

GROUNDWATER QUALITY OF REGIONS SURROUNDING THE NOYYAL RIVER IN TIRUPPUR DISTRICT AND ITS IMPACT ON AGRICULTURE

ABSTRACT

Public policy is in response to public real-world problems. Its relevance is also important essential as well. One such policy is ~~the control of~~ to control the pollution problem in rivers. In this connection, evidence is focused here by a research study on Noyyal river pollution in Tiruppur district of Tamil Nadu state in India. The Noyyal ~~river is one of the non-perennial rivers flowing in the eastern part of Tamil Nadu~~ River is one of the non-perennial rivers flowing in the eastern part of Tamil Nadu, predominantly in the Tiruppur district. Its river basin, including groundwater, gradually deteriorated due to ~~discharge of industrial effluents (pollution) over years in the river until the year 2011~~ after which the ZLD policy is ~~the discharge of industrial effluents (pollution) over the years until 2011, after which the ZLD policy was~~ in practice in complete stoppage of pollution. ~~In this study, groundwater quality and its impact on the area surrounding the Noyyal river in the Avinashi and Palladam blocks of the Tiruppur district after the implementation of ZLD have been evaluated~~ This study evaluated groundwater quality and its impact on the area surrounding the Noyyal River in the Avinashi and Palladam blocks of the Tiruppur district after the implementation of ZLD. The selected block is divided into ~~3~~ three regions based on the distance from the river, with 40 sample farms from each region contributing to a total of 120 samples. Based on the farmer's opinion, the study found that ~~the quality of water was very poor in the closer region as it tastes to be poor (salty) and not suitable~~ water quality was inferior in the closer region as it tasted inadequate (salty) and unsuitable for use. However, in distant ~~region~~ regions, the water tastes good. The results can be proved with ~~the results of~~ groundwater samples in the study area with a

~~high amount of high~~ salt contents (Ca, Mg, Na, K, Cl, etc.). The constructed water quality index is also high (>75%) in the closer region, ~~which shows the intensity of pollutions~~ showing the pollution intensity. The study concludes that pollution caused by the dyeing industries in the groundwater still exists in the study area and therefore recommends allotment of a small area of land under farm ponds to store good quality ~~of~~ water during rains; thereby ensuring percolation of rainwater to improve the quality of groundwater and thus enabling the ecosystem for agricultural improvement.

Keywords: Noyyal ~~river~~ River, Groundwater pollution, Quality, Agriculture.

INTRODUCTION

Groundwater is a very good and excellent source of drinking water and irrigation due to the purification properties of the soil. In arid and dry zones, groundwater becomes the main primary source of water water source (Fried, 1975). Today ~~groundwater quality is~~ groundwater quality has deteriorated due to several industrial and man-made activities. It includes the discharge of industrial ~~waste water~~ wastewater, tannery waste, etc., into river basins. These wastes not only deteriorate the quality of river water, the polluted water percolates into the ground and causes deteriorate river water quality and cause polluted water to percolate into the ground and cause groundwater pollution (Karpagam, 1991).

Groundwater contamination ~~is the result of polluted water that~~ infiltrates through the soil and rock and eventually hits ground water results from polluted water infiltrating the soil and rock and eventually reaching groundwater. This process can take many years and can take place occur at a distance far from the well where contamination is found. Once the groundwater is contaminated, it ~~is very difficult~~ is not straightforward to remediate. (Geetha *et al.*, 2008). The

discharge of effluents from industries is likely to affect ~~the quality of groundwater~~groundwater quality.

Most dyeing units discharge ~~the untreated effluent into the land, which ultimately pollutes the ground water~~untreated effluent into the land, ultimately polluting the groundwater and making and makes it unfit for drinking- (Noel ~~and~~& Rajan, 2015). The dye effluent is highly toxic ~~in nature~~ as it contains ~~high suspended solid, COD, dye and chemicals along with a high concentration of heavy metals like Cu, Cd, Zn Ni and Pb. The dye effluent contaminates the surface and groundwater, thereby,~~highly suspended solids, COD, dye, and chemicals and a high concentration of heavy metals like Cu, Cd, Zn, Ni, and Pb. The dye effluent contaminates the surface and groundwater, -making it unsuitable for irrigation and drinking (Mathur ~~and~~& Bhatnagar, 2007).

Public policy is in response to public real-world problems. Its relevance **is also important/significant**. One such policy is ~~the control of~~to control the pollution problem in rivers. In this connection, evidence is focused here by a research study on Noyyal river pollution in Tiruppur district of Tamil Nadu state in India. The Noyyal ~~river is one of the non-perennial rivers flowing in the eastern part of Tamil Nadu~~River is one of the non-perennial rivers flowing in the eastern part of Tamil Nadu, predominantly in the Tiruppur district. Its river basin ~~including groundwater, gradually became deteriorated due to discharge of industrial effluents (pollution) over years in the river until 2011, after which ZLD policy is,~~including groundwater, gradually deteriorated due to the discharge of industrial effluents (pollution) over the years until 2011, after which ZLD policy was in practice in complete stoppage of pollution.

ZLD - Zero Liquid Discharge policy **means, dye waste water is not to be discharged** into the river, instead it has to be purified and reused by the industry itself, in order to control pollution in the Noyyal river **dye waste water is not to be discharged into the river; instead, it has to be**

purified and reused by the industry itself in order to control pollution in the Noyyal River as ordered by the High Court in the year 2011. Because of this, the pollution by industries in the river was stopped. ~~But the effect of pollution caused prior to the year 2011 still continues even now, particularly in groundwater, which affects groundwater irrigated crops as far as agriculture (Akilan, 2016 and Babu et al., 2017) since groundwater pollution is very difficult to be remediated~~ However, the effect of pollution caused prior to the year 2011 continues even now, particularly in groundwater, which affects groundwater-irrigated crops as far as agriculture (Akilan, 2016; Babu et al., 2017) since groundwater pollution is challenging to remediate. ~~For improving irrigation and sustainable groundwater use, this is a hindrance~~ This is a hindrance to improving irrigation and sustainable groundwater use.

Furthermore, this poses negative impacts on agriculture and economics till now. This paved the way for us to attempt a research work that helps us ~~to understand the current status of pollution and its effect~~ understand the current status of pollution and its effects. Specific objectives of one such study are 1) to rank the farmers' opinion on the quality of groundwater in terms of taste, appearance ~~and use among the sample farms to develop an index of water quality and 2) to analyse,~~ and use among the sample farms to develop an index of water quality and 2) to analyze the impact of water quality on agriculture in the sample farms.

DESIGN OF THE STUDY

Area selection

Avinashi and Palladam ~~blocks of Tiruppur district, blocks of Tiruppur district, is are~~ purposively selected, which is suitable to find the current status of groundwater pollution. The reason is that among the blocks through which Noyyal flows in the Tiruppur district, Avinashi and Palladam block has a larger area under groundwater irrigation.

Sampling design

The study area is divided into three different regions based on the distance of the sample farms from the Noyyal ~~river,~~ River to find the current status of groundwater pollution and its impact on agriculture. The regions are **less than** 1 km from the river (closer region), 1-3 km from the river (middle region), and greater than 3 km from the river (distant region). Under each category, a quota of 40 farmers were selected randomly ~~and hence;~~ hence, the total sample size ~~constitutes~~ constituted 120 farmers. The primary data was collected from the sample farm households with the help of well-structured, pre-tested interview schedules, bearing questions ~~in relation to~~ about the ~~objectives of the study~~ study's objectives.

Methodology

Water Quality Index

The water quality index is constructed using primary data collected during the survey among the farm households. **Farmers** were asked to rate water quality based ~~upon the parameters like taste, appearance and use. Based on the ratings of farmers water quality using three point scale is as follows~~ on taste, appearance, and use. Based on their ratings, water quality is rated using a three-point scale.

$$WQI = (\text{-----}) (1)$$

Where,

‘t’ **refers to taste** – (poor – 3, medium – 2, normal – 1)

‘a’ **refers to appearance** – (bad – 3, medium – 2, good – 1)

‘u’ **refers to use** – (agriculture – 3, household and agriculture – 2, drinking, household and agriculture – 1)

In addition, six water samples were collected and given for analysis in the soil testing laboratory of the Tiruppur district, and the results were tabulated. Two samples from each category (one from bore well and the other from open well) were taken for analysing a bore well and the other from an open well) were taken to analyze the salt concentrations.

RESULTS AND DISCUSSION

Farmers' opinion on groundwater quality in the study area

The wells are mainly used for irrigation by the sample farmers, as most of the living houses are attached to farms. Therefore, in this study, parameters like taste, appearance and use of groundwater are considered to support farmers opinion, and groundwater use support farmers' opinions, and the results are tabulated below.

Table – 1 Farmers' opinion on groundwater quality in the study area

S.No	Particulars	Farm location from Noyyal river <u>River</u>					
		<1km (Closer region)		1-3km (Middle region)		>3km (Distant region)	
		No. of farmer	Percentage	No. of farmer	Percentage	No. of farmer	Percentage
1.	Taste						
	Poor	33	82.50	1	2.50	-	-
	Medium	7	17.50	34	85.00	10	25.00
	Normal	-	-	5	12.50	30	75.00
	Total	40	100.00	40	100.00	40	100.00
2.	Appearance						
	Bad	-	-	-	-	-	-
	Medium	29	72.50	3	7.50	-	-
	Good	11	27.50	37	92.50	40	100.00
	Total	40	100.00	40	100.00	40	100.00
3.	Use						
	Agriculture	40	100.00	21	52.50	-	-

	Household	-	-	19	47.50	26	65.00
	Drinking	-	-	-	-	14	35.00
	Total	40	100.00	40	100.00	40	100.00

It ~~could-can~~ be seen from Table – 1, ~~that~~ in the closer region, all parameters of groundwater quality were of poor quality. On the contrary, it was good in the regions far from the river based on farmers' ~~opinion~~opinions. Taste is one of the most important parameters of water. In the closer region, ~~82.50 per cent of the sample respondents rated poor (taste) indicating the percent of the sample respondents rated poor (taste), indicating~~ poor quality. In the middle region ~~85.00 per cent of the sample respondents rated the taste as medium, 2.50 per cent rated as poor and 12.50 per cent, 85.00 percent of the sample respondents rated the taste as medium, 2.50 percent as poor, and 12.50 percent~~ as ~~normal~~usual. However, ~~in the distant region 75.00 per cent of the sample respondents rated taste as normal, only 25.00 per cent as medium, 75.00 percent of the sample respondents rated taste as expected in the distant region, only 25.00 percent as a medium, and no~~ poor taste was reported.

Second, ~~using the appearance~~ the appearance of the groundwater was rated among the sample respondents. No one rated the ~~water appearance as bad in all the water's appearance as wrong in all~~ three regions. According to ~~72.50 per cent of the sample farms, the appearance was medium and 27.50 per cent~~ percent of the sample farms, the appearance was medium, and ~~27.50 percent~~ percent of the sample farms were as good in the closer region. In distant ~~region~~regions, all the respondents rated ~~the~~their appearance as good. This is because ~~of the reason that~~ the water is salty ~~in nature~~ alone, and when it comes to appearance, it is not as bad as dyeing water.

Third, based ~~upon-on~~ the usage, the groundwater was rated. ~~100-One hundred per cent of the respondent used ground water only for agriculture~~ percent of the respondents used groundwater ~~only for agriculture; no-and-no~~ other use was observed in the closer region. They also stated that

the groundwater is very poor in their region and unfit for agriculture, ~~however, there is no other source for irrigation,;~~ however, there is no other source for irrigation, and the groundwater is being used. In middle region, groundwater is being used for agriculture (52.50 per cent) and other household purposes (47.50 per cent) the middle region, groundwater is used for agriculture (52.50 percent) and other household purposes (47.50 percent). In distant ~~region~~ regions, the groundwater is being used for drinking also groundwater is also being used for drinking. 35.00 per cent of the sample respondent uses the water for drinking, household percent of the sample respondents use the water for drinking, household, and agriculture. 65.00 per cent uses percent is used for agriculture and household purposes.

It could be concluded that the ~~quality of water~~ water quality was ~~very poor~~ inferior in the closer region, as it tastes ~~to be poor (salty) and is not suitable for use.~~ However, in distant region ~~the water tastes good and is used for all three purposes. It could be concluded that groundwater quality based on taste, appearance and use was very poor in closer region and distant region, having~~ poor (salty) and is unsuitable for use. However, the water tastes good in the distant regions and is used for all three purposes. It could be concluded that groundwater quality based on taste, appearance, and use was inferior in the closer and distant regions with good groundwater quality but good groundwater quality with few limitations.

Construction of Water Quality Index using ~~farmers~~ farmers' rating

~~Water quality index was constructed using farmers rating as three grades of water quality viz., good, medium~~ The water quality index was constructed using farmers' ratings of three water quality grades: good, medium, and poor. The results were are presented in the table below. Low water Quality index indicating less pollution (< 50 per cent) and high water Quality Index

indicating high pollution (76—100 per cent) A low water Quality index indicates less pollution (< 50 percent), and a high water Quality Index indicates high pollution (76 – 100 percent).

Table – 2. Water Quality Index using ~~farmers~~ farmers' rating

WQI	Farm location from Noyyal river <u>River</u>					
	<1km (Closer region)		1-3km (Middle region)		>3km (Distant region)	
	No. of farmers	Mean	No. of farmers	Mean	No. of farmers	Mean
Poor (76-100 %)	40 (100.00)	83.89	1 (2.50)	77.78	-	-
Medium (50 – 75 %)	-	-	35 (87.50)	62.54	10 (25.00)	55.56
Good (< 50 %)	-	-	4 (10.00)	44.44	30 (75.00)	39.26
Total	40 (100.00)		40 (100.00)		40 (100.00)	

Note: Figures in the parentheses indicate the percentage share ~~to~~ of the total.

It could be inferred from Table -2, ~~that water quality index constructed using the farmer's rating were~~ that the water quality index constructed using the farmer's rating was very high for all the groundwater samples in the closer region. The average value is about 83.89 ~~per cent in closer region~~ percent in closer regions and ~~and it~~ is of poor grade. In the middle region, all three grades of water quality were found. Only one ~~sample water quality falls under a poor region with 77.78 percent of water quality sample falls under a poor region with 77.78 percent of the~~ water quality index. 35 ~~Thirty-five~~ groundwater samples (87.50 ~~per cent~~) fall into medium grade with an average of 62.54 per cent ~~percent~~ fall into medium grade with an average of 62.54 percent, and 4 ~~four~~ samples fall under good grade with an average water quality of 44.44 percent. The water samples in distant ~~region~~ regions fall under medium and good grades. ~~30~~ Thirty samples ~~in good grade and 10 samples fall in medium grade with 39.26 per cent and 55.56 per cent of~~ are in good grade, and

ten are in medium grade, with 39.26 percent and 55.56 percent of the water quality index, respectively. It can also be stated that ~~lower the value of water quality index, higher is its quality~~ lower the value of the water quality index, the higher its quality, and vice versa. The results could be interpreted that farms ~~located~~ more than 3 km from the river had ~~very significantly~~ less or no pollution, and groundwater pollution had been diluted to a greater extent. Groundwater was highly polluted in ~~closer region, and moderately polluted in the middle region, and very less or no pollution in the closer region, moderately polluted in the middle region, and very little or no pollution in the~~ distant region.

Test results of groundwater sample

Table –3. Salt concentrations of groundwater samples

S.No	Particulars	Farm location from Noyyal river River						Permissible limit for irrigation water quality by FAO
		<1km (Closer region)		1-3km (Middle region)		>3km (Distant region)		
		Open well	Bore Well	Open well	Bore well	Open well	Bore well	
1.	pH	6.95	7.19	7.7	7.3	7.1	7.40	6.5 – 7.4
2.	EC (dSm ⁻¹)	10.9	7.7	2.9	2.8	1.8	1.7	3
3.	Chloride (meq/l)	55.2	41.2	24.0	18.0	12.0	11.1	10
4.	Calcium (ppm)	340	140	70	106	42	60	250
5.	Magnesium (ppm)	312	376.8	195.6	153.6	90	117.6	40
6.	Sodium (ppm)	358.8	299.46	154.56	151.57	128.34	117.3	200
7.	Potassium (ppm)	54.21	70.98	10.53	13.36	10.92	11.31	50
8.	Bicarbonate (meq/l)	0.9	0.5	0.6	0.7	0.5	0.4	8.5

9.	Sodium Absorption Ratio (SAR)	4.77	4.34	3.05	3.13	2.01	2.55	-
10.	Salt type	Magnesium chloride						NA

It could be inferred from Table 3, that all the values were higher in the closer region that all the values were higher in the closer region and and the values were drastically reduced in the distant region. EC values are very high in the closer region beyond the safe levels showing high levels of pollution in that region and they decrease in the middle region and tends, showing high levels of pollution in that region, and they decrease in the middle region and tend to safe levels in distant regions. Salts like Calcium, Magnesium, Sodium and Chloride are higher than critical values in the closer region and tend to, and Chloride are higher than critical values in the closer region and tend to have safer values in the distant region. However, Magnesium concentration is higher in all the three regions. But However, pH, potassium and bicarbonate values lie within the safer, and bicarbonate values are within the safest levels. It could be concluded that most of the values in the closer region exceed general recommendations. Sheriff and Hussain, (2017) and Gowsar et al., (2017) and Gowsar et al. (2019) reported similar results in the groundwater samples taken in selected places of Tiruppur district. The results of groundwater quality values obtained are compared with the FAO permissible limits for irrigation water. It was found that the majority of the ionic concentrations were beyond the permissible limits prescribed by FAO. The maximum permissible limit for Electrical Conductivity (EC) was 3-three dSm^{-1} , the value of EC in the closer region is greater than 7, and the value in the closer region was greater than 7, which was more than two times the limit. The maximum permissible limit for Magnesium and Chloride was 40 ppm and 10-ten meq/l , in all the three regions the values are very high, beyond the permissible limits since, magnesium chloride was found to be dominant in all the; in all three

regions, the values are very high, beyond the permissible limits since magnesium chloride was dominant in all three regions. This can be said as evidence forevidenced by the ratings given by farmers and the constructed water quality index. Since ~~according to farmers' rating~~, according to farmers' ratings, the closer region is highly affected by pollution, the same trend can be seen from the groundwater sample test results.

Impact of groundwater pollution on agriculture

Several factors have been ~~analysed to study the impact of groundwater pollution on agricultural farms and~~ analyzed to study the impact of groundwater pollution on agricultural farms. They are as follows.

Table – 4. Demographic pattern of the sample farms

S.No	Particulars	Farm location from Noyyal river River					
		<1km (Closer region)		1-3km (Middle region)		>3km (Distant region)	
		Number	Percentag e	Number	Percentag e	Number	Percenta ge
1	Age						
	<40	7	17.50	12	30.00	3	7.50
	40-50	21	52.50	12	30.00	20	50.00
	>50	12	30.00	16	40.00	17	42.50
	Total	40	100.00	40	100.00	40	100.00
2	Education						
	Illiterate	1	2.50	6	15.00	4	10.00
	Primary	5	12.50	5	12.50	7	17.50
	Secondary	16	40.00	8	20.00	15	37.50
	Higher Secondary	11	27.50	7	17.50	2	5.00
	College	7	17.50	14	35.00	12	30.00
	Total	40	100.00	40	100.00	40	100.00
3	Average Family size (in numbers)						
	Male	1.45	34.36	1.62	37.33	1.35	33.75

	Female	1.47	34.84	1.52	35.03	1.40	35.00
	Children	1.30	30.80	1.20	27.64	1.25	31.25
	Total	4.22	100.00	4.34	100.00	4.00	100.00
4	Farming experience (in years)						
	<15	9	22.50	12	30.00	8	20.00
	15-25	15	37.50	18	45.00	24	60.00
	>25	16	40.00	10	25.00	8	20.00
	Total	40	100.00	40	100.00	40	100.00

It could be inferred from ~~the Table 4 that young farmers having age below 40 was low compared to other age groups in all the~~ Table 4 that the number of young farmers aged below 40 was low compared to other age groups in all three regions. However, it was ~~very low/shallow~~ in distant region, having only 7.50 per cent (3 sample farmers) compared to middle region, having 30 per cent (12 sample farms) and the closer region, having 17.50 per cent the distant region, having only 7.50 percent (3 sample farmers), compared to the middle region, having 30 percent (12 sample farms), and the closer region, having 17.50 percent (7 sample farms). The age group of 40-50 was found to be dominating in ~~closer region (52.50 per cent) and distant region (50.00 per cent),~~ whereas in middle region, the age group above 50 is high (40.00 per cent the closer region (52.50 percent) and distant region (50.00 percent), whereas in the middle region, the age group above 50 is high (40.00 percent) among the sample farms.

~~Information on education level of the sample respondents is very important because an educated farmer would normally aware of technological, environmental and institutional changes and they follow any new strategies quickly by adopting it~~ the education level of the sample respondents is crucial because an educated farmer would normally be aware of technological, environmental, and institutional changes, and they follow any new strategies quickly by adopting them. Education influences the decision-making capacity of the farmers. The table ~~showed~~ shows

the education level of the head of the family of the sample farms. The level of illiterate was found to be low in all the regions ~~viz., closer region (2.50 per cent), middle region (15.00 per cent) and distant region (10.00 per cent, viz., the closer region (2.50 percent), middle region (15.00 percent), and distant region (10.00 percent)~~ among the sample farms. It can also be stated that ~~majority of the family heads had basic school education and few graduated also~~ the majority of the family heads had basic school education, and few graduated in all the regions.

The family size of the respondents revealed that the number of children ~~were found to be low in all the~~ was found to be low in all three regions. However, the average family size was higher in ~~middle region with average family size of 4.34 whereas in closer region it was 4.22 and it was very low in distant region with~~ the middle region, with an average family size of 4.34, whereas in the closer region, it was 4.22, and it was very low in the distant regions, with an average family size of 4.00 numbers. Only in ~~middle region, male population was high, whereas in other two regions~~ the middle region was the male population high, whereas, in the other two regions, the female population was found to be dominating.

Farming experience is another ~~important~~ critical factor that determines the decision-making capacity and success of the farm. Among the sample respondents, the ~~numbers farmers with farming experience more than 15 years was high in all the~~ number of farmers with a farming experience of more than 15 years was high in all three regions. During the field survey, most ~~of the farmers said that~~ farmers said farming was their forefather's occupation. In the study area, most of the farmers had ~~very good~~ excellent agricultural experience. Almost 65 ~~per cent~~ percent of the farmers in each region ~~having experience more than 15 years~~ have more than 15 years of experience. It can be concluded from the above table that there ~~exists minor variation among the sample farmers in case of farming experience and average family size, whereas in age and~~

education is minor variation among the sample farmers regarding farming experience and average family size, whereas variation exists in age and education variation exists. However, pollution has no impact on demographic characteristics.

Table – 5. Changes in the cropping and occupation of the study area

S.No	Particulars	Farm location from Noyyal river <u>River</u>		
		<1km (Closer region)	1-3km (Middle region)	>3km (Distant region)
1	Predominant irrigated crop	Coconut	Coconut, Banana	Banana, Coconut
2	Predominant rainfed crop	Sorghum	Sorghum	Groundnut, Sorghum
3	Predominant occupation	Powerloom, shops	Powerloom, farming, and fabrication	Farming and fabrication

It could be inferred from Table –5, that Coconut is found to be the predominant irrigated crop in the study area that Coconut is the predominant irrigated crop in the study area, followed by banana. The predominant rainfed crop is sorghum in the study area, followed by groundnut. However, banana is not cultivated in closer region, it is grown only in middle region and distant regionbananas are not cultivated in the closer regions; they are grown only in the middle and distant regions. The reason may be due to high intensity of pollution causing unfavourable conditionthe high intensity of pollution, which causes unfavorable conditions for banana growth in the closer region. Similarly, groundnut is not grown in closer and middle region as rainfed crop, grown only in distant regiongroundnuts are not grown in closer and middle regions as rainfed crops; they are grown only in distant regions. The reason may be due to land degradation-land degradation caused by use of polluted water for irrigation causing unfavourable condition for groundnut cultivation in the closer and middle regionusing polluted water for irrigation, causing unfavorable conditions for groundnut cultivation in the closer and middle regions. It should be noted that banana becomes the

~~predominant irrigated crop in the distant region and same for groundnut also as rainfed crop~~
bananas have become the predominant irrigated crop in distant regions, and the same is valid for groundnuts, which are also rainfed crops. This shows the status of groundwater quality and land degradation in the closer region. ~~Power looms~~Power looms, farming ~~and fabrication are found to be the predominant occupation,~~ and fabrication are the predominant occupations in the study area. However, farming is predominant in ~~middle and distant region, this is because people in the closer region shifted towards other occupations and made it favourable~~ the middle and distant regions because people in the closer region shifted towards other occupations, which made it favorable for various shops in the town to dominate.

Gross income of the sample respondents

Gross income earned by the sample farms ~~under different sources~~ is earned using different sources, viz., ~~On-farm~~On-farm income, ~~off-farm~~off-farm income, and Non-farm income are presented in the table below.

Table – 6. Gross income of the sample farms (in ₹/year)

S.No	Income source	Farm location from Noyyal river <u>River</u>		
		<1km (Closer region)	1-3km (Middle region)	>3km (Distant region)
1	On-farm <u>On-farm</u> income	99433.15 (15.96)	123590.40 (19.68)	140678.33 (35.12)
2	Off-farm <u>Off-farm</u> income	17775.00 (2.85)	45225.34 (7.20)	47250.00 (11.80)
	Total farm income	117208.15 (18.81)	168815.74 (26.88)	187928.33 (46.92)
3	Non-farm income	505750.00 (81.19)	459200.00 (73.12)	212575.00 (53.08)
	Total gross income	622958.15 (100.00)	628015.74 (100.00)	400503.33 (100.00)

Note: Figures in the parentheses ~~indicates~~ indicate the percentage share ~~to of~~ the total income

It could be inferred from Table –6, ~~that middle region has high gross income compared to~~ that the middle region has a high gross income compared to the other two regions. This is because ~~of the reason that the region has good income in farming and also in the region has good farming and non-farm income non-farm sector.~~ However, distant region has high farm income ~~indicating~~ regions have high farm incomes, which indicates the suitability of agriculture and allied activities. In the closer region ~~non-farm income contributes to 81.19 per cent to the total gross income whereas the sum of on farm and off farm is only 18.81 per cent, non-farm income contributes 81.19 percent to the total gross income, whereas the sum of on-farm and off-farm is only 18.81 percent~~ to the total gross income. In the middle region ~~non-farm income provides 73.12 per cent to the total gross income and the sum of on farm and off farm contributes to 26.88 per cent, non-farm income provides 73.12 percent of the total gross income, and the sum of on-farm and off-farm contributes 26.88 percent.~~ In the distant region ~~non farm income is very low compared to other two regions and it is about 53.08 per cent to the total and farm income is about 46.92 per cent to, non-farm income is meager compared to the other two regions, it is about 53.08 percent of the total, and farm income is about 46.92 percent of~~ the total gross income. This clearly shows that agriculture has become ~~unfavourable in the closer region compared to~~ unfavorable in the closer region compared to the other two regions because of pollution intensity. Devi et al., (2008) and Gopal et al., (2019) also reported the similar effects related to dye effluents and its (2008) and Gopal et al. (2019) also reported similar effects related to dye effluents and their impact on agriculture.

CONCLUSION

The study revealed that pollution caused by the dyeing industries in the groundwater still exists in the study area, causing deterioration of water quality, reduced crop income ~~and crop land~~, ~~and cropland~~ values in the closer region. The study also revealed that agricultural occupation was drastically reduced in the areas closer to the Noyyal ~~river~~ River. Several farms stopped agricultural activities and switched ~~towards other different to other~~ occupations. The study area has enough water facilities to practice agriculture, but the problem lies in ~~terms of~~ quality. Hence, the study recommends that all the farms to allot a small area of land under farm ponds accordingly to store good quality of water during rains in those ponds; allot a small area of land under farm ponds accordingly to store good water quality during rains in those ponds, thereby ensuring percolation to improve the groundwater quality thereby ensuring percolation to improve the quality of groundwater. Percolation of good quality water into the ground reduces the salt concentration of groundwater. The Public Works Department (PWD) may start desalinating all the waterbodies in the Noyyal region and allowing **them to harvest rainwater to use only for groundwater recharge purposes.**

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) ~~and text to image generators have been used during .) and text-to-image generators have been used during the~~ writing or editing of manuscripts.

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