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A Study of The Effect of Temperature Variation on Cocoon Parameters of Muga Silkworm During the Drying Stage by Convection and Infrared Heating.

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ABSTRACT

Designing a system or device to dry Muga cocoons and kill pupa while maintaining the quality of the dried cocoon is a very challenging task, for producing good quality Muga silk. The proposed design includes a system for drying Muga cocoons at a controlled temperature. The paper explains the basic principle of the cocoon drying system that is designed for controlled drying of the Muga cocoon under the specified limits of heating. The dryer is designed mechanically with a steel enclosure, with insulated walls, for heating the inner space with a 1000-Watt convection heater and a 650-Watt Infrared heater. The mechanical performance of this dryer was tested for the effective drying of Muga cocoons using both the convection and IR heating methods. The temperature of the designed dryer was maintained at 70^0, 80^0, 90^0, and 100° C, as required, during the drying stage. Using this dryer, the moisture content of the Muga cocoons was brought to about 6-12% and was maintained at that level. Thus, this dryer was effective and efficient in maintaining a controlled environment for drying the cocoons, thus sustaining the required quality of the dried cocoon for producing quality Muga silk.

Keywords : Muga cocoon, Convection, Infrared, Temperature, Moisture content, Shell ratio, Pupae.

INTRODUCTION

Assam is the largest producer of Muga silk produced by Antheraea Assamensis silkworm in the world. Assam contributes a total of 95% of India's total Muga silk production. However, Muga silkworm cocoons produced by traditional sun-drying systems do not meet global market requirements and cocoon quality becomes very low after drying (Zafar *et al*. 2019). This method cannot control heat, cleanliness, and heating time. Therefore, cocoon quality deteriorates (U sub T *et al*. 2008). This method has a negative effect on the sericin layers of these cocoons and decreases the quality characteristics by exposing cocoons to ultraviolet and infrared rays, which in turn, increase the total reeling losses of cocoons. It was also indicated that the silk filament loses about 50% of its strength if exposed to ultraviolet rays for 6 hours. Several methods of artificial drying have been tried to kill the pupae, by spreading cocoons on perforated mats or in a wire box where they are exposed to steam or water for three hours. After that, the cocoons are subjected to drying. But the method most commonly used for pupae-killing and drying cocoons involves blowing hot air at 50° C to 102° C ± 2° C vertically through a grill on which the cocoons are placed in mesh bags (Hegazy

et al. 2006). Hot-air dryer in comparison with the traditional sun-drying method accelerates the drying of cocoons by killing the pupa inside it (Hendaw *et al*. 2017). Drying Muga cocoons involves killing the pupa inside it and preserving the cocoon for a longer period of time at normal temperature and humidity. When fresh cocoons are placed in the drying machine, water in the cocoon shell evaporates rapidly and heat enters the pupa through the shell. After the pupa is dead, generally 10 minutes later the pupa's body evaporates. Cocoon drying continues gradually and when the desired amount of water has evaporated, the speed of drying is reduced relative to the decrease of moisture until drying is completed. The drying temperature impacts the cocoon shell and its resultant raw silk yield. For example, if the temperature exceeds certain limits, sericin degenerates, and concurrently efficiency, reliability, and raw silk percentage decline. It is advisable to observe the following limits: For hot air drying 115° C ± 5° C is recommended in contact with the cocoon. For steam-heat drying 102° C ± 2° C is the preferred guideline (Safarov Jasur *et al*. 2018). While setting a higher finishing temperature increases drying efficiency, the melting point of sericin declines when the drying rate exceeds 50 percent. The finishing temperature should be reduced gradually from 60° C in hot air drying and 55° C in steam-heat drying (Mubashar Hussain *et al*. 2011). Sun-drying kills the pupa but it shows inferior reeling performance and raw silk quality compared to hot-water drying and oven method.

This paper describes the design of a Muga cocoon dryer using convection and Infra-Red heating methods under a controlled temperature. The study may lead to a major solution to the technological and physical challenges faced during the traditional methods of drying Muga cocoons. This work may provide a better alternative to conventional Muga cocoon drying, in order to improve the quality of the raw silk and the reeling performance.

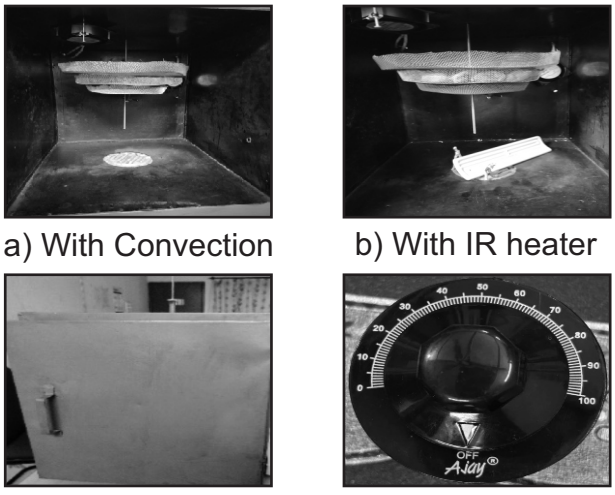
MATERIALS AND METHODS

The Muga cocoon samples were collected from different regions of Assam and were used for experimentation. A mechanical dryer was designed, fabricated, and used for stifling Muga cocoons. The studied drying system consised of a drying chamber enclosed with three stacks made of netted steel. The mechanical dryer consised of five main parts: the drying frame, a drying rack, a heating source with a temperature control unit (Energy regulator), and an air-cooling system (processor fan), as shown in Figure 1. The drying frame was constructed using a plain sheet with dimensions of 50 cm X 50 cm X 50 cm as shown in Figure 1. The three sides of the dryer were covered with 5 cm thick steel sheets and insulated with fiberglass to reduce heat loss. The fourth side was the door of the dryer with a thickness of 2.5cm and it was also insulated to avoid heat loss. The main dryer frame was attached with two heating sources (Convection and Infrared) alternately. A 1000 W Convection heater and a 650 W Infrared heater were used as heating sources alternately inside the drying chamber and the performance of both was observed. An industrial thermometer in the range of 0-110˚C was installed on the back side of the drying frame to continuously monitor the temperature. The drying rack

consisted of three netted racks made of steel. A 10-inch diameter rack was attached in between a 12-inch and 8.5-inch diameter rack. The racks were stacked together such that the higher diameter rack was installed at the top and the lower diameter rack was installed at the bottom to avoid the Muga cocoon from falling down while shuffling as shown in the Figure 2. A 6 mm steel shaft was attached with screws and nuts at the center of the three racks to continuously shuffle the Muga cocoons during the drying process. A 0-100 scale (1000 Watts) energy regulator was used to control the temperature of the heating sources. The air-cooling system consisted of two processor fans (50/60Hz, 0.08A) installed inside the heating chamber. One fan was installed at the top and another was installed at the back side of the dryer so that air would be circulated uniformly for each drying rack inside the drying chamber. This air-cooling system helped the temperature of the drying chamber to cool down slowly and to circulate the air around the drying racks.

Experimental Procedure

Freshly harvested Muga cocoons were collected from different parts of the state of Assam and were used in this investigation. A batch of 10 cocoons was taken to conduct the experiment each time. The study was performed at four different levels of temperatures, *viz*., 70˚, 80˚, 90˚, and 100˚ C, and the moisture content of dried cocoons was studied manually for these different levels of temperature. The dryer was heated up to each temperature level for a certain time period until the cocoons got dried to the expected level. The cocoons were placed in medium and small trays for drying them using both convection and IR heating methods separately. In the convection heating method, the energy regulator was adjusted initially at 30 scales and then increased by 5 scales every 5 minutes. In both the convection and IR heating methods, the temperature was monitored every 5 minutes using the Industrial Thermometer. The heat treatment was stopped as soon as the temperature reached its desired level and the two processor fans inside the dryer were switched on immediately for uniform circulation of air. When the dryer would reach its cooling temperature of approximately 50˚C the door would be opened and the dried cocoons would be collected from the trays. For each treatment, the collected cocoons were weighed using a digital balance after and before drying to calculate different cocoon parameters.



a) With Convection b) With IR heater

c) Drying frame d) Energy regulator

Figure 1: Images of the designed drying system

The moisture content of the dried Muga cocoons could be calculated using the formula:

%Moisture content = [(w - d)/d] X 100

where *w* = initial weight of the cocoon and *d* = dried weight of the cocoon.

Cocoon weight is the approximate measure

of the raw silk obtained from the dried reeled cocoons (Mahadevappa, D *et al*. 2000). In the present study, a sample of 10 cocoons was taken and this sample represents the entire quality of individual replicate. The individual weight of the cocoon was measured for 10 cocoons and an average of weight was considered as the approximate weight of the dried cocoon. The cocoon weight was measured in grams. The shell weight represents the total quantity of silk in a Muga cocoon. The average single shell weight was calculated from 10 shells used for the measurement of cocoon weight. The cocoon shell ratio represents the amount of silk present in a single cocoon and it is expressed as a percentage. It can be calculated as follows:

Cocoon shell ratio (%) = {(Weight of the cocoon shell)/ (Weight of the entire cocoon)} x 100

RESULTS AND DISCUSSIONS

3.1 Effect of temperature on moisture content, cocoon weight, shell weight, and shell ratio

The moisture content of the Muga cocoon was studied and compared at four different levels of temperature, *viz*., 70˚, 80˚, 90˚, and 100˚C for both Convection and IR. Cocoon moisture content was decreased with an increase in temperature for both the Convection and IR heating methods. The average moisture content, cocoon weight, shell weight, and shell ratio of the cocoon at different temperature levels are shown in Table 1. It was observed from Figure 2 that the moisture content of the Muga cocoon dried using the proposed drying system is optimal (6-12%) at 100˚C for both Convection and IR heating methods. However, Table 1 and Figure 2 represented that the IR heating method provides a more accurate moisture content compared to the Convection method as the moisture content was 10.8% at 100˚ C which was in the range of optimum value suitable for producing quality Muga silk and preserving the Muga cocoon for longer period of time [1]. Figure 3 represented that the cocoon weight gradually decreased as the temperature of the dryer increased. A maximum value of 1.14 gm at 70˚C and a minimum value of 0.56 gm at 100˚C was recorded using the Convection heating method. Similarly, a maximum value of 1.71 gm at 70˚C and a minimum value of 1.04 gm at 100˚C was recorded using the IR heating method for the proposed system design.

Table 1: Cocoon parameters with respect to temperature for convection and

Heating Method	Temp (^{0}C)	Average Cocoon weight (gm)	Average Shell weight (gm)	Average Shell Ratio (%)	Average Moisture content (%)
Convection	70	1.14	0.56	49.1	44.4
	80	0.75	0. 40	53.33	39.12
	90	0.63	0.39	62	20.73
	100	0.56	0.37	66	13.2
IR	70	1.71	0.85	49.7	29.37
	80	1.33	0.76	57.1	29.36
	90	1.15	0.725	63	15.5
	100	1.04	0.70	67.3	10.8

It was observed from Figure 5 that the average shell ratio varied approximately linearly with respect to temperature. Figure 4 and 5 represented that the shell weight and shell ratio obtained from the cocoon dried using the IR heating method gave a more accurate result. The maximum shell ratio obtained at 100˚C for convection and IR methods were 66 per cent and 67.3 per cent respectively. Whereas the minimum shell ratio obtained at 70˚C for the Convection and IR methods were 49.1 per cent and 49.7 per cent respectively. It was observed from the present study that the optimum levels of moisture content, cocoon weight, shell weight, and shell ratio were obtained at 100˚C for both Convection and IR heating methods

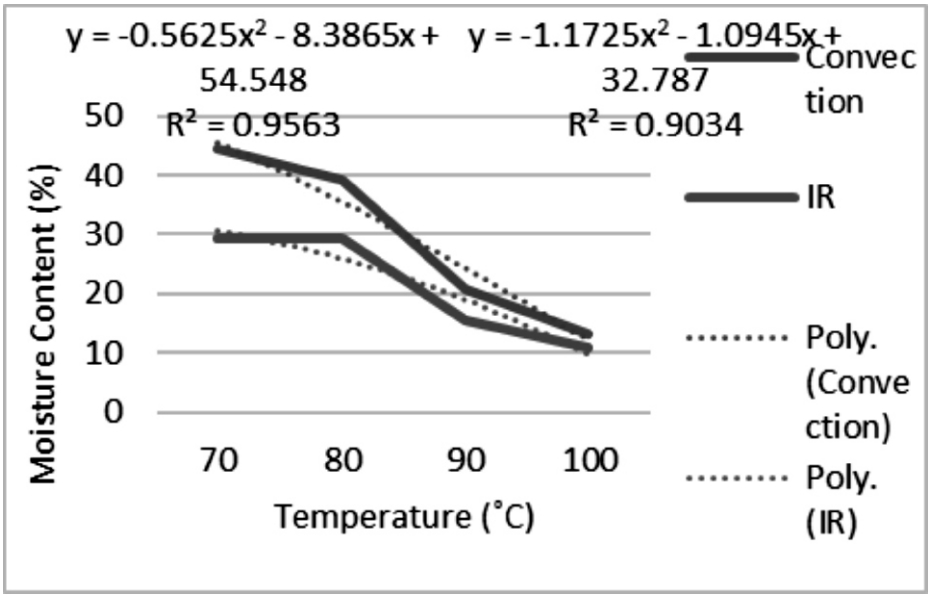


Figure 2: Temperature vs. Moisture content graph

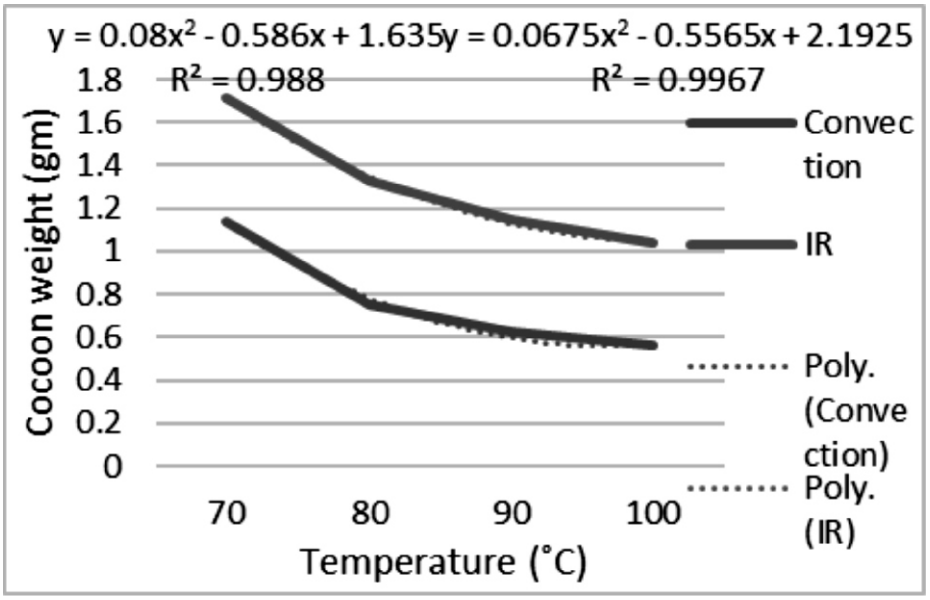


Figure 3: Temperature vs. Cocoon weight graph

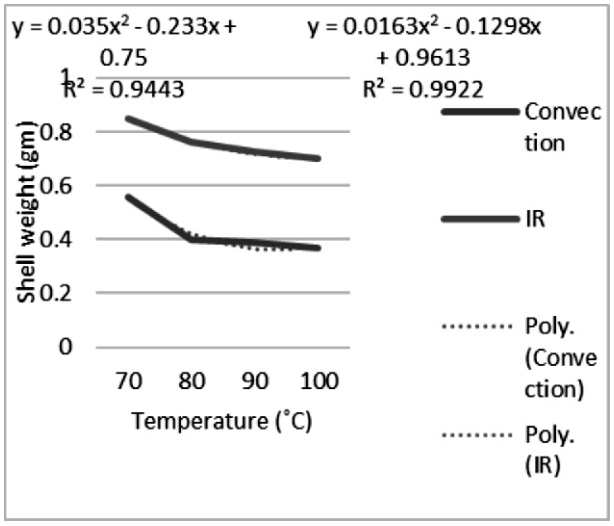


Figure 4: Temperature vs. Shell weight graph

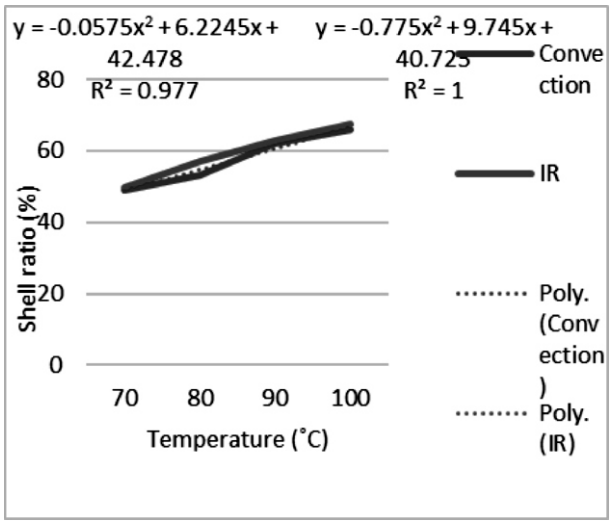


Figure 5: Temperature vs. Shell ratio graph

3.2 Effect of temperature on drying time

The effect of temperature on the time of drying Muga cocoon is shown in Table 2. It can be observed from Figure 6 that the drying time of the Muga cocoon increased approximately linearly with temperature. Figure 6 also implied that the IR heating method was a bit faster than the Convection heating method while drying the Muga cocoon.

Table 2: Effect of temperature on time

Heating Method	Temperature (^{0}C)	Time (mins)
Convection	70	15
	80	16
	90	17
	100	18
IR	70	12
	80	13
	90	14
	100	15

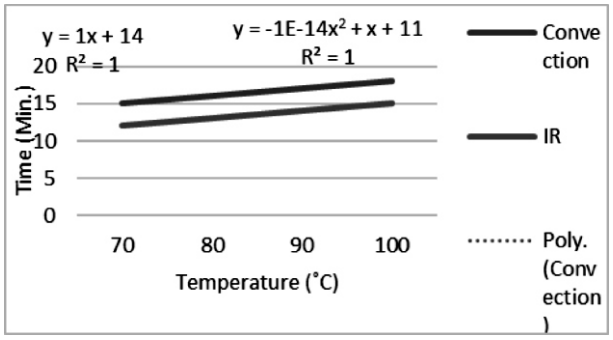


Fig. 6: Temperature vs time graph

CONCLUSION

The effect of temperature on different cocoon parameters can be seen from the results of the experiment conducted for the drying of Muga cocoons using the Convection and IR heating methods. It can be observed that when the temperature is increased for both methods the quality of the cocoon improves with regard to the moisture content, cocoon weight, shell weight, and shell ratio. The temperature of the designed dryer was maintained at 70˚, 80˚, 90˚, and 100˚C, as required, during the drying stage. Using this dryer moisture content of the cocoon was maintained at 6 - 12% at the temperature level of 100˚C. Therefore, the designed system would be an efficient and appropriate one for drying Muga cocoons in a controlled environment, to maintain the optimum values of different parameters such as cocoon weight, shell weight, and shell ratio. It can be concluded from the comparative study of Convection

and IR heating methods for the four different levels of temperature (70º, 80º, 90º and 100˚C) that both the methods would be efficient for drying Muga cocoons at a maximum temperature of 100˚C while maintaining the quality of the Cocoon for producing good quality Muga Silk. The study also implies that the designed dryer using the IR heating method is the more energy-efficient method as compared to the Convection at a low cost for drying Muga cocoon due to its less consumption of energy. Moreover, it provides a safe environment inside the drying chamber, as the heat generation of the IR heater is more localized. The performance of the IR heating method is also faster than the Convection heating method. Hence, the controlled IR heating method can be a better choice for drying Muga Cocoons, for maintaining a high quality of dried cocoons for Muga silk production.

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Spatial Monitoring of Agricultural Drought Using Multiple Drought Indices Using GIS Approach in Sabarkantha district of North Gujarat Region

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ABSTRACT

Drought is a meteorological anomaly that is defined by an acute shortage of moisture. Low rainfall, which affects agricultural production, is the main reason for agricultural drought. The use of RS and GIS has recently made significant contributions to the assessment of numerous natural and artificial hazards. In the present study, different agricultural drought indices have been used to measure the severity of drought and identify the amount of areas that have been severely affected by droughtin Sabarkantha district using Landsat 8 data from 2013to 2019.According to the data obtained, the results showed that NDVI and NDWI both decreased by 4% to 6%, while LST significantly increased by 0.35°C to 2.5°C. The results of the NDVI indices shows that 2518.10 sq.km area and 59.03 sq.km area falls under severe dry and moderate wet conditions in 2013, which is 60.12% and 1.40%, respectively in Sabarkantha district.The result of the VCI thematic map for the year 2018 shows 28.8 sq.km area as extreme dry and 112.29 sq.km km as severe drought. Moderate drought covered an area of 2397.88 sq.km which is about 57.25% of the study area. Similarly, in 2019, 46.93% of the area falls under moderate dry and 38.38% of the area fell under normal dry. This relationship revealed that when rainfall increases, NDVI and VCI also tend to decrease. Also, there is an increase in NDBI. As a result, the occurrence of agricultural droughts increased. According to the VCI analysis, the study region contains areas of extreme, high, and moderate drought, respectively.

Keywords : Agricultural drought, Remote sensing and GIS, Rainfall, NDVI, NDWI, NDBI, LST and VCI.

INTRODUCTION

Drought is a frequent or erratic natural occurrence in almost every kind of climate in the world. Usually, it occurs when precipitation gradually decreases naturally (Badaq Jamali *et al.*, 2005). The major rainy season in India accounts for around 95% of the country's crop production, hence rainfall during this period is essential for agricultural activity. Contritely, the drought state has drawn less attention and has been the subject of less scientific investigation than natural catastrophes like floods or hurricanes. When it comes to damage and loss, drought can be far more destructive than flood, hurricane, and storm surge combined (Alam et al., 2012).In many countries across the world, drought has become a regular occurrence due to climate change and fluctuation. It shows up as an erratic and unpredictable distribution of rainfall in farming areas that rely on it, especially in dry and semi-arid ecosystems.

Frequent and severe drought is one of the most important natural disasters in sub-saharan Africa (Tadesse *et al.*, 2008). Droughts are often followed by severe economic, social, and environmental crises, which are typified by the emergence of unstable agricultural sectors (Kandji and Verchot 2006).

Agriculture is the main economic sector which is affected by agricultural drought. Since agriculture is the largest user of water and hence most susceptible to agricultural drought, it is particularly affected negatively by short-term droughts during important growth phases. Remotely sensed data and GIS tools have been used to track changes in the environment and urban features during the years. According to Surya et al. (2020), the research of regional eco-environment should concentrate on ecosystem conservation and economic development. As such, it has saved in creasing attention from global researchers. Soil moisture shortage is a characteristic of agricultural droughts (Dracup *et al.*, 1980). The science of remote sensing gathers data on a location or thing on Earth's surface without physically studying the subject of the data (Aggarwal 2003).

Because of its high geographical and temporal resolutions, consistent, wide coverage, and ability to assess and track aspects of terrestrial ecosystems at several scales, RS has become a valuable instrument (Gu and Wylie 2015).The assessment and ongoing monitoring of surface water resources depend heavily on satellite remote sensing. Using a variety of sensors and resolutions, satellite remote sensing is used to gather data regarding surface water resources (Chawla et al., 2020).

The NDVI, a measure of vegetative health, is one of the most widely used techniques for monitoring drought occurrences amongst those indices (GU *et al.*, 2007). The various vegetation indices were applied based on the findings of this study (Acharya *et al.*, 2019). LST is crucial for agricultural studies, urban heat island effects, and environmental monitoring research (Lu and Weng 2006). Remote multispectral and hyperspectral observations have proven to be an essential source of data for assessing drought and vegetation changes (Yang *et al*., 2012).

It has been shown by Xu (2006) that MNDWI is especially effective in locating open water. Typically, the MNDWI has a negative value for soil and vegetation and a positive value for water bodies. In LST-related investigations (Julien *et al.*, 2006), the NDVI is widely utilised to measure plant abundance. Water is shown by negative NDVI values, while built-up regions and bare land are shown by positive NDVI values up to 0.2. Higher NDVI values imply healthy vegetation, and more than 0.2 NDVI values indicate the presence of vegetation (Guha *et al.*, 2018).The ±1 value of the NDVI is variable. Here, the NDVI value of +1 indicates the dense vegetation; water usually has an NDVI value of less than zero (Taloor *et al.*, 2021).

Among various indices, one of the most often used methods for monitoring drought episodes is the NDVI, which serves as a probe for vegetative health (Rhee *et al.*, 2010). It has been suggested that combining temperature and vegetation index will improve the method. Different studies shows that remote sensing are drawn to the interesting link between LST

and NDVI from a variety of angles (Govil et al., 2019). Time and space play a major role in this relationship's form and intensity. The LST-NDVI association is typically negative in tropical environments (Gorgani *et al.*, 2013). As an early warning system, the combination of LST and NDVI offers a good connection and useful information for identifying agricultural drought (Sruthi *et al.*, 2015).This information is essential for early warning, risk assessment, resource management, and decision-making in agriculture, water resource management, disaster preparedness, and environmental conservation in drought-prone regions.

Geospatial approaches can help with the identification and mapping of agriculturally drought-prone areas as well as the proper site monitoring for specific mitigation initiatives. A map of the agricultural drought risk zones will be created by this research, which will help policymakers decide what steps to take in light of the risk. On the other hand, data that illustrates how to maintain soil moisture and manage crops in drought-prone areas is beneficial to scholars. It might also be beneficial for governmental and non-governmental organisations (NGOs) in managing drought.

The scope of agricultural drought analysis using RS and GIS tools is extensive and valuable for monitoring, assessing, and managing drought impacts on agriculture. These can be used to monitor and track drought conditions in real-time or over extended periods. Satellite imagery and remote sensing data help in assessing various drought indicators like precipitation, soil moisture, and vegetation health, which are critical for agricultural planning. Also, it can provide quantitative measures of drought severity, helping to categorize drought events as mild, moderate, or severe. This information is crucial for resource allocation and drought impact assessment.

The main objective of the present study is to evaluating multiple drought indices viz., NDVI, NDWI, LST, NDBI, and VCI for assessment of drought in Sabarkantha district using Lands at 8 from 2013 to 2019.Also, to assess the impact of on drought patterns and trends to study the shifts in vegetation, water availability, and temperature, which are essential for adaptation and mitigation strategies. Also, estimate the area falls under each categorize of drought such as mild, moderate, severe, or extreme drought, based on index values.

The Sabarkantha district, which is a part of North Gujarat, is located between latitudes 23°03' and 24°30' N and longitudes 72°43' and 73°39' E which is shown in Figure 1. The annual average rainfall of the district is 825 mm, and the maximum temperature is

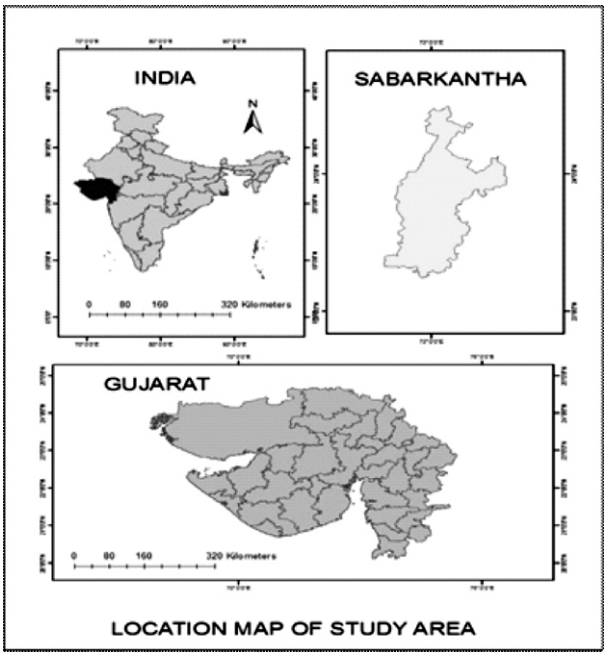


Figure 1: Study Area Map

40.5o C and the minimum is 9.04o C. For estimation of drought indices the Lands at data has been downloaded from the Earth Explorer (https://earthexplorer.usgs.gov/) and the images taken from Lands at 8 satellite with a spatial resolution of 30 m were used. The study will enable us to make a proper plan for irrigation practice in drought-vulnerable areas and will provide prior knowledge of challenges during cultivation in this region.

MATERIALS AND METHODS

The Lands at 8 band characteristics are shown in Table 1 below. A band is the name given to each range, and Lands at 8 contains 11 bands. Red, green, and blue sensors on Lands at are numbered 4, 3, and 2 respectively. Different bands were employed in the current location to estimate the drought indices, the section below explains the methodology for the current investigation.

Table 1: Lands at 8 Band Characteristics

Band No.	Description	Wavelength (mm)	Band No.	Description	Wavelength (mm)
1	Coastal Aerosol	0.430 - 0.450	6	SWIR 1	1.570 - 1.650
2	Blue	0.450 - 0.510	7	SWIR 2	2.110 - 2.290
3	Green	0.530 - 0.590	8	Panchromatic	0.500 - 0.680
4	Red	0.640 - 0.670	9	Cirrus	1.360 - 1.380
5	Near Infrared	0.850 - 0.880	10	TIRS 1	10.60 - 11.19
			11	TIRS 2	11.50 - 12.51

NDVI (Normalized Difference Vegetation Index), NDWI (Normalized Difference Water Index), LST (Land Surface Temperature), NDBI (Normalized Difference Built-Up Index), and VCI (Vegetation Condition Index) are widely used remote sensing and satellite-based indices in drought assessment. These indices can be used to assess the impact of climate change on drought patterns and trends. Long-term data series from 2013 to 2019 used to study the shifts in vegetation phenology, water availability, and temperature, which are essential for adaptation and mitigation strategies.

Normalised Difference Vegetation Index (NDVI)

A popular slope-based vegetation index that uses the red and near infrared bands is called NDVI. Additionally, the measurement scale has the advantageous virtue of having a range from -1 to 1, where -1 corresponds to non-vegetated surfaces and 0 roughly corresponds to no vegetation. High NDVI values indicate healthy vegetation, while low values suggest stressed or sparse vegetation. Here, the NDVI is calculated to depict the drought's susceptibility.In drought assessment, decreasing NDVI values can indicate reduced plant growth and water stress in crops and natural vegetation.The calculation was made using the following equation:

$$\mathrm{NDVI} = \frac{(\mathrm{NIR} - \mathrm{RED})}{(\mathrm{NIR} + \mathrm{RED})}$$

Normalised Difference Water Index (NDWI)

McfeetersS.K. (1996) backed the use of NDWI to emphasise water bodies which is based on the observation that vegetation has the highest near-infrared reflection and water has the highest near-infrared absorption. NDWI quantifies the presence of water in the environment, including surface water, soil moisture, and vegetation canopy water content. Decreasing NDWI values can indicate reduced water availability, such as drying rivers, lakes, or soil moisture deficits.The calculation was made using the equation:

$$\mathrm{NDWI} = \frac{(\mathrm{NIR} - \mathrm{SWIR})}{(\mathrm{NIR} + \mathrm{SWIR})}$$

Normalized Difference Built-up Index (NDBI)

The NDBI measures how much more reflective built-up regions.NDBI is used to detect the presence of built-up or impervious surfaces in urban areas.The below equation has been used for computing NDBI, which is very useful for mapping urban built-up areas:

$$\mathrm{NDBI} = \frac{(\mathrm{SWIR} - \mathrm{NIR})}{(\mathrm{SWIR} + \mathrm{NIR})}$$

Vegetation Condition Index (VCI)

Based on NDVImin and NDVImax values, VCI is a popular algorithm for evaluating vegetation state. The VCI, which is given as a percentage (%), provides a sense of where the observed value falls in relation to the extreme values (minimum and maximum) from prior years. VCI assesses the health and vigor of vegetation by comparing current NDVI values with long-term averages. Decreased VCI values indicate vegetation stress, which can be attributed to drought conditions. VCI is particularly valuable for monitoring the impact of drought on agricultural crops.

These indices are often used in combination and integrated with Geographic Information Systems (GIS) for a more comprehensive assessment of drought conditions.

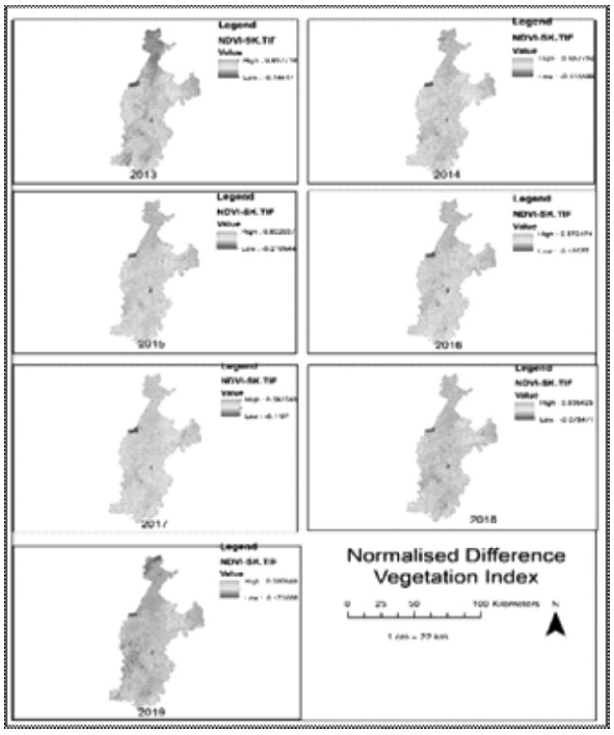
The VCI was computed using the equation shown below:

$$\mathrm{VCI}_{ij} = \frac{\mathrm{NDVI}_j - \mathrm{NDVI}_{min}}{\mathrm{NDVI}_{max} + \mathrm{NDVI}_{min}} * 100$$

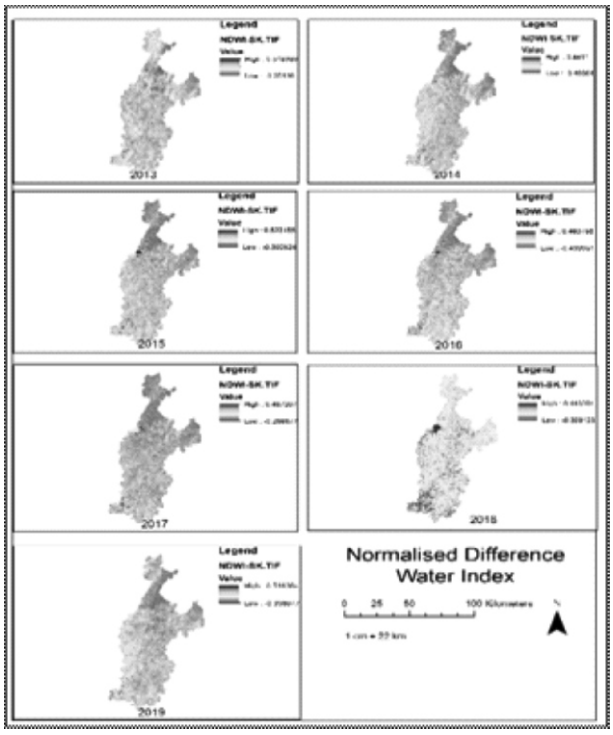
RESULTS AND DISCUSSION

In the present study, RS images that are multi-temporal and multi-resolution can give the fundamental information needed to analyse spatial data using a long-term series of Landsat 8 data from 2013 to 2019 to determine the severity of drought using several agricultural drought indices and understand how they relate to NDVI, NDWI, MNDWI, NDBI, LST, and VCI in Sabarkantha district.

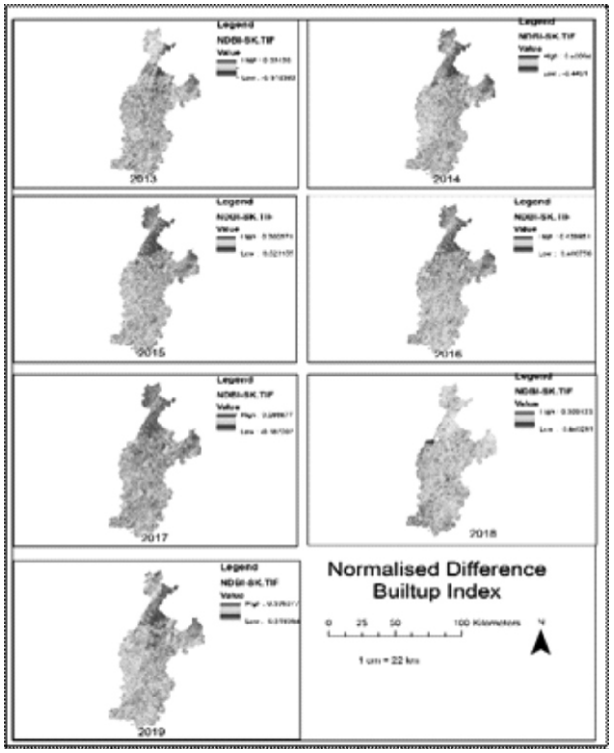
The NDVI is a vegetation indicator generated from Lands at that takes into account the vegetation's reflectance in the near-infrared (NIR) and red bands of electromagnetic radiation. The high NDVI values indicate healthy, thick vegetation, and it has become the primary tool for describing the phenology of vegetation. Because of monthly variations in vegetation responses, the obtained NDVI data was analysed for each year. NDVI values were often highest during wet seasons and lowest during dry seasons. The NDVI threshold value is between -1 and +1. The NDVI value decreases with increasing temperature, indicating a reduction in vegetation density. A severe agricultural drought is brought on by a reduction in soil



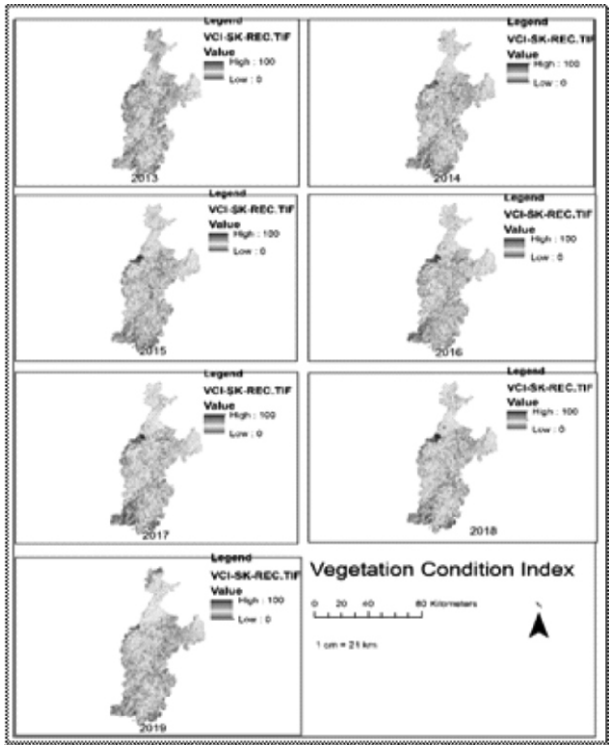
(a) Normalised Difference Vegetation Index



(b) Normalised Difference Water Index



(c) Normalised Difference Builtup Index



(d) Vegetation Condition Index

Figure 2: Maps of Agriculture Drought Indices

In the present study area, NDVI values range from -0.1107 to 0.1965, and an average NDVI of 0.2061 was observed. The results of 2013 show the minimum NDVI value as -0.1447 and the maximum value as 0.1965. Similarly, for the remaining year, the statistical data obtained for NDVI images is shown in Table 2. The NDVI maximum value declined from 2013 to 2019, while the minimum NDVI value was raised significantly, according to the image statistics and NDVI data obtained. However, from 2013 to 2019, the mean NDVI value decreased. As a result, it indicates that during the study period, the vegetation's decline.

Table 2: Obtain Values for LST and NDVI

	2013	2014	2015	2016	2017	2018	2019
LSTmin	22.81	11.75	13.62	24.59	27.03	25.36	13.78
LSTmax	44.08	43.04	47.50	47.56	48.05	43.07	42.62
NDVImin	-0.1447	-0.1155	-0.2105	-0.1257	-0.1107	-0.0784	-0.1736
NDVImax	0.6337	0.5577	0.6020	0.5724	0.5925	0.5954	0.5809
NDVIAvg	0.1965	0.2070	0.2093	0.1962	0.2010	0.2061	0.1869

The results of the NDVI indices show that 2518.10 sq.km area and 59.03 sq.km area falls under severe dry and moderate wet conditions in 2013, which is 60.12% and 1.40%, respectively, in Sabarkantha district. Owing to the low annual average rainfall in the Sabarkantha district in 2018 (427.15 mm), the dryness in the study region has dramatically increased, with 2486.70 sq.km as severe dry and 1545 sq.km as moderate dry, which is the highest amongst the study periods considered. Similar results were observed and analysed for the remaining years of the study period. Also, from the results of the NDVI, it was observed that the minimum percentage of dry areas in the year 2019 during this year was 875.39 mm in the study region, and the temperature derived from LST maps also shows that the minimum temperature was 13.78°C and the maximum temperature was 42.62°C. The developed images for NDVI from 2013 to 2019 are shown in Figure 2(a).

The NDWI unit is a numeric value that depends on the presence of surface water and varies from -1 to +1. A high water content in the plant is indicated by a higher NDWI measurement. Low NDWI values imply low vegetation water content; therefore, when there is a shortage of water, the NDWI rate falls. The NDWI value rises as precipitation increases. In the provided area, the average NDWI value for the water content of vegetation drops numerically from 2013 to 2019: 0.41, 0.39, 0.43, 0.42, and 0.41. The developed images for NDWI from 2013 to 2019 are shown in Figure 2(b).

The results of the NDBI indices show that it was feasible to observe changes in land use dynamics by comparing the fraction of the year's total area occupied by each feature to the features of the land feature. The built-up area increased by almost 4% over the last seven years (from 85% to 89%). The developed images for NDBI from 2013 to 2019 are shown in Figure 2(C).

The LST maps were prepared from satellite data analysis and represent the spatial distribution of surface temperature in the Sabarkantha district. LST analysis has shown a higher surface temperature on built-up and bare surfaces and a lower

temperature in healthy vegetated areas. Dry soil is usually visualised by a high LST. The minimum LST for the Sabarkantha region from 2013 to 2019 was 22.81°C, 11.75°C, 13.62°C, 24.59°C, 27.03°C, 25.36°C, and 13.78°C and the maximum temperature was 44.08°C, 43.04°C, 47.50°C, 47.56°C, 48.05°C, 43.07°C, 42.62°C respectively, which is shown in Table 2. The results also indicate that LST increased significantly from 2013 to 2019, but decreased slightly in 2014 and 2015. It was observed that dry conditions had high LST and low NDVI during the study period.

The stress of decreased water availability and rising temperatures on vegetation during the dry season is calculated by the VCI index values, which range from 0 to 100. The smaller the values, the higher the stress on the health of the vegetation. From no drought to intense, the VCI maps were easily divided into seven stages of drought severity, which are displayed in the below tables. Table 3 shows the severity of the classification of drought, ranging from extreme drought to extreme wet conditions for different years.

Table 3: Results of Vegetation Condition Index for Sabarkantha district

	2013	2014	2015	2016	2017	2018	2019
1 ED	21.09	24.80	23.32	23.34	27.82	28.80	16.86
2 SD	341.19	51.62	29.79	19.99	35.57	112.29	151.51
3 MD	2269.07	1998.75	1443.87	1145.29	1989.08	2397.88	1965.74
4 NN	1106.36	1446.96	1959.50	2281.74	1467.29	1022.97	1607.37
5 MW	343.94	422.22	474.89	495.73	371.69	349.77	295.90
6 SW	98.16	181.73	189.89	155.35	194.03	189.28	110.89
7 EW	8.69	62.44	67.25	67.09	103.03	87.53	40.25
Sq.km Area	4188.48	4188.48	4188.48	4188.48	4188.48	4188.48	4188.48

Table 4: Percentage Area of Vegetation Condition Index

Classification	2013	2014	2015	2016	2017	2018	2019
1 ED	0.504	0.592	0.557	0.557	0.664	0.687	0.402
2 SD	8.147	1.233	0.711	0.477	0.849	2.681	3.618
3 MD	54.18	47.72	34.47	27.34	47.49	57.25	46.93
4 NN	26.41	34.55	46.78	54.48	35.03	24.42	38.38
5 MW	8.21	10.08	11.33	11.83	8.87	8.35	7.06
6 SW	2.34	4.33	4.53	3.70	4.63	4.52	2.64
7 EW	0.206	1.483	1.599	1.599	2.455	2.083	0.955
	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Similarly, Table 4 shows the percentage area under each class for the same The result of the VCI thematic map for the year 2018 shows almost 28.8 sq.km area as extreme drought, 112.29 sq.km as severe drought, and moderate drought covered an area of 2397.88 sq. km, which is about 57.25% of the study area. The average rainfall is only 427.15 mm in the study region, due to which vegetation in the study area has decreased drastically compared with the previous years. Also, the land surface temperature in 2018 was the lowest compared to other years. Similarly, in 2019,

46.93% of the area falls under moderate dry and 38.38 of the area as normal dry. From the above table and figure, it is implied that the drought extent in the research area has been significant throughout, from mild drought to severe drought. By comparing VCI with individual LST and NDVI values, the severity was mainly due to the rise of LST. The developed images for VCI from 2013 to 2019 are shown in Figure 2(d).

CONCLUSIONS

The southwest monsoon typically starts from July to September, which is the main time period for agriculture, so the results of the data analysis here are concentrated on the months of April and May. If the region encounters drought towards the end of the season, it indicates that the whole region will be affected by dry conditions. According to the results obtained, the research area's NDVI and NDWI both fall by 4% to 6%, while LST significantly increased by 0.35°C to 2.8°C.The results of the NDVI indices show that 2518.10 sq.km area and 59.03 sq.km area falls under severe dry and moderate wet conditions in 2013, which is 60.12% and 1.40% respectively of Sabarkantha district. The built-up area over the past seven years has expanded by around 4% (from 85% to 89%). The significant positive association between LST and NDBI indicates that surface temperatures are higher in more populated areas. The result of the VCI thematic map for the year 2018 shows almost 28.8 sq. km of area as extreme and 112.29 sq. km as severe drought, and moderate drought covered an area of 2397.88 sq. km, which is about 57.25% of the total study area.The results of multiple agricultural drought indices were analysed for Sabarkantha district during 2013 to 2019, and it was found that more than 60% of the land was dry. The results of this study will help smallholder farmers mitigate the effects of drought by participating in a variety of on- and off-farm activities, and it could aid in enhancing the current agricultural drought monitoring systems used in Sabarkantha and North Gujarat in general.

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A Comparative Study on Carbon Footprint knowledge of Rural andUrban Women of Bhilwara, Rajasthan

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ABSTRACT

Over the past few decades carbon emissions have experienced a fourfold increase. If this trend continues it won't be long before the Earth's condition becomes severely affected leading to dire consequences for our planet. The present study was conducted in the Bhilwara district of Rajasthan to determine the knowledge level of respondents regarding carbon footprints. A total of 480 rural and urban women were selected for the present study and data was collected through the interview method using a standardized knowledge test. For the analysis of data frequency, percentage and mean percent score were used to calculate the knowledge level of respondents and a z-test was administered to find out the difference in knowledge level between rural and urban respondents. The results revealed that none of the rural respondents possessed a good understanding of carbon footprints, while a small percentage (10%) of urban respondents demonstrated a good level of knowledge regarding carbon footprint. A significant difference in knowledge was observed between both respondents. Rural respondents had an average knowledge score of 2.96, while urban respondents scored significantly higher at 9.15 with a z-score of -8.57 at the 1% level of significance.

Keywords: Carbon footprint, Carbon emission, Rural women, Greenhouse emission, Comparative study, Carbon, Urban women

INTRODUTION

Pollution is not merely a term it constitutes an undeniable facet of contemporary human existence (Naidu *et al.*, 2021). It has emerged as a widespread and pressing issue in the modern world (Mittiga, 2022). Presently, India ranks as the second most polluted country globally. Pollution is characterized as the introduction of pollutants or contaminants into the environment resulting in adverse changes (Mehmoode*et al*., 2022). The most recent report from the Intergovernmental Panel on Climate Change (IPCC) released in April 2022, underscores the imperative to limit global warming to 1.5°C emphasizing that if this action is not taken promptly it may never materialize (Chowdhuri *et al.,* 2022). Notably the climate crisis is rapidly intensifying driven by factors such as deforestation, drought, pollution and plastic waste with the consequences visible worldwide (Lin *et al.,* 2022).The concentration of greenhouse gases has been steadily increasing over the past few decades leading to a rise in the global average temperature. Many human activities including household electricity consumption for heating and cooling, power generation and the production of food and goods result in greenhouse gas emissions further hastening global warming and

climate change. Projections indicate that India's waste generation will surge from 62 million tons to 165 million tons by 2030 (Kumar *et. al* 2017). In India there are variations in the average annual per capita carbon emissions between rural and urban areas with urban areas averaging 2.5 tons of CO_2e and rural areas at 0.85 tons of CO_2e (Alhashmi, 2021). On a global scale, India stands as the third-largest contributor to carbon emissions accounting for 2.46 billion metric tons equivalent to 6.8 per cent of total global emissions. Nevertheless, India's per capita carbon emissions remain comparatively low at 1.84 tons a stark contrast to the United States 16 tons. In recent years the pollution issue in Rajasthan has grown increasingly alarming. Recognizing the gravity of the situation, it became imperative to investigate public awareness with a specific focus on environmental pollution and the carbon footprint. Thus, the present study was undertaken to find out the knowledge of rural and urban women regarding their carbon footprint.

MATERIALS AND METHODS

The study was undertaken in Bhilwara district, Rajasthan. Out of the 12 panchayat samities four were randomly selected from each direction which was namely Kotri, Mandal, Hurda and Suwana. To obtain a representative sample of Bhilwara district a list of villages was prepared for each selected Panchayat Samiti. From each list two villages were randomly selected *i.e*. total of eight villages namely Jawal, Kanti, Mandal, Meja, Dantra, Dhanpura, Suwana and Kodukota were selected for data collection. From each village a sample of 30 rural women was selected from the list prepared with the help of anganwadi workers. Thus, the total sample size for rural women was 240. For urban households, a list of colonies was compiled and eight colonies (two from each direction) were randomly selected namely Aayam, Gokuldham, Swastik enclave, Dwarika, Manglam, ShyamVihar, KamlaVihar and KesarKunj. From each colony, a sample of 30 urban women was selected. Thus, the total sample size for urban women was 240. In this study, data on the knowledge of carbon footprints at the household level were collected through door-to-door interviews. To know the existing knowledge of carbon footprints, an interview schedule consisting of 28 closed-ended and open ended questions was developed. Questions were structured to determine the knowledge of rural and urban women regarding the environment, environment pollution and carbon footprint. The knowledge test was formulated based on the available literature and was evaluated by subject matter specialists to ascertain the clarity of questions and also to know whether all the selected aspects are covered adequately or not. The reliability of the tool was also measured. The necessary modifications were made as per the suggestions given by experts. For analysis of data frequency, percentage and mean percent score were used to calculate the knowledge level of respondents and a z-test was administered to find out the difference in knowledge level of rural and urban respondents.

RESULTS AND DISCUSSION

Demographic profile of the respondents

Majority of the rural and urban respondents were between the age group of 20 to 45 years who were educated upto primary education. In rural areas, more than half of the respondents (55.83%) were of medium socio-economic status, whereas nearly one-third of respondents (30.42%) belonged to high socio-economic status

and only 13.75 percent of respondents were found in the category of low socio-economic status. In urban areas the majority of respondents (85%) belonged to high socio-economic status and only 15 percent of respondents belonged to medium socio-economic status. None of the respondents were in the low socio-economic category.

Knowledge of the respondents about carbon footprint

An in-depth inquiry into the knowledge of the respondents in four components was made to find out the knowledge of rural and urban women regarding their carbon

Table 1: Component-wise knowledge of the rural and urban respondents about carbon footprint n= 480

S.No.	Components	Rural (240) MPS	Urban (240) MPS
1.	Knowledge about Environment	22.17	45.17
2.	Knowledge about household activities responsible for environment pollution	8.96	24.90
3.	Knowledge about carbon emission and carbon footprint	0	10.42
4.	Knowledge about rules and regulations about environment cleanliness	2.78	13.89
	Overall mean per cent of knowledge	8.48	3.60

Table 1 presents the component-wise overall knowledge of the urban and rural respondents. Knowledge about the carbon footprint of urban and rural respondents was measured with MPS of 3.60 and 8.48, respectively.The critical examination of the knowledge score highlights that urban respondents possessed average knowledge about the environment with MPS 45.17 and poor knowledge of other components, viz., household activities responsible for environmental pollution (MPS 24.90), rules and regulations about environmental cleanliness (MPS 13.89), and carbon emissions and carbon footprints (MPS 10.42). Rural respondents exhibited limited awareness regarding the four aspects of the carbon footprint. Their knowledge scores for environmental awareness, understanding household activities contributing to environmental pollution, familiarity with environmental cleanliness regulations, comprehension of carbon emissions and the carbon footprint were notably low with MPS of 22.17, 8.96, 2.78 and zero, respectively. These findings underscore the need for targeted educational and awareness-building efforts particularly in rural areas to enhance understanding and knowledge about environmental issues and the carbon footprint.

Table 2 presents noteworthy findings regarding the knowledge of respondents in urban and rural areas. In the urban area, approximately two-thirds of the respondents (62.50%) were aware of the importance of cleanliness in their surroundings. On the other hand, in rural areas, less than half of the respondents (45%) possessed this knowledge. Regarding the understanding of the term "environment," more than half of the urban respondents (53.33%) were familiar with its meaning whereas less than one-fourth of the rural respondents (20.83%) could provide a definition. In terms of knowledge about different types of pollution, such as air

Table 2: Distribution of rural and urban respondents according to their knowledge about environment n=480

S. No.	Aspects	Rural (240)		Urban (240)	
		f	%	f	%
1.	Cleanliness of surrounding	108	45	150	62.50
2.	Meaning of environment	50	20.83	128	53.33
3.	Meaning of Environment pollution	40	16.67	72	30
4.	Personal problems due to pollution	32	13.33	78	32.50
5.	Types of pollution	36	15	114	47.50

pollution, water pollution and noise pollution nearly half of the urban respondents (47.50%) had this awareness while only 15% of the rural respondents demonstrated knowledge in this area.

When it comes to personal problems caused by pollution around one-third of urban respondents (32.50%) were knowledgeable about such issues compared to only 13.33% of rural respondents who possessed this knowledge. Additionally, approximately one-third of urban respondents (30%) were familiar with the concept of environmental pollution while only 16.67 per cent of rural respondents had knowledge in this domain. A study conducted by Levist on 2011 and Mortoja *et al*. 2022 also reported similar findings, indicating that the majority of people exhibited moderate concern about climate conditions and did not perceive them as posing significant personal harm. These findings highlight the disparities in knowledge between urban and rural areas, with urban respondents generally exhibiting higher levels of awareness regarding cleanliness, environmental concepts, pollution types, personal problems caused by pollution and the meaning of environmental pollution.

Table 3: Distribution of rural and urban respondents according to their knowledge about household activities responsible for environment pollution n=480

S. No.	Aspects	Rural (240)		Urban (240)	
		f	%	f	%
1.	Daily household activities are responsible to pollute the environment	20	8.33	70	29.17
2.	Cooking fuels and electrical appliances used in the house are cause of pollution	10	4.17	56	23.33
3.	Kitchen waste and plastic materials used in the house are reason for environment pollution	16	6.67	52	21.67
4.	Continuous environment pollution will lead to life in danger	112	46.67	158	65.83
5.	Listened about reuse, refuse, recycle or reduce in terms of environment	14	5.83	90	37.50
6.	Sanitary napkins are also made from a kind of plastic material	0	0	32	13.33
7.	Separate dustbin arrangement are there dispose of sanitary napkins	0	0	10	4.17
8.	Sanitary napkin is also cause of pollution	0	0	10	4.17

Table 3 provides insightful information about the respondents awareness levels regarding pollution and related factors. In both urban and rural areas, nearly two-thirds of the respondents (65.83% urban and 46.67% rural) were aware of the current state of pollution and recognized that continuous environmental pollution poses a threat to human life. This finding aligns with a study conducted by Yu and Wang (2013), which reported that 78 per cent of respondents agreed that climate change harms residents and society, while only 4 per cent disagreed.

Regarding knowledge about environmentally-friendly practices such as reuse, refuse, recycle or reduce more than one-third of urban respondents (37.50%) were familiar with these terms, whereas only 5.83 per cent of rural respondents had knowledge in this area.

In terms of awareness about daily household activities contributing to pollution 29.17 per cent of urban respondents possessed this knowledge, while in the rural area only 8.33 per cent of respondents were aware of such activities. This finding is supported by the study by Ge *et al*. (2021), which reported that 85 per cent of respondents fairly or strongly agreed that human activities are a cause of climate change.

Regarding the understanding of the role of cooking fuels and electrical appliances in causing pollution 23.33 per cent of urban respondents and 4.17 per cent of rural respondents had this knowledge, respectively. Similar findings were mentioned by Dida (2022), who found that respondents in Sub-Saharan Africa had limited knowledge about the health effects and predisposing factors associated with the use of kerosene and fuel wood as energy sources. In terms of knowledge about kitchen waste and plastic materials as contributors to environmental pollution, 21.67 per cent of urban respondents and 6.67 per cent of rural respondents were aware of this connection. Yusuf and Fajri (2022) also found in their study that a significant proportion of respondents (65.9%) lacked knowledge about waste management. Regarding knowledge about sanitary napkins, 13.33 per cent of urban respondents were aware that they are made from a type of plastic material and only 4.17 per cent of urban respondents knew about the availability of separate dustbins for disposing of sanitary napkins and the potential pollution caused by improper disposal. None of the rural respondents had knowledge in this area. Garg (2012) and Sinha and Paul (2018) reported in their study that the Indian government proposed a subsidized sanitary napkin scheme for rural adolescent girls, but several challenges, including awareness, availability, quality, regular supply, privacy, water supply, disposal and reproductive health education and family support, need simultaneous attention for the promotion of menstrual hygiene.

Overall these findings indicate disparities in knowledge levels between urban and rural areas highlighting the need for targeted awareness campaigns and educational interventions to enhance understanding of pollution-related issues and promote environmentally-friendly practices among the population.

The findings presented in Table 4 are concerning as they reveal a lack of awareness and knowledge about carbon footprints among the respondents. In the urban area, slightly over half of the respondents (54.17%) had heard about carbon emissions and only 21.67 per cent had heard about carbon footprints.

Table 4: Distribution of respondents according to their knowledge about carbon footprint n=480

S. No.	Aspects	Rural (240)		Urban(240)	
		f	%	f	%
1.	Heard about Carbon emission	0	0	130	54.17
2.	Sources of carbon emission	0	0	46	19.17
3.	Heard about Carbon footprint	0	0	52	21.67
4.	Meaning of carbon footprint	0	0	24	10
5.	Sources of Carbon footprint	0	0	18	7.5
6.	Disadvantages of Carbon Footprint	0	0	20	8.33
7.	Effects of Carbon Footprint	0	0	10	4.17
8.	Carbon emission can be increased or decreased even by human activities	0	0	0	0
9.	Contributors of Carbon footprint	0	0	0	0
10.	Food consumption, transportation and household energy are also a contributor of carbon footprint	0	0	0	0
11.	Calculate one's own carbon footprint	0	0	0	0
12.	Various ways of reduction of carbon footprint	0	0	0	0

Similarly, Rahman *et al*. (2019) found in their study that 54.2 per cent of respondents had acquired knowledge about climate change from some source while 45.8 per cent had not heard of climate change at all. Furthermore, only 19.17 per cent of urban respondents in the present study knew the sources of carbon emissions and a mere 10 per cent knew the meaning of the carbon footprint. Additionally, less than 10 per cent of urban respondents were aware of the disadvantages, sources and effects of carbon footprints.

None of the rural respondents had any knowledge about these aspects. This lack of knowledge is alarming, especially in the current age where people are heavily engaged in social media but remain unaware of important environmental concepts. It is particularly concerning that the rural respondents scored zero in terms of knowledge about carbon emission contributors to carbon footprints, food consumption and transportation as contributors to carbon footprints, calculating one's own carbon footprint and various ways to reduce carbon footprints. Tobler (2012) and Hoppe *et al*. (2018) also found in their study that people still hold several misconceptions regarding carbon emissions and climate change indicating a need for better education and awareness campaigns. These findings highlight the urgent need for comprehensive education and awareness programs to bridge the knowledge gap and enhance understanding of carbon footprints and their implications. By increasing knowledge and awareness individuals can be empowered to make informed decisions and take actions that contribute to the reduction of carbon emissions and the mitigation of climate change impacts.

The findings presented in Table 5 shed light on the knowledge of respondents regarding rules and regulations related to environmental cleanliness. In the urban area, 41.67 per cent of respondents were aware that the Government of Rajasthan had banned the manufacturing, sale and use of identified single-use plastic items as of July 1, 2022. However, in rural areas, only

Table 5: Distribution of rural and urban respondents according to their knowledge about rules and regulations about environment cleanliness n=480

S. No.	Aspects	Rural (240)		Urban (240)	
		f	%	f	%
1.	Government of Rajasthan banned the manufacture, sale and use of identified single - use plastic items like plates, cups, straws, trays and polystyrene from July 1, 2022	20	8.33	100	41.67
2.	Environment protection act (1986) to prevent environment and life of human being	0	0	20	8.33
3.	Cleanliness complaint can be made on Rajasthan Sampark Portal by dialing 181	0	0	0	0

8.33 per cent of respondents had knowledge about this ban. Furthermore, only 8.33 per cent of urban respondents were aware of the Environment Protection Act (1986), which is aimed at preventing environmental damage and safeguarding human life. In contrast, none of the rural respondents had any knowledge about this legislation. It is concerning to note that neither the rural nor urban respondents had any information about the Rajasthan Sampark Portal, which serves as a platform for registering information related to cleanliness by dialing 181. This lack of awareness about such platforms and initiatives hinders the effective communication and reporting of cleanliness-related issues. The limited knowledge exhibited by the respondents regarding environmental control measures and prevention criteria is a sensitive issue. In the face of constant environmental changes and the serious problems they pose, it is essential for individuals to be informed about measures that can help mitigate and prevent environmental damage. As mentioned by Wang and Zhou (2020), the majority of respondents in China believed that the government should take a leading role in responding to climate change. This highlights the importance of government action and the need for public awareness and support for environmental initiatives. Addressing this knowledge gap requires comprehensive awareness campaigns and educational programs that focus on informing individuals about environmental regulations, government initiatives and platforms for reporting environmental concerns. By enhancing knowledge and understanding individuals can actively participate in environmental protection and contribute to a more sustainable future.

Overall knowledge of the rural and urban respondent about carbon footprint

To know the level of knowledge of the respondents about carbon footprints, they were grouped into three categories of knowledge namely poor, average and good on the basis of their mean percent scores.

Figure 1 provides an overview of the distribution of rural and urban respondents across different categories of knowledge regarding carbon footprints. The majority of rural respondents (86.67%) exhibited poor knowledge, indicating a lack of understanding in this area. Only 13.33 per cent of rural respondents had average knowledge, while none of them had good knowledge regarding carbon footprints.

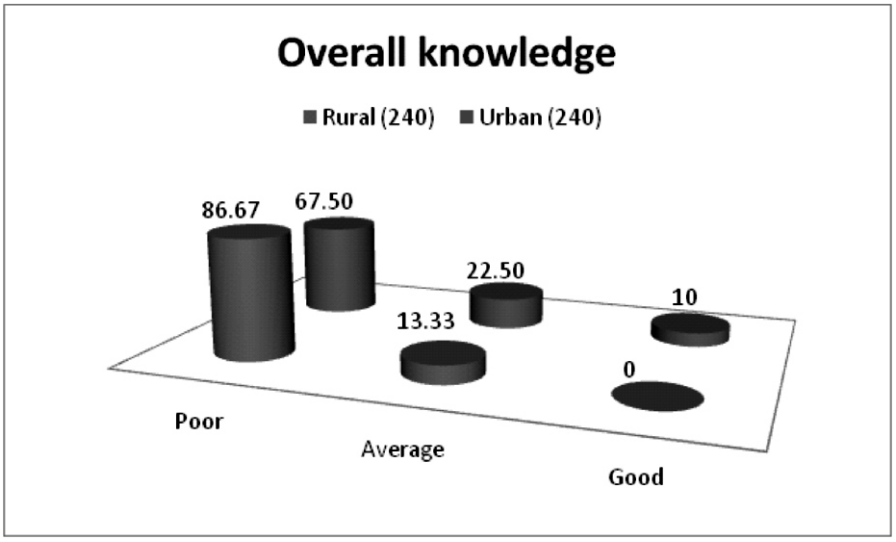


Fig.1: Distribution of rural and urban respondents by their overall knowledge about carbon footprint

Among urban respondents more than two-thirds (67.50%) fell into the poor knowledge category, suggesting a similar lack of awareness compared to the rural respondents. Around one-fourth (22.50%) of urban respondents had average knowledge and only 10 per cent demonstrated good knowledge about carbon footprints.

These findings underscore a significant disparity between rural and urban respondents in terms of their knowledge about carbon footprints. The majority of both rural and urban participants exhibited limited understanding in this domain, with rural respondents showing a slightly higher proportion of poor knowledge. This suggests a need for targeted educational interventions and awareness campaigns to enhance the knowledge and awareness of individuals both in rural and urban areas regarding carbon footprints and their implications for the environment.

Upon examining Table 6, it becomes evident that a significant difference exists in the knowledge levels regarding carbon footprints between rural and urban respondents. The data presented in Table 7 demonstrates that the mean knowledge value of rural respondents is 2.96, while the mean knowledge value of urban respondents is 9.15. By conducting a statistical analysis at a 1 per cent level of significance, a Z score of -8.57 was obtained, indicating a substantial difference between the knowledge levels of rural and urban respondents. This finding suggests that urban respondents possess a significantly higher level of knowledge about carbon footprints compared to their

Table 6: Significance of difference in rural and urban respondent's knowledge about carbon footprint

S.No.	Particular	Mean value	Z score
1.	Knowledge of Rural respondents	2.96	-8.57*
2.	Knowledge of urban respondents	9.15	

*Significant at 1% level of significance

rural counterparts. The results highlight the disparity in knowledge between rural and urban areas emphasizing the need for targeted interventions to enhance awareness and knowledge regarding carbon footprint particularly in rural communities.

CONCLUSION

The findings of the study indicate that there is a significant lack of knowledge among both rural and urban respondents when it comes to understanding the concept of carbon footprint. This lack of knowledge is particularly pronounced in rural areas where none of the respondents demonstrated good knowledge about carbon footprints. In urban areas although a small percentage of respondents showed good knowledge the majority still fell into the poor knowledge category. The disparities in knowledge levels between rural and urban respondents can be attributed to various factors. Urban respondents may have better access to education including formal education and exposure to information through social media and other sources. Their engagement in discussions related to environmental issues might contribute to a higher level of awareness and understanding of carbon footprints. On the other hand rural respondents may have limited access to educational resources and may be less exposed to information about environmental topics.

The study highlights the concerning fact that both rural and urban women lack knowledge regarding the proper use of technologies and often engage in negligent household activities that contribute to increased carbon emissions. This emphasizes the urgent need for educational interventions and awareness campaigns targeting women in both rural and urban areas. By enhancing their knowledge and awareness about carbon footprints and their implications for the environment, individuals can be empowered to adopt more sustainable practices and reduce their carbon emissions. By promoting green and sustainable behaviors such as adopting renewable energy sources, practicing waste reduction and recycling and using eco-friendly products, individuals can actively contribute to mitigating the negative effects of their carbon footprint. Ultimately, the goal is to create a more environmentally conscious society that understands the importance of reducing carbon emissions and works towards a sustainable future.

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Climate Perceptions and Access to Information Among Spice Farmers in Idukki District of Kerala

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ABSTRACT

Agricultural sector is a significant component of the rural livelihoods and food security in India. Climate variability and change is increasingly affecting the agricultural outcomes in the country. Farmer's perceptions and information on weather change is an important determinant of making adequate responses to this challenge. The main objective of this paper is to examine the nature and sources of weather information gathered by farmers. It is also necessary to understand the differences in farmer's perceptions on long term changes in weather, and trends observed in actual weather station data. This study is undertaken in a Spice farming community of Idukki district in Kerala. The study finds considerable differences in farmer's perceptions and weather station data. The results indicate the use of both conventional and modern sources of weather information among farmers. Although, there are substantial socio-economic disparities deciding the access to weather information within the community. The study suggests the need for providing more timely and reliable weather information to farmers in regional scales.

Keywords: Climate change; Weather information; Agriculture; Spices

INTRODUCTION

Agriculture is a major source of livelihood and is fundamental for food security especially for developing countries. For India, although the share of agriculture in national income is declining over the years (<15% in 2010-11 from 37% in 1970-71), the sector remains as a significant component in terms of food security, rural employment, and poverty alleviation (Birthal *et al.*,2014). Despite this importance, the sector largely remains rainfed and is dominated by small holders. Climate variability and change is an important challenge in this context which is significantly affecting agricultural productivity in the country (Morton, 2007; Mertz, 2009). In this context, perceptions of weather change among farmers and the access to weather information to counter such impacts are important. Farmer's perceptions about weather change are a fundamental part of forming responses against it. In addition to their own experiences and perceptions, farmers also make communications on weather changes with their peer farmers or family. Although lack of timely and accurate information may lead to ineffective responses against weather. How farmers perceive weather can be different from the weather station data. To what extent farmer's perception matches with weather station data, thus underlines the need for better weather information.

Weather information can be viewed as an everyday decision-making tool against various types of risk. It can optimize different aspects of production including timing of planting or harvesting, extent of irrigation, usage of fertilizers and pesticides and, changes in cropping pattern. These adjustments can result in better production, reduction in costs and more resilience to climate related stress. Over the years, many governments and civil societies have acknowledged the need for effective weather information in agriculture. There has been attempts to make meteorological data more accessible and disseminate it in regional levels. There are still constraints in reaching this information to the farmers and enabling them in better decision making. Thus, this study tries to map the farmer's perception on weather and the accessibility of weather information in the community. The study is undertaken in a Spice farming community of Idukki district in Kerala. Given the lucrative and commercial nature of Spice cultivation, information plays an important role in farm level decision making. This makes it an important case for the current study.

LITERATURE REVIEW

Many studies have looked at the importance of weather information in agriculture (Hellmuth *et al*., 2005; Patt *et al*., 2005;Fafchamps & Minten, 2012; Yegbemey *et al*., 2014; Mittal *et al*., 2018). Camacho & Conover (2019) conducted a randomised controlled trial experiment on small farmers in rural Colombia. A group of farmers received text messages on prices and weather forecasts. Farmers who received the messages were found to be making changes in their farming interventions. Mugerwa *et al*., (2014) finds that some farmers identify conventional weather forecasts as unreliable and only provides a broader understanding. Limited knowledge to predict weather based on conventional ways have led to less resilience in the face of issues like drought. Many farmers regard informal contacts with peer farmers and private input suppliers as the major source of information in addition to their own perceptions. Trust and timing are two important components of weather information (Kumar *et al.*,2020).

Caine *et al.*,(2015) specified the increasing importance of information and communication technologies like Mobile phones for weather information. Use of visual and participatory applications and videos on mobile devices will be highly helpful for farmers. In addition to providing information, increase in mobile data collection and devising farmer friendly tools is important. Batte *et al*., (1990) points out the difference in information sources between large and small farmers. Large farmers preferred marketing consultants, commercial newsletters, and cooperative information services. Age and farm size are also shown as important in deciding information access. Gbangou *et al*.,(2020) indicates that jointly producing climate information with the involvement of both farmers and scientific community is crucial. There should be continuous activities such as training, monitoring, and technical support.

Mittal (2016) finds that information through mobile phones have reduced information asymmetry among the farming community. Especially the gender differences in access to information has been narrowed down due to mobile phones. Pandey & Singh (2020) through a study in Uttar Pradesh finds that access to better information has resulted in effective spatial arbitrage and crop grading

in the study region. Das et al. (2016) also gives insights into the importance of mobile phones, voice mails and SMS solutions for weather related issues in farming. A voice messaging system in local language was found to be effective in West Bengal. Wamalwa *et al*.,(2016) studies the importance of agro-climatic information in the adoption of climate smart practices among small farmers in the context of Kisii county in Kenya. Overall, this interaction is reported to be low among small scale farmers. This is a challenge in devising climate smart policies in agriculture.

OBJECTIVES

To examine the long-term changes in key weather variables in the region through meteorological data from weather stations

To compare the farmer's perceptions on weather changes and the weather station data

To assess the sources of weather information accessed by farmers and the factors determining it

To examine the barriers in weather information access as reported by the farmers

MATERIALS AND METHODS

The study area is the Idukki district of Kerala which is the largest district in the state. The district is situated between 9°51'0"N latitude and 76°58'0.01"E longitude. The district is known for its significant involvement in Spice farming. Nearly 90 percent of the district's area comprises of high ranges shielded by mountains, hills, and deep valleys. Also. more than fifty percent of district's area is covered by forest with unique agro-climatic pattern making it suitable for the cultivation of Spices. A sample of 20 farmers each were purposively collected from six Gram Panchayats in the Idukki district. The present study uses a mix of primary and secondary data sources, for understanding the incidence of weather changes and the access of weather information by farmers in the region. Primary data about farmer's perceptions of weather and access to weather information were collected through a survey. The data was collected through a structured questionnaire from a total of 120 farmers. The data was collected on socio-economic and demographic details of the farmers, perceptions on weather change, major sources of weather information, and the barriers in getting information. For primary data analysis statistical measures such as frequency and percentage, arithmetic mean, ranking, and correlations were used.

Secondary data was used to understand the changes in key weather variables for the study region over time. Estimation of long-term changes in weather variables were undertaken through a trend analysis of climate data from 1990 to 2020. The annual data on precipitation, relative humidity, temperature and wind speed were retrieved from NASA POWER (The Prediction of Worldwide Energy Resources data set, retrieved from; https://power.larc. nasa. gov/) for Idukki district. Mann-Kendall test and Sen's slope estimator are used to understand the actual trend of weather data and to detect the direction of change in this paper.

Mann-Kendall is a non-parametric test performed to detect the trends in time-series data.The Mann–Kendall statistic (Mann 1945; Kendall 1975) is calculated as:

$$S = \sum_{i-1}^{n-1} \sum_{j=i+1}^{n} sgn(X_j - X_i)$$

Where n is the number of data points, X_i and X_j are the annual data values in the years i and j (j>i), respectively,

Mann-Kendall statistic (S), were calculated for each weather variable. If, p-value of S-statistic is less than 0.01, then there is a significant trend in the weather variables over time at 1% level of significance. When the sign of S statistic is positive, it denotes an increasing trend. The negative sign denotes a decreasing trend. In addition, Sen's slope estimators are also calculated to understand the slope of the weather variables. Sen's slope graphs are also given, where a negative slope denotes a declining trend and a positive value indicates and increasing trend. XLSTAT trial version and STATA 15 statistical software were used for the data analysis.

RESULTS AND DISCUSSION

1. To Examine the Long-term Changes in Key Weather Variables in the Study Region Through Weather Station Data

The study used yearly data on precipitation, relative humidity, temperature, and wind speed to understand the nature of changes in long term climate in Idukki district. The summary statistics of major climatic variables indicate some characteristics of the climate in Idukki district and is reported in Table1.

Table1: Summary Statistics of Major Climate Variables in Idukki District (1990-2020)

Climate Variable	Minimum	Maximum	Mean	SD
Precipitation (millimetres)	1286.720	2636.720	1938.925	339.435
Relative humidity(Percent)	14.280	15.500	14.969	0.311
Temperature(Celsius)	20.700	25.520	23.493	1.302
Wind speed (meter/second)	0.380	0.470	0.426	0.024

Mean precipitation level is 1938.92 mm and the summary of the data shows considerable variations from the mean. Precipitation in the region is thus showing substantial variations ranging from a minimum value of 1286.720 to a maximum value of 2636.720mm. The average relative humidity is around 14.96. Annual temperature is ranging from 20.7C to 25.5 C with a mean temperature of 23.4C. Although the values are not showing much fluctuation like precipitation, optimal temperature ranges are significant for climate sensitive spice crops like Pepper and Cardamom. Wind speed is also not showing much fluctuations in the data, ranging from a minimum of 0.380m/s to a maximum of 0.470m/s. In order to understand the long-term changes in weather patterns of the region, a trend analysis using Mann Kendall test and Sen's slope are conducted.

Results of trend analysis using Mann-Kendall test along with the p value and Sen's slope graphs indicating the magnitude of the trends are presented in Table 2. Except precipitation, all three other variables indicate significant trend. Although the summary statistics indicated anomalies in the precipitation data, there are no long-term significant trends in the data. Relative humidity is showing an increasing trend over the years. Average temperature and wind speed are indicating decreasing trends

Table2: Results of Mann-Kendall and Sen's slope Analysis

Climate Variable	Mann-Kendall Statistic (S)	p-value	Sen's slope	Observed trend
Precipitation	13	0.838	1.688	No significant trend
Relative humidity	228***	0.000	0.025	Increasing
Temperature	-161***	0.007	-0.079	Decreasing
Wind speed	-259***	0.0001	-0.002	Decreasing

(***Significant at 1%)

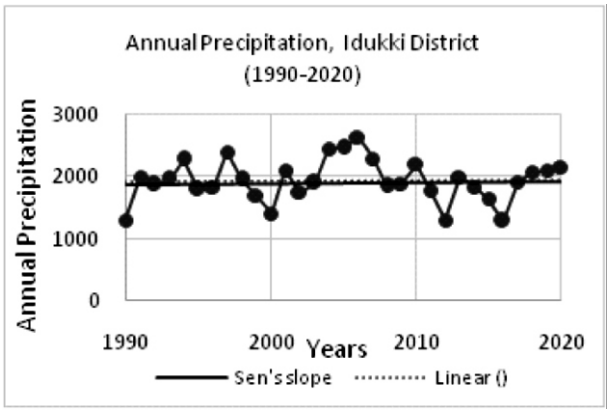


Figure 1: Sen's slope analysis of Annual Precipitation, Idukki District, (1990-2020)

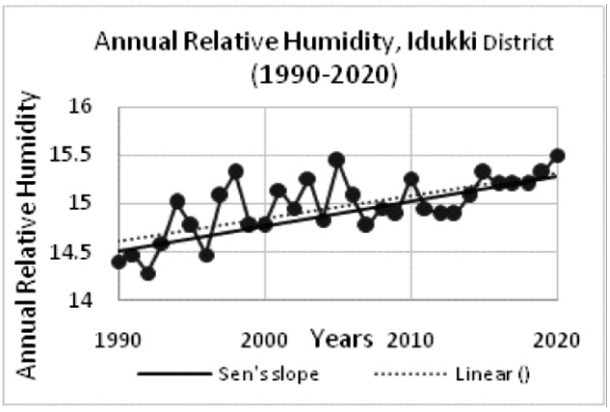


Figure 2: Sen's slope analysis of Annual Relative Humidity, Idukki District, (1990-2020)

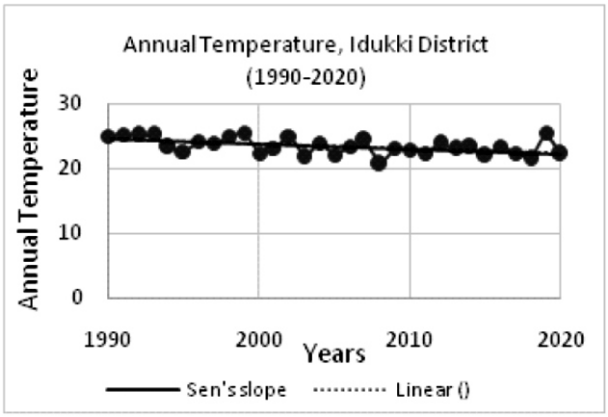


Figure 3: Sen's slope analysis of Annual Temperature

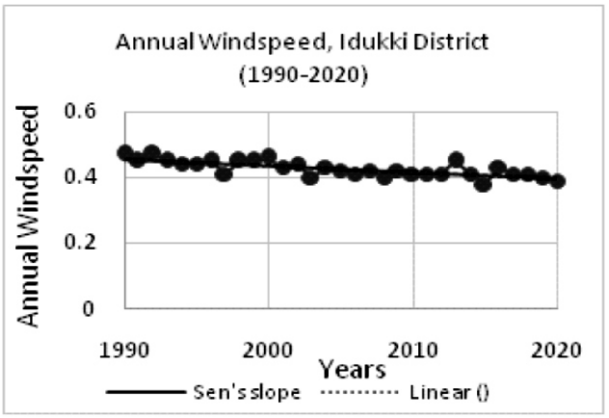


Figure 4: Sen's slope analysis of Annual Temperature, Idukki District, (1990-2020)

2. To Understand the Perceptions of Farmers on Weather Change and Compare it with Weather Station Data

The trend analysis test in the last section indicates significant variation in relative humidity, temperature and windspeed. This section presents the results from the field survey on how farmers in the study region are perceiving long term changes in weather. Tabe 3 presents percentage analysis of farmers perception of two major weather variables, rainfall, and temperature.

Table 3: Comparison of farmer's perception with weather data

Weather Variables	Farmer's perception	General trends from weather data	Major impacts on Spice crops
Rainfall	Increase= 57.50% Decrease=23.33% No change= 19.17%	Increasing	-Changes in seasonal flowering habitat -High pest and disease incidence -Loss of soil minerals
Temperature	Increase= 88.33 % Decrease=3.40% No change=7.50%	Decreasing	-Changes in water availability -Drying of plants -Delayed ripening of fruit capsules

(Source; Authors calculation from survey data)

Rainfall trends observed by farmers indicate mixed changes. 57.50% of the farmers report an increase in rainfall over time in the region. 23.33 % indicate decrease and 19.17% indicate no change. This mixed perception might also be due to that fact that intensity of extreme rainfall events and floods has increased in the recent years. Singh (2018) observes that farmer's perception about gradual changes such as rainfall patterns may overlap with more intrinsically noticeable phenomenon such as extreme rainfalls. Earlier the region used to have a consistent rainfall pattern in a moderate intensity, although now it is deficit rainfall in some months followed by heavy spell of rain in others. Temperature as observed by farmers is mostly increasing over time and 88.33 per cent of farmers report an increase. Since most of the farmers in the study region cultivates Spice crop like Pepper and Cardamom, mean optimal temperature range is highly significant. Any changes exceeding such limits will be difficult for the farmers since these crops are traditionally rainfed. Some farmers indicate recurring crop loss due to strong winds, which has become a routine event in the region now. Issues like wind-driven flower and fruit shedding, damage in the roots and acceleration of drying of the plants due to hot winds are commonly observed.The results compared with weather station trends show there is significant differences in official weather data and how farmers understand weather changes. This underlines the importance of bringing reliable weather information to the farming communities. It will help in real time decision making and better susceptibility to issues like climate change.

3. To Assess the Farmer's Choice of Weather Information Source and the Factors Determining It

The percentage analysis of farmer's access to weather information shows the active use of several sources among the community. The major sources of weather information as reported by the farmers are newspaper and magazines, radio and television, mobile phones and internet, peer farmers, and government sources. Table 3 depicts the percentage analysis of various sources of weather information.

Table 4: Farmer's Choice of Weather Information Sources

Sources of Weather Information	Percentage of Farmers
Newspapers and magazines	59.17 %
Radio and television	62.50 %
Mobile phones and internet	35.83 %
Peer farmers	68.33 %
Government sources	8.33 %

(Source: Author's calculation from the survey data)

Most relied source of weather information according to the farmers are getting information through peer farmers (68.33 %). Farmers are also dependent on media sources such as Radio and television (62.50 %) and Newspapers and magazines (59.17 %). Increasing digitalization has led to the use of mobile phones and internet (35.83 %) among the farmers for getting weather information. Only 8.33% of farmers access government sources for weather information. Given this, next section estimates the major determinants of preferred source of weather information among the farmers. Table 5 depicts the summary statistics of major socio-economic and demographic characteristics of sample farmers.

Table 5: Summary statistics of socio-economic and demographic variables of the farm households

Variable	Mean	Std. Dev	Min	Max
Land Size (In acres)	3.301583	3.252177	.1	25
Age of the respondent (In years)	50.175	12.0431	26	76
Education of the respondent (In years)	10.35833	3.444142	0	17
Monthly household expenditure	10420.83	5158.006	1000	40000
Gender of the respondent	1.116667	.3223687	1	2
Household has non-farm income	.4666667	.5009794	0	1
Membership in Farm groups	.425	.4964157	0	1

(Source; Authors calculation from survey data)

The sample is a mix of marginal, small and large farmers ranging from 10 cent to 25 acres of landholding, since Spice crops are cultivated as both small holdings and as large plantations. The mean age of respondent's are around 50 years. Education level of respondents in years ranges from 0 to 17. The mean monthly household expenditure is Rs.10,420. Only 11.67% of the respondents are females and rest are male. Around 46% of the farmers also have non-farm income sources. About 42% of the farmers are members in farm groups. Using the above variables, the determinants of sources of adaptation information is examined. The results of correlation analysis between socio-economic and demographic variables and each source of adaptation are presented in Table 6. The results indicate a significant role of these variable in determining the farmer's choice of weather information.

Access to other farmers for weather information is correlated with gender of the respondent and monthly household expenditure. Female headed household may have less networks, resulting in low access to other farmers for information.

Table 6: Correlation analysis of sources of weather information and socio-economic variables

Variables	Other farmers	Newspapers and farm magazines	Radio and television	Mobile phones and internet	Government sources
Land Size (In acres)	0.1428	0.3192***	0.2216**	0.3347***	0.2641**
	(0.1198)	(0.0004)	(0.0150)	(0.0002)	(0.0036)
Gender of the	-0.3649***	-0.1201	0.1201	-0.2704***	-0.1091
respondent	(0.0001)	(0.1914)	(0.1912)	(0.0028)	(0.2355)
Age of the	0.0441	-0.2132**	-0.3389 ***	-0.3125 ***	-0.1321
respondent (In years)	(0.6324)	(0.0194)	(0.0002)	(0.0005)	(0.1505)
Education of the	-0.1060	0.3719***	0.4404 ***	0.4218***	0.1350
respondent (In years)	(0.2491)	(0.0001)	(0.0001)	(0.0001)	(0.1416)
Monthly household	0.1979 **	0.2371 ***	0.1349	0.2355***	0.0689
expenditure	(0.0302)	(0.0091)	(0.1417)	(0.0096)	(0.4544)
Household has	-0.1328	-0.1681	-0.3248**	-0.3901	0.0455
non-farm income	(0.4334)	(0.2683)	(0.0371)	(0.0080)	(1.0000)
Membership in	0.2488	0.3689**	0.4486***	0.7361***	0.3711*
Farm groups	(0.1152)	(0.0144)	(0.0023)	(0.0000)	(0.0949)

[Significant at 1%***, 5%**, 10%*] (Source; Authors calculation from survey data)

Similarly, low-income households may have more community interaction or more reliance on traditional sources of information. In the case of access to newspapers and farm magazines, higher land size, education, monthly expenditure, and membership in farm groups are important factors. Also, young respondents are more probable to undertake information through Newspaper and magazines. Above mentioned factors also contribute to the access to Radio and television for weather information. In addition, household has non-farm income is negatively correlated with access to radio and television. All variables except household have non-farm income is correlated to the use of mobile phones and internet for weather information. Access to government sources for information is influenced by only land size and membership in farm groups.

4. To examine the barriers in weather information access as reported by the farmers

The major barriers in getting of weather information is reported by farmers and is summarized below in table 7;

The results indicate limited information sources as the highest barrier to get reliable climate information. It is followed by additional cost. Farmers also report limited accessibility to weather data sources as an issue. Lack of adequate schemes followed

Table 7: Barriers in accessing weather information as reported by farmers

	Percentage	Rank
Limited Accessibility	52.50	III
Limited information sources	78.33	I
Low responses	30.83	V
Lack of adequate schemes	35.9	IV
Additional cost	72.50	II

(Source; Authors calculation from survey data)

by low responses are other barriers.

CONCLUSION

In conclusion weather changes indicate an important issue in the study region and among spice farmers. Farmer's perceptions about weather change and trends observed through weather station data are slightly different with one another. This difference points out the need for more effective and reliable weather information in the region. Thus, the study has examined the importance of access to weather information in the farming community. The results indicate the use of both conventional sources like peer interaction and modern sources such as internet and mobile phones to gather information on weather. Estimations on the major determinants of these sources indicate many disparities within the community. The study suggests the need for providing more timely and reliable weather information to farmers in regional scales.

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Effectiveness of Embroidery Training in Developing Skills among Adolescent Girls

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ABSTRACT

The present study was an endeavor to develop skills in embroidery among rural girls. Four trainings of two days duration each on basic embroidery was organized for rural girls of four villages of Banaskantha district. Total 160 rural girls participated in these training programs. Five basic stitches of embroidery namely Herringbone stitch, chain, stitch, stem stitch, lazy daisy stitch and buttonhole were taught to the girls. The pre and post test research design was used to check the effectiveness of training programmes. Interview technique was used for collecting data. Data was analyzed by using frequency, percentage, mean and t-test. Findings show that training on embroidery was very effective in terms of knowledge enhancement and skill development of the respondents regarding embroidery.

Key words : Embroidery, Knowledge, Skill, Training, Girls

INTRODUCTION

India is the land of rich culture and diverse traditions. Almost every region of India has a distinct style of embroidery based on cultural history of the region. The ethnic hand embroidery is no longer the choice of occupation for the poor Indian artisans alone but is the weakness of the elite both in India and foreign markets. Embroidery is the handicraft of decorating fabric or other materials with needle and thread or yarn. Embroidery may also incorporate other materials such as, pearls, beads, quills, and sequins. Today, embroidery is most often seen on caps, hats, coats, blankets, dress shirts, denim, stockings, and golf shirts. Embroidery is available with a wide variety of thread or yarn color. The basic techniques or stitches on surviving examples of the earliest embroidery chain stitch, buttonhole or blanket stitch, running stitch, satin stitch, cross stitch remain the fundamental techniques of hand embroidery today.

India is still a virgin market for embroideries. Traditionally, embroidery is used for ornamentation of apparel and other products. This a form of embellishment is now getting popular in menswear. There is a huge potential of embroidery in the country, which is still to be tapped. It can be a good avenue for rural women to fight financial crises. Thus, the rural women should be trained in embroidery to initiate income generating activities at household level. Therefore, the efforts had made to develop skills among rural girls in embroidery by organizing training programmes. The present study was conducted to assess the effectiveness of the training on basic embroidery.

Review of Literature

Gupta and Verma (2013) reported that

trainings on supplementary nutrition, balance diet, immunization and smokeless chulha played prime role in influencing technological changes and enhancing knowledge of rural women. They also illustrated that majority of farm women (55.55%) gained medium knowledge.

Ajrawat *et al.* (2013) conducted on-campus and off-campus training programmes and assessed its impact. In on-campus training almost three fourth respondents (73.00%) gained high level of knowledge while in off-campus trainings 74.00 per cent respondents had medium level of knowledge.

Chandra *et al*. (2015) reported that knowledge gain was more in on-campus trainings as compared to off campus trainings. They elaborated that majority of the trainees (71.00%) had high level of knowledge in on-campus trainings whereas medium level of knowledge gained in off campus training (71.0%).

Bala and Jain (2017) reported that most of the respondents (68.89%) of cutting and tailoring trainings acquired high level skills in designing, stitching, surface enrichment, machine care and operation, entrepreneurial education and precautions.

Ahuja *et al.* (2019) reported knowledge enhancement of rural women of Ambala district through dairy trainings in different aspects of dairy farming *viz*. breeding (35.00%), animal housing (11.00%), vaccination (24.00%), balance diet (34.00%), care of new borne calf (29.00%), clean milk production (33.00%) and artificial insemination (25.00%).

MATERIALS AND MATHODS

Present study was conducted in Banaskantha district of Gujarat. Rural girls of four villages namely Samau Mota, Sardarpur, Dalwana and Shivnagar were selected for the present study. Four training programmes of two days duration each were organised on embroidery. Total 160 rural girls participated in these training programs. During the training, various samples were prepared by the respondents by using 5 stitches *i.e*. Herringbone stitch, chain, stitch, stem stitch, lazy daisy stitch and buttonhole stitch. The participatory demonstration method was used for imparting training. Pre and post-test research design was used to check knowledge gain and skill development of respondents on embroidery. Interview technique was used for collecting data. Interview schedule was developed by researcher. Data were analysed by using frequency, percentage, mean and t-test.

RESULTS AND DISCUSSION

Background information of the respondents

The most of the respondents (77.5%) were of the age between 16 to 20 years remaining belonged to OBC caste (90.6%). Less than fifty percent respondents (40.6%) had education up to middle level and 33.1 per cent respondents educated up to secondary. Only six respondents (3.7%) were graduated. Majority of the respondents were from nuclear families (65.0%) having 5-8 members (48.1%) and unmarried (66.9%). Their main family occupation was agriculture (38.1%) and had annual family income less than one lakh (62.5%). Most of the respondents (77.5%) had a medium level of mass media exposure and low participation (100.00%) in social organization.

Reasons for Attending the Trainings

Table 2 provides information regarding reasons for attending the trainings. Data clearly show that three fourth of the respondents attended fruits and vegetables preservation training to learn new things and for their own interest while same number of the respondents (75.0%) attended needle and embroidery training for acquiring new skills. Around 65-70 per cent respondents attended fruits and vegetables preservation and embroidery and needle work trainings for utilizing their free time. Desire to establish an enterprise and contributing in family income have emerged as important factors contributing to participation in training programme as reported by 24-50 per cent trainees. Further data revealed that 11.76- 55 per cent respondents attended trainings as per the

Table 1 : Distribution of the respondents on the basis of reasons for attending training programmes on embroidery n =160*

S. No.	Reasons	f	%
1	To acquire new skills	150	93.8
2	To utilize free time	64	40.0
4	To initiate income generating activity/ enterprise	56	35.0
5	For their own interest	146	91.3
6	As per the advice of friends and neighbours	35	21.9
7	To increase family income	10	6.3

*Multiple responses

Perusal of Table 1 reveals that most of the respondents had attended training due to acquire new skills (93.8%) and their own interest (91.3%). Less than half of the respondents attended training for utilizing their leisure time (40.0%) and initiating income generating activity (35.0%). Some of the respondents (21.9%) participated in the training as per advice by the friends and neighbours. Very few respondents (6.3%) attended training for increasing family income.

Opinion of respondents towards different aspects of embroidery training programme

Data in Table 2 present information pertaining to the opinion of the respondents regarding different aspects of embroidery training. All the respondents were fully satisfied with the training time, materials, methods, practical orientation and technical guidance provided in the training programme. A good number of the respondents had most favourable opinion towards training content (93.8%), training place (90.6%), and training duration (87.5%). Some of the respondents reported that training duration can be increased for better learning and more stitches of embroidery should be taught in the training programmes. Few respondents suggested that such training should organise in the village. Findings get decisive support from the findings of Purohit (2015) that most of the respondents were fully satisfied with the training duration, place, methods, content and technical guidance provided in the training programme on fruits and vegetable preservation.

Table 2 : Opinion of respondents towards different aspects of embroidery training programme n=160*

S.No.	Training aspects	Satisfied f (%)	Some what satisfied f f(%)	Not satisfied f (%)
1	Training time	160(100)	-	-
2	Training duration	140(87.5)	20 (12.5)	-
3	Training Materials	160 (100)	-	-
4	Training Place	145(90.6)	15(9.4)	-
5	Training Methods	160(100)	-	-
6	Training Content	150 (93.8)	10 (6.2)	-
7	Practical orientation	160(100)	-	-
8	Technical Guidance	160(100)	-	-

*Multiple responses

Effectiveness of training on knowledge and skill development of the respondents

An attempt has been made in this study to find out the effectiveness of training on the knowledge gain and skill development of the respondents in embroidery.

Table: 3 Effectiveness of training programme on knowledge and skill development of the respondents n = 160

S. No.	Aspects	Pre knowledge		Post knowledge		Gain	t value
		Mean	SD	Mean	SD	Mean	
1.	Concept of embroidery	1.91	0.29	2.00	0.00	0.09	2.5463*
2.	Knowledge about basic stitches	0.382	0.754	4.816	0.298	4.434	62.226*
3.	Usage of embroidery	2.54	.896	7.46	1.154	4.92	40.039*
4.	Material required for embroidery	2.24	1.025	5.66	1.423	3.42	25.074*
5.	Process of embroidery	1.15	0.358	3.86	0.396	2.71	66.151*
Development of skills in making different stitches							
	Different embroidery stitches	Pre		Post		Gain	t value
		Mean	SD	Mean	SD	Mean	
1.	Herringbone	1.02	0.136	3.34	0.889	2.33	21.7060*
2.	Chain	1.06	0.231	3.51	0.727	2.47	27.1046*
3.	Stem	1.08	0.264	3.34	0.840	2.23	20.5543*
4.	Laisydaisy	1.93	0.254	3.23	1.005	2.16	15.139*
5.	Buttonhole	1.88	0.325	3.07	1.094	2.08	12.817*

* Value significant at 5% level of significant

There is a significant difference between pre and post knowledge of the respondents in all aspects of embroidery as the calculated t-value is higher than tabulated t-value. Data clearly show that the highest gain in knowledge was seen in material required for embroidery (3.42), knowledge of basic stitches (4.434) and usage of

embroidery (4.92). It was found in an informal discussion with respondents that they had heard about embroidery and also seen few embroidered articles but they did not have much knowledge about the stitches of embroidery and the utilization of embroidery for making various articles. Although they knew that cloth, needle and thread required for making any embroidery design but did not know about frame, carbon paper are also required for embroidery work. As they were acquainted with embroidery articles so they already knew the concept of embroidery (0.9). Prior to training one or two respondents had skill in one or two stitches but after the training most of the respondents developed medium to high skill in all the taught embroidery stitches (2.08 to 2.47). Embroidery training depict that training was beneficial in developing skills in embroidery in almost all the respondents. They learnt different stitches and acquired competence in preparing different articles like cushion cover, salwar suit, frock, bedsheet etc by using these stitches. The respondents also reported that they attended training due to acquire skills in embroidery and proper utilization of free time. Overall training is effective in enhancing knowledge and skill in embroidery among rural girls.

Findings are supported by the findings of Veeranjaneyulu *et al* (2014) that apparel making and embroidery training program enhanced knowledge of trainees about 151.6% in the apparel making and embroidery. The beneficiaries got hands on experience during the training program and started individual units in their respective villages and also got employment in the nearby apparel companies.

CONCLUSION

The embroidery training was very effective in developing knowledge and skill in rural girls in embroidery. They can utilize the knowledge gained and skills developed in embroidery for household and commercial purpose. There is a need to organise skill development trainings for women from time to time which helps them in initiating income generating activities to become economically independent.

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Assessment of Training Need for Banana Cultivators in Uttar Pradesh, India

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ABSTRACT

India holds a dominant position in the global banana production landscape, accounting were an impressive 22.5% of the world's total banana output. The significant contribution to the agricultural sector amounts to 2% of India's Agricultural GDP (Government of India (2019). The research was carried out in the Fakharpur and Hijurpur blocks of Uttar Pradesh's Bahraich district of Uttar Pradesh. The research identified key training needs among banana growers. The highest priority areas for training included manures and fertilizers, propagation, pruning and desuckering. Farmers preferred university scientists as their top choice for organizing training programs, followed by district horticulture officers, progressive farmers, village-level workers, and block-level officers. Most farmers favoured conducting training at the field level or in villages, reflecting their practical orientation. The study revealed positive correlations between age, experience, farm size of banana growers and their training needs. Education, on the other hand, showed a negative correlation with training needs, as more educated farmers were better equipped to access information independently. The research also assessed farmers' attitudes toward banana cultivation, with 70% of respondents having a favorable view due to its profitability. Education, farm size, and the area under banana cultivation positively influenced farmers' attitudes. These findings highlight the importance of tailored training programs in addressing the specific needs of banana growers in Uttar Pradesh, with a focus on areas such as soil management, propagation, pest control, and storage practices.

INTRODUCTION

The banana occupies a distinguished place as one of the earliest cultivated crops, with India recognized as one of its primary centers of origin. Worldwide, there exists a rich diversity of over 1000 distinct banana varieties. Within India, the banana claims the second-highest position among fruit crops, trailing only behind the mango in importance. Furthermore, it enjoys the status of being the most widely consumed fruit in the country. Bananas contribute significantly, comprising approximately 32% of India's total fruit production. This prominence can be attributed to several factors, including its year-round availability, affordability, and wide range of varieties, delightful taste, and its nutritional and medicinal values, which cater to people of all strata (Vision ICAR-NRCB 2050). Globally, bananas are cherished not only for their nutritional content but also for their substantial economic significance,

particularly for small-scale farmers in developing nations (FAO, 2012).

The total area dedicated to banana cultivation in India covers approximately 858,100 hectares, constituting about 13 percent of the overall fruit cultivation land. Bananas hold the distinction of being the second most significant fruit crop in the country, following mangoes. India's average banana yield stands at an impressive 34 tons per hectare, which is considered quite commendable on a global scale. Specifically in Uttar Pradesh, the cultivation area allocated for bananas spans 67,400 hectares, resulting in a total production of 3,078.73 thousand tons. This equates to a productivity of 45.68 tons per hectare, at present India is the largest producer of banana in the world (Kumar, 2008).

It is imperative that farmers be trained in banana cultivation to keep them abreast of the latest innovations available so as to maintain its quality and stability in production. Training is vital and essential to induce motivation, create confidence and inculcate efficiency in an individual. Training only can bridge the enormous gap between the remarkable yield achieved by the scientist and that obtained by the farmers.

Keeping the above facts in view, a study entitled “Assessment of Training Need of Banana Grower of Uttar Pradesh” was planned with the following specific objectives:-

1. To identify the training needs in the main areas of banana cultivation as perceived by the banana growers.
2. To identify respondents' preference for types of trainer and location of training
3. To determine the relationship between selected socio-economic factors and training needs of banana growers.
4. To study the attitude of banana growers towards banana cultivation and its relationship with socio-economic factors.

MATERIALS AND METHODS

The study was carried out In Uttar Pradesh state. The farmers in the districts such as Sitapur, Kaushambi, Bahraich, Faizabad, and Barabanki of Uttar Pradesh are growing bananas along with the more traditional produce of paddy, sesame and maize.

The study was conducted in Fakharpur and Hijurpur block of Bahraich district of Uttar Pradesh as the Bahraich district being more concentration of banana cultivation in the state (4000 ha). From this district, two blocks, were purposively selected on the basis of large area under banana production. From these two blocks ten villages of banana growers and from each village 10 banana growers were selected for this study. Thus, a total of 100 respondents formed the sample. Data were collected with the help of structural interview schedule.

Assessment of training needs

Total 18 main areas in which banana growers needed training were identified for the study purpose. A three-point rating scale (most needed-3, needed-2, and not needed-1) was employed to measure the training needs of banana growers in the main areas of banana cultivation. The respondents were asked to indicate any one of three alternative responses against each item of the main areas, depending upon their level of training needs.

Firstly, the total training need score of a particular item was calculated considering the responses expressed by all the respondents. Secondly, the mean score of a

particular item was worked out by dividing the total score of that particular item with the total number of respondent (100).

Finally, based on the mean score, the rank order of preference for training in a particular area was found by following the class intervals of the scores assigned to the three-points of the rating scale as illustrated below:-

2.25-3.00= Most Needed

1.50-2.24= Needed

0.75-1.49= Not Needed

RESULTS AND DISCUSSION

Training needs in main areas of banana cultivation

As the data in Table 1 reveals, the area in which the respondents needed training most and which ranked first was manures and fertilizers. This is in agreement with the finding of Babanna. T,(2002), Kumar. H.S, (2008). Other areas in which training was perceived as 'most needed' by the respondents were in descending order, propagation, pruning and desuckering, plant disease protection/ pest control, harvesting, improved varieties of banana and storage. The areas *viz.*, irrigation, intercultural operations, time of planting, spacing, rotation and inter-cropping and marketing were perceived as just 'needed', while the banana growers did not need any training in areas like preparatory cultivation, weed control, improved implements and credits.

Table 1: Training needs of banana growers in the main areas of banana cultivation n=100

Sl. No	Main Area	Training Needs			Total Score	Mean	Rank
		Most needed	Needed	Not needed			
1	Improved varieties of banana	54	33	13	241	2.41	VI
2	Propagation	80	17	3	277	2.77	II
3	Preparatory cultivation	10	28	62	148	1.48	XIV
4	Time of planting	45	25	30	215	2.15	X
5	Spacing of planting	38	32	30	208	2.08	XI
6	Manures and fertilizers	83	15	2	281	2.81	I
7	Irrigation	44	30	26	218	2.18	VIII
8	Pruning and de-suckering	76	16	8	268	2.68	III
9	Inter-cultural operation	42	32	26	116	2.16	IX
10	Rotation and inter-cropping	28	48	24	204	2.04	XII
11	Weed control	15	15	70	145	1.45	XV
12	Pest control	75	15	12	261	2.61	IV
13	Plant diseases protection	73	15	12	261	2.61	IV
14	Improved implements	7	28	65	142	1.42	XVI
15	Harvesting	57	35	8	249	2.59	V
16	Storage	45	32	23	222	2.22	VII
17	Marketing	15	40	45	170	1.70	XIII
18	Credit	6	22	72	134	1.34	XVII

The respondents appeared to be aware of the facts that soil fertility gets depleted with successive cropping and ultimately affects the crop growth resulting in poor yield. They realised that application of fertilizers is obviously very essential. In terms of nutrients, nitrogen has a vital role in inducting flowering, synchronizing, flowering in the first ratoon crop and hastening growth (Gopalan *et al*., 1980), Realising the importance of fertilizers, the banana growers might have considered this area as most important one in terms of their training need.

Banana is propagated vegetatively by means of suckers or rhizomes which are considered to be the seed material for multiplication, (Paranjpe *et al.* 1974).It is believed that often suckers originate in pairs from opposite sides and when one is removed, the other grows well. Unless desuckering operation is done promptly, nutrition of the parent plants as well as growth vigor, size and fruiting period of flower are affected. The banana growers might not be aware of these facts and hence considered propagation, pruning and desuckering as the second and third 'most needed' areas of training.

High-yielding verities of any crop are very susceptible to pests and diseases and banana is not an exception to this. But fortunately, banana cultivation in India is not affected so severely as in other countries. However, pests and diseases cause a considerable damage to the crops. The banana growers are not able to identify the symptoms in the plants caused pests, diseases, or nematodes. They are also generally not aware of control measures. These reasons might have motivated them to assign fourth rank to pests and diseases control so far as the need of training is concerned.

Most of the respondents were found growing a particular variety of banana based on a preconceived idea and did not know much about others. Recently, a number of verities have been released which cause confusion in the minds of the farmers who are not in a position to decide as to which variety should be grown. The soil and agro-climatic conditions suitable to one variety may not be so far the others and the selection of a proper variety as per the soil conditions, topography, drainage, etc, becomes a problem for the farmers. This is why improved varieties of banana were considered as one of those areas in which training is needed most.

Banana plant is made of a pseudo stem. It has no capacity to withstand the natural rain, etc. The plant is also easily broken after emergence of bunch, before it attains maturity. In order to saves the bunch, adequate knowledge in storage is essential. Poor knowledge in storage leads to quick disposal due to its perishable nature. The other areas in which the respondents just indicated their need for training were harvesting, irrigation, intercultural operations, time of planting, spacing of planting, rotation and intercropping and marketing in descending order.

The areas in which the respondents did not need any training were preparatory cultivation, weed control, improved implements and credits in descending order.

Most of the banana growers were members of co-operative societies. Loans from banks were also available to them. Few of them were also getting loan from local money lenders. The timely and adequate supply of credit by farm financing institutions may go long way in popularizing the banana in the area which in turn may lead to higher

income and employment generation to the banana growers. For all these reasons perhaps, they held the view that training is not required with respect to credit. Use of improved implements in banana cultivation is negligible. Weed is perhaps not a problem in banana cultivation and so is preparatory cultivation. Perhaps due to these reasons, the respondents required minimal training in the four areas: preparatory cultivation, improved implements, credit, and weed control.

Table 2: Distribution of respondents according to their preference for trainer n=100

Sl.No	Response Categories	Mean Score	Ranking
1	VLWs	2.14	IV
2	Progressive farmers	2.23	III
3	Block level officers	2.10	V
4	District horticulture officers	2.48	I
5	Universities Scientists	2.42	II

The farmers' preferences for various categories of trainers in training programms were assessed and summarized in Table 2. The table demonstrates that the farmers ranked university scientists as their top choice among other trainers for organizing training programms. Following this, district horticulture officers, progressive farmers, village level workers (VLWs), and block level officers were ranked second, third, fourth, and fifth, respectively, by the farmers (Singh and Saini, 2004,and Pasvan et al 2013)

Preferences for ideal location for training sessions

The farmers were surveyed to ascertain their preferences regarding various training venues, as outlined in table 3.

Table 3: Preference for ideal location for organizing training n=100

Sl.No	Response Categories	Mean Score	Ranking
1	At the field	2.47	I
2	In the village	2.36	II
3	At the block headquarters	1.65	III
4	At the agricultural university/ KVK/Training Institutions	1.27	IV

The results indicate that the majority of the farmers favoured organizing training camps at the field level as the ideal location. The second most preferred option was conducting training at the village level, which was deemed suitable for the majority of farmers' training needs. The third choice for place for organising training was the block headquarters. The least favored option among all surveyed farmers was conducting training at the agricultural university/KVK/ITI. The result of the study was in line of the study conducted by Pasha *et al* in 2013.

Relation betweensocio-economic factors and training needs of banana growers

Table 4 reveals that age, experience in banana cultivation, farm size and area under banana cultivation had positive and significant correlation with training needs in the main areas of training. Education had significantly negative correlation with needs in the main areas of banana cultivation. The farmers with more age and experience in banana cultivation generally have less

contact with extension personnel. Therefore, they need more training in the main areas of cultivation. As the farm size and areas of cultivation increases, the training need in the main areas also increases due to the fact that larger areas under banana cultivation are exposed to greater hazards of farming. As such, theses farmers need more training in the main areas to adopt the latest techniques in banana cultivation so as to harvest a good return.

Table 4: Co-efficient of correlation between socio-economic factors and training needs of banana growers

Sl. No	Socio- Economic Factors	Correlation co-efficient 'r' value
1	Age	0.2576**
2	Education	-0.2454**
3	Occupation	-0.0491 NS
4	Social participation	-0.1830 NS
5	Income	-0.1067 NS
6	Experience in banana cultivation	0.2152*
7	Farm size	0.4096**
8	Areas under banana	0.6819**

NS = Non-significant; * = Significant at 0.05 %; ** = Significant at 0.01 %

Education was found to be negatively correlated with training needs in the main areas of banana cultivation. This might be due to the fact that education develops the mental faculty of an individual as a result of which he/she grasps analysis and interprets things in a better way than the less educated ones. The more educated farmers can make use of printed materials too. Possibly due to these reasons, the farmers with high level of education did feel the need of training in the main areas of banana cultivation. The remaining factors like occupation, social participation and income had no significant relationship with the training needs.

Attitude of banana growers towards banana cultivation

As a part of the study, an attempt was made to analyses whether the farmers had favourable or unfavourable attitude towards banana cultivation. The farmers' responses regarding their attitude towards banana cultivation are presented in table 5.

Table 5: Distribution of banana growers according to their attitude toward Banana cultivation

Sl.No	Attitude	Percentage
1	Favourable	70.00
2	Neutral	17.00
3	Unfavourable	13.60

It is evident from the data in Table 5, that 70 percent of the respondents under the study had favourable attitude towards banana cultivation. This confirms that banana cultivation is profitable for most of the farmers. However, 17 and 13 percent of the farmers respectively appeared to have neutral and unfavourable attitudes towards banana cultivation respectively. These farmers might have less area under banana cultivation and hence no worth-while profit.

Table 6: Co-efficient of correlation between socio-economic factors and attitude towards banana cultivation

Sl.No	Socio-economic factors	Correlation co-efficient 'r' value
1	Age	-0.1339 NS
2	Education	0.5819**
3	Occupation	0.1007 NS
4	Social Participation	0.0827 NS
5	Income	0.1004 NS
6	Experience in banana cultivation	-0.0808 NS
7	Farm size	0.2971**
8	Area under banana	0.2680**

NS = Non-significant; * = Significant at 0.05 %; ** = Significant at 0.01 %

From Table 6, it can be seen that the factors such as education, farm size and area under banana were found to be positively and significantly correlated with attitude towards banana cultivation. With increased education, farmers realise the merits of banana cultivation in terms of its economic return in a better way than the less educated ones. The larger farm size, the higher acreage under banana brings greater economic return to the farmers. All these contribute to their favourable attitude towards banana cultivation. Other factors such as age, occupation, social participation, income and experience in banana cultivation had no association with attitude towards banana cultivation.

CONCLUSION

Banana is most important crop in the district under study. Of late, its cultivation has become a difficult proportion mainly because of the technical know-how involved in banana cultivation and its longevity in the field. Therefore, the farmers were not able to follow the recommended practices in the cultivation. Inspite of this, banana is grown and will continue to be grown on large areas in Bahraich District. The finding of study focus on some of the inherent short-coming in banana cultivation which will go a long way in providing the much needed feedback to the scientists and the extension personnel.

The study suggests, that the training programme should be well organized, taking into consideration the local needs and problems and applicability of new techniques. It should primarily include manures and fertilizers, propagation, pruning and desuckering, plant protection, improved variations of banana and storage in relation to banana cultivation.Since farm size and area under banana were positively and significantly correlated with training needs of farmers, special attention and care should be given to the farmers having larger farm size and bigger area under banana.

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Toxicity Assessment of Micronutrients on the Physiological Potential of Freshwater Indian Major Carp, *Labeorohita*

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ABSTRACT

The present investigation was planned to observe various toxicological changes of heavy metals copper and zinc on freshwater Indian major carp *Labeorohita*. The main objectives were to investigate the LC_{10}, LC_{25} and LC_{50}concentrations of copper and zinc for *L. rohita* and its impact on haematological and histological alteration of the vital organs (liver, gill and kidney). The findings showed a significantly increased fatalitypercentage as toxicant concentrations escalated ($F=1347.21$; $p<0.05$: for copper, and $F=754.37$; $p<0.05$: for zinc). Fish was more sensitive towards zinc toxicity ($R^2=0.947$) as compared to copper ($R^2=0.924$). The haematological study revealed that the short-term and long-term toxicity of heavy metal resulted in significant decreases in Hb %, RBC count and PCV value, with the exception of increased WBC count, MCV, MCH and MCHC values. The histopathology findings demonstrated that fish exposed toheavy metals for an extended period of time at lower concentrations and at higher concentrations had more severe and frequent organ lesions with several alterations and degenerations.

Keywords: Copper, Haematological indices, Histopathological changes, Labeorohita, LC_{50}, Zinc

INTRODUCTION

Aquatic bodies may be extensively contaminated with heavy metals due to technological innovation, industrial expansion, and anthropogenic activities. Heavy metals are known to be potent biological poisons due to their persistence, non-biodegradability, toxicity, and propensity to accumulate in organisms and go through biomagnification. Among the heavy metals, Zn and Cu are the most prevalent required micronutrients that play a key role in growth, reproduction, development, cardiac function metabolism, and immune system catalysis(Hedayatiet al*.,* 2013; Guoet al*.,* 2022). They are highly toxic at higher concentrations, causing damage to numerous organs such as the gills, kidneys, and spleens, impairing osmoregulation, and causing teratogenicity and chromosomal abnormalities(Fahmy, 2000; Grosell *et al.*,2002).

Fish exhibit a variety of physiological reactions, including blood pressure fluctuations, concerns with ion regulation, difficulties with oxygen intake, and assessments of their health in response to pollution exposure. Calculating the LC_{50}, or the amount of a toxin in a lethal concentration (LC) that will kill 50 per cent of

the test animal population in a given amount of time, is the best technique to test for acute toxicity. Haematological and histological measures, which have been frequently employed as helpful biomarkers to assess the environmental change, stress or toxicity of any xenobiotics, are of particular importance in terms of toxicity bioassay parameters. Blood carries the majority of the metals that a fish organism absorbs throughout its body(Akahori et al.,1999). Metal that has been ingested by fish through a number of organs is then delivered by the blood to the liver. There, it may be kept, discharged in bile, returned to circulation for potential excretion by the kidney or gills, or retained in extrahepatic tissues like fat. Heavy metals consequently accumulate through circulation into a variety of fish tissues, resulting in anatomical, morphological, histopathological, and biochemical alterations in several tissues that may severely reduce fish quality (Olojo *et al.*, 2005; Fadel and Gaber, 2007).

Indian major carp, *Labeorohita* is most widely used in research works because it is capable to absorb, adapting nature to the laboratory condition and fixing the toxic metals from the adjacent. The knowledge of the heavy metals (copper and zinc) toxicity in the physiology of Indian major carp is meagre. Consequently, the main objective of the present study is to determine the impact of different concentrations of copper and zinc in Indian freshwater carp *Labeorohita* using haematological profiling viz., Hb, RBC, WBC, PCV, MCV, MCH, and MCHC, and histology of the vital organs (liver, gill and kidney).

MATERIALS AND METHODS

A. Estimation of median lethal concentration

Healthy fish of uniform weight and length were chosen for the toxicity testing. The varied concentrations of Cu and Zn were chosen for the study (0.25 mg/l to 6 mg/l: Cu and 5 mg/l to 35 mg/l: Zn). Concurrently, the control group was also kept active. To ensure consistency, ten animals were used to evaluate each concentration's effects in triplicate. Fish mortality was measured at logarithmic time intervals, in order to determine the LC50 for each interval. In order to keep the hazardous level in a constant condition, all solutions (control and test) were routinely refreshed (often at intervals of 24 hours). Dead fish were removed immediately. Throughout the trial, fish were not fed. At the completion of the exposure duration, the fish were immediately sacrificed. The biochemical and histological contents (gill, kidney, and liver) were examined in the context of heavy metal toxicity.

B. Estimation of Haematological content

1. Sampling of Blood

After determining 96 h LC_{50} value of Zn and Cu, fishes were exposed to 96 h LC_{50} for 15 and 30 days. After the exposure period, blood was drawn from the caudal vessels using an insulin syringe and a 22-gauge needle while using EDTA (ethylenediaminetetraacetate) as an anticoagulant. Haemoglobin content was measured by Sahli's haemoglobinometer. The microhaematocrit method(Snieszko, 1960) was used to determine PCV. RBC and WBC were counted under the light microscope using an improved Neubauer hemocytometer and calculated using the given formulae *viz.*, (No. of cells x Dilution factor x Depth factor)/ Area counted. The mean corpuscular volume (MCV: μm^3) was calculated as (PCV x 100) / RBC in million, mean corpuscular haemoglobin (MCH) as

Hb(g/dl) x 100 / RBC in million and mean corpuscular haemoglobin concentration (MCHC) by Hb (g/dl) x 100 /PCV (%).

A. Process of Histological Assessment

At the end of the duration experiment of Zn and Cu toxicity (96h of LC_{50} for 15 and 30 days), the desired tissue (gill, Kidney and liver) was dissected and fixed in Bouin's fixative for 24 hr. The tissues were then embedded in paraffin after being dried using a graduated ethanol series. Weswox's rotary microtome was used to cut tissue into sections that were 6-7 µm thick, and further it was stained with hematoxylin and eosin.The stained histological sections of various tissues were further examined under the microscope to study the effect of the test chemical (Zn and Cu).

B. Data analysis

The fish mortality was presented in percentage. It was recorded every 24 hr up to 96 hr study period. The data were analyzed statistically by one-way analysis of variance (ANOVA). The median lethal and sub-median lethal concentrations (LC_{10}, LC_{25} and LC_{50}) with 95% confidence limits were estimated by probit analysis(Finney, 1971) with the statistic software (IBM SPSS version 20). The histological sections of Gill, Kidney and Liver tissues were examined at 10X magnification under the brightfield microscope (Olympus).

RESULTS AND DISCUSSION

1. Lethal toxicity tests

The freshwater Indian carp, *Labeorohita*, was shown to be highly poisonous to copper than zinc, according to the current result. Fish showed varied degrees of mortality to different concentrations of copper and zinc. The mortality was significantly increased with the concentrations at 96 hr duration of the experiment (F=1347.21- Copper, F=754.37- Zinc*; p*<0.05). In lower concentrations of copper (0.25 mg/l) and zinc (1 mg/l), fish showed 0% mortality and at higher doses of copper (6 mg/l) and zinc (35 mg/l) toxicant showed 100 % mortality in 96 hr exposure duration (Figure 1). Based on the mortality, LC_{10}, LC_{25} and LC_{50} values were calculated by probit analysis (Table 1). The regression analysis resulted that zinc toxicity analysis showed R^2=0.947 and copper showed R^2=0.924 value which interpreted that zinc followed the goodness of fit measure and showed a high level of correlation as compared to copper (Figure 1). Similar observations were discovered by many researchers(Ciji and Nandan, 2013; Wepener *et al.*, 2001; Dhanapakiamet al.,2006). Chinni and Yallapragda (2000) performed an acute toxicity test on *Penaeus indicus* post larva with Pb, Zn, Cd & Cu heavy metals and obtained 96h LC_{50} and concluded that copper (2.535 mg/l) was most toxic among all other heavy metals. Present findings nearly correspond with the LC_{50} value of zinc in several fishes like in *Clariaslazera* (12.25 mg/l), *Cnesterodondecemmaculatus* (12.40 mg/l), *Parophrysvetulus* (14.50 mg/l) and *Clariasbatrachus* (17.22 mg/l)(Shenker and Cherr, 1990; Annune *et al.*, 1992; Joshi, 2011).

2. Haematological parameters

The exposed fish to sub-lethal concentrations of copper and zinc showed decreased Hb, RBC, PCV, and increased WBC, MCV, MCH and MCHC concentrations in short-term and long-term duration exposure as compared to control. The short-term exposure(15 days of 1/10th of 96 hr LC_{50}: 0.25 mg/l) of copper toxicant showed decreased Hb% (4.96±0.07), RBC count (1.09±0.18x10^{6}cells/mm^3) and PCV% (31.99±1.12), and increased WBC count

(21.07±1.16x10^{3}cells/mm^3), MCV (94.25±1.49 µm^3), MCH (42.68±1.1pg) and MCHC (35.77±1.15 %). The same pattern of observations was recorded in long-term exposure (30 days of 1/25th of 96 hr LC_{50}: 0.102mg/l) of copper. It showed 4.84±0.17 % Hb, 0.68±0.33 x 10^6/mm^3 RBC, 32.01±0.51 x 10^3 cells /mm^3 WBC, 28.57±0.82 % PCV, 96.08±1.67 µm^3 MCV, 45.65±0.53pg MCH and 31.87±1.09 % MCHC.

The zinc-exposed fish showed low values of haematological indices as compared to copper-exposed fish. It showed 4.61±0.12% Hb, 1.77±0.55 x10^{6}cells/mm^3 RBC, 28.43±1.37 x 10^3 cells /mm^3 WBC, 33.38±1.12 % PCV, 94.67±0.24 µm^3 MCV, 43.29±1.3 pg MCH and 34.17±1.21 % MCHC in short term exposure for 15 days (1/10th of 96 hr LC_{50}: 1.99 mg/l). The long-term exposure for 30 days (1/25th of 96 hr LC_{50}: 0.79 mg/l) of zinc induced increased haematological indices such as 4.42±0.02% Hb, 1.61±0.63 x10^{6}cells/mm^3 RBC, 34.48±1.09 x 10^3 cells /mm^3 WBC, 28.62±1.87 % PCV, 98.32±1.52 µm^3 MCV, 47.89±1.68 pg MCH and 32.59±1.93 % MCHC (Table 2; Figure 2).

The exposure to copper and zinc significantly affected Hb%, RBC, PCV, and increased WBC, MCV, MCH, and MCHC content, which is consistent with other scientific findings (Griffin *et al.*, 1999; Kori-Siakpere and Ubogu, 2008; Dutta *et al.*, 2016). Intestinal iron absorption is hindered by heavy metal exposure, resulting in hypochromic anaemia which decreases RBC, PCV and Hb content(Joshi et al., 2002). Suganthi et al. (2015) showed that the hemolysis of blood cells reflects changes in Hb and PCV count, and decreased total RBC count in *O. mossambicus*, exposed to different concentrations of ZnO(30-70ppm). According to Hoq and Haque (2014), the decline in RBC count was also caused by a failure to produce erythrocytes, internal hemorrhages, or decreased osmoregulation under stressful conditions, which led to a decrease in Hb and PCV content and confirmed intravascular hemolysis in the blood arteries of the liver and kidney.

According to John (2007), the fish's leucocytosis defensive mechanism response to diseased conditions and foreign materials may account for the abrupt rise in WBC count. Additionally, it denotes leukemia, hypersplenism, inflammation, and damage brought on by bacterial infections of bodily tissues (Nordenson, 2004).In the current study, a significant increase in MCV and MCH indicates to red blood cell swelling or a decline in TEC values, both of which were associated with macrolyticanemia (Ghalazy, 1992; Raina and Sachar, 2014; Parmila and Rajan, 2020An increase in MCV was also observed in fish treated with xenobiotics, according to Gupta et al. (2009). A drop in cellular blood iron may be the reason for the MCH's considerable shift, which would then affect the blood's capacity to carry oxygen and induce erythropoiesis (Hodson *et al.*, 1978). The higher MCHC values showed that heavy metals applications to fish may be caused macrocytic anemia (Celik *et al.*, 2013). According to Ramesh *et al.* (2014) and Abdel Khalek et al. (2016), the change in MCH and MCHC could be due to anemia brought on by production in the hemopoietic tissues under the influence of the deposited metal oxide, RBC hemolysis, or both. Similar outcomes were observed in *O. mossambicus*treated to zinc (Nussey *et al.*, 2002) and *Clariasalbopunctatus* exposed to organophosphorus insecticide (Mgbenka *et al.*, 2005). The generation of oxygen is

reduced by the high dose of heavy metals, which prevents macrophage activation, motility, and phagocytosis. The immune-suppressing effects of heavy metals in fish have been documented in numerous research (Sampath et al., 1998; Witeska, 2005; Kori-Siakpere and Ubogu, 2008).

3. Histopathological study

In the present investigation, fish exposed to copper and zinc toxicants had a variety of histopathological alterations found in their gill, kidney, and liver tissues. Fish treated with higher quantities and even low concentrations of heavy metals with prolonged exposure showed more severe and frequent organ damage. The observations of histopathological analysis showed that heavy metals caused vacuolation, fusion of primary gill lamellae and inter lamellar space, degeneration of gill lamella, separation of the basement membrane, necrosis, desquamation, cellular swelling, and blood congestion. In the secondary lamellae, there were sclerotic and necrotic gill arches, few mucous cells, and no chloride cells among the epithelial cells. Prolonged exposure caused telangiectasia of the primary and secondary lamellae, which was characterized by hyperplasia of concentric rings, histolysis of the primary lamellae, mucous gland, dispersed gill lamellae, and blood cells. Numerous researchers have also documented the same findings (Ortiz et al., 2003; Mishra and Mohanti, 2008). Lamellar fusion may be protective because it minimizes the exposed gill surface area (Ortiz et al., 2003), whereas epithelium lifting or detachment of epithelial cells (chloride cells, pavement cells) lengthens the route taken by the toxin to enter the bloodstream and impairs oxygen uptake (Kumar *et al.*, 2010).

The study of the kidney's histological structure showed degenerated renal tubules and bowman capsules. The epithelial cells lining the renal tubules exhibited severe degranulation hypertrophy, resulting in tubular lumen shrinkage. Vacuolization of epithelial cells was found, as well as damage to hematopoietic tissues. There was also dilation, oedema, and hypertrophied nuclei of renal tubules. Glomeruli were found to have vacuolization and disordered blood capillaries. By the 30th day, the damage had become more evident and severe. Similar results have been seen in *Clariasbatrachus, Cyprinus carpio, Oreochromis mossambicus* and *Oreochromis niloticus* exposed to heavy metals such as copper sulfate, zinc chloride and zinc sulphate (Figueiredo-Fernandes *et al.*, 2007; Vinodini and Narayan, 2009; Hoq and Haque *et al.*, 2014). Gupta and Srivastava (2006) also noted vacuolation, abnormal nuclei orientation, desquamation in renal tubule epithelial cells, and reduction of glomerular tuft and capsules.

The parenchymal architecture of the hepatocytes was also altered which resulted in inflammation, hepatocyte rupturing and increased accumulation of pyknotic nuclei, clumping, nuclei condensation, vacuolization of tissue, as well as several foci of coagulative necrosis and blood vessel degeneration. Cirrhosis developed when the entire tissue became necrotic. Hepatocytes in the treated liver had smaller nuclei with compacted nuclear chromatin more commonly. The central vein had been injured and was heavily vacuolized (Figure 3). The histopathological analysis of the liver showed many studies which demonstrated the same alterations (Abdel-Moneim and Abdel-Mohsen, 2010; Udotong and John, 2015; Abdel-Tawwab, 2016). Hepatocytes often undergo size changes, their nuclei are pushed to the

periphery, and some of the cell membranes are torn, fusion of cells together and the appearance of binucleate or multinucleate cells, cytoplasmic and nuclear degeneration (Pacheco and Santos, 2002).

CONCLUSION

Aquatic ecosystems that run near different agricultural areas have a high probability of being contaminated by runoff and their leaching into groundwater can extend their toxic effects to all aquatic organisms. It is abundantly obvious that the river's metal contamination is ongoing and that this is having an impact on the health of local fish. Despite being harmed histologically, biochemically, and hematologically by river contamination, they continue to thrive. But it is clear that this species will struggle to live if pollution keeps happening in this way. For ecological life to continue functioning, it is crucial that we preserve our natural resources and native species.

Table 1: LC_{10}, LC_{25} and LC_{50} values with its 95% confidence limit (upper and lower limit) at 96 hr exposure period in freshwater Indian major carp *L.rohita* exposed to heavy metal.

Heavy metal	Toxicity parameters	LC10	LC25	LC50
Copper Toxicity	Lethal Concentrations	0.52	1.48	2.55
	Upper Limit	0.82	1.70	2.76
	Lower Limit	0.17	1.23	2.35
Zinc Toxicity	Lethal Concentrations	8.38	13.86	19.94
	Upper Limit	10.91	15.82	21.86
	Lower Limit	4.87	11.41	18.1

Table 2: Blood profiling of exposed freshwater Indian major crap, *L.rohita*to 96 hr LC_{50} for 15 days ($1/10^{th}$ of 96 hr LC_{50}) and 30 days ($1/25^{th}$ of 96 hr LC_{50}) of copper and zinc toxicity.

Parameters	Control	Copper (LC_{50}: 2.55 mg/l)		Zinc (LC_{50}: 19.94 mg/l)	
		15 days (0.25 mg/l)	30 days (0.102 mg/l)	15days (1.99 mg/l)	30 days (0.79 mg/l)
Hb (%)	6.64 ±0.46	4.96 ±0.07	4.84 ±0.17	4.61±0.12	4.42±0.02
RBC (10^6 cells /mm3)	1.71 ±0.49	1.09 ±0.18	0.68 ±0.33	1.77±0.55	1.61±0.63
WBC (10^3 cells /mm3)	12.7 ±0.57	21.07±1.16	32.01±0.51	28.43±1.37	34.48±1.09
PCV (%)	36.02 ±1.79	31.99 ±1.12	28.57 ±0.82	33.38±1.12	28.62±1.87
MCV (µm3)	90.64 ±1.71	94.25 ±1.49	96.08 ±1.67	94.67±0.24	98.32±1.52
MCH (pg)	37.89 ±1.55	42.68 ±1.1	45.65 ±0.53	43.29±1.3	47.89±1.68
MCHC (%)	28.25 ±1.92	35.77 ±1.15	31.87 ±1.09	34.17±1.21	32.59±1.93

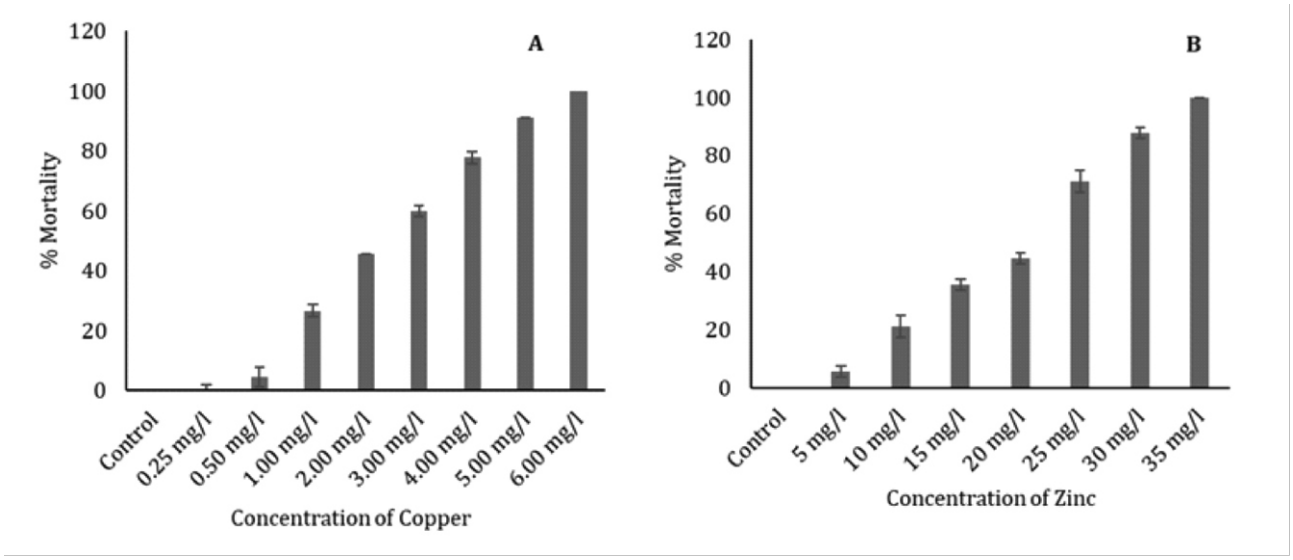


Fig. 1. Effect of varied concentrations of copper (A) and zinc (B) for 96 hr on % mortality of freshwater Indian major carp,*Labeorohita*. Values were represented as means ± SEM of a percentage of mortality. Data were analyzed by one-way ANOVA (p< 0.05). Probit transformed the response of freshwater fish, *Labeorohita* under exposure of copper (C) and zinc (D).

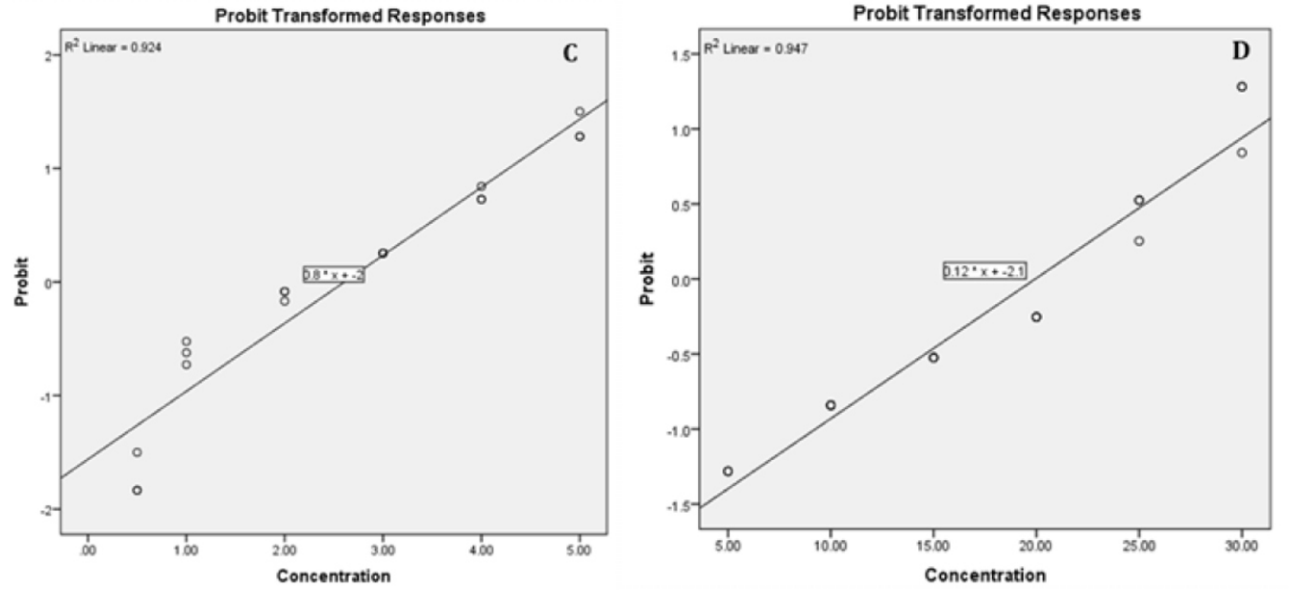
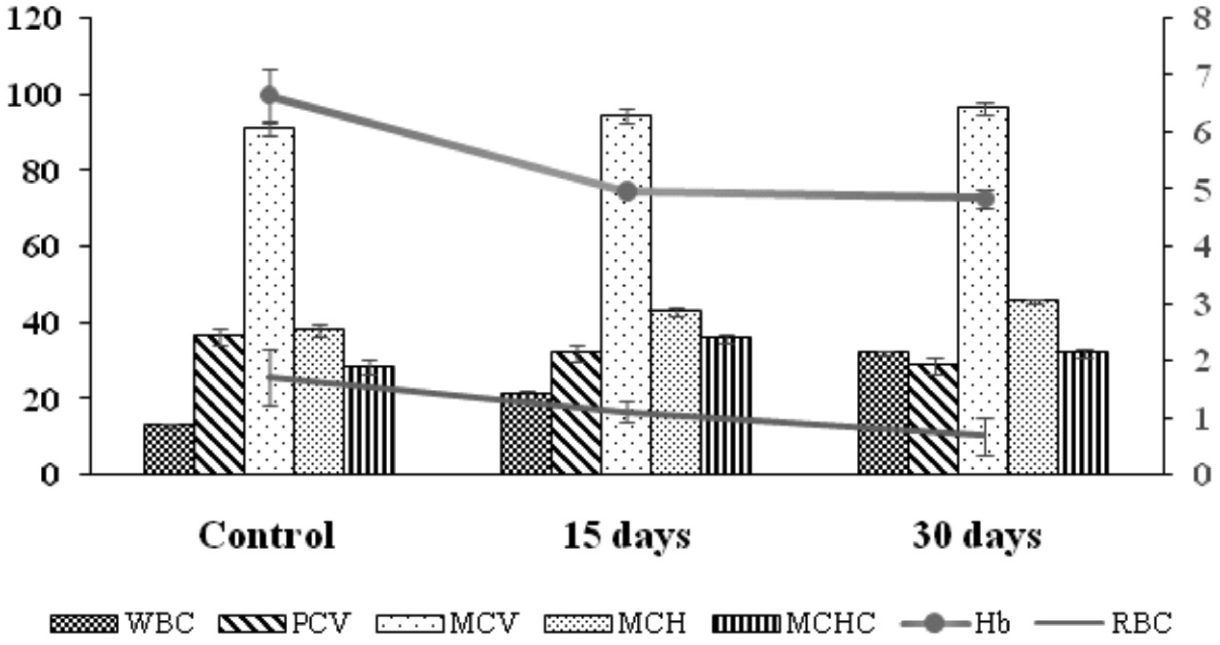
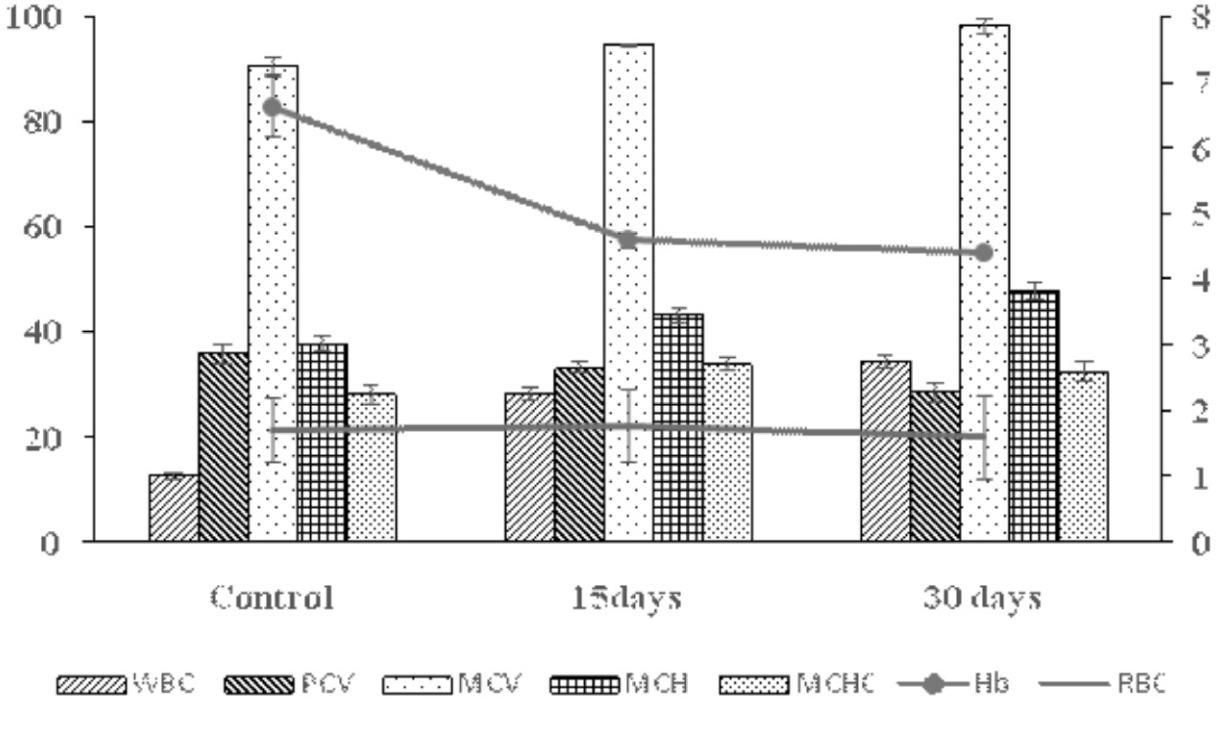


Fig. 2. Short-term (15 days) and long-term (30 days) exposure of sub-lethal concentration of copper (A) and zinc (B) on various haematological indices (Hb, RBC, WBC, PCV, MCH, MCV and MCHC) of freshwater Indian major carp,*Labeorohita*. Values were represented as means ± SEM of a percentage of mortality. Data were analyzed by one-way ANOVA (p< 0.05).


120
100
80
60
40
20
0
8
7
6
5
4
3
2
1
0
Control
15 days
30 days
WBC
PCV
MCV
MCH
MCHC
Hb
RBC


100
80
60
40
20
0
8
7
6
5
4
3
2
1
0
Control
15days
30 days
WBC
PCV
MCV
MCH
MCHC
Hb
RBC

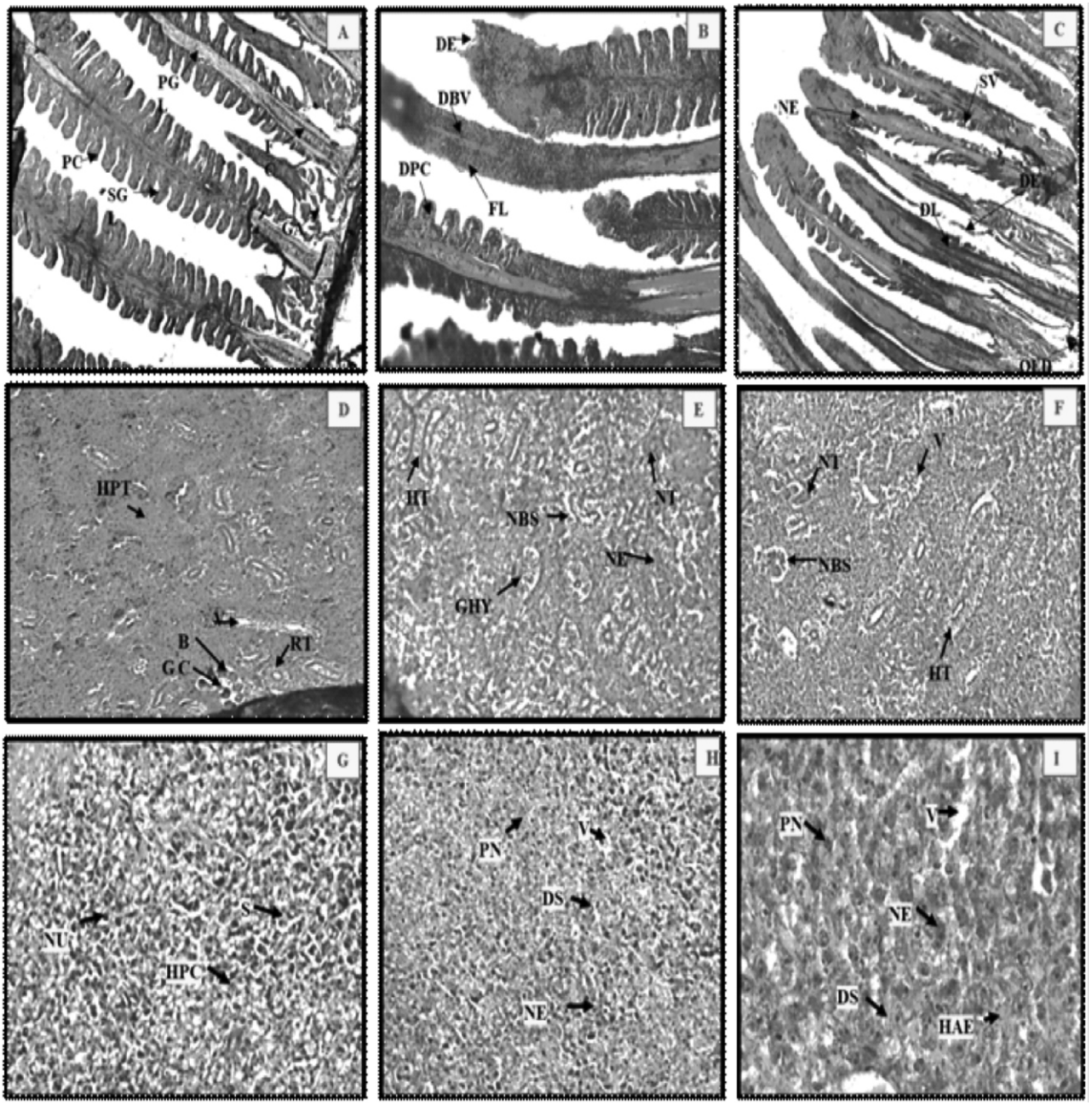


Fig. 3. Photomicrograph of histological sections of gill (A, B, C), kidney (D, E, F) and liver (G, H, I) of fish*Labeorohita* was shown using haematoxylin & eosin stain, represented sections of control fish (A: gill, D: kidney, G: liver) and exposed fish to 30 days to 96 hr LC_{50} of copper (1/25th of 96 hr LC_{50}-0.102mg/l: B, E, H) and zinc (1/25th of 96 hr LC_{50}: 0.79 mg/l: C, F, I). The control section of gill (A) represented hepatocytes with their uniform nuclei, gill arch (GA), filament cartilage (FC), normal pilar cell (PC), primary gill lamella (PGL), and secondary gill lamella (SGL) while treated fish (B, C) to heavy metals showed cytoplasmic vacuolation (V), fused lamella (FL), necrosis (NE), damaged lamella (DL), clubbed lamella (CL), short villi (SV),

degeneration of epithelium (DE), degeneration of piller cell (DPC), degeneration of blood vessel (DBV) and oedema (OED). The image of the control kidney (D) showed: G- Glomeruli, BC- Bowmen's Capsule, RT- Renal Tubule, HPT- Hematopoietic Tissue, and in exposed fish to copper (E) and zinc (F) showed vacuolation (V), GHY- Hyperplasia of Glomeruli, NBS- New Bowmen's Space, NT- Necrosis Tubule, DL- Lumen of Tubule Dilated, NE- Necrosis, HT- Hypertrophy of Tubule. Section of control liver (G) showed normal nucleus (NU), hepatocytes (HPC), kupffer cells (KC), S- Sinusoids and in treated sections (H, I): HAE- Hemorrhages, NE- Necrosis, DS- Distended Sinusoids, V- Vacuolation, PN- Pyknotic Nuclei. Images were acquired at 20x magnification.

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