputs, fertilisers, insecticides, and mechanical energy. Studies show that because farm mechanisation applies inputs with timeliness, quality, and precision, it increases agricultural yield. NCAER (1980) reported that compared to bullock farms, 815 agricultural households in 85 localities produced 72% more sorghum and 7% more cotton. Tractor-owning and tractor-hiring farms increased productivity by 4.1–54.8%, according to ITES, Madras. 1975). Because of better deadlines and higher input costs, bespoke hire farms saw a lower percentage increase than farms with tractors. Production was boosted by improved irrigation, fertiliser, and mechanisation. Mechanisation of agriculture increased human labour, according to studies. Compared to bullocks, tractors required 1.3–12% less work. Male casual labour increased by 38.55%. Unpaid labour decreased. Mechanised small farms required 5.7% more labour, according to NCAER (1973). As per

IIM, Ahmedabad (1975), mechanisation does not result in a decrease in labour force. In summary, a greater area, higher labour productivity, and a higher average cropping intensity led to an increase in inputs as a result of farm mechanisation. Profitability of agricultural mechanisation is dependent on crop input efficiency, quality, and timeliness. Mechanisation reduced agricultural labour hours while replacing 60–100% of animal power. By creating, maintaining, and repairing tractors and other farm equipment, mechanisation increased the amount of labour available on and off the farm.

Vanita Ahlawat and Renu (2016) investigated the impact of irrigation and the regional disparity in cropping intensity in Haryana. Crop concentration can be advantageous for state agriculture. Cropping maximum area many times is referred to as cropping intensity. This study examines the district-level agriculture intensity in Haryana. Crop intensity is affected by irrigation. The source of the data is Haryana Statistical Abstracts. Data are analysed using variance, average, and linear regression. The intensity of cultivation varies by district. Gurgaon, Jhajjar, and Rewari did not succeed in agricultural intensification; Panipat and Karnal did. Sirsa and Fatehabad fared okay. Agroclimatic factors, irrigation, rainfall, and modern farming practices can all affect this fluctuation. District agriculture is impacted by irrigation. It accurately forecasts cropping intensity. Agricultural intensity rises with improved irrigation. The study suggested using irrigation to increase agricultural productivity. With the exception of Gurgon, Jhajjar, Rewari, and Mewat, Haryana develops well. The government and its allies need to improve agricultural inputs and irrigation systems in low-performing districts in order to eliminate regional disparities and increase cropping intensity.

In 2022, Narmadha and Karunakaran looked at the agricultural diversification of Tamil Nadu. The agro-climatic and farming practices of Tamil Nadu are distinct from those of other Indian states, posing problems for the environment and food security. The study examines land use and agricultural patterns in Tamil Nadu from 2001 to 2020. Important crop area data were provided by secondary sources. The major crop growth is tracked throughout time (2001-2020) via the compound growth rate. The direction of the annual cropping pattern and the crop diversification index were found using Markov chain analysis. The amount of non-agricultural and fallow land rose. In contrast to paddy, bajra, sugarcane, groundnut, and gingelly, maize, legumes, fruits, vegetables, coconut, and cotton are rising. In Tamil Nadu, net sown area for food crops is declining more than that for non-food crops. Crop intensification has increased in the state, reducing crop failure, revenue loss, and loss of rural jobs, according to the Agricultural Diversification Index score. Food crops were declining while non-food crops were expanding, according to the transitional probability matrices. Crop intensification is shown by the state's agricultural diversification index. Stability in the diversification index will lower crop failure, revenue loss, and unemployment in rural areas. As a result, the study suggests keeping a reasonable farm profit and treating farmers who grow horticultural crops especially well because they improve the government's ecosystem.

Institutions and participation in irrigation were studied by Ravikumar and Sharif (2012). Tracking was done on CII cost, function, and farmer participation. In Tamil Nadu, Namakkal is home to many CIIs. Participating farmers paid more per ha-cm of irrigation water than non-participating farmers because of their larger initial investment. Non-participant farmers in sugarcane that uses a lot of water make more money per unit of water used than do participating farmers. Logit analysis shows that the distance between the farm and the institutional irrigation well has a negative impact on participation, while credit availability at the irrigation institution's inception, well ownership, and land holding size favourably improve participation. The study recommended expanding the idea of Community Infrastructure Improvements (CIIs), providing subsidised initial investments to marginalised groups to increase participation, allocating water based on land holding and cropping patterns, and promptly revising CII rules and regulations to enhance operation.

In 2010, Kumar promoted drip irrigation. Where? Why? The study investigates what promotes or discourages the adoption of drip irrigation and how it impacts agriculture. Net seeded, net irrigated, cropping, and irrigation intensity were all raised with drip irrigation. Farmers are hampered by the drip technique's low holding area and initial cost. Difficulties include cropping patterns, subsidies, and technical assistance. Crops including coconuts, bananas, grapes, and others may benefit from micro irrigation. Drip irrigation is determined by cropping pattern. In locations lacking labour and water, drip irrigation is effective. Drip irrigation was found to increase cropping intensity, irrigation intensity, net seeded area, and net irrigated area. Crops including coconuts, bananas, grapes, and others may benefit from micro irrigation. Drip irrigation is determined by cropping pattern. Age, education, size of farm, crop spacing, and activities conducted off-farm and outside of it all had a significant impact on drip adoption. In regions where labour and water are scarce, our technique might promote drip irrigation and wider crop spacing.

Maneesh P and M. Yesurajan (2016) looked at the sustainability of irrigation for food security in Tamil Nadu. Floods, droughts, crop failure due to climate change, farmer suicide, and other significant challenges have been faced by the agriculture sector. Scarcity of water is paramount. undermining sustainable agriculture and food security. Irrigation comes mostly from wells and river tanks. Tamil Nadu is irrigated by groundwater. The state's diminishing groundwater resources are used for irrigation. In 2010–11, the irrigated net area fell and then climbed from 2887 hector to 2919 hector. The net-irrigated area grew from 2010 to 2011. Irrigation area since 2000–01 was 2947. The state's irrigation intensity increased to 115.43 hectors in 2014–15 after dropping from 120.89 hectors to 113.06 in 2010–11. Farming in the state is affected by irrigation. Crops are raised and lowered by irrigation. Long-term irrigation will thereby improve agriculture and reduce food insecurity in the state. Tamil Nadu has a limited supply of water, which needs to be properly managed because of rising demand and declining quality. Agriculture and water access are linked by less precipitation and flooded areas. Alarms about water reduce crop yield. Agriculture is powered by water. According to the study, agriculture is harmed by water constraint. Food insecurity and farm sustainability are caused by a fall in grain output. In order to preserve agriculture in the state, the government must act quickly to encourage appropriate irrigation technologies.

2012 saw Jayanta Saud investigate how irrigation influences the intensity of agriculture in Assam. In Assam's rural areas, 86% of people are employed in agriculture. The majority of Assam's agricultural land is used less because it is only farmed once a year. A few factors that impact land usage and agricultural intensity are irrigation, technology (HYV seeds), institutional (property rights), factor market, and others. Monsoonal cultivation is intensified by irrigation. The agroclimatic zones of the Brahmaputra valley in Assam exhibit high levels of cultivation. The study found that agricultural intensity is influenced by irrigation. In the state's Brahmaputra valley, irrigation has increased land use and agricultural intensity, resulting in extensive growth. Water shortage demands water management. Planning for irrigation is necessary for water management. Farmers require an irrigation design and cropping strategy for each irrigation season in order to maximise economic return or water-use efficiency.

Groundwater irrigation boosts Bikaner's agricultural productivity, according to Ramraj Prajapat (2022). In Bikaner, Rajasthan, the growth rates of groundwater irrigated areas as well as the intensity and productivity of agriculture were assessed. The five decades that comprised canals, tube wells, wells, and other irrigated fields were: decade I (1970–1980), decade II (1980–1990), decade III (1990–2000), decade IV (2000–2010), and decade V (2010). (2010–20). 2010–17. Rajasthan and Bikaner were irrigated more quickly by tube wells than by traditional methods. Crop output and intensity decreased as the area fed by rain increased. Bikaner agriculture in the 1970s was aided by canals. This could be brought on by unpredictable canal water, unfinished irrigation projects, and inadequate maintenance of surface irrigation equipment. As a result of increased groundwater use, there were more tube wells. Because crops may be sown in more seasons, tube wells have increased agricultural production. Water from the surface and the ground enhanced crop productivity. Rain lowers crop productivity and intensity. Surface and groundwater as well as irrigation efficiency are necessary for long-term irrigation viability.

The irrigation climate change in Tiruchirappalli was assessed by Karthikeyan et al. in 2022. Long-term variations in temperature and weather are called climate change. Irrigation water was diminished by climate change and global warming. In Tiruchirappalli, Tamil Nadu, India, this study assessed the effects of climate change on ground water, canal, and canal-ground water irrigation ecosystems. Three blocks in Tiruchirappalli were examined. 15 localities and 150 farms. The intensity of groundnut and sesame irrigation rose in all three irrigation ecosystems. Water was lost in three irrigation ecosystems. In Tiruchirappalli, more water was applied to sugarcane, green gramme, and sorghum than to other significant crops. Using the Ricardian model, farmers' net income in all three irrigation ecosystems was impacted by climate change. In all three irrigation ecosystems, the Ricardian model showed that farmers' net income increased with rainfall during the Kharif and Rabi seasons, whereas in the groundwater and canal irrigation ecosystems, it dropped with the highest temperature of the Kharif season. The irrigation ecosystem's climate-smart technology adoption features were examined using the Tobit model. The Tobit model results indicated that in all three irrigation ecosystems, adoption of climate-smart technologies was influenced by farm size, education, and extension contact. Little was produced in all three irrigation situations because to labour constraints and climate-smart technologies. District climate should be minimised and improved by government climate planning.

India's irrigation-productivity relationship was examined by Songqing Jin et al. (2012). how agricultural yield, land costs, and cropping intensities are affected by irrigation. Enough households cultivating numerous plots under various irrigation settings is our primary identifier. Cropping intensities are the main factor influencing all four outcomes once irrigation is taken into account together with household fixed variables and plot attributes. Watering is important. We suggest raising the quality and accessibility of Indian irrigation. This paper promotes irrigation infrastructure investment in India. Why some states have better irrigation than others is not explained in this paper. In order to maximise the financing of irrigation investments, future research should look at the causes of irrigation's disparate outcomes in different states.

K. Sivasubramaniyan (2016) evaluated irrigation in Tamil Nadu. India's yield, acreage, and production of wheat and rice stagnated till independence. India's economy expanded following a strategy. Irrigated land and crop yields in post-independence India were significant factors, particularly in Tamil Nadu, Andhra Pradesh, Madhya Pradesh, Punjab, Haryana, West Bengal, and Uttar Pradesh. This article looks at the evolution of irrigated agriculture in Tamil Nadu, India, from 1950–1951 to 2010–2011 in order to comprehend the spread of agricultural. Irrigated paddy and wheat acreage, yield, and extent in Tamil Nadu and India were investigated. India's low yields of wheat and rice suggest that the government is taking steps to maintain these crops. Only three of India's four primary irrigation sources are used by Tamil Nadu because the contribution of "other sources" is minimal. In Tamil Nadu and throughout

India, the latter source has declined more than tanks and canals over the preceding fifty years. This source replenishes groundwater in the majority of settlements. It is important to build and extensively rehabilitate tank irrigation. It is not possible to sustain well irrigation without tanks and canals. Tanks are essential to irrigated agriculture in Tamil Nadu.

III. CONCLUSION

Tamil Nadu experiences two major monsoons, the northeast monsoon and the southwest monsoon, which result in many cropping seasons annually and a high cropping intensity. This results in a high cropping intensity since it enables the year-round cultivation of a wide range of crops. Data on cropping intensity was recorded for 2020 at 125.400 ha th. Compared to the prior figure for 2019 of 123.800 ha th, this represents an increase.

Agricultural Land Cropping Intensity data is updated yearly, averaging 120.800 ha th from Mar 2003 to 2020, with 18 observations. The statistics set a record low of 113.100 ha th in 2013 and an all-time high of 8,251.000 ha th in 2003. Agricultural Land Cropping Intensity data remains active status in CEIC and is reported by Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare.

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