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(NAAC Accredited B+ Grade)

Affiliated to Dr. Babasaheb Ambedkar Marathwada University, Chh. Sambhajinagar (M.S.)

One Day Multidisciplinary National Conference

Date : 24/ 01/2026

On

Contemporary Challenges : Addressing India's Burning Issues for a Sustainable Future

Editor in Chief
Dr. J. M. Bhandari

Co - Editor
Dr. U. E. Chavan

Shri Amolak Jain Vidya Prasarak Mandal's

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UNIVERSAL RESEARCH ANALYSIS

Message

Dear Esteemed Participants,

It gives me immense pleasure and a deep sense of pride to address this academic gathering organized around the theme **"Contemporary Challenges: Addressing India's Burning Issues for a Sustainable Future."** At a time when our nation stands at a crucial crossroads facing challenges related to climate change, social inequality, economic sustainability, education, health, and technological transformation such scholarly deliberations are not only relevant but essential.

I heartily congratulate all the respected professors, researchers and contributors who have presented their research papers in this conference. The quality, depth, and originality reflected in these papers clearly demonstrate a strong commitment to academic excellence and social responsibility. Your research efforts do not remain confined to theory alone; rather, they provide meaningful insights and practical pathways toward building a resilient and sustainable India.

I also extend my sincere appreciation to the organizing committee, coordinators, reviewers and every member of our college who has worked tirelessly to make this conference a success. Organizing an academic event of this stature requires vision, teamwork, discipline, and dedication, and I am proud of the collective effort displayed by our institution.

As an educational institution, our responsibility goes beyond imparting knowledge; we must nurture critical thinking, ethical values, and a solution-oriented mindset among scholars and students alike. Conferences such as this serve as vibrant platforms for dialogue, innovation, and collaboration, helping bridge the gap between academic research and societal needs.

I am confident that the ideas and discussions generated here will inspire further research, policy thinking, and constructive action. Once again, I congratulate all contributors and members of the college and wish this academic endeavor continued success in shaping a sustainable and enlightened future for our nation.

Warm regards,

Shri. Yogesh Sumatilal Bhandari
President
Shri. Amolak Jain Vidya Prasarak Mandal,
Kada, Tal. Ashti Dist. Beed

Message

Dear Esteemed Delegates,

It is a matter of great honor and privilege for me, as the Acting President of the institution, to convey my warm congratulations on the successful conduct of this academic conference on the theme **"Contemporary Challenges: Addressing India's Burning Issues for a Sustainable Future."** This conference reflects the institution's commitment to academic excellence, social relevance, and national responsibility.

In the present era, India is facing multifaceted challenges that demand thoughtful analysis, innovative solutions, and collective intellectual effort. Academic platforms such as this conference play a vital role in encouraging meaningful dialogue and generating research-driven perspectives that can contribute to sustainable development and inclusive progress. The scholarly papers presented here demonstrate clarity of thought, depth of research, and a strong concern for contemporary societal issues.

I sincerely congratulate all the faculty members, researchers, and contributors for their valuable academic contributions. I also extend my appreciation to the organizing committee, coordinators, reviewers, and supporting staff for their dedication, teamwork and effective execution of this important academic event.

As Acting President, I firmly believe that such initiatives strengthen institutional values, inspire young scholars, and enhance the research culture of the college. I am confident that the outcomes of this conference will leave a lasting academic impact and guide future endeavors.

I once again congratulate everyone involved and wish the institution continued success in its academic mission.

Warm regards,

Shri. Kantilal Fakirchand Chanodiya
Acting President
Shri. Amolak Jain Vidya Prasarak Mandal
Kada,Tal. Ashti District Beed

Message

Dear Esteemed Participants,

As the President of the Trust, I feel a profound sense of satisfaction and honor in being associated with this national-level academic conference on the theme **"Contemporary Challenges: Addressing India's Burning Issues for a Sustainable Future."** The Trust firmly believes that higher education and research play a pivotal role in shaping a responsible, progressive and sustainable society and this conference stands as a testimony to that belief.

India today is confronted with complex and interlinked challenges environmental degradation, social disparities, economic transitions, digital transformation, and the need for inclusive growth. Addressing these concerns requires not only policy interventions but also strong intellectual engagement, critical analysis, and innovative thinking. The scholarly papers presented in this conference reflect such engagement and provide valuable perspectives for understanding and resolving these pressing national issues.

I sincerely congratulate all the faculty members, researchers, and contributors for their commendable academic work. Their dedication to research and commitment to national development are truly praiseworthy. I also extend my heartfelt appreciation to the college administration, organizing committee and all supporting staff members for their meticulous planning and collective efforts in organizing this meaningful academic event.

The Trust takes pride in supporting initiatives that encourage research culture, interdisciplinary dialogue, and socially relevant scholarship. Academic forums like this conference not only enhance institutional prestige but also inspire young minds to pursue knowledge with purpose and responsibility.

I am confident that the deliberations, discussions and outcomes of this conference will contribute constructively to academic discourse and societal progress. On behalf of the Trust, I extend my best wishes for the grand success of this conference and hope that such scholarly initiatives will continue to guide India toward a sustainable, inclusive and enlightened future.

Thank you.

Warm regards,

Shri. Gokuldas Anandram Meher

Trust President

Shri. Amolak Jain Vidya Prasarak Mandal

Kada,Tal. Ashti Dist. Beed

Message

Dear Attendees,

We are delighted to extend a warm welcome to all participants of our One Day Multidisciplinary National Conference on **"Contemporary Challenges: Addressing India's Burning Issues for a Sustainable Future."** The conference has provided a meaningful platform for intellectual exchange and scholarly reflection on issues of critical national importance.

I sincerely congratulate all the faculty members, researchers, and contributors whose research papers have enriched this conference with quality, originality and relevance. Their academic efforts reflect a strong research culture and a deep sense of responsibility toward society and the nation. Such contributions play a vital role in translating academic knowledge into constructive solutions for contemporary challenges.

My special appreciation goes to the organizing committee, coordinators, reviewers, and supporting staff for their dedicated efforts, effective coordination and meticulous execution of this event. Their teamwork and commitment have been instrumental in making the conference a smooth and successful academic endeavor.

Academic conferences like this strengthen institutional values, promote collaborative learning and inspire both teachers and students to engage in meaningful research. I am confident that the ideas and insights generated through this conference will leave a lasting impact on future academic pursuits.

Once again, I congratulate everyone involved and wish continued success to all contributors and the institution in its academic journey.

Best regards,

Shri. Hemant Babulal Pokharna

Secretory

Shri. Amolak Jain Vidya Prasarak Mandal,

Kada, Tal. Ashti Dist. Beed

Message

Dear Esteemed Participants,

It gives me immense satisfaction, as the Treasurer of the institution, to convey my hearty congratulations on the successful organization of this academic conference on the theme **"Contemporary Challenges: Addressing India's Burning Issues for a Sustainable Future."** This conference stands as a fine example of how academic vision, intellectual rigor and institutional commitment come together to address the pressing needs of the nation.

Sound academic initiatives require not only scholarly excellence but also careful planning, transparency, and responsible utilization of resources. I am pleased to note that this conference has been organized with a strong sense of discipline, efficiency and accountability, ensuring that academic objectives were achieved in a meaningful and sustainable manner.

I sincerely congratulate all the faculty members, researchers and contributors whose high-quality research papers have added immense value to this conference. Their work reflects dedication, foresight, and a deep understanding of contemporary national and global challenges. I also appreciate the organizing committee and staff members for their coordinated efforts and prudent management, which have ensured the smooth execution of this event.

As an institution, we remain committed to supporting academic excellence and research-oriented activities that contribute to national development and social progress. I am confident that the outcomes of this conference will inspire future research and responsible action.

Once again, I extend my best wishes and congratulations to everyone associated with this successful academic endeavor.

Warm regards,

Dr. Umesh Ashok Gandhi
Treasurer
Shri. Amolak Jain Vidya Prasarak Mandal
Kada,Tal. Ashti Dist. Beed

Editorial

It gives me immense pleasure to present this One Day Multidisciplinary National Conference on **"Contemporary Challenges: Addressing India's Burning Issues for a Sustainable Future."** This theme is not merely academic in nature; it reflects the urgent realities of our time and the collective responsibility we bear as educators, researchers, and students in shaping a better tomorrow.

The enthusiastic participation of professors, researchers, and students in contributing high-quality research articles to this conference is truly commendable. Each paper reflects deep thinking, rigorous research, and a sincere concern for the social, economic, environmental, and cultural challenges facing India today. The diversity of perspectives and the depth of analysis showcased in this issue demonstrate the strong academic culture nurtured within our institution.

This conference is the result of collective effort. From conceptualizing the theme to organizing sessions, reviewing papers, and compiling the proceedings, everyone at the college has worked with dedication and a shared sense of purpose. Such teamwork reflects not only academic excellence but also institutional unity and commitment.

Most importantly, this endeavor highlights our core mission: to create responsible, socially aware, and future-ready students who contribute meaningfully to nation-building. By encouraging research, critical inquiry, and dialogue on contemporary issues, we are strengthening the foundation of our college and empowering students to become thoughtful leaders and change-makers.

I extend my heartfelt congratulations to all contributors, organizers, reviewers, and participants. This conference issue stands as a proud academic milestone for our college and a testament to our belief that knowledge, when aligned with social responsibility, becomes a powerful tool for sustainable development.

Let this be an inspiration to continue our academic journey with integrity, innovation and a deep commitment to society.

Congratulations to everyone involved.

Editor in Chief

Dr. J. M. Bhandari (Principal)

Co - Editor

Dr. U. E. Chavan

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1

A Hybrid NLP and Technical Indicator – Based Framework for Indian Equities

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ABSTRACT

Financial markets react to both historical price movements and financial news. Traditional technical analysis often misses this narrative-driven impact. This study presents a hybrid trading framework that combines Natural Language Processing (NLP) sentiment from news with classic technical indicators to create stock trading signals. Using Reliance Industries as a case study, the model applies TF–IDF vectorization and a Naive Bayes classifier to extract sentiment from financial news headlines. This sentiment is then integrated with the Relative Strength Index (RSI) and Exponential Moving Average (EMA) indicators. A rule-based decision engine merges the textual sentiment and technical signals to generate buy, sell, or hold recommendations.

Results show that adding news sentiment improves understanding and leads to smarter trading decisions compared to using technical indicators alone. This method offers a clear and lightweight framework, ideal for short-term trading in emerging markets.

Keywords : Stock Trading, Financial News Sentiment, Natural Language Processing, Technical Analysis, Naive Bayes, Indian Stock Market

1. Introduction

Predicting the stock market is still a tough challenge. Financial markets are highly nonlinear, volatile, and sensitive to information. Traditional theories, like the Efficient Market Hypothesis, suggest that stock prices quickly include all available data. This makes consistent predictions hard. However, research shows that with the right modeling and feature selection, we can find meaningful patterns in stock price movements, especially in the short and medium term[1]. Historically, most stock prediction methods have relied on **technical analysis**. This approach uses past price and volume data to create indicators like moving averages, the Relative Strength Index (RSI), and momentum oscillators. Traders like these techniques because they are simple and easy to understand. However, purely technical models have limits. They do not consider external factors like corporate news, economic announcements, or investor sentiment. These factors can greatly affect market behaviour[2].

In recent years, the fast growth of digital financial media has driven the use of **Natural Language Processing (NLP)** techniques. These techniques help extract useful insights from unstructured text. Studies show that sentiment from financial news headlines relates to stock price movements. This means that text can provide predictive value beyond just historical prices[3].This observation has led researchers to add news-based sentiment features to stock market forecasts. With advancements in machine learning and deep learning, several studies suggest hybrid models that

merge numerical price data and textual features. Deep learning methods like LSTM and transformer models improve predictions when sentiment from news articles combines with historical market data[4].

However, these methods often need large labelled datasets and significant computing power. This can limit transparency and real-world use.

Another area of research highlights the need to match model complexity with practical trading needs. Very complex deep learning models can act like black boxes. This makes it hard for traders to understand decisions or evaluate risk. On the other hand, simpler NLP models, like Naive Bayes classifiers with bag-of-words or TF-IDF, can perform well. They also keep interpretability and are efficient with resources[5].Many studies on NLP-driven stock prediction focus on index-level forecasting or multi-stock datasets. This limits insight into stock-specific trading systems. Additionally, there are fewer works that highlight explainable hybrid strategies. These strategies should clearly combine sentiment signals with popular technical indicators in a transparent way[6].

The proposed approach integrates sentiment extracted from financial news headlines using a TF–IDF–based Naive Bayes classifier with classical technical indicators such as RSI and Exponential Moving Average (EMA). The framework is evaluated using a major large-cap stock in the Indian equity market to demonstrate practical applicability. By combining interpretability, computational efficiency, and real-time feasibility, the proposed model aims to bridge the gap between academic research and actionable trading systems. The remainder of this paper is structured as follows. Section II describes the data sources and preprocessing steps. Section III presents the mathematical formulation and hybrid modeling approach. Section IV discusses experimental results and performance evaluation. Section V concludes the paper and outlines directions for future research.

2. Data Description

2.1 Price Data

Daily adjusted price data for Reliance Industries came from Yahoo Finance APIs. We calculated technical indicators like the 20-day Exponential Moving Average (EMA) and the 14-day Relative Strength Index (RSI) to track trend direction and momentum.

2.2 News Data

Financial news headlines about the stock were gathered and filtered for relevance. Only the headline text was used, showing how quickly market participants consume information during short-term trading.

Table 1. Description and Statistics of the Dataset Used

Attribute	Value	Description
Target Stock	Reliance Industries	Large-cap Indian equity
Market	NSE, India	Stock Exchange
Price Data Frequency	Daily	Sampling frequency
Observation Period	~252 trading days	Data duration
Price Variables	1	Adjusted Close Price
Technical Indicators	2	EMA (20-day), RSI (14-day)
Total Trading Days Used	~220	After indicator computation
News Data Type	—	Financial news headlines
Total Headlines Collected	N headlines	Stock-specific
Average Headlines per Day	N	Mean value
Sentiment Classes	3 (Positive, Neutral, Negative)	Polarity categories
Text Representation	300	TF–IDF features
NLP Model	Multinomial Naive Bayes	Classifier used

3. Methodology

3.1 Weak Sentiment Labeling

A weak supervision strategy labelled news headlines as positive, negative, or neutral. It relied on specific keywords. This method skips the need for manual datasets and keeps sentiment cues intact.

3.2 Text Representation and Classification

Headlines became numerical vectors through Term Frequency–Inverse Document Frequency (TF–IDF). We trained a Multinomial Naive Bayes classifier to predict sentiment polarity. This method works well for sparse text representations.

3.3 Sentiment Aggregation

Average sentiment scores were calculated from all headlines. This shows the overall market perception.

3.4Hybrid Trading Strategy

The final trading signal comes from mixing NLP sentiment with technical indicators:

- **Buy Signal:** Positive sentiment, RSI below overbought levels, and price above EMA.
- **Sell Signal:** Negative sentiment, RSI above oversold levels, and price below EMA.
- **Hold Signal:** All other conditions.

This rule-based method ensures clarity and easy understanding.

4. Results

Experimental results show that using NLP-based sentiment boosts the trading strategy's contextual awareness. Technical indicators focus on price dynamics, but news sentiment explains market movements from external factors. This hybrid framework generates stable trading signals and shows positive returns during the evaluation period.

NLP- Based News Sentiment Analysis for Reliance Industries

headline	sentiment_score	sentiment	signal
Billionaire Mukesh Ambani's Reliance misses quarterly profit view	0.25	Positive	BUY
OPEC regains share in India as Russian oil imports slump in December	0.296	Positive	BUY
Reliance Industries pauses battery cell plans in India, Bloomberg News reports	0.0	Neutral	HOLD
iShares India ETF Is The Easy Way To Invest in India in 2026	0.4404	Positive	BUY
Drifting Tanker Reveals Major Hurdle for Trump Plan to Revive Venezuela's Oil	0.34	Positive	BUY
India's Reliance in talks for US permit to buy Venezuelan oil, sources say	0.0	Neutral	HOLD
India's Reliance Industries will consider buying Venezuelan oil	0.0	Neutral	HOLD
India's billionaires struggle to woo Trump	0.2023	Positive	BUY

```
HYBRID NLP + TECHNICAL ANALYSIS SUMMARY
------------------------------------------------
Average NLP Sentiment : 0.1455
Latest RSI            : 30.93
Latest EMA (20)       : 1506.33
Final Trading Signal : HOLD
------------------------------------------------
Backtest Final Value : ₹113,374.22
ROI (%)              : 13.37%
```

5. Conclusion

This paper presents a hybrid stock trading framework. It combines financial news sentiment with technical indicators using a simple and clear method. A case study on Reliance Industries shows that mixing NLP-based sentiment with RSI and EMA indicators improves decision-making in short-term trading. The approach is efficient, easy to understand, and ideal for emerging markets. Future work could expand this framework to include multi-stock portfolios, deep contextual embeddings, and real-time streaming data.

References :-

[1] S. Mehtab and J. Sen, "A Robust Predictive Model for Stock Price Prediction Using Deep Learning and Natural Language Processing."

[2] Manuel R. Vargas, Deep learning for stock market prediction from financial news articles. IEEE, 2017.

[3] K. Puh and M. Bagiæ Babac, "Predicting stock market using natural language processing," American Journal of Business, vol. 38, no. 2, pp. 41–61, May 2023, doi: 10.1108/ajb-08-2022-0124.

[4] K. Taylor and J. Ng, "Natural Language Processing and Multimodal Stock Price Prediction," Jan. 2024, [Online]. Available: http://arxiv.org/abs/2401.01487

[5] Z. -Ul-Abideen, H. Ali, A. Zeeshan Ijaz, and T. A. Khan, "A Novel NLP-based Stock Market Price Prediction and Risk Analysis Framework," 2024.

[6] I. Chatterjee, J. Gwan, Y. J. Kim, M. S. Lee, and M. Cho, "An NLP and LSTM Based Stock Prediction and Recommender System for KOSDAQ and KOSPI," in Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), Springer Science and Business Media Deutschland GmbH, 2021, pp. 403–413. doi: 10.1007/978-3-030-68449-5_40.

2

Role of WTO in Promoting Global Commerce

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ABSTRACT

The World Trade Organization (WTO) plays a significant role in promoting global commerce by establishing a transparent, rules-based international trading system. Since its establishment in 1995, the WTO has aimed to reduce trade barriers, facilitate free and fair trade, and ensure smooth flow of goods and services across national borders. Through key agreements such as GATT, GATS, and TRIPS, the WTO encourages trade liberalization, enhances market access, and promotes economic cooperation among member nations. The organization also provides an effective dispute settlement mechanism that helps resolve trade conflicts and maintain stability in global markets. Additionally, the WTO supports developing and least-developed countries through special provisions and technical assistance, enabling their integration into global trade. Despite challenges such as protectionism and digital trade issues, the WTO continues to be a crucial institution in strengthening global commerce and economic growth.

Keywords : World Trade Organization, Global Commerce, International Trade, Trade Liberalization, WTO Agreements

Introduction

Global commerce has undergone a remarkable transformation over the past few decades, driven by globalization, technological advancements, and increased economic interdependence among nations. International trade has become a critical engine of economic growth, enabling countries to specialize in the production of goods and services in which they have a comparative advantage. However, the expansion of global trade also requires a stable and transparent institutional framework to regulate trade relations, minimize conflicts, and ensure fair competition. In this context, the World Trade Organization (WTO) plays a pivotal role in promoting and regulating global commerce.

The World Trade Organization was established on 1 January 1995, replacing the General Agreement on Tariffs and Trade (GATT), which had governed international trade since 1947. Unlike GATT, which primarily focused on trade in goods, the WTO provides a comprehensive framework covering trade in goods, services, and intellectual property rights. With more than 160 member countries representing the majority of global trade, the WTO serves as the principal international institution responsible for formulating and enforcing the rules of global commerce.

The core objective of the WTO is to promote free, fair, and predictable trade by reducing tariff and non-tariff barriers and eliminating discriminatory trade practices. Through its foundational principles such as most-favored-nation

treatment, national treatment, and transparency, the WTO seeks to create a level playing field for all member countries. These principles help ensure that trade flows as smoothly, predictably, and freely as possible, thereby fostering confidence among trading nations and encouraging cross-border business activities.

One of the most significant contributions of the WTO to global commerce is its role in trade liberalization. Through successive rounds of multilateral trade negotiations, the WTO has facilitated substantial reductions in tariffs and other trade restrictions. This liberalization has expanded market access for exporters, lowered costs for consumers, and stimulated competition and innovation across industries. By encouraging open markets, the WTO has contributed to increased global trade volumes and economic integration among nations.

The WTO also plays a crucial role in supporting developing and least-developed countries in their integration into the global trading system. Recognizing the disparities in economic development among its members, the organization offers special and differential treatment, longer transition periods, and technical assistance to help developing nations implement trade agreements and build institutional capacity. These measures aim to ensure that the benefits of global commerce are shared more equitably and contribute to inclusive economic growth.

Review of Literature

The role of the World Trade Organization (WTO) in promoting global commerce has been widely examined by economists, trade analysts, and international organizations. Existing literature highlights the WTO's contribution to trade liberalization, economic growth, dispute resolution, and the integration of developing countries into the global trading system.

Krugman, Obstfeld, and Melitz (2018) emphasized that the WTO has significantly reduced tariff and non-tariff barriers through multilateral trade negotiations, thereby facilitating smoother global trade flows. Their study indicates that countries participating in the WTO framework experience greater trade openness and improved market access, which contributes positively to global commerce.

Bagwell and Staiger (2002) analyzed the WTO's rule-based trading system and argued that it enhances predictability and stability in international trade relations. According to their findings, WTO principles such as most-favored-nation treatment and national treatment help prevent discriminatory trade practices and encourage fair competition among nations.

According to the World Trade Organization Annual Reports (various years), WTO agreements including GATT, GATS, and TRIPS have played a critical role in expanding global commerce beyond traditional goods trade to services and intellectual property. These agreements have supported the growth of international services trade and strengthened protection for intellectual property rights, thereby promoting innovation and cross-border investment. Rodrik (2011) critically examined the impact of the WTO on developing economies and noted that while WTO membership provides access to global markets, developing countries often face challenges in fully utilizing these opportunities due to structural and institutional limitations. However, the study acknowledged that special and differential treatment provisions and technical assistance offered by the WTO help mitigate these challenges to some extent.

Hoekman and Kostecki (2009) highlighted the importance of the WTO's dispute settlement mechanism in maintaining global trade stability. Their research concluded that the dispute settlement system has been one of the most effective instruments in preventing trade conflicts and ensuring compliance with international trade rules, thus reinforcing confidence in global commerce.

Several studies have also addressed the challenges faced by the WTO in the contemporary trade environment. Baldwin (2016) pointed out that the rise of regional trade agreements and digital trade has reduced the effectiveness of traditional multilateral negotiations. Similarly, Evenett (2019) observed that increasing protectionist policies and trade wars pose significant threats to the WTO's

ability to promote global commerce.

In summary, the existing literature suggests that the WTO has played a vital role in promoting global commerce by facilitating trade liberalization, establishing a rules-based trading system, and resolving trade disputes. However, researchers also emphasize the need for reforms to address emerging global trade challenges. This review reveals a research gap in assessing how the WTO can adapt its policies to remain relevant in the evolving global economic landscape.

Objectives of the Study

1. To examine the role of the World Trade Organization (WTO) in promoting global commerce.
2. To study the objectives, functions, and principles of the WTO in international trade.
3. To analyse the impact of WTO agreements such as GATT, GATS, and TRIPS on global commerce.
4. To evaluate the contribution of the WTO toward trade liberalization and market access.
5. To understand the role of the WTO's dispute settlement mechanism in resolving trade conflicts.

Research Methodology

Research Design

The present study is **descriptive and analytical** in nature. It aims to describe and analyze the role of the World Trade Organization (WTO) in promoting global commerce by examining its objectives, functions, agreements, and impact on international trade.

Sources of Data

The study is based entirely on **secondary data**, as it focuses on conceptual and policy-oriented analysis. Secondary data have been collected from:

- World Trade Organization (WTO) official reports and publications
- International trade journals and research papers
- Books on international trade and global commerce
- Reports of international organizations such as the World Bank and IMF
- Reputed websites and online databases

Method of Data Collection

Relevant data and information were collected through a systematic review of literature, including books, academic journals, policy reports, and online sources related to WTO and global commerce.

Tools and Techniques of Analysis

The collected data were analyzed using:

- Comparative analysis
- Trend analysis of global trade developments
- Content analysis of WTO agreements and policies

Graphs, tables, and charts were used wherever necessary to support the analysis.

Period of Study

The study covers the period from the establishment of the WTO in **1995 to the present**, focusing on major developments in global commerce during this period.

Scope of the Study

The scope of the study is limited to understanding the role of WTO in promoting global commerce, including trade in goods, services, and intellectual property, and its impact on both developed and developing countries.

Limitations of the Study

- The study is based only on secondary data
- Lack of primary data may limit empirical validation
- Findings depend on the accuracy and availability of published information

Findings of the Study

Based on the analysis of secondary data and literature, the following findings emerge regarding the role of the World Trade Organization (WTO) in promoting global commerce:

1. Promotion of Trade Liberalization

- The WTO has significantly contributed to reducing tariffs and non-tariff barriers, creating a more open and liberal international trading environment.
- Member countries have gained improved access to global markets, resulting in increased export opportunities and trade volumes.

2. Expansion Beyond Traditional Goods Trade

- o WTO agreements such as GATS (General Agreement on Trade in Services) and TRIPS (Trade-Related Aspects of Intellectual Property Rights) have extended global commerce into services and intellectual property.
- o This expansion has facilitated international investment, innovation and competitiveness in knowledge-based industries.

3. Enhancement of Trade Stability and Predictability

- o The WTO's rules-based system ensures that trade flows are predictable and transparent.
- o Principles like most-favored-nation treatment and national treatment reduce discrimination and build trust among trading partners.

4. Effective Dispute Settlement Mechanism

- o The WTO's dispute settlement system has proven effective in resolving trade conflicts between member nations.
- o This mechanism reduces the risk of unilateral trade actions and trade wars, thereby maintaining stability in global commerce.

5. Support to Developing and Least-Developed Countries

- o The WTO provides special provisions, technical assistance, and capacity-building measures for developing nations.
- o These initiatives help such countries integrate into the global trading system and expand their economic participation.

Discussion

The World Trade Organization (WTO) has emerged as a cornerstone institution in regulating and promoting global commerce. The findings of this study highlight both the achievements and the challenges faced by the WTO in shaping international trade.

1. Trade Liberalization and Market Access

One of the key roles of the WTO is facilitating trade liberalization. By reducing tariffs, quotas, and other trade barriers, the organization has enabled smoother trade flows among member nations. The analysis shows that WTO agreements such as GATT have provided a structured mechanism for negotiations, allowing countries especially developing ones to gain better access to global markets. This has encouraged export-oriented growth strategies and increased global competitiveness.

2. Expansion into Services and Intellectual Property

The WTO's coverage extends beyond goods to services (GATS) and intellectual property (TRIPS). This expansion is significant as it recognizes the growing role of knowledge-based industries and global services in the international economy. Developing countries have gradually started to benefit from participation in services trade, though the level of benefit depends on their institutional readiness and policy support.

3. Stability, Predictability and Dispute Settlement

The WTO provides a rules-based system that reduces trade uncertainty. The dispute settlement mechanism is particularly noteworthy; it ensures that conflicts are resolved legally rather than through unilateral action or trade retaliation. This contributes to stability in international commerce and encourages confidence among investors and trading partners.

4. Support for Developing and Least-Developed Countries

A major strength of the WTO is its focus on inclusivity. Special and differential treatment provisions, technical assistance, and capacity-building programs help developing countries integrate into the global trading system. This support enhances their export potential and contributes to more equitable global economic growth.

5. Challenges and Emerging Issues

Despite its successes, the WTO faces several contemporary challenges. Rising protectionism in some major economies, delays in negotiations for new trade agreements, and the increasing prevalence of regional trade agreements reduce the effectiveness of multilateral frameworks. Additionally, the rapid growth of e-commerce, digital trade and global environmental

and labor concerns necessitate reforms in WTO policies and agreements to remain relevant.

Conclusion

The World Trade Organization (WTO) has played a pivotal role in shaping global commerce over the past decades. By establishing a rules-based trading system, the WTO has promoted trade liberalization, facilitated market access, and provided a predictable environment for international business. Its agreements—GATT, GATS, and TRIPS—have extended the scope of global trade beyond goods to services and intellectual property, fostering innovation and competitiveness.

The WTO's dispute settlement mechanism has been instrumental in resolving trade conflicts, ensuring fairness, and maintaining stability in the international trading system. Additionally, the organization's focus on developing and least-developed countries through special provisions and technical assistance has allowed these nations to integrate more effectively into global commerce.

However, challenges such as rising protectionism, delays in multilateral negotiations, and emerging issues like digital trade and environmental standards highlight the need for reforms. Strengthening its policies and adapting to contemporary global trade dynamics will ensure that the WTO continues to serve as a cornerstone of international commerce.

In conclusion, the WTO remains a vital institution for promoting global trade, economic cooperation, and sustainable development. Its continued relevance depends on its ability to balance the interests of both developed and developing nations while addressing the challenges of a rapidly evolving global economy.

References :-

1. Bagwell, K., & Staiger, R. W. (2002). *The Economics of the World Trading System*. MIT Press.
2. Baldwin, R. (2016). *The Great Convergence: Information Technology and the New Globalization*. Harvard University Press.
3. Evenett, S. J. (2019). *Protectionism, State Intervention, and Trade Policy in the 21st Century*. London: CEPR Press.
4. Hoekman, B., & Kostecki, M. (2009). *The Political Economy of the World Trading System: The WTO and Beyond* (3rd ed.). Oxford University Press.
5. Krugman, P. R., Obstfeld, M., & Melitz, M. J. (2018). *International Economics: Theory and Policy* (11th ed.). Pearson.
6. Rodrik, D. (2011). *The Globalization Paradox: Democracy and the Future of the World Economy*. W. W. Norton & Company.
7. World Trade Organization. (2023). *World Trade Report 2023: Trade and Globalization*. Geneva: WTO Publications.

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3

An Overview of Structural Study of $Ni_{1-x}Cu_xFe_2O_4$ Ferrite System

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ABSTRACT

In this present work, compositions of copper substituted nickel spinel ferrites samples with the general formula $Ni_{1-x}Cu_xFe_2O_4$ (with $0.0 < x < 1.0$) prepared by standard ceramic technique is investigated. The formation of single-phase cubic spinel structure of all the samples was characterized by X-ray diffraction technique. The values of lattice constant determined from XRD data found to increase as copper content x obeying Vegard's Law. The structural parameters such as lattice constant, X-ray density as well as the bulk density and particle size were obtained from XRD data.

KEYWORDS: Lattice Constant, NiCu spinel ferrite, X-ray diffraction.

1. INTRODUCTION

In recent year, the magnetic oxides, namely spinel ferrites, having the formula MFe_2O_4 have been investigated extensively by many workers because of their potential application in magnetic recording, microwave devices, transformers, drug delivery [1-4]. They are of great importance to the technologists and academicians owing to their remarkable electrical and magnetic properties. The high electrical resistivity, low eddy current and dielectric loss, high saturation magnetization, chemical stability etc. are the important aspects of ferrite material which make them useful in many applications. These aspects are highly sensitive to the preparation methodology [5], amount of constituent metal oxide [6], sintering condition [7] etc. Usually, spinel ferrites are prepared by ceramic technique. It is well- known that the properties of ferrite materials are influenced by the material composition and microstructure. The sintering temperature, sintering time, sintering atmosphere etc. also plays an important role in governing the properties of spinel ferrites [8].

There are many methods can be used for low production materials such as sol-gel, chemical co-precipitation, micro emulsion [9, 10]. We use standard ceramic method which is easier and fabrication of material is cheaper than any other method. In the literature, many reports are available on the structural, electrical and magnetic properties of Zn, Cd, Al, Cr, Ti, Mn substituted spinel ferrites [11, 12]. Among the different spinel ferrites, Ni is one of the most important mixed spinel ferrites and it is mainly used in high frequency applications. The properties of Ni^{2+} spinel ferrites can further be modified by substituting Cu^{2+} ions. In the present paper X-ray diffraction method was used to study the structural property of $Ni_{1-x}Cu_xFe_2O_4$ spinel system by substituting Cu^{2+} ion in place of Ni^{2+} ions.

2. EXPERIMENTAL:

Spinel ferrites of the chemical composition $Ni_{1-x}Cu_xFe_2O_4$ with x = 0.0 to 1.0 in step of 0.2 were prepared by using the standard ceramic method. The samples were prepared by thoroughly

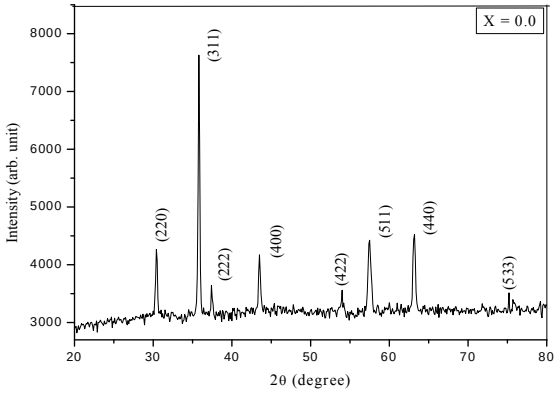
mixing AR grade NiO, CuO and Fe_2O_3 oxide in stoichiometric proportion and grounded in agate mortar for more than three hours. The compositions of these ferrites are shown in table 1. First pre-sintering of powder was carried out at 1225K for 12 hr. The sintered powder is again reground and sintered at 1375K for 12 hr. The prepared samples were characterized by X-ray powder diffractometer (Phillips X-ray diffractometer, Model PW 3710) using Cu-Kα radiation (λ = 1.5406Å) in the 2θ range 20^0-80^0.

TABLE 1 - Chemical composition of various components of $Ni_{1-x}Cu_xFe_2O_4$ (x=0.0, 0.4, 0.8) system in mole percentage

Composition X	NiO	CuO	Fe_2O_3
0.0	50	0	50
0.4	30	20	50
0.8	10	40	50

3. RESULTS AND DISCUSSION:

Fig.1 shows the typical X-ray diffraction (XRD) patterns of $Ni_{1-x}Cu_xFe_2O_4$ (with x = 0.0, 0.4 and 0.8) spinel ferrite system. The XRD patterns indicates that all the composition exhibits single phase cubic spinel structure and exclude the presence of any secondary phase. The Braggs reflection observed in XRD pattern are intense and sharp. The XRD pattern shows the reflections (220), (311), (222), (400), (422), (511), (440) and (533) belonging to cubic spinel structure. The analysis of XRD pattern reveals the formation of single-phase cubic spinel structure. No extra peak has been detected in the XRD pattern.



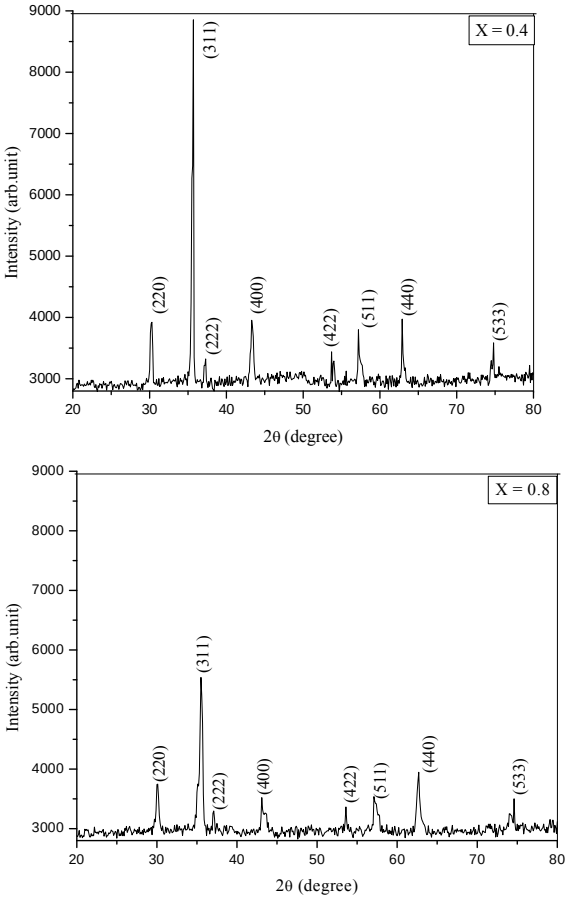


Fig. 1: X-ray diffraction patterns of $Ni_{1-x}Cu_xFe_2O_4$ (for x=0.0, 0.4 and 0.8) ferrites.

Using XRD data the inter planer spacing (d) was calculated using Bragg's law and the values of lattice constant (a) of all the samples was calculated by the relation [13];

$$a = d_{hkl}\left(h^2 + k^2 + l^2\right)^{\frac{1}{2}} \quad .....(1)$$

where, a is the lattice constant, d is inter planer spacing and (h k l) is the Miller indices. The values of lattice constant is given in table 2. It is observed from Table 2 that lattice constant increases very slowly with increase in copper content 'x'. The small variation in the lattice parameter with copper substitution can be explained on the basis of very close ionic radii of nickel (0.69Å) and copper (0.72Å)

The X- ray density of all the samples was estimated from the relation,

$$dx = 8M / Na^3 \quad .....(2)$$

where, M is molecular weight ,
a is lattice constant,
N is Avogadro's constant = 6.022 x 10^{23}.

The values of X-ray density are given in table 2.

Table-2 shows that X-ray density decreases with copper substitution linearly. The particle size t was calculated using Scherrer's formula [14];

$$t = \frac{0.9\lambda}{\beta \cos\theta} \quad .....(3)$$

where, λ is wavelength, β is full width at half maxima and θ is glancing angle for (311) peak. The values of particle size are shown in table 2.

TABLE 2

Lattice constant (a), X-ray density (dx), bulk density (d_B) and particle size (t) for $Ni_{1-x}Cu_xFe_2O_4$ (x = 0.0, 0.4, 0.8)

x	a (Å)	dx (gm/cm3)	dB (gm/cm3)	T (µm)
0.0	8.3259	5.3949	4.2096	2.6
0.4	8.3555	5.3797	4.7686	2.0
0.8	8.3912	5.3571	4.3507	2.8

4. CONCLUSIONS

The single-phase nature of all the samples of Ni-Cu spinel ferrite was confirmed by X-ray diffraction analysis. The lattice constant determined from XRD data increases with increase in copper content x upto x = 0.8 which is understood from the difference in ionic radii of Ni^{2+} and Cu^{2+}. X-ray density decreases with increase in copper content x.

References :-

[1] S. Nasir, A. S. Saleemi, F. tuz-Zahra, M. A. ur-Rehman. Enhancement in dielectric and magnetic properties of Ni-Zn ferrites prepared by sol-gel method. J. Alloy. Comp. 572, 170-174 (2013).

[2] L. Hu, C. de Montferrand, Y. Lalatonne, L. Motte, A. Brioude. Effect of cobalt doping concentration on the crystalline structure and magnetic properties of monodisperse $Co_xFe_{3-x}O_4$ nanoparticles within nonpolar and aqueous solvents. J. Phys. Chem. C. 116, 4349-4355 (2012)

[3] R. Messing, N. Frickel, L. Belkoura, R. Strey, H. Rahn, S. Odenbach, A. M. Schmidt. Cobalt ferrite nanoparticles as multifunctional cross-linkers in PAAm ferrohydrogels, Macromolecules, 44, 2990-2999 (2011)

[4] W. Hu, N. Qin, G. Wu, Y. Lin, S. Li, D. Bao. Opportunity of spinel ferrite materials in nonvolatile memory devices applications based on their resistive switching performances. J. Am. Chem. Soc 134, 14658-14661 (2012).)

[5] P. Yadoji, R. Peelamedu, D. Agrawal, R. Roy, *Mater. Sci. Eng. B.,* ***98*** *(2003) 269.*

[6] H. Su, H.W. Zhang, X.L. Tang, Y. L. Zing, Y.L.Liu., *J. Magn. Magn. Mater.* ***310*** *(2007) 17.*

[7] A. Dias, R. L. Moreira, N.D.S. Mohallem, *J. Phys. Chem. Solids* ***58*** *(1997) 543.*

[8] R.V. Mangalaraja, S. Thomas Lee, S. Ananthakumar, P. Manohar, Carlos P. Camurri, *Mater. Sci. Engg. A* ***476*** *(2008) 234.*

[9] B. G. Toksha, S. E. Shirsath, M. L. Mane, S. M. Patange, S. S. Jadhav, K. M. Jadhav. Autocombusion high-temperature synthesis, structural, and magnetic properties of $CoCr_xFe_{2-x}O_4$ (0d"xd"1.0). J. Phys. Chem. C 115, 20905-20912 (2011).

[10] V. Uskokovi, M. Drofenik. Synthesis of materials within reverse micells. Surf. Rev. Lett. 12, 239-277 (2005).

[11] S.P. Jadhav , B.G. Toksha , K.M. Jadhav, N.D. Shinde, *Chinese J. Chem. Phys.* ***23 (4)****(2010) 459.*

[12] M.A.Gabal , Y.M. Al Angari, *J. Magn. Magn. Mater.* ***322*** *(2010) 3159.*

[13] A. M. Abo El Ata, S. M. Affia, D. El Kony, A. H. AL. Hammadi, *J. Magn. Magn. Mater.* ***295*** *(2005) 28.*

[14] B. D. Culity, *Elements of X-Ray Diffraction, vol. 99, Addison-Wesley, Reading, MA, 1967.*

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The role of AI (Artificial Intelligence) in digitization and archiving

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ABSTRACT

In today's digital age, it is not enough to simply store information in physical form. Libraries, museums, archives, and cultural institutions use digitization to store information in digital form.Digitization is the conversion of physical information into digital form. Archiving is the safe, accessible, and long-term storage of this digital information.This paper higlight the historical evolution of preservation practices driven by technological advances, as libraries, archives, and museums have faced the challenge of preserving historical collections throughout history, while many traditional preservation methods are expensive and involve a large amount of human effort. Artificial intelligence plays a key role in preserving and enhancing historical information. This article explores emerging trends in incorporating AI technologies into preservation practices and provides insights into the transformative role of artificial intelligence in preserving for the future.

Keywords: Artificial Intelligence, Digitization and Archiving.

Introduction:

Preservation and conservation of historical written materialsmeans the preservation and preservation of historical documents, manuscripts, books, correspondence, maps, and other written sources. This includes not only their collection, but also their long-term preservation, availability for use, and the permanent preservation of information for future generations.Preserving the written material was a very difficult task, because the paper was affected by heat, wind and rain. This caused the paper to tear, making the information on it unclear. In the past, spraying pesticides, cleaning, etc. were used to prevent this.But in today's 21st century, in the digital age and the era of artificial intelligence, digitizing and storing information has become easier.AI's ability to redefine the archiving and digitization process not only presents an opportunity to preserve our cultural heritage, but also a responsibility to address the ethical implications that come with such powerful technologies.Artificial intelligence has made it possible to make India's cultural heritage and historical legacy available to the next generation.This article discusses the role of artificial intelligence in digitization and archiving.

Meanings of Keywords:

1) Artificial Intelligence:

Artificial intelligence is a computer system or mechanism that is capable of thinking, learning, making decisions, solving problems, and gaining knowledge from experience, similar to human intelligence.

According to John McCarthy: "Artificial intelligence is a system that imitates human intelligence."

According to Stuart Russell and Peter Norvig: A system that acts intelligently, makes decisions,

and achieves goals is called artificial intelligence."

2) Digitization:

"Digitization is the process of converting information in physical (paper, manuscript, photograph, audio-video, etc.) form into digital (electronic) form."

"Digitization is the process of converting physical or analog information into digital form for easy storage, access, and preservation."

According to UNESCO*"Digitization is the process of converting analogue or physical information into a digital form that can be stored, accessed and preserved electronically."*

3) Archiving:

A collection is the gathering, arrangement, and preservation of various things (objects, information, artworks) together, which results in an aggregation, storage, or compilation; it may be related to a specific subject (e.g., a book collection) or in the form of historical records, artworks, information (e.g., a library, a museum).

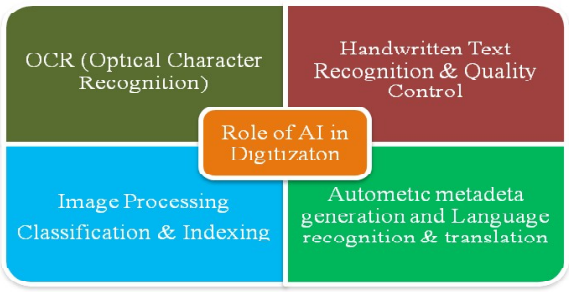
According to Society of American Archivists"Archiving is the systematic process of acquiring, preserving, and making available records of enduring value."

According to UNESCO"Archives are records of enduring value preserved for their historical, legal, administrative, or cultural significance."

As mentioned above, different types of definitions of Keywords have been introduced.

Role of AI in Digitization:

Digitization is the conversion of physical information into digital form.Today, libraries, museums, archive, educational and cultural institutions are digitizing documents on a large scale.In this process, artificial intelligence (AI) has made digitization faster, more accurate, smarter and more effective.The following diagram illustrates the role of artificial intelligence in digitization.



1) OCR (Optical Character Recognition) :

OCR (Optical Character Recognition) is the process of converting characters and text from scanned documents or images into a digital form that can be read by a computer. Traditional OCR systems were limited; they could only recognize clear, printed text. Artificial intelligence (AI) has made OCR systems more accurate, intelligent, and multilingual.AI-based OCR: Cleans up blurry images, removes blemishes, and improves contrast and brightness, increasing text recognition accuracy.

2) Handwritten Text Recognition:

Handwritten Text Recognition (HTR) is the process of recognizing handwritten text (handwriting) by a computer and converting it into digital text. Handwritten text recognition is more complex than printed text because: each person's handwriting is different, the size, alignment, and style of letters vary, and old documents are torn, blurred, or worn. Artificial intelligence effectively solves these challenges. In the HTR system recognizing handwritten characters in an image, creating words and sentences from the characters, increasing accuracy by understanding the context of the text, and from this, understanding the meaning and context of the text.

3) Image Processing :

Image Processing is the process of modifying, analyzing, and extracting useful information from images using a computer.Image processing includes image acquisition, image enhancement, image analysis, and image feature recognition. AI has made all these processes decision-making similar to human intelligence. Image Segmentation is the process of dividing an image into different parts, separating text, images, and background.Image Restoration and Reconstruction involves the important task of digitally repairing torn, incomplete, or damaged images, restoring old photos, maps and manuscripts.

4) Automatic Metadata Generation :

In today's information age, millions of digital documents, images, audio-video files are stored in libraries, archives, museums and digital repositories. Metadata is essential for proper management, search and retrieval of this information. Since manual metadata creation is

time-consuming and error-prone, automated metadata creation based on artificial intelligence (AI) becomes important. There are three types of metadata, which include descriptive (title, author, subject, keywords), structural (number wise pages, file structure) and administrative metadata (creation date, format, rights.) Natural Language Processing is used to help AI read the text in a document, identify important words and concepts, and create topics, keywords, and summaries.

5) Document classification and indexing:

Digital libraries, archives, museums and research institutions store a large amount of documents. Classification and indexing of these documents is very important to facilitate their search, retrieval and management. In the traditional way, this work depends on human labor, which is time-consuming, error-prone and veryexpensive. Artificial Intelligence (AI) brings automation, accuracy and speed to this process.Document classification simplifies digital collection management by grouping documents according to subject, type, period, author, etc.In indexing, AI identifies important words and metadata in the document and creates a suitable index for the search system. It understands the context of the words and does the appropriate tagging.

6) Document classification and indexing:

In the digital age, information is available in many languages and scripts. Libraries, archives, research institutions, online forums, and other places contain a large amount of multilingual documents. Language recognition and translation are crucial to ensure the discovery, retrieval, and use of this information. Traditional human translation is time-consuming and error-prone. Artificial intelligence has made accurate language recognition and automated translation possible.This process involves accurately converting text from one language to another, taking into account vocabulary, grammar, context, and style.Artificial intelligence uses Machine Translation (MT) systems to translate, and Neural Machine Translation technology takes semantics, grammar, and context into account, producing accurate and natural translations based on context.

7) Quality Assurance:

Quality Control (QC) is a system for checking whether a product, process, or service is of the proper quality. Traditional Quality Control uses human observation, measurement, and sample inspection. However, human observation is subject to errors, limitations in accuracy, and is a time-consuming process. Artificial Intelligence has made quality control more automated, accurate, fast, and data-driven.AI identifies patterns and predictive defects from historical product data and works to improve and predict quality. Artificial intelligence uses Natural Language Processing to identify errors, discrepancies, and omissions in a document or report.

The role of artificial intelligence in digitization has been explained above.

Role of AI in Archiving:

Archiving is the process of preserving, managing, and keeping important information or documents available for future use in a secure manner.Digital archives include scanned documents, e-books and databases, multimedia. Traditional archiving methods involved storing documents in filing cabinets or archives, manually classifying and indexing them. This process was time-consuming, error-prone, and limited search ability.Archiving means preserving, preserving, and making available important information or documents for future use in a secure manner.

Document classification is made possible by artificial intelligence. AI automatically classifies documents by subject, author, type, and time period. This makes managing large digital collections easier.Artificial intelligence automatically generates metadata during archiving. In this, AI creates key words, summaries, keywords, indexes in the document. In doing so, it uses Natural Language Processing (NLP) to create consistent and searchable information.

Language Detection & Translation helps increase the search ability of archives by automatically translating and identifying multilingual documents.It is useful for converting handwritten and printed documents into digital format through OCR and HTR processes and for text recognition, correction and classification.It involves restoring

faded or damaged documents by digitally enhancing old images, maps, and photographs.Artificial intelligence helps identify errors or discrepancies in scanned documents and keep data accurate, complete, and organized.Collections are being organized with the help of natural language processing, machine learning, biometric identification, optical character recognition and other cutting-edge artificial intelligence technologies to realize the innovation of automated archiving and intelligent classification.

The main way to achieve this is to rely on natural language processing technology to deeply train machine learning models through large information of text files, accurately extract key information and semantic features of the text, and analyze possible correlations between text properties and categories. On this basis, machine learning algorithms are used to classify and model multi-dimensional data and build a dynamically updated corpus. When new collection data is input, the system will intelligently compare it with the existing model in the corpus, and quickly complete intelligent classification of collections through pattern matching and feature analysis.

Artificial intelligence is revolutionizing the archiving process. Artificial intelligence makes documents accurate, fast, automated and searchable. It also makes libraries, museums and archives more efficient. Preservation and retrieval of multilingual, old, handwritten and digital documents has become possible thanks to artificial intelligence. Artificial intelligence-based archiving has become an essential tool for the future of digital information management.

The names of major institutions engaged in digitization and archiving through artificial intelligence (AI) are given below.

1) National Archives of India (NAI).
2) Asiatic Society, Calcutta (India).
3) AI4Bharat (India) (Research Lab)
4) Bhandarkar Oriental Research Institute (India)
5) Saraswathi Mahal Library (India)
6) University of Toronto & National Archives
7) National Archives and Records Administration (NARA), USA
8) The National Archives, UK
9) Time Machine Project (Europe)
10) SUCHO (Saving Ukrainian Cultural Heritage Online)

Conclusion :

The use of AI in digitization and archiving helps organizations create fast, accurate, automated, multilingual, and searchable digital collections. This enables libraries, archives, and museums to achieve efficient, future-proof, and research-friendly information management.

References:

1. Midde, Ramu (2024), Redefining *Library Services: The Role of Artificial Intelligence in Simplifying Archival Management*, JETIR. Volume 11, Issue 11.
2. Singh, K. P. (2020),*Machine learning in academic libraries: Case studies from India*. DESIDOC Journal of Library & Information Technology, 40(6).
3. Shonhe, L. (2025), *Integration of Artificial Intelligence in Archives and Records Management. In: Advances in Computational Intelligence and Robotics*, IGI Global.
4. Syahidan, A. (2024) *Digital Transformation in the Management of the National Archives of the Republic of Indonesia: A Qualitative Analysis of Challenges and Opportunities in Improving the Efficiency and Effectiveness of Archive Management*. Social Impact Journal, 3.
5. Zhai, Y., & Chen, Q. (2019), *AI-enabled tools for metadata generation in libraries: Trends and challenges*. Library Hi Tech, 37(3).
6. **https://www.historica.org/blog/ais-role-in-preserving-digital-archives**
7. **https://www.ptc.com/en/blogs/corporate/artificial-intelligence-digital-transformation**
8. National Digital Library of India (NDLI) Reports (2023). AI-based tools for archival and cataloging. Retrieved from https://www.ndl.gov.in

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Traditional Ethnomedicinal Plants Used for childhood Skin diseases By Parner Tehsil , Ahilyanagar, Maharashtra, India

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ABSTRACT

The skin is the largest and most substantial organ of the human body.Skin diseases are common for every age group of people throughout the world. The psychosomatic aspect of the skin as an organ has interesting implications for a number of diseases. The disfiguring effect of many eczematous diseases affects not only the body, but also the psyche, and both are in constant interplay during the course of chronic skin disease. A number of common diseases account for the vast majority of the skin disease burden; therefore, implementing effective treatments targeted at those conditions results in significant gain for both personal and public health. Among the various treatment modalities, the usage of medicinal plants gained greater extent of therapeutic efficacy as well as least side effects and is getting popularity in modern ages. This article mainly focuses on certain common child skin disease conditions and the plants used in the treatment of diseases and the different formulations that are available in the pharmaceutical field. Total 10 diseases get cure by 60 plant species

Key words: Child, Acne, Dermatitis, Medicinal plants, Skin diseases, Treatments etc.

INTRODUCTION:

Medicinal plants used for skin-related diseases were prepared using maceration and applied topically as lotion. Commonly encountered childhood diseases in the study area. The nominal group technique and the interviews enabled the researcher to identify 8 diseases categories generated from the prevalent 20-24 sub-diseases as classified by the participants. The most prevalent categories of childhood diseases were skin-related diseases (Burns, skin irritation and warts). Skin-related diseases are still a huge concern and cause morbidity among children in developing countries. According to Hay et al., 2014, skin infections contribute to approximately 34% of occupational health diseases globally. Notably, the high occurrence of skin-related diseases in children could be associated with their low immune systems or low socio-economic status, favourable tropical weather, neglect and poor hygienic living conditions, including the lack of clean water and sanitation, particularly in the remote areas. The high prevalence of skin-related diseases observed in the current study may be partially associated with opportunistic skin infections.

The interest in nature as a source of potential chemotherapeutic agent continues. Natural and their derivatives represent more than 50% of all the drugs products in clinical use in the world today. Higher plants contribute no less than 25% of the total [5,3]. In the last 40 years, many potent drugs have been derived from flowering plants. The purpose of this work is to present few lesser known traditional Indian medicinal plants, their bioactive phytochemical, part of the plant used in various children skin diseases. In present study

the survey & documentation of 60plants useful in child skin care were studied in some localities like Khadakwadi, Wadgoan Sawatal, Karjule Harya, Kasare, Gargundi, Palashi, Pokhari, Palaspur, Garkhindietc of Parner Tehsil, Ahilyanagar (Ahmednagar) district, Maharashtra. Enumeration of plants includes botanical name, family, local names and uses with detailed formulation, mode of use and doses. These plant species are related to the various paediatrics skin problems. These plants have been utilized as home remedies. Some plants are also used in the product like gel, paste, lotion, powder etc

MATERIALS AND METHODS:

The study area was surveyed randomly in different regions of Parner Tehsil of Ahmednagar District from December 2023 to June 2024. Local people who have knowledge about medicinal use of plants were interviewed and documentation done by using questionnaire. The purpose of the interview was explained to informers and approval was obtained regarding the names of plants used for treating child skin issues. Plants were identified with the help of Ahmednagar District (Maharashtra) and Flora of Maharashtra.

Skin Diseases

1. Eczema (Dermatitis)-

Eczema an inflammatory response to a variety of agents acting on the skin from outside or from within the body such as chemicals and drugs, hypersensitivity to various antigens and haptens. Eczema is an inflammation of skin due to immune system activation against an allergen stress, or environmental triggers. There are 8. several types of eczema including atopic dermatitis, contact dermatitis, dyshidrotic eczema, neurodermatitis, nummular eczema, stasis dermatitis, and hand eczema. In 2010, it was estimated that eczema affected approximately 230 million people worldwide, that is, nearly 3.5% of the world population [7] The most common treatment for eczema is corticosteroids. However, patients are highly affected by side effects caused by long-term use. The incorporation of some topical herbals into the treatment regimen may minimize these side effects [2]

Plants Used in Eczema

Sr. No	Botanical Name & (Family)	Local Name	Use/s
1	*Aloe barbadensis* Mill. (Liliaceae)	Korphad	Fresh leaf paste is applied externally on infected area twice a day till cure.
2.	*Triumfettarhombo idea* Jacq. (Tiliaceae)	Chutri	Fresh leaf paste is applied externally on infected area twice a day till cure.
3.	*Cocculushirsutus* (L.) Diels (Menispermaceae)	Vasanvel	Crushed leaves are applied on infected area.

2. Psoriasis-Psoriasis is a chronic inflammatory dermatitis associated with arthritis, myopathy, enteropathy and heart disease, mainly affects skin of elbow, knees, scalp and lumbosacral areas.

Plants Used in Psoriasis-

Sr. No	Botanical Name & (Family)	Local Name	Use/s
1	*Argemone mexicana*. (Papaveraceae)	Bilayat, Pivala Dhotra	Fresh plant sap and paste of root powder applied externally on infected area.
2.	*Glycyrrhiza glabra* Linn. (Fabaceae)	Licorice Jeshthamadh	Root extract is applied on infected area.

2. **Acne-** Acne is one of the most widespread human diseases. It affects over 80% of teenagers and may remain until adulthood. About 67 million visits for acne treatment were reported between 2005 and 2016 [13] Besides, acne is associated with infectious pathogens such as Cutibacterium acnes, although other organisms, such as Staphylococci, have also been isolated [9] These organisms also induce inflammatory reactions that may complicate the treatment. Thus, acne treatment protocol depends on its severity. Alternative and complementary medicine is common in patients affected by acne and infectious skin diseases [12,9]

Plants Used in Acne-

Sr. No.	Botanical Name & (Family	Local Name	Use/s
1.	*Arnica montana* L. (Asteraceae)	Arnica	Shoot extract is externally applied on acne.
2.	*Citrus aurantium* L. (Rutaceae)	Santra	Fruit juice and peel externally applied on acne
3.	*Cucumissativus* L. (Cucurbitaceae)	Kakdi	Seed paste applied on acne.
4.	*Cocculushirsutus* (L.) Diels (Menispermaceae)	Vasanvel	The paste of leaf is applied on acne
5.	*FicusreligiosaL.* (Moraceae)	Peepal, Pimpal	Bark is crushed with water and apply on pimples
6.	*Lavendulaangustifolia* L. (Lamiaceae)	Lavender	Volatile oil from flower is externally applied on acne.
7.	*Melaleuca alternifolia Cheel.* (Myrtaceae)	Tea tree oil	Leaf oil applied on acne.
8,	*Rosa indica* L. (Rosaceae)	Rose	Rose water applied on acne
9.	*Simmondsiachinensis* (Link) C.K. Schneid. (Buxaceae)	Jojoba	Seed oil is used externally on acne.

4. Furuncles (Boils, Burn)-

One of the most health-threatening issues in the world is burn injury. The healing of burn wounds is a complex process, involving inflammation, granulation, and tissue remodelling. Since ancient times, plants have been used as therapeutics. Medicinal and conventional plants are considered to treat a wide range of diseases as healthy, sustainable, and inexpensive sources of treatment for wounds [10]

Plants Used in Furuncles (Boils, Burn)

Sr. No.	Botanical Name & (Family)	Local Name	Use/s
1.	*Aloe barbadensis* Mill. (Liliaceae).	Aloe	Leaf gel is externally applied on burn.
2.	*Amorphophallusbulbifer* Blume (Araceae)	Suran	Decoction of root and leaf is applied on burn.
3.	*Murrayakonenigii* (L.) Spreng. (Rutaceae)	Kadhipatta	Leaf oil and extract applied on burn till it cures.
4.	*Ailanthus excels* Roxb. (Simaroubaceae)	Maharuk	Leaf paste is applied till cure.
5.	*Amaranthusspinosus* L.(Amaranthaceae)	Katemath	Paste of root is applied on boils.
6.	*Allium sativum*L. (Liliacaeae)	Garlic	Paste of bulb is applied on boils.
7.	*Allium cepa* L. (Liliacaeae)	Onion.	Paste of bulb is applied on skin allergy due to burn & boils.
8.	*Bryophyllumpinnatum*(Lam.) Kurz. (Crasullaceae)	Patharchatta.	Paste of leaves on boils and sores.
9.	*Cheilocostusspeciosus* (J.Koenig.) C.D. Specht. (Zinziberaceae)	Rasoliya	Leaf paste on boils. Root paste with oil of *Cinnamomum tamala*also on boils
10	*Flacourtia indica* (Burm.f.) Merr. (Flacourtiaceae)	Tambut, Athruna	Paste of bark externally applied on boils or carbuncle
11.	*FicusreligiosaL.* (Moraceae)	Peepal,Pimpal	Bark is crushed with water and apply on boils
12.	*Lepidagathis cuspidate* Nees. (Acanthaceae)	Kate Adulsa,Ikhra	Paste of leaves applied on boils and blisters
13	*Mangifera indica* L.(Anacardiaceae)	Mango tree, Aam	The gum is applied externally on boils
14.	*Mirabilis jalapa*L.(Nyctaginaceae)	Gulbans, Gulbakshi	Leaf juice is externally applied on burns.
15.	*Solanumamericanum* Mill (Solanaceae)	Kaamoni, ghati, American Black Nightshade	Fruit powder with milk is orally given for boil
16.	*Vanda tessellate* (Roxb) H	Vanda Orchid	Root paste is externally applied on burn.

5. Scabies - Scabies is a common ectoparasitic infestation caused by Sarcoptesscabei, a human-specific mite that is highly prevalent in some areas of the developing world. Scabies is transmitted by direct contact.

Plants Used in Scabies

Sr. No.	Botanical Name & (Family	Local Name	Use/s
1.	*Ailanthus excels* Roxb .Maharuk (Simaroubaceae)	Maharuk.	Leaf paste is applied twice a day on scabies till cure
2	*Argemonemexicana* L. (Papaveraceae)	Bilayat, Pivala Dhotra	Latex of stem is mixed with equal quantity of coconut oil and applied once a day for 2-3 days on scabies.
3.	*Azadirachta indica* A. Juss.(Meliaceae)	Kadu limb	Stem bark ash is mixed with coconut oil is applied on scabies.
4.	*Curcuma longa* L.(Zingiberaceae)	Haldi, Curcuma	Rhizome of Curcuma and leaf of *Azadirachta indica* taken in equal Proportion, crushed to make paste and applied over scabies
5	*Clitoriaternatea*L. (Fabaceae)	Gokarna	Leaf juice is given orally twice a day for six days to cure scabies
6.	*Euphorbia antiquorum*L. (Euphorbiaceae)	Tidhari Nivadung	The stem pulp is externally applied to cure skin diseases such as sores and scabies.
7.	*Hibiscus rosa-sinensis* L (Malvaceae)	Jasvanda	Paste of leaf externally applied on scabies
8.	*Mirabilis jalapa*L.Gulabkshi (Nyctaginaceae)	Gulabkshi	The root paste is smeared in scabies
9.	*Plumeriarubra* L.(Apocynaceae)	Chafa	Bark paste is externally applied on Scabies
10.	*Phyllanthusembl ica*L (Euphorbiaceae)	Amla	The fruit extracted juice of *E.officinalis* is mixed with sugar and the mixture is orally taken for scabies

6. Warts. -Warts are infection of the epidermis caused by human papilloma virus (HPV) of different genotypes. Different HPV types may preferentially infect either cornified stratified squamous epithelium of skin or uncornified mucous membranes.

Plants Used in Warts-

Sr. No.	Botanical Name & (Family	Local Name	Use/s
1.	*Curcuma longa*L. (Zingiberaceae)	Haldi, Curcuma	Rhizome is applied on warts.

7. Itching. -Itching (pruritus) may develop because of any one of several factors and these should be elicited whenever possible. For example, the presence of parasites (scabies, especially in children) causes intolerable itching, so the underlying complaint should be treated

Plants Used in Itching-

Sr. No	Botanical Name & (Family	Local Name	Use/s
1.	*Avenasativa*L. (Poaceae)	Shofan	Colloidal oat extract is externally applied on infected area.
2.	*Cynoglossumlanceolatum* Forssk. (Boraginaceae)	Nisurdi,Kali Nisurdi Laksmana	Juice of Leaves orally given for itching.
3.	*Casearia*ellipticaWilld. (Flacourtiaceae)	Chilla	Paste of Leaves applied on infected area.
4.	*Curculigoorchioides*Gaertn. (Hypoxidaceae)	Kali musli	Rhizome extract applied as paste on itching
5.	*Melia azedarach* L. (Meliaceae)	Baikan,Bakam	The fruit paste is applied externally on skin allergy
6.	*Cissampelospareira* L.(Menispermaceae)	Paadha/ Pahadvel	Paste of Leavesexternallyapplied on skin.
7.	*Phyllanthusemblica*L (Euphorbiaceae)	Amla	Euphorbiaceae 1.The fruits are orally taken for dry skin & itching.

8.	*Pongamiapinnata* (L.) Pierre.(Fabaceae)	Karanju,Karanj	Oil from Seeds rubbed on itching.
9.	*Senna tora*L. (Caesalpiniaceae)	Takala, Tarota	Paste of seed powder mixed with wheat flour made used on boils itching
10.	*Terminalia alata* B. Heyne ex Roth, (Combretaceae)	Ajantree,Ain,Sant aliSatada	Paste of Leaves applied on itching
11.	*Vitexnegundo*L. (Verbenaceae)	Nirgudi	Leaves fried in mustard oil made on boils itching
12.	*Brassica juncea*(L.)Coss. (Brassicaceae)	Mohari,Rai	Paste of seeds & oil applied on itching.
13	*Celosia argentea* L. (Amaranthaceae)	Kurdu,Kombada	The decoction ofleaves is used to wash skin of allergy
14	*Garugapinnata*Roxb. (Burseraceae)	Kakad, Garuga, Jiga	Fruit pulp is applied on itching.

8. Others –Cut &Wounds, Chicken Pox, Rashes, Diaper rash, Dry skin, [1] Cuts& scraps, Ringworms, Leprosy, Swelling &pains, Insect bite, Dark spot etc.

Plants Used in Others-

Sr. No	Botanical Name & (Family	Local Name	Use/s
1.	*Aloe barbadensis* Mill.(Liliaceae)	Aloe	a) Gel is applied externally on Small wounds, minor skin irritations like burn up, injures and scratched affected area. b) Gel with olive oil in the ratio 3/2 is applied on affected Diaper Dermatitis area for the children in each age group three times in a day for a period of 10 days
2.	*Achyranthesaspera* L (Amaranthaceae)	Aghada	Root paste is applied on affected area of insect bite
3..	*Azadirachta indica* A.Juss. (Meliaceae)	Kadu limb	Giving a bath with neem leaf water for Skin allergy and skin rash.
4.	*Averrhoa carambola* L. (Oxalidaceae)	Star fruit	Apply the star fruit pulp on the ring worm infected area
5.	*Aervasanguinolenta*(L.) Blume (Amaranthaceae)	Desert cotton	Leaf paste applied externally on cuts and wounds
6.	*Acoruscalamus* L. (Aracaceae /Acoraceae)	Vekhand	5gm rhizome paste is applied twice aday up to 7 days on chicken pox.
7.	*Bacopa monnieri*(L.) Edwall. (Scrophulariaceae)	Bramhi	Leaf pest is applied on Skin diseases and rashes.
8.	*Calendula officinalis* L. (Asteraceae)	Makhmali	Flower is used for compresses in poorly healing wounds, bruises, rashes, boils and dermatitis.
9.	*Cocos nucifera* L. (Arecaceae)	Naral/Coconut	Coconut oil is applied on Diaper rash, Dry skin, Cuts and scrapes
10.	*Cyanodon dactylon* (L.) Pers.(Poaceae)	Durva	Whole plant Paste applied on affected. Cuts and wound
11.	*Catherantusroseus* (L.) G.Don. (Apocynaceae)	Sadafuli	Leaf pest is applied on wound.
12.	*Cassia fistula* L. (Fabaceae)	Bahava	Pulp of ripe fruit applied on ringworm.
13.	*Eranthemum pulchellum* Andrews (Acanthaceae)	JungliAboli	Leaves applied externally on feet cracked.
14.	*Mimosa pudica* L. (Mimosaceae)	Lajalu	Root paste id applied on wound.
15.	*Eclipta prostrata* (L.) Hassk.(Asteraceae)	Bhringaraj, Maka	Leaf juice is applied to stop bleeding in fresh cuts
16.	*Crossandra infundibuliformis* (L.)Ness (Acanthaceae)	Aboli	Flower extract is remedy for wound healing.
17.	*Oxalis corniculata* L. (Oxalidaceae)	Amboshi	Paste of aerial shoot & root is applied over inset bite.
18.	*Ocimum sanctum* L. (Lamiaceae)	Tulsi	Leaves extract applied onRingworm,Leucodermaand Dark spot infected area.
19.	*Gloriosa superba* L. (Liliaceae)	Kal-lavi	Corn juice is applied over leprosy infected area.
20.	*Trigonellafenumgraecum* L (Fabaceae).	Methi	Seed soaked in half glass of water for overnight. 10 ml of water is given 2-3 times a day for 2-3 days till the eruption of pox is brought out completely
21.	*Wrightia arborea* (Dennst.) Mabb. (Apocyanaceae)	Pandu kuda	Latex is applied on cut and wound

RESULTS AND DISCUSSION

During the investigation, it was found that 60 plant species were used as herbal medicine for the treatment of child skin diseases. Of 60 genera and 44 families of angiosperms, Fabaceae with 5 species ranked first, and was the dominant family followed by Liliaceae, Menispermaceae, Asteraceae and Euphorbiaceae with three species each. Majority of families were monospecific. Nine species namely, Aloe barbadensis, Argemonemexicana, Phyllanthusemblica, Mirabilis jalapa, Azadirachta indica,Ailanthus excels, Curcuma longa Cyanodondactylon, Glycyrrhizaglabra, used to cure various kinds of skin diseases.while Wrightia tinctoria is extensively used for psoriasis ([11,12]). Anthropogenic disturbances such as unsustainable harvesting, cultivation practices and overexploitation lead to threat to such potential genetic resources. Such Anthropogenic pressures lead medicinal plants to decline drastically in its natural condition ([8]).

CONCLUSION:

Herbal drugs have found to possess great potential in the treatment of various kinds of child skin diseases. Medicinal plants are a rich source of active ingredients and can be effective for treating skin inflammations in the pediatric age group. It is important to know what herbal preparations are available, how to use them, what possible side effects or interactions may occur to allow for more effective patient counselling. As their use has increased in recent years, further research is needed regarding the effectiveness, safety, optimal uses, and standardization of herbal preparations ([4]).

A total of 60 species have been recorded for the treatment of child skin problems. The information collected from respondents indicates that they are aware about medicinal plants and their uses. This knowledge was inherited from their ancestors but vanishing gradually and requires attention. Most of the plants were wild and herbs, so their conservation is necessary for utilization of generations to come. This can be done by encouraging local people for the cultivation of these plants. Furthermore, this preliminary study may act as a baseline for the discovery of new plant-based medicines. These plant species can be Studied in detail for different phytochemicals to understand their medicinal activity

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References :-

1. Amin, R., Lechner, A., Vogt, A., Blume-Peytavi, U., &Kottner, J. (2021). Molecular characterization of xerosis cutis: A systematic review. PLOS One, 16(12), e0261253. https://doi.org/10.1371/journal.pone. 0261253
2. Chen, H. Y., Lin, Y. H., Huang, J. W., & Chen, Y. C. (2015). Chinese herbal medicine network and core treatments for allergic skin diseases: Implications from a nationwide database. Journal of Ethnopharmacology, 168, 260–267. https://doi.org/10.1016/j.jep.2015.04.002
3. Cragg, G. M., & Newman, D. J. (2005).Plants as a source of anti-cancer agents.Journal of Ethnopharmacology, 100(1–2), 72–79.
4. Dorina.Shengjergji Dervishi 1, * , Emi Panariti 2 and ArnisaNuna 3 Trend of using herbal based preparations in pediatric skin inflammation disorders GSC Biological and Pharmaceutical Sciences, 2022, 21(03), 190–195
5. Farnsworth, N.R., Akerele, O., Bingel, A.S., Soejarto, D.D. and Guo, Z. (1985) 'Medicinal plants in therapy', Bulletin of the World Health Organization 63: 965–981.
6. Hamid Nasri 1, Mahmoud Bahmani 2, NajmehShahinfard 3, AtefehMoradiNafchi 4, ShirinSaberianpour 4, Mahmoud RafieianKopaei4,*Medicinal Plants for the Treatment of Acne Vulgaris: A Review of Recent Evidences Jundishapur J Microbiol. 2015 Nov 21;8(11):e25580. doi: 10.5812/jjm.25580

7. Hay, R. J., Johns, N. E., Williams, H. C., Bolliger, I. W., Dellavalle, R. P., Margolis, D. J., Marks, R., Naldi, L., Weinstock, M. A., Wulf, S. K., Michaud, C., J L Murray, C., &Naghavi, M. (2014). The global burden of skin disease in 2010: An analysis of the
8. Laloo RC, Kharlukhi L, Jeeva S & Mishra BP, Sacred forests of Meghalaya as a treasure house of medicinal plants: Effect of disturbance on population structure and natural regeneration of important species, CurrSci, 90 (2) (2006) 225–232.
9. Qadan, F., Thewaini, A. J., Ali, D. A., Afifi, R., Elkhawad, A., &Matalka, K. Z. (2005). The antimicrobial activities of Psidiumguajava and Juglansregia leaf extracts to acnedeveloping organisms. The American Journal of Chinese Medicine, 33(2), 197–204.https://doi.org/10.1142/S0192415X0500278
10. Seyhan, N. (2020). Evaluation of the healing effects of Hypericumperforatum and Curcumin on burn wounds in rats. Evidence-Based Complementary and Alternative Medicine, 2020, 6462956. https://doi.org/10. 1155/2020/6462956
11. Siddiqui MB, Alam MM & Husain W, Traditional treatment of skin diseases in Uttar Pradesh, India, Econ Bot, 43 (1989) 480-48612.Suseela Bai &Nesamoni, Traditional treatment of Psoriasis, J Scott Res Forum, 1 (1) (2005) 10–13.
12. Taylor, M. T., & Barbieri, J. S. (2020). Depression screening at visits for acne in the United States, 2005-2016. Journal of the American Academy of Dermatology, 83(3),936–938. https://doi.org/10.1016/j.jaad. 2019.12.076

6

Need for Contract Farming in India

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Introduction

Contract farming can be defined as agricultural production carried out according to an agreement between a buyer and farmers, which establishes conditions for the production and marketing of a farm products. Typically, the farmer agrees to provide agreed quantities of a specific agricultural product. These should meet the quality standards of the purchaser and to be supplied at the time determined by the purchaser. In turn, the buyer committed to purchase the product and, in some cases, to support production through, for example, the supply of farm inputs, land preparation and the provision of technical advice.

Informal model- This model is the most transient and speculative of all contract farming models, with a risk of default by both the promoter and the farmer (van Gent, n.d., p.5). However, this depends on the situation: interdependence of contract parties or long-term trustful relationships may reduce the risk of opportunistic behavior. Special features of this CF model are:

- Small firms conclude simple, informal seasonal production contracts with smallholders.
- The success often depends on the availability and quality of external extension services.
- Embedded services, if at all provided, are limited to the delivery of basic inputs, occasionally on credit; advice is usually limited to grading and quality control.
- Typical products requiring minimal processing / packaging, vertical coordination; e.g. fresh fruit / vegetables for local markets, sometimes also staple crops.

Intermediary model -

In this model, the buyer subcontracts an intermediary (collector, aggregator or farmer organisation) who formally or informally contracts farmers (combination of the centralized / informal models). Special characteristics of this CF model are:

- The intermediary provides embedded services (usually passing through services provided by buyers against service charges) and purchases the crop.
- This model can work, if well-designed and if incentive- structures are adequate and control mechanisms are in place.
- This model can bear disadvantages for vertical coordination and for providing incentives to farmers (buyers may lose control of production processes, quality assurance and regularity of supplies; farmers may not benefit from technology transfer; there is also a risk of price distortion and reduced incomes for farmers).

Multipartite model-

This model can develop from the centralized or nucleus estate models, e.g. following the privatization of para-statals. It involves various organisations such as governmental statutory bodies alongside private companies and sometimes

financial institutions. Special features:

- This model may feature as joint ventures of parastatals / community companies with domestic / foreign investors for processing.
- The vertical coordination depends on the discretion of the firm. Due attention has to paid to possible political interference.
- This model may also feature as farm-firm arrangement complemented by agreements with 3rd party service providers (e.g. extension, training, credits, inputs, logistics).
- Separate organisations (e.g. cooperatives) may organize farmers and provide embedded services (e.g. credits, extension, marketing, sometimes also processing).

Advantages

Contract farming is looking towards the benefits both for the farm-producers as well as to the agro-processing firms. Producer / farmer

- Makes small scale farming competitive-small scale farming competitive-small farmers can access technology, credit, marketing channels and information while lowering transaction costs
- Assured market for their produce at their doorsteps, reducing marketing and transaction costs
- It reduces the risk of production, price and marketing costs.
- Contract farming can open up new markets which would otherwise be unavailable to small farmers.
- It also ensures higher production of better quality, financial support in cash / or kind and technical guidance to the farmers.
- In case of agri-processing level, it ensures consistent supply of agricultural produce with quality, at right time and low cost.

Agri-based firms

- Optimally utilize their installed capacity, infrastructure and manpower, and respond to food safety and quality concerns of the consumers.
- Make direct private investment in agricultural activities.
- The price fixation is done by the negotiation between the producers and firms
- The farmers enter into contract production with an assured price under term and conditions.

Challenges

- Contract farming arrangements are often criticized for being biased in favor of firms or large farmers, while exploiting the poor bargaining power of small farmers.
- Problems faced by growers like undue quality cut on produce by firms, delayed deliveries at the factory, delayed payments, low price and pesticide attack on the contract crop which raised the cost of production
- Contracting agreements are often verbal or informal in nature, and even written contracts often do not provide the legal protection in India that may be observed in other countries. Lack of enforceability of contractual provisions can result in breach of contracts by either party.
- Single buyer – Multiple Sellers (Monopsony).
- Adverse gender effects- Women have less access to contract farming than men.

Policy Support

Agricultural marketing is regulated by the State's Agricultural Produce Marketing Regulation (APMR) Acts. In order to regulate and develop practice of contract farming, Government has been actively advocating to the States / Union Territories (UTs) to reform their Agri-marketing laws to provide a system of registration of contract farming sponsors, recording of their agreements and proper dispute settlement mechanism for orderly promotion of contract farming in the country. So far, 21 States (Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Goa, Gujarat, Haryana, Himachal Pradesh, Jharkhand, Karnataka, Maharashtra, Madhya Pradesh, Mizoram, Nagaland, Odisha, Pubjab (separate Act), Rajasthan, Sikkim, Telangana, Tripura and Uttarakhand) have amended their Agricultural Produce Marketing Regulation (APMR) Acts to provide for contract farming and out of them, only 13 States (Andhra Pradesh, Chhattisgarh, Goa, Gujarat, Haryana,

Himachal Pradesh, Jharkhand, Karnataka, Maharashtra, Madhya Pradesh, Odisha, Rajasthan and Telangana) have notified the rules to implement the provision.

Agricultural Produce suitable for Contract Farming

The various agricultural produce are suitable for practices under contract farming like tomato pulp, organic dyes, poultry, pulpwood, mushrooms, dairy processing, edible oils, exotic vegetables, baby corn cultivation, basmati rice, medicinal plants, potato for making chips and wafers, onions, mandarin oranges, durum wheat, flowers and orchids, etc.

The Government's Role in Contract Farming

The governments has been making efforts to integrate farmers with agro-industries to ensure that they get better prices for their produce. That is why contract farming has come to be seen as a panacea. Contract farming refers to an agreement between farmers and marketing firms for the production and supply of agricultural products under forward agreements, frequently at predetermined prices. The contract between farmers and buyers insulates farmers from price risk, helps them develop new skills, and Provides opportunity for new markets Nevertheless, contract farming suffers from market failures.

Monopsony: Typically, contract firms enter into an agreement with farmers to grow differentiated crops. This leads to firm into a sole buyer and farmers into price-takers. Contracting firms can exploit this situation to their advantage by offering lower prices to farmers.

In India, contract farming is regulated under the Indian Contract Act, 1872. The Act has many general provisions that are relevant to contract farming, including the formation of contracts, obligations of parties, and consequences in case of breach of contract. In addition to this the model APMC (agricultural produce market committee) Act, 2003 provides specific provisions for contract farming, like compulsory registration of contract farming sponsors and dispute settlement.

Conclusions

The present modern farming involving tremendous amount of technological input and market orientation which require capital resources, it is but inevitable to involve private corporate business interests in agricultural development through contract farming systems. The above discussion suggests that it is not the contract per se which spells hardship or doom for small growers as a system, but how it is practiced in a given context. In fact, all over the world, contracting of some kind is a necessity for many or most forms of modern commercial agriculture. Though there are some scholars who has caution about the widespread applicability of contract farming as a development tool (Glover, 1987), if there are enough mechanisms to monitor and use the contract for developmental purposes, it has the potential to lead to a betterment of all the parties, especially the small and marginal farmers.

Contracts require frequent and independent scrutiny so that they remain competitive both with similar contracts and with open market transactions. Wide publicity of contract terms will help to stimulate competition. From the producers' point of view, specific points to be considered in negotiating the contract terms include the method of determining the producers' price, adjustments for quality differentials, allowance for climatic variations, farm practices, credit terms, provisions for renewal and termination of contracts and for arbitration (Hill and Ingersent, 1987). Though the state regulation of contracts is desirable, but if the firms really want to sabotage the contract, there is no way they can be prevented from doing so (Glover, 1987; Glover and Kusterer, 1990). Therefore, vigorous bargaining co-operatives or other agricultural producer organisations are needed to negotiate equitable contracts. This kind of organisations have been able to secure the standardization of contracts and their scrutiny by a government agency in the US (Wilson, 1986).

References :-

1) J C Abbott, 'Marketing, The Rural Poor and Sustainability', in J C Abbott (ed.): Agricultural and Food Marketing in Developing Countries- Selected Readings, (Oxon: UK: CAB International 1993), 65-92.
2) M Asano Tamanol, "Farmers Industries, and the State: The Culture of Contract Farming in Spain and Japan", 30 (3) Comparative Studies in Society and History, (1988)
3) G S Bhalia an G Singh, 'Impact of GATT on Punjab Agriculture', (Delhi: Ajanta: 1996).
4) M Bharadwaj and J S Palan (n.d.):'Co-operative Alignment with the Corporate- The New Direction', mimeo, 4.
5) V Benziger, 'Small Fields, Big Money: Two Successful Programmes in Helping Small Farmers Make the Transition to High Value-Added Crops', 24 (11) World Development, (1996), 1681-1693
6) M Boehjie, J Akrige and D Downey, 'Restructuring Agribusiness for the 21th Century', 11 (6) Agribusiness, (1995), 493-500
7) M Buch-Hansen and H S Marcussen, 'Contract Farming and the Peasantry: Cases from Western Kenya', 23 Review of African Political Economy, (1982), 9-36
8) D Bulow and A Sorensen, 'Gender and Contract Farming: Tea Outgrower Schemes in Kenya', 56 Review of African Political Economy, (1993), 38-52
9) D Burch, 'Globalized Agriculture and Agri-food Restructuring in South East Asia: The Thai Experience' in D Burch, R E Rickson and G Lawrence (eds,): Globalisation and Agri-Food Restructuring- Perspectives from the Australasia Region, (USA: Avebury: Brookfield 1996), 323-344
10) R A J Clapp, 'Representing Reciprocity, Reproducing Domination: Ideology and the Labour Process in Latin American Contract Farming', 16 (1) The Journal of Peasant Studies, (1998) 5-39.

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A Scenario of Agricultural Finance and Its Impact on Farmers in Maharashtra

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ABSTRACT

Agricultural finance plays a crucial role in sustaining farm production, ensuring timely availability of inputs, and stabilizing the income of farmers. In Maharashtra, where agriculture is heavily dependent on monsoon rainfall and small landholdings dominate, access to adequate and affordable finance significantly influences farmers' livelihoods. This paper examines the structure of agricultural finance in Maharashtra, focusing on institutional and non-institutional sources of credit, government support schemes, and the challenges faced by farmers in accessing finance. It also analyzes the impact of agricultural finance on productivity, indebtedness, and rural development. The study finds that while institutional finance and government interventions have improved credit availability, issues such as loan defaults, dependence on moneylenders, and ineffective implementation of schemes continue to affect farmers adversely. The paper concludes with policy recommendations aimed at strengthening rural credit systems and enhancing financial inclusion in Maharashtra's agricultural sector.

Keywords : Agricultural finance, loans, cooperative banks, farmer indebtedness.

Introduction :

Agriculture plays a vital role in the economy of Maharashtra and provides livelihood to a large section of the rural population. Despite rapid industrial and urban development, a significant proportion of farmers in the state depend on agriculture for income and employment. However, farming in Maharashtra is highly uncertain due to factors such as dependence on monsoon rainfall, frequent droughts, fluctuating market prices, and rising input costs. In this context, agricultural finance becomes a crucial support system for farmers.

Agricultural finance refers to the provision of credit, loans, subsidies, and insurance facilities to meet the financial requirements of agricultural operations. In Maharashtra, access to timely and affordable finance determines farmers' ability to purchase inputs, adopt modern technology, and manage production risks. Institutional sources such as commercial banks and cooperative banks play a major role in providing agricultural credit, while non-institutional sources like moneylenders still exist in rural areas due to procedural and accessibility issues.

The impact of agricultural finance on farmers in Maharashtra has been both positive and challenging. While government initiatives such as interest subvention, crop loans, and loan waiver schemes have improved access to credit, problems like farmer indebtedness, delayed loan disbursement, and dependence on informal lenders continue to persist. Therefore, studying the scenario of agricultural finance and its impact on farmers is

essential to understand the effectiveness of existing financial systems and to identify measures for improving the economic condition of farmers in Maharashtra.

Concept and Importance of Agricultural Finance

Agricultural finance refers to the provision of financial resources to farmers for carrying out agricultural and allied activities. It includes credit, loans, subsidies, insurance, and other financial services required for farming operations. In simple words, agricultural finance helps farmers manage money for cultivation, from sowing to harvesting and marketing. It covers-

Short-term finance – for seeds, fertilizers, pesticides, labor, irrigation

Medium-term finance – for tools, machinery, livestock, wells

Long-term finance – for land development, tractors, irrigation projects

Because agriculture depends on seasons, weather, and prices, farmers cannot rely only on savings. Therefore, finance becomes a support system for agricultural production.

Importance of Agricultural Finance

Agricultural finance is important for the following reasons:

Ensures Timely Availability of Inputs

Finance enables farmers to buy seeds, fertilizers, pesticides, and machinery at the right time, which directly affects crop yield.

Increases Agricultural Productivity

With adequate credit, farmers can adopt improved seeds, modern tools, and irrigation methods, leading to higher production.

Reduces Dependence on Moneylenders

Institutional finance from banks and cooperatives protects farmers from high-interest loans charged by private moneylenders.

Supports Adoption of Modern Technology

Financial support allows investment in mechanization, drip irrigation, and climate-resilient farming techniques.

Stabilizes Farmers' Income

Credit, subsidies, and insurance help farmers manage risks caused by droughts, floods, and price fluctuations.

Promotes Rural Development

Improved agricultural income leads to better living standards, employment generation, and overall rural growth.

Encourages Allied Activities

Finance supports animal husbandry, dairy, poultry, and fisheries, helping farmers diversify income sources. Without adequate financial support, farmers are unable to invest in productive activities, leading to low yields and poverty.

Sources of Agricultural Finance in Maharashtra

Institutional Sources

Institutional sources include commercial banks, regional rural banks, cooperative banks, and microfinance institutions. These sources provide credit at relatively low interest rates and are regulated by the Reserve Bank of India. In Maharashtra, District Central Cooperative Banks (DCCBs) and Primary Agricultural Credit Societies (PACS) play a major role in rural lending. Crop loans up to ₹ 3 lakh are provided at subsidized interest rates, and farmers who repay on time receive interest subvention, making such loans nearly interest-free.

Non-Institutional Sources

Non-institutional sources include moneylenders, traders, landlords, and relatives. Although easily accessible, these sources charge very high interest rates and often exploit farmers. Despite policy efforts, many small and marginal farmers in Maharashtra still depend on moneylenders due to delays and procedural complexities in institutional credit.

Government Initiatives for Agricultural Finance

The government has introduced several schemes to improve agricultural finance in Maharashtra:

Interest Subvention Scheme: Provides subsidized crop loans to farmers who repay on time.

Farm Loan Waiver Schemes: Implemented to reduce the debt burden of distressed farmers.

Pradhan Mantri Kisan Samman Nidhi (PM-KISAN): Offers direct income support to farmers.

Pradhan Mantri Fasal Bima Yojana (PMFBY):

Crop insurance scheme to protect farmers from losses due to natural calamities.

Support to Cooperative Banks: The Maharashtra government has recapitalized cooperative banks to strengthen rural credit delivery. These initiatives aim to enhance financial inclusion & reduce agrarian distress.

Challenges in Agricultural Finance

Despite various initiatives, several challenges persist:

Delayed Credit Disbursement : Many farmers do not receive loans on time, especially during sowing seasons, affecting crop production.

Rising Indebtedness : Crop failures, price fluctuations, and repeated borrowing have led to increasing farm loan defaults and non-performing assets.

Dependence on Moneylenders : Due to limited access to formal credit, farmers often rely on private moneylenders, leading to exploitation and debt traps.

Low Financial Literacy : Lack of awareness about banking procedures, insurance, and repayment terms restrict effective use of financial services.

Impact of Agricultural Finance on Farmers

Positive Impact

1. Improved access to quality inputs
2. Increased agricultural productivity
3. Adoption of modern farming techniques
4. Enhanced income stability
5. Growth of allied activities such as animal husbandry

Negative Impact

1. Accumulation of debt due to repeated crop failures
2. Credit contraction after loan waivers
3. Psychological stress and financial insecurity
4. Regional disparities in credit distribution

The impact of agricultural finance in Maharashtra is thus mixed, reflecting both support and structural weaknesses.

Policy Recommendations

To improve the effectiveness of agricultural finance in Maharashtra, the following measures are suggested:

1. Strengthening cooperative banks and improving governance
2. Simplifying loan procedures and reducing delays
3. Expanding financial literacy programs in rural areas
4. Promoting crop insurance and climate-resilient finance
5. Encouraging diversified income sources and value-addition activities

Conclusion

Agricultural finance is a critical component of Maharashtra's rural economy and farmer welfare. While institutional credit, subsidies, and government schemes have expanded financial access, persistent challenges such as indebtedness, delayed credit, and reliance on moneylenders continue to affect farmers. Strengthening rural financial institutions, improving implementation of schemes, and enhancing financial literacy are essential to ensure sustainable agricultural development. A well-structured and inclusive agricultural finance system can significantly improve the livelihoods of farmers and contribute to long-term rural prosperity in Maharashtra.

References :-

1. Government of India. (2023). Agricultural credit in India: Trends and issues. Ministry of Agriculture & Farmers Welfare.
2. Government of Maharashtra. (2024). Economic Survey of Maharashtra. Directorate of Economics and Statistics.
3. Indian Express. (2025). Why bad debts are rising in Maharashtra's farm sector.
4. Reserve Bank of India. (2024). Report on trends and progress of banking in India.
5. Scroll.in. (2021). Maharashtra farmers rely on private moneylenders as crop loan disbursal takes a hit.

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Habitat Loss and Faunal Decline in Beed, Maharashtra: Addressing Burning Issues through Zoological Research

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ABSTRACT

Beed district in Maharashtra's semi-arid Marathwada region faces significant ecological challenges arising from persistent drought, water scarcity, and anthropogenic habitat degradation. These pressures have resulted in the contraction and fragmentation of natural habitats, leading to measurable declines in faunal diversity across terrestrial, freshwater, and avian communities. This research article integrates findings from field surveys, regional environmental assessments, and targeted zoological studies to identify the main drivers of habitat loss in Beed, document emerging patterns of faunal decline, and propose how zoological research can inform effective conservation strategies. The study emphasises that coordinated interdisciplinary action combining rigorous scientific monitoring, local community engagement, and policy interventions is essential to safeguard biodiversity in Beed's fragile ecosystems and support sustainable coexistence of people and wildlife.

Keywords : Beed district, habitat loss, faunal decline, biodiversity, zoological research, Marathwada

1. Introduction

Beed district, situated in the drought-prone Marathwada region of Maharashtra, India, is typified by a semi-arid climate, relatively sparse forest cover, and prolonged water scarcity. These environmental conditions are exacerbated by low and erratic rainfall patterns, elevated evapotranspiration rates, and over-extraction of groundwater, collectively undermining the quality, continuity, and resilience of wildlife habitats across the district (IndianDistricts.in, 2025).Habitat loss manifests through degradation of natural ecosystems such as dry deciduous forests, grasslands, and riparian corridors resulting in reduced availability of shelter, food resources, and critical breeding sites. Habitat degradation also disrupts ecosystem services such as nutrient cycling, soil stabilization, pollination, and climatic regulation, which are foundational to both biodiversity persistence and human well-being. The cumulative impacts of habitat loss lead to cascading ecological disruptions affecting organisms from apex predators and large mammals to reptiles, birds, and aquatic biota.

In this context, zoological research plays a fundamental role in documenting species distribution and abundance, understanding ecological responses to environmental change, and generating scientific evidence to underpin

conservation planning.

2. Evidence of Habitat Loss and Faunal Decline in Beed

Environmental Context in Beed

The physical landscape of Beed is dominated by rugged topography with limited perennial water sources. Natural vegetation is predominantly composed of dry deciduous forests and scrublands interspersed with grasslands adapted to low-moisture conditions. However, these habitats are under increasing stress owing to human pressures such as deforestation for fuelwood and expanding agricultural needs, which have intensified habitat degradation over time (IndianDistricts.in, 2025).The absence of stable water flows in many rivers and streams, coupled with declining groundwater reserves, constrains the persistence of riparian and wetland habitats that would otherwise support higher levels of faunal diversity.

Wild Fauna Patterns and Decline

Although comprehensive systematic surveys of wildlife in Beed are limited, existing environmental profiles indicate a notable contraction of larger fauna historically documented in the region. For example, apex predators such as tigers (Panthera tigris) were once part of the broader faunal assemblage of central India but are no longer present in Beed, reflecting the loss of extensive forest cover and prey base.

Leopards (Panthera pardus), which are more adaptable to fragmented landscapes, persist in remnant forest patches. However, their increasing movement into agricultural areas including incidents of livestock predation, such as the reported case of a suspected leopard killing goats in Wangi village underscores the consequences of shrinking natural habitats and heightened human–wildlife conflict (Times of India News, 2025).In the aquatic realm, freshwater crabs ecologically important as detritivores and nutrient cyclers have come under pressure from unsustainable harvesting, particularly during monsoon breeding periods. This concern has led local fisheries authorities to issue advisories warning against crab catching during monsoon months to protect reproductive cycles and maintain ecological function (Times of India, 2025).

Avifaunal Diversity and Habitat Quality

Notwithstanding broader patterns of habitat degradation, certain water bodies in Beed, such as Majalgaon Reservoir and its tributaries, retain significant ecological value. A two-year avifaunal study documented the presence of 84 bird species representing 15 orders and 30 families, including a mix of resident and migratory waterbirds attracted by available water and associated vegetation (Pawar et al., 2018).These findings demonstrate that pockets of high habitat quality particularly well-maintained wetlands with sufficient water and vegetative structure can sustain robust biodiversity even within a generally water-stressed landscape. Such reservoirs act as critical refugia for avian communities and highlight the importance of local habitat conditions in determining faunal persistence.

3. Major Drivers of Habitat Loss in Beed

Climatic and Hydrological Stressors

Beed's semi-arid environment is characterized by frequent droughts, erratic rainfall, and declining groundwater levels. These climatic and hydrological stressors reduce the extent and quality of aquatic and riparian habitats, particularly in dry riverbeds such as the Bindusara (Bendsura) River, which often fails to sustain perennial flows (Wikipedia, 2025). The resultant contraction of wetland areas diminishes habitat suitability for many species, especially aquatic organisms and birds reliant on water bodies.

Vegetation Loss and Land-Use Change

Deforestation for fuelwood, construction materials, and agricultural expansion continues to erode natural vegetative cover in Beed. Key tree

species such as mango (Mangifera indica), neem (Azadirachta indica), and salai (Boswellia serrata) are subject to high extraction pressure, leading to recruitment failure and reduction of habitat complexity. The thinning of vegetative cover diminishes shelter and forage availability for a variety of wildlife, contributing to declines in local species diversity (Grokipedia – Beed profile).

Unsustainable Resource Use and Habitat Fragmentation

Agricultural intensification and livestock grazing, particularly in rain-fed regions with limited irrigation, contribute to habitat fragmentation and land degradation. Expansion of cropland often comes at the expense of natural grasslands and open habitats essential for many native species. Fragmentation interrupts landscape connectivity, limiting wildlife movement and reducing genetic exchange across populations, which can have long-term demographic consequences for faunal species (Mongabay India, 2019).

Role of Zoological Research in Conservation

Biodiversity Assessment and Monitoring

Rigorous scientific inventories and monitoring programs, such as avifaunal surveys and periodic wildlife censuses, provide essential baseline data on species richness, distribution, and population trends. These data are crucial for detecting early signs of faunal decline, identifying priority habitats, and assessing the effectiveness of ongoing management interventions.

Habitat Prioritisation and Restoration

Detailed ecological research allows conservation practitioners to prioritise habitats that are critical for faunal survival. For instance, wetlands that support diverse avian communities may be prioritised for enhancement through improved water management, invasive species control, and creation of vegetated buffer zones that reduce disturbance and improve ecosystem health.

Integrating Local Knowledge and Community Participation

Engaging local stakeholders including farmers, fishers, and village communities in biodiversity monitoring and habitat protection initiatives strengthens conservation outcomes. Participatory research methodologies empower residents to understand ecological processes, adopt sustainable practices, and contribute to data collection, creating a shared stewardship over natural resources.

5. Recommendations for Conservation and Future Research

Establish Long-Term Ecological Monitoring: Develop standardised monitoring protocols across terrestrial and aquatic systems to track faunal responses to habitat change over time.Habitat Mapping and Connectivity Analysis: Utilise spatial tools such as GIS and remote sensing to map habitat patches, corridors, and fragmentation patterns, identifying priority conservation areas.Water Resource Management Integration: Strengthen watershed conservation and water harvesting initiatives to enhance wetland habitats that support diverse aquatic and avian species.

Community-Led Conservation Initiatives: Implement co-designed research and action programs that involve local stakeholders in habitat restoration, sustainable land practices, and biodiversity stewardship.

Conclusion

Beed district exemplifies the combined impacts of climatic stress, water scarcity, vegetation loss, and land-use change on habitat quality and biodiversity. These pressures have resulted in measurable declines in faunal diversity across multiple ecological domains, from terrestrial mammals and reptiles to aquatic organisms and birds. Zoological research provides indispensable insights into the status and trends of wildlife

populations, the ecological drivers of habitat loss, and practical pathways for conservation action. By integrating scientific evidence with community engagement and supportive policy frameworks, it is possible to design and implement sustainable strategies that enhance habitat quality and promote faunal resilience in Beed's ecosystems.

References :-

1. Indian Districts.in (2025). Environmental overview of Beed district, Maharashtra: climate, flora, fauna, and water scarcity. https://indiandistricts.in/statistics/maharashtra/beed/environment/?utm_source=chatgpt.com
2. Times of India (2025). Beed freshwater crab conservation warning by Fisheries Department. https://times of india.indiatimes.com/city/aurangabad/fisheries-department-warns-against-crab-catching-during-monsoon-in-beed/articleshow/123533465.cms?utm_source=chatgpt.com
3. Pawar, R. T., Pathan, T. S., & Bhosale, Y. M. (2018). Avifaunal study of Majalgaon Reservoir and tributaries, Beed, Maharashtra. International Journal of Scientific Research in Biological Sciences. https://ijsrbs.isroset.org/index.php/j/article/view/246?utm_source=chatgpt.com
4. Wikipedia (2025). Bindusara River ecological context. https://en.wikipedia.org/wiki/Bindusara_Rive r?utm_source=chatgpt.com
5. Grokipedia (2025). Vegetation suppression and land degradation in Beed. https://grokipedia.com/page/Beed?utm_source=chatgpt.com
6. Mongabay India (2019). Marathwada drought and watershed conservation challenges affecting Beed region. https://india.mongabay.com/2019/04/marathwada-parched-as-watershed-conservation-remains-neglected/?utm_source=chatgpt.com
7. Times of India News (2025). Local example of leopard–livestock interaction in Beed. https://times of india.indiatimes.com/city/aurangabad/11-goats-killed-in-suspected-leopard-attack-in-village-news-beed- town/articleshow/122927795.cms?utm_source=chatgpt.com

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Rethinking Bird Diversity: Challenges and Opportunities for Sustainable Growth

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ABSTRACT

Bird diversity underpins essential ecosystem services—such as seed dispersal, pollination, pest control, and nutrient cycling—and serves as a key indicator of environmental health. However, global bird populations are experiencing alarming declines due to habitat loss, climate change, urbanization, and other anthropogenic pressures. This paper reviews the ***urgent challenges facing bird diversity****, explores emerging opportunities for sustainable growth in avian conservation, and proposes integrated strategies for safeguarding avian biodiversity within broader sustainability frameworks.*

1. Introduction

Birds are found across most terrestrial and aquatic ecosystems and play irreplaceable functional roles in the environment. Globally, bird diversity reflects the overall state of ecosystem health, making avian conservation a priority within sustainable biodiversity management frameworks. Despite conservation efforts, bird species continue to decline in many regions, prompting the need to rethink traditional conservation strategies and to integrate sustainable development goals with biodiversity protection.

2. The Ecological Importance of Bird Diversity

Birds contribute significantly to ecological processes: they disperse seeds, regulate insect populations, assist in pollination, and act as scavengers. Their sensitivity to environmental changes also makes them effective bioindicators for ecosystem monitoring and health assessment. Thus, preserving bird diversity supports broader ecosystem stability and resilience, which are essential for sustainable development.

3. Urgent Challenges to Bird Diversity

3.1 Habitat Loss and Land-Use Change

Habitat loss remains the dominant threat to birds worldwide. Agricultural expansion, deforestation, and urbanization reduce and fragment habitats essential for feeding, breeding, and migration. A global study showed that habitat modification reduces the number of species performing vital roles such as pollination and seed dispersal, thereby undermining ecosystem services.

3.2 Population Declines and Extinction Risks

Recent assessments indicate dramatic declines in global bird populations. In North America, nearly 75% of bird species are declining, including many formerly abundant species. Similarly, research suggests that over 500 bird species could go extinct within the next century without targeted conservation efforts, emphasizing the severity of the biodiversity crisis.

3.3 Climate Change and Extreme Events

Climate change alters habitat conditions, affects food availability, disrupts migration patterns, and can decouple breeding cycles from peak resource availability. These impacts contribute to

declining resilience among bird populations globally, particularly in sensitive ecosystems.

3.4 Urbanization and Environmental Stressors

Rapid urban growth, particularly in developing regions, is reshaping landscapes and biodiversity patterns. Unplanned urbanization reduces habitat quality and fosters homogenized bird communities dominated by generalist species at the expense of specialists—threatening ecological functions and resilience.

3.5 Wetland Degradation and Water Management

Wetlands support millions of resident and migratory birds, yet global wetland loss and mismanagement—especially in arid zones—severely restrict available habitats and annual migratory refuges for birds, diminishing regional biodiversity levels.

4. Opportunities for Sustainable Growth in Avian Conservation

4.1 Targeted Conservation and Recovery Programs

Large-scale protection alone may not be sufficient to prevent extinctions; however, combining threat reduction with targeted recovery programs can avoid substantial functional diversity loss among the most vulnerable bird species. Prioritizing key species with unique ecological roles can maximize biodiversity conservation outcomes.

4.2 Community Monitoring and Citizen Science

Citizen science initiatives—such as national bird monitoring programs—engage the public in data collection, improving long-term records of bird distribution and abundance. These datasets strengthen conservation planning and help track trends in bird populations over time.

4.3 Nature-Based Solutions and Multidisciplinary Planning

Integrating nature-based solutions into land management, urban planning, and climate mitigation strategies can benefit both biodiversity and human communities. Mapping areas where bird conservation aligns with carbon storage and human well-being can inform sustainable land use.

4.4 Technological Innovations in Monitoring and Conservation

Emerging technologies such as AI-assisted monitoring systems enable rapid detection of species and threats, enhancing conservation efficiency. For example, AI tools can detect and classify bird movements near wind turbines to reduce avian collisions, contributing to technology-enabled biodiversity protection.

4.5 Habitat Planning in Sustainable Urban Development

Strategic urban planning that preserves green spaces, restores riparian corridors, and implements land-sharing approaches can support avian diversity within urban landscapes, promoting resilience and ecosystem services even in densely populated areas.

5. Discussion

Reframing bird conservation strategies to address both biodiversity protection and sustainable development offers multidimensional benefits. Conservation actions must move beyond isolated protected areas toward inclusive frameworks that integrate climate mitigation, urban planning, community engagement, and technological innovation. Combining global commitments—such as those outlined in the Kunming-Montreal Global Biodiversity Framework—with localized conservation initiatives can enhance bird biodiversity outcomes while supporting wider ecological resilience.

6. Conclusion

Bird diversity is a cornerstone of ecological stability and sustainable ecosystem services. Yet, birds face urgent threats from habitat loss, climate change, urban expansion, and environmental degradation. Addressing these challenges requires a holistic approach that blends targeted conservation, community participation, science-based monitoring, and interdisciplinary planning. By rethinking how bird conservation aligns with sustainable growth, policymakers and practitioners can safeguard avian biodiversity while promoting resilient ecosystems for future generations.

References :-

1. Arya A.K., Bachheti A., Sethi V.K., et al. Birds and environment: a multidisciplinary approach to ecological, behavioural and conservation issues. BMC Zoology, 2024. (Springer)
2. Edwards D., Global bird study reveals declining ecosystem resilience, University of Cambridge Research, 2025. (University of Cambridge)
3. Collapsing bird numbers in North America prompt fears of ecological crisis, The Guardian, 2025. (The Guardian)
4. 'Extinction crisis' could see 500 bird species vanish within a century, The Guardian, 2025. (The Guardian)
5. Threat reduction must be coupled with targeted recovery programmes to conserve global bird diversity, Nature Ecology & Evolution, 2025. (Nature)
6. Common Bird Monitoring of India, Wikipedia. (Wikipedia)
7. A nature-based conservation framework that aligns opportunities for bird biodiversity, climate mitigation, and human equity, Scientific Reports, 2025. (Nature)
8. Designing the biodiversity-friendly city of the future: An avian community perspective, Landscape and Urban Planning, 2025. (ScienceDirect)
9. Sustainability and avian biodiversity tensions in wastewater management in arid zones, Biological Conservation, 2025. (ScienceDirect)
10. BirdRecorder's AI on Sky: Safeguarding birds of prey by detection and classification (AI application in conservation). (arXiv)

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A Critical Review of Digital Technologies In Agri-Food Processing

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ABSTRACT

An overview of current developments in the application of digital technologies in agri-food processing is given in this article. The agri-food sector must handle sustainability issues while simultaneously producing more food with less resources due to the rising demand for food. Food production, processing, and distribution are being revolutionized by digital technologies like blockchain, robotics, artificial intelligence, and the Internet of Things. Increased productivity, enhanced product quality and safety, decreased waste, and environmental sustainability are just a few advantages of these technologies. Real-time monitoring of vital factors like temperature, pH, and moisture is made possible by digital technologies, which can help stop food spoiling, cut down on food waste, and guarantee that consumers receive safe, high-quality food. The study covers anticipated future changes as well as the obstacles and opportunities for the sector to use digital technologies more widely.

Key Ward : Digital, agri, food ,technologies.

Introduction

From fundamental agriculture to the developed food and beverage industries, the agri-food business is a complicated, interconnected production chain. This strategy, referred to as "field to fork" (F2F), is regarded as one of the most crucial industries in the world, greatly advancing national economies and having a significant social impact.The manufacturing industry is robust and intricate, posing a variety of operational and process difficulties [1] The agri-food sector needs to come up with creative and sustainable ways to meet the demands of an expanding population while also increasing agricultural output and product quality. Technology is crucial to agri-food operations and decision-making, just like in any other industry.For instance, Internet of Things (IoT) technologies can be integrated with data-gathering or collection devices like drones and sensors. In order to inform agricultural stakeholders and support field management, these devices can interact with decision-support software [2]. This allows for efficient management of watering, harvesting, and the use of weed or pest control techniques .[3] Put more simply, the application of digital technologies in the agri-food industry seeks to solve sustainability issues by boosting profits and alleviating the burden on supply chain participants. By showing current patterns in needs, digital technologies can assist these players in responding promptly to complicated, external circumstances that are beyond their control, such as market behaviors, weather, and policies. This article discusses new digital technologies created to enhance the agri-food sector and evaluates more than 75 papers.

Current developments in digital technologies for quality assurance and food safety

An estimated 420,000 people perish and

600 million become ill after consuming tainted food each year. As a result, a risk-based approach to food production is required. This has also made it more urgent to create a more sustainable food system by utilizing creative approaches to food resilience while accounting for financial and environmental limitations .[4]By combining information and communication technologies like IoT, industrial IoT (IIoT), cobots, cloud computing, big data analytics, artificial intelligence (AI), digital twin (DT), blockchain, sixth-generation (6 G) communication technology, and machine learning (ML), Industry 4.0 can ensure food demand and food security sustainability. Digital applications of these technologies include data collecting, transmission, processing (e.g., evaluating food waste and visualizing the elements influencing food quality), management, and analysis.[5] By addressing problems and streamlining supply-chain operations, its implementation seeks to improve food security and integrity all the way from farm to consumer. Additionally, these technologies support waste management and cost reduction initiatives. The food traceability system could be enhanced by additional technologies like radio frequency identification and traceability software.We can greatly reduce the hazards associated with contaminated foods and establish a more secure and sustainable food system by emphasizing food safety and quality management and utilizing the potential of cutting-edge technologies. A strong framework that protects public health and guarantees that customers receive safe, high-quality food will be based on the integration of risk-based methods, creative solutions, and traceability measures.[6,7]

The application of digital technologies to agri-food processing

Electronic tools, systems, devices, and resources that can create, store, or process data are known as digital technologies. This covers software programs, Terms like "digital agriculture," "agriculture 4 0," and "digital agricultural revolution" are used in agriculture to refer to a strategy meant to increase the efficiency of food production. Each of these terms describes a strategy meant to increase the efficiency of food production. This efficiency is attained by using modern technologies (such as the Internet of Things, Big Data, artificial intelligence, cloud computing, remote sensing, etc.) and streamlining the transfer of high-quality data. higher production yields, better food product nutrition, higher transparency, better animal welfare, and greener production are just a few of the social, environmental, and economic objectives that can be attained through food system optimization.

Various digital technologies utilized in the processing of agricultural products

1. Artificial intelligence (AI): The theory and development of computer systems that can carry out activities that traditionally needed human intelligence, like speech recognition, decision-making, and pattern recognition, is known as artificial intelligence (AI). Natural language processing (NLP), deep learning, machine learning, and other technologies are all included under the general term artificial intelligence (AI). AI can be used in agri-food processing to automate processes like crop yield forecasts, food safety risk detection, and produce sorting, grading, and packaging. Additionally, it can be used to reduce poverty, minimize hunger, preserve natural resources, enhance food security, and attain self-sufficiency.

2.Internet of Things (IoT): Physical items with embedded sensors, computing power, software, and other technologies that link and share data with other systems and devices over the Internet or other communication networks are referred to as the Internet of Things (IoT). In the agri-food sector, the majority of IoT uses of digital technologies concentrate on tracking temperature, traceability, humidity, color, and enhancing sustainability performance. IoT can be used to monitor other factors including temperature, humidity, soil composition, and crop physiology, which can offer data for more precise crop monitoring.

3.Big data (BD) technologies: The term "big data" mostly describes data sets that are too big or complicated for conventional data processing technologies to handle. Three main areas make the integration of BD technologies in agri-food projects crucial: i) the extension of farmers' data to produce new knowledge; ii) the development of innovative

services and processes by software developers and IT providers; and iii) the extension and adaptation of BD models connected to ICT and Factories of the Future (FoF) for agriculture. There are currently many Big Data repositories that guarantee the use and accessibility of Agri-Food data.

4.Automation and robotization: Robots and machines may now carry out duties that were previously completed by humans thanks to digital technologies. The food industry's shift to smart factories is being accelerated by automation and robotization, which are also propelling the development of smart agriculture. Robotic technology can increase productivity and lower labor costs in agri-food processing by automating processes including seeding, planting, weeding, picking, handling, harvesting, cutting, slicing, and packaging.

5.Blockchain: Blockchain is a shared, unchangeable digital ledger that offers a single source of truth and makes it possible to track assets and record transactions inside a business network. With data spread over several computers, blockchain functions as a decentralized distributed database that is impervious to manipulation. the its many benefits in guaranteeing food traceability, transparency, safety, and security, this technology's use in the agri-food supply chain has progressively expanded.

Conclusion

In conclusion, digital technologies give the agri-food sector a revolutionary chance with major benefits in terms of productivity, food safety, sustainability, and transparency. The growing use of internet of things, artificial intelligence, blockchain, and robotics in agri-food processing demonstrates effective applications and portends a bright future. However, resolving important issues is necessary if these technologies are to reach their full potential. All parties involved in the agri-food industry must work together to overcome the significant obstacles posed by cost, technological accessibility, technical know-how, and opposition to change.In light of this, focused developments in particular areas of digital technology, like blockchain, autonomous systems, big data and analytics, 3D printing, virtual and augmented reality, and more, have enormous potential for the sector. For the benefit of farmers, food processors, and consumers, the agri-food industry has the chance to develop sustainability, efficiency, and transparency through ongoing innovation and partnerships.

References :-

1. H. Panetto, M. Lezoche, J.E. Hernandez Hormazabal, M. del Mar Eva Alemany Diaz, J. Kacprzyk Special issue on Agri-Food 4.0 and digitalization in agriculture supply chains New directions, challenges and applications Computers in Industry, 116 (2020), Article 103188
2. A. Glaros, D. Thomas, E. Nost, E. Nelson, T. Schumilas Digital technologies in local agri-food systems: Opportunities for a more interoperable digital farmgate sector Frontiers in Sustainability, 4 (2023), Article 1073873,
3. S. Fountas, B. Espejo-García, A. Kasimati, N. Mylonas, N. Darra The future of digital agriculture: Technologies and opportunities IT Profession, 22 (2020), pp. 24-28,
4. S. Guruswamy, M. Poji´c, J. Subramanian, J. Mastilovi´c, S. Sarang, A. Subbanagounder, G. to janovi´c, V. Jeoti Toward better food security using concepts from industry 5.0 Sensors, 22 (2022), p. 8377
5. M. Flamini, M. Naldi Maturity of industry 4.0: A systematic literature review of assessment campaigns Journal of Open Innovation: Technology, Market, and Complexity, 8 (2022), p. 51
6. J. Ingram, D. Maye What are the implications of digitalisation for agricultural knowledge? Frontiers in Sustainable Food Systems, 4 (2020), p. 66
7. V. Raja, S. Krishnamoorthy, J.A. Moses, C Anandharamakrishnan ICT applications for the food industry R. Bhat (Ed.), Future foods, Academic Press, Cambridge, MA, USA (2022), pp. 613-626

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Need of Preseason Agriculture And Proces of Smart Farming

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ABSTRACT

Precision agriculture, often known as precision farming, is a farming approach that optimizes agricultural processes by the use of technology. Precision agriculture aims to boost output, minimize waste, and protect the environment. Precision agriculture includes collecting and interpreting data on crop health, soil conditions, and weather patterns using modern technology such as sensors, GPS, and data processing. This information is then utilized to make better decisions regarding farming, fertilizing, irrigation, and other agriculture-related activities so that productivity can be increased without any adverse effect by maximizing resource input efficiency. Precision agriculture can be defined as: "the application of modern information technologies to provide, process and analyse multisource data of high spatial and temporal resolution for decision making and operations in the management of crop production" With the help of technology, agriculture may become more profitable while having a less negative environmental effect. Precision agriculture is an integrated crop management system that aims to optimize the inputs with the actual crop demands. It makes use of the most modern advancements in micro irrigation, sensor networks, greenhouses, and protected agricultural structures involving precise application use of agricultural inputs depending.

Keywords – precision, technology, GPS, resolution, optimize

Introduction :

economy, contributing over 13% of the GDP and providing jobs for 70% of the population. Agriculture is a complex system depending on the interaction of resources like soil, water, agrochemicals, labour and even on climatic conditions prevailing in a particular region. The world population is predicted to reach 9.6 billion by 2050, requiring food production to nearly quadruple from present levels to feed every mouth. The growing demand for food with the increasing population has made it essential for the judicious use and management of these resources.

An important factor affecting agriculture is climate change, causing agricultural yields to be lower and there will be a greater need for food supply. Climate change might have an impact on irrigated agriculture productivity across all agro ecological zones due to temperature increases and changes in water supply. By 2050, our water demand will exceed the available supply. Our irrigated area needs to increase from 79 million ha to 146 million ha to accomplish a higher food output of 494 million tons by 2050. It is also certain that the availability of labour for agricultural activity is going to be in short supply in future. Therefore, to overcome these challenges, a combination of agricultural science and information technology for more efficient, economically viable, and ecologically sustainable crop production is needed, which is

termed precision agriculture.

Background

Precision agriculture has been around for several decades. The use of aerial photographs and yield maps dates to the 1960s. Precision agriculture has its roots in the United States, where the first commercial GPS was introduced in the 1980s. This technology was quickly adopted by farmers, who used it to track the location of farm machinery and sensors, allowing them to apply inputs precisely where and when they were needed. However, it was not until the 1990s that precision agriculture started gaining widespread popularity with the development of Global Positioning System (GPS) technology and Geographic Information System (GIS). Over the years, precision agriculture has evolved to include a range of other technologies, such as sensors, drones, and artificial intelligence. Today, precision agriculture is practised in many parts of the world and rapidly growing in popularity due to its many benefits.

Objective

Assessing and managing field variability: It includes information regarding variation in soil properties, environmental characteristics and management practices.

Doing the right thing in the right place at the right time: It enables decisions to be made and applied at the appropriate time and in the correct location considering spatial and temporal variability.

Increasing the effectiveness of inputs: Efficient use of inputs by their proper distribution and target-based application. 485 High Value Agriculture.

Maximising usage of minimum land unit: Each land unit can be used by the farmer more productively after knowing about the condition and status of the field.

BASIC STEPS IN SMART FARMING

1. Assessing variability: The first step in precision farming is to assess variability. Because one cannot manage what one does not understand. Factors that affect the crop yield vary both spatially (in space) and temporally (with time). This quantification of variability is a challenging aspect of precision farming. Various techniques are available for measuring this variation and are being extensively used. Many of the tools in precision farming are used for determining the spatial variability rather than the temporal variability.

2. Managing variability: After properly assessing the variability, the farmer has to provide inputs according to the variability of the field. This application is site-specific to effectively manage spatial variability. Global Positioning System (GPS) is used for noting the site coordinates to avoid any wastage and for the right distribution of the inputs. The more spatial variability in a field more the potential and value of precise management. However, the difficulty grows as the temporal component of spatial variability increases. When applied to soil fertility, this theory would support the notion that phosphorus and potassium fertility are extremely favourable to precision management due to low temporal variability. In some circumstances, the temporal component of variability for N might be greater than the spatial component, making precise N control considerably more challenging.

3. Evaluation: Precision agriculture evaluation involves three main spheres- (a) Economic, (b) Environmental and (c) Transfer of Technology. Evaluation of the precision framing is done in terms of the resulting potential benefits which are mainly the environmental benefits occurring by adopting technological interventions. Reduced pesticide usage, greater nutrient use efficiencies, increased efficiency of controlled inputs, and enhanced soil productivity from degradation are some of the gains of precision farming. The use of technology can enhance production efficiency and make precision. High Value Agriculture farming more feasible and profitable. Technology transfer involves how to interact with the farmers. The concerns related to the operator's management skill, the spatial distribution of infrastructure, and the compatibility of technology with particular farms will alter dramatically as precision agriculture advances.

Precision agriculture is based on four key principles:

1. Site-specific crop management:

The system focuses on managing different portions of a field according to their distinct qualities and requirements. Farmers may administer inputs such as chemical fertilizers, water, and herbicides

precisely where and when they are required by using data on soil type, moisture levels, topography, and other parameters. This reduces waste and improves efficiency.

2.Data-driven decision-making: Precision agriculture is based on data collection and analysis to make crop management decisions. This involves employing sensors, drones, and other technologies to monitor crop growth, soil health, weather conditions, and other elements that impact crop yields and quality.

3.Automation and robotics: Precision agriculture entails the use of robots and automated systems to accomplish activities such as planting, harvesting, and crop monitoring. This can save labour costs and increase efficiency, while also allowing farmers to collect more precise agricultural data.

4.Sustainability: Precision agriculture strives to reduce waste and environmental effects by using resources more efficiently and decreasing the need for toxic pesticides and other inputs.

TECHNOLOGIES AND TECHNIQUES USED IN PRECISION AGRICULTURE

1.Data Process and Decision-Making Technologies.

i. Geographic Information System (GIS): Geographic Information Systems (GIS) includes computer hardware and software systems that generate maps by combining different features and location data. GIS is used to analyse and manage spatial data, such as crop yields, soil types, and weather patterns. GIS maps store a lot of information in the form of layers like yield, soil type, rainfall, soil nutrients, etc. It involves statistical and spatial methods to analyse the geography and characteristics of the field. It can also extrapolate the information to the locations on the field with no recorded data based on spatial variability.

ii. Machine learning and artificial intelligence: Artificial intelligence and machine learning have a huge potential to revolutionize Precision agriculture. Large amounts of data from satellites and sensors can be used to generate information about crop and soil conditions. The algorithm's training of historical data along with real-time sensing can be used to recognise patterns with the help of machine learning tools to predict and indicate crop health, nutrient deficiency and crop stresses which would help the farmer to take the right measures at the right time for improving the crop yield. Machine learning can help farmers identify the water and nutrient requirements and can also help in forecasting the yield of the crops.

iii. Geo-mapping: GIS, satellite and sensor data can be used to produce maps like soil maps, nutrient levels etc., and assign that information to the field location.

2. Data Collection Technologies

i. Global positioning system (GPS): GPS are satellite-based navigation systems that let the farmer know about the exact features of the field. A farmer can know about the field boundaries, soil type, soil fertility, invasion of pests and weeds, crop yield, etc. and create precision maps. It includes a Differential Global Positioning System (DGPS), antenna and receiver and provides the information in real-time. The farmer can depend on the system for precise application of inputs like seeds, fertilizers, pesticides and also water for irrigation. GPS is also used to guide the machinery movement and track the location of farm equipment.

ii. Remote sensing: It involves using satellites, sensors and drones for data collection on environmental factors like temperature and humidity, crop health, soil moisture, etc. Remote sensing data can be helpful to farmers in locating stress conditions on the farms, differentiating between various crop species, monitoring their health, identifying pests and weeds, drought monitoring, etc. Aggregated images can be used for creating contour maps for tracking the flow of water, determining variable-rate seeding, and creating yield maps of areas with varied levels of productivity.

Some of the applications of remote sensing are given below:

- information on soil characteristics like texture and soil structure.
- nutrient level of the soil.
- plant population and plant nutrients.
- water shortage.
- Crop yield monitoring.
- Monitoring the movement of fertilizers and detecting weed invasion Precision Agriculture.

iii. Grid soil sampling: Grid sampling follows similar principles of soil sampling but with increased intensity of sampling. Soil samples collected in a systematic grid include the location information and hence can be mapped. It involves dividing a field into grids of around 0.5-5 hectares. Several samples are obtained from each grid, combined, and delivered to the laboratory for examination. Soil sampling utilizing a digitally mapped grid with geo-referenced points can help growers gain a more precise picture of nutrients and soil pH at any one moment and the variance from year to year.

iv. Yield Monitoring and Mapping: Yield monitors continuously measure the amount of grains collected in the combine. These monitors can be connected with GPS to collect the data for creating yield maps. This information can be useful for evaluating and managing the effects of inputs like fertilizers, pesticides, farming operations like irrigation and tillage, etc. on crop production. Yield information also helps in determining how the changing climate has influenced production so that proper management decisions can be taken.

v. Crop scouting: Crop scouting is the monitoring, inspection, or surveillance of a crop for general plant health, including insect pests, diseases, nutritional issues, etc. The advancement of precision agricultural technologies has immensely benefited farmers in crop scouting. Farmers keep precise logs of their fields using smart devices like computers and mobile phones. The evolution of global positioning systems (GPS) and unmanned aerial vehicles (UAVs) has helped farmers High Value Agriculture to detect damaged seeds, early signs of pests, soil moisture issues, and post-spray pesticide or fertilizer performance, helping them to improve yield, and maximize crop efficiency and provide site-specific management to the field.

3.Application Technologies

i. Variable-rate technologies (VRT): VRT is used to adjust the rate of inputs such as fertilizers, pesticides, and irrigation based on soil conditions and crop needs. VRT systems are automated to deliver the inputs based on the soil requirements. For example, if a farmer wants to control the fertilizer application in his field, soil samples must be collected in a systematic manner known as grid soil sampling to map the soil data to generate a nutrient requirement map of the field. This map is then loaded to a computer connected with a variable rate spreader for fertilizer application which according to the map and GPS information controls the amount and kind of fertilizer distribution.

ii. Auto-Guidance systems: These systems enable the farmer to navigate the vehicles and their equipment with the help of GPS and sensors with a high degree of accuracy. This system reduces human error and reduces resource usage saving farmers money. For instance, an auto-steering system assists the farmer with the help of navigation systems like GPS allowing more accurate driving. The farmer can focus on the working of the equipment attached to the vehicle. Intelligent guiding systems provide guidance patterns based on the geometry of the field and eliminate chances of overlapping reducing the overuse of resources. Auto-guidance systems can also be useful for record-keeping and analysis by storing information about the location and movements of vehicles and equipment.

iii. Agricultural Robots: Agribots or Agbots have transformed traditional agriculture into smart agriculture. Overdependence on primary sector economic activities such as agriculture is a big concern for emerging nations such as India. Agribots have reduced the dependency of farmers on manual labour. Agricultural robots help in performing various farm operations like harvesting, spraying, irrigation, weed control, seeding, etc. Now advanced fruit-harvesting robots are being created that can recognise ripe fruits, adapt to their size and form, and delicately pick them off trees.

iv. Automatic irrigation systems: Irrigation systems are automated with sensors, computers, timers and other devices. Automatic irrigation systems consist of three main components-a microcontroller, motor driven circuit and sensor circuit. Such systems need minimum farmer intervention as the farmer can manage and regulate irrigation without visiting the field. Using automatic irrigation systems has resulted in effective usage of water and increased yield. A study has revealed that there was up to 90% of water saving by using automated irrigation systems. These systems work

by continuously monitoring the soil moisture and other parameters like temperature on a real-time basis. The sensor senses the moisture levels and sends feedback to the system, activating the pump only when the moisture level gets depleted. Hence the system provides water to the plants at the right time and in the right amount.

STATUS OF PRECISION FARMING IN INDIA

The market for precision farming is anticipated to grow at a CAGR of 8% and reach $14.6 billion by 2026. Despite its infancy in India; precision farming has the potential to help make that nation the world's top producer of agricultural goods by increasing farm profitability and efficiency.

The adoption of precision agriculture in India faces two major challenges:

- Due to its distinct pattern of land ownership, inadequate infrastructure, lack of farmers' willingness to take on the risk, social and economic circumstances, and demography, India is still at the early stages of precision farming adoption.
- The small size of most Indian agricultural landholdings restricts economic returns from currently available precision farming equipment. Over 58% of land holdings in the nation are smaller than 1 hectare. Only the states of Gujarat, Punjab, Rajasthan, and Haryana, where more than 20% of the land is used for agriculture, have operational holding sizes of more than 4 hectares.

Precision farming research is being supported by the Indian Council of Agricultural Research, State Agricultural Universities, and the National Committee on Plasticulture Applications in Horticulture. Different State governments, the Ministry of Agriculture, the Ministry of Water Resources, and others have funded promotional campaigns for precision agricultural technologies. The Government of India has set up 22 Precision Farming Development Canter's (PFDCs) across the nation to create and promote regionally specific Precision Farming Technologies like Micro Irrigation and High-Tech Agriculture like Plasticulture, protected cultivation, vertical farming, hydroponics, aeroponics, sensor development and automation, DSS development, and fertigation for maximizing the production and productivity per unit area to benefit the farmers' and consumers' socioeconomic circumstances. These 22 PFDCs are located in State/Central Agricultural Universities (SAUs), ICAR Institutes and IITs in the States of Karnataka, Madhya Pradesh, Odisha, Rajasthan, Tamil Nadu, Haryana, Telangana, West Bengal, Ladakh, Uttar Pradesh, Punjab, Gujarat, Uttrakhand, Maharashtra, Chhattisgarh, Jharkhand, Bihar, Himachal Pradesh, Kerala, Manipur, Assam.

CONCLISION

a) Increased crop yields and reduced Costs Farmers may enhance their crop management procedures and increase yields by employing precision agriculture techniques. It helps to High Value Agriculture guarantee that crops are not over or under-fertilized or irrigated by allowing them to alter the quantity of fertilizer, water, and other inputs according to soil conditions and crop demands. This in turn will help the farmer to cut their input costs. Farmers can use inputs more effectively and avoid waste by adjusting crop management techniques.

b) Efficiency improvement Farmers may use modern tools, equipment, and information to boost the productivity of their labour, land, and time resulting in an overall increase in agricultural production efficiency.

c) Improved sustainability by reducing pesticide use and enhancing soil health, precision agriculture may assist farmers in lessening their negative environmental impacts. Precision agriculture may cut pollution and conserve wildlife by using lesser amounts of pesticides. Precision agriculture can assist in preventing erosion and enhance water quality by enhancing soil health.

d) Better decision-making Farmers can make better decisions regarding crop management by adopting precision agriculture. The information collected

about the field, crop and weather conditions can help the farmer make better decisions regarding the application of inputs like seeds, fertilizers, pesticides and various farm activities like harvesting.

Precision agriculture has emerged as one of the potential approaches for agricultural growth which encourages using the appropriate inputs in the right amounts at the right time and location using the correct technologies or procedures. The use of technologies and tools like GIS, GPS, Remote sensing, VRT, sensors, precision maps, artificial intelligence and robotics have made it possible for the farmers to have an insight into the spatial and temporal variability in the field. Such technologies and tools equip farmers to use inputs more efficiently while reducing the adverse impact on the environment. Precision agriculture, which combines several technologies, enables site-specific management of the farm for both economic and environmental benefits.

References :-

1. Ministry of Agriculture and Farmers Welfare. Agricultural Statistics at a Glance 2024. New Delhi: Government of India; 2024.
2. Zhang N, Wang M, Wang N. Precision agriculture—a worldwide overview. Comput Electron Agric. 2022;36(2-3):113-32.
3. Bongiovanni R, Lowenberg-Deboer J. Precision agriculture and sustainability. Precis Agric. 2024;5(4):359-87.
4. Mondal P, Basu M. Adoption of precision agriculture technologies in India: A village level study. Technol Forecast Soc Change. 2023;91:226-38.
5. Balafoutis A, Beck B, Fountas S, Vangeyte J, Van der Wal T. Precision agriculture technologies positively contributing to GHG emissions mitigation, farm productivity and economics. Sustainability. 2024;9(8):1339.
6. Kumar A, Singh R, Sharma DK. Challenges and opportunities in Indian agriculture: A comprehensive review. Agric Syst. 2023;156:45-62.
7. Pathak H, Saharawat YS, Gathala M, Ladha JK. Impact of resource-conserving technologies on productivity and profitability of rice-wheat system. Crop Prot. 2024;40:116-21.
8. Pierce FJ, Nowak P. Aspects of precision agriculture. Adv Agron. 2023;67:1-85.

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Fungal Diseases' Prevalence And Impact on Chilli At Different Growth Stages In Jalna District

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ABSTRACT

The present study documents the stage-wise occurrence and intensity of major fungal pathogens affecting the crop during sapling, vegetative, and reproductive phases. The results revealed clear variation in pathogen prevalence across crop growth stages. Pythium aphanidermatum and Rhizoctonia solani were predominantly associated with the sapling stage, showing high to moderate incidence, while their presence declined in later stages. Fungal pathogens such as Alternaria alternata, Alternaria solani, Cercosporacapsici, Colletotrichum capsici, and Colletotrichum gloeosporioides were more prevalent during vegetative and reproductive stages, with A. solani and C. capsici showing the highest intensity during reproductive growth. Fusarium oxysporum and Verticillium dahliae were mainly detected during sapling and vegetative stages but were absent during reproduction, whereas Fusarium solani showed a contrasting pattern with higher incidence at the sapling stage. Leveillula taurica and Phytophthora capsici exhibited moderate occurrence across vegetative and reproductive stages. Overall, the study highlights distinct stage-specific dominance of fungal pathogens, emphasizing the importance of growth-stage–based disease management strategies for effective crop protection.

KEY WORDS: Prevalence, Chilli,Fungal Diseases, Jalna

INTRODUCTION

Capsicum is also known as chilli. It belongs to the Solanaceae family, which has been around for about 9500 years. Originally cultivated in Peru around 7500 BC, it is a native of Southern America (MacNeish, 1964). It has good levels of thiamine, riboflavin, vitamin A, vitamin C, and capsaicin. It contains around 8.8 grams of carbohydrates, 5.3 grams of sugar, 1.9 grams of protein, and 534 micrograms of â-carotene per 100 grams, according to Panda et al. (2010). The climate in India is perfect for cultivating a wide range of chilli plants. China, which generates roughly 4 lakh tones annually. 11 lakh tones of the world's production come from India.

Maharashtra, Gujarat, Andhra Pradesh, Tamil Nadu, and Kashmir are the states that produce the most chillies. Although it was grown year-round, the primary growth season is February through April. Numerous fungal diseases attack the chilli crop at various stages of development. These are mostly anthracnose, powdery mildew, Cercosporaleaf spot, root rot disease, and damping off. The present study investigates the different phases of fungal diseases that impact chillies from the region of Jalna district.

MATERIALS AND METHODS

In the Jalna district, diseased samples were collected from various local marketplaces and farms used for cultivating chillies. Critical analysis

was done on the symptoms the infection causes on the plant's leaves, stems, and fruits. In order to isolate and identify the disease-causing microorganisms, samples showing typical signs of fruit rot were collected from nearby markets and chilli growing areas then transportedin plastic bags to the study lab.

The available literature, which included manuals and monographs, was used to identify isolated fungal types. Barnet and Hunter (1972), Ellis (1971), Thom and Raper (1945), Gilman (1959), Nagamani et al. (2006), and Mukadam et al. (2006).

RESULTS AND DISCUSSION

Jalna district is famous for commercial and research cultivation of Chilli. It was evident that at sapling stage Alternaria alternata, Alternaria solani, Colletotrichum capsici, Fusarium oxysporum, Fusarium solani, Phytophthora capsici, Pythium aphanidermatum, Rhizoctonia solani, Sclerotiumrolfsii, and Verticillium dhaliae. Vegetative stage crop was dominated by Alternaria alternata, Alternaria solani, Phytophthora capsici, Colletotrichum capsici, Colletotrichum gloeosporioides, Fusarium solani, Leveillula taurica, and Phytophthora capsici.

Fungal incidence on Chilly from Jalna

Name of Fungi	Crop Stages		
	Sapling	Vegetative	Reproductive
Alternaria alternata	+	++	++
Alternaria solani	–	++	+++
Cercosporacapsici	–	+++	++
Colletotrichum capsici	+	+	++
Colletotrichum gloeosporioides	–	++	++
Fusarium oxysporum	+	++	–
Fusarium solani	++	–	+
Leveillula taurica	–	++	+
Phytophthora capsici	++	+	+
Pythium aphanidermatum	+++	–	–
Rhizoctonia solani	++	–	–
Sclerotium rolfsii	+	+	–
Verticillium dhaliae	+	+	–

(+++) = High, (++) = Medium, (+) = Low, (-) = Absent

Alternaria alternata was observed at the sapling stage at a low level and showed moderate incidence during both vegetative and reproductive stages. Alternaria solani was absent during the sapling stage but showed moderate infection in the vegetative stage and a high level of incidence in the reproductive stage. Cercosporacapsici was not detected in saplings, showed high incidence during the vegetative stage, and moderate occurrence during the reproductive stage. Colletotrichum capsici occurred at low levels during both sapling and vegetative stages and increased to moderate levels during the reproductive stage, while Colletotrichum gloeosporioides was absent in saplings but showed moderate presence during vegetative and reproductive stages.

Fusarium oxysporum was present at low levels during the sapling stage, increased to moderate levels during vegetative growth, and was not observed in the reproductive stage. In contrast, Fusarium solani showed moderate incidence at the sapling stage, was absent during the vegetative stage, and reappeared at a low level during the reproductive stage. Leveillula taurica was absent in saplings, moderately present in the vegetative stage, and occurred at low levels in the reproductive stage. Phytophthora capsici showed moderate incidence at the sapling stage and low incidence during both vegetative and reproductive stages. Pythium aphanidermatum was highly prevalent at the sapling stage but was not detected during vegetative and reproductive stages, while Rhizoctonia solani showed moderate occurrence only at the sapling stage. Sclerotium rolfsii and Verticillium dahliae were present at low levels during both sapling and vegetative stages but were absent during the reproductive stage.

References :-

1. Barnett H and Hunter B. B., 1972. Illustrated genera of imperfect Fungi. 3rd ed. Burgers publishing Company USA. 241.
2. Ellis M. B., 1971. Dematiaceus Hyphomycetes. Kew Surrey UK: Commonwealth Mycological Institute.
3. Gilman, J.C., 1959. A manual of soil fungi. Published by Oxford and IBH publishing co. 2nd ed. pp.449.
4. MacNeish RS. 1964. Ancient Meso American civilization. Science.;143 (3606):531-537
5. Mukadam D.S., Patil M. S., Chavan A. M., and Patil A. R. 2006. "The Illustrations of Fungi." Sarswati publication, Aurangabad.
6. Nagamani A., Kumar I. K. and Manoharachary C. 2006. Hand Book of Soil Fungi, I.K. International Publishing House Pvt Ltd, New Delhi, India.
7. Panda, R., Panda, H., Prakash, K., and Panda, A. 2010. Prospects of Indian Chillies. Science tech entrepreneur, pp. 8.
8. Thom and Raper 1945. A manual of the Aspergilli, Baltimore, the Williams & Wilkins Company.

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National Geospatial Policy 2022 as a Geospatial foundation for Viksit Bharat 2047

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ABSTRACT

The National Geospatial Policy (NGP) 2022, notified on December 28, 2022, sets a long-term vision to 2035 to liberalize and democratize India's geospatial ecosystem, enabling seamless access, innovation, and cross-sector adoption of geospatial data and services. By opening the mapping ecosystem to domestic industry, academia, and government, NGP 2022 aims to catalyse precision planning, digital governance, and resilient infrastructure for core enabling conditions for Viksit Bharat 2047. Its emphasis on standards, open access, public-private collaboration, and mission-mode applications links geospatial intelligence with inclusive, smart growth across sectors such as land administration, urban development, logistics, environment, and disaster risk reduction. The broader vision frames geospatial capabilities as the "nervous system" for India's development journey to 2047, supporting digital twins, real-time decision-making, and last-mile service delivery.

Keywords: Geospatial Policy Framework, Viksit Bharat 2047 Vision, Digital Public Infrastructure (DPI, Geospatial Intelligence Systems, Public-Private Collaboration Models,

Objective:

1. To enable open geospatial access, the policy seeks to reduce institutional and technical barriers to high-quality, up-to-date spatial data, thereby facilitating its use in governance, industry, and research. This openness is intended to spur innovation, strengthen domestic capability, and democratize the geospatial ecosystem.
2. To standardize and integrate geospatial resources, the policy emphasizes the adoption of interoperable standards, registers, and platforms. Such integration will ensure that geospatial information functions as a reliable and consistent layer of digital public infrastructure across diverse sectors of the economy and society.
3. To catalyse national priorities, the policy aims to align geospatial missions with critical developmental agendas, including land records modernization, urban transformation, logistics efficiency, environmental stewardship, and disaster resilience. These applications are positioned as essential enablers for realizing the vision of Viksit Bharat 2047.
4. To foster competitive ecosystems, the policy seeks to empower Indian companies to compete globally by providing clarity in regulatory frameworks, encouraging the adoption of modern technologies, and expanding market access in mapping and geospatial services. This objective underscores the role of geospatial innovation in advancing "Atmanirbhar Bharat" and enhancing India's global competitiveness.

Introduction:

The National Geospatial Policy (NGP) 2022, formally notified by the Government of India, represents a landmark initiative aimed at positioning the country as a global leader in the geospatial domain. By liberalizing access to mapping data, modernizing technical standards, and mainstreaming geospatial applications across governance, industry, and academia, the policy seeks to transform India's spatial data ecosystem into a dynamic, innovation-driven framework. Its long-term horizon, extending to 2035, reflects a phased approach toward building a mature geospatial infrastructure that is both inclusive and sustainable.

In the broader developmental context, the policy assumes strategic significance for the realization of **Viksit Bharat 2047**, the national vision of a fully developed India by the centenary of independence. Geospatial intelligence is encompassing spatial analytics, digital twins, and real-time monitoringis also conceptualized as a critical layer of digital public infrastructure. It enables precision planning, efficient execution, and equitable delivery of services by linking locational information about assets, populations, risks, and opportunities to governance processes. Thus, NGP 2022 is not merely a sectoral reform but a foundational instrument for advancing accountable governance, fostering domestic innovation, and ensuring inclusive growth in alignment with India's long-term developmental aspirations.

1. Evaluating Policy Provisions for Strategic Alignment with Viksit Bharat 2047 Objectives"

Introduction:

The National Geospatial Policy (NGP) 2022 establishes a comprehensive framework for the liberalization, standardization, and integration of geospatial data in India. To assess its long-term developmental impact, it is essential to evaluate the specific policy provisions in relation to the strategic objectives of "Viksit Bharat 2047**"**, which envisions India as a fully developed nation by its centenary of independence. This evaluation highlights how the clauses of NGP 2022 are ranging from open data access and interoperability standards to mission-mode applications and public-private collaboration an align with national priorities such as precision governance, inclusive growth, environmental resilience, and technological self-reliance. By systematically analysing these provisions, the study underscores the role of geospatial intelligence as a foundational enabler for achieving the transformative aspirations of Viksit Bharat 2047.

1.1 Access liberalization and democratization:

Access liberalization and democratization under the National Geospatial Policy 2022 means making geospatial data freely available, easier to use, and open to all stakeholders, government, private industry, academia, and citizens of India, so that innovation and inclusive development can flourish.

a) Access Liberalization: This refers to removing restrictions and bureaucratic hurdles around geospatial data that were earlier tightly controlled by government agencies like the Survey of India. Before 2022 the high-resolution maps, satellite imagery, and elevation data were restricted. Private companies or researchers had to go through lengthy approvals, often discouraging innovation. After NGP 2022, the policy allows open access to topographical maps, digital elevation models, and satellite imagery for Indian entities without prior approvals.e.g.A startup working on drone-based precision agriculture can now directly access high-resolution maps and overlay them with crop health data, helping farmers optimize irrigation and fertilizer use. Logistics companies can use open geospatial datasets to plan efficient delivery routes, reducing fuel costs and improving service.

b) Democratization: This means making geospatial data usable by everyone, not just specialized government agencies or large corporations. The policy encourages open platforms, common standards, and shared registries so that data can be integrated easily across sectors. It also promotes citizen participation, e.g. crowdsourced mapping of local infrastructure, disaster-affected areas, or environmental monitoring. e.g. Urban planning: Citizens and local bodies can use open geospatial platforms to map potholes, water pipelines, or waste collection points,

feeding into smart city dashboards. Disaster management: During floods, NGOs and communities can access satellite imagery and elevation models to identify safe zones and plan relief distribution. Education: Universities can freely use geospatial datasets for teaching GIS and remote sensing, without needing special licenses. By democratizing access, even small startups, rural innovators, and local governments can harness geospatial intelligence.Liberalized access reduces duplication of effort and speeds up project execution. Domestic companies can build indigenous solutions instead of depending on foreign mapping services.Access liberalization removes barriers, while democratization ensures everyone can benefit.

1.2 Standards, interoperability, and registries:

In the National Geospatial Policy 2022, "standards, interoperability, and registries" are about ensuring that geospatial data from different sources can work together seamlessly, be trusted, and be reused across sectors. This makes geospatial information a reliable layer of India's digital public infrastructure for "Viksit Bharat 2047".

a) Standards: Standards define how geospatial data is collected, stored, and shared so that it is consistent and accurate. The NGP 2022 emphasizes adopting internationally recognized standards (ISO, OGC: Open Geospatial Consortium) while tailoring them to Indian needs. e.g. Land records digitization under "Digital India Land Records Modernization Programme" (DILRMP) uses standardized cadastral mapping formats so that maps from different states can be integrated into a national platform. Satellite imagery from ISRO and drone surveys can be layered together because they follow common metadata and coordinate standards.

b) Interoperability: Interoperability ensures that datasets from different agencies, technologies, or states can "talk" to each other. NGP 2022 calls for interoperable platforms so that geospatial data can be integrated with other digital public goods like Aadhaar, UPI, or logistics networks. e.g. **Smart Cities Mission:** Utility maps (water, electricity, sewage) are interoperable with urban planning GIS, allowing city dashboards to show real-time service delivery. **Agriculture:** Soil maps, weather data, and crop health imagery can be combined to give farmers precision advisories. **Disaster management:** Flood maps from the Central Water Commission can be integrated with satellite rainfall data and local evacuation routes, enabling coordinated response.

c) Registries: Registries are authoritative reference databases that act as "single sources of truth" for geospatial identifiers.NGP 2022 promotes **national registries** for addresses, parcels, and infrastructure to avoid duplication and ensure reliability. e.g. **National Spatial Data Infrastructure (NSDI):** Acts as a clearinghouse where ministries and states upload standardized datasets for public use.**Address registry:** A national digital address database linked to geospatial coordinates can help in e-commerce deliveries, emergency services, and census operations.**Environmental registry:** Mapping wetlands, forests, and biodiversity hotspots ensures consistent monitoring and reporting for climate commitments.

d) Data Illustration: Survey of India's Open Series Maps (OSM): Now freely available in standardized formats, enabling startups to overlay transport or demographic data.**National Urban Digital Mission (NUDM):** Uses interoperable geospatial layers to create **digital twins of cities**, integrating registries of property, utilities, and transport.**Drone-based mapping of villages (SVAMITVA scheme):** Produces cadastral maps that feed into a national land registry, reducing disputes and improving credit access for farmers.

1.3 Public-private collaboration and domestic innovation:

Public-private collaboration and domestic innovation in the National Geospatial Policy 2022 are about creating a strong partnership between government agencies, private companies, and academia to build India's self-reliant geospatial ecosystem. This ensures that India can innovate domestically, reduce dependence on foreign mapping services, and compete globally.

a) Public-Private Collaboration: The government acts as an enabler rather than a controller. It provides open data, sets standards,

and builds national registries, while private firms and startups create applications, services, and platforms.Government agencies like **Survey of India, ISRO, and NRSC** provide foundational datasets (maps, satellite imagery).Private companies use these datasets to build solutions in logistics, agriculture, smart cities, and disaster management.Academia contributes research, training, and innovation in GIS and remote sensing.**e.g.SVAMITVA Scheme:** Survey of India provides drone-based cadastral maps of villages. Private firms develop apps for property registration and banks use them for collateral verification.**Smart Cities Mission:** Public agencies provide base maps, while private IT companies build dashboards integrating traffic, utilities, and citizen services.**Disaster Management:** ISRO shares satellite flood maps; NGOs and startups use them to design evacuation apps and relief distribution systems.

b) Domestic Innovation: Encourage Indian companies to develop indigenous mapping technologies, analytics platforms, and geospatial services instead of relying on foreign providers like Google Maps or foreign satellite imagery.**Focus areas:Drone mapping and surveying** by Indian startups.**AI-driven geospatial analytics** for agriculture, environment, and urban planning.**Digital twins of cities and infrastructure** built by Indian IT firms.**Integration with Digital Public Infrastructure** (Aadhaar, UPI, DigiLocker) to create location-linked services.**e.g.MapmyIndia:** An Indian company providing navigation and mapping services, now integrated into government platforms like Aarogya Setu.**Garuda Aerospace:** A drone startup offering precision agriculture and disaster response mapping.**Indian IT majors (Infosys, TCS, Wipro):** Building geospatial solutions for smart cities, logistics optimization, and environmental monitoring.**Startups in agriculture:** Using satellite imagery and soil maps to provide crop advisories to farmers, reducing costs and increasing yields.**Self-reliance i.e. "Atmanirbhar Bharat":** Domestic innovation reduces dependence on foreign geospatial services.**Job creation:** Expanding geospatial startups and industries creates high-skill employment.**Global competitiveness:** Indian firms can export geospatial solutions worldwide.**Inclusive growth:** Local innovators can tailor solutions for rural India, disaster-prone regions, and underserved communities. Public-private collaboration ensures access and governance, while domestic innovation builds indigenous solutions. Together, they make geospatial data a driver of India's transformation toward Viksit Bharat 2047.

1.4 Mission-mode applications across sectors:

Mission-mode applications translate geospatial capabilities into targeted, outcome-focused programs that modernize core sectors, integrate data across agencies, and accelerate delivery-directly supporting Viksit Bharat 2047 through precision planning, efficient execution, and inclusive growth.

a) Land administration and property rights: Cadastral modernization: High-accuracy drone and satellite mapping produce updated parcel boundaries, enabling clean land titles, lowered disputes, and faster registration and valuation.**Credit access:** Digitized property maps linked to owner records streamline collateral verification for banks and microfinance.**e.g.** Village-scale drone mapping feeds state land registries under mission-mode digitization, creating a reliable spatial foundation for taxation, planning, and rural infrastructure.

b) Urban planning and infrastructure: Digital twins: 3D city models integrate utilities, transport, environment, and building data for scenario testing, permitting, and resilience planning.**Utility GIS:** Standardized layers for water, power, sewage, and Fiber enable coordinated maintenance, outage response, and leakage reduction.**PM Gati Shakti integration:** Geospatial platforms align multi-agency projects, reduce duplication, and optimize corridors for logistics and industry siting.**e.g.** Smart city command centres fuse traffic feeds, utility maps, and citizen reports for real-time service delivery and urban safety.

c) Transport, logistics, and economic corridors: Network optimization: Route planning integrates road quality, congestion, weather, and regulatory checkpoints to cut travel time and

emissions.

Asset monitoring: Geotagged warehouses, ports, railheads, and cold chains support capacity planning and targeted investment.**e.g.** Mission-mode logistics planning under "PM Gati Shakti" uses common geospatial layers across ministries to synchronize last-mile connectivity and industrial cluster access.

d) Agriculture and rural development: Precision advisories:

Combining soil maps, crop health imagery, and weather forecasts guides irrigation, nutrient management, and pest control.

Crop insurance and risk: Geo-referenced yield estimation and hazard mapping improve claim transparency and timeliness.**e.g.** Startups and cooperatives deliver farm-level recommendations by overlaying satellite NDVI with local soil data and rainfall, improving yields and input efficiency.

e) Environment, climate, and disaster resilience: Hazard mapping: Flood, landslide, cyclone, and heat-risk layers integrated with exposure data inform early warning and response plans.**Carbon and biodiversity accounting:** Spatial monitoring of forests, wetlands, and ecosystems supports compliance and conservation targeting. e.g. Real-time flood dashboards combine satellite rainfall, river gauges, DEMs, and evacuation routes to coordinate relief and reduce losses.

f) Governance, social protection, and inclusion: Targeting and verification: Geotagged beneficiaries, facilities, and assets reduce leakages and improve program reach.**Service performance:** Location-linked dashboards track school, clinic, and scheme outcomes for rapid course correction. e.g. Mission-mode audits geotag public works and social assets, enabling transparent payments and community monitoring.

g) Energy, utilities, and digital public infrastructure: Grid planning: Spatial demand forecasts and renewable resource maps guide siting of solar, wind, and storage.**Fiber and 5G rollout:** GIS-led planning maximizes coverage while minimizing cost and disruption. e.g. Utility regulators use standardized network registries to coordinate upgrades and monitor reliability at neighbourhood scale.

h) Industry, mining, and landuse governance: Complainagement: Spatial analytics align extraction with rehabilitation, water use, and biodiversity safeguards. E.g. Mission dashboards monitor mine boundaries, reclamation.

Compliance and safety: Geospatial registries track licenses, buffer zones, and environmental clearances.**Resource man** progress, and community impact using authoritative base maps.

i) Education, research, and skill ecosystems: Open datasets: Universities access standardized imagery, elevation, and base maps to train practitioners and accelerate R&D.

Innovation pipelines: Grants and sandboxes help startups build interoperable tools for sector missions.**E.g.** Curriculum-integrated geospatial labs produce domain specialists for city digital twins, agri-tech, and climate services.

Productivity gains: Integrated planning and monitoring lower costs and delays.

Transparency: Geotagging and public dashboards strengthen accountability.

1.5 Governance, accountability, and inclusion:

Governance, accountability, and inclusion under the National Geospatial Policy 2022 (NGP 2022) highlight how geospatial data can strengthen transparency, citizen participation, and equitable service delivery is key pillars for achieving Viksit Bharat 2047.

a) Governance: Using geospatial intelligence to improve decision-making, planning, and monitoring in government programs.Integrate geospatial layers into digital governance platforms so that ministries, states, and local bodies can coordinate effectively.**e.g.**

PM Gati Shakti: Ministries share geospatial data on roads, railways, ports, and pipelines to plan integrated infrastructure corridors.

SVAMITVA Scheme: Drone-based cadastral maps provide accurate land records, reducing disputes and enabling rural governance.**Smart Cities Mission:** GIS dashboards track utilities, traffic, and citizen services in real time, improving urban governance.

b) Accountability: Ensuring transparency and traceability of government actions by linking them to location-based evidence.Geotagging assets,

projects, and beneficiaries' makes it possible to audit progress and reduce leakages.**e.g.GRAMG works:** Public assets like ponds, roads, and schools are geotagged, allowing citizens and auditors to verify their existence and quality.**Disaster relief:** Relief camps and distribution points are mapped, ensuring aid reaches intended locations and preventing duplication.**Environmental monitoring:** Forest cover and wetlands are tracked via satellite imagery, holding agencies accountable for conservation targets.

c) Inclusion: Using geospatial tools to identify underserved areas and ensure equitable distribution of resources and services.Democratize access to geospatial data so that local governments, NGOs, and communities can participate in planning and monitoring.**e.g.Healthcare access:** Mapping hospitals and clinics against population density highlights gaps in rural and tribal areas, guiding new investments.**Education planning:** School locations are mapped with demographic data to identify regions lacking adequate facilities.**Social protection:** Beneficiary households are geotagged to ensure subsidies, pensions, and welfare schemes reach marginalized groups.**Governance:** Builds a responsive, evidence-based administration. **Accountability:**Strengthens trust in public institutions by reducing corruption and inefficiency.

Conclusion:

NGP 2022 provides the geospatial backbone for Viksit Bharat 2047 by making high-quality location data accessible, interoperable, and actionable across India's development priorities. Its liberalization thrust and ecosystem focus position geospatial intelligence as a core layer of digital public infrastructure—enabling precision planning, efficient execution, and inclusive outcomes at national scale. Realizing the 2047 vision will depend on sustained implementation: building standards and registries, nurturing domestic industry, integrating with sectoral missions, and embedding geospatial analytics into everyday governance.

References :-

1. Michael N. Demers (2020) Fundamentals of Geographic Information Systems Source: Digital Library of India Scanning Centre: C-DAC, Noida Source Library.
2. Burrough, p. A., and McDonnell, r. (1998) Principles of Geographical Information Systems Principles of Geographical Information Systems. Oxford University Press, Oxford, U.K.
3. Paul A. Longley, Michael F. Goodchild, David J. Maguire, David W. Rhind (2005) Geographic Information Systems and Science,Jhon Wiley & Sons.
4. Basudeb Bhatta, (2011) Remote Sensing and GIS by Oxford University Press, 2nd Edition, 2011.
5. Matt Duckham, Michael F. Worboys (2004) GIS: A Computing Perspective, Second Edition, CRC Press; 2nd edition (11 May 2004)
6. John R. Jensen (2022) Introductory Digital Image Processing, A Remote Sensing Perspective, 4Th Edn. PEARSON INDIA.
7. Menno-Jan Kraak, FerjanOrMeling (2020) Cartography, Visualization of Geospatial Data, Fourth Edition, CRC Press.
8. Wenzhong Shi, Peter F. Fisher and Michael F. Goodchild (Eds) (2002). Spatial Data Quality: Taylor and Francis, London and New York, 2002.
9. Joshua Tauberer (2012) Open Government Data: The Book, by; Sunlight Foundation Open Data Policy Guidelines 2012 (updated in 2014!).
10. Anthony M. Townsend (2014) Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia,W. W. Norton & Company.
11. The National Geospatial Policy, 2022, notified by the Government of India on December 28, 2022.

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Unveiling Vedic Mathematics: A Jewel of Indian Knowledge Systems

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ABSTRACT

Vedic Mathematics is based on the Vedas, particularly the Atharva Veda, and was rediscovered and popularized by Bharati Krishna Tirthaji Maharaja in the early 20th century. It comprises of different sutras and sub-sutras. This paper explores the historical origins, key features, and modern applications of Vedic mathematics which are known for its simplicity, efficiency, and versatility in solving complex mathematical problems.This study highlights growing relevance of Vedic Mathematics in swiftly and efficiently doing the mathematical calculations.

Introduction

A theory is never born in a single day—it is the result of years of continuous effort and evolution. Vedic Mathematics is no exception. Its roots can be traced back over 2,000 years, shortly after the invention of the number system. During that time, much of Indian knowledge was preserved in the form of the Vedas, forming the foundation of the traditional Indian knowledge system [1],[2].

India has contributed immensely to the world through its ancient wisdom. Some of the most notable contributions include:

- **Ayurveda** – a traditional system of medicine that emphasises natural healing methods [3].
- **Yoga** – a holistic system of physical and mental practices aimed at promoting health and well-being [4].
- **Vastu Shastra** – an ancient science of architecture and design focused on creating harmony and balance in living spaces [5].
- **Vedic Mathematics** – a system of mathematical techniques and principles originating in ancient India, known for its simplicity, speed, and mental calculation methods [1].

These systems reflect the profound intellectual and spiritual heritage of India. This article mainly focuses on the ancient Indian knowledge of mathematics from the Vedas.

Vedic Mathematics, though rooted in ancient Indian scriptures, remained largely unknown to the modern world until its rediscovery in the early 20th century. The credit for this revival goes to **Jagadguru Swami Bharati Krishna Tirthaji Maharaj,** a brilliant scholar and former Shankaracharya of Govardhan Math, Puri [1], [6]. Between 1911 and 1918, Tirthaji conducted extensive research into the Vedas, especially the Atharva Veda, and claimed to have discovered a set of 16 **Sutras** (aphorisms) and 13 **Upasutras** (sub-sutras), which formed the foundation of Vedic Mathematics. These sutras encapsulate mental strategies for rapid and efficient calculation techniques, applicable across arithmetic, algebra, geometry, and calculus [1].

In 1965, long after years of refining his methods, Tirthaji's book titled *Vedic Mathematics* was published posthumously. This single volume became the cornerstone of the modern understanding and spread of Vedic Mathematics. His rediscovery brought to light the brilliance of

India's mathematical heritage, revealing how ancient methods can be applied to solve modern problems quickly and intuitively [1], [7].

In this article, we explore Vedic Mathematics, its various applications, and its potential for the future.

II. Principles of Vedic Mathematics

16 Sutras

Following table indicates 16 main sutras of Vedic Mathematics on which all big calculations rely:

No.	Sutra (Sanskrit)	Meaning	Example
1.	**EkādhikenaPūrvena**	By one more than the previous one	Find 1/19: Use 2 (1 more than 1) repeatedly to get repeating decimal
2.	**NikhilamNavataścaramamDaśatah**	All from 9 and the last from 10	1000 − 782 = 218 → (9−7, 9−8, 10−2) = 218
3.	**ŪrdhvaTiryagbhyām**	Vertically and crosswise	23 × 12: (2×1)=2, (2×2)+(3×1)=7, (3×2)=6 → 276
4.	**ParāvartyaYojayet**	Transpose and adjust	Solve 1/(x + 1): Use expansion with negative root
5.	**ŚūnyamSāmyasamuccaye**	If the sum is the same, it is zero	(x + 3)/(x + 7) = (y + 3)/(y + 7) → x = y
6.	**(Ānurūpye) Śūnyamanyat**	If one is in ratio, the other is zero	If 3x = 6x → x = 0
7.	**SankalanaVyavakalanābhyām**	By addition and subtraction	(a + b)(a − b) = a² − b²
8.	**Pūranāpūranābhyām**	By completion or non-completion	47 × 43: Base 50, (−3)×(−7)=21, 47+43=90 → 2021
9.	**Chalana Kalanābhyām**	Differences and similarities	Used to solve: x + y = 10, x − y = 4
10.	**Yāvadūnam**	Whatever the deficiency	98²: Deficiency = 2 → (100−2)=98, 2²=04 → 9604
11.	**YāvadūnamTāvadūnīkṛtyaVargaṃCayoḥ**	Deficiency subtracted and square of remainder	96²: 100−4=96, 4²=16 → 9216
12.	**ŚeṣānyankenaCaramena**	Remainders by the last digit	Divisibility test using osculation (e.g., 1331 by 11)
13.	**Sopaṇapadyam**	Sequential steps	Cube root of 6859 → stepwise breakdown = 19
14.	**EkanyūnenaPūrvena**	By one less than the previous one	999 × 999 = (1000 − 1)² = 998001
15.	**Gunitasamuccayah**	The product of the sum of coefficients	(x + 2)(x + 3) = x² + 5x + 6 → verify by coefficient sum
16.	**Gunakasamuccayah**	The factors of the sum of coefficients	Factor x² + 5x + 6 → (x+2)(x+3)

Following table indicates 13 subsutras of vedic mathematics on which all calculations relies and get more simpler:

No.	Sub-sutra (Sanskrit)	Meaning	Example
1.	Anurūpyena	Proportionally	Used to find square roots: √(25/49) = 5/7
2.	SisyateŚeṣasamjñah	The remainder remains constant	Division: 1001 ÷ 7 → Remainder pattern repeats
3.	KevalaihSaptakamGunyat	Multiply by 7 only	Used in recurring decimals involving 7: 1/7 = 0.142857...
4.	Vestanam	Osculation (reduction by a number)	Test divisibility by 7 using osculation rule
5.	Yāvadunam	Whatever the deficiency	97^2: 100−3 = 97 → 3^2 = 09 → Answer: 9409
6.	YāvadunamTāvadūnīkṛtyaVargaṃCayoḥ	Deficiency subtracted and square of the remainder	$94^2 = (100-6)^2 = 88$
7.	AntyayorDaśake'pi	Last digits add up to 10	37 × 43 = (30+7)(30+13) → Shortcut via 10-rule
8.	Antyayoreva	Only the last terms	71 × 21 = (70+1)(20+1): 1×1 = 1, 70×20 = 1400, cross terms = 91×20 + 70×1 = 1491
9.	Samucchaye'pi	The total or aggregate	Solving algebra: Use common term aggregation
10.	LopanaSthāpanābhyām	By elimination and retention	Used in simultaneous equations to eliminate variable
11.	ĀmtyātAṁtyena	Final by the final	Factor: Last digit logic in multiplying or dividing polynomials
12.	Yugmaṭāganam	Grouping in pairs	Used in squaring: $(a + b)^2 = a^2 + 2ab + b^2$
13.	PūṛṇaPūṃābhyām	By the completion or non-completion	Similar to Nikhilam: Complete numbers to base for multiplication (e.g., 48 × 42 using base 50)

Key Features of Vedic Mathematics:

Vedic Mathematics is built upon **16 main sutras (formulas)** and **13 sub-sutras (corollaries) as given in above two tables** derived from ancient Indian texts, offering systematic and logical approaches to problem-solving. Its key features are:

· **Covers Multiple Branches of Mathematics**

The techniques apply to various fields including **arithmetic, algebra, geometry, calculus,** and more, making it a comprehensive mathematical system.

· **Simplified Calculations**

The methods simplify complex problems and enable **quick solutions**, often using just a few mental steps instead of lengthy written procedures.

· **Mental Math Emphasis**

Vedic Mathematics encourages**mental calculations**, reducing dependency on pen, paper,

or calculators and improving **concentration**and**mental agility.**

· **Useful for Competitive Exams**

It is highly beneficial for students preparing for**competitive exams**, where**speed and accuracy**are essential.

· **Applicable from Basic to Advanced Levels**

The sutras can be used for a wide range of problems—from**basic arithmetic to advanced calculus**—making it useful across grade levels and academic fields.

· **Promotes Unified Understanding**

Vedic Mathematics integrates different mathematical concepts, fostering a **holistic view**and deeper understanding of**numerical and algebraic relationships.**

· **Enhances Logical Thinking**

It improves**problem-solving ability, analytical thinking**, and encourages learners to approach problems creatively and efficiently.

· **Reduces Math Anxiety**

By making math easier and more enjoyable, Vedic techniques help students build **confidence**and**interest**in the subject.

· **Time-Tested and Relevant Today**

Though ancient in origin, Vedic Mathematics remains**relevant and practical**in modern education, technology, and even AI research.

Applications of Vedic Mathematics:

· Applications of Vedic Mathematics are widespread across various fields such as education, competitive exams, finance, and even computer science.

· In competitive exams, Vedic Mathematics helps save valuable time while improving accuracy. By using simple mental tricks and sutras, students can perform arithmetic operations like multiplication, division, squaring, and square roots much faster than traditional methods.

· Principles of Vedic Mathematics extend beyond education into advanced fields of engineering and technology, where sutras like *Urdhva-Tiryakbhyam* are used to design high-speed multipliers in VLSI circuits, digital signal processing, and cryptography.

· In the realm of Artificial Intelligence, researchers are exploring its integration with learning analytics to develop intelligent, adaptive educational tools.

· This seamless blend of ancient wisdom and modern innovation underscores the timeless relevance and versatility of Vedic Mathematics in both academic and technological domains.

Conclusion:

Vedic mathematics is a testament to the rich intellectual heritage of India. Its principles, rooted in ancient wisdom, offer practical solutions to modern mathematical challenges. By addressing the existing limitations and exploring new applications, Vedic mathematics can emerge as a sustainable and innovative knowledge system for the 21st century. Today, Vedic Mathematics is taught in schools, used in competitive exam preparation, and studied as a tool for enhancing mental math abilities. The rediscovery has sparked a global interest in ancient Indian knowledge systems, reaffirming that traditional wisdom can still play a vital role in contemporary education.

References :-

[1] B. K. Tirthaji, *Vedic Mathematics*, Delhi: Motilal Banarsidass, 1965.

[2] S. G. Dani, "Vedic Mathematics: Myth and Reality," Indian Institute of Technology Bombay, Mumbai, 2006.

[3] P. V. Sharma, *Introduction to Ayurveda*, Varanasi: Chaukhamba Orientalia, 1995.

[4] G. Feuerstein, *The Yoga Tradition: Its History, Literature, Philosophy and Practice*, Prescott, AZ: Hohm Press, 1998.

[5] R. Niranjan, *Vastu: Breathing Life into Space*, New Delhi: Roli Books, 2005.

[6] K. Rangachari, "The Rediscovery of Vedic Mathematics," *Journal of Indian History and Culture*, vol. 9, no. 2, pp. 41–58, 2002.

[7] G. G. Joseph, *The Crest of the Peacock: Non-European Roots of Mathematics*, Princeton, NJ: Princeton University Press, 2000.

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Indian Knowledge Systems as Catalysts for Chemical Innovation and Sustainable Technologies

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ABSTRACT

Indian Knowledge Systems (IKS) represent a millennium-old intellectual tradition that integrates empirical practices with philosophical frameworks emphasizing harmony with nature. In recent years, IKS has gained scholarly attention as its role in chemical innovation and sustainable technologies emerges as a key interdisciplinary research area. This review critically examines historical chemical knowledge embedded in Indian traditions alongside contemporary literature and sustainability frameworks. It argues that IKS provides epistemic foundations and inspiration for modern chemical research, particularly in green chemistry, sustainable materials, and eco-technology development.By synthesizing interdisciplinary literature, this article explores the potential contributions of IKS to environmentally benign chemical processes and innovations aligned with global sustainability goals. Challenges related to the validation, standardization, and ethical integration of traditional knowledge into modern practices are discussed, highlighting both the opportunities and complexities involved in translating indigenous wisdom into scientifically validated innovations. Future research directions are proposed to further explore the integration of IKS into contemporary chemical innovation and sustainability paradigms.

Keywords: Indian Knowledge Systems, Green Chemistry, Sustainable Technologies, Rasashastra, Chemical Innovation

1. Introduction

Sustainability has emerged as a defining challenge for twenty-first-century chemical sciences, as conventional chemical processes, while technologically advanced; often entail high energy consumption, hazardous reagents, and significant waste generation. In this context, Indian Knowledge Systems (IKS), which encompass traditional sciences such as Ayurveda, Rasashastralikes alchemical and metallurgical traditions [1], ecological wisdom, and indigenous materials science offer alternative epistemologies rooted in resource efficiency, circularity, and environmental harmony [2]. These systems historically emphasized elemental theory, purification processes, and the sustainable use of resources, concepts that align conceptually with modern principles in chemistry and sustainability [3].Recent policy and academic initiatives in India have underscored the relevance of IKS for innovation-driven and sustainable development, motivating renewed scholarly interest in its scientific and technological dimensions. The contemporary relevance of IKS in sustainable innovation has been discussed extensively in sustainability studies, particularly in the context of the Sustainable Development Goals (SDGs) [4]. As we navigate the challenges of modern chemical sciences, the insights and practices offered by Indian Knowledge

Systems present valuable pathways towards a more sustainable future(Figure 1).

Fig.1.IKS as Catalysts for Chemical Innovation and Sustainable Technologies

2. Historical Foundations of Chemical Knowledge in Indian Traditions

Indian intellectual traditions document sophisticated chemical knowledge dating back to ancient and medieval periods. Rasashastra texts describe systematic methods for purification, calcination, alloying, and synthesis of inorganic and organometallic compounds. Classical treatises such as RasaratnaSamuccaya outline laboratory apparatus controlled heating techniques, and quality testing methods, reflecting empirical rigor comparable to early chemical engineering principles [5, 6].In addition to alchemical practices, traditional Indian metallurgy produced advanced materials such as wootz steel, renowned for its high carbon content and superior mechanical properties. Indigenous knowledge related to dyes, pigments, fermentation, cosmetics, and natural polymers further illustrates the breadth of chemical understanding embedded in artisanal and medicinal traditions [7, 8].

3. Indian Knowledge Systems and Contemporary Chemical Innovation

Although explicit references to Indigenous Knowledge Systems (IKS) remain limited in mainstream chemistry journals, recent interdisciplinary research increasingly recognizes indigenous knowledge as a driver of innovation, particularly within sustainability frameworks that emphasize holistic system thinking, low-input processes, ethical material use, and life-cycle awareness aligned with green chemistry principles and the Sustainable Development Goals [9]. Contemporary chemical innovation inspired by IKS includes the exploration of plant-derived reagents, natural catalysts, bio-based and biodegradable materials, natural dyes, corrosion inhibitors, and energy-efficient material processing informed by traditional botanical and metallurgical knowledge, while studies on environmental sustainability highlight how traditional ecological principles support modern practices in resource management, biodiversity conservation, and eco-technology development; collectively, integrating indigenous chemical practices with modern analytical tools is seen as a pathway to catalyze novel, sustainable technologies despite their still-limited representation in mainstream scientific literature [10-12].

4. Alignment with Green Chemistry and Sustainable Technologies

The principles of green chemistry such as waste prevention, safer solvents, renewable feedstocks, non-toxic synthesis, and energy efficiency resonate strongly with Indian Knowledge Systems (IKS) philosophies that emphasize ecological balance, non-harmful practices, and respect for interconnectedness. Traditional practices including aqueous-based processing, minimal reagent excess, reuse of by-products, Vrikshayurveda, and indigenous water conservation reflect a systems-level approach grounded in concepts like [ta (balance) and harmony with nature, anticipating modern sustainability frameworks such as life-cycle assessment, circular economy models, climate action, and responsible consumption [13, 14]. By integrating IKS-inspired ecological wisdom with modern analytical tools, researchers can develop culturally and ethically sensitive sustainable chemical technologies that effectively address challenges of climate change, pollution, and resource scarcity while reducing energy and material footprints [15,16].

5. Case Studies and Emerging Applications

Recent applied research demonstrates the practical relevance of IKS-inspired innovation, even when studies do not explicitly label themselves as IKS-based. Examples include the use of plant-derived compounds and herbal extracts as natural

pH indicators, freshness sensors, and antimicrobial coatings in intelligent packaging, blending traditional botanical knowledge with modern analytical chemistry [17]. Additional innovations involve traditional water-treatment materials adapted for contemporary use and historical metallurgical techniques analyzed scientifically to inspire more sustainable material processing strategies [18,19]. Collectively, these works illustrate the translational potential of indigenous chemical knowledge when integrated with contemporary science, highlighting how traditional insights from Indian research contexts continue to inform and enrich modern chemical innovation despite the relatively limited number of peer-reviewed studies explicitly framed as IKS-based.

6. Challenges and Future Directions

Despite growing interest, integrating Indigenous Knowledge Systems (IKS) into chemical research faces significant challenges, including the limited number of formal scientific studies validating IKS-based innovations, the need for rigorous experimental and methodological frameworks to translate traditional knowledge into certified sustainable technologies, issues of standardization and intellectual property, and the risk of oversimplifying or romanticizing traditional practices without empirical verification. Addressing these challenges requires future research to prioritize interdisciplinary, mixed-methods approaches that combine historical and textual scholarship with laboratory experimentation and sustainability assessment, alongside collaborations among chemists, anthropologists, and sustainability scientists to scientifically validate and adapt IKS practices [20]. Institutional support through dedicated research centers, targeted funding mechanisms, curriculum integration, and supportive university and policy initiatives will be crucial for mainstreaming IKS-informed chemical innovation, thereby enabling meaningful contributions to sustainable development goals and global green technology transitions [21, 22].

7. Conclusion

Indian Knowledge Systems (IKS) constitute a valuable yet underexplored intellectual resource for advancing chemical innovation and sustainable technologies, offering rich empirical wisdom that can complement modern scientific methodologies. Although the explicit integration of IKS into contemporary chemical research remains nascent, increasing recognition within sustainability discourse and interdisciplinary journals points to a fertile frontier for exploration. By systematically bridging ancient knowledge with modern validation techniques, researchers can uncover environmentally benign processes, sustainable materials, and ethically grounded innovation pathways. To fully realize these potential, sustained research efforts, rigorous scientific validation, and supportive policy frameworks are essential for embedding IKS meaningfully within the future of sustainable chemical sciences.

References :-

[1] Acharya, P., 2018. Rasashastra and traditional Indian metallurgy: Scientific perspectives. Indian Journal of History of Science, 53(3), pp. 321-334. https://doi.org/10.16943/ijhs/2018/v53i3/49447

[2] Patwardhan, B., Mutalik, G., &Tillu, G., 2020. Integrative approaches for sustainable development: Relevance of traditional knowledge systems. Journal of Ayurveda and Integrative Medicine, 11(4), pp. 479-486. https://doi.org/10.1016/j.jaim.2020.07.003

[3] Biswas, Arun Kumar, 1986. Rasa-Ratna-Samüccaya and Mineral Processing State-of-Art in the 13th Centurya.d. India. Indian Journal of History of Science, 22 (1), pp. 29-46

[4] Traditional Indian Knowledge Systems in Environmental Sustainability. International Journal ofMultidisciplinary Global Research, 2025.

[5] White, David G., 1996. The alchemical body: Siddha traditions in medieval India. ISBN 9780226149349.

[6] Meulenbeld, Gerrit J., 1999. A history of Indian medical literature. Groningen: E. Forsten. ISBN 9789069801247.

[7] Saptarshi B., 2025. Chemical Knowledge and Practices in Ancient and Medieval

India. International Academic Publishing House (IAPH), Dr. Rajiba Lochan Mahapatra, Dr. Arpan Das and Dr. Somnath Das (eds.), Revisiting the past knowledge tradition of Bharat: A critique (Volume-1), pp. 93-99. ISBN: 978-81-978955-6-2, https://doi.org/10.52756/rpktbc.2025.e01.010

[8] Mukherjee, B., 2019. Chemical knowledge and practices in ancient and medieval India. In History of science and technology in India, pp. 215-238. Indian Academy of Sciences.

[9] Kumar, A., Singh, R., & Chandra, R., 2021. Indigenous knowledge systems and sustainable environmental management in India. Environmental Development, 39, 100626. https://doi.org/10.1016/j. envdev. 2021.100626

[10] Sharma, N., Trivedi, M., &Choudhary, M., 2025. From tradition to transform: SDGs and the role of the Indian knowledge system in India's growth through environment, social, and economic factors. Discover Sustainability, 6, 1110. https://doi.org/10.1007/s43621025-01905-3

[11] Anastas, P. T., Eghbali, N., & Zimmerman, J. B., 2020. Green chemistry and sustainability science: The road ahead. ACS Sustainable Chemistry & Engineering, 8(40), pp. 14998-15004.

[12] Vora, B., &Hussain, T., 2025. Indian knowledge system: A catalyst for sustainable development and global leadership. International Journal of Innovation in Engineering Research & Management, 12(4), pp. 74-77.

[13] Sharma, P. V., 2007. Vrikshayurveda of Parashara. ChaukhambhaOrientalia.

[14] Sheikh, M.M., 2025. Indian Knowledge System and Sustainable Development: Integrating Ancient Wisdom with Modern Sustainable Development Goals, Journal of Global Resources, 11(1). https://doi.org/10.46587/JGR.2025.v11i01.006

[15] Dudve, K. S., Tripathi, L. K., 2018. Indian Knowledge Systems in Resource Management: Bridging Ancient Wisdom with Modern Sustainable Development Goals (SDGs). Accent Journal of Economics Ecology & Engineering, 10(2), pp. 273-279. https://www.ajeee.co.in/index.php/ajeee/article/view/5529

[16] Verma, D. A. K., Karthikeyan, D. M., Selvarajan, S., Kaur, S., Garg, P., Deepak, S., &Goyal, S., 2025. Green Chemistry Approaches for Sustainable Industrial ýProcesses. International Journal of Basic and Applied Sciences, 14(1), pp. 88-91. https://doi.org/10.14419/ptb8ns73

[17] Chethan Kumar, 2025. From dye to detector: Bengaluru scientists turn herbal extract into milk freshness sensor. https://timesofindia.indiatimes.com/city/bengaluru/from-dye-to-detector-bengaluru-scientists-turn-herbal-extract-into-milk-freshnessensor/articleshow print/124727569.cms

[18] Mithra G., Veettil, R. P., Sadasivuni, K. K., 2025. Green solutions for clean water: Natural materials in contaminant detection and removal. Trends in Environmental Analytical Chemistry,48,e00285, https://doi.org/10.1016/j.teac.2025.e00285

[19] Ladole, C. A., Joshi, P. S., Kolhe, S. V., 2025.Indian Knowledge Systems and Metallurgy: Traditional Techniques and Scientific Legacy.Vidyabharati International Interdisciplinary Research Journal, 20(1), pp. 40-45.

[20] Blaser-Mapitsa, C., 2022. A scoping review of intersections between indigenous knowledge systems and complexity-responsive evaluation research. African Evaluation Journal, 10(1), a624. https://doi.org/10.4102/aej.v10i1.624

[21] Greggain, Joshua., 2023. Etuaptmumk: Two-Eyed Seeing. British Columbia Medical Journal, 65(5), 155.

[22] Singh-Pillay, A., Madlala, A., 2026.Legitimising Indigenous knowledge systems as a pathway to sustainable development. Discover Education. https://doi.org/10.1007/s44217-025-01062-9

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Social Media as a Tool for Cultural Heritage: Awareness and Conservation

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ABSTRACT

In the contemporary digital era, social media has become one of the most powerful tools of communication, influencing almost every aspect of human life. It has transformed the way people interact, learn, share information, and express identity. Cultural heritage, which includes monuments, historical sites, traditional practices, rituals, languages, arts, crafts, and collective memories, is no longer limited to physical spaces such as museums, archives, and heritage sites. Through social media platforms like Facebook, Instagram, YouTube or Twitter, cultural heritage now exists in digital form, accessible to global audiences. This paper examines how social media functions as a tool for cultural heritage awareness and conservation. It discusses how digital platforms help in promoting heritage, encouraging participation, supporting education, and mobilising conservation efforts. At the same time, it critically analyses challenges such as misinformation, loss of authenticity, commercialisation, digital divide, and ethical concerns. The paper argues that social media, when used responsibly and inclusively, can significantly contribute to the sustainable preservation of both tangible and intangible cultural heritage.

Keywords: media, cultural heritage, conservation, digital divide, sustainability

Introduction

Cultural heritage represents the shared history, values, beliefs, and traditions of a community or nation. It encompasses both tangible heritage, including monuments, historical buildings, artefacts, paintings, sculptures, and manuscripts, and intangible heritage, comprising oral traditions, folk songs, dances, rituals, festivals, languages, culinary practices, and traditional knowledge. Cultural heritage provides people with a sense of identity and belonging. It connects the present generation with its ancestors and offers guidance for the future. However, cultural heritage worldwide is under serious threat due to urbanisation, industrialisation, globalisation, climate change, war, neglect, and changing lifestyles. Many monuments are deteriorating, and many traditions are disappearing because younger generations often move away from traditional ways of life.

Traditionally, the responsibility of preserving and promoting cultural heritage rested mainly with governments, museums, archives, universities, and cultural organisations. These institutions collected artefacts, documented traditions, conducted research, and organised exhibitions. Although these efforts were important, they often reached only a limited audience. Heritage communication was largely one-directional, where experts produced knowledge, and the public consumed it passively. Ordinary people had little opportunity to share their own stories or interpretations of culture.

The development of digital technology and the internet has changed this situation. Social media

platforms have revolutionised communication by allowing people to create, share, and interact with content easily and instantly. Social media is no longer just a tool for entertainment or personal communication; it has become a space where culture, politics, education, and identity are constantly shaped and reshaped. In the field of cultural heritage, social media has opened new possibilities for awareness, participation, education, and conservation. Heritage is now visible in photographs, videos, blogs, reels, and online discussions shared by both institutions and individuals.

Social media has become an important tool in shaping how people understand and value cultural heritage. Through these platforms, communities can document their own traditions, festivals, and rituals; while elders share memories and young people reinterpret practices in modern digital forms. Beyond community use, museums and cultural organisations reach global audiences through virtual tours, and activists mobilise public support to protect heritage under threat. However, these benefits bring new challenges regarding authenticity, representation, inequality, commercialisation, and ethics. Therefore, it is necessary to study both the positive and negative aspects of social media in relation to cultural heritage.

Objectives

The main objectives of this study are:

1. To understand the role of social media in creating awareness about cultural heritage.
2. To examine how social media supports the conservation of tangible and intangible heritage.
3. To analyse the role of participation and community engagement in digital heritage.
4. To identify challenges such as misinformation, the digital divide, and commercialisation.
5. To suggest ways to use social media responsibly and effectively for heritage preservation.

Literature Review

1. Priyanka Pathak & Rachana Gangwar

Priyanka Pathak and Rachana Gangwar conducted an empirical study titled "Exploring the Role of Social Media in Preserving and Promoting the Cultural Heritage of Uttarakhand: A Critical Study." This research focuses on how social media helps preserve and promote the cultural heritage of Uttarakhand through wider community engagement and digital outreach.

2. Uma Thakur & Ashwani Sharma - Uma Thakur (Research Scholar) and Prof. Dr Ashwani Sharma examined social media's influence on "the cultural fabric of the Shimla Hills," analysing how digital platforms affect regional customs, rituals, dialects, and intergenerational knowledge. Their work highlights social media's role in either preserving or altering local cultural identity.

3. Henry Jenkins – Convergence Culture: Where Old and New Media Collide (2006)- Jenkins introduces the concept of participatory culture, where audiences do not passively consume media but actively produce and share content. His work is foundational for understanding how social media empowers users to co-create heritage narratives rather than merely receive them from institutions.

4. Ernest A.Rogers–Diffusion of Innovations (2003)- Rogers' theory explains how new ideas and technologies spread through social networks. In the context of heritage, this model helps analyse how social media accelerates the dissemination of heritage content and mobilises communities around awareness and conservation initiatives.

5. Giuliana B. Giaccardi – Heritage and Social Media: Understanding Heritage in a Participatory Culture (2012) - Giaccardi examines how digital platforms reshape heritage practices. She argues that social media facilitates participatory heritage, where users contribute personal memories, interpretations, and digital documentation, redefining traditional top-down approaches.

Many studies show that social media plays a strong role in cultural promotion. Visual platforms like Instagram and YouTube attract attention to heritage sites and traditions through attractive images and videos. Hashtag campaigns and viral posts help spread awareness quickly. Researchers also highlight how social media supports intangible heritage by allowing people to record songs, dances, languages, and rituals that might otherwise

disappear.

At the same time, scholars warn about the dangers of digital heritage. Some argue that social media often promotes simplified or romanticised images of culture. Complex histories may be reduced to beautiful pictures or entertaining stories. There is also the risk of cultural exploitation, where traditions are used for commercial gain without respect for their meaning. The digital divide is another major concern, as many communities lack access to technology and therefore cannot represent themselves online. Ethical issues related to consent, privacy, and sacred traditions are also widely discussed in academic literature.

Social media has become one of the most effective tools for creating awareness about cultural heritage. Through posts, stories, reels, and videos, heritage is presented in ways that are visually attractive and emotionally engaging. A photograph of a historical monument at sunset, a video of a traditional dance, or a story about an old festival can easily attract attention and curiosity. Unlike textbooks or formal lectures, social media content is often short, colourful, and interactive, which suits the interests of younger generations.

Hashtag campaigns play an important role in spreading awareness. When people use common hashtags related to heritage days, festivals, or local traditions, their posts become part of a larger digital conversation. This allows people from different regions and cultures to learn about each other's heritage. Such campaigns also encourage people to explore their own cultural roots and share personal memories and experiences. This emotional connection makes heritage more meaningful than simple factual knowledge.

One of the most important contributions of social media is participation. In the past, heritage narratives were controlled mainly by experts and institutions. Today, social media allows everyone to become a storyteller. Community members can share stories about their villages, families, rituals, and traditions. Elders can talk about the past, and young people can combine tradition with modern creativity. This participatory storytelling creates a sense of ownership. When people feel that heritage belongs to them, they are more likely to respect and protect it.

Social media also plays a major role in education. Museums, libraries, and cultural organisations use platforms to share historical facts, photographs, and videos. Virtual tours allow people to visit heritage sites without travelling. Teachers and students use online content to learn history and culture in creative ways. Young people, who spend much of their time online, are more likely to engage with short videos and interactive content than with traditional textbooks. In this way, social media supports both formal and informal education and makes cultural learning more accessible.

In terms of conservation, social media is a powerful tool for advocacy. Many heritage sites are threatened by pollution, urban development, natural disasters, and neglect. When people share images and videos of damaged monuments or disappearing traditions, it creates public concern. Online campaigns, petitions, and fundraising efforts often start on social media. Crowdfunding platforms shared through digital networks help raise money for restoration projects and cultural programs. In several cases, viral posts have forced authorities to take action to protect heritage sites that were earlier ignored.

Community monitoring is another important aspect. Local people often act as the first protectors of heritage. With smartphones, they can document threats such as illegal construction, vandalism, or environmental damage. When this information is shared online, it becomes visible to a wide audience, including media and government authorities. This public visibility increases pressure for quick action. It also connects local struggles with national and international supporters.

Social media is especially useful for preserving intangible heritage. Many traditions are disappearing because young people move away from traditional lifestyles. Through social media, elders can record and share songs, stories, crafts, and languages. Short videos teaching traditional dances, recipes, or language phrases are popular among young users. This digital transmission supports intergenerational learning and keeps traditions alive in new forms.

However, the use of social media in cultural heritage also has serious problems. One major issue is misinformation. Because anyone can post content, incorrect or incomplete information can spread easily. Historical facts may be distorted,

and cultural practices may be shown without proper context. This can lead to misunderstanding and stereotypes. Another problem is commercialisation. When heritage becomes popular online, it may attract mass tourism. While tourism can bring income, uncontrolled tourism can damage sites and disturb local communities. Traditions may be turned into performances for tourists, losing their original meaning.

The digital divide is another serious challenge. Not all communities have access to the internet or digital devices. Poor, rural, or marginalised groups may not be able to share their heritage online. As a result, social media representations of culture often reflect the voices of more privileged groups. Language barriers also reduce participation, as global platforms mainly promote dominant languages.

Ethical concerns are also important. Some rituals and traditions are sacred and should not be shared publicly. Posting such content without permission can be disrespectful. There are also issues of privacy when personal stories or family traditions are shared online. Social media algorithms further influence what becomes visible. Content that is entertaining or visually attractive is promoted more than serious educational material. This can push heritage communication toward superficial trends rather than deep understanding.

To use social media effectively for cultural heritage, careful planning is needed. Heritage institutions should develop clear digital strategies. Communities should be involved in content creation so that their voices are respected. Training programs can help people learn digital storytelling and ethical sharing. Clear guidelines should be made to ensure accuracy, consent, and cultural sensitivity. Governments and organisations should also work to reduce the digital divide by improving internet access and digital literacy.

Conclusion

Social media has transformed the way cultural heritage is experienced, shared, and preserved. It brings heritage into everyday digital life, making it visible and meaningful to people across the world. Through participation, education, and advocacy, social media supports both awareness and conservation of cultural heritage. It allows communities to tell their own stories, strengthens emotional connections with tradition, and mobilises collective action for preservation.

Challenges such as misinformation, inequality, commercialisation, and ethical concerns cannot be ignored. Responsible use of social media requires careful planning, community involvement, and clear ethical guidelines. When used thoughtfully and inclusively, social media can connect past and present, tradition and technology, and ensure that cultural heritage continues to live for future generations.

References :-

1. Cameron, F., & Kenderdine, S. (Eds.). (2007). Theorising Digital Cultural Heritage. MIT Press.
2. Giaccardi, E. (2012). Heritage and Social Media: Understanding Heritage in a Participatory Culture. Routledge.
3. Jenkins, H. (2006). Convergence Culture: Where Old and New Media Collide. New York University Press.
4. Rogers, E. M. (2003). Diffusion of Innovations (5th ed.). Free Press.
5. Katz, E., Blumler, J. G., & Gurevitch, M. (1973). Uses and gratifications research. The Public Opinion Quarterly, 37(4), 509–523.
6. Pathak, P., & Gangwar, R. (2025). Exploring the Role of Social Media in Preserving and Promoting the Cultural Heritage of Uttarakhand: A Critical Study. International Journal for Innovative Research in Multidisciplinary Field.
7. Thakur, U., & Sharma, A. (2025). Social Media and the Cultural Fabric of the Shimla Hills: A Study of Preservation and Change. International Journal on Science and Technology (IJSAT).
8. Kalele, G., Chayapathi, A. R., Faisal, M., Tiwari, R., Srivastava, M., Sahu, B. N., &Korwar, G. (2025). Sentiment Analysis of Folk art Social Campaigns. ShodhKosh: Journal of Visual and Performing Arts, 6(4S), 43–53.

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Myth, Matrimony and the Metamorphosis of the Subaltern : A Comprehensive Gendered Critique of Girish Karnad's Naga-Mandala

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ABSTRACT

Girish Karnad's Naga-Mandala (1988) serves as a profound interrogation of patriarchal structures through the intricate blending of Kannada oral folk tales, myth, and magical realism. This research paper offers a comprehensive gendered critique of the play, focusing on the metamorphosis of the subaltern female protagonist, Rani, from a subjugated, isolated housewife into an empowered, autonomous agent. The study examines how the restrictive institution of matrimony- symbolized by Appanna's tyranny- traps the feminine self, rendering her voiceless. By employing a feminist and post-colonial framework, the analysis highlights how the mythical intervention of the shape-shifting Naga (serpent) acts as a catalyst, allowing Rani to navigate her sexual desire and cognitive awakening.

Furthermore, the research delves into the 'metamorphosis' not just of her status, but of her consciousness, transforming her from a 'passive other' to a 'deified subject' in the eyes of her community. Through a close reading of the text, this paper argues that Karnad uses the story-within-a-story structure to challenge traditional, misogynistic definitions of feminine chastity and to subvert the patriarchal monopoly on power, ultimately presenting a nuanced portrayal of female resilience and agency in contemporary Indian society.

Keywords: Subaltern, Gender Critique, Matrimony, Myth, Metamorphosis, Feminism, Agency, Patriarchy.

The intersection of folklore and modern gender discourse in Indian drama is perhaps nowhere more vividly articulated than in Girish Karnad's 1988 play, Naga-Mandala. By repurposing oral traditions collected by A.K. Ramanujan, Karnad constructs a narrative that functions as both a celebration of indigenous storytelling and a scathing indictment of the patriarchal structures that define the Indian domestic sphere. The play, which translates to 'The Play with a Cobra,' utilizes the figure of the Naga- a shape-shifting serpent- to explore the fragmented identity of the Indian woman and the systemic injustices inherent in the traditional institution of marriage. At its core, Naga-Mandala is a journey of female self-actualization, tracing the protagonist Rani's evolution from a marginalized, voiceless victim to a venerated goddess whose agency ultimately subverts the very moral codes intended to suppress her.

The Framework of Patriarchal Hegemony and the Archetypal Male

In analyzing the gender perspective of Naga-Mandala, the character of Appanna serves as the primary vessel for patriarchal authority. His name, which literally signifies 'any man,' suggests that his behaviour is not an individual aberration but a representative manifestation of male chauvinism in rural South Indian society. The play introduces Rani and Appanna at the onset of their marital life, a union decided by Rani's parents

without her consent, highlighting the historical commoditization of the female body in the marriage market. Appanna's immediate conduct toward his bride is characterized by a 'rule of dread,' defined by cold indifference and physical confinement.

The domestic space into which Rani is brought functions as a panoptic on where her movements are monitored and her voice is stifled. Appanna's practice of locking Rani inside the house while he visits his concubine at night is a visceral symbol of the 'patriarchic cage'. This solitary confinement is interpreted by scholars as a modern iteration of the medieval 'chastity belt,' designed to reduce women's talents to mere housework while excluding them from intellectual enlightenment and social enjoyment. The husband's power is totalizing; he denies Rani any 'vocal relationship' with the outside world, effectively rendering her a 'subaltern' who cannot speak within the established power structures.

Narrative Agency and the Subversion of the Male Voice

The prologue of Naga-Mandala establishes a meta-theatrical framework that is essential to its gendered reading. It introduces a 'Man'- a playwright who is cursed to die because he has made his audiences sleep. This figure represents the exhaustion of male-centric, classical storytelling traditions. His survival is contingent upon his ability to listen to 'The Story' and 'The Song,' which have escaped from an old woman who refused to share them. By personifying the Story and the Song as female figures, Karnad creates a 'distinctly female context' that provides a 'lived counterpoint' to the patriarchal structures of classical texts.

The entry of the personified 'Flames'- representing women from different households who gather at night to share gossip- further reinforces the idea of a 'female sub-culture'. For these women, the act of telling stories is a transformative process, turning a 'silent woman into a speaking person'. This shift in narrative agency is critical; it moves the focus from the male writer's predicament to a 'choral, communal, and distinctly women-centric ethoses. The Flames and the Story represent a creative force that cannot be 'choked' or 'imprisoned' by repressive structures, as they eventually escape the domestic confines to earn a life of their own.

The Psychosexual Awakening: Naga and the Fragmentation of Desire

The arrival of the Naga, a shape-shifting cobra who falls in love with Rani after consuming a magic root, introduces the play's central magical-realist conflict. The Naga assumes the form of Appanna at night, creating a 'split personality' within the marital bed. While the daytime Appanna is indifferent and harsh, the nighttime Naga-Appanna is an embodiment of love, passion, and concern. This dichotomy explores the failure of the patriarchal male to achieve a "harmonious existence of body and mind," as the qualities of the 'ideal lover' and the 'dominating husband'is fragmented between two separate entities.

For Rani, this situation creates a 'negotiated space' where she begins to discover her identity as a 'sexual being'. Initially, Rani is depicted as 'frigid' and someone who 'detests sex,' likely due to the animalistic and non-consensual nature of her daytime husband's visits. The Naga, however, breaks her hesitancy with 'honeyed words' andcaresses, educating her about 'physicality' and initiating her into a world of sensual pleasure. This awakening is significant from a feminist perspective because it validates a woman's 'right to seek satisfaction and meaning' in her relationships, moving away from the paradigm of marriage as mere endurance.

However, the Naga's role is not entirely liberating. He also utilizes the 'patriarchal discourse' of silence, warning Rani not to ask questions or look out the window during his night visits. Rani's willingness to accept this 'life lived by fiction and half-truth' highlights the precariousness of her position; she is forced to choose between the 'harsh reality' of Appanna's cruelty and the 'heavenly bliss' of an illusory love. Her refusal to confront the obvious contradictions in 'Appanna's' behavior- such as the serpentine vision in the mirror or his cold blood- indicates a 'conscious refusal to disentangle the disparity' in order to preserve her only source of emotional sanctuary.

Institutional Double Standards and the Construction of the 'Goddess'

The climax of the play addresses the 'timeless test of anticipated female honor'-the chastity-test. When Rani conceives a child that Appanna knows is not his, he accuses her of adultery. The village elders, acting as the arbiters of patriarchal morality, demand a public trial. This trial, involving holding a red-hot iron or a venomous snake, exposes the 'prevalent double standard' of the society. While Rani is subjected to a life-threatening ordeal, Appanna's own open adultery with a concubine is ignored by the elders, highlighting the 'optimum futility of justice' in a gender-based court.

Rani's success in the 'snake ordeal' is a masterful subversion of the mythic tradition. Unlike Sita in the Ramayana, who is saved by her literal purity, Rani is saved by her 'very infidelity'. Because the Naga is her lover, he does not bite her; instead, he garlands her. Her confession- that she has touched only her husband and the King Cobra- becomes a 'paradoxical truth' that effectively 'mocks the classic Hindu mythic chastity test'.

The subsequent 'apotheoses of Rani into a 'goddess incarnate' represents a reversal of power dynamics. Appanna, the previously authoritative husband, is forced to prostrate himself at her feet and spend the rest of his life in her service. However, this 'elevation into divinity' is fraught with ambiguity. Critics question whether this transformation truly liberates Rani as a woman or simply abstracts her into an "unattainable ideal," reinforcing the patriarchal binary that views women as either "an inferior or a goddess," but never as an equal.

Symbolism and Geometric Structures in Naga-Mandala

The title itself, Naga-Mandala, carries significant symbolic weight, referring to the union of male and female principles through the 'Mandala'—a decorative pictorial drawing that imposes order over chaos. The play's structure is visualized through 'intertwined triangles': one representing the triad of Rani, Appanna, and Naga, and the other representing Rani, Kurudavva, and Kappanna. In Hindu tradition, this intersection symbolizes the union of Shiva (Supreme Consciousness) and Shakti (Creative Force), suggesting that Rani's personal journey is emblematic of a broader cosmic and social restoration. Other symbols enrich the play's feminist evaluation:

The Eagle: Represents Rani's repressed desire for flight and freedom from her 'marginalized position'.

The Mongoose and the Dog: Symbols of the aggressive policing of the domestic space by the patriarchal husband.

The Magic Root: A catalyst for the supernatural, representing the 'subversive strategies' women employ to find gratification when traditional channels are blocked.

The Long Hair: Associated with the 'black King Cobra,' her hair becomes a site of transition; at the end of the play, it becomes a sanctuary where she protects her secret lover, the Naga.

Alternate Endings and the Matriarchal Future

Karnad's play is notable for its multiple endings, a device that allows for a 'nuanced examination of morality' and the complexity of female truth. In the first ending, the Naga realizes he cannot coexist with Appanna and decides to strangle himself in Rani's hair to ensure her happiness. In the second, 'live' ending, Rani discovers the dead cobra in her hair but chooses to keep it there, symbolically integrating her 'forbidden' love into her legitimate domestic life.

This conclusion is particularly resonant for feminist analysis because it portrays Rani as an 'active member of the family' with 'decision-making power'. She is no longer the 'tongue-tied and obedient girl' but a 'mature woman' who commands her husband. The shift from patriarchy to a 'trace of matriarchy' at the end anticipates a social evolution where women are no longer 'commoditized'but valued as individuals with 'human desires'. Karnad thus uses the folk tale not to reinforce tradition, but to 'make it literally stand on its head,' questioning the very values it appears to uphold.

Intergenerational Patriarchal Internalization: Gowri and Kurudavva

A nuanced gendered reading of Naga-Mandala must also account for the roles of older women who navigate the patriarchal system differently. Gowri, Rani's mother-in-law, is noted for having 'accepted and internalized patriarchal values,' perpetuating the cycle of oppression by enforcing strict norms on the younger generation. This illustrates how patriarchy is not merely a male imposition but a systemic structure sustained through social indoctrination across generations.

In contrast, Kurudavva, the blind and aged woman, represents a 'ray of hope' and a source of maternal wisdom for Rani. Her blindness is ironically paired with a deep 'insight' into beauty and desire; she is the one who recognizes Rani's 'superb beauty' and provides the magic root as a 'catalyst for action' to bring love into the marriage. Kurudavva uses the same 'subversive strategies' she once used to secure her own husband, positioning her as a mentor in female resistance. Her son, Kappanna, though a male figure, remains under her control, momentarily reversing the traditional mother-son hierarchy and providing a parallel 'other' triangle of relationships that complicates the central plot.

The Three-Stage Life Cycle of Dependence

The play effectively documents what scholars call the 'three stages of womanhood' in traditional Indian culture, characterized by persistent dependence. Rani's journey is defined by these transitions: as a daughter, she depends on her parents; as a wife, she depends on Appanna; and even the older Kurudavva lacks social 'capacity' without her son Kappanna. This cycle suggests that fulfillment for a woman is traditionally viewed only through the lens of marriage and motherhood, yet the play reveals the irony of this 'fulfillment,' as Rani finds herself 'not belonging' in either her natal home or her husband's home until she carves out her own domain.

The Performative Self and the Critique of Subjectivity

Drawing on postmodern theories of gender, particularly the work of Judith Butler, Naga-Mandala can be read as a study of 'performativity'. Gender in the play is not a 'persistent category' but an 'unremitting act' created through repetitive performances. Rani's transformation is a 'narrative transfiguration' where she begins to 'view gender as a performance' that can be manipulated. By successfully performing the role of the 'chaste wife' during the snake trial- despite her 'unfaithfulness' with the Naga- Rani exposes the 'limited interpretation' of chastity as a social performance rather than an essential moral truth. The play thus serves as a 'theoretical model' for reconstituting the fabric of everyday life. Rani's quest is not just a personal struggle but a 'transformative agenda for Indian women,' addressing the 'collective neglect' they face. By filling the 'silence of women in Indian patriarchal society,' Karnad gives Rani an 'interrogatory narrative voice' that critiques patriarchal subjectivity while inserting a 'resistant feminist ideology' into the discourse of gender.

Conclusion

Ultimately, Girish Karnad's Naga-Mandala is an exhaustive critique of male bigotry and the repressive nature of the patriarchal culture that treats women as objects of possession rather than subjects of desire. Through the character of Rani, the play dismantles the 'orthodox conception of marital love,' redirecting the focus from duty and endurance to 'autonomy and personal happiness'. The transformation of the Naga into her husband blurs the distinction between 'sacred and profane,' suggesting that love and identity surpass rigid social structures. By the end of the play, the submissive and suppressed woman has broken the barriers intended to imprison her, emerging as a 'confident and mature' individual who manages her own narrative and her own truth. Naga-Mandala thus remains a poignant and timeless exploration of women's liberation, inviting audiences to reflect on the 'courage needed to challenge the status quo' in a society where tradition often clashes with individual aspirations.

References :-

Primary Sources:

1. Karnad, Girish. Naga-Mandala: Play with a Cobra. Oxford University Press, 1990.
2. Karnad, Girish. Collected Plays: Tughlaq, Hayavadana, Bali: The Sacrifice, Naga-Mandala. Vol. 1, Oxford University Press, 2005.

Secondary Sources:

1. Babu, M. S. (1999) "The Concept of Chastity and Naga-Mandala". The Plays of -Girish Karnad: Critical Perspectives, edited by Jaydipsingh Dodiya. New Delhi: P1restige Books.
2. Bala, A. (2014) Mythological Aspects in Girish Karnad's Naga-Mandala in Language in India: Strength for Today and Bright Hope for Tomorrow, 14(2), 1-7.
3. Butler, J. (1992) Gender Trouble.London: Psychology Press. Gupta, S. (1999) "Naga-Mandala: A Story of Marriage and Love". The Plays of Girish Karnad Critical Perspectives, edited by Jaydeep Sinha Dodiya, New Delhi: Prestige Books.
4. Karnad, G. (1990) Naga-Mandala: Play with a Cobra. Delhi: Oxford University Press. Karnad, G. (1994) Three Plays, New Delhi: Oxford University Press.
5. Karnad, G. (1995) "Performance, Meaning, and the Materials of Modern Indian Theatre" in New Theatre Quarterly, 11(44), 355-370.
6. Karnad, G. (2010) Collected Plays, Tughlaq, Hayavadana, Bali: The Sacrifice, Naga-Mandala. New Delhi: Oxford University Press.
7. Rajeshwar, S. (1995) "The Indian world of Indian women: Neurotic characters of Indian women novelists." Feminism and literature, edited by Veena Noble Dass. New Delhi: Prestige Books.
8. Shah, S. (2014) "The Semiotic Significance of 'Mandala' in Girish Karnad's Naga-Mandala." Blog Spot.com.Web. 25 March 2014.
9. Spivak, G.C. (2006) Can the Subaltern Speak? The Post-Colonial Studies reader, edited by Bill Ascroft et al. New York: Routledge.

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From Jamaica to Britain: Cultural Transition and Identity in Andrea Levy's Selected Works

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ABSTRACT

Andrea Levy's fiction powerfully articulates the experiences of Caribbean migrants negotiating identity within the cultural space of postwar Britain. This paper explores the theme of cultural transition from Jamaica to Britain in Andrea Levy's selected works, examining how migration reshapes personal, cultural, and national identities. Through characters who traverse geographical and psychological boundaries, Levy portrays identity as fluid, contested, and continually reconstructed. Drawing on postcolonial and diaspora theories, particularly concepts of hybridity, displacement, and belonging, the study analyzes how Jamaican cultural heritage interacts with British social realities to produce hybrid identities. The paper highlights the tensions between memory and modernity, homeland and host nation, acceptance and alienation, as faced by first- and second-generation migrants. Levy's narratives challenge dominant notions of Britishness by foregrounding marginalized voices and revealing the racial and cultural exclusions embedded within British society. By portraying both the pain and possibility inherent in cultural transition, Levy redefines identity not as a fixed essence but as an evolving process shaped by history, race, gender, and migration. This study ultimately argues that Andrea Levy's selected works offer a nuanced representation of diasporic identity, emphasizing cultural negotiation as a means of survival, resistance, and self-definition within the Black British experience.

Introduction

Migration from the Caribbean to Britain in the mid-twentieth century marked a significant historical and cultural shift that reshaped British society and literature. The arrival of the Windrush generation brought with it complex questions of identity, belonging, and cultural negotiation, particularly for migrants who found themselves positioned between the memories of Jamaica and the realities of Britain. Black British literature has emerged as a powerful space for articulating these experiences, and among its most influential voices is Andrea Levy, whose fiction vividly represents the cultural transition from Jamaica to Britain and its impact on individual and collective identity.

Andrea Levy's selected works—most notably Small Island, Fruit of the Lemon, and Never Far from Nowhere—explore the emotional, psychological, and social consequences of migration. Her narratives focus on ordinary men and women who confront racism, displacement, and cultural dislocation while attempting to construct meaningful identities in an often-hostile British environment. Through nuanced characterization and multiple narrative perspectives, Levy foregrounds the voices historically marginalized in dominant British discourse, thereby challenging monolithic notions of Britishness and national identity.

The cultural transition depicted in Levy's

fiction is not merely a movement across geographical borders but a profound negotiation between cultural inheritance and social reality. Jamaican traditions, memories, and communal values frequently come into tension with British norms, expectations, and racial hierarchies. This negotiation gives rise to hybrid identities that reflect both continuity and change. Levy presents identity as dynamic rather than fixed, shaped by factors such as race, gender, class, and historical memory. Her works illustrate how migrants and their descendants navigate the complexities of cultural belonging while resisting cultural erasure.

This study examines how Andrea Levy represents cultural transition from Jamaica to Britain and how this transition influences the formation of diasporic identity in her selected works. Drawing on postcolonial and diaspora theories, the paper analyzes themes of displacement, hybridity, memory, and belonging to demonstrate how Levy redefines identity as a process of ongoing negotiation. By situating personal narratives within broader historical and cultural contexts, this research argues that Levy's fiction not only documents migrant experiences but also reimagines British cultural identity through a diasporic lens.

Objectives of the Study

To examine the representation of cultural transition from Jamaica to Britain in Andrea Levy's selected works. To analyze the construction and negotiation of identity among Caribbean migrants and their descendants in Levy's fiction. To explore the impact of migration on personal and collective identity, with particular reference to race, gender, and class. To investigate the role of memory, homeland, and cultural heritage in shaping diasporic identities in Andrea Levy's narratives.

To study the concept of hybridity and in-betweenness as a result of cultural encounters between Jamaican and British societies. To examine experiences of displacement, alienation, and belonging faced by characters during and after migration. To assess how Andrea Levy challenges dominant notions of Britishness through the portrayal of marginalized Black British voices.

Significance of the Study

This study holds significance for literary, cultural, and postcolonial studies by offering an in-depth analysis of cultural transition and identity formation in Andrea Levy's selected works. By focusing on the movement from Jamaica to Britain, the research highlights the lived experiences of Caribbean migrants and their descendants, a group historically marginalized within British literary and cultural narratives. The study foregrounds voices that challenge dominant constructions of British identity and contribute to a more inclusive understanding of national and cultural belonging.

The research is significant in its contribution to Black British literature, as it underscores Andrea Levy's role in documenting the complexities of diasporic life and cultural negotiation. By examining how Levy portrays migration, displacement, and hybridity, the study deepens critical understanding of how identity is shaped by race, gender, history, and memory within a postcolonial context. It also enriches scholarly discourse on diaspora by demonstrating how cultural transition is not merely a physical relocation but a continuous process of psychological and cultural negotiation.

From a theoretical perspective, this study applies postcolonial and diaspora frameworks to illuminate key concepts such as hybridity, in-betweenness, and cultural negotiation. In doing so, it bridges literary analysis with cultural theory, offering insights into how fiction reflects and critiques social realities such as racism, exclusion, and cultural assimilation. The study further contributes to ongoing debates about nationhood and belonging by showing how Levy's narratives redefine Britishness through multicultural and diasporic experiences.

Academically, this research will be valuable to students and scholars of postcolonial literature, migration studies, and cultural studies by providing a focused and comprehensive analysis of Andrea Levy's works. It also serves as a reference for future research on Caribbean diaspora writing and identity studies. Ultimately, the study emphasizes the relevance of literature as a powerful medium for understanding cultural transition, identity formation, and the enduring impact of colonial history in contemporary society.

Research Methodology

The present study adopts a qualitative and analytical research methodology to examine cultural transition and identity in Andrea Levy's selected works. The research is primarily text-based and interpretative, focusing on close reading and critical analysis of literary texts within a postcolonial framework.

Primary Sources

The primary sources for this study are the selected novels of Andrea Levy, including Small Island, Fruit of the Lemon, and Never Far from Nowhere. These texts are analyzed to explore themes of migration, cultural displacement, identity formation, and diasporic experience, with particular emphasis on the transition from Jamaica to Britain.

Secondary Sources

Secondary sources include scholarly books, journal articles, critical essays, interviews, and reviews related to Andrea Levy's works, Black British literature, postcolonial studies, and diaspora theory. Critical writings by theorists such as Stuart Hall, Homi K. Bhabha, and Paul Gilroy are consulted to provide theoretical support and contextual grounding for the analysis.

Theoretical Framework

The study is grounded in postcolonial and diaspora theories, focusing on key concepts such as hybridity, cultural negotiation, in-betweenness, identity, and belonging. These theoretical perspectives are employed to interpret the characters' experiences of migration and cultural transition, and to analyze how colonial history and racial hierarchies influence identity construction in Britain.

Method of AnalysisThe research employs close textual analysis to examine narrative structure, characterization, language, and thematic patterns in the selected novels. Comparative analysis is used where necessary to highlight similarities and differences in the representation of identity and cultural transition across the texts. Attention is also given to historical and socio-cultural contexts, particularly postwar migration and the Windrush generation, to enhance interpretative depth.

Scope of the Study

The study is limited to selected works of Andrea Levy and focuses specifically on the cultural transition from Jamaica to Britain and its impact on identity. While acknowledging broader issues of global migration and multiculturalism, the research does not extend to comparative studies with other diasporic writers.

Research Design

This research follows a descriptive–analytical design, aiming to describe the cultural experiences portrayed in the texts and analyze their significance in relation to identity formation. The study does not involve empirical data collection or statistical analysis, relying instead on literary interpretation supported by established critical theories.

Conclusion

This study has examined the theme of cultural transition from Jamaica to Britain in Andrea Levy's selected works, focusing on how migration shapes identity formation within the Black British diasporic experience. Through a close analysis of novels such as Small Island, Fruit of the Lemon, and Never Far from Nowhere, the research has demonstrated that Andrea Levy portrays identity as a dynamic and evolving process influenced by displacement, memory, race, gender, and historical context. Migration in Levy's fiction is not presented merely as physical movement but as a complex psychological and cultural journey that challenges traditional notions of home and belonging.

The findings of the study reveal that Levy's characters often inhabit an in-between space, negotiating Jamaican cultural heritage alongside the social and racial realities of British society. This condition of hybridity highlights both the tensions and possibilities inherent in diasporic life. While characters frequently encounter racism, alienation, and exclusion, they also develop strategies of resilience, adaptation, and self-definition. Levy's narratives thus underscore cultural negotiation as a crucial means of survival and identity assertion within a postcolonial setting. Furthermore, this study has shown that Andrea Levy's fiction plays a significant role in challenging dominant narratives of Britishness. By foregrounding marginalized voices and recovering suppressed histories, her works contribute to a

more inclusive and plural understanding of national identity. The emphasis on memory and history allows Levy to connect individual experiences with broader colonial and postcolonial realities, revealing the lasting impact of empire on contemporary British society.

In conclusion, From Jamaica to Britain: Cultural Transition and Identity in Andrea Levy's Selected Works affirms the importance of literature as a critical space for examining migration, identity, and cultural belonging. Andrea Levy's novels not only document the struggles of Caribbean migrants but also reimagine identity as a fluid, negotiated, and empowering process. This study contributes to existing scholarship on Black British and postcolonial literature and opens avenues for further research into diasporic writing, transnational identity, and cultural hybridity in contemporary literature.

References :-

1. Levy, A. (1994). Every Light in the House Burnin'. London: Headline Review.
2. Levy, A. (1996). Never Far from Nowhere. London: Headline Review.
3. Levy, A. (1999). Fruit of the Lemon. London: Headline Review.
4. Levy, A. (2004). Small Island. London: Headline Review.
5. Levy, A. (2014). Six Stories & An Essay. London: Headline Review.
6. Baxter, J., & James, ___ (eds.). (Year). Andrea Levy: Contemporary Critical Perspectives. Bloomsbury Academic.
7. Asiri, A. (2024). Collective Memory in the Diaspora in Crossing the River & Small Island. International Journal of Linguistics, Literature and Translation, 7(1), 16–31.
8. Paul, A. K. (2023). Belongingness and Identity: Contested Space in Andrea Levy's Small Island. Journal of Namibian Studies: History Politics Culture, 33, 253–261.
9. Khan, R., Bhat, S. H., & Hussain, M. (2025). The Double Consciousness of the Diaspora: Memory and Assimilation in Andrea Levy's Novels. Communications on Applied Nonlinear Analysis.
10. Lojo Rodríguez, L. M. (2023). Borders, Liminality and National Identity in Andrea Levy's Short Stories. Journal of the Short Story in English, 80–81, 155–169.

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Inclusive Growth and Employment Generation

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ABSTRACT

In recent decades, inclusive growth has gained prominence as a core development objective due to increasing concerns over inequality, unemployment, and uneven distribution of economic gains. Although economic growth remains a necessary condition for development, its effectiveness in improving social welfare largely depends on its capacity to generate productive and decent employment. Growth processes that fail to create sufficient employment opportunities often result in social exclusion and persistent inequality, thereby undermining long-term sustainability. This paper examines the interrelationship between inclusive growth and employment generation, emphasizing employment as the principal mechanism through which economic expansion translates into shared prosperity. Adopting a conceptual and analytical approach supported by secondary data and international policy experiences, the study investigates the structural and institutional factors that influence employment-led inclusiveness. It identifies key challenges such as the expansion of capital-intensive growth patterns, widespread labour in formalization, skill mismatches, technological change, and gender-based disparities in labour force participation. Particular attention is given to emerging economies, with reference to India, where rapid economic growth has not been accompanied by proportional employment creation. The analysis highlights the significance of targeted public policies including skill development initiatives, promotion of micro, small and medium enterprises, labour market reforms, and social protection systems in strengthening the inclusiveness of growth. The paper concludes that inclusive growth cannot be achieved automatically through market-driven expansion and requires a deliberate policy framework that places employment generation and decent work at the centre of development strategies.

Keywords: Inclusive Growth, Employment Generation, LabourMarket,Inequality, Sustainable Development.

Introduction

Economic growth has traditionally been treated as the principal measure of development performance. Conventional economic theories assumed that increased output would naturally generate employment opportunities and lead to poverty reduction. However, contemporary global experience has demonstrated that high growth rates do not necessarily guarantee improved employment outcomes or equitable income distribution. Several economies have experienced sustained growth alongside rising unemployment, underemployment, and income inequality, highlighting the limitations of growth-centric development models.

This growing disconnect has shifted policy attention toward inclusive growth, a framework that emphasizes both the pace and the pattern of economic expansion. Inclusive growth seeks to

ensure that economic progress benefits a broad cross-section of society rather than being concentrated among a few. Employment generation is central to this objective, as labour income remains the primary source of livelihood for the majority of households, particularly in developing and emerging economies.

This paper aims to analyse the role of employment generation in achieving inclusive growth. It explores how employment functions as a transmission channel between growth and equity and examines the policy conditions required to strengthen this linkage. The study adopts a conceptual and analytical methodology, drawing on international experiences and the context of emerging economies.

Theoretical Perspective on Inclusive Growth

Inclusive growth is a multidimensional development concept that extends beyond aggregate income growth to include social participation, equality of opportunity, and access to productive resources. Unlike development strategies that prioritize output expansion alone, inclusive growth focuses on the distributional outcomes of economic progress.

A defining feature of inclusive growth is its emphasis on productive employment. Employment enables individuals to actively participate in the growth process while simultaneously benefiting from it. When growth generates widespread employment opportunities, it promotes income equality and social stability.

The conceptual foundation of inclusive growth rests on three interrelated components: sustained economic expansion, broad-based employment generation, and social inclusion. These components collectively determine whether growth outcomes translate into long-term and equitable development.

Employment as a Catalyst for Inclusive Outcomes

Employment generation plays a critical role in converting economic growth into inclusive development. Job creation enhances household incomes, strengthens domestic demand, and reduces poverty levels. Moreover, employment contributes to skill development, social integration, and economic resilience.

However, the inclusiveness of growth depends not only on the number of jobs created but also on their quality. Employment characterized by low wages, job insecurity, and lack of social protection limits the distributive impact of growth. Therefore, inclusive growth requires the creation of decent and productive employment.

Labour-intensive sectors such as agriculture, manufacturing, construction, and services offer significant potential for employment expansion. Policy measures that support entrepreneurship, small enterprises, and rural non-farm activities can enhance the employment responsiveness of economic growth.

Structural Barriers to Employment-Led Inclusive Growth

Despite its importance, employment-centered inclusive growth faces multiple structural challenges. One major constraint arises from growth patterns dominated by capital-intensive industries, which generate limited employment opportunities. Technological progress, while improving productivity, has further reduced labour absorption in several sectors.

Skill mismatch represents another critical challenge. Education and training systems often fail to meet labour market requirements, resulting in unemployment among educated workers and skill shortages in key industries. Additionally, widespread labourin formalization restricts access to social security and decent working conditions.

Gender inequality, regional imbalances, and unequal access to education and finance further weaken the inclusiveness of employment growth. Addressing these challenges requires coordinated policy interventions rather than reliance on market mechanisms alone.

Employment and Inclusive Growth in Emerging Economies

Emerging economies provide valuable insights into the complexities of growth-employment dynamics. Rapid economic expansion has not always translated into proportional job creation. India, for instance, has experienced phases of high growth accompanied by weak employment outcomes, often described as jobless growth.

The persistence of informal employment, low female labour force participation, and regional disparities remain major concerns. Governments have introduced policy initiatives focusing on skill development, industrial promotion, entrepreneurship, and employment support. While these measures have improved income security and employability, their impact on formal employment creation has been limited.

Strengthening manufacturing capacity, promoting micro and small enterprises, and improving labour market institutions are essential for ensuring that growth translates into inclusive employment opportunities.

Policy Framework for Employment-Centric Inclusive Growth

Achieving inclusive growth through employment generation requires a comprehensive and integrated policy framework. Macroeconomic policies should prioritize stable growth while supporting employment-intensive sectors. Education and skill development systems must be aligned with evolving labour market needs.

Labour market reforms should encourage formal job creation while safeguarding worker rights. Social protection mechanisms are necessary to reduce vulnerability and support workforce transitions. Public investment in infrastructure, digital connectivity, and green industries can generate employment while promoting sustainability.

Effective governance and institutional capacity are crucial for ensuring that private sector participation contributes to inclusive outcomes.

Global Dimension and Sustainable Development Goals

At the international level, inclusive growth and employment generation are closely aligned with the Sustainable Development Goals, particularly SDG 8 on decent work and SDG 10 on reducing inequality. Cross-country experience indicates that economies combining growth with strong labour institutions and social policies achieve more equitable outcomes.

Global cooperation, technology diffusion, and inclusive trade practices can further support employment-led growth in developing regions. The shift toward environmentally sustainable development also offers opportunities for creating inclusive green jobs.

Conclusion

Inclusive growth and employment generation are fundamentally interconnected. Economic expansion that fails to create productive and decent employment cannot ensure social equity or long-term stability. Employment remains the most effective mechanism through which the benefits of growth are broadly distributed.

The paper concludes that inclusive growth requires deliberate policy orientation toward employment creation, human capital development, and institutional strengthening. For emerging economies, integrating employment objectives into growth strategies is essential for addressing inequality, poverty, and social exclusion. Sustainable development can be achieved only when growth, employment, and inclusion are pursued simultaneously.

References :-

1. International Labour Organization. (2021). World Employment and Social Outlook.
2. OECD. (2020). Inclusive Growth Framework.
3. United Nations. (2015).
4. Transforming Our World: The 2030 Agenda for Sustainable Development.
5. World Bank. (2018). Growth, Employment and Poverty Reduction.

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Physical Education and Injury Prevention: A Review of the Literature

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ABSTRACT

Physical education (PE) plays a crucial role in promoting physical fitness, motor skills development, and overall well-being in students and athletes. One of its key benefits is injury prevention, as structured PE programs educate individuals on proper movement techniques, body mechanics, and safety practices. This literature review examines the relationship between physical education and injury prevention by analysing studies on exercise physiology, biomechanics, and sports safety. Research indicates that well-designed PE programs incorporating warm-up routines, strength training, flexibility exercises, and injury awareness strategies significantly reduce the risk of musculoskeletal injuries. Additionally, PE fosters knowledge of proper posture, balance, and coordination, which are essential in minimizing accidents during physical activities. However, challenges such as inadequate training for educators, lack of standardized injury prevention curricula, and varying levels of student participation affect the effectiveness of PE in reducing injuries. This review highlights the need for evidence-based strategies in PE to enhance injury prevention and ensure long-term physical health in students and athletes.

Introduction

Physical education (PE) is a fundamental component of a well-rounded education, promoting physical fitness, motor skill development, and overall health. Beyond these benefits, PE plays a crucial role in injury prevention by educating students on proper movement techniques, body mechanics, and sports safety practices. Understanding how structured PE programs contribute to reducing injury risks is essential for educators, coaches, and policymakers aiming to enhance student well-being.

Research suggests that incorporating warm-ups, strength training, flexibility exercises, and proper sports techniques within PE curricula can significantly lower the likelihood of injuries, particularly musculoskeletal and sports-related injuries. Additionally, PE fosters awareness of risk factors, such as poor posture, inadequate conditioning, and improper equipment use, which can contribute to injury. However, challenges such as inconsistent PE curricula, varying levels of teacher training, and lack of standardized injury prevention programs limit the effectiveness of PE in minimizing injuries.

This literature review explores existing research on the relationship between physical education and injury prevention. It examines key factors influencing injury rates, best practices in PE for reducing injuries, and areas that require further research. By understanding the impact of PE on injury prevention, educators and health professionals can develop more effective programs that promote lifelong physical health and safety.

Objectives of the Study

The primary objective of this study is to review existing literature on the role of physical

education (PE) in injury prevention and to identify best practices for minimizing injury risks. Specifically, the study aims to:

1.Examine the Relationship Between Physical Education and Injury Prevention – Analyse how structured PE programs contribute to reducing the risk of injuries in students and athletes.

2.Identify Key Injury Prevention Strategies in PE – Explore effective methods such as warm-ups, strength training, flexibility exercises, and proper biomechanics education in reducing injuries.

3.Assess the Role of PE Teachers and Coaches in Injury Prevention – Evaluate the importance of proper training, certification, and instructional methods used by educators in promoting injury prevention.

4.Highlight Common Injuries and Risk Factors in PE and Sports Activities – Identify the most prevalent injuries associated with physical activity and the underlying causes, such as improper technique, lack of conditioning, or inadequate safety measures.

5.Analyze Challenges in Implementing Injury Prevention Strategies – Investigate barriers such as lack of standardized curricula, limited resources, and varying levels of student participation in injury prevention programs.

Significance of the Study

This study is significant as it highlights the essential role of physical education (PE) in preventing injuries and promoting long-term physical well-being. By reviewing existing literature on injury prevention strategies in PE, this study provides valuable insights for educators, coaches, policymakers, and students.

1.For Educators and Coaches – The study helps PE teachers and coaches understand the importance of proper training techniques, injury prevention strategies, and safety guidelines to reduce the risk of injuries in students and athletes.

2.For Students and Athletes – By emphasizing injury prevention methods such as warm-ups, stretching, strength training, and correct movement techniques, students can develop safer exercise habits and improve their physical performance while minimizing injury risks.

3.For Schools and Educational Institutions – The findings provide schools with evidence-based recommendations for enhancing PE curricula, ensuring that injury prevention is an integral part of physical education programs.

4.For Policymakers and Health Professionals – The study offers insights into the need for standardized injury prevention programs, proper training for PE instructors, and policies that promote student safety in physical activities.

5.For Future Research – By identifying gaps in existing literature, this study lays the foundation for further research on injury prevention strategies, their long-term effectiveness, and the development of new injury prevention models in PE.

Research Methodology

This study employs a literature review methodology to analyse existing research on the role of physical education (PE) in injury prevention. The methodology involves systematically collecting, analysing, and synthesizing relevant studies to understand best practices, challenges, and gaps in the field.

1. Research Design

A qualitative, descriptive research design is used to examine how PE contributes to injury prevention. The study focuses on reviewing peer-reviewed journal articles, books, and reports related to PE, injury prevention strategies, biomechanics, and sports safety.

2. Data Collection Methods

Database Search: Relevant literature is sourced from academic databases such as Google Scholar, PubMed, ScienceDirect, JSTOR, and Research Gate. Keywords and Search Terms: The search includes terms like "physical education and injury prevention," "sports safety in schools," "injury prevention strategies in PE," and "role of biomechanics in injury prevention."

Selection Criteria:

Studies published within the last 10-15 years (to ensure relevance). Peer-reviewed articles and credible sources. Research focusing on school-based PE programs and injury prevention techniques. Exclusion of studies unrelated to educational settings or non-empirical sources.

Hypothesis

Since this study is a literature review, it

does not conduct direct experiments or surveys but instead analyses existing research. However, based on previous studies, the following hypotheses can be formulated: There is no significant relationship between participation in physical education and the prevention of injuries in students and athletes.
Physical education significantly contributes to injury prevention by improving strength, flexibility, coordination, and awareness of proper movement techniques.

3. Specific Hypotheses:

Students who participate in structured physical education programs are less likely to experience sports-related injuries than those who do not. Proper warm-ups, stretching, and strength training in PE reduce the risk of musculoskeletal injuries. Educating students on biomechanics, posture, and movement techniques in PE decreases the likelihood of injury. Schools with well-trained PE instructors and standardized injury prevention programs report fewer injuries among students.

Conclusion

This literature review highlights the critical role of physical education (PE) in injury prevention, emphasizing that well-structured PE programs significantly reduce the risk of injuries among students and athletes. Research suggests that incorporating warm-ups, strength training, flexibility exercises, and biomechanics education in PE curricula helps enhance physical fitness, improve movement efficiency, and minimize injury risks. Furthermore, educating students on proper posture, balance, and sports safety practices fosters long-term injury prevention and overall well-being.

However, challenges such as inconsistent PE curricula, inadequate teacher training, and limited awareness of injury prevention strategies hinder the effectiveness of PE in reducing injuries. Addressing these issues requires the implementation of standardized injury prevention programs, professional development for PE instructors, and increased emphasis on safety education in schools.

In conclusion, physical education is not only essential for promoting physical fitness but also serves as a key component in injury prevention. By integrating evidence-based injury prevention strategies into PE programs, schools can ensure safer physical activity environments and contribute to the long-term health and well-being of students. Further research and policy improvements are necessary to maximize the benefits of PE in injury prevention and overall student development.

References :-

1. Faigenbaum, A. D., & Myer, G. D. (2012). "Resistance Training Among Young Athletes: Safety, Efficacy, and Injury Prevention Effects." British Journal of Sports Medicine, 46(7), 489-495.
2. Degenhardt, B. F., et al. (2007). "The Role of Physical Activity in Injury Prevention and Rehabilitation." Journal of the American Osteopathic Association, 107(11), 514-520.
3. McGuine, T. A., & Keene, J. S. (2006). "The Effect of a Balance Training Program on the Risk of Ankle Sprains in High School Athletes." The American Journal of Sports Medicine, 34(7), 1103-1111.
4. Hewett, T. E., Lindenfeld, T. N., Riccobene, J. V., & Noyes, F. R. (1999). "The Effect of Neuromuscular Training on the Incidence of Knee Injury in Female Athletes: A Prospective Study." The American Journal of Sports Medicine, 27(6), 699-706.
5. Centers for Disease Control and Prevention (CDC). (2011). "Physical Education and Injury Prevention in Schools." CDC School Health Guidelines.
6. Gabbett, T. J. (2016). "The Training-Injury Prevention Paradox: Should Athletes Be Training Smarter and Harder?" British Journal of Sports Medicine, 50(5), 273-280.
7. Meeuwisse, W. H., Tyreman, H., Hagel, B., & Emery, C. (2007). "A Dynamic Model of Etiology in Sport Injury: The Recursive Nature of Risk and Causation." Clinical Journal of Sport Medicine, 17(3), 215-219.

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Combating Drought And Water Security: Need Of Future

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ABSTRACT

Water security is defined as the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and Water related disasters, and for preserving ecosystems in a climate of peace and political stability. The paper characterizes the phenomena of droughts and water scarcity in Polish agriculture and their impacts on crop yield. Various preventive measures should be undertaken to mitigate the harmful effects of droughts and water scarcity. The most important is thedevelopment of water resources. To accomplish this aim, small scale water retention projects and irrigation development programs should be further implemented in many provinces of Poland. Effective use of irrigation water, optimization of water distribution, crop rotation, rehabilitation and modernization of the existing irrigation systems, soil reclamation are the examples of other measures. The pressure for increased water supplies is intensifying in Poland. That is why there is an urgent need to improve the uniform national plans of drought and water scarcity mitigation including guidelines on how to prevent and counteract the effects of water scarcity in agriculture and to release recommendations stating the most adequate measures to be undertaken.

Key words: Drought, mitigation, water scarcity, Actions and measures for drought and water scarcity.

1. INTRODUCTION

Water is essential to all life on Earth. The lack of water or availability is essential for inhibitor of economic development, as water nourishes healthy ecosystems for food production, and human and animal health. Droughts can be considered as a temporary de-crease of the average water availability due to e.g. rainfall deficiency. Water scarcity occurs where there are insufficient water resources to satisfy long-term average requirements. It refers to long-term water imbalances, combining low water availability with a level of water demand exceeding the supply capacity of the natural system. Water scarcity is not only caused by natural reasons but it is also the effect of human activities. The characterization of these phenomena is often controversial and not agreed. Some scientists, engineers, professionals anddecision-makers equate drought with water scarcity or water deficit. Others point out that water scarcity isdue to drought or simply prefer to write about drought water scarcity. In this publication water scarcity in agriculture is considered to be caused by a meteorological drought and is treated as an agricultural drought defined and quantified by soil moisture deficit and crop water stress affecting crop growth and yield. The frequency of droughts and their severity increased in recent years and it is very likely that they will increase in near future due to predicted climate changes. There

is a critical need for reliable information relevant the impacts of droughts and drought hazard mitigation. For counteracting drought impacts drought risk management plans are to be elaborated and implemented. The general objective of drought risk management plans is to support regional initiatives through the application of preparedness and mitigation measures. In relation to drought it is said that drought management plans should contain the following elements: 1) drought related data and information concerning drought formation, exposure to drought and impacts of droughts. 2) A set of drought measures for various applications based on the information that is readily available, 3) methods for drought assessment and pre-diction. 4) Drought hazard and vulnerability to drought. 5) Identification of drought management approach(immediate response or decrease vulnerability) to recover or mitigate direct and indirect impacts of drought within economic, environmental and social contexts .The same or similar approach and elements should also apply to water scarcity. Plans of drought and water scarcity mitigation should determine directions and measures as well as the intensity of organizational, technical, R&D and innovative actions, which would aim at counteracting droughts and serve to limit their effects on the national economy and on agriculture in particular. One of the specific objectives of the plan of mitigation of water deficit is to develop guidelines for developing and implementing different actions and measures leading to minimize negative effects of water deficit. Providing integrated guidelines for mitigating water scarcity is a step forward in attempt to establish drought management policy. The challenge for development of drought risk management scheme is integration of different approaches and concepts arising from different national, regional and sectoral contexts. The recommendations on how to assess drought risk, how to mitigate drought impacts and to create the catalogue of mitigation tools are the frameworks for drought risk management. General objective of the study is to define and in-dicate possible mitigation actions and measures with the aim to minimize water scarcity in agriculture and its impacts in the background of practical experiences of utilizing different methods.

2. INTERRELATIONSHIPS BETWEEN DROUGHT AND WATER SCARCITY IMPACTS OF WATER SCARCITY IN AGRICULTURE

The negative effect of droughts and water scarcity in India is complex and can be observed in various branches of the national economy. Most commonly agricultural drought is defined as soil water deficit of a particular crop at a particular time period or moment, affecting crop yield and leading to significant decline in crop yield. A crop decrease is a final effect of soil water deficit and depends largely on the duration and intensity of the drought. Soil droughts and soil water deficits negatively affect crops. Autumn, winter and early spring droughts usually cause a decrease in winter and spring crops while spring droughts a decrease in spring crops. The meteorological drought is expressed solely on the basis of the departure of rainfall from average and duration of the dry period. Agricultural drought is usually treated as an effect of waterdeficit, especially of crop water deficit. Any realistic definition of agricultural drought should account for the variable susceptibility of crops at different stages of crop development. A spatial differentiation of crop yield reduction depending on meteorologicaldrought category and soils was determined. The lessreduction is observed on the soil with greater total available soil water. Among field crops late potato isthe most vulnerable crop to be damaged by drought. Its potential yield reduction can be more than 50% on light soils on most area of Poland during extreme meteorological drought. Least yield reduction is for winter wheat and winter rape. In most regions there is no negative effect of meteorological drought on yield of these crops.

3. ACTIONS AND MEASURES FOR DROUGHT AND WATER SCARCITY

The actions for drought and water scarcity mitigation should be identified within of pre-impact programs that are intended to reduce vulnerability and impacts. Various measures could be recommended, all of them are means to accomplish the strategic goal controlling the negative effects of water scarcity in agriculture. Water scarcity mitigation measures can be divided into three groups, on account of the time of undertaking (actions):1. Operational – undertaken when

drought begins and in the time of its lasting, 2. Short-term – undertaken before drought in advance up to 5 years. 3. Long-term – undertaken in long perspective up to 25 years.

Among operational actions the most important and commonly used are irrigation, controlling water management in a watershed, flow control in rivers, controlling water intakes from rivers and lakes. Short-term measures essentially to be taken up at local level include adjusting actions to optimize agricultural production without major systemic changes in the system of agricultural production. They may include earlier sowing, changing plant varieties, deep plowing, soilloosening, mulching, and rainwater harvesting, artificial recharge of groundwater, comprehensive water saving schemes such as deficit irrigation. Long-term mitigation measures relate to the larger systemic changes and may include: change in landuse, changes in agricultural production systems, and introduction of new crops, new irrigation management strategies, advanced technology and management of conducting irrigation, development of small water retention, watershed management and development,agroclimatic regional planning, creation of ground and surface water storages, integration of small reservoirs with major reservoirs, integrated basin planning, inter-basin transfer of water, development of community-based natural resources management plans, new land management techniques, developing consciousness among people about the scarcity of water. Because of possible increase in water shortage in agriculture due to droughts and unfavorable climate changes the main actions and measures should lead to achieve the strategic aims: – increase of local water resources and their availability,increase in water use efficiency,decrease in water needs for crops, intensification of irrigation. To achieve these goals, the following actions are distinguished: 1. increasing water resources retention available for agriculture, mainly for irrigation. 2. Increasing soil water retention and its availability for plants. 3. Modification of the technology of water use onfarms and in fields. 4. Improvement in the social awareness of droughts, their effects.

4. Other preventive actions is drought forecasting and early warnings. Forecasting and early warnings are of great importance in planning and preparing to undertake actions aimed at avoiding or minimizing the negative effects of droughts. Institutional solutions should consider local problems within a region, which result from the frequency of droughts, their character and the impact they exert upon various water users as well as those problems originating from the expected economic losses due to the water deficit.

1. Storage capacity increase 2. Water transfers. 3. Locating new potential resources.4. Aqueducts and canals. 5. Groundwater recharge. 6. Water treatment & reuse of wastewater/recycling.

RECCOMEDATIONS AND CONCLUSIONS

1. Continue to mainstream the land-water linkageinto relevant national policies and strategies
2. Establish and build national capacities inthe monitoring of water resources,includingwetlands.
3. Implement land and water conservationapproaches and taking water managementdecisions at the appropriate level, in particular atwatershed level, through participatory river basinorganizations, inclusive of community and genderperspectives and of indigenous and traditionalknowledge.
4. Improve water-use efficiency by using allavailable methods for all uses, with special focuson agriculture as the main consumer, to reducethe pressure on water resources; developingwastewater reuse where appropriate; trainingfarmers, women and local communities on watersavingtechniques.Actions and measures for mitigating the effects of droughts and water scarcity as well as uncertainties asto how the climate will change and how it will influence agriculture are the challenges that planners, designers, farmers, agricultural and extension serviceswill have to cope with. How agriculture and agricultural water management will have to adapt to climate changes is the serious question to be answered in the near future. All of the above mentioned actions and measures should be addressed in long-term strategy for drought control, for mitigating effects of droughts, water scarcity and observed climate change as well as for adaptation of agriculture and agricultural water management to predicted climate change. The problems of drought control and the resulting activities are a challenge to India to have a drought

mitigation strategy and to look for new and more perfect solutions and their implementation in regions with a high risk of droughts. This basis for any activity should be a strategic program, which would determine how and in which way to achieve the requested strategic goals. There is an urgent need to improve and to implement the uniform national plans of drought and waterscarcity mitigation including national water saving policy and its legal aspects, the issuing of drought advisories and warnings, the creation of guidelines on how to prevent and counteract the effects of droughtand water scarcity and to release recommendations stating the most adequate measures to be undertaken.

References :-

[1] Lorenzo-Lacruz, J., Vicente-Serrano, S.M., Lopez-Moreno, J.I., Begueria, S., Garcia-Ruiz, J.M. and Cuadrat, J.M. (2010) The impact of droughts and water management on various hydrological systems in the headwaters of the Tagus River (central Spain). Journal of Hydrology, 386(1), 13–26. https://doi.org/10.1016/j.jhydrol.2010.01.001

[2] World Bank. 2016. "High and Dry: Climate Change, Water, and the Economy." World Bank, Washington, DC.

[3] UN Water (2018) United Nations World Water Development Report, Nature-based Solutions for Water, launched 19 March 2018

[4] Hallegatte, S., Green, C., Nicholls, R. J., & Corfee-Morlot, J. (2013). Future flood losses in major coastal cities. Nature climate change, 3(9), 802.

[5] Hertel, Thomas W. and Liu, Jing (2016) Implications of water scarcity for economic growth OECD Environmental Woking Papers no. 109, OECD, Paris.

[6] UN Water (2018) United Nations World Water Development Report, Nature-based Solutions for Water, launched 19 March 2018

[7] Money, A. (2014). Corporate water risk: A critique of prevailing best practice. J. Mgmt. & Sustainability, 4, 42.

[8] Abubakar, S. M., Pakistan 7th most vulnerable country to climate change, says Germanwatch. Available at: https://www.dawn.com/news/1369425 (Accessed25. June 2018).

[9] Aurat Foundation (2012) Alternative Report on CEDAW. Available at: https://www.af.org.pk/Reports/NGO%20 Alternative%20 Report% 20on%20 CEDAW%20 2012.pdf (Accessed 25. June 2018).

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A Study of Sustainable Agricultural Systems for Environmental Resilience and Food Security: A Review

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ABSTRACT

Sustainable agriculture has turn out as a critical response to the growing challenges of environmental degradation, climate change and socio-economic challenges related with traditional agricultural systems. The present study aims to evaluate sustainable agriculture as an integrated framework comprising ecological conservation, economic viability and social equity. A systematic analysis of literature, reports and documented case studies was conducted to assess the impacts of sustainable agricultural practices on soil health, biodiversity, crop productivity, resource-use efficiency and rural livelihoods. The results revealed that sustainable agricultural systems increases soil fertility, soil organic carbon, reduces dependency on external inputs, improves resilience to climate change and supports rural livelihoods without compromising productivity. However, adoption remains limited by policy gaps, limited technical knowledge and market barriers. The study demonstrates that sustainable agricultural practicescan effectively contribute to resilient food systems and environmental sustainability when enabled by strong institutional frameworks and inclusive participatory approaches.

Keywords: Biodiversity, Climate change,Crop productivity,Food security, Soil health

1. Introduction

Agriculture plays an important role in sustaining human civilization by providing food and fiber.**(Tilman et al.,2002)**.The agricultural production has increased significantly due to technological advancements, improved crop species, use of chemical fertilizers and pesticides in last few decades.**(FAO, 2017; Foley et al., 2011)**. These developments have increased food availability but also led to severe environmental problems such as soil degradation, water pollution, biodiversity loss and increased greenhouse gas production.**(Pretty, 2008; Lal, 2015)**. These challenges raised serious concerns regarding the long-term sustainability of traditional agricultural practices.**(Reganold&Wachter, 2016)**. Sustainable agriculture has gained importance as an alternative model that seeks to balance productivity with environmental protection.**(Gliessman, 2015)**.It emphasizes efficient use of natural resources, conservation of ecosystems and economic stability for farming communities.**(Altieri, 2018)**.Sustainable agriculture adopts a systems-based approach that recognizes the interdependence between ecological processes and agricultural productivity. **(Altieri& Nicholls, 2020)**. Climate change, increasing population and limited land have further underscored the importance of sustainable agriculture.**(Godfray et al., 2010; IPCC, 2019)**. Sustainable agriculture includes solutions by enhancing use of natural resources, improving soil

health and increasing resilience to climatic stresses.**(Rockstrom et al., 2017; Pretty et al., 2018)**.The present study aims to provide a comprehensive evaluation of sustainable agriculture by examining key sustainable agricultural practices as well as to assess their environmental and socio-economic impacts with
identification of challenges and opportunities for large scale adoption.

2. Materials and Methods

2.1 Study Design

This study is based on a qualitative and analytical research design by using secondary data. A systematic review of existing literature was conducted to synthesize current knowledge on sustainable agricultural practices and its impacts across various aspects of the environmental studies.

2.2 Data Sources

Data were collected from various research articles, books, review articles, international organization reports and policy documents published from 2000 to 2025.**(FAO, 2018; UNEP, 2021)**.A systematic search was performed across online databases such as Google Scholar, Scopus-indexed journals, Web of Scienceto get relevant data.**(Reganold et al., 2011)**.

2.3 Selection Criteria

Publications were selected based on relevance to sustainable agriculture and coverage of environmental, economic or social dimensions.**(Pretty, 2008)**. Studies focusing purely on conventional intensive agriculture were excluded unless used for comparison.**(Tilman et al., 2002)**.

2.4 Data Analysis

The collected literature was analyzedsystematically and the important indicators such as soil quality, crop yield stability, biodiversity conservation, input efficiency and livelihood outcomes were extracted and synthesized. **(Gliessman, 2015; Lal, 2015)**.Comparative analysis was used to evaluate sustainable agriculture relative to conventional systems. **(Ponisio et al., 2015)**.

3. Results

3.1 Impact on Soil Health

The reviewed studies reported improvements in soil organic matter, nutrient availability and microbial activity under sustainable agricultural practices.**(Lal, 2015; Montgomery, 2017)**.Techniques such as crop rotation, green manuring, compost application and reduced tillage extensivelyincreased soil structure and water-holding capacity.**(Altieri, 2018)**.Increased soil organic carbon was identified as a key indicator of long-term sustainability.**(Rockstrom et al., 2017)**.

3.2 Crop Productivity and Yield Stability

Results revealed that initial yields in sustainable systems may be slightly lower than conventional systems but yield stability over time was significantly higher.**(Pretty et al., 2018; Ponisio et al., 2015)**. Diversified cropping systems exhibited reduced vulnerability to pests, diseases and climatic stresses resulting in more consistent production.**(Tscharntke et al., 2012)**.

3.3 Biodiversity Conservation

Sustainable agricultural practices such as intercropping, agroforestry and reduced chemical use were related with increased on-farm biodiversity.**(Altieri, 2018)**. Higher populations of beneficial insects, soil fauna and pollinators were reported contributing to natural pest regulation and ecosystem balance.**(Tscharntke et al., 2012)**.

3.4 Resource-Use Efficiency

Sustainable systems demonstrated improved efficiency in the use of water, nutrients and energy.**(Rockstrom et al., 2017)**. Integrated nutrient management reduced fertilizer losses while efficient irrigation practices reduced water consumption without compromising crop growth.**(FAO, 2017)**.

3.5 Socio-Economic Outcomes

Farmers adopting sustainable practices reported reduced input costs and improved net income over time.**(Reganold&Wachter, 2016)**.Enhanced food diversity and improved nutritional security at the household level were also observed.**(FAO, 2018)**. Community-based approaches strengthened social cohesion and knowledge sharing.**(Altieri& Nicholls, 2020)**.

4. Discussion

The findings of this study highlights the multifunctional benefits of sustainable agriculture across environmental, economic and social

domains.**(Pretty, 2008; Gliessman, 2015)**. Improved soil health under sustainable practices directly contributes to enhanced productivity and resilience supporting earlier research that identifies soil as the foundation of agricultural sustainability.**(Lal, 2015)**. Yield stability rather than maximum yield emerged as a critical advantage of sustainable agriculture.**(Ponisio et al., 2015)**. Diversification strategies reduced risk by spreading production across multiple crops and ecological niches.**(Tscharntke et al., 2012)**.

The conservation of biodiversity observed in sustainable systems underscores the importance of ecological processes in agricultural landscapes.**(Altieri, 2018)**. Biodiversity enhances ecosystem services such as pollination, nutrient cycling and pest control reducing reliance on synthetic inputs.**(Foley et al., 2011)**.Despite these benefits, adoption of sustainable agriculture remains limited.**(FAO, 2017)**.Barriers include lack of awareness, insufficient extension services, short-term economic pressures and policy frameworks that favour conventional input-intensive systems.**(Reganold et al., 2011)**.Integrated policy support, market incentives and participatory research approaches required to address these challenges.**(Altieri& Nicholls, 2020)**.

5. Conclusion

The evidences synthesized in this study demonstrates that sustainable agricultural systems improves soil health, conserve biodiversity, uses natural resources and support socio-economic well-being.Concerted efforts are required from policymakers, researchers, extension agencies and farming communities to realize the full potential of sustainable agriculture. Future strategies should focus on context-specific solutions, capacity building and integration of traditional knowledge with modern research.

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References :-

1. Altieri, M. A. (2018). Agroecology: The science of sustainable agriculture (3rd ed.). CRC Press. https://doi.org/10.1201/9780429495465
2. Altieri, M. A., & Nicholls, C. I. (2020). Agroecology and the reconstruction of a post-COVID-19 agriculture. Journal of Peasant Studies, 47(5), 881–898. https://doi.org/10.1080/03066150.2020.1782891
3. Foley, J. A., Ramankutty, N., Brauman, K. A., Cassidy, E. S., Gerber, J. S., Johnston, M., Mueller, N. D., O'Connell, C., Ray, D. K., West, P. C., Balzer, C., Bennett, E. M., Carpenter, S. R., Hill, J., Monfreda, C., Polasky, S., Rockström, J., Sheehan, J., Siebert, S., &Zaks, D. P. M. (2011). Solutions for a cultivated planet. Nature, 478(7369), 337–342. https://doi.org/10.1038/nature10452
4. Food and Agriculture Organization of the United Nations. (2017). The future of food and agriculture – Trends and challenges. FAO.
5. Food and Agriculture Organization of the United Nations. (2018). Sustainable food systems: Concept and framework. FAO.
6. Gliessman, S. R. (2015). Agroecology: The ecology of sustainable food systems (3rd ed.). CRC Press.
7. Godfray, H. C. J., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., Pretty, J., Robinson, S., Thomas, S. M., &Toulmin, C. (2010). Food security: The challenge of feeding 9 billion people. Science, 327(5967), 812–818. https://doi.org/10.1126/science.1185383
8. Lal, R. (2015). Restoring soil quality to mitigate soil degradation. Sustainability, 7(5), 5875–5895. https://doi.org/10.3390/su7055875
9. Montgomery, D. R. (2017). Growing a revolution: Bringing our soil back to life. W. W. Norton & Company.

10. Ponisio, L. C., M'Gonigle, L. K., Mace, K. C., Palomino, J., De Valpine, P., &Kremen, C. (2015). Diversification practices reduce organic to conventional yield gap. Proceedings of the Royal Society B: Biological Sciences, 282(1799), 20141396. https://doi.org/10.1098/rspb.2014.1396
11. Pretty, J. (2008). Agricultural sustainability: Concepts, principles and evidence. Philosophical Transactions of the Royal Society B: Biological Sciences, 363(1491), 447–465. https://doi.org/10.1098/rstb.2007.2163
12. Pretty, J., Benton, T. G., Bharucha, Z. P., Dicks, L. V., Flora, C. B., Godfray, H. C. J., Goulson, D., Hartley, S., Lampkin, N., Morris, C., Pierzynski, G., Prasad, P. V. V., Reganold, J., Rockström, J., Smith, P., Thorne, P., &Wratten, S. (2018). Global assessment of agricultural system redesign for sustainable intensification. Nature Sustainability, 1(8), 441–446. https://doi.org/10.1038/s41893-018-0114-0
13. Reganold, J. P., &Wachter, J. M. (2016). Organic agriculture in the twenty-first century. Nature Plants, 2, Article 15221. https://doi.org/10.1038/nplants.2015.221
14. Reganold, J. P., Glover, J. D., Andrews, P. K., &Hinman, H. R. (2011). Sustainability of three apple production systems. Nature, 410(6831), 926–930. https://doi.org/10.1038/35073574
15. Rockström, J., Williams, J., Daily, G., Noble, A., Matthews, N., Gordon, L., Wetterstrand, H., DeClerck, F., Shah, M., Steduto, P., Fraiture, C. D., Hatibu, N., Unver, O., Bird, J., Sibanda, L., & Smith, J. (2017). Sustainable intensification of agriculture for human prosperity and global sustainability. Annual Review of Environment and Resources, 42, 257–284. https://doi.org/10.1146/annurev-environ-102016-060746
16. Tilman, D., Cassman, K. G., Matson, P. A., Naylor, R., &Polasky, S. (2002). Agricultural sustainability and intensive production practices. Nature, 418(6898), 671–677. https://doi.org/10.1038/nature01014
17. Tscharntke, T., Clough, Y., Wanger, T. C., Jackson, L., Motzke, I., Perfecto, I., Vandermeer, J., & Whitbread, A. (2012). Global food security, biodiversity conservation and the future of agricultural intensification. Biological Conservation, 151(1), 53–59. https://doi.org/10.1016/j.biocon.2012.01.068
18. United Nations Environment Programme. (2021). Food systems and natural resources. UNEP.

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The Narrative Production of Feminist Consciousness: Gendered Subjectivity and the Discursive Construction of the New Woman in Shashi Deshpande's Novels

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ABSTRACT

This paper undertakes a rigorous examination of the narrative modalities through which feminist consciousness is constituted, mediated, and problematized in the fictional corpus of Shashi Deshpande, with particular emphasis on the discursive fabrication of gendered subjectivity and the ideological figuration of the New Woman. Anchored within the epistemic conditions of postcolonial Indian modernity, the study interrogates how Deshpande's narrative praxis functions as a critical site for the contestation and reconfiguration of patriarchal hegemonies. Drawing upon an interdisciplinary theoretical matrix encompassing poststructuralist feminism, Foucauldian discourse theory, and feminist narratology, the research elucidates the processes by which female subjectivity emerges as a historically contingent, linguistically mediated, and culturally inscribed construct.

The paper argues that Deshpande's protagonists inhabit liminal and heteroglossic spaces wherein personal memory, affective experience, and socio-symbolic regulation intersect, producing fractured yet resistant modes of selfhood. Through narrative techniques such as interior monologue, non-linear temporality, and reflexive focalization, Deshpande not only thematizes the crisis of female identity but also enacts, at the level of form, a sustained critique of normative gender ideologies. These narrative strategies facilitate the articulation of a feminist consciousness that is neither teleological nor homogenized, but instead processual, self-reflexive, and dialogically constituted.

Ultimately, the study posits that the New Woman in Deshpande's fiction is not a stable ideological category but a discursively negotiated subject-position, continuously reconstituted through acts of narration, silence, and resistance. By foregrounding the politics of representation and the materiality of narrative form, this paper contributes to contemporary feminist literary scholarship by reconceptualizing agency as an emergent, relational phenomenon embedded within power-laden cultural discourses.

Key Words: Feminist consciousness; Narrative subjectivity; Gender discourse; The New Woman; Postcolonial Indian fiction; Shashi Deshpande; Feminist narratology; Discursive identity formation; Interiorization and silence

Highlights:

- Examines feminist consciousness as a narratively produced, processual phenomenon rather than a fixed ideological stance.
- Analyzes gendered subjectivity through narrative strategies of interiority, silence, and retrospection.
- Offers a comparative reading of The Dark Holds No Terrors, Roots and Shadows, and That

Long Silence.

· Reconfigures the figure of the New Woman as a discursively negotiated and historically contingent subject-position.

· Demonstrates narrative form as an epistemological mechanism shaping feminist awareness in postcolonial Indian fiction.

Introduction:

Postcolonial Indian English women's writing has increasingly foregrounded the complex processes through which feminist consciousness is formed within everyday social and cultural structures. Rather than presenting emancipation as a definitive rupture, contemporary feminist narratives emphasize interiority, self-reflection, and discursive negotiation as central to gendered subjectivity. Literary texts thus function as critical spaces where feminist awareness is narratively produced.

Shashi Deshpande's novels exemplify this shift by focusing on women's introspective engagement with patriarchal norms embedded in family and marriage. This study examines The Dark Holds No Terrors, Roots and Shadows, and That Long Silence to explore how feminist consciousness and the figure of the New Woman emerge through narrative strategies such as silence, memory, and interior monologue. By integrating feminist narratology and poststructuralist feminist theory, the research foregrounds narrative form as a key site for understanding feminist subjectivity in postcolonial Indian fiction.

Review of Literature:

Scholarly engagement with Shashi Deshpande's fiction has predominantly approached her novels through feminist and sociocultural lenses, emphasizing women's marginalization within domestic and marital structures. While such studies have been instrumental in establishing the feminist orientation of her work, they often conceptualize feminist consciousness as an assumed thematic presence rather than as a process emerging through narrative articulation.

Critical analyses of novels such as The Dark Holds No Terrors and That Long Silence have foregrounded silence, endurance, and psychological conflict as defining features of women's experience. However, these readings frequently privilege thematic interpretation over formal analysis, resulting in limited attention to narrative strategies—such as interior monologue and temporal reconfiguration—as active agents in shaping feminist subjectivity.

Recent theoretical interventions informed by poststructuralist feminism and discourse theory have begun to challenge essentialist readings of Deshpande's female protagonists. Nevertheless, a comprehensive narratological examination that integrates feminist theory with comparative textual analysis remains underdeveloped, creating space for further inquiry into the narrative production of feminist consciousness in her fiction.

Research Gap and Objectives:

Despite sustained critical engagement with Shashi Deshpande's fiction, existing scholarship has largely prioritized thematic and sociocultural readings that treat feminist consciousness as either an assumed ideological stance or a completed emancipatory outcome. Such approaches have insufficiently examined the narrative and discursive processes through which feminist awareness is produced, negotiated, and unsettled. Moreover, Deshpande's narrative strategies—particularly interiority, temporal modulation, and perspectival complexity—remain under-theorized as constitutive forces in the formation of gendered subjectivity. The figure of the New Woman has similarly been addressed as a representational category rather than as a narratively constructed subject-position. This study addresses this critical gap by foregrounding a narratologically informed, poststructuralist feminist analysis of feminist consciousness in Deshpande's novels.

The primary objective of this study is to critically examine the narrative processes through which feminist consciousness is constituted and articulated in the selected novels of Shashi Deshpande, namely The Dark Holds No Terrors, Roots and Shadows, and That Long Silence. Rather than treating feminist awareness as a thematic constant or ideological given, the research seeks to interrogate its emergence as a discursively mediated and narratively produced phenomenon

within postcolonial Indian English fiction.

Specifically, the study aims to:

1. Analyse the construction of gendered subjectivity in the selected novels by examining how female selfhood is shaped through memory, silence, desire, and relational power within familial and marital contexts.

2. Investigate the role of narrative form and technique—including interior monologue, temporal fragmentation, retrospective narration, and focalization—in facilitating the production of feminist consciousness.

3. Examine the discursive representation of the New Woman as a contingent and evolving subject-position, rather than as a fixed ideological archetype of emancipation or resistance.

4. Interrogate the intersection of personal experience and cultural discourse to reveal how patriarchal norms are internalized, negotiated, and occasionally destabilized within women's everyday lives.

5. Situate Shashi Deshpande's fiction within contemporary feminist theoretical frameworks, particularly poststructuralist feminism and feminist narratology, to elucidate the epistemological implications of narrative self-representation.

6. Contribute to feminist literary scholarship by advancing a comparative, theoretically grounded approach that foregrounds narrative production as central to the understanding of feminist agency and consciousness in postcolonial literature.

Through these objectives, the study seeks to extend existing critical discourse by offering a nuanced and methodologically rigorous examination of feminist consciousness as an emergent, processual, and narratively constituted form of subjectivity.

Theoretical Framework:

This study draws upon poststructuralist feminist theory to conceptualize feminist consciousness as a discursively produced and non-essentialized form of awareness. Gendered subjectivity is understood as fluid and relational, constituted through ongoing negotiations with patriarchal language and cultural norms rather than through fixed identities or linear emancipation. Feminist narratology informs the analysis by foregrounding narrative form as an epistemological site of feminist meaning-making. Techniques such as interior monologue, silence, and temporal fragmentation are examined as narrative strategies through which female subjectivity is articulated, deferred, and reconstituted.

Discourse theory and gender–subjectivity studies situate individual experience within broader regimes of power, revealing how institutional narratives of domesticity and femininity regulate women's self-perception. Feminist consciousness emerges through moments of reflexive disruption, where dominant discourses are critically apprehended and re-signified.

Methodology:

The study adopts a qualitative, interpretive research design grounded in close textual analysis to examine the narrative production of feminist consciousness in Shashi Deshpande's selected novels. The methodology privileges depth of interpretation over empirical generalization, aligning with humanistic modes of literary inquiry.

A comparative analytical approach is employed to investigate The Dark Holds No Terrors, Roots and Shadows, and That Long Silence, with attention to narrative structure, focalization, interior monologue, and discursive patterns. These elements are analyzed as constitutive mechanisms through which gendered subjectivity is narratively articulated.

The analysis is informed by poststructuralist feminist theory, feminist narratology, and discourse analysis, enabling an examination of how patriarchal norms are internalized, negotiated, and reconfigured within narrative form. Interpretation proceeds through iterative reading, theoretical triangulation, and contextualization within postcolonial feminist discourse.

Textual Analysis with Critical Discussion:

In The Dark Holds No Terrors, Shashi Deshpande inaugurates a narrative paradigm wherein psychic inwardness operates as the principal locus for the articulation of feminist self-consciousness. The novel's introspective narrative economy privileges cognitive and affective

processes over external action, thereby situating subject formation within the realm of reflective self-scrutiny. Saru's interior discourse reveals a subjectivity constituted through sedimented experiences of familial exclusion, professional dissonance, and conjugal subordination. Feminist consciousness, in this configuration, materializes not as an ideological proclamation but as a gradual epistemic awakening catalyzed by narrative self-examination. The text thus positions narration itself as a generative force, through which the protagonist apprehends the gendered asymmetries governing her existence.

The narrative temporality of The Dark Holds No Terrors is marked by a deliberate fragmentation that resists linear coherence, thereby foregrounding memory as a constitutive element of subjectivity. Deshpande's oscillation between present consciousness and recollected experience enables a recursive interrogation of formative moments that have inscribed patriarchal values onto Saru's psyche. These temporal dislocations function as epistemological ruptures through which the protagonist revisits, reassesses, and ultimately destabilizes inherited gender scripts. Feminist awareness emerges here as a narratively mediated phenomenon, produced through the interpretive reworking of memory rather than through decisive narrative resolution. In this sense, temporality becomes a critical apparatus for exposing the constructedness of gendered identity.

Deshpande's representation of marital intimacy in The Dark Holds No Terrors foregrounds the female body as a site of symbolic inscription and ideological control. Saru's conjugal experiences expose the covert operations of patriarchal authority enacted through affective manipulation and sexual coercion. However, the narrative refrains from collapsing the protagonist into a static position of victimhood; instead, it charts the evolution of her perceptual awareness regarding the structural determinants of her suffering. Through sustained interior reflection, Saru discerns the extent to which marital violence is legitimized by culturally entrenched norms of masculinity and feminine acquiescence. Feminist consciousness thus crystallizes as an interpretive lens through which the body is re-signified as a politically charged terrain rather than a passive object of domination. A crucial dimension of subject formation in The Dark Holds No Terrors is articulated through Saru's conflicted engagement with maternal authority, which operates as a conduit for the transmission of patriarchal ideology. The maternal figure's disciplinary practices and differential valuation of children exemplify how gender normativity is reproduced within domestic spaces. Deshpande's narrative complicates feminist critique by illuminating the paradoxical positioning of women as both subjects and agents of ideological enforcement. Saru's feminist consciousness is activated through her belated recognition of this dynamic, enabling a critical demarcation between individual maternal behavior and systemic gender asymmetry. The novel thereby situates feminist awareness within an intergenerational matrix of power and inheritance.

In The Dark Holds No Terrors, the construction of the New Woman is achieved not through declarative emancipation but through narrative self-authorization and epistemic recalibration. Saru's return to her ancestral home initiates a symbolic regression that facilitates a rearticulation of identity grounded in critical self-awareness. The narrative eschews conclusive resolutions, instead presenting feminist subjectivity as an open-ended, reflexive enterprise. Through sustained narrative articulation, Saru attains a provisional mode of agency predicated on interpretive clarity rather than ideological finality. Deshpande thus reconceptualizes the New Woman as a discursively produced subject whose feminist consciousness is continually negotiated within the constraints of cultural memory and embodied experience.

In Roots and Shadows, Deshpande mobilizes ancestral memory as a narrative apparatus through which the stratified formation of female consciousness is rendered visible. Indu's re-entry into the familial household precipitates a profound confrontation with inherited codes of gendered conduct that have long governed her psychic and social orientation. The narrative situates subjectivity not as an autonomous construct

but as an accretive formation shaped by intergenerational residues of authority, obligation, and suppression. Feminist consciousness in the novel materializes through Indu's critical re-engagement with these genealogical inscriptions, enabling her to recognize the ways in which personal identity is inextricable from historically sedimented structures of power. The text thereby reframes selfhood as an ongoing negotiation between inherited constraint and interpretive agency.

The domestic environment in Roots and Shadows is configured as a discursively charged space wherein normative femininity is continuously rehearsed, monitored, and legitimized. Deshpande constructs the ancestral home as an ideological microcosm that naturalizes gender hierarchies through ritualized practices, affective economies, and spatial segregation. Indu's perceptual estrangement from this environment facilitates a critical awareness of domesticity as a mechanism of ideological reproduction rather than a neutral site of cultural continuity. Feminist consciousness emerges through spatial estrangement, as the protagonist deciphers the home as a locus of symbolic containment that simultaneously demands compliance and forecloses dissent.

Deshpande's treatment of female desire in Roots and Shadows constitutes a decisive rupture from moral orthodoxies that seek to discipline women's affective and corporeal autonomy. Indu's transgressive relational choices are narratively positioned as moments of existential inquiry rather than ethical aberration. The novel refuses reductive moralization, instead situating desire within a broader discourse of self-authentication and subjective legitimacy. Feminist consciousness crystallizes through Indu's confrontation with the dissonance between socially sanctioned virtue and lived emotional truth, thereby exposing the fragility of moral frameworks that privilege female self-effacement over self-realization.

Language in Roots and Shadows functions as a terrain of ideological struggle, mediating the conditions under which women may speak, remain silent, or be spoken for. Deshpande interrogates silence not as an innate feminine disposition but as a cultivated response to institutionalized hierarchies within family and society. Indu's gradual movement toward expressive autonomy reveals the extent to which verbal articulation is entangled with power, legitimacy, and self-recognition. Feminist consciousness unfolds as a linguistic awakening, wherein the protagonist discerns that silence operates less as protection and more as a mechanism of ideological compliance.

In Roots and Shadows, the New Woman is narratively produced through ethical negotiation rather than radical repudiation of cultural inheritance. Indu's evolving self-concept resists binary oppositions of tradition and modernity, instead occupying an intermediary subject-position that enables selective engagement with both. The novel advances a model of feminist subjectivity grounded in discernment, reflexivity, and contextual agency. Feminist consciousness is thus rendered as an adaptive and dialogic process, wherein autonomy is achieved not through erasure of roots but through critical recalibration of relational and cultural affiliations.

In That Long Silence, Deshpande conceptualizes silence not as an absence of articulation but as a historically conditioned mode of female subjectivity produced within patriarchal discourses of respectability and endurance. The protagonist Jaya's prolonged muteness functions as both a psychological defense mechanism and a culturally sanctioned practice of compliance. Through a narrative structure deeply invested in interior retrospection, the novel exposes silence as a learned epistemology that governs women's modes of perception, self-expression, and relational negotiation. Feminist consciousness, in this framework, emerges through Jaya's gradual recognition of silence as an instrument of ideological containment rather than moral virtue, thereby transforming muteness into a site of critical inquiry. The novel's retrospective narrative mode enables a sustained interrogation of marital conventions that normalize emotional erasure and gendered asymmetry. Jaya's recollections of conjugal life reveal how marriage operates as a disciplinary institution that rewards female acquiescence while marginalizing dissenting subjectivities. Deshpande

refrains from depicting marital conflict through overt dramatization; instead, the slow accumulation of narrative memory foregrounds the pervasive ordinariness of female self-suppression. Feminist consciousness is narratively generated through this retrospective excavation, as Jaya reconstructs her past not as personal failure but as a product of systemic gender expectations.

That Long Silence foregrounds authorship as a critical metaphor for women's struggle over narrative authority and self-representation. Jaya's thwarted aspirations as a writer mirror her constrained capacity for self-articulation within familial and social hierarchies. The novel situates creative expression as a contested terrain, wherein women's voices are permitted only insofar as they remain non-disruptive. Feminist consciousness materializes through Jaya's recognition of the incompatibility between imposed silence and authentic self-expression, positioning voice as both an ethical imperative and a political act.

Deshpande's manipulation of temporal sequence in That Long Silence facilitates a non-linear exploration of identity formation, wherein past experiences are continuously reinterpreted in light of present awareness. Jaya's narrative oscillation between memory and immediacy destabilizes the notion of a fixed self, revealing subjectivity as mutable and historically contingent. Feminist consciousness unfolds as an interpretive practice, wherein recollection becomes a means of dismantling normalized patterns of endurance and invisibility. Through this temporal fluidity, the novel articulates selfhood as a narrative construct open to revision and re-signification.

In That Long Silence, the figure of the New Woman is articulated through a reorientation toward speech, narrative agency, and ethical self-assertion. Jaya's movement toward articulation does not culminate in dramatic rupture but in a conscious refusal to perpetuate silence as a moral obligation. The novel resists idealized resolutions, instead presenting feminist consciousness as an emergent disposition grounded in self-awareness and discursive accountability. Deshpande thus reconfigures the New Woman as a narratively produced subject who claims agency through articulation, reflexivity, and sustained resistance to ideological erasure.

When examined in critical constellation, The Dark Holds No Terrors, Roots and Shadows, and That Long Silence collectively articulate a sustained and methodologically coherent interrogation of feminist subject formation in Shashi Deshpande's narrative imagination. Across these novels, feminist consciousness does not manifest as an a priori ideological posture nor as a conclusive moment of emancipation; rather, it is narratively precipitated through prolonged encounters with interior conflict, affective dissonance, and discursively sanctioned silences. Saru's psychic excavation of marital and corporeal subjugation, Indu's ethically fraught engagement with ancestral memory and desire, and Jaya's gradual repudiation of muteness as moral virtue collectively foreground female subjectivity as an unstable, historically sedimented, and narratively reconstituted formation. In each text, the New Woman is neither idealized nor monumentalized but emerges as a provisional subject-position forged through reflexive narration, epistemic recalibration, and incremental resistance to normalized gender scripts. By consistently privileging introspection over insurgency and negotiation over radical rupture, Deshpande advances a feminist epistemology grounded in relationality, discursivity, and ethical self-awareness. This triadic textual analysis thus demonstrates that feminist agency within Deshpande's oeuvre is not an event but a process—one that is continually produced, deferred, and reconfigured through the act of narration itself.

Conclusion:

This study has demonstrated that Shashi Deshpande's fiction offers a sustained and nuanced exploration of the narrative production of feminist consciousness, wherein gendered subjectivity is constituted through discursive, relational, and mnemonic processes rather than through definitive moments of emancipation. Through a comparative analysis of The Dark Holds No Terrors, Roots and Shadows, and That Long Silence, the research establishes that feminist consciousness in Deshpande's novels emerges as a processual and reflexive formation, shaped by interior negotiation

with patriarchal structures embedded within familial, marital, and cultural domains.

The trajectories of Saru, Indu, and Jaya collectively reveal subjectivity as historically inscribed and narratively reconstituted, challenging liberal feminist models that equate agency with autonomy or rupture. By privileging interiority, silence, and retrospection, Deshpande reconceptualizes resistance as a relational and ethically complex practice situated within everyday experience. Crucially, the study underscores narrative form as an epistemological mechanism through which feminist awareness becomes intelligible, positioning narration as both a site of constraint and a mode of self-authorization.

By reframing the New Woman as a discursively constituted and historically contingent subject-position, this research contributes to feminist literary scholarship by advancing a non-teleological understanding of feminist agency. Deshpande's fiction ultimately affirms feminist consciousness as an ongoing process of becoming, continually shaped and reshaped through narrative self-reflection within postcolonial modernity.

Future Scope of Research:

Future research may extend this analytical framework to Shashi Deshpande's broader corpus and to comparative studies of Indian women's writing, enabling an exploration of feminist consciousness across diverse narrative, cultural, and generational contexts.

Interdisciplinary approaches drawing on affect theory, trauma studies, or reception studies may further illuminate the narrative dynamics of silence, memory, and gendered subjectivity, thereby deepening contemporary feminist literary inquiry.

References :-

1. Deshpande, S. (1980). The Dark Holds No Terrors. New Delhi: Penguin Books.
2. Deshpande, S. (1982). Roots and Shadows. New Delhi: Orient Paperbacks.
3. Deshpande, S. (1988). That Long Silence. New Delhi: Penguin Books.
4. Butler, J. (1990). Gender Trouble: Feminism and the Subversion of Identity. New York: Routledge.
5. Cixous, H. (1976). The laugh of the Medusa. Signs, 1(4), 875–893.
6. Foucault, M. (1972). The Archaeology of Knowledge. London: Tavistock.
7. Foucault, M. (1980). Power/Knowledge: Selected Interviews and Other Writings. New York: Pantheon.
8. Gilbert, S. M., &Gubar, S. (1979). The Madwoman in the Attic. New Haven: Yale University Press.
9. Lanser, S. S. (1992). Fictions of Authority: Women Writers and Narrative Voice. Ithaca: Cornell University Press.
10. Moi, T. (2002). Sexual/Textual Politics: Feminist Literary Theory. London: Routledge.
11. Nayar, P. K. (2009). Postcolonial Literature: An Introduction. New Delhi: Pearson.
12. Showalter, E. (1985). The New Feminist Criticism. New York: Pantheon Books.
13. Spivak, G. C. (1988). Can the subaltern speak? In C. Nelson & L. Grossberg (Eds.), Marxism and the Interpretation of Culture (pp. 271–313). Urbana: University of Illinois Press.
14. Tong, R. (2009). Feminist Thought: A More Comprehensive Introduction. Boulder: Westview Press.

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Sports for Mental Health: Boosting the Mind with Movement

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ABSTRACT

In a time when psychological stress and mental health issues are increasing, sports play a role that goes beyond just physical fitness, they provide notable psychological benefits. This article highlights how engaging in sports can boost mental well-being by lowering stress, anxiety and depression, thanks to endorphin release and the fostering of healthy routines. It also stresses the positive effects of sports on self-confidence, emotional resilience and social interaction, showing how teamwork and goal-driven efforts improve interpersonal skills and create a supportive community. Moreover, this article brieflyexplains how sports develop mental toughness by teaching individuals to handle pressure, setbacks and competition. Combining research and practical insights, it highlights the importance of promoting regular sports participation across all ages as an accessible, preventive, and healing strategy for better mental health and greater life satisfaction.

Introduction:

Today's fast-paced and competitive environment makes mental health just as vital as physical health. Sports and physical activity are essential in shaping a person's character. In today's busy, technology-focused world, physical fitness is often overlooked, leading to physical and mental issues. Participating in sports and staying active not only boosts physical health but also supports overall personality growth. A balanced personality includes physical strength, mental clarity, emotional control, and social skills, all of which are developed through sports.

Firstly, sports foster physical fitness and discipline. Regular exercise enhances strength, endurance, flexibility, and coordination. A healthy body underpins a confident personality. Sports demand adherence to rules, consistent practice, and good time management, instilling discipline and responsibility that often carry over into academic and professional life.

Secondly, sports aid mental and emotional growthincreasingly, stress, anxiety, depression and emotional fatigue affect people of all ages. In this context, sports and physical activity serve as powerful tools for enhancing mental well-being. They not only strengthen the body but also support the development of a healthy, resilient and balanced mind. In this article we look the mental benefits of sports participation.

Sports as a Natural Stress Reliever

Engaging in sports reduces stress by releasing endorphins, known as "feel-good hormones," which elevate mood and promote feelings of happiness and relaxation. Activities like running, football, kabaddi, yoga, basketball, or swimming allow individuals to temporarily detach from daily worries and stay focused on the present moment. This mental pause is vital for easing emotional tension and avoiding burnout.

Building Self-Confidence and Self-Esteem

Sports offer opportunities to set goals,

conquer challenges and celebrate achievements. Whether learning a new skill, improving performance or winning a match, every success boosts self-confidence. Even setbacks teach valuable lessons about perseverance, discipline and believing in oneself. Over time, these experiences foster a positive self-image and emotional resilience.

Alleviating Anxiety and Depression

Regular involvement in sports helps reduce symptoms of anxiety and depression. Physical activity improves sleep, sharpens concentration and stabilizes mood. Team sports, in particular, foster a sense of belonging and provide social support, which is essential for those feeling lonely or emotionally distressed. The routine of training and competitions adds structure and purpose to daily life.

Developing Social Skills and Emotional Awareness

Participating in sports promotes interaction, teamwork, communication and empathy. Playing with teammates and competing respectfully against opponents teach cooperation, leadership, and emotional regulation. These social skills strengthen relationships and decrease feelings of isolation. For young people, sports create a safe space to express emotions and manage frustration in positive ways.

Fostering Resilience and Mental Toughness

Sports help individuals learn to handle pressure, setbacks, and uncertainty. Facing tough opponents, experiencing losses, and striving for growth cultivate resilience and mental toughness. These qualities can be applied to daily challenges, such as academic stress, work pressures, and personal difficulties.

Sports as a Preventive and Therapeutic Resource

Recognized increasingly as a preventive and supportive tool for mental health, sports are promoted in schools, colleges, and communities to create healthier, happier environments. Mental health experts often recommend physical activity as a complement to counselling or therapy, emphasizing its long-term benefits for emotional stability.

Conclusion

Sports go beyond competition and fitness; they are a vital means of supporting mental health and overall well-being. By reducing stress, lifting mood, building confidence, and fostering social bonds, sports help individuals lead balanced, fulfilling lives. Promoting sports participation from a young age and making physical activity a routine can significantly improve societal mental health. In nurturing the body through sports, we nurture the mind as well.

References :-

1. Mahardika, G. P., & Lahinda, J. (2025). Psychological benefits of recreational sports for university students. Journal of Physical Education Health and Sport.
2. Shermatov, G. (n.d.). The role of sports in promoting mental health. American Journal of Social Science.
3. Eime, R. M., Young, J. A., Harvey, J. T., Charity, M. J., & Payne, W. R. (2023). Mental health through sport: Systematic review. Systematic Reviews.
4. Mammen, G., & Faulkner, G. (Year). Physical activity and mental health benefits. Sports and Psychological Health Journal.
5. WebMD Editorial Contributors. (2024). How sports can help reduce stress and ease depression. WebMD.
6. A systematic review of the psychological and social benefits of participation in sport for children and adolescents. (2013). International Journal of Behavioral Nutrition and Physical Activity.
7. Physical activity and mental health in India: A narrative review. (2012). PubMed.
8. Colman, A. M. (2001). Oxford Dictionary of Psychology. New York: Oxford University Press Inc.
9. Garret, H. (1969). Statiatica inPsychology and Education. Bombay: Bombay Newbury House.
10. Kamlesh, D. M. (2011). Psychology in Physical Education and Sports. New Delhi: Khel Sahitya Kendra.

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Indian Chemical Heritage: A Jewel in the Crown of IKS

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ABSTRACT

Indian Knowledge Systems (IKS) are the result of centuries of learning, observation, and practical experience that developed in India over thousands of years. These systems cover a wide range of subjects, including health, agriculture, astronomy, mathematics, philosophy, and the sciences. One of the most important and fascinating areas within IKS is the traditional knowledge of chemistry. This knowledge is reflected in various ancient Indian practices such as Rasashastra: the science of processing metals and minerals for health, metallurgy, medicine, especially in Ayurveda and materials science. Indian chemistry was not just limited to theoretical understanding but was also based on hands-on techniques and experimentation. This review article aims to explore the richness and complexity of chemical knowledge in ancient India. It highlights how this traditional wisdom was far ahead of its time and how it can still offer valuable insights today. By connecting this ancient knowledge with current scientific studies, the paper also discusses how Indian chemistry can be integrated into today's academic education and scientific research for a more holistic and culturally rooted learning experience.

Introduction

India has a long and rich tradition of knowledge that has evolved over thousands of years. This vast body of knowledge, known today as the Indian Knowledge Systems (IKS), includes a wide range of disciplines such as philosophy, science, art, health, and technology. It was not developed overnight but grew naturally through careful observation, continuous learning, and deep reflection by scholars, teachers, and practitioners across generations. One of the most important branches within IKS is the traditional Indian understanding of chemistry, which is often called "Rasashastra" or "Rasavidya" in ancient texts. This form of chemistry was not limited to just theory; it was a hands-on science based on real-life applications and careful experimentation.

Unlike the popular belief that ancient knowledge was mostly spiritual or philosophical, Indian chemistry had practical uses in everyday life. It was applied in preparing medicines, working with metals, making dyes, perfumes, and even in agricultural and environmental practices. These scientific methods were well-organised and thoughtfully documented by scholars, showing that our ancestors had a deep and systematic understanding of how materials behave and change. This research paper focuses on the development and use of chemistry in ancient India, how it was practised, and how it contributed to various fields such as health, metallurgy, and natural science. It also highlights the importance of recognising this rich heritage today, especially in academic and scientific circles, where traditional knowledge can still offer valuable insights and sustainable solutions for modern problems.

Ancient Foundations of Indian Chemistry

The roots of chemistry in India go back thousands of years and are deeply embedded in the country's cultural, spiritual, and scientific traditions. In ancient Indian philosophy, all matter in the universe was believed to be made up of five fundamental elements known as the "Pancha Mahabhutas": Agni (fire), Jala (water), Prithvi (earth), Vayu (air), and Akasha (space). These elements were not just symbolic or spiritual; they represented real physical and chemical properties of the substances found in nature. This idea laid the foundation for a deeper understanding of how materials interact, transform, and behave under different conditions.

Over time, these early concepts evolved into practical applications in areas such as health, metallurgy, and daily life. One of the most important developments in ancient Indian chemical knowledge was the emergence of Rasashastra, a branch of Ayurveda that focused on the use of minerals, metals, and other natural substances to prepare medicines. Rasashastra is believed to have developed around the 8th century CE, but the chemical ideas it applied had already been known and practised for many centuries before that.

Even during the Vedic period, long before formal chemistry was known to the world, Indian scholars were experimenting with fire-based rituals, known as Yajnas, which involved the use of different herbs, minerals, and substances under heat. These rituals required a basic understanding of combustion, transformation of materials, and chemical reactions, though the language used to describe them was spiritual and symbolic.

Further evidence of early chemical practices can be found in two ancient Ayurvedic texts,"Charaka Samhita" and "Sushruta Samhita",dated around 600 BCE or earlier. These texts offer detailed descriptions of the preparation of herbal medicines, mineral formulations, and metallic compounds. They discuss methods such as Shodhana (purification) to remove toxic properties, Marana (calcination) to make metals digestible, Bhavana (wet grinding and mixing with herbal juices), and Murchana (fermentation) to enhance the therapeutic qualities of natural substances. These techniques show a clear understanding of how substances change when heated, mixed, or treated with other compounds, basic ideas at the heart of modern chemistry.

What makes Indian chemistry remarkable is that it was not based on presumptions or superstition. It was an empirical science, built through centuries of observation, experimentation, and documentation. Scholars and practitioners worked carefully with different materials, recorded their results, and refined their methods over time. The knowledge was passed down in the form of Sanskrit texts, often written in verses to aid memory, and taught within educational institutions, families, and guilds.

Indian chemists were not only preparing medicines but also dealing with materials in ways that showed deep insight into their nature. They knew how to transform metals, extract plant essences, distil liquids, and preserve substances, all without the help of modern instruments. Their understanding of material transformations, reactions under heat, and long-term storage indicates that chemistry in ancient India was not just practical but also highly advanced for its time. Long before the scientific revolutions in Europe, Indian thinkers were exploring and applying principles that align closely with what we now recognise as chemical science. Their work laid a strong foundation for various applied fields like medicine, metallurgy, perfumery, dyeing, and agriculture. In this way, the early Indian approach to chemistry formed one of the strongest pillars of the Indian Knowledge Systems, contributing to both spiritual well-being and scientific advancement.

Applications

Medicine and Pharmaceuticals

One of the most important and long-lasting uses of traditional Indian chemical knowledge can be seen in the area of medicine. In ancient India, a special branch of Ayurveda called Rasashastra focused on preparing medicines using various metals and minerals such as mercury, sulfur, gold, silver, copper, lead, and even arsenic. These materials were not used directly but were carefully purified and processed through multiple steps to make them safe and effective. The final products,

called bhasmas, were fine powders made by burning or heating the metals in a controlled way. These bhasmas were believed to boost health, improve immunity, and increase strength and life span.

Interestingly, modern scientific research has found that many of these bhasmas contain very tiny particles, even at the nano level, which suggests that ancient Indian healers had a surprisingly deep understanding of material properties, even without modern tools. Several traditional techniques were used during the preparation of these medicines, such as bhavana (grinding with herbal liquids), putapaka (heating or burning in closed containers), and shodhana (purifying harmful substances). These processes show that people had strong knowledge of how to change substances through heat, grinding, or mixing,basic ideas in chemistry.
In addition to metallic medicines, many herbal remedies were also prepared using methods like soaking, extracting plant juices, and fermentation. These methods are quite similar to those used in modern drug production. Natural preservatives and stabilisers were used to make the medicines last longer without spoiling, which shows that they also understood how to maintain the quality of medicines over time. Ancient Ayurvedic texts even included detailed information about medicine dosage, their side effects , andshelf-life. All of this proves that medical chemistry in ancient India was well-organised, carefully studied, and far ahead of its time.

Material Transformation

In ancient India, alchemy (Rasavidya) aimed at both material change and spiritual growth. Unlike Western alchemy, which focused on turning metals into gold, Indian alchemy emphasised health, innovation, and inner transformation. Indian alchemists used advanced methods like distillation, crystallization, and sublimation, along with specially designed tools such as the dola yantra and khalva yantra. These practices show a deep understanding of chemistry and spiritual philosophy, blending scientific technique with holistic thinking.

Metallurgy and Materials Science

India made remarkable progress in metallurgy in ancient times. Skilled methods were used to extract and work with metals like iron, copper, zinc, and gold. A great example is the Iron Pillar in Delhi, built around 400 CE, which has stood for over 1,600 years without rusting. This was possible because of its special composition, which includes high phosphorus and lacks sulfur and manganese. Another major achievement was the creation of Wootz steel, a strong and sharp high-carbon steel. It was highly valued and traded with the Middle East, where it was used to make the well-known Damascus swords. India also developed a way to extract zinc through distillation at the Zawar mines in Rajasthan in the 12th century. This method was used on a large scale, centuries before Europe discovered it. These practices show a deep understanding of chemical ideas like heating control, alloying, and chemical reactions, which are still important in modern material science.

Cosmetics, Perfumery, and Dyes

Ancient Indian chemistry also found expression in the fields of personal care, perfumery, and textile dyeing. The preparation of attars (natural perfumes) from flowers, herbs, and spices involved steam distillation, solvent extraction, and fermentation. Classical texts such as Brihat Samhita detail the preparation of deodorants, skin ointments, hair dyes, and face masks using chemical processes. Likewise, the dyeing of fabrics using indigo, turmeric, madder, and lac reflected a sophisticated understanding of natural dyes, fixatives, and pH-sensitive colour changes. These traditions were not merely cosmetic, they were rooted in health, ritual purity, and ecological harmony. The knowledge of organic substances and their interactions laid the foundation for early organic chemistry in India.

Environmental and Agricultural Chemistry

Indian agricultural traditions employed a deep understanding of chemistry in soil management, pest control, and crop nutrition. Natural fertilizers like jeevamrut, panchagavya, and compost were used based on their chemical decomposition and microbial action. Ancient texts like Vrikshayurveda discuss soil testing, plant nutrition, and water management in detail. Ash, lime, cow urine, and herbal decoctions were used as pesticides and growth promoters. Water purification techniques using charcoal, sand, and

herbs like Tulsi reflect early environmental chemistry practices. These sustainable methods align with the principles of green chemistry and are gaining renewed attention in the context of climate change and organic farming.

Legacy and Academic Excellence

The legacy of Indian chemistry is not just technical; it is academic and institutional. Ancient universities like Takshashila and Nalanda offered instruction in medicine, metallurgy, and chemistry. Texts were written systematically, and knowledge was transmitted through oral and written traditions, often in poetic form to aid memorization. The influence of Indian chemical thought extended beyond borders, impacting Islamic and later European alchemical traditions. Scholars like "Nagarjuna","Sushruta", and "Charaka" exemplified the fusion of scientific inquiry with philosophical depth. Today, this legacy is being rediscovered and validated through interdisciplinary research. The National Education Policy (NEP) 2020 encourages the integration of IKS into mainstream education, creating opportunities to revisit, revise, and revive India's scientific heritage.

Conclusion

Indian chemistry knowledge is a vital jewel in the crown of the Indian Knowledge Systems. It represents a holistic, empirical, and innovative tradition that spanned medicine, alchemy, metallurgy, and environmental science. Far from being outdated, these practices offer sustainable, nature-friendly, and scientifically sound models that can complement modern scientific pursuits. Recognizing, researching, and integrating this legacy is essential for nurturing academic excellence and fostering pride in our intellectual heritage. As India strides forward in science and technology, the wisdom of its past can serve as a guiding light for a more integrated and sustainable future.

References :-

1. P. Ray, History of Chemistry in Ancient and Medieval India, Calcutta: Indian Chemical Society, 1956.
2. D. Banerji, A Brief History of Rasashastra, Varanasi: Chaukhambha Sanskrit Bhavan, 2002.
3. A L. Basham, The Wonder That Was India, London: Sidgwick & Jackson, 1954.
4. R. K. Sharma, Bhagwan Dash, Charaka Samhita: Text with English Translation and Critical Exposition Based on Chakrapani Datta's Ayurveda Dipika, Vols. 1–4, Varanasi: Chowkhamba Sanskrit Series Office, 1998.
5. P. V. Sharma, Sushruta Samhita: With English Translation of Text and Dalhana's Commentary, Varanasi: Chaukhambha Visvabharati, 2001.
6. S. Mahdihassan, "Alchemy and Hindu Chemistry," Indian Journal of the History of Science, vol. 9, no. 2, pp. 55–75, 1974.
7. R. C. Gupta, "The Iron Pillar at Delhi," Indian Journal of History of Science, vol. 14, no. 1, pp. 15–24, 1979.
8. A K. Biswas, Science in India, New Delhi: National Book Trust, 1996.
9. R. S. T. Fischer, "The Distillation of Zinc in India in the 12th Century," Ambix, vol. 10, no. 3, pp. 99–111, 1962.
10. R. Venugopalan, Alchemy and Chemists in India, New Delhi: National Book Trust, 1976.
11. G. G. Kochhar, "Wootz Steel: An Advanced Material of the Ancient World," Indian Journal of History of Science, vol. 27, no. 4, pp. 345–358, 1992.
12. V. L. Chopra and V. P. Sharma, "Panchagavya: Indigenous Preparation for Organic Farming," Indian Council of Agricultural Research, 2005.
13. N. Jha and S. Sinha, Vrikshayurveda: The Science of Plant Life, New Delhi: Asian Agri-History Foundation, 2002.
14. Government of India, National Education Policy 2020, Ministry of Education, New Delhi, 2020.

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Conceptual Background, Rasashastric Practices and Current Scientific Significance of Nanoscience in Indian Knowledge Systems

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ABSTRACT

Many of the deep philosophical and empirical insights into the nature of matter found in Indian Knowledge Systems (IKS) have clear conceptual connections to contemporary nanoscience. By describing ultra-minute, imperceptible entities and their aggregation into visible forms, ancient Indian philosophical schools like Vaiúecika and Nyâya developed an atomistic view of matter through the concepts of ParamâGu, AGu, and TrasareGu. At the same time, Rasashastra, an Ayurvedic applied discipline, created advanced methods for turning metals and minerals into Bhasmas, which are extremely fine medicinal preparations. Recent scientific studies have demonstrated the presence of nanoparticles in a number of traditional bhasmas, giving traditional methods empirical support. In this paper, IKS's nanoscience-related concepts are critically reviewed, their relevance to sustainable and green nanotechnology is discussed, and they are correlated with current nanoscale science. The study emphasizes how combining IKS with contemporary analytical techniques can stimulate the creation of environmentally friendly nanomaterials and innovative biomedical uses.

Keywords: Indian Knowledge Systems, Nanoscience, ParamâGu, Rasashastra, Bhasma, Green Nanotechnology

Introduction

Nanoscience has become a fundamental aspect of contemporary chemistry and materials science, mostly because of the extraordinary physicochemical changes that materials experience when their size is reduced to the nanometer scale (1–100 nm). At this size, matter has qualities that are quite different from those of larger objects. For example, it has more reactive surfaces, different electrical behavior, better catalytic efficiency, and distinctive optical responses. These size-dependent phenomena have resulted in extensive applications of nanomaterials in catalysis, medicine, energy storage, and environmental remediation, solidifying nanoscience as a revolutionary multidisciplinary domain. Even though nanotechnology is often seen as a fresh scientific breakthrough, the notion that matter is made up of very tiny, undetectable units is not new. Historical and philosophical documentation reveals that several ancient civilizations tried to grasp the underlying essence of matter. Indian Knowledge Systems (IKS) stand out among these intellectual traditions for their well-organized and ongoing discussion of the nature of matter, which combines philosophical reasoning with practical experience.

More than 2,000 years ago, classical Indian philosophical systems, especially Vaiœecika and Nyâya, spoke about an atomistic understanding of matter. These theories argued that all material objects are fundamentally constituted of indivisible, imperceptible particles that manifest apparent qualities only via aggregation. The terms ParamâGu

(the smallest indivisible unit) and AGu (very minute matter) show a deep awareness of the hierarchy of materials and size. Although these concepts were not articulated inside scientific or mathematical frameworks, they exemplify a nuanced endeavor to elucidate the structure and behavior of matter beyond immediate sensory experience. In addition to these intellectual underpinnings, ancient India also made progress in practical material sciences. The most notable example is Rasashastra, a specialist branch of Ayurveda that focuses on metals, minerals, and how to change them into medicines. Rasashastric literature delineate methodical techniques for the purification and transformation of substantial metals and mineral materials into ultra-fine, physiologically acceptable forms referred to as Bhasmas. People liked these preparations because they were stronger, worked faster, and stayed stable. These are now known as the main benefits of nanoscale materials. These methods included repeated heating, mechanical size reduction, and contact with organic fluids, which shows that the scientists had a practical grasp of how to change materials at very small sizes.

Recent advancements in analytical and characterisation methodologies have facilitated the scientific examination of traditional bhasmas, uncovering the existence of metal and metal oxide particles inside the nanoscale scale. These results provide a strong link between ancient practices and current nanoscience, indicating that Rasashastra is an early, experience-based method of making nanomaterials. These discoveries have rekindled interest in Indigenous Knowledge Systems (IKS) as a significant repository for sustainable and environmentally friendly methodologies in nanomaterial creation.

In this light, the current paper seeks to rigorously analyze the theoretical and practical aspects of nanoscience integrated inside Indian Knowledge Systems. This work aims to underscore the scientific significance of Indian Knowledge Systems (IKS) and its prospective contributions to current nanomaterial research by linking ancient atomistic ideas and Rasashastric techniques with modern principles of nanochemistry and materials science. Instead than directly comparing ancient ideas to present scientific models, the study focuses on conceptual convergence, empirical understanding, and sustainability-oriented activities that are still very important in chemical research today.

Atomistic Concepts in Indian Philosophical Traditions

a. ParamâGu and AGu: The Smallest Units of Matter

One of the first systematic atomistic frameworks in Indian intellectual history is presented in the VaiœecikaDarœana, which is credited to the philosopher KaGâda. The idea of ParamâGu, which is the tiniest, indivisible, and primordial unit of material existence, is central to this theory. It is said that ParamâGu are immortal beings that are beyond the realm of sensory awareness and incapable of further division. Importantly, the Vaiœecika philosophy stresses that material features only appear when these units interact and mix; individual paramâGu do not have visible attributes in isolation.This concept of observable matter being composed of undetectable basic components shows a qualitative knowledge of material hierarchy that is consistent with contemporary chemical theory. The conceptual understanding that matter exists at scales lower than human experience demonstrates a sophisticated philosophical engagement with the nature of material reality, even if KaGâda'sparamâGu cannot be immediately equated with atoms or subatomic particles.The Upanicads and the Bhagavad Gîtâ use the word AGu to indicate extreme minuteness, which complements the Vaiœecika viewpoint. The often used phrase "aGoraGîyâAsam" (smaller than the tiniest) expresses a sense of size that goes beyond simple observation. Such statements imply an early understanding that matter may exist in forms that are not readily visible but are crucial in shaping macroscopic behavior in the context of materials science.These atomistic concepts clearly deviate from merely continuous theories of matter, even if they were developed inside philosophical and metaphysical frameworks rather than via experimental confirmation. Given their focus on

invisibility, indivisibility, and structural hierarchy, these ideas may be seen as early philosophical forerunners of atomic theory and nanoscale science from a modern perspective.

b. Aggregation Theory: TrasareGu and DvyaGuka

In addition to putting out the idea of paramâGu, Vaiœecika philosophy offers a thorough explanation of how material objects form via methodical accumulation. This theory states that the initial level of interaction between basic components is represented by DvyaGuka, or binary aggregates, which are formed when individual paramâGu come together. TrasareGu, a ternary aggregate that is defined as the smallest unit of substance observable to the human senses, is created by further aggregation. A hierarchical assembly process is introduced by this incremental model of matter production, where complexity and visibility gradually grow via combination. From a chemical standpoint, this method is conceptually very similar to contemporary bottom-up material synthesis, in which atoms or molecules form clusters and then develop into nanoparticles and bigger structures. It is very important to recognize TrasareGu as the boundary between invisible and perceptible matter since it reflects the current knowledge that particle size controls interactions with light and optical vision. Despite the absence of quantitative descriptors like size, mass, or bonding energy, Vaiœecika aggregation theory provides a logical qualitative description for the transformation of sub-visible units into observable matter. An intuitive understanding of particle assembly and scale-dependent properties—two major topics in modern nanoscience and nanochemistry—is reflected in this philosophical study of aggregation.

Rasashastra: Empirical Nanoscience in Practice

a. Bhasma Preparation and Processing

With a major emphasis on transforming metals and minerals into forms that are therapeutically helpful, Rasashastra is the applied material science component of Indian knowledge systems. The two distinct processing steps of MâraGa (calcination) and Odhana (purification) are essential to this discipline. A range of physicochemical processes, such as heat cycling and metal quenching in organic or aqueous media like plant extracts, oils, or decoctions, are part of Œodhana. Chemically speaking, these processes make it easier to eliminate contaminants, change the surface, and maybe encourage partial oxidation or complexation of metallic species. Repeated rounds of regulated heating and mechanical grinding, sometimes with organic additives present, comprise the succeeding MâraGa process. Phase changes, solid-state processes, and a gradual decrease in particle size are all encouraged by these cycles. Bulk metals or minerals are transformed into highly dispersed, fine powders known as Bhasmas by the combined effects of mechanical attrition and thermal stress. Crucially, these procedures use chemicals that are naturally generated and are carried out under generally moderate settings, demonstrating an intrinsically sustainable method of material processing. From the perspective of contemporary nanochemistry, •odhana and MâraGa may be seen as early examples of top-down particle size reduction combined with surface functionalization, in which organic components from herbal media may influence particle development and aggregation by acting as stabilizing or capping agents.

b. Modern Characterization of Bhasmas

The rigorous scientific examination of traditional bhasma preparations has been made possible by advancements in analytical instruments. Many conventionally manufactured bhasmas include particles in the nanoscale size range, according to many independent investigations using atomic force microscopy (AFM), transmission electron microscopy (TEM), scanning electron microscopy (SEM), and X-ray diffraction (XRD). Additionally, these studies have shed light on surface morphology, phase composition, and crystallinity.For example, it has been observed that Loha Bhasma and Yashada Bhasma often display nanocrystalline iron oxide and zinc oxide phases, respectively, while Swarna Bhasma is mostly composed of gold nanoparticles contained inside an organic or mineral matrix. High surface-to-volume ratios, which are a major determinant of

reactivity, dissolution behavior, and interaction with biological systems, are the consequence of these particles' nanoscale size.Traditional claims about the increased effectiveness and bioavailability of bhasmas are scientifically supported by these experimental findings. Modern characterization indicates that particle size, surface chemistry, and phase structure are important factors in determining biological activity rather than attributing therapeutic performance only to elemental composition. This aligns Rasashastric products with modern nanomaterials used in catalysis and medicine.

c. **Traditional Quality Tests and Nano-Scale Indicators**

A set of qualitative tests intended to evaluate the appropriateness and refinement of bhasmas before their use as medicines is described in classical Rasashastra literature. Among them, RekhâpûrGatva, which assesses a powder's capacity to pierce the skin's small wrinkles, acts as a proxy for extreme fineness and large surface area. Similarly, a bhasma'sVâritaratva, or capacity to float on water's surface, indicates improved surface interactions with the liquid medium and decreased bulk density.These conventional tests may be linked to contemporary physicochemical factors including particle size distribution, surface energy, and interfacial behavior from the standpoint of materials chemistry. These empirical evaluations show a functional awareness of how surface characteristics and material fineness affect performance, despite their qualitative nature. Their ongoing applicability demonstrates the experiential knowledge ingrained in Rasashastra and emphasizes how it aligns with fundamental ideas of contemporary nanoscience.

A Viewpoint on Sustainability and Green Nanotechnology

The intrinsic sustainability of Indian Knowledge Systems' approach to material processing is among their most persuasive contributions to the current scientific conversation. Rasashastric approaches, which prioritized the use of naturally derived reagents, few synthetic additives, and repeated low-intensity processing cycles, produced material transformations that were both effective and environmentally conscious long before green chemistry principles were formally articulated. Such actions demonstrate a profound understanding of material safety, waste reduction, and resource conservation.During the purifying and calcination procedures, Rasashastra heavily depends on mineral supplies, aqueous media, plant extracts, and biodegradable organic materials. From the standpoint of nanochemistry, these organic materials might have a variety of uses, such as stabilizing matrices for particle formation, surface modifiers, and mild reducing agents. These ancient processes differ from many contemporary nanoparticle synthesis methods, which often require hazardous chemicals and large energy inputs, in that they do not use harsh solvents, poisonous reducing agents, or severe reaction conditions.Additionally, compared to continuous high-temperature or high-pressure systems, Rasashastric processing usually involves regulated heating, thermal cycling, and mechanical grinding, resulting in comparatively low energy needs. These circumstances align with the fundamental ideas of process intensification and energy efficiency, which are essential to the production of sustainable chemicals. These procedures' regulated, repetitive nature also permits incremental particle refining without producing a lot of waste.In order to minimize resource consumption and any environmental impact, the final products, known as bhasmas, are made to be biocompatible, stable, and effective at low doses. These qualities are in line with current objectives in green nanotechnology, which focuses on creating nanomaterials that are safe for the environment and human health in addition to having excellent functionality.When taken as a whole, Rasashastric techniques provide important conceptual and methodological insights for the creation of environmentally benign methods for the synthesis of nanomaterials. It could be conceivable to create sustainable nanotechnological platforms that satisfy environmental and performance requirements by combining conventional IKS-based processing techniques with contemporary analytical control and safety assessment. By using established knowledge systems, such an interdisciplinary approach has the potential to advance green

nanotechnology.

Combining Modern Nanoscience with Indian Knowledge Systems

The conceptual coherence and empirical richness of Indian Knowledge Systems need careful scientific interaction, despite the fact that ancient Indian texts lack quantitative measurements, instrumental data, and empirically repeatable processes in the contemporary scientific sense. These traditions may be analyzed as qualitative frameworks that provide important insights into material transformation, particle refinement, and functional performance at very tiny scales, as opposed to being seen just through a historical or cultural perspective.IKS-inspired approaches must be translated into empirically controlled systems in order to be integrated with modern nanoscience. Particle size, morphology, phase composition, and surface chemistry in materials formed from Rasashastric methods may be thoroughly investigated thanks to contemporary analytical technologies including electron microscopy, X-ray diffraction, spectroscopy, and surface analysis techniques. In addition to confirming conventional findings, this kind of characterisation makes it possible to develop structure–property connections, which are essential to contemporary materials chemistry.There is a lot of promise for this integrated method in a variety of application sectors. Designing safer and more efficient medication delivery methods may be aided by knowledge of the surface chemistry and nanoscale characteristics of materials formed from bhasma. The large surface area and defect-rich structures seen in certain conventionally treated materials may serve as inspiration for the creation of heterogeneous catalysts that are produced using low-energy, environmentally friendly methods. In a similar vein, IKS-based processing techniques may guide ecologically friendly synthesis paths in sustainable materials research that reduce the use of dangerous chemicals and energy.Crucially, this kind of integration does not mean that old ideas and contemporary scientific models are directly equivalent. Rather, it places an emphasis on methodological inspiration and conceptual convergence, where conventional wisdom directs the development of hypotheses and experimental designs within a strict scientific framework. Researchers may create novel, sustainable nanomaterials while preserving methodological transparency and reproducibility by fusing the accuracy of modern nanoscience with the practical knowledge of IKS.

Conclusion

Indian knowledge systems provide a solid theoretical and applied basis that is very compatible with contemporary nanotechnology. Together, aggregation theories, Rasashastric practices, and philosophical atomism show a sophisticated comprehension of ultra-fine matter and its functional relevance. This assessment emphasizes IKS's ability to guide the development of modern nanoscience and green technologies rather of seeing it as just historical.

References :-

1. KaGâda. VaiúecikaSûtra. Translated with commentary by Nandalal Sinha. Sacred Books of the Hindus, Vol. VI. Allahabad: The Panini Office, 1923.
2. ÚaEkara Miúra. VaiúecikaSûtra Bhâcya. Translated by Ganganatha Jha. Poona: Oriental Book Agency, 1916.
3. The Principal Upanicads. Edited and translated by S. Radhakrishnan. London: George Allen & Unwin Ltd., 1953.
4. ÚârEgadhara-SaChitâ. Translated by K. R. Srikantha Murthy. Varanasi: Chaukhambha Orientalia, 1984.
5. Rasaratna Samuccaya. Translated by A. D. Satpute. Delhi: Chaukhambha Sanskrit Pratishthan, 2003.
6. Rasendra Sara Sangraha. Translated by V. S. Sharma. Varanasi: Chaukhambha Orientalia, 2000.
7. Brown, C. L., Bushell, G., Whitehouse, M. W., et al. "Nanocrystalline Gold Prepared from Gold(I) Thiolate Complexes: A Comparative Study with Swarna Bhasma." Gold Bulletin 40, no. 3 (2007): 245–250. https://doi.org/10.1007/BF03215584
8. Chaudhary, A. "Ayurvedic Bhasmas:

Overview on Nanomaterialistic Aspects, Applications, and Perspectives." Journal of Experimental Nanoscience 15, no. 1 (2020): 1–15. https://doi.org/10.1080/17458080.2020.1748165

9. Kumar, A., Nair, A. G. C., Reddy, A. V. R., et al. "Physicochemical Characterization of Lauha Bhasma: A Traditional Ayurvedic Medicine." Journal of Pharmaceutical and Biomedical Analysis 41, no. 4 (2006): 1476–1482. https://doi.org/10.1016/j.jpba.2006.01.060
10. Paul, S., & Chugh, A. "Assessing the Role of Ayurvedic 'Bhasms' as Ethno-Nanomedicine in the Metal Based Nanomedicine Patent Regime." Journal of Intellectual Property Rights 16 (2011): 509–515.
11. Pal, D., Sahu, C. K., & Haldar, A. "Bhasma: The Ancient Indian Nanomedicine." Journal of Advanced Pharmaceutical Technology & Research 5, no. 1 (2014): 4–12. https://doi.org/10.4103/2231-4040.126980
12. Singh, N., & Reddy, K. R. C. "Particle Size Analysis of Ayurvedic Medicine Tamra Bhasma by Dynamic Light Scattering and Zeta Potential." International Journal of Research in Ayurveda and Pharmacy 2, no. 1 (2011): 30–34.
13. Wadekar, M. P., Rode, C. V., Bendale, Y. N., et al. "Preparation and Characterization of a Copper Based Indian Traditional Drug: Tamra Bhasma." Journal of Pharmaceutical and Biomedical Analysis 39, no. 5 (2005): 951–955. https://doi.org/10.1016/j.jpba.2005.05.023
14. Jha, D. K., & Shah, N. C. "The Rasashastra Perspective of Nanotechnology in Ayurveda." Annals of Ayurvedic Medicine 11, no. 1-2 (2022): 13–25. https://doi.org/10.5455/AAM.136291
15. Kumar, A., & Kumar, S. "Atomism in Vaiœecika and Its Relevance to Modern Science." Journal of Indian Philosophy 45, no. 4 (2017): 671–685. https://doi.org/10.1007/s10781-017-9322-6
16. Miryala, S. B., & Sushma, N. J. "From ParamâGu to Nanoparticles: A Historical and Scientific Exploration of Indian Alchemy." Substantia: An International Journal of the History of Chemistry 5, no. 2 (2021): 77–89.
17. Sarkar, P. K., & Chaudhary, A. K. "Ayurvedic Bhasma: The Most Ancient Application of Nanomedicine." Journal of Scientific and Industrial Research 69 (2010): 901–905.
18. Singh, R. H. "The Holistic Principles of Ayurvedic Medicine and Their Convergence with Systems Biology and Nanotechnology." Ancient Science of Life 28, no. 3 (2009): 3–9.
19. Valiathan, M. S. "An Ayurvedic View of Life." Current Science 96, no. 9 (2009): 1186–1192.
20. Anastas, P. T., & Warner, J. C. Green Chemistry: Theory and Practice. Oxford: Oxford University Press, 1998.
21. Dahl, J. A., Maddux, B. L. S., & Hutchison, J. E. "Toward Greener Nanosynthesis." Chemical Reviews 107, no. 6 (2007): 2228–2269. https://doi.org/10.1021/cr050943k
22. Sharma, V. K., Filip, J., Zboril, R., & Varma, R. S. "Natural Inorganic Nanoparticles – Formation, Fate, and Toxicity in the Environment." Chemical Society Reviews 44, no. 23 (2015): 8410–8423. https://doi.org/10.1039/C5CS00236B
23. Varma, R. S. "Journey on Greener Pathways: From the Use of Alternate Energy Inputs and Benign Reaction Media to Sustainable Applications of Nano-Catalysts in Synthesis and Environmental Remediation." Green Chemistry 16, no. 4 (2014): 2027–2041. https://doi.org/10.1039/C3GC42640H
24. Fahlman, B. D. Materials Chemistry. 3rd ed. Cham, Switzerland: Springer, 2018.

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Mathematical Modelling for Sustainable Development: Addressing India's Contemporary Challenges

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ABSTRACT

India faces interconnected challenges such as rapid urbanization, water scarcity, air pollution, energy demand, and agricultural stress due to climate change. Sustainable development requires evidence-based policy decisions supported by quantitative tools. This paper proposes mathematical models to analyze and optimize resource utilization, environmental protection, and socio-economic growth. Differential equations, optimization techniques, and system dynamics are employed to model real-world Indian scenarios. The study demonstrates how mathematical modelling can guide sustainable policy interventions and long-term planning.

Keywords : Sustainable Development, Mathematical Modelling, Resource Optimization, Climate Change, India

1. Introduction

India's development trajectory is marked by economic growth alongside environmental degradation and social inequality. Conventional qualitative approaches are insufficient to address such complex, interlinked systems. Mathematical modelling provides a structured approach to:
Predict long-term impacts
Optimize limited resources
Evaluate policy scenarios
This paper explores mathematical models addressing India's burning sustainability issues.

2. Contemporary Sustainability Challenges in India

Water Scarcity and Groundwater Depletion
Air Pollution in Urban Centers
Energy Demand vs Renewable Transition
Agricultural Productivity under Climate Stress
Urban Waste Management

3. Mathematical Modelling Framework

3.1 Water Resource Sustainability Model

Let:
- W(t) = groundwater level at time
- R(t) = natural recharge
- C(t)= consumption rate

Differential Equation Model:

$$\frac{dW}{dt} = R(t) - C(t)$$

Sustainability Condition:

$$R(t) \geq C(t)$$

This model helps determine critical extraction limits for Indian states such as Punjab and Rajasthan.

3.2 Air Pollution Dispersion Model

Let:
- P(t)= pollutant concentration
- E = emission rate
- ë = natural decay/removal rate

$$\frac{dP}{dt} = E - \lambda P(t)$$

This model evaluates the effectiveness of emission-control policies like odd-even traffic rules in Delhi.

3.3 Renewable Energy Optimization Model

Let:

- Es = solar energy output
- Ew = wind energy output
- Cw = total energy demand

Objective Function:

Minimize Z= CsEs+CwEw

Subject to:

Es+Ew $\geq$

Linear programming helps design cost-effective renewable energy portfolios for India.

3.4 Agricultural Yield Model under Climate Change

Let:

- Y = crop yield
- T= temperature
- R= rainfall

This regression-based model predicts yield fluctuations and assists in crop planning.

3.5 Urban Waste Management Model

Let:

- G(t)= waste generated
- R(t) = recycled waste

$$\frac{dG}{dt} = \alpha P - R(t)$$

Where P is population growth. This supports sustainable city planning under Swachh Bharat Mission.

4. Results and Discussion

Mathematical models reveal threshold limits beyond which systems become unsustainable.

Renewable energy optimization significantly reduces environmental costs.

Predictive agricultural models support climate-resilient farming.

5. Policy Implications

Evidence-based decision-making for sustainable governance

State-wise resource allocation strategies

Long-term environmental planning

6. Future Scope

AI-integrated sustainability models

Stochastic and fuzzy models for uncertainty

Real-time data-driven modelling

7. Conclusion

Mathematical modelling is a powerful tool for addressing India's sustainable development challenges. Integrating quantitative analysis with policy frameworks can ensure economic growth while preserving environmental and social well-being.

References :-

1. United Nations. (2015). Transforming our world: The 2030 Agenda for Sustainable Development. United Nations Publishing.
2. Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India. (2021). India: Third Biennial Update Report to the UNFCCC.
3. Central Ground Water Board. (2020). Ground Water Year Book – India. Government of India.
4. World Bank. (2018). South Asia's Hotspots: The Impact of Temperature and Precipitation Changes on Living Standards. World Bank Publications.
5. Narain, S., & Krupnick, A. (2007). The Impact of Delhi's CNG Program on Air Quality. Resources for the Future.
6. IPCC. (2021). Climate Change 2021: The Physical Science Basis. Cambridge University Press.
7. Rao, S., &Charyulu, D. K. (2019). Mathematical modelling for sustainable agriculture under climate variability in India. Journal of Environmental Management, 231, 110–118.
8. Debnath, K. B., &Mourshed, M. (2018). Challenges and gaps of energy planning models for the developing world. Renewable and Sustainable Energy Reviews, 88, 418–430.
9. Sterman, J. D. (2000). Business Dynamics: Systems Thinking and Modeling for a Complex World. McGraw-Hill.
10. Tiwari, G., & Jain, D. (2019). Urban transport and air pollution modelling in Indian cities. Transportation Research Procedia, 48, 300–312.

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Studies On Safflower (Carthamus tinctorious L.) A Review

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ABSTRACT

Safflower (Carthamus tinctorius L.) a member of the Asteraceae family is an annual herb found in Asia, India, and the Middle East. It is well-known for its traditional applications, phytochemistry, and medicinal qualities. It is 130 cm tall, with tubular flowers and lanceolate leaves. It contains over 200 bioactive substances, such as polyacetylenes, flavonoids, alkaloids like N-feruloylserotonin, quinochalcones like hydroxysafflor yellow A (HSYA), and fatty acids with a high linoleic acid content. Pharmacological research highlights its antimicrobial effectiveness against dandruff and acne-causing bacteria, hypoglycaemic action by promoting insulin secretion and reducing oxidative stress, antioxidant potential, and anti-inflammatory properties ascribed to saponins, stigmasterol's, and other constituents.

Key Words-Safflower, Medicinal, Pharmacology.

1. INTRODUCTION-

Carthamus tinctoriousL.belongs to family "Asteraceae".Asteraceae is recognized as the largest family of flowering plants and contains more than 1500 genera and 22,000 species ranging from annual herbs to woody shrubs.

This genus is native to Asia (India) and the Middle East. This plant has a busy habit. It grows to a height of 100 to 130 cm. The leaves are large and lanceolate, with serrinate margins. The flowers are radial and tubular and produces large inflorescences (flower heads) (Singh V. and Nimbkar N. 2006; Emongor, 2010; Zhou, et al., 2014).

1.1 Taxonomical Classification:

Kingdom	Plantae
Division	Spermatophyta
Class	Dicotyledonae
Sub Class	Gamopetalae
Order	Asterales
Family	Asteraceae
Genus	*Carthamus*
Species	*C. tinctorious*

1.2Vernacular Names:

Safflower is known by many other names around the world kusum, kasunmba, kusumbo, kusubi, karbi, ma, sufir, kar/karar, sendurgam, agnisikha, hebu, su, suban and many others as affore, asfiore, asfrole, astifore, asfiori, zaffrole or zaffrone, saffiore to safflower while in China it is known as hung-hua or 'red flower' (Smith 1996).

1.3 Morphology:

C. tinctorius is characterized as a dense, annual herb with the multiple branchesclassified as primary, secondary, and tertiary, each culminating in a spherical structure known as a capitulum (Zargari 1990).

There are four types of cultivar groups were distinguished depending on the color of the flower before and after drying: (1) yellow blooming and red dried flowers, (2) yellow blooming and dried flowers, (3) orange blooming and dark red dried flowers, (4) whiteblooming and dried flowers (Singh V. and Nimbkar N., 2006).

Safflower is resistant to wind, drought (Hill 2008),

and salinity (Kaya M., et al.,2003). Safflower can be cultivated on low-fertility soil (Shabana R., et al., 2013), preferably in warm and not to humid climate. The largest plantations are in India and Bengal, southern France, USA, Iran, Egypt, and China (Hill D. 2008; Shirwaikar, et al.,2010; Hu, et al., 2016).

2. REVIEW OF LITERATURE -

2.1. Drugdiscovery frommedicinal plants:

Plant have been utilized as medicines for thousands of years. These medicines initially took the form of crude drugs such as tinctures, teas, poultices, powders, and other herbal formulations. The specific plants to be used and the methods of application for particular ailments were passed down through oral history. Eventually information regarding medicinal plants was recorded in herbals. In more recent history, the use of plants as medicines has involved the isolation of active compounds, beginning with the insolation of morphine from opium in early 19th century.

Drug discovery from medicinal plants has evolved to include numerous fields of inquiry and various methods of analysis. The drug discovery process of medicinal plants has expanded to encompass many areas of research and different analytical techniques. Theprocess typically begins with a botanist, ethno botanist, ethno pharmacologist, or plant ecologist who collects and identifies the plant of interest.

Collection may involve species with known biological activity and the bioactive compounds in the species have not been isolated or may randomly collected taxa for large screening program. It is imperative to uphold the intellectual property rights of the specific country from which the desired plant(s) are gathered (Baker et al., 1995).

2.2. Phytochemistry:

More than 200 compounds have been isolated from C. tinctorius: flavonoids, phenylethanolic glycosides, coumarins, fatty acids, steroids, polysaccharide (Asgarpanah, J., & Kazemivash, N., 2013), and quinochalcones (Zhou, et al., 2014).

2.2.1.Quinochalcones:

Quinochalcones consist of almost all the red and yellow pigments in C. tinctoriusflowers. The main component of the yellow pigment is Hydroxysafflor yellow A (HSYA) (Zhang, et al., 2016). These compounds have unique C-glucosylquinochalcone structures that exist only in safflower which have been reported to be the main bioactive compound of safflower. These pigments are used as natural alternatives to synthetic dyes. The main compounds were the hydroxysafflor yellow A (HSYA) and anhydrosafflor yellow B (AHSYB) in all samples (Buyukkurt, et al., 2021). Quinochalcone componds such as HSYA, safflor yellow A, and carthamin, exist only in safflower, mainly belonging to C-glycosides (Yue, et al., 2013).

2.2.2 Flavonoid:

Flavonoids are natural polyphenol compounds that are widely distributed in medicinal plants. This compound exhibits a wide range of biological activities and is considered a characteristic and active constituent of C. tinctorius. More than 50 flavonoid derivatives, such as quinochalcones, C-glycosides, O-glycosides, and kaempferol derivatives, have been isolated from C. tinctorius (Zhang, et al., 2016).

Flavonoids in safflower are of can be divided into two categories: special and common. The special group exists in safflower has a unique structure and significant activity in the treatment ofcardiovascular and cerebrovascular diseases (Buyukkurt, et al., 2021).

Thus, the special flavonoid biosynthesis pathway in safflower has attracted research attention, and some flavonoid biosynthesis genes and transcription factors in safflower have been successfully cloned. Flavonoids in safflower belong to common group are exists in many species, also possess a variety of activities, which are represented by kaempferol, hyperoside, naringenin, quercetin, and luteolin (Zhang,et al., 2016).

2.2.3 Alkaloid:

Alkaloids, such as N-feruloylserotonin, N-feruloyltryptamine, and serotonin derivatives, are also widely distributed in the flowers and seeds of C. tinctorius. N-feruloylserotonin and N-(p-coumaroyl) are generally considered to be the main active alkaloids (Zhang,et al., 2016).

Serotonin and spermidine derivatives have been isolated from Safflower. Several pure

serotonin derivatives were found to have antioxidant activity (Asgarpanah, J., & Kazemivash, N., 2013). Two new spermidine compounds have been isolated from C. tinctorius flowers:safflospermidineA and safflospermidine B, and two known compounds N1, N5, N10-(Z)-tri-p-coumaroylspermidine and N1, N5, N10-(E)-tri-p-coumaroylspermidine (Zhang,et al., 2016).

2.2.4 Polyacetylene:

Polyacetylene represents a class of simple linear conjugated polymers and related derivatives with conjugated triple bonds. In early reports of polyacetylene in C. tinctorius plants in the 1980s, polyacetylene has since been distributed in roots, flowers, immature seeds, and stems infected with Phytophthora (Zhang, et al., 2016).

Several pairs of cis-trans isomers were observed from the structure of components isolated from Safflower. Perhaps because of its low content, its pharmacological action is rarely investigated (Zhou, et al.,2014).

2.2.5 OrganicAcid:

Safflower is a plant that contains various organic acids in the oil from its seeds. Standard safflower oil contains approximately 71-75% linoleic acid, 16-20% oleic acid, 6-8% palmitic acid, and 2-3% stearic acid (Zhang,et al., 2016).

2.2.6 Other Components:

Many other components have been isolated from C. tinctorius, such as roseoside, uridine, uracil (Zhang, 2016), erythro-alkane-6, 8-diol, lignans, aromatic glucosides, and many more. Several pure compounds were isolated and proven to have biological action. KinobeonA, isolated from safflower cell culture, was shown to have potent antioxidants. A lignan glycoside, traceloside, was investigated to exert an antiestrogenic effect. In addition, the bioactive triterpenoid saponin, 3β-O-[β-D-xylopyranosyl(1-3)-O-β-D-galac-topyranosyl]-lup-12-ene-28 oic acid-28-O-α L - rhamnopyranosyl ester, exhibits anti-inflammatory activity (Zhou, et al., 2014).

2.3. Pharmacological Activities:

Safflower exhibits significant antimicrobial activity against acne-causing bacteria. In the antidandruff test, the microbial inhibition zone that causes dandruff was obtained by 9 mm for Safflower extract, 3 mm for antifungal (fluconazole), and no solvent inhibition zone (control). It is proven that the presence of saponins and stigmasterols could control various microbial growths. The ability of saponins to form soap also helps damage the walls of microbial cells, which in turn causes leakage of proteins and enzymes from these cells (James, et al., 2018).

The bioactive compounds of Safflower extract, namely flavonoid derivatives, glycosides, sterols, and serotonin, are reported to have different ways of inhibiting bacterial growth, such as inhibiting protein synthesis and cell membranes, interfering and inhibiting the binding of enzymes, such as ATPase, inhibiting the use of oxygen by bacteria, and denatures bacterial cell proteins and damages the cytoplasmic membrane. In addition, the hydrophobic components of the essential oil contained in the Safflower extract werereported to be effective against gram-positive and gram-negative bacteria (Khatimah, K., & Purwanti, S., 2021).

Safflower extract doses of 200mg/kg and 300mg/kg after 30 days compared with diabetes control showed a significant increase in insulin levels. Safflower might have a hypoglycemic effect by increasing insulin secretion due to its anti-inflammatory effect. Safflower contains carthamin, known as polyunsaturated fatty acid (78% linolenic acid), which has the highest antioxidant potential, helps in free radical scavenging activity and helps reduce oxidative stress. Thus, improving blood glucose levels (Qazi, et al., 2014).

References :-

1. Asgarpanah, J., andKazemivash, N. (2013). Phytochemistry, pharmacology and medicinal properties of Carthamus tinctorius L. Chinese journal of integrative medicine, 19, 153-159.
2. Baker, J. T., Borris, R. P., Carté, B., Cordell, G. A., Soejarto, D. D., Cragg, G. M., ... and Tyler, V. E. (1995). Natural product drug discovery and development: new perspectives on international collaboration. Journal of natural products, 58(9), 1325-1357.
3. Buyukkurt, O. K., Guclu, G., Barutcular,

C., Selli, S., and Kelebek, H. (2021). LC-MS/MS fingerprint and simultaneous quantification of bioactive compounds in safflower petals (Carthamus tinctorius L.). Microchemical Journal, 171, 106850.

4. Hill, D. S. (2008). Pests of crops in warmer climates and their control. SpringerScience & Business Media.
5. Hu, X., Yin, S., Huang, Z., Elomri, A., and Lu, Y. (2016). A new phenylpropanoidderivative isolated from Carthamus tinctorius L. Records of Natural Products, 10(1), 17.
6. James, J. M., Geethumol, C. U., Anilkumar, A., and Selvaraj, G. (2018). Phytochemical screening, antibacterial and allelopathic effects of few invasive plants of Kerala. Plant Science Today, 5(4), 175-181.
7. Khatimah, K., and Purwanti, S. (2021, June). The antibacterial activity of Kasumba turate (Carthamus tintorius L.) against Salmonella pullorum and Escherichia coli as an alternative feed additive for poultry. In IOP Conference Series: Earth and Environmental Science (Vol. 788, No. 1, p. 012191). IOP Publishing. perspectives on international collaboration. Journal of natural products, 58(9), 1325-1357.
8. Qazi, N., Khan, R. A., Rizwani, G. H., and Feroz, Z. (2014). Effect of Carthamus tinctorius (Safflower) on fasting blood glucose and insulin levels in alloxan induced diabetic rabbits. Pak. J. Pharm. Sci, 27(2), 377-380.
9. Shabana, R., Abd El-Mohsen, A. A., Gouda, H. A. H., and Hafez, H. S. (2013). Impact of temperature fluctuation on yield and quality traits of different safflower genotypes. Scientific Research and Review Journal, 1(3), 74-87.
10. Shirwaikar, A., Khan, S., Kamariya, Y. H., Patel, B. D., and Gajera, F. P. (2010). Medicinal plants for the management of post menopausal osteoporosis: A review.
11. Singh, V., andNimbkar, N. (2006). Safflower (Carthamus tinctorius L.). Chapter, 6,167-194.
12. Smith, Joseph R. (1996). Safflower. AOCS Publishing.The Open Bone Journal, 2(1).
13. Yue, S., Tang, Y., Li, S., and Duan, J. A. (2013). Chemical and biological properties of quinochalcone C-glycosides from the florets of Carthamus tinctorius. Molecules, 18(12), 15220-15254.
14. Zargari, A. (1990). Medicinal plants, vol. 4. University of Tehran Pub., Tehran, Iran.
15. Zhang, L. L., Tian, K., Tang, Z. H., Chen, X. J., Bian, Z. X., Wang, Y. T., and Lu, J. J. (2016). Phytochemistry and Pharmacology of Carthamus tinctorius L. The American journal of Chinese medicine, 44(02), 197-226.
16. Zhou, X., Tang, L., Xu, Y., Zhou, G., and Wang, Z. (2014). Towards a better understanding of medicinal uses of Carthamus tinctorius L. in traditional Chinese medicine: a phytochemical and pharmacological review. Journal of ethnopharmacology, 151(1), 27-43.

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Emerging Trends in Mathematics

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ABSTRACT

Mathematics has always been a dynamic discipline, evolving in tandem with scientific, technological, and societal advancements. In the twenty-first century, emerging trends in mathematics reflect a fusion of traditional mathematical rigour with computational advances, cross-disciplinary integration, and real-world problem solving. The objective of this paper is to explore the major contemporary directions influencing mathematical research, education, and application. We review key trends such as data-driven mathematics, computational and algorithmic methods, mathematical modeling in complex systems, topological data analysis, quantum computing and information theory, homotopy type theory, deep learning-inspired mathematics, and ethical considerations in mathematical applications. Particular emphasis is placed on how these trends interrelate with artificial intelligence, big data, physics, biology, and economics. We investigate how traditional boundaries between pure and applied mathematics are dissolving as mathematicians work on interdisciplinary problems requiring both deep theoretical insight and computational sophistication. Additionally, the paper discusses the evolution of mathematical education to accommodate these trends, highlighting the importance of computational literacy and collaborative research. This survey seeks to provide a comprehensive understanding of the vibrant directions in contemporary mathematics, drawing on recent developments and pointing toward future research opportunities. The scope of this paper encompasses both theoretical advances and practical implementations, offering scholars and practitioners a roadmap of the mathematical landscape in the digital age.

Keywords : Data driven mathematics, Machine Learning, Computational and Algorithmic Mathematics, Topological Data Analysis (TDA).

1. Introduction

Mathematics, often regarded as the language of science, is continually transformed by new challenges and opportunities. Over centuries, mathematical thought has progressed from classical geometry and algebra to highly abstract structures and powerful computational frameworks. Today, the rate of change in mathematics is accelerating due to technological innovation, data proliferation, interdisciplinary research, and societal demands. Emerging trends in mathematics not only reflect advancements within the field itself, but also its broadening influence across domains such as computer science, biology, economics, and physics.

The traditional dichotomy between *pure mathematics* — concerned with abstract structures and theoretical foundations — and *applied mathematics* — focused on solving practical problems — is diminishing. This shift is partly driven by the need to analyze large datasets, model complex phenomena, and develop algorithms with real-world relevance. For example, the rise

of machine learning has brought mathematicians into the centre of research in optimization, probability theory, and high-dimensional geometry. In addition, mathematical research is increasingly collaborative and multidisciplinary. Complex systems in nature, finance, climate science, and social networks require not only mathematical models, but integration with domain expertise from other fields. Mathematical modeling and simulation play crucial roles in understanding epidemics, predicting climate change, and designing resilient infrastructures.

Another driver of emerging trends is the expansion of computing power. High-performance computing, symbolic computation systems, and automated theorem proving are reshaping how mathematics is done. Computer-assisted proofs, once controversial, are now accepted and essential in areas such as topology and combinatorics.

This paper surveys key emerging trends that characterize contemporary mathematics. We begin by examining *data-driven mathematics* and its interplay with statistics and machine learning. We then discuss computational and algorithmic mathematics, followed by mathematical modeling of complex systems. Next, we explore advanced topics such as topological data analysis and homotopy type theory, and finally address the evolving landscape of mathematics education and ethical considerations in mathematical applications.

2. Data-Driven Mathematics

The emergence of large data sets — "big data" — in science, business, and technology has created a demand for mathematical frameworks that can extract meaning from complex information. Data-driven mathematics encompasses areas such as statistics, machine learning, information theory, and high-dimensional analysis. While statistics is a well-established mathematical field, modern applications require novel theoretical developments to address challenges posed by massive, noisy, and high-dimensional data.

2.1 High-Dimensional Probability and Random Matrices

One prominent trend is the study of high-dimensional probability, where traditional intuition about randomness breaks down. In high dimensions, random vectors and matrices exhibit surprising structure. For instance, the concentration of measure phenomenon implies that high-dimensional distributions behave in a remarkably predictable way. Random matrix theory, originally developed in physics, now underpins techniques in statistics and machine learning, such as principal component analysis (PCA) and network analysis.

2.2 Machine Learning and Optimization

Machine learning has propelled research into optimization theory, generalization bounds, and statistical learning frameworks. Deep learning, in particular, relies on optimization of highly non-convex loss landscapes. While current practice focuses on heuristics and empirical performance, ongoing mathematical research seeks to explain and improve the theoretical foundations of learning algorithms. Topics such as overparameterization, implicit regularization, and generalization in neural networks represent active research fronts.

2.3 Information Theory and Data Compression

Information theory, rooted in entropy and coding theory, continues to evolve in response to modern communication systems and data compression needs. Mathematical research in this area addresses fundamental limits on data transmission, storage efficiency, and error correction. With applications in genomics and quantum communication, information theory remains central to understanding and exploiting data.

2.4 Statistical Topology and Geometry

Emerging mathematical techniques are designed to capture shape and structure in data. For example, *topological data analysis* (TDA) applies tools from algebraic topology to identify features of data sets that are robust to noise. This approach is particularly useful in fields such as neuroscience and sensor networks.

Data-driven mathematics signifies a shift toward frameworks capable of handling the complexity and scale of modern information. It represents a fruitful intersection of theoretical rigor and practical necessity.

3. Computational and Algorithmic Mathematics

As computation becomes central to mathematical research and application, new trends are emerging in algorithmic design, computational complexity, and computer-assisted mathematics.

3.1 Symbolic and Numeric Computation

Symbolic computation systems (like Mathematica and Maple) and numeric computation libraries (such as MATLAB and NumPy) have broadened the capability of mathematicians to experiment with conjectures, perform extensive calculations, and visualize results. New developments focus on efficiency, parallel computation, and integration with machine learning.

3.2 Algorithmic Complexity and Quantum Algorithms

Understanding the intrinsic difficulty of computational problems drives research in algorithmic complexity theory. Classical problems in P vs NP, approximation algorithms, and randomized algorithms continue to shape the landscape.

The advent of *quantum computing* introduces new paradigms. Quantum algorithms, such as Shor's algorithm for integer factorization and Grover's search, demonstrate theoretical speedups over classical counterparts. Mathematical research in this area includes quantum error correction, complexity classes in the quantum setting, and novel algorithmic frameworks.

3.3 Computer-Assisted Proofs and Automated Reasoning

Computer-assisted proofs are gaining acceptance in mathematics. The proof of the four-color theorem is a classic example; contemporary developments include automated theorem provers and proof assistants like Coq, Lean, and Isabelle. Recent initiatives have translated large portions of undergraduate mathematics into formal proofs, improving reliability and opening new directions in proof theory.

3.4 Computational Topology and Geometry

Advances in computational geometry and topology support applications in robotics, graphics, and data analysis. Efficient algorithms for mesh generation, geometric optimization, and topological invariants are driving progress in both theoretical and applied contexts.

Computational mathematics thus plays a dual role: it enhances traditional mathematical inquiry and addresses practical problems requiring algorithmic solutions.

4. Mathematical Modeling of Complex Systems

Complex systems — characterized by many interacting components — are ubiquitous in nature and society. Examples include ecosystems, financial markets, the human brain, and social networks. Mathematical modeling of complexity requires tools that can capture emergent behavior, nonlinearity, and stochastic dynamics.

4.1 Nonlinear Dynamics and Chaos

Nonlinear differential equations and dynamical systems theory remain central to understanding complex phenomena. Chaos theory, with its sensitivity to initial conditions, has applications in weather prediction, fluid dynamics, and population dynamics. The mathematical challenge lies in identifying patterns and invariants amid apparent unpredictability.

4.2 Network Science

Networks provide a framework for representing interactions within complex systems. Graph theory — studying vertices connected by edges — has expanded into *network science*, which addresses structural properties like connectivity, centrality, and community detection. Applications range from epidemiology to information spread on social media.

4.3 Stochastic Processes and Random Graphs

Random processes model uncertainties in complex systems. Stochastic differential equations describe systems influenced by noise, while random graphs model the probabilistic growth of networks. Recent work investigates phase transitions in networks and percolation theory, with implications for resilience and contagion.

4.4 Multiscale and Multiphysics Models

Many systems interact across scales — from molecular to macroscopic. Multiscale models link phenomena at different levels, requiring sophisticated mathematical techniques for analysis and simulation. Coupling of physical processes, such as thermal and mechanical effects, demands multiphysicsmodeling approaches.

The study of complex systems highlights the role of mathematics as a unifying language capable of describing and predicting collective behavior across diverse domains.

5. Advanced Theoretical Trends

Beyond applied and computational developments, theoretical mathematics continues to evolve, producing deep concepts with future potential.

5.1 Topological Data Analysis (TDA)

TDA uses algebraic topology to study the shape of data. Concepts such as *persistent homology* quantify features like loops and voids in datasets. This approach is robust to noise and useful in fields such as material science, neuroscience, and genomics. The ongoing development of computational tools and theoretical foundations makes TDA a vibrant area of research.

5.2 Homotopy Type Theory and Univalent Foundations

Homotopy type theory (HoTT) is an emerging foundation for mathematics rooted in both logic and topology. It reinterprets mathematical objects in terms of homotopy — a concept from algebraic topology — and provides a new perspective on equality and computation. HoTT has stimulated interest in new proof strategies and formalization of mathematics.

5.3 Algebraic Geometry and Number Theory

Classical fields such as algebraic geometry and number theory are experiencing renewed interest due to connections with physics, cryptography, and modular forms. Research on motives, arithmetic geometry, and p-adic methods reflects deep structural inquiries with long-term significance.

5.4 Category Theory and Higher Categories

Category theory, which abstracts mathematical structures and relationships, continues to influence areas ranging from logic to quantum physics. Higher category theory extends these ideas to multi-level morphisms, offering frameworks that could unify diverse mathematical domains.

These advanced theoretical trends, while abstract, often yield unexpected applications and enrich our conceptual understanding of mathematics.

6. Education and the Future of Mathematics

The rapid evolution of mathematics poses challenges and opportunities for education. Traditional curricula emphasize calculus, linear algebra, and classical theory; however, emerging trends demand additional competencies.

6.1 Computational Literacy

Competence in programming, numerical methods, and computational thinking is now essential. Tools such as Python, R, and specialized mathematical software empower students to experiment, visualize, and solve real-world problems.

6.2 Interdisciplinary Training

Mathematics education is increasingly integrated with other disciplines. For example, computational biology programs require students to understand differential equations, statistics, and algorithms within a biological context. Such interdisciplinary training prepares students for research and industry roles.

6.3 Project-Based Learning

To reflect the collaborative nature of contemporary mathematics, educators are adopting project-based and inquiry-driven pedagogies. These approaches allow learners to tackle open-ended problems, fostering creativity, resilience, and deeper understanding.

6.4 Ethical and Social Considerations

As mathematical models influence decisions in finance, healthcare, and social policy, ethical considerations become vital. Students must learn to scrutinize assumptions, understand limitations, and consider societal impacts of mathematical applications.

Education in mathematics must adapt to produce graduates who are not only technically proficient but also equipped to apply mathematical thinking in a complex, data-driven world.

7. Ethical and Societal Implications

With the expanded use of mathematical models in decision-making comes responsibility. Algorithms power financial markets, determine credit scores, and influence judicial sentencing. Without proper oversight, biases in data and models can perpetuate inequality. Mathematicians are therefore engaging with ethical frameworks to ensure fairness, accountability, and transparency in algorithmic systems.

The rise of artificial intelligence has intensified debates about autonomy, privacy, and human oversight. Mathematics plays a crucial role in quantifying risk, optimizing outcomes, and formalizing fairness constraints. This trend underscores the need for mathematical research that incorporates values and ethics into formal systems.

8. Conclusion

Mathematics in the twenty-first century is marked by interconnected trends that bridge theory and application. Data-driven methods, computational advances, modeling of complex systems, and deep theoretical innovations illustrate the expanding role of mathematics in science and society. Education and ethical considerations are integral to this evolution, ensuring that mathematical tools are applied responsibly and effectively. As we look ahead, emerging trends signal a vibrant future in which mathematics continues to adapt, inspire, and solve the challenges of our time.

References :-

1. Chazal, F., & Michel, B. (2017). *An Introduction to Topological Data Analysis: Fundamental and Practical Aspects for Data Scientists. arXiv preprint.*
2. Su, Z., Liu, X., Bou Hamdan, L., Maroulas, V., Wu, J., Carlsson, G., & Wei, G.-W. (2025). *Topological Data Analysis and Topological Deep Learning Beyond Persistent Homology — A Review. arXiv preprint.*
3. Pascucci, V., Tricoche, X., Hagen, H., & Tierny, J. (Eds.). (2011). *Topological Methods in Data Analysis and Visualization: Theory, Algorithms, and Applications.*
4. Hotz, I., Masood, T. B., Sadlo, F., & Tierny, J. (Eds.). (2021). *Topological Methods in Data Analysis and Visualization VI: Theory, Applications, and Software.*
5. Edelsbrunner, H., & Harer, J. (2010). *Computational Topology for Data Analysis.*
6. Boissonnat, J.-D., Chazal, F., &Yvinec, M. (2018). *Geometric and Topological Inference.* Cambridge University Press.
7. Boissonnat, J.-D., &Yvinec, M. (1998). *Algorithmic Geometry.*
8. Miscellaneous authors. *Algorithms and Combinatoricsseries.*
9. Khatreja, K. (2025). *Emerging Trends in Mathematics Education: Integrating Technology, Equity, and Critical Pedagogy. International Research Journal on Advanced Engineering and Management (IRJAEM).*
10. Maqruf, A., Herman, T., Nurlaelah, E., Ko-Wai Tang, W., et al. (2025). *Exploring the Research Trends of Mathematics in STEM Education. AIMS Education.*
11. Aggarwal, G. (2025). *Studies of Mathematics: A Review of Research Trends, Themes and Implications. Recent Trends in Mathematics.*
12. *Trends in mathematics education and insights from a meta-review and bibliometric analysis of review studies.* (2024). *ZDM – Mathematics Education.*

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Indian Folk Theatres with Reference to Some Popular Folk Theatre Forms and Social Media: An Overview

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ABSTRACT

This research paper aims to provide an overview of different forms of Indian folk theatre across India. It appears in a narrative form and is emerged initially in Vedic and Buddhist culture and then in the 15th and 16th centuries flourished in different regions. The well-renowned dramatist Bharat Muni has discussed nine rasas in his milestone work 'Natyashastra'. Folk theatre is associated with Bharat Muni's work. However, this research study is limited to the analysis of some folk theatre forms such as Jatra of West Bengal, Bhavai of Gujarat, Tamasha of Maharashtra, and Yakashagana of Karnataka.

In the current digital platform, the Indian folk theatres also face many challenges rather than advantages. Nowadays Internet is used as a transmission and a platform for the performance of folk theatres. The artists perform as a profession on the poor financial support and that is why they get another profession for their livelihood.

Keywords: *Indian folk theatre, communication, socio-cultural elements, and social media.*

Introduction

Folk theatre is a composite art that includes music, dance, mime, costume, epic, etc. It has been performed in almost every state of India since ancient times. It is considered a powerful medium of communication. It mainly focuses on social awareness among people and brings entertainment. Different folk theatres have different backgrounds and they are embedded in their indigenous language, culture, and society. Jatra in West Bengal, Yakshagana in Karanatak, Bhavai in Gujarat, Nautanki in Uttar Pradesh, Rajasthan, and Punjab, Tamasha in Maharashtra, Therukuttu in Tamil Nadu. It creates a sense of unity in diversity by keeping originality and faith in their culture. These folk theatres are also performed on auspicious occasions. The present study analyses the different folk theatre forms. It aims at dealing with social media in the present scenario. Indian folk theatre is a vast area of research but the researcher tries to focus on some folk theatre forms. Extensive exposure to digital glare is causing eye diseases. In India, folk theatre can be traced back to the 15th and 16th centuries and emerged as a medium of communication in various regions with deep roots in local surroundings, culture, and native identity. It is performed across India and is widely used to convey important messages about extremely complex socio-cultural and that is used to disseminate political factors for creating awareness in society. It is an example of the diversity in India.

With the changing times, this form is more effectively facing new technological challenges. Social media encourages folk theatre to reach the audience. The internet is the dawn of new innovative performances. As a result of the convergence from local to global maintain the global relationship. Apart from this, there are some disadvantages. The mixture of conventional cultural

things with the new social media becomes complex for the global audience.

Literature Review

The folk theatre has been passed down from one generation to another. It has lost its relevance due to modernization. To understand folk theatre, a brief discussion of the history of the region, its society, and its culture is important for the present research. Bharat Muni's Natyashastra is a portrayal of Indian theatre's divine origin. A plethora of writings on Folk theatre is available. Many books are written in Marathi about 'Tamasha'. The Marathi film 'Pinjra' focuses on the life of Tamasha artists and many films are created that manifest the different aspects and predicament of women characters. The documentary 'Silent Ghungroos' unfolds the origins of Tamasha from the Peshwa period to the modern contemporary period. However, folk forms survived through social media platforms and preserved traditional folk performances. Video uploading of performances, interviews with artists, films, and documentaries are all helping to cross the boundaries and manifest the Indian Folk theatre. However, the disadvantage of this digital platform is that the audience does not enjoy the live performances. Apart from that, Live-streaming performances are also gaining popularity through YouTube, and Facebook and also posting short clips on social media platforms. Collaboration and innovation are made between social media and folk theatre to make folk theatre more relevant to today's world. Social media like GoFundMe and Facebook were used for crowdfunding campaigns during COVID-19 to provide support for the artists. After all, there is uncertainty about the fund and they might have to struggle in the future.

Relevance of the Study and Scope for Future Research

Folk Theatre is the most powerful medium of communication among the masses. It disseminates the social, cultural, and political factors. Initially, this form used to deal with only religion, legend, and mythology. Later it started to include the folk stories of romance. Bharat Muni's Natyashastra' is associated with the folk theatre. Even Richard Schechter's 'Performance Theory' and Victor Turner's 'Contemporary Cultural Performance talk about cultural performance and explore the performative culture and visual culture. The culture can be perceived through language, power, gender and society. In folk theatre, actors and communal factors are important for the understanding of the essence of culture and its society. Earlier, folk theatre was directly associated with the audience and its culture but in modern times it is mainly associated with technology and global mass. Henry Jenkins' Media Convergence Theory presents the hybridization of old and new media in the content and new electronic media. Audiences become active and interact through commenting, sharing, and crowdfunding shows. Digital technology has created a great impact on changing human behaviour. Social media works as a mediator to transform cultural practices at the global level. Folk theatre fills the gap between cultural, geographical, and social boundaries from various points of view through social media. Social media including Facebook, Twitter, Instagram, and LinkedIn are the sources of marketing and these sources are helping for the wide connectivity across the globe.

Being an indigenous form, Indian folk theatre directly appeals to the audience due to its language and themes. Conversely, the classical theatre was based on Bharata Muni's Natyashastra in sophisticated form around the urban area. Thus, this research paper is of great value and significance as it presents the scenario of Indian folk theatre from the beginning to the present. Balwant Gargi in his seminal book, *Theatre in India* differentiates between Sanskrit and folk theatres as follows:

"Sanskrit drama, addressed to a sophisticated audience of courtiers, used a highly ornate language that did not touch the life of the people. It is the folk theatre in its diverse forms Evolution of Sanskrit and Folk Theatres Institute of Lifelong Learning, University of Delhi which is rooted in their lives. It has changed, adapted, and developed, adjusting itself to changing social conditions." (Balwant 82-3).

Balwant Gargi rightly points out that Sanskrit drama was more sophisticated and could reach at the grassroot but the folk theatre rooted in traditional culture. Indian folk theatre is divided into two broad types-1) Religious and 2) Secular. These two types of folk theatre influence

each other. Most often the folk and traditional forms are mainly narrative like Ramlila, Rasleela, Nautanki, Swang, etc. without any movement, gesture, or dance. It can also be classified into three categories- 1) Ritual theatre 2) Theatre of Entertainment, 3) and South Indian Theatre.

Ritual theatre is rooted in religious and mythological traditions for example Ramleela of Uttar Pradesh presents the performance of the Ramayana, and celebrates it with music, dance, and conversations in the days of Dussehra. It holds UNESCO recognition as an "Intangible Cultural Heritage of Humanity". Rasleela of Gujarat and North India is a dance play that presents teenage love tales of Krishna and Radha.

Theatres of Entertainment

Bhavai in Rajasthan is a folk theatre that utilizes dance to narrate stories in a series of short plays. It is performed with clay pots or metal pitchers with skills from the backdrop of semi-classical music. Popular Nautanki narratives such as Bhakta Puranmal, Lajjawati, Bhakta Hardaul, Nautanki Shahzadi, and Mission Suhani discuss the theme of women's representation in the Nautanki tradition. The impact of patriarchy on man-woman relationship is presented. The *jatra*, on a 16-foot (5-meter) square platform, have gangways that run through the surrounding audience and connect the stage to the dressing room. Actors enter and exit through these gangways, which serve a function similar to the *hanamachi* of the Japanese Kabuki theatre. Jatra of Best Bengal and the Tamasha of Maharashtra are nonreligious forms of theatre.

Tamasha is a very popular folk theatre in rural Maharashtra from the 16th century. There are two types of Tamasha: dholki bhaari and the older form, sangeet baari with more dance and music. Traditionally, the kolhati groups perform in Tamasha. In Tamasha in Maharashtra, Lavani is a form of song and dance and played on the beats of a Dholki, an instrument. In Tamasha, exaggerated makeup sometimes attracts the audience while dancing in phad (stage). Earlier, a male character played the role of a female character but as per the changing times, female characters are playing the role of female characters very boldly. Tamasha is performed at night by lower-class artists. Once, it was banned due to obscenity by former Chief Minister Babasaheb Thakare. The female dancer performs Lavani wearing a nauvari saree (nine-yard long saree) which is wrapped around in a kashta drape, the Ghungroo (ankle bells), tied the hair back in a bun called a *juda* or *ambada*a and around the bun *gajra* is tied. The Gajra is a flower garland for the hair, heavy jewelry that includes a necklace, Zumke (earrings), a nath (nose ring), bangles, a kamarpatta (a belt at the waist), and a large red bindi on the forehead are all beautify the performer. Lavanya means beauty and the beautiful woman dances with facial expressions and songs in front of a large audience. Bharat Muni's Natyashtra is the foundation of the rasas and Shringara (Love) is exemplified through tender movements and feeling, graceful bodily gestures, eye contact, and beauty. Traditionally, tamasha had a dancer known as Nachya, a poet known as Shahir who was also the Sutradhar, and a Vidushaka or jester. Here the Sutradhar deals with Hasya (laughs) ras through witty dialogue and humorous performances. Hasya ras are mainly used for amusement.

The two types of performances are seen on the platform in Maharashtra. Lokshahir Ram Jagannath Joshi (1762-1812) contributed to the Tamasha and Pawada. He was an upper-class Brahman and married the Tamasha dancer Baya (Hansa Wadkar). Because of this, he was outlawed by the members of his caste. The film "Classical Marathi Tamasha Musical" is a biopic of the poet, kirtan, and Lavani performer Ram Joshi, that is set in the Peshwa Period.

The south Indian forms give importance to dance forms like Kathakali and Krishnattam of Kerala while the north Indian forms emphasize songs like khyal of Rajasthan, the Maach of Madhya Pradesh, Nautanki of Uttar Pradesh and Swang of Punjab, and Jatra of Bengal. In the 19th century, it dealt with love stories and social and political themes. Jatra means "to go in a procession." It originated in West Bengal and later on became popular in Orissa and Eastern Bihar. In the 15th century, some devotees of Krishna went on singing and dancing and this singing with dramatic rhythm is known as the Jatra. Earlier it was performed the whole night but came to an hour's performance. It is a single character's performance with dialogue and action. In between, the vivek (conscience) appears and criticizes the

dialogue and tells philosophy. He talks about the inner feelings of the character and also tells the inner meanings of outer actions. Rabindranath Tagore also advocated this folk theatre for disseminating social awareness in the rural part of the country. The eradication of untouchability is the major theme of Jatra in those days. Jatra of West Bengal and Tamasha of Maharashtra are performed on the basis of a commercial point of view. The artists learn the art by watching the elders throughout their lives and they get it as a heredity. In modern times, the increased use of internet technology and the sharing of Jatra performances through YouTube, Instagram, and Facebook bring this folk theatre to a wider audience. This folk theatre uses loud music, and lighting and is performed on giant outdoor stages. Yakashagan of Karnataka is also a very popular folk theatre form. Yakshagan means songs of demigods. It is a unique and vibrant theatre form that balances dance, makeupmusic, dialogue and costume narrate mythological stories. The themes of this traditional form are based on mythological stories and Puranas. For example, from the great epic Ramayana, the episodes are performed like Lav-Kush Yuddh, Baali-Sugreeva Yuddha, and Panchavati, and from another great epic Mahabharat, the most popular episodes are performed like Draupadi Swayamvar, Abhimanyu vadh, Karna-Arjun Yuddh and Subhadra Viva. It is about music, songs, dances, and dialogues. Narahari Thirtha has given the real shape to Yakshagan through Dashavatar's performance. Like Tamasha, in Yakshagan, the artists are adorned with colourful costumes and big headgear. It started in Vaishnav Bhakti Movement during the 11th century in the coastal areas. It is performed in the temple from sunrise to sunset and at the background, a group of musicians play drums and pipes. The stage is decorated with banana and mango leaves, and flowers for gracing the atmosphere with colourful festive feel. The folk theatre shows the experiences and situations of the real world.

Puppet Theatre is also performed in some parts of India Shadow, Glove, Doll, and String puppets are well-known forms. Besides, dramatic art is also found in solo forms like Bharatanatyam, Kathak, Odissi, and Mohiniyattam. Kerala is also known for its rich cultural heritage through various art forms and dances. Mohiniyattam stands for the dance of the divine enchantress which originated from Kerala. It is a combination of Kathakali and Bharatanatyam and is known as Kerala's popular classical dance form. In Indian mythology, Mohiniyattam is referred to as Mohini-attam. Here attam means rhythmic motion or dance, and the word Mohini is taken from "Mohini" – a famous female avatar of the Hindu god Vishnu. It articulates the spiritual message through facial expressions and body movements. Folk theatre plays a crucial role from entertainment to enlightenment. All the performers in the day time work in different profession for their livelihood.
Before independence, folk theatre played a vital role in arousing the conscience of the people against British Rule. Mahatma Gandhi started socio-political campaigns and through folk theatre created an atmosphere of development. In 1940, the Indian People's Theatre Association (IPTA) handled some well-known regional theatres. The folk theatres are performed in the open air with a gaudy appearance. Initially, the folk theatre was performed for only the entertainment but later on it was also used to spread the messages or an awareness about social and political issues among people. The artists showcase the performance from the inner and outer sides. More importantly, men play the roles of female characters with bright ornaments and the colourful costumes. In the globalized world and the changing time, the artists also go through different innovations such as themes, lights, and makeups. The Indian folk theatres unveil the rich Indian tradition through different parts of India.

Bharat Muni's Natyashastra presents the nine rasas and out of them music, dance, beauty, and obscenity (bhibhats) are predominantly preoccupied in the space in the folk theatres. Jatra, Tamasha, Yakshagan, and Mohiniattayam are the best examples of these rasas.

The folk theatre goes through transformational changes such as cultural practices in modern societies, the digital landscape, and the more globalized and technological world.

Findings

Jatra of West Bengal, Tamasha of Maharashtra, Yakshagana of Karnataka, and

Mohiniattaya of Kerala are popular folk theatres. As per the changing time, Jatra, the orchestra is also performed. Folk theatre is performed in every state or region and continues to survive from one generation to another in contemporary times. The past situation and the present situation have not remained as it is. Lack of interest in folk theatre is increasing due to the weightage of social media like Facebook, Twitter, Instagram, and LinkedIn. However, folk theatre has adopted technology and accepted the challenges and opportunities for better performances. The government provides the path for sustainable development and tries to bridge the gap between conventional and modern content and technologies. Traditional folk dance on the street presents the best folk culture of India. The marginalized community is actively involved in such a type of folk theatre.

Methodology

The primary and secondary data are gathered for the present study. The primary data includes interviews and play manifestations. The secondary source material is mainly the relevant published or unpublished material. The data is acquired through online articles and research papers.

Conclusion

For the survival of folk theatre in the future, the young generation's acceptance is a necessary step and it would be only possible by introducing folk theatre as a subject in the curriculum from school to higher education. Moreover, it would be a source of livelihood for the performers and the degree holders. There should be many well-equipped theatre training institutes. It is expected that this study will encourage more such folk theatre-based research activity about some of the neglected areas of Indian folk theatre. This type of research will help to preserve, sustain, and foster Indian folk theatre. The amalgamation of traditional folk theatre and social media will lead to a loss of cultural significance.

References :-

1. Gargi, Balwant. *Theatre in India*. Theatre Arts Book, New York, 1960.
2. Bhagavat, D.N., *An Outline of Indian Folklore*. Bombay: Popular Book Depot, 1958.
3. Goffman, Erving. *The Presentation of Self in Everyday Life*. New York: Doubleday, 1959.
4. Melkote, S.R. *Communication for Development in the Third World: Theory and Practice*. New Delhi: Sage, 1991.
5. Mukhopadhyay, D. *Folk Arts and Social Communication*. New Delhi: Publications Division., 1994.
6. Parmar, S. *Traditional Folk Media*. New Delhi: Geka Books, 1975.
7. Schechner, Richard. *Performance Theory*. 2nd edition. New York and London: Routledge, 1988.
8. St. John, Graham (ed.). *Victor Turner and Contemporary Cultural Performance*. New York and Oxford: Berghahn Books, 2008.
9. Wolf, Naomi. *The Beauty Myth: How Images of Beauty are used Against Women*. Harper Collins, 2002.

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A Review of the Advancement of Thin-Film Transistor Technology and Applications

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Introduction:

Thin-film transistor (TFT) technology is well-known and widely utilized in flat-panel displays, computers, smart phones, video gaming systems, and personal digital assistants. This technique has revolutionized video systems, allowing flat panels of increasingly bigger size to be generated. The diagonal dimension of today's TFT liquid crystal display (TFT-LCD) substrates is 164 inches.The first fully transparent zinc oxide thin-film transistor (ZnO TFT) was produced in 2003 (1), and several significant studies have been published (2-6). Organic and hydrogenated amorphous silicon (a-Si:H) TFTs have also been shown, although their use is limited because to the low mobility of the conductive channels. Since its inception in 2003-2004, ZnO and related materials have emerged as attractive contenders for channel materials in flexible and transparent TFTs. (1, 4), When compared to other inorganic wide bandgap semiconductors such as gallium nitride (GaN) and silicon carbide (SiC), ZnO materials have a significant advantage for flexible devices due to their low synthesis temperature, which is the most important requirement in flexible device fabrication processes.

History of development of TFT technology

The first TFT-LCD was exhibited in 1973, becoming the primary focus of TFT technology research and development (7). The original TFT was a CdS TFT, which was succeeded by a CdSe TFT. Both exhibited remarkable carrier mobility, exceeding 40 $cm2V^{-}1\ s^{-}1$ (8). However, due to fabrication issues, such as the stability of the semiconductor's quality on a large surface, as well as device dependability, application to LCDs was not commercialized.The development of hydrogenated amorphous silicon (a-Si:H) in the early 1980s significantly improved the stability and characteristics of TFTs, allowing the production of active matrix (AM)LCDs, and the first TFT-LCD was commercialized in 1989. The semiconducting layer improved as other materials were developed. Table II highlights and contrasts several semiconductor materials produced for TFT-LCDs since the 1960s. The invention of transparent oxide semiconductors such as indium gallium zinc oxide (IGZO) was a significant step forward in enhancing the properties of TFTs. Power consumption was further lowered due to the increased carrier mobility, and transparent transistors were created, resulting in a greater aperture ratio of the LCDs (9).

Applications using TFT technology

With the rapid advancement of science and technology in flexible transparent electronics, numerous remarkable inventions are on the verge of commercialization (10, 11). IGZO panels have previously been utilized in iPad and iPad Pro products, and Apple is considering using them in its upcoming iPhone, which will be released in late 2017.Flexible transparent displays and other applications face more challenges before being widely available. They have been made from the early 2010s by firms such as LG Display, AUO, and JDI (12). The TFT array substrate is combined with an OLED and a pressure sensor layer. The latter converts pressure into an electrical signal that is then passed to TFTs, which control and modulate

the OLED.The pressure sensor can be a pressure-sensitive rubber with resistance that changes with pressure, such as poly (methyl methacrylate) (PMMA), or a soft polymer containing conductive particles.For all these sensors, postprocessing of the TFT array substrate is needed in order to add a layer sensitive to the species to be detected. Many of these sensors are OTFTs because of the easier postprocessing. Among the chemical sensors, ion-sensitive field-effect transistor (ISFET) sensors are well known. In such devices the gate of the TFT has to be extended in order to increase the area of the surface used for detection and these sensors have to be covered with a thin layer of an insulator such as silicon nitride. A typical sensitivity of 54mV/pH has been reported(14). Concerning TFT gas sensors, many applications related to the environment and the detection of hazards have been realized. They are in competition with commercially available gas sensors which are often based on metal oxides and operate at high temperatures. The advantages of TFT gas sensors are the short response time, high sensitivity and room-temperature functioning. However, stability with time and usage is a limitation. Most TFT biosensors use OTFT technology. Those that are not based on OTFTs often use high-mobility semiconductors like ZnO or carbon nanotubes. Many applications include the development of immunological sensors for cancer diagnosis (15, 16). Biosensors are highly selective sensors because molecular recognition is typically conducted using complementary couples such as antigens/antibodies and enzyme/enzymatic substrates, or by hybridizing a DNA-probe strand with a DNA-target strand. A sensitive layer, similar to that used in chemical sensors, is required to convert the biochemical signal into an electrically quantifiable physical property. Antibodies, enzymes, and DNA probes are bonded to the sensitive layer.The reaction of the target molecules with the complementary molecules changes the surface electrical characteristics of the sensing layer, causing charge accumulation or increasing or decreasing the conductivity. These variations are detected by the TFT whose source–drain current is modulated by these effects. The first applications that were targeted were the detection by enzymatic reactions. In particular, glucose sensing using glucose oxidase was among the first targets (17, 18).

TFT technology has been used not only for LCDs but also for physical, chemical and biochemical sensing. However, the structure of the TFT devices used for LCDs exhibit very interesting characteristics for applications involving bio-logical cells and can potentially be used as an electrical platform for experiments on cells.

Conclusion

In this paper, we examined the feasibility of using TFT technology to conduct biological cell studies. A full history of TFT technology development and common applications such as LCDs, X-ray detection, pressure sensing for touch panel displays, infrared sensing, and biochemical sensing have been provided.

References

1) Hoffman R L, Norris B J and Wager J F 2003 Appl. Phys. Lett.82 733–5
2) Nomura K, Ohta H, Ueda K, Kamiya T, Hirano M and Hosono H 2003 Science3001269–72
3) Wager J F 2003 Science300 1245–6
4) Carcia P F, McLean R S, Reilly M H and Jr G N 2003 Appl. Phys. Lett.82 1117–9
5) Park J-S, Kim T-W, Stryakhilev D, Lee J-S, An S-G, Pyo Y-S, Lee D-B, Mo Y G, Jin D-Uand Chung H K 2009 Appl. Phys. Lett.95 13503
6) Tripathi A K, Smits E C P, Putten J B P H van der, Neer M van, Myny K, Nag M, SteudelS,Vicca P, O'Neill K, Veenendaal E van, Genoe J, Heremans P and Gelinck G H 2011 Appl.Phys. Lett. 98 162102
7) T. P. Brody, J. A. Asars, and G. D. Dixon, IEEE Trans. Electron Devices20, 995 (1973).
8) P. K. Weimer, Proc. IRE 50, 1462 (1962).
9) T. Matsuno, Sharp Information 104, 13 (2012)
10) LeeD 2016 CES 2016: Hands-on with LG's roll-up flexible screen, January 5,2016,BBC News
11) Cervant E 2015 Report: flexible displays will dominate the future with foldable, rollable and even stretchable panels, September 8, 2015, Android Auth.
12) G. Walker, Information Display, Display Week, 2014, p. 40.
13) F. Yan, P. Estrela, Y. Mo, P. Migliorato, and H. Maeda, Sensors 5, 293 (2005).

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Nanoparticle synthesis from rhizome of *Acorus calamus* L

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ABSTRACT

Nanoparticles has multiple applications in health and welfare of plants and humanbeing. Present study was pertained to evaluate the free radical scavenging properties of nanoparticles synthesized using aqueous extract of Acorus calamus rhizome. Results showed that all the samples viz. Aqueous extracts and metal based particles of Zinc, Copper, Ferrous and Magnesium possesses dose dependent scavenging potential. Present study proved that the particles have potential to quench the free radicals. Future study can be helpful to study the different aspects of the particles synthesized.

Keywords: Rhizome,Nanoparticles, Synthesis; etc

Introduction:

Acorus calamus L., commonly known as sweet flag, is a medicinal plant that has been traditionally used for its therapeutic properties. Ethnobotanical Uses: Acorus calamus has a rich history in traditional medicine and cultural practices. Rhizomes: The rhizomes of A. calamus are horizontal, aromatic, and branched. They are reddish brown externally and white internally. The rhizomes are the primary source of the plant's medicinal properties due to their high essential oil content. Its rhizomes are used in various traditional systems of medicine, including Ayurveda, Traditional Chinese Medicine (TCM), and Native American medicine.Medicinal Uses: The rhizomes are used to treat gastrointestinal disorders, fever, asthma, and inflammation. They are also used as a sedative and in the treatment of neurological disorders. Aromatic Uses: The essential oil extracted from the rhizomes is used in perfumery, incense, and as a flavoring agent. Nanoparticles synthesized from plant extracts have gained attention due to their eco-friendly nature and potential biomedical applications. *Acorus calamus*-mediated green synthesis has shown promising results in producing nanoparticles with antioxidant and free radical quenching properties (Sharma et al., 2019; Gupta et al, 2023). Acorus calamus L., a medicinal plant rich in bioactive compounds, has been explored for its ability to synthesize nanoparticles with antioxidant properties.

Materials and Methods:

Solutions and reagents: The chemicals required for the experiments were, Zinc acetate, Copper sulphate, Magnesium sulphate, ferric chloride, Acetate buffer (pH 04 and pH 10), phosphate buffer and double distilled water; etc.

Preparation of powder: Rhizomes of *Acorus calamus* were purchased from local market and it was thoroughly washed with distilled water and dried at room temperature. After drying, rhizomes were chopped into small pieces & pulverized to fine powder using modern pestle .

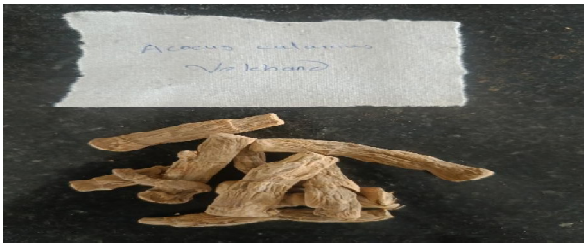


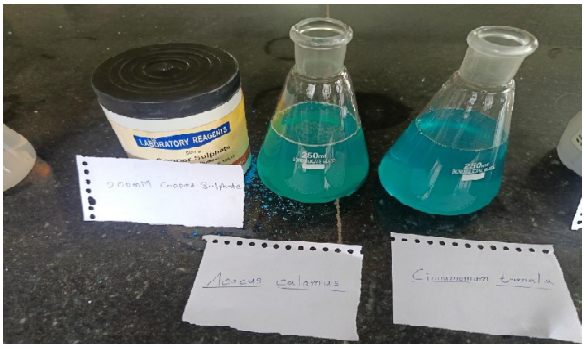
Figure 01: *Acorus calamus* L.

Preparation of aqueous extract: About 10g of freshly prepared dry sample powder were suspended in 100 ml of double distilled water and boiled at 60° C temperature for 15 minutes. Then filtered the solution through a whatman filter paper No.1 and the solution was used as stock solution for further experimental use.

Nanoparticle synthesis from rhizomes of *Acorus calamus:*

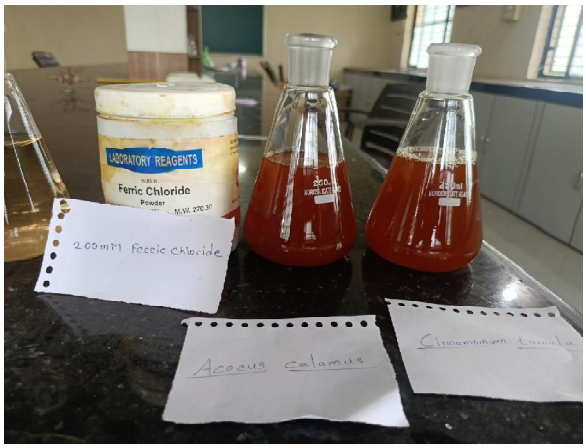
ZnO particles of *Acorus calamus*: Three different conical flasks were used for the purpose of Zinc oxide metal nanoparticle synthesis. In first flask 10 ml of plant extract were mixed with 90 ml of 200mM zinc acetate solution. In second flask 20 ml of plant extract were mixed with 80 ml of 200mM zinc acetate solution. While in third conical flask, 30 ml of extract were mixed with 70 ml of metal solution. The mixture were kept for precipitation of metal based nanoparticles for 12 hours at open sunlight. The synthesis of particle were examined by UV-Vis-NIR spectra scanned at 200nm to 1100nm. The growth of the particle were observed by the highest optimal density.

CuO particles of *Acorus calamus*: Three different conical flasks were used for the purpose of Copper oxide metal nanoparticle synthesis. In first flask 10 ml of plant extract were mixed with 90 ml of 200mM copper sulphate solution. In second flask 20 ml of plant extract were mixed with 80 ml of 200mM Copper sulphate solution. While in third conical flask, 30 ml of extract were mixed with 70 ml of metal solution. The synthesis of particle were examined by UV-Vis-NIR spectra scanned at 200nm to 1100nm. The growth of the particle were observed by the highest optimal density.



MgO particles of *Acorus calamus*: Three different conical flasks were used for the purpose of magnesium oxide metal nanoparticle synthesis. In first flask 10 ml of plant extract were mixed with 90 ml of 200mM magnesium sulphate solution. In second flask 20 ml of plant extract were mixed with 80 ml of 200mM magnesium sulphate solution. While in third conical flask, 30 ml of extract were mixed with 70 ml of metal solution. The synthesis of particle were examined by UV-Vis-NIR spectra scanned at 200nm to 1100nm. The growth of the particle were observed by the highest optimal density.

Fe_2O_3 particles of *Acorus calamus*: Three different conical flasks were used for the purpose of Copper oxide metal nanoparticle synthesis. In first flask 10 ml of plant extract were mixed with 90 ml of 200mM copper sulphate solution. In second flask 20 ml of plant extract were mixed with 80 ml of 200mM Copper sulphate solution. While in third conical flask, 30 ml of extract were mixed with 70 ml of metal solution. The synthesis of particle were examined by UV-Vis-NIR spectra scanned at 200nm to 1100nm. The growth of the particle were observed by the highest optimal density.



Results obtained: Results obtained showed thatuniform size of nanoparticle synthesis were carried out at the proportion of 1:9 ratio for Zn, Cu and Fe particles. While, for Mg particles 2:8 proportion was suitable for the synthesis. Therefore, for further experimental work the proportion of 1:9 will be used for the synthesis of ZnO, CuO and Fe_2O_3 particles. While for magnesium based particles the 20: 80 ratio will be used.

Conclusion:

Based on the results obtained from the study, it can be concluded that for further experimental work the proportion of 1:9 will be used for the synthesis of ZnO, CuO and Fe_2O_3 particles. While for magnesium based particles the 20: 80 ratio will be used.

References :-

1. Chang, Shang-Tzen & Wu, Jyh-Horng & Wang, Sheng-Yang & Kang, Pei-Ling & Yang, Ning-Sun & Shyur, Lie-Fen. (2001). Antioxidant Activity of Extracts from Acacia confusa Bark and Heartwood. Journal of agricultural and food chemistry. 49. 10.1021/jf0100907.
2. Deepshikha Gupta, Anuj Boora, Amisha Thakur, Tejendra K Gupta (2023). Green and sustainable synthesis of nanomaterials: Recent advancements and limitations, Environmental Research, Volume 231, Part 3.
3. Imam, Hashmat & Nigar, Zar & Azhar, Mohd & Sofi, Ghulamuddin& Hussain, Azad. (2013). Sweet flag (Acorus calamus Linn.): An incredible medicinal herb. International Journal of Green Pharmacy. 7. 288.
4. Patel S, Gupta M. (2020). A review on antioxidant properties of Acorus calamus nanoparticles. J Adv Res, 8: 123-135.
5. Reddy, Jayachandra & Mata, Rani & Gupta, Arvind & Sudha Rani, Sadras. (2014). Biological activities of green silver nanoparticles synthesized with Acorous calamus rhizome extract. European journal of medicinal chemistry. 85C. 784-794. 10.1016/j.ejmech.2014.08.024.
6. S. kazemi, A. Hosseingholian, S.D. Gohari, F. Feirahi, F. Moammeri, G. Mesbahian, Z.S. Moghaddam, Q. Ren, 2023. Recent advances in green synthesized nanoparticles: from production to application, Materials Today Sustainability, Volume 24.
7. Sharma R, et al. (2018). Biomedical applications of Acorus calamus nanoparticles. Int J Nanomedicine, 13: 1155-1167.
8. Sharma R, Singh A, Pandey AK. Green synthesis of nanoparticles and its potential application. J Nanotechnol. 2019; 7(4): 215-223.
9. Singh A, Bhat TK, Sharma OP. Clinical biochemistry of hepatotoxicity. J Clin Toxicol. 2018; 8(2): 1-12.
10. Singh A, et al. (2017). Antioxidant activity of green-synthesized nanoparticles of Acorus calamus. J Nanosci Nanotechnol, 17(3): 1567-1572.

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Vedic Ethics and Administrative Practices: A Study of the Indian Knowledge System in Public Governance

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ABSTRACT

This study explores the integration of Vedic ethics and administrative practices within the Indian Knowledge System (IKS) to enhance contemporary public governance. Rooted in the philosophical traditions of the Vedas, the ethical framework emphasizes concepts such as Dharma (duty), Satya (truth), and transparency, which serve as foundational principles for governance. The research critically examines the relevance of Vedic teachings, particularly as seen in Kautilya's Arthashastra*, in addressing modern challenges related to accountability, ethical leadership, and sustainable development. The study highlights how Vedic ethics inform policy-making, enhance administrative efficiency, and promote moral integrity in public institutions. The study discusses the adaptability of these ancient principles in fostering inclusive and just governance systems. The findings underscore the potential for integrating Vedic knowledge into modern administrative frameworks, thereby strengthening ethical governance and reinforcing India's commitment to a values-driven public sector.*

***Keywords**: Vedic Ethics, Indian Knowledge System, Public Governance, Dharma, Kautilya's Arthashastra, Ethical Leadership, Administrative Practices, Transparency, Accountability, Sustainable Development etc.*

Introduction:

In the exploration of Vedic ethics and administrative practices, it becomes imperative to understand how the ancient Indian knowledge system has influenced contemporary public governance. Rooted in a rich philosophical tradition, the Vedic texts offer profound insights into moral values, duty, and governance principles that resonate through centuries, shaping societal norms and public administration in India. This paper aims to critically examine the integration of Vedic ethical frameworks in modern administrative practices, illustrating their enduring relevance in promoting transparency, accountability, and ethical conduct within governmental structures. The study seeks to illuminate the potential for these ancient philosophies to inform current governance challenges. This investigation highlights the historical significance of Vedic ethics and proposes their applicability in reinforcing the integrity of public institutions, thereby contributing to a more just and effective governance system in India.

Vedic Ethics and Its Relevance to Contemporary Governance:

The Vedic ethical framework offers profound insights into the principles guiding governance, reflecting a synthesis of moral duty (dharma) and social obligation. Central to Vedic ethics is the notion of righteousness, which informs individual behavior serves as a foundational pillar for statecraft. The teachings of Kautilyas Arthashastra exemplify this interplay, as they prioritize national security and ethical governance to achieve state stability and prosperity. Notably,

the text conveys that 69.88% of its content is devoted to national security, thereby underscoring the importance of ethical leadership in safeguarding a states interests (Saad et al.). The evolution of medical practices from Vedic times to contemporary periods, as explored in various scholarly researches, illustrates the enduring nature of ethical concerns in governance, highlighting the necessity of integrating ethical dimensions into public health and administrative systems (Dabak et al.). As such, Vedic ethics remains relevant in shaping modern governance strategies.

Vedic Principles and Ethical Governance:

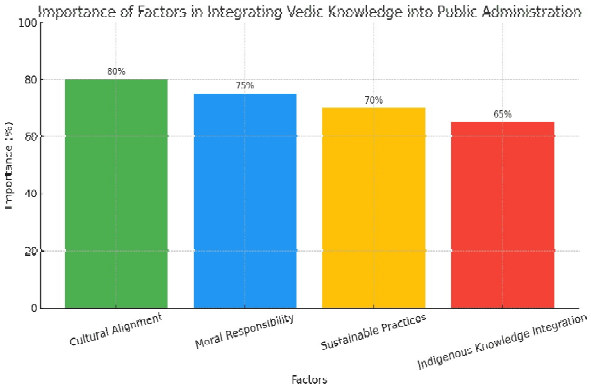
The principles rooted in Vedic knowledge offer profound insights into ethical governance, emphasizing a holistic approach to administration that integrates traditional values with contemporary practices. Central to Vedic ethics is the concept of Dharma, which underscores the importance of righteousness and duty in governance, advocating for a system where leaders are accountable to their communities and guided by moral imperatives. This ethical framework allows for a synthesis of indigenous knowledge and modern governance models, fostering sustainable development as highlighted in the study of traditional agriculture in Nepal, where Vedic knowledge informs agricultural practices within a cosmological context (Willett et al.). Furthermore, the transition from magico-religious epistemologies to more empirical systems in ancient India reveals the evolution of administrative thought in managing societal issues, such as mental health, enhancing understanding of governance's socio-cultural dimensions (Dabak et al.). Vedic principles encourage a governance model that prioritizes ethical considerations and community welfare.

The Role of Dharma in Shaping Ethical Administrative Practices:

The concept of Dharma plays a pivotal role in shaping ethical administrative practices within the framework of Vedic ethics, providing a comprehensive moral foundation for governance. Rooted in the principles of righteousness and duty, Dharma emphasizes the importance of ethical conduct and social responsibility, guiding leaders to prioritize the welfare of the community. In ancient texts such as the Arthashastra and the Mahabharata, Dharma serves as a vital reference point for decision-making, illuminating the path toward justice and equity in administration. As evidenced by the integration of Vedic wisdom in contemporary governance strategies as the ethical underpinning remains relevant to promote integrity and accountability in public leadership (Gohel R). The emphasis on Dharma as a collective responsibility fosters a sense of unity and shared purpose, reinforcing the interconnectedness of governance and society, thus enhancing the overall effectiveness of administrative practices (Brahmacari SKD).

Integration of Vedic Knowledge in Modern Public Administration

The integration of Vedic knowledge into modern public administration presents a unique opportunity to enhance governance practices through ethical frameworks and holistic perspectives. Administrators develop policies that resonate with the cultural and spiritual values of the Indian populace, fostering greater alignment between government actions and societal expectations. This approach advocates for a form of governance that is mindful of economic progress and the moral responsibility inherent in public service which is shown n below graph:



The bar chart 1.1 Importance of Various Factor iin Integrating Vedic Knowledge into Public Administration

This bar chart illustrates the perceived importance of various factors in integrating Vedic knowledge into modern public administration. The data highlights that cultural alignment is viewed as the most important (80%), followed by moral responsibility (75%), sustainable practices (70%), and indigenous knowledge integration (65%). This visual supports the narrative regarding enhancing

governance through ethical frameworks and holistic perspectives.

Outlined in the discourse on sacred activism and the integration of culturally significant knowledge systems lead to a more responsible global community, encouraging activists and leaders to consider the broader implications of their decisions ((Abbasi et al.)). Moreover, understanding indigenous knowledge—like that found within Vedic traditions—enhance agricultural policies and promote sustainable practices, thereby facilitating a development model that respects traditional cosmologies while addressing contemporary challenges ((Willett et al.)).

Case Studies of Successful Implementation of Vedic Principles in Governance:

The exploration of successful implementations of Vedic principles in governance highlights practical applications that align with contemporary administrative needs. One notable case is the incorporation of ethical leadership frameworks derived from Vedic teachings, resulting in enhanced leader-member exchanges within organizations. Such frameworks emphasize empathetic communication, which has been linked to improved management effectiveness, particularly within non-profit entities like Waqf institutions, where ethical governance is paramount (Sharip SM et al., p. 217-236). Another relevant facet is the adaptation of Vedic values that advocate for transparency and accountability, critical issues underscored by modern ethical standards in corporate governance (Rogo Ašiæ, p. 215-218). These initiatives underscore the adaptability of Vedic ethics to address current challenges, promoting sustainable governance practices that honor both tradition and contemporary expectations. Thus, these case studies affirm the relevance of Vedic principles and serve as a blueprint for enriched public governance in the modern context.

Reflection on the Impact of Vedic Ethics on Future Public Governance Practices:

The enduring influence of Vedic ethics on contemporary public governance practices cannot be overstated. Rooted in principles such as truth (satya), duty (dharma), and righteousness, Vedic thought places a paramount emphasis on integrity and ethical leadership. Societies grapple with complex governance challenges and the application of these principles foster a culture of accountability and transparency within public administration. Future governance frameworks that incorporate Vedic insights may promote a holistic approach to policy-making, encouraging leaders to prioritize the collective welfare of society over individual gain. Vedic ethics advocate for an inclusive governance model, ensuring that diverse voices are heard in the decision-making process. Future leaders can nurture a more just and equitable society, ultimately creating governance systems that resonate with both ethical imperatives and practical outcomes. This synergy between ancient wisdom and contemporary needs could redefine how public administration is conceived and enacted.

Conclusion:

Thus, the examination of Vedic ethics within the framework of public governance elucidates the profound influence of ancient Indian knowledge systems on contemporary administrative practices. This study reveals that principles rooted in texts such as the Arthashastra inform national security strategies and establish a broader ethical foundation for governance. The systematic exploration of Kautilyas theories, particularly his Saptanga and Mandala models, underscores how these ancient insights remain relevant in todays complex political landscape, where the interplay of power and ethics is critical (Saad et al.). Moreover, the evolution of medical understanding in the Vedic context underscores the transformative nature of knowledge systems, linking empirical practices to broader societal values, thus fostering a holistic approach to governance that harmonizes wisdom with actionable policy (Dabak et al.). It gains a richer understanding of the role of Vedic ethics in shaping a principled framework for modern public administration.

References :-

1. Sharfizie Mohd Sharip, Marinah Awang, Ramlee Ismail. "Empathetic Language of Leadership in Religious-based Non-Profit Organizations: The Case of Waqf Institutions in Malaysia". The International Journal of Academic Research in Business and Social Sciences,2020, https://www.semanticscholar.org/paper/ea5848b703404c2a925ad255d675359696be12e7
2. Andrijana Rogošiæ. "Ethical Issues in Accounting in Prosperity and a Financial Crisis". Zeszyty Teoretyczne Rachunkowoœci, 2020, https://www.semanticscholar.org/paper/571e40218ad88acfe9b9b7d3bf487566a6301f59
3. Srivas Krishna Das Brahmacari. "Evidence of Vedic Sanâtana Hinduism as a Global Dharma". International Journal of Science and Research Archive, 2024, https://www.semanticscholar.org/paper/414920943983e5980824d94b5f17e2ebe2ebf8a2
4. Raj Gohel. "Integrating Ancient Indian Wisdom into Modern Strategies: Addressing International Challenges". International Journal For Multidisciplinary Research, 2024, https://www.semanticscholar.org/paper/f7b9f178bafd66a8527fb5f5a45ec9559475e209
5. Saad, Muhammad, Wenxiang, Liu. "National Security in Kautilya's Arthashastra: A Content Analysis". 'AI Publications', 2020, https://core.ac.uk/download/pdf/326758114.pdf
6. Dabak, Eshan. "Madness Then, Insanity Now: The Evolution of Madness and Medicine in India from Ancient to Modern Times". 2018, https://core.ac.uk/download/211344218.pdf
7. Willett, Anthony B. J.. "Indigenous knowledge and its implication for agricultural development and agricultural education: a case study of the Vedic tradition in Nepal". Iowa State University Digital Repository, 1993, https://core.ac.uk/download/38900431.pdf
8. Abbasi, Ali, Basham, Cappelli, Chen, Edwina Pio, Gulati, et al.. "Sacred activism through seva and khidmat: Contextualising management and organisations in South Asia". 'Cambridge University Press (CUP)', 2014, https://core.ac.uk/download/30732395.pdf

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English language teaching and language

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ABSTRACT

English language is not only taught as compulsory subject at schools, colleges and universities but also used as medium of instruction in some government school and other field. Teaching English language requires not only the skill, knowledge of subject, methods and strategies but also infrastructural facilities like language laboratory, teaching aids, teaching learning materials and teacher's resources books and audio-visual aid etc. The effective teaching and learning is depends on use of suitable teaching aids and teachers competence. There are many methods emerged in the 21st century for teaching and learning of English language. Teaching English language becomes challenging for teachers at school education system in India. The present study focused on English language teaching and learning.

Keywords: Educational system, English language teaching, language learning, teacher, teaching aids.

I. INTRODUCTION

It is now nearly 400years since the English language came to India with the British. As colonial subjects we had no other but to learn English. It is often it has been almost two centuries that English education was introduced in India and since then it has been playing an important role in our lives,not to mention our educational system. It is generally held that the British introduced English in our educational system in order to produce cheap clerks for their colonial administration and to produce what Lord Macaulay called "a class of people, Indian in blood and colors, but English in taste, in opinions, in morals and in intellect" (Baruah, 1984).Raja gopala chary said that English was the gift of Goddess Saraswathi to Indian and that in our anger and hatred we should not throw away the baby(English) with the bath water (the English people) (Ramakrishna, 2007).

Jawaharlal Nehru opined, "If you push out English, does Hindi fully take its place? I hope it will. But I wish to avoid the danger of one unifying factor being pushed out without another unifying factor fully taking its place. In that event there will be a gap. The creation of any such gap or hiatus must be avoided at all costs. It is this that leads me to the conclusion that English is likely to have an important place in the foreseeable future" (Nayyer, 2004). Hence the English language is given more importance to study in education.

II.ROLE AND IMPORTANCE OF ENGLISH LANGUAGE IN INDIA

English language has been recognized as important language in different ways such as a national link language, as an international link language and as a Library language. Majority of educated people use English language for speaking and reading throughout the world. The statistics collected by David Crystal (1997:61) shows that nearly 670 million people use English with fluency and competency. Most of the countries in the world whosemother tongue is not English learn this as a second language. In India, English is used different sectors like Administration, Judicature, Legislature

and Commerce etc. It is used still as a medium of instruction in Medicine, Engineering, Science and Technology etc.

According to Sharma(2011), the importance of teaching English India states:

i. English has today be come one of the major language so the world.
ii. It will be very difficult to neglect English language be cause of rich Literature, Scientific and Technic alnature of the language.
iii. Englis his given access to the treasure of knowledge.
iv. It provide support unities to Indians to get employment through out India.
v. It provides a strong binding force to keep all Indians united.

III.DIFFERENCE BET WEEN FIRST LANGUAGE AND SECOND LANGUAGE

Language is a unique characteristic of human beings. It is the vehicle of thought. Many linguists may think oflanguage only as a combination of words and phrases and sentences based on aset of grammatical rules thereare many different languages are spoken in the world. The different languages are used all over the world. Thereare many varieties within the language. Cambridge International Dictionary of English (1995) defines the term"Language" as: A system of communication consisting of small and set of rules which decide the ways in whichthese parts can be combined to produce messages that have meaning. Sapir described, "Language is a purelyhuman and non-instinctive method of communicating ideas, emotions, and desires by means of a system ofvoluntarily produced symbols". According to Parel (2008), the first language is defined it is the language that anindividual has acquired when he was child as a part of natural process of acquiring language without any formaltraining. It is referred as mother tongue (L1). The term second language can be defined as when a child learns a language systematically or he is given particular training for it is called second language. It is referred as(L2).

IV. ENGLISH LANGUAGE TEACHING IN INDIA

The British introduced the English system of education in India in 1935. It was the language used by British administration and thus politically imposed on the Indian educational system. English was taught as a compulsory subject. Though it was a burden for the Indian people during those times, now it has turned to be a blessing in disguise.

In India, English was taught in a number of ways and circumstances. Various states have devised their own educational policies, incorporating English as a second language, or giving it the status of a foreign language. However, it continues to be taught at various levels all over the country. The Education commission has recommended that the study of English as a co-language should be compulsory up to class X. English may therefore be taught as a compulsory subject at school level and made an optional subject thereafter.

Major trends in 21st century language teaching include the Oral Approach, Situational language teaching, the Audio-Lingual method and the alternative approaches and methods which include the Silent-way method, Total Physical Response method, Suggest- Pedia, Neuro - linguistic programming, the Lexical Approach as well as competency based language teaching. The current approach in language teaching is known as Communicative Approach. It includes communicative language teaching, the natural approach, cooperative language learning, content-based instruction and task based language learning.

V. TEACHING ENGLISH LANGUAGE IS NOT AN EASY TASK

Teaching English language is not an easy task, it requires the teachers to have ability to use methods and approaches and teaching aids. Teacher has to play many roles in the classroom. One side teachers have to focuson teaching the lesson at understanding level of students. Another side they have to complete the syllabus giventime andassess the learningof the students in the classroom. If classroom is observed, there can be find variation among the students competency. Teachers necessary keep it mind before prepare lesson plan. A par from that time factor and infrastructure, resources are mostly necessary things for teaching language in the classroom. Language is not subject, like chemistry, mathematics but it is skill oriented where practice is needed to acquire skills of language. All main basic skills of language like Listening, Speaking,

Reading and Writing are integrated. Most of the studies conducted on the areas of methods of teaching, diagnosis the learning difficulties, teaching Grammar, Spelling, and Pronunciation etc. However few studies revealed that majority of the teachers were not professionally equipped to teach English.

Majority of teachers were not aware of appropriate methods of teaching English in the classroom. Teachers felt that size of classroom, lack of resources, and quantum of workload affected the teaching in the class room. Considering these facts, it is very much necessary to find out problems in teaching English with respect to school related, availability of instructional resources, background of teachers, methods of teaching English and teachers experiences. This particular study tries to shower light on some of the issues and thus found to be significant. The present study has been confined to rural areas of Upper primary and Secondary schools.

CONCLUSION

VI. ENGLISH LANGUAGE LEARNING AND METHODS TO OVER COME THE PROBLEMS

- Teacher's resource books and text books should be provided in time to teachers and students respectively. Language laboratory should be set up to develop language skills in The students.
- The Course book should be made to develop language skills in the students.
- Teachers should be trained and encouraged to employ new methods and approaches to teach English language.

References :-

[1] APSCF,(2011).Andhra Pradesh State Curriculum Frame work. Hyderabad : SCERT.

[2] Bhattarcharjee, (1984).A study to investigate the Teaching of English Higher Secondary School of East.

[3] Khasi Hills. In M.B Buch, (1978-1983),Fourth Survey of Research in Education, New Delhi: NCERT.

[4] Baruah, T.C.(1991).The English Teacher's Hand book. New Delhi :Sterling Publishers Private Limited.

[5] Nayyer Shamshi, (2004).Modern Teaching of English. New Delhi: Anmol publications Private Limited.

[6] Government of India.(1964-1966).Report of Education Commission. New Delhi: GOI.

[7] Government of India. (1968).National Policy on Education. New Delhi: GOI.

[8] Krashan, S.(1981), Second language acquisition and second language learning, oxford: per gam on. In

[9] Richard, C.Jack Rodgers, S. Theodore. (2001), Approach and Methods in language teaching. [10] Cambridge University Press.

[11] NCERT.(2000).National Curriculum Frame work for school Education. New Delhi: NCERT.

[12] NCERT.(2005).National curriculum Frame work for school Education. New Delhi: NCERT.

[13] Parel, M. (2008). English Language Teaching, (Methods, Tools and Techniques). Jaipur: Sunrise Publishers Pt.Lt

[14] Prem Shankar(2003). Teaching of English, New Delhi, APH Publishing Corporation.

[15] Sivarajan, K.,Ramakrishnan, T.V.,& Mridula, K. (2008).EnglishL an guage Education. [16] Calicut: Calicut University publishers.

[17] Sharma, A. (2011). Importance of Teaching English in India.Retrieved from http://www.preservearticles.com/201102244205/what-is-the-importance-of-teaching-english-inindia.html

[18] Sind khedkar, S.D. (2012).Objectives of Teaching and Learning English in India. Journal of Arts, Science & Commerce, (3)(1), ISSN 2231-4172. Retrieved from www.researchersworld.com.