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Chapter - 1

Coffee Production and Export Performance of India: A Statistical Analysis

Pallabi Medhi, Gyandeep Sharma and Amisha Kundu

Abstract

This research examines the trends and patterns of coffee cultivation, output, and trade in the global market. Secondary data on the area, yield, and output of coffee from 1990-91 to 2021-22, and the quantity, value, and per unit value of coffee exports by India from 1995-96 to 2021-22. Non-parametric Mann-Kendell's test is used to detect any trends in the data. For significant value of test statistic, exponential curve fitting to the variable is done and the compound annual growth rate (CAGR) is computed. The results show that the CAGRs for area, output, export quantity, export value, and unit value are 1.79%, 1.94%, 2.96%, 7.71%, and 4.57% respectively. We use the export performance ratio (EPR) to measure the comparative advantage of coffee over other commodities. The outcome indicates that coffee has a stable and positive variation trend in the export performance ratio.

Keywords: Coffee, trend analysis, export performance ratio, production

1. Introduction

Coffee is a remarkable commodity in terms of both quantity and value in the domestic and international markets. The main producers of coffee are developing countries, while the major consumers are from developed nations. Coffee was first introduced to India from Yemen in 1600 AD and planted in the high hills of Baba Budan's Courtyard, Chikmagalur district of Karnataka. The first commercial cultivation of coffee began in the 18th century by British entrepreneurs in South India. India grows mainly two species of coffee: Arabica and Robusta. Arabica is a mild coffee with more aroma and higher market value than Robusta. Robusta, on the other hand, is a strong coffee with higher caffeine content and a bitter taste.

India produced 360,500 metric tonnes (MT) of coffee in 2022, accounting for 3.41% of the world's total coffee production and ranking as

the seventh largest coffee producer in the world. India grows both Robusta and Arabica varieties of coffee, with a ratio of 67:33. Coffee is traditionally grown in the southern states of India, namely Karnataka, Kerala and Tamil Nadu. Karnataka was the leading coffee producer in 2022, with 254,575 MT (70.6%) of the total output, followed by Kerala with 73,750 MT (20.5%) and Tamil Nadu with 19,340 MT (5.4%). Non-traditional coffee is also cultivated in Andhra Pradesh, Odisha and the North Eastern States of India, with a combined production of 12,675 MT (3.5%) in 2022, of which 12,210 MT came from Andhra Pradesh, 465 MT from Odisha and 160 MT from North Eastern Region.

About 65-70% of the total coffee production in India is exported to various countries. India's share in the global coffee exports is 5.11%, with Italy, Germany, Russia, Belgium and USA being the top five importers of Indian coffee. Indian Robusta coffee has a high market value in the international market due to its good blending quality.

Coffee is an export product with a low import intensity and high employment content. More than six lakh persons are directly employed, and an equal number of individuals get indirectly get employed from this sector

2. Objective

The present study has been conducted with the following specific objectives

i) To compare the variety of coffee in terms of area, production, productivity graphically.

ii) To examine the trend area, production, yield, export quantity, export value and per unit export value of coffee in India.

iii) To analyse the Export Performance of coffee in India.

3. Data source

Secondary data from the Coffee Board of India for the period of 1990-2022 was used in this study. The Coffee Board of India is an organisation managed by Ministry of Commerce and Industry, Govt. of India to promote coffee production in India. The data was downloaded from this website on 15 September, 2023.

4. Review of literature

Statistical analysis of area, production and productivity of coffee in India. It reviews the past and present studies related to this topic as it is quite significant in nature to understand the concepts.

- Kumareswaram T, Singh HP, Kamalvanshi V, Sharma A and Kumar D (2019) used the concept of export performance ratio (EPR) of coffee in India, which is a measure of international trade specialization and identifies the comparative advantage or disadvantage a country has for a commodity with respect to another country or group of countries or the world.
- Soujanya C.K., Venkataramana M. N and Pradeepa Babu B. N. (2023) uses compound annual growth rates (CAGR) to estimate the relative change in the area, production, and productivity of coffee across five major coffee-producing countries *viz*. Brazil, Colombia, Honduras, Indonesia, and Vietnam and India. The authors also use trend lines to observe the fluctuations in the area, production, and productivity of coffee across the countries from 1961 to 2020. Additionally, the paper calculates an instability index for the area, production, and productivity of coffee in major coffee-producing countries.
- Balakrishnan M, Chandran K (2018) examines the impact of coffee production on the country's economy and environment, as well as the challenges faced by small scale farmers. Authors used the exponential growth function and the method of least squares to estimate the growth in area, production, productivity, quantity exported, export value, and unit value realized from exports. They also used the compound growth rate formula to compute the growth rate of coffee exports for two periods: the pre-WTO period (1980-1981 to 1990-1991) and the post-WTO period (1991-92 to 2015-2016).
- Nsabimana, A., & Tirkaso, W. T. (2020) examines the impact and implications of preferential trade agreements on coffee export performance in Eastern and Southern African countries. Both static and dynamic gravity model specifications to analyse the effects of trade agreements on social-economic growth.
- Ahmadzai, A. B., Sidana, B. K., & Guleria, A. (2022) examines the growth performance and share of coffee in agricultural export from 2000-01 to 2016–17 in India. The authors collected data on the quantity of coffee exports from 2005-06 to 2016-17 and used first-order Markov chain analysis to examine the direction of trade and changing pattern of coffee exports.

5. Methodology

Here, we employ the following methods:-

a) Trend analysis: To determine the general tendency of the data to increase or decrease over a long time we perform trend analysis. To describe the given data, we use an exponential curve and its parameters are obtained using the least square principle.

$$y_t = mn^t \quad \ldots (1)$$

Where, y_t denote the area, production, productivity, export quantity and export value.

t denote year

m and n are constants to be determined using the least squares method

Taking natural logarithm on both sides of equation (1) we get

$$\log y_t = \log m + t \log n$$

This facilitates the use of linear regression (Goon, Gupta and Dasgupta, 2016, p. 317)

b) Compound growth rate: The compound growth rate 'r' is given by

$$\mathrm{CGR(r)} = [\mathrm{antilog(logn)} - 1] \times 100$$

(Kumareswaran *et al*, 2018)

c) Mann Kendall's test statistic: The trend tests were conducted using the non-parametric Mann Kendell's trend test, which is less influenced by outliers. This test identifies trends in a time series without determining if the trend is linear or non-linear. The statistic for the Mann Kendell's test is provided as follows:

$$S = \sum_{i=1}^{N-1} * \sum_{j=i+1}^{N} \mathrm{sgn}(y_j - y_i)$$

Where, S is the Mann Kendell's test statistics

y_i and y_j are the sequential data values of the time series in years i and j (j>i)

N is the length of the time series

A positive value of S indicates an increasing trend, whereas negative value indicates a decreasing trend. The signum function is given by

$$\mathrm{sgn}(x_j - x_i) = \begin{cases} 1 \text{ if } (y_j - y_i) > 0 \\ 0 \text{ if } (y_j - y_i) = 0 \\ -1 \text{ if } (y_j - y_i) < 0 \end{cases}$$

The variance of S, for the situation where there may be ties (i.e., equal values) in x is given by

$$\mathrm{Var}(s) = \frac{1}{18}[n(n-1)(2n+5) - \sum_{i=1}^{m} k_i(k_i-1)(2k_i+5)$$

Where, m is the number of groups in the dataset

k_i is the number of data points in the i th tied group.

For n>10, Z_{MK} approximates the standard normal distribution and is computed as follows:

$$Z_{MK} = \begin{cases} \frac{S-1}{\sqrt{\mathrm{var}(S)}} \text{ if } S > 0 \\ 0 \text{ if } S = 0 \\ \frac{S+1}{\sqrt{\mathrm{var}(S)}} \text{ if } S < 0 \end{cases}$$

The presence of a significant trend is evaluated using Z_{MK} value. In two-sided test for trend, the null hypothesis H_0 should be accepted if $Z_{MK} < Z_{1-\alpha/2}$ at a given level of significance. $Z_{1-\alpha/2}$ is the critical value of Z_{MK} from the standard normal table. (Kamal & Pachauri, 2018)

d) Export performance ratio (EPR): EPR is a ratio that shows how well a country can export coffee compared to other countries. It is calculated by dividing the percentage of global coffee exports that come from the country by the percentage of global coffee production that comes from the country. If EPR is more than 1, it means that the country is good at exporting coffee. If EPR is less than 1, it means that the country is not good at exporting coffee. The formula for EPR is:

"$EPR_i = ((Ei/CE))/(Wi/WE)$

Ei = Export of coffee commodity from India.

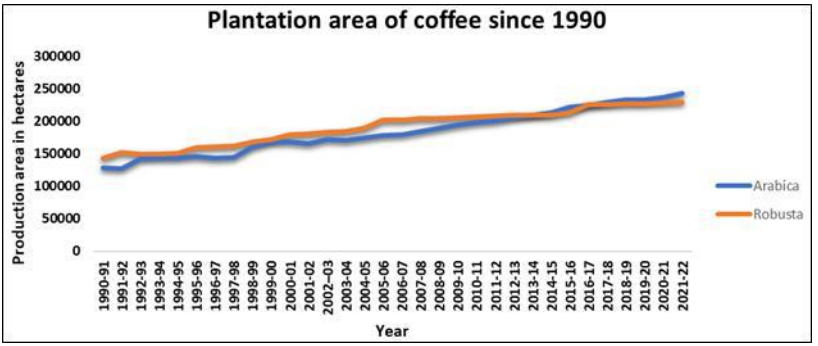
CE = Aggregate export of agricultural products from India.

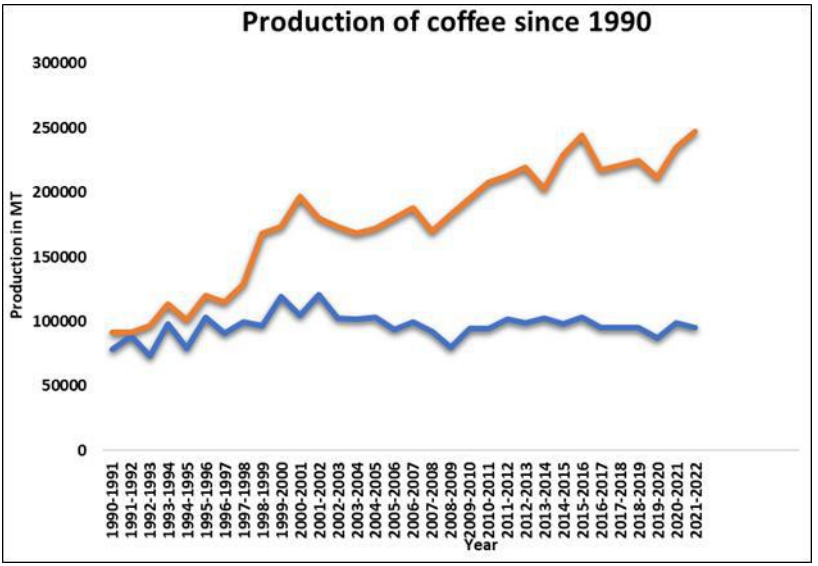
Wi = Total world exports of coffee commodity products.

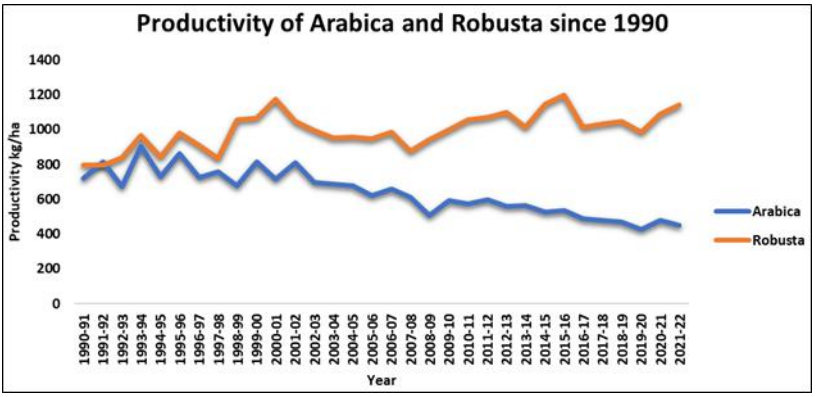
WE = Total world exports of all agricultural products" (Kumareswaran *et al*, 2018).

6. Results and discussion

6.1 Comparison of coffee varieties graphically

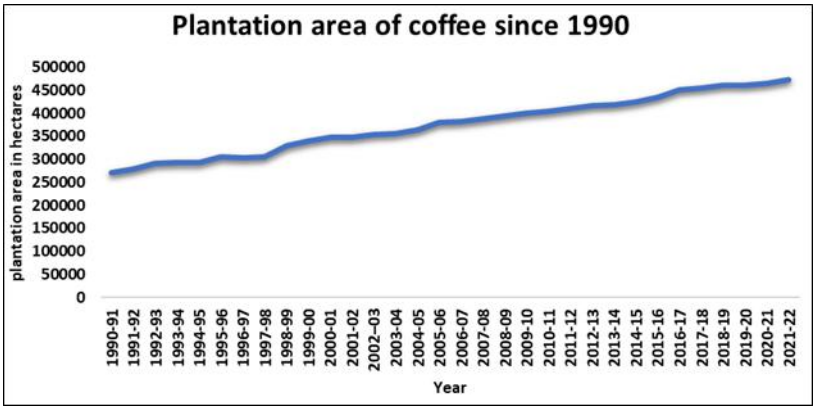


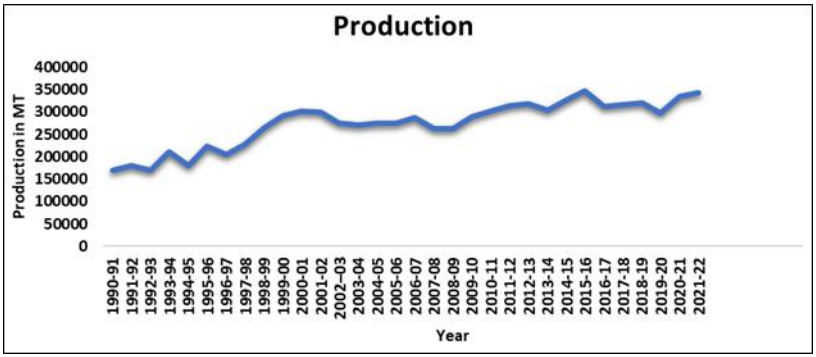


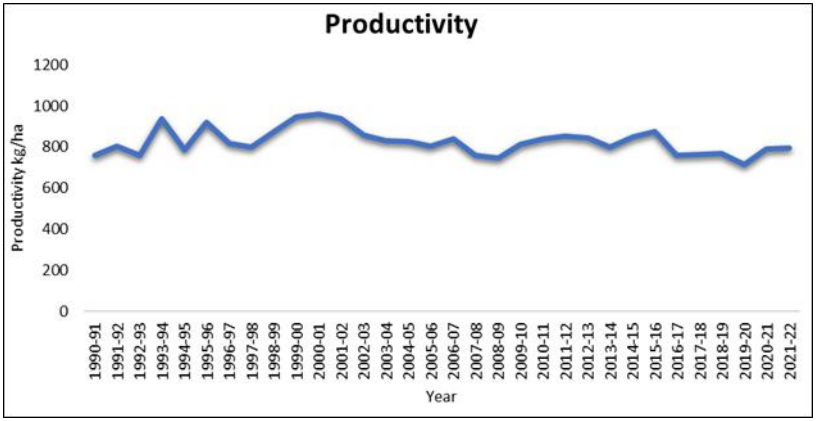


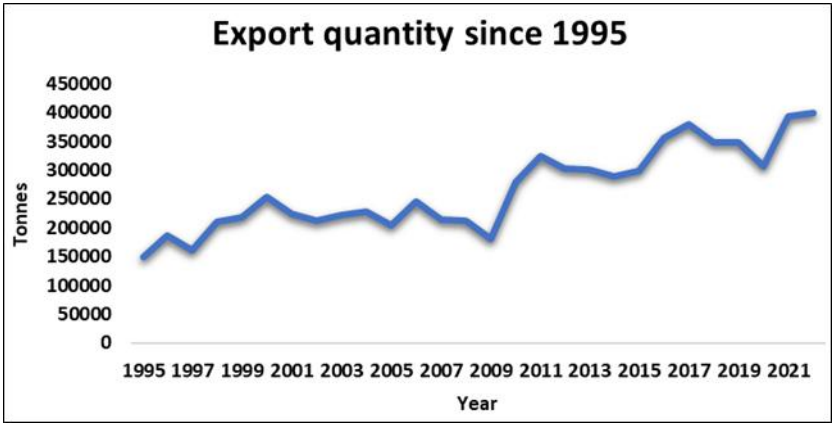
From the above three graphs we can see that the plantation area of coffee for both species of coffee has been almost same since 1990, but the production and productivity have a stark difference. This suggests that the climate of India is more suitable for Robusta than Arabica.

6.2 Trend analysis

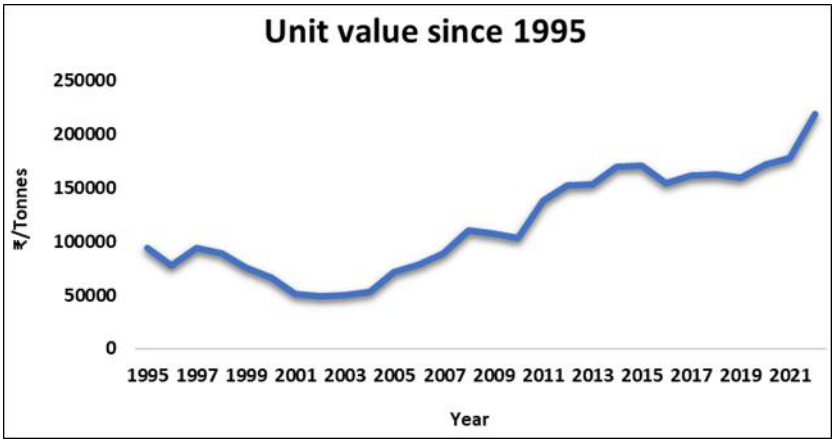







Export quantity since 1995
Tonnes
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
1995 1997 1999 2001 2003 2005 2007 2009 2011 2013 2015 2017 2019 2021
Year


Export value since 1995
₹ Crores
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1995 1997 1999 2001 2003 2005 2007 2009 2011 2013 2015 2017 2019 2021
Year


Unit value since 1995
₹/Tonnes
250000
200000
150000
100000
50000
0
1995 1997 1999 2001 2003 2005 2007 2009 2011 2013 2015 2017 2019 2021
Year

From the above diagrams, we see that the plantation area, coffee production, export quantity, export value and unit value have increased significantly over the past year and it seems there exists some trend. However, the productivity of coffee remains almost constant over years.

To test hypothesis for existence of trend for plantation area, production, productivity, export quantity, export value and unit value of coffee we frame the following null and alterative hypothesis which are given below:

H_{01}: There is no trend for plantation area.

H_{11}: There is trend for plantation area.

In similar way we frame null and alternative hypothesis for the other variables. The results of Mann Kendell's test statistic are given for each variable in the table below:

Variables	Test statistic (S)	Var (S)	τ	p-value
Plantation area	492	3802.67	0.99	1.689e-15**
Production	358	3802.67	0.72	7.069e-09**
Productivity	-84	3800.67	-0.17	0.1782
Export quantity	256	2562	0.68	4.706e-07**
Export value	294	2562	0.78	7.095e-09**
Export unit vale	252	2562	0.67	7.09e-07**

** indicates significance at 1% level of significance

To check for the estimation of exponential trend component we frame the following null and alternative hypothesis

$H`_{01}$: The slope coefficient of the model is 0.

$H`_{11}$: The slope coefficient of the model is non zero.

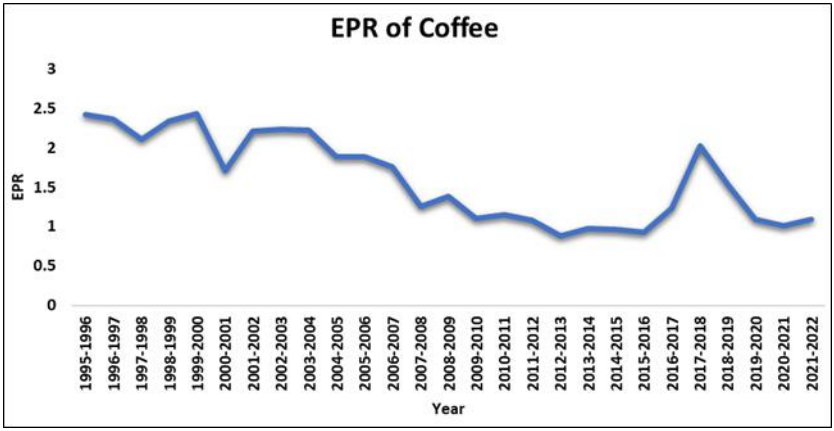
Similarly, the null and alternative hypothesis of the other variables can be framed. The p-value of ANOVA test along with other important measures are given in the table below:

Variables	R^2	Slope	Intercept	p-value	CAGR
Area	0.9841**	1.783e-02	-2.294e+01	2.2e-16**	1.799066
Production	0.7424**	0.019263	-26.132287	2.423e-10**	1.944989
Export quantity (Tonne)	0.78**	0.029520	-46.835800	3.001e-10**	2.996039
Export value (₹ crores)	0.8236**	7.427e-02	-1.413e+02	1.65e-11**	7.710296
Realized unit value (₹/tonne)	0.6746**	0.044755	-78.320602	8.494e-08**	4.577148

** indicates significance at 1% level of significant.

6.3 Export performance ratio (EPR) of coffee

Sl. No.	Year	EPR of coffee
1.	1995-1996	2.42
2.	1996-1997	2.36
3.	1997-1998	2.11
4.	1998-1999	2.34
5.	1999-2000	2.43
6.	2000-2001	1.71
7.	2001-2002	2.21
8.	2002-2003	2.24
9.	2003-2004	2.22
10.	2004-2005	1.88
11.	2005-2006	1.89
12.	2006-2007	1.76
13.	2007-2008	1.26
14.	2008-2009	1.38
15.	2009-2010	1.10
16.	2010-2011	1.15
17.	2011-2012	1.08
18.	2012-2013	0.88
19.	2013-2014	0.98
20.	2014-2015	0.96
21.	2015-2016	0.93
22.	2016-2017	1.23
23.	2017-2018	2.02
24.	2018-2019	1.54
25.	2019-2020	1.09
26.	2020-2021	1.01
27.	2021-2022	1.09



From the graph we observe that there is fluctuation of EPR in our study. From 1995-1996 to 2011-2012 the EPR of coffee was greater than 1 indicating that India has more comparative advantage than other countries. From 2012-2013 to 2015-2016 the EPR was less than 1 indicating that India has less advantage in exports in comparison to other countries. After 2015-2016 the EPR remains above 1. Overall, there is a positive stable trend in EPR.

7. Conclusion

Coffee is primarily an export-oriented commodity, contributing significantly to India's foreign exchange reserves. As a flourishing coffee exporter, India has witnessed positive growth rates in plantation area, production, export quantity, and per-unit export value, indicative of a promising trend. Nevertheless, coffee productivity has remained stagnant over the years, warranting improvements through the adoption of new technologies and cultivation practices in coffee-growing regions. The Export Performance Ratio (EPR) reflects fluctuations attributable to the increasing number of global coffee exporters. To address this issue, the government can provide crucial support to farmers through financial assistance, boost industry associations, and offer risk-mitigating insurance options. Furthermore, exporters stand to gain from government efforts to negotiate favourable trade agreements with coffee-importing nations.

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Chapter - 2
Gender Issues Reflected in Indian Cinema: From Post Independent Period to Present Times

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Chapter - 2

Gender Issues Reflected in Indian Cinema: From Post Independent period to Present Times

Dr. Vijay Songire and Dr. Kamalakar Gaikwad

Abstract

Cinema being one of the most attractive audio visual aids proved as a comfortable medium for entertainment. But its role is not limited to entertainment. Indian Cinema is instrumental in bringing forth the realities of contemporary society to the limelight. As a genre, Cinema is a mixture of fantasy and reality. Indian Cinema right from its inception delved into the reality of contemporary society. The present paper investigates gender issues reflected in the Indian Cinema from the Post Independent era till present times. The attempt of the paper is to identify the different issues faced by women which were well reflected in the cinema and its overall impact upon the common masses. Furthermore, the paper deliberately looks into the changing images of women portrayed in Indian Cinema. The objective of the paper is to show how cinema and society are complementary to each other and their relationship is reciprocal. Most importantly, the paper discusses the female characters from few iconic movies which transformed the roles of women in Indian cinema as well as it broke the stereotypes of women in Indian society.

Keywords: Indian cinema, female characters, feminism, patriarchy, gender discrimination, images of women, etc.

1. Introduction

The 1920s witnessed a significant transformation in Indian cinema. The medium evolved from silent films to talkies, amplifying its reach and influence. This change was welcome with all excitement by the audience. Dadasaheb Phalke who is honoured as the father of Indian cinema produced the first Indian feature film called Raja Harishchandra (1913). His contribution to Indian cinema is noteworthy. He went to Nasik and established Hindustan Film Company and produced films like *Sri Krishna Janma, Mohini Bhasmasura, Satyavan Savitri, Lankadahan, Kalimardhan, Setu Bandhan* and so on. He produced about 45 feature films and 16 small films during 1913-

1932 and provided a solid foundation for the growth of the Indian film industry. Another producer Baburao Painter was greatly influenced by the cinematic works of Phalke and established Maharashtra Film Company which contributed about 200 film technicians. A new age of talkie films began in India in 1929. Ardeshir Irani produced the first talkie film namely Alam Ara in 1931 which was a landmark incident in the history of cinema. During the 1940s there were prominent filmmakers who contributed to the development of cinema such as Sohrab Modi, Master Vinayaka, Bimal Roy, Pritwi Raj Kapur etc.

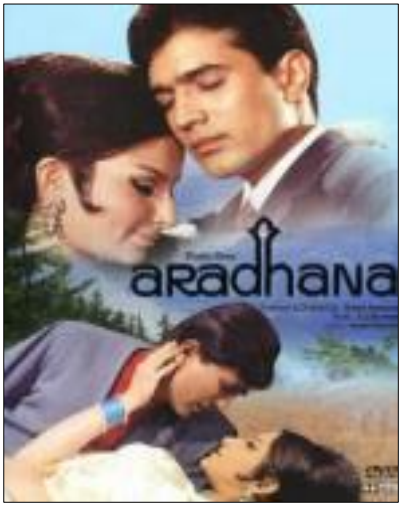
2. Gender Issues in Indian Cinema: 1950s to 1980s

Mother India is a classic film coming from the early era of Indian Cinema. It was a path-breaking film of its time. It is considered to be one of Nargis Dutt's most impressive and iconic performances. Nargis as Radha is a poor villager who fights against all odds to raise her two sons. She is looked upon as the epitome of justice and a god-like figure by the villagers. Staying true to her principles, she kills her immoral son for justice's sake. The second half of the film shows Radha as a typical mother who showers her love and affection on her grown sons. Her son Birjoo turns into a dacoit but is protected by Radha who tries to plead for forgiveness from the villagers. But when Birjoo abducts a woman from her marriage, Radha takes a stand and tells him to return the girl or she will shoot him. Radha's act of unity with the girl being abducted is not because of any attachment but an act of unity with the whole of womanhood.

Mother India was a path-breaking film of the early cinema. In this film Nargis as Radha, who is a poor villager, fights against all odds to raise her

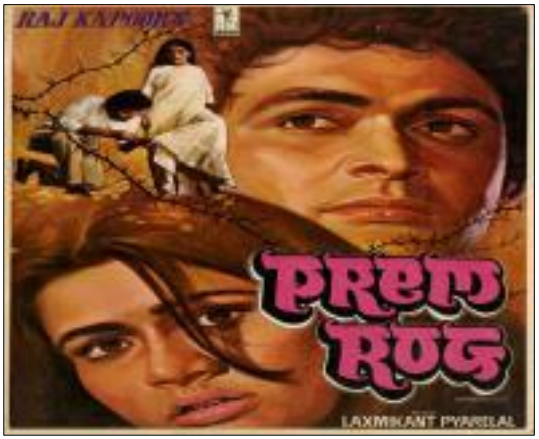
sons. She is looked upon as the example of justice. Staying true to her principles, she killed her immoral son for justice's sake. Movie Astitva unveils issues that are unspoken of in the society like extramarital affairs and spousal abuse. This film speaks about a woman who tries to find her own identity outside her marriage and finally moves away from her husband and son.

As Geetanjali Chandra writes, "The movie transcends its time by promoting the idea of equality in male and female characteristics by depicting Nargis as a nurturing yet one with valour (Chakravarty, 1993). In addition to being high on gush of emotions, the movie brought various social issues into limelight that modern India faces even today such as extortion, poverty and lack of education. The movie also emphasised on keeping justice and honesty above all" [1]. In the classical Bollywood only some of the movies were based in which women were portrayed as strong and empowered. In early cinema we can see that a secondary position is imposed on women by strong environmental forces of society and they are shown to be oppressed by various societal pressures. In fact, these women were presented from the male point of view in that women cannot have a respectable or independent identity without being under the protection and control of men. Examples: - Aradhana (1969), Pakeezah (1971), Nikaah (1982), and UmraoJaan (1982).



The movie Aradhana by Shakti Samanta celebrates the theme of woman's sacrifice which she makes for all wellness to her family. The woman protagonist in the novel goes through all hardships and it shows the secondary position of women too in the society. After her husband's demise her life becomes challenging. Pakeezah, the move which is successful to show the

wretched condition of women under the falsehood and double standard of patriarchy. It brings forth the issues of the women community who are called *Tawaaif*. Men who enjoy the beauty and flesh of women in their frequent visits to the prostitutes. However, the traditional families do not accept Tawaaif as a wife and she is not given respect as other women. B.R Chopra's Nikaah is another movie which again attacks upon male hegemony which considers women as objects. B.R Chopra makes a social comment on the sharia laws of divorce (Talaq) and its misuse in Indian Muslim society. Haider and Nilofar are students at Osmania University. Haider, an aspiring poet, falls in love with Nilofar without knowing she is already engaged to Wasim, who is a Nawab. The issue of exploitation of women due to the social conventions like Talak became a focal point of the movie. The female protagonist takes a strong stand against this exploitation and refuses to remarry with the first husband. Nikaah and Umrao Jan are also movies which talk about female subjugation. In Nikaah the female is a victim of age old tradition.



Prem Rog (1982) a movie directed by Raj Kapoor was a big success commercially. It was a perfect blend of a moving story, melodious music, with its unforgettable star cast. It unfolds the harsh reality of Indian widows in villages who don't have good fortune after their husband's funeral. The movie unfolds the truth in Indian society where a woman's life is secondary and she is compelled to follow the codes and conducts set by the society. The females in this movie are shown as victims of patriarchy. Similarly, the women portrayed in *Maine Pyar Kiya, Kayamat se Kayamat Tak, Chandani* though look literate and well settled they remain dominated under patriarchy and never show courage to break the social norms. Srijita Sarkar in her thesis, An analysis of Hindi women-centric films in India quotes Saltz as, "When Americans think of Indian cinema they most likely think of classic Bollywood:

movie stars dripping with old- fashioned glamour, long films with improbable plots improbably interrupted by song-and-dance sequences (and never by kissing). And if Americans think at all about the other Indian cinema- often called the parallel cinema- they probably think of the lyrical naturalism of Satyajit Ray, whose greatest films were made a decade ago." (Sarkar, 2012) [2]. With the changing scenario of the society the portrayal of women too changed.

Mirch Masala (1987) directed by Ketan Mehta in 1989, showing this changing role of women in Indian cinema. A story of Sonbai (Smita Patil) working in a chilli factory in the western part of pre-independence India. Her husband gets a job in the railways and leaves for the city. In the meantime the Subedar (or tax collector, played by Naseeruddin Shah) arrives to collect taxes and is attracted by Sonbai. He asks the village headman, the Mukhi, to bring her but the headman brings the wrong woman. The next day Sonbai passes by the Subedar's camp where she is stopped and grabbed by the Subedar. She frees herself and runs into the chilli factory where she works. An old Muslim watchman Abu Miyan (Om Puri) provides her with the protection. A parallel track is of Mukhi's wife, the Mukhiain, who is not treated well by her husband. She tries to get support for Sonbai after learning that the males of the village including her own husband who allied with the Subedar to hand over Sonbai to him. Mukhiain's protest is rudely crushed by the men, and the Subedar, accompanied by all the men of the village, reaches the factory, breaking the factory doors, killing the watchman. In the final scene the Subedar approaches Sonbai when suddenly the other women in the factory throw bags of chilli powder on his face. The movies tell about the helplessness of women in patriarchal set up where they are treated as objects of wish fulfilment.

The 1980's began to witness a shift in the psyche of women characters, who displayed a need to break free of their environments, thereby rising above what is traditionally expected of Indian women, namely to show tolerance

toward society and men, even when unjustly treated. In the early 1980s, women characters were portrayed as fending more for themselves and also making independent choices regarding their marital partners and work [3]. (Ayob, 2008) Women try to assert their identity. They do want to make their career and do succeed in their endeavours. But they have limitations and they are also treated as secondary.

As Pooja Rai asserts in her thesis, "Women are denied access to power and socio-economic status which is generally given to men. Women alone are expected to assume responsibility for household work. No matter how major a female succeeds in athletics, business, science and technology or business, society always expects a woman to be responsible for carrying out all household duties because of her gender. The socio-economic, cultural and religious influences establish a psychological perception regime that finds a woman more vulnerable than a man and that is why any part of society treats women as secondary" [4].

3. Women Portrayal in Indian Cinema: 1990s and onwards

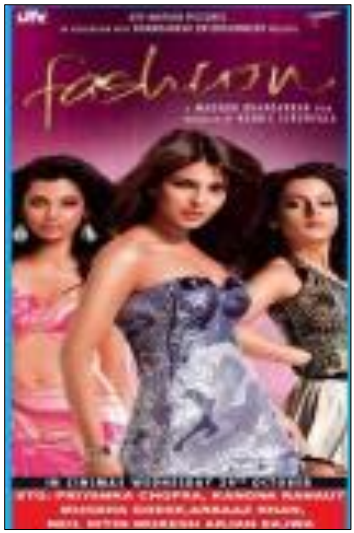
Dil To Pagal Hai, *Hum Dil De Chuke Sanam*, *Raja Hindustani*, *Hum Aapke Hain Kaun*, *Dilwale Dulhania Le Jayenge* etc. In the movies mentioned above, the females are shown as passive characters. They are expected to follow certain traditions. They themselves agree to those norms and they are not even aware about their subordinate status in the society. The males are given more importance. The story moves around the decisions made by heroes and not the heroines. In *Dil to Pagal Hai* which moves around a love triangle. It offers the audience with a blending of musical feast and eye-catching scenery amidst the love relationship. But the women portrayed in the movie are the same who believe in family traditions and they do not want to go beyond the confines of family. Both Pooja and Nisha are the major female characters who love their friend Rahul who is a choreographer. At the end we see a union of Rahul and Pooja with the consent of the family. Nisha who wants to build up her career in dancing later in the failure in love relationship aspires dancing. Most importantly, here there is no more scope for female characters for development. They are stereotypes and treated as subordinates. In *Hum Dil De Chuke Sanam* also the female character is treated in not a mature manner. A female character, Nandini who is in love with the Italian singer. However, she is not allowed by her father to marry him and her marriage is engaged with Vanraj. As the story moves ahead, it is found that though she is married she does not forget Sameer, her lover and despises her own husband. Her lover, Sameer too sends letters to her. One day all letters sent by Sameer are found to Nandini and her husband. Vanraj, who is genuinely in love with her wife, understands her feelings and promises her that

he will help both of them to unite together. They both leave for Italy. After a long investigation they find Sameer. However, the moments Nandini lived with her husband Vanraj remain unforgettable for her and she deserts her lover thereafter. As Ruchi Agarwal writes in her article "Changing Roles of Women in Indian Cinema".

…women appear to have lost the space they had created for themselves. As films became more shiny and hi-tech, the heroes took centre stage and the heroines remained more of a glamour component. Their presence did nothing to move the story forward. The more India became global the more the Bollywood films regressed. Some of the hit films of the post-liberalization, in the 1990s, showed a desire for a traditional way of life when women kept their homes and men earned the bread [5].

The women in Indian cinema during the 1990s were educated and from well to do families. However, their roles were limited to fulfil the desires of their family members. They could not raise their voices against their parents. They remained silent instead of their potential to face the situation.

4. Women in Indian Cinema at present



The movie Fashion (2008) tells the dark truth of the fashion industry where the females who want to make their career in modelling are humiliated sexually. It is a story of aspiring model Meghna Mathur (Priyanka Chopra Jonas) who wants to go to Mumbai and become a supermodel. Against her father's wishes who wants her to become a Chartered Accountant, Meghna leaves her home to find success in the modelling world. At the end she loses

all her tie ups with not only her family but also her boyfriend who genuinely loves her. The movie successfully presents the hidden potential of women who can establish their own identity in a society if they are given freedom.

The movie *Dangal* (2016) renders the theme of gender equality. It makes everybody think that every girl should be given an opportunity equal to males. It gives a strong voice against established stereotypes which believe that certain professions are suitable to males but in reality it is not so. Therefore, Dangal becomes a path breaking movie which convinces us to rethink the unthinkable.

The movie *Pink* (2016) gives a strong voice against gender discrimination. A female central character who is a victim of assault takes a stand against the male oppressor. She takes help of an advocate for justice. The movie talks on women rights and her security concerns. It makes it very clear that women are not safe even in cities where people boast the tags like 'educated' and highly 'sophisticated'.

5. Conclusion

It is worth mentioning that Indian cinema has drastically transformed from the Mook Film to Digital ones. The roles of women too changed with passing times. The women who were shown as victims of patriarchy, social customs earlier in the 1960s to 1990s later emerged as central characters. They represent themselves as independent in the recent movies like fashion, Pink, Kahaani, English Vinglish, Raazi portray the voice of Indian rising women who do not want to limit their identity within the institutions of marriage and family. They want to assert their identity as female and as a whole not as 'other' or 'secondary' No doubt, Indian Cinema is successful in depicting the varied images, characters and roles of women in Indian society. However, there is scope for further improvement in women's characters who can truly assert their unique identity.

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Chapter - 3
Biblical Revelation of Human Psychology and Spiritual Convalescence through the Afflictions of Job, A Man of God

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Chapter - 3

Biblical Revelation of Human Psychology and Spiritual Convalescence through the Afflictions of Job, A Man of God

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Abstract

The present research is rightly called as 'trauma research' which deals with the theological elucidation of psychology and religious restoration through the tribulations of Job, a Man of God'. Psychological exploration in contemporary era has exposed various experiences of sufferings and thrashing. This research paper provides the appropriate insight to Job's experience of afflictions. Here the researcher would like to demonstrate the traits of Job from the perspective of psychological theory with spiritual healing with respect to trauma and religious responses to adversity**.** It focuses on the psychology of Job and his religious unshakable faith through divine healing.

The prime motive of this research paper is to investigate psychosomatic *speculation, s*tate of mind and consciousness of Job in affliction, substantial torment, spiritual healing, psyche, affliction, physical torture, spiritual resistance etc. Present research highlights the psychology and faith healing through the Bible and weaves together the perspectives with respect to psychosomatic theory and biblical investigation in a review of Job's experiences from preliminary disturbances through definitive reinstatement.

Keywords: Biblical interpretation, psychology, spiritual or faith healing, sufferings, tragedy

Introduction

The title of the research paper is: *'Biblical Revelation of Psychology and Spiritual Convalescence through the Afflictions of Job, A Man of God'.* Considering the significance of the title, it would be convenient to contemplate on the key terms of the present research paper such as psychology, spiritual or faith healing, sufferings, psyche, physical torture and blessings from God. These concepts will help the readers to comprehend the study in detail and enable them to figure out the mindset of Job, a man of God.

Psychology is the systematic analysis of psyche and human behaviour. It deals with the study of cognizant and non-conscious phenomenon, including emotions and feelings. It is an intellectual regulation of mammoth compass, crossing the limitations between the innate and social sciences.

Spiritual healing is the biblical concept which strictly adheres to divine faith. It testifies the faith of the believer. The healer fully believes that God is the best healer and he redeems us from every physical torment. It works like the everlasting energy and divine tonic. Here the believers experience self-healing. It overpowers the scientific rationale.

Faith healing, as the name suggests, is the trend of prayer. Here the priest lays his hands on the patient and prays for his spiritual health. The believers in Christianity believe that their diseases can be absolutely cured through their utmost faith. This faith healing, in fact, encourages a celestial supremacy and charisma in them. In today's contemporary era, scientists, thinkers, philosophers, doctors regard divine healing as a pseudo-science out of their methodical based approach.

Affliction is a foundation of unrelenting soreness or anguish. The word affliction is derivates from Latin word *'afflictare'* means to harass or to torment. The concept *'afflicted'* stands for impaired or stricken. Such person is mentally or physically unfit.

Psyche means mind or deeper feelings, beliefs and thoughts of a person. The word 'psyche' comes from the Greek word psyche means the soul, mind, spirit or imperceptible conscious creature which occupies the physical body.

Physical torture is the intentional imposition of rigorous hurting on a person as retribution, declaration of guilt, questioning for information or threatening third parties.

Materials and Research methodology

The data and information presented in this study were investigated, scrutinized and verified on the basis of theoretical and analytical aspects. The method employed for this study is practical oriented and based on practical considerations.

Literature review

Literature review is the critical aspect which analyses the earlier researcher's perspectives on the said topic. Here are some of the research articles which indeed offer the insight to the readers about the theoretical background of the study.

The research article depicts the story of Job, a man of God who was blameless and upright. He remains loyal to God even in the midst of terrible loss and deep sorrow. We witness Job's anguish in various forms, including the death of his children and servants, loss of property, and bodily sores. Job used foul language to his birth date and wished for his death.

In this research article, the narrator has delineated the focus on physical suffering, mental pain and despair, spiritual sense of being alone.

Interpretation of psychological and traumatic theory

Psychological theory assumes that:

Here the researcher mentions the mentality and psyche of Job in his sufferings. The biblical story of Job has its own significance which primarily focuses on his mentality and suffering with respect to psychology and spiritual healing. Job is the protagonist, God fearing person and a man of God who has the caliber to tolerate all kinds of sufferings.

He had seven sons and three daughters. Also, he had seven thousand sheep, three thousand camels, five hundred yoke of oxen, five hundred female donkeys and a very large household. He was one of the richest persons in the Eastern region. He would rise early in the morning and offer burnt offerings according to the number of his family. God gave him abundant blessings. God witnesses about Job, is the symbol of human sorrow in the context of religious faith. Job is the ideal example of human suffering and epitome of our misery. In a real sense, he is the portrayal of traumatic stressor. He faces several unexpected calamities in his life such as threat, physical assault, torture, serious injury, violent assault, domestic violence, death like situations etc. Here the readers can comprehend the comprehensive nature of Job's sufferings, multi-faceted adversities, natural calamities and hardships. He loses everything all of a sudden at social, financial and vocational level and becomes the object of ridicule and alienation. Suffering becomes an assault in the realm of experience and creates concentric circles of sorrow. Job endures all physical losses but he mentions his greatest loss, loss of relationship with God.

He laments for this loss,

Here Job's cognitive suppositions regarding God, particularly about the nature of God's evenhandedness are unexpectedly and drastically challenged by his experience of disturbance. Job was engulfed by striking, disorienting, irresistible, volatile and irrepressible traumas. Research demonstrates that disturbing events do have the authority to shatter through even the most

firmly cognitive deformations. Individuals with the insensible statement of overstated personal control may be challenged through distressing actions by the abrupt, dreadful and disagreeable authenticity of human weakness.

The readers can visualize spiritual struggle of job and his spiritual realities in the context of his adversity. Traumatic events can produce a strain on his spirit of faith and nature of understanding others. The person who is involved in spiritual struggle may feel disillusioned or irritate with God. He may also experience disappointment with the devout neighborhood and, eventually, even defeat of faith. This spiritual struggle finally develops into a persistent stressor and leads to overall psychological strain. Job was the man who endured his faith in response to adversity. His post-traumatic growth can be demonstrated by psychological adjustment. In fact, trauma is the contradictory occurrence of ultimate advantage. Ruthlessness of the trauma appears on the level of psycho-pathology.

Physical Torture and Sufferings

The story of Job is an example of hopelessness, loss and anguish. The readers visualize that Job was a man of upright and blameless. He was a man of God with deep integrity. Satan wants to test traits of Job and wish to check his loyalty with God in the midst of dreadful trouncing and profound unhappiness. So, we find Job's suffering in many forms such as the death of his children and servants, loss of property, and bodily sores. Here we see that God promptly responds to Job's anguish. Job curses the day he was born. He declares that his life is very miserable and he wishes for death. Job's friends tried to console him in his sufferings. Job is obstinately insubordinate and his questions are our questions:

'What have I done? Why is God punishing me?'

God replaces Job's stubbornness with humility. We as a human being cannot explain the actions of God. Immediately Job's suffering is put into perspective. It is not the will of God that children of God should suffer.

Suffering brings many tribulations. They can be problematical. Affliction is a part of human experience. Life can be full of awful despair, soreness and hopelessness. In book of Job, we witness the realistic problems, right attitude about trouble and pain and honest record of sufferer's doubts. Job was unaware about the advent of test and sufferings in his life. The purpose behind the test was to verify Job's love for God, his loyalty and his fair relationship with God.

Being a servant and friend of God, he has to prove his faithful life to God. Test was the medium through which he was going to accept and face tribulations courageously. The fact is that in our suffering we do not know all the facts. If we are known about it, we could able to tackle the problems. Here the matter is that how Job and his friends feel, say and think about the unexpected trial and tribulations in their lives. These events brought misery in their life. But this was the great and perfect plan of God for them.

God always overcomes evil plans and changes awful situations. He converts high-quality things out of horrific things.

We can't deny the fact that the people who follow God and live a holy life are reserved for the pain and sufferings. They undergo through trials and tribulations. They are testified like a gold which is put in fire in order to check its purity. Christian life is meant for suffering. If any problem arises in our life, we the believers generally curse God and ask,

'Why it's happen to me? Why it's with me and not with others?'

We have chosen to live a holy life in order to get security, success and wealth in our life. We should not correlate our holiness with the sufferings which enter in our life. If we do so, we doubt on God's goodness and grace. In fact, troubles increase our standard of spirituality. Believers feel that suffering is a terrible experience.

We must not assume that our corporal anguish is God's chastisement. Job knows very well that he was innocent. Generally, people have sufferings due to their sins. It is wrong to suggest that God will penalize us with corporeal sickness. God can make use of the understanding of torment for our integrity. We should never suppose that affliction is a squander. It may sometimes seem to be so. But it is certainly not a waste. Job thinks that God's actions with men can be a mystery. God always behave with his people in a reasonable manner. God delivers us from all physical and mental pain. Job cries out for a judge. He is acquainted with the fact that God is absolutely just. He knows that man's need is very great. He wants somebody to pay attention to both parties. He wants somebody to evaluate both divine power and himself.

Satan took permission from God and wanted to testify Job. In the introductory chapters, especially in chapter 1 and 2, the readers witness the tales of the death of Job's children, servants, and livestock and the destruction of Job's property. The book of Job describes the traumas that befall on the blameless and upright man one after another. Eventually, Job is made miserable with an excruciating, mutilating sickness. He responded all these

events positively. He showed his customary faith in God. In this adversity, he did not commit any sin against God and never charged God with wrong. Besides adverse situation, he still remained steady to his integrity.

He boldly asserts,

Afterwards, Satan stretched out his hands against Job and he was strucked with painful boils from the sole of his foot to the crown of his head. (Job 2:7) in this worst condition Job's wife also condemned him,

Here Job rebukes his wife by saying,

Here the researcher wishes to reflect the psychological truth, presence of trauma in Job's life and his sufferings. Job's three friends Eliphaz, Bildad and Zophar heard of all this adversity. They visited him, mourn with him and comforted him. (Job 2:11) They saw that his grief was very great. They witnessed Job's desperate situation. They raised their eyes and did not recognize him. They lifted their voices and wept. They tore their robe and sprinkled dust on his head towards heaven. Also, they sat down with him on the ground seven days. They responded to him in a most unexpected way. No one uttered a single word to him. They stunned and immobilized before the enormity of Job's calamities. (Job 2:12-13)

We witness verbal encounter between both Job and his friends, emotional appeal, rational defense, heated arguments etc. Job finds real peace and comfort only through God and not with his friend's advice. Job faces the dilemma through his sufferings. In the dialogue, Job and his friends engage in debate regarding the conceptions of God and nature of God's universal justice. Job's friends think that it is the plan of God about Job to bring the calamities in his life. Through these calamities, may Lord wants to correct him and wish to increase his righteousness. The readers observe disagreement between Job and his friends. It is the reality that impartiality in the world should be a predictable conclusion of a person's temperament and manners. Job's three friends conclude that Job must be deserving of his tragedies. The adversity might be caused due to his hidden sin or some secret transgression.

For example, Eliphaz comments,

Job's friend Eliphaz confidently argues,

Bildad Shuhite, Job's friend proclaims about God's judgment,

'Does God subvert judgment? Or does the almighty pervert justice?'

However, Job did not take risks with evil. It is the conviction of Job that he has suffered as an innocent man. This was undeserved suffering for him.

Job is abruptly confronted with a catastrophe in his world. Here the researcher asks series of questions to the reader,

'How can a guiltless person undergo in a cosmos guided by conventional structures of reward and vengeance? How can a just God authorize the torment of blameless persons? How can the virtuous God he once knew be the same unfair God he now comes across? How is he responsible for the immense inconsistency in his understanding of God pre- and post-trauma?'

Spiritual Healing and Blessings

Both Job and his friends assume that reality should obey the rules to receive the standards of reward and justice. They believe in the principle of poetic justice and authority of God. Blessing should necessarily follow the righteous and the goodness will reap reward. The adversity should befall the wicked and sin will reap punishment. It is Job's sense of control which urges the universal truth that rather than blaming to our situation and misfortunes, we can prevent our sufferings by surrendering them in the hands of God. Ultimately, Job argues with his friends if a blameless person endures, then God must be unmerited. Job decries against the God who has denied him justice,

In this conceptual framework, there is a shifting of responsibility. Here Job's friends blame him and Job blames to God. Job characterizes himself as one involved in discouraging lawsuit against God. Job answers,

Job witnesses dual image of God as the redeemer (good God) and destroyer (bad God). He proclaims,

Here Job wishes for his death as the pains are unbearable to him. He thinks that heavy hand of God has fallen upon him. Job offers plea to God,

In this adverse situation, he adheres to the promises of God and declares his faith and hope on God,

This is the testimony given by Job creates divine hope in God. We can see the fulfillment of Job's faith in the verse, Job: 42:5,

The above statements are the evidences of the psychological validity of Job's experience of sufferings. In his trauma, Job experiences God as judge, a justice, defender, supreme power and a true friend. In all his misfortunes, despair and afflictions, Job showed his emotional restraint in the form of patience and perseverance. It reflects his steadfastness in his distress. Job revealed his patience and ambition like Jacob. We witness Jacob's perseverance in his strong conviction. He struggles with God and receives

blessings from God through his energetic resistance. From that moment, he has been christened as 'Israel' means 'blessed'. He says to God,

In the same manner, Job like Israel, being a true devotee, relentlessly pursued Almighty God and waited for God's answer. He believed in God's munificence. In the whirlwind, God responds to Job's complaint,

Job, after a long suffering, pleased God and received heavenly blessings from God. He fully believed in the capacity of God. He asserts,

The final outcome of Job's suffering was blessed one. There was a tremendous transformation in Job's life. Job 42:10, 12 states,

Conclusion

The affliction of Job is indeed an ideal example to the believers and the people who lives in the surrounding of religious faith. This research paper attempts to describe Job's human psychology and spiritual healing through his sufferings by stating biblical revelation with numerous biblical examples. The study also focuses on trauma theory with the help of theological analysis which fulfils the tragedy of Job. As a believer, we are generally shaken by the trivial worldly aspects. We out of fear can't tolerate the sufferings due to lack of patience. We are generally bewildered and feel alienated by the depth of sufferings in our world. For us, Job is the perfect iconic figure through whom we are always encouraged to bear the adversities and oddities. Job's cry to God provides a fervent recitation of humanity's investigation for understanding. In every odd circumstance and in our sorrow, hopelessness, anger, despair, depression, we find the real peace by reading the life of Job through biblical contexts. The paper focuses on the fact that God has the power to give, take away, and give again.

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Chapter - 4
Optimizing Short-Term Hydro-Thermal Scheduling for Cost and Emission Reduction using Genetic Algorithms

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Chapter - 4

Optimizing Short-Term Hydro-Thermal Scheduling for Cost and Emission Reduction using Genetic Algorithms

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Abstract

The Hydrothermal Generation Scheduling Problem poses a complex challenge due to its nonlinear optimization nature, characterized by high dimensionality, a mix of continuous and discrete variables, the absence of an explicit objective function, and the presence of equality and inequality constraints. Additionally, it is a large, multi-modal, and non-convex problem. Traditional optimization techniques like Lagrangian, Firefly, Modified Firefly (Taher Niknam 2012), and Flower Pollination Algorithm (Rodriguez *et al*., 2016) struggle to yield near-optimal solutions for such a problem. To address the inefficiencies associated with the Hydrothermal Generation Scheduling Problem, this study introduces an optimization model employing a Multi-Objective Genetic Algorithm-based Hydrothermal Scheduling (MOGAHTS). This approach aims to enhance efficiency and robustness in tackling the complexities of the problem. Typically, the Hydrothermal Generation Scheduling Problem is decomposed into smaller problems to facilitate its resolution. This involves three primary decision stages, segregated through a time hierarchical decomposition, encompassing the Hydrothermal Power Generation Demand Problem, the total power generation cost for demands, and the emission rate corresponding to specific power demands.

Keywords: Genetic algorithm, short-term hydrothermal scheduling, cost optimization, emission reduction

1. Introduction

Long range problem includes the yearly cyclic nature of reservoir water inflows and seasonal load demand and correspondingly a scheduling period of one year is used. The solution of the long range problem considers the dynamics of head variations through the water flow continuity equation. The coordination of the operation of hydroelectric plants involves, of course, the

scheduling of water releases. The long-range hydro-scheduling problem involves the long-range forecasting of water availability and the scheduling of reservoir water releases (i.e., "drawdown") for an interval of time that depends on the reservoir capacities. Typical long-range scheduling goes anywhere from 1 week to 1 year or several years. For hydro schemes with a capacity of impounding water over several seasons, the long-range problem involves meteorological and statistical analysis. Nearer-term water inflow forecasts might be based on snow melt expectations and near-term weather forecasts. For the long-term drawdown schedule, a basic policy selection must be made. Should the water be used under the assumption that it will be replaced at a rate based on the statistically expected (i.e., mean value) rate, or should the water be released using a "worst-case" prediction. In the first instance, it may well be possible to save a great deal of electric energy production expense by displacing thermal generation with hydro-generation (Eiben A.E & Smith J.E 2003). If, on the other hand, a worst-case policy was selected, the hydro plants would be run so as to minimize the risk of violating any of the hydrological constraints (e.g., running reservoirs too low, not having enough water to navigate a river). Conceivably, such a schedule would hold back water until it became quite likely that even worst-case rainfall (runoff, etc.) would still give ample water to meet the constraints.

Optimizing short-term hydro-thermal scheduling for cost and emission reduction using Genetic Algorithms (GAs) is a complex but promising task. This optimization problem involves determining the optimal operation schedule for a power system with both hydro and thermal units, considering various constraints and objectives such as minimizing costs and reducing emissions.

Here is a general framework for approaching this problem:

Problem formulation

Define the objective function: Typically, it involves minimizing the total cost (fuel cost, start-up costs, etc.) and/or minimizing emissions (carbon dioxide, sulfur dioxide, etc.).

Formulate constraints: These can include power balance equations, water balance equations, unit operating limits, and other operational and environmental constraints.

Representation: Represent the scheduling problem using a suitable encoding scheme. This encoding should be able to represent the scheduling of hydro and thermal units over a specified time horizon.

Initialization: Generate an initial population of schedules. Each schedule is a potential solution to the optimization problem.

Evaluation: Evaluate the fitness of each schedule in the population based on the defined objective function. This involves simulating the operation of the power system for each schedule.

Genetic operators: Apply genetic operators such as selection, crossover, and mutation to create a new generation of schedules. These operators mimic the process of natural selection and genetic recombination.

Constraint handling: Implement mechanisms to handle constraints. Infeasible solutions should be penalized or repaired during the optimization process.

Termination criteria: Define criteria for terminating the optimization process. This could be a maximum number of generations, convergence criteria, or a combination of factors.

Implementation: Implement the GA algorithm using a programming language or a GA library. Consider parallel processing or distributed computing for large-scale problems.

Validation and Sensitivity analysis: Validate the optimized schedules against real-world data or historical records. Perform sensitivity analysis to understand the impact of parameter variations on the optimization results.

Fine-tuning: Fine-tune the algorithm parameters based on the results of the initial optimization runs. This may involve adjusting mutation rates, crossover probabilities, and population sizes.

Integration with decision support systems: Integrate the optimized schedules into decision support systems for real-time operation. This ensures that the scheduling decisions are practically implementable.

Documentation and Reporting: Document the optimization process, results, and any insights gained during the study. Prepare clear reports for stakeholders.

2. Requirement for base load and peak load operation

The suitability of a plant for supplying the base load or peak load depends on its characteristics. For base load operation a plant should have following features:

1. The operating costs of the plant should be low.
2. The plant should be capable of working continuously long period.

3. Few operating personnel should be required for plant operation.
4. It should be possible to repair the plant speedily and economically.

For peak load operation, a plant should have following features:

1. It should be possible to start, synchronize and load the plant quickly.
2. The plant should have quick response to load variations.

The hydro plants are well suited for both base load and peak load operation. Since their capital cost is high, they should be, as far as possible, used for base load operation. However during the periods of lean river flow, a hydro plant may be used as a peak load plant. A thermal plant gives minimum cost per unit of energy generated when used as a based load plant. A steam plant needs considerable time for being started from clod conditions. However to conserve fuel it can be used as a peak load plant. Nuclear plants are suitable for operation only as base load plants. Diesel and gas turbine plants are very suitable for peak load operation. However due to the increasing oil cost these plants are playing only a small role in bulk power generation by utilities.

2.1 Hydroelectric power plant models

Hydroelectric power plants harness water power of generation of electric energy. The potential energy of water is converted to kinetic energy. When water drops through a height, the energy is able to rotate turbines which are coupled to alternators. These plants have the advantage of very low operating cost. Moreover they can be started and loaded quickly. However they take long time for installation and entail huge investment. Moreover, their firm capacity is low and need to be backed by steam plants.

2.2 Neural network

Classification

a) **Run off river plants:** They use water as it comes. No storage is required. Evidently there is no control on flow of water.

b) **Reservoir plants:** Water is stored in a big reservoir behind dam. Water flows through penstock and enter the turbine.

Types of turbines

a) **Pelton turbine:** It is characterized by high head and low quantity of water.

b) **Francis turbine:** It is a reaction turbine suitable for medium heads and medium water, Flow.

c) **Kaplan turbine:** It is also a reaction turbine suitable for low head and large quantity of water.

Pumped storage plants: It is a special type of plant suitable for supplying peak load. During peak load, it generates electrical energy. During off-peak period the same water is pumped back from trail water pond so that the same water is used again to generate electrical energy.

3. Combined working of run-off river plant and steam plant

A run off river hydro plant uses water as it is available. These plants have a small pond age which makes it possible to cope with hour to hour fluctuation of load. The run offs of rivers vary widely during the year. The ratio of run off during rainy season to that during dry season may be as a large as 100. As such the run off river have very little firm capacity. The usefulness of these plants can be considerably increased if such a plant is used in combination with a steam plant. When such a combination exists, the hydro plant may carry the base load (up to its installed capacity) during the periods of high stream flows and the stream plant may carry the peak load. During the period of lean flow the steam plant supplies the base load and hydro plant supplies the peak load. Thus the amount of load carried by the steam plant can be adjusted to conform with the available river flow. Such a plan of operation results in a greater utilization factor (ratio of amount of energy developed to the amount of energy available in the stream) of the river flow and a saving in the amount of fuel consumed in the steam plant.

The determination of the sizes of runoff river plant and steam plant for supplying a given area requires the knowledge of the load curve of the area, the efficiency of the hydro plant, transmission loss and the stream flow. The stream flow available for 97% of the time during the year is used for calculating the capacity of the hydro plant. Since the loads on week days are higher than the loads during weekends, the capacity is determined in the basis of week day load curve. It is assumed that the run off river plant has a small pond age to take into account the hour to hour fluctuations of the load during the day.

4. Testing analysis

Dynamic programming algorithm and Genetic algorithm are used to solve the short term hydrothermal scheduling problem. Short-Term Hydro Thermal Scheduling (STHTS) is a very complicated optimization problem.

Many successful and powerful optimization methods and algorithms have been employed to solve this problem. It is a dynamic non-linear problem and requires solving unit commitment and economic power load dispatch problems. The main purpose of hydrothermal coordination is to minimize the cost of operation subject to attainment of a certain level of security and reliability. Also, owing to environmental considerations, operation at absolute minimum cost cannot be the only objective of optimal thermal unit commitment in the recent year. The environmental effect of thermal power generation is also becoming a major concern in most countries.

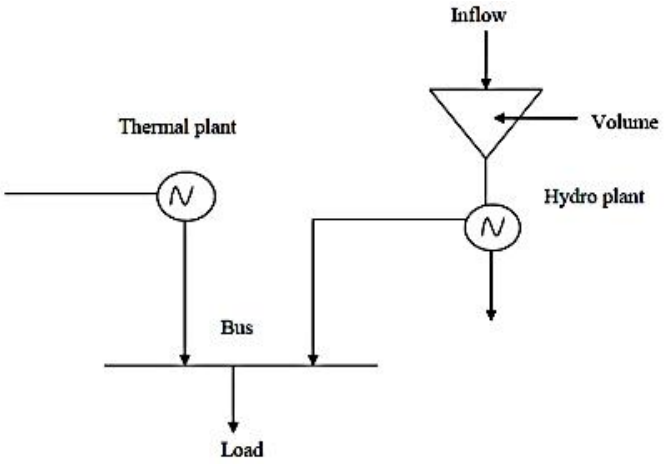


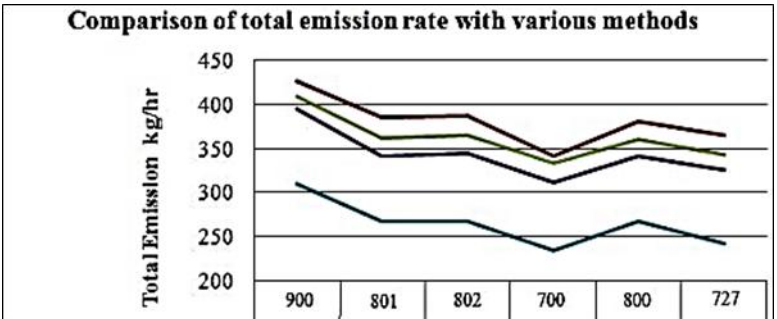
Fig 1: Test System

In Short-term hydrothermal scheduling, Fuel cost calculation vital important role. So to find fuel cost, Genetic Algorithm and Dynamic Programming based method is proposed. Figure 1 show the test system, which is consists of one thermal and one hydro generating station connected to load as shown in. Table 1 shows the Cost coefficient.

Table 1: Load and Natural Inflow

Period J	$P_{Load\ j}$	Inflow Rate r(j) (arce-ft/h)
1	600	1000
2	1000	1000
3	900	1000
4	500	1000
5	400	1000
6	300	1000

The Table gives the summarizes calculation for initial stage j=1 and j=2 respectively. The tabulation for second and succeeding interval is more complex since there are a number of initial volume states to consider.



	900	801	802	700	800	727
Lagrangian Total Emission kg/hr	426.2	385.0	387.4	342.1	381.0	365.4
Firefly Total Emission kg/hr	408.9	362.0	364.5	332.9	360.0	342.8
flower pollination Total Emission kg/hr	395.2	342.1	344.4	312.1	340.8	325.4
MOGAHTS Total Emission kg/hr	309.6	267.0	267.4	234.8	266.7	242.3

Fig 2: Comparison of Emission Rate

From the observation of the simulation results, the multi objective genetic algorithm method is efficient than the other conventional algorithm for short term hydrothermal scheduling.

Conclusion

The simulated results of the total generation cost and emission rate, obtained from both the proposed techniques and conventional techniques are hereby organized in a proper way for easy comparison and analyzing purpose. Among the above results, the proposed multi objective genetic algorithm shows feasibility and effectiveness in determining the total generation cost and the emission rate than the conventional methods.

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Chapter - 5
Power Management System for Fuel Cell Applications and Materials

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Chapter - 5

Power Management System for Fuel Cell Applications and Materials

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Abstract

The growing dependence on electrical energy has become a fundamental requirement across various sectors including housing, public service buildings, industry, lighting, transportation, and healthcare. However, this dependence has led to the utilization of fossil fuels for electricity generation, resulting in significant environmental issues. Consequently, there is an ongoing exploration of alternative energy sources that are more environmentally friendly. Fuel cells have emerged as promising electricity generation systems due to their ability to produce electricity while emitting water vapor as waste. The fuel source for fuel cells, hydrogen, is not naturally available in its pure state on Earth, thus it needs to be obtained from various sources. The production of hydrogen presents certain environmental challenges as it requires specific methods. Fuel cells can be broadly categorized into two groups: chemical and biological. These cells are manufactured using a range of materials that include metals and carbon. To ensure the efficient utilization of the electrical energy produced by fuel cells, power management circuits are employed. This study aims to provide comprehensive information on the fundamental features, types, application areas, environmental impacts, and power management circuits associated with fuel cells".

Keywords: Fuel cell, materials, electrode, power, electrical devices

1. Introduction

Fuel cells are briefly defined as devices or systems that convert chemical energy into electrical energy. The chemical energy in question here is hydrogen, which is utilized as a fuel in fuel cells. The important features that distinguish a fuel cell from a battery are that there is no need for charging for electricity generation and that electricity production continues as long as fuel is provided.

In recent studies, the following benefits have been cited as the reason why fuel cells have been identified as one efficient energy conversion device:

- They are environmentally friendly.
- They only release water as a by-product.
- They do not contain moving parts.
- They work silently.

Topics covered in this study are given below:

- Information about the basic properties of fuel cells.
- Types of fuel cells.
- Application areas of fuel cells.
- Environmental effects of fuel cells.
- Power management circuits of fuel cells.

2. Fuel cells and essential properties

A fuel cell essential consists of an anode, cathode, and electrolyte. Membranes that act as electrolytes are used in some fuel cells. Fuel cells with a membrane consist of two parts, the anode segment and the cathode segment. In a conventional fuel cell, fuel (hydrogen) is continuously supplied to the anode. In other words, the anode is fed with hydrogen. Usually, oxygen from the air or any oxidant is continuously supplied to the cathode. That is, the cathode is constantly supplied with oxygen or another oxidant. The electrochemical reactions required for the fuel cell to produce electrical energy take place at the electrodes (anode and cathode). Electrical charge movements occur due to the reactions taking place at the electrodes. Thanks to these charge movements, electrical energy is produced by the fuel cell.

The reaction occurring at the anode of fuel cells is given in equation (1).

Anode reaction: $H_2 \rightarrow 2H^+ + 2e^-$ (1)

The reaction occurring at the cathode of fuel cells is given in equation (2).

Cathode reaction: $H_2 + 2e^- + \frac{1}{2}O_2 \rightarrow 2H^+ + 2e^-$ (2)

The total reaction of the anode and cathode are given in equation (3).

Total reaction: $H_2 + \frac{1}{2}O_2 \rightarrow H_2O + \text{Energy}$ (3)

Explanation of equations (1), (2), and (3) in a little more detail reveals the following information:

Hydrogen gas reacts at the anode, it releasing hydrogen ions and electrons. Hydrogen ions migrate to the cathode through the electrolyte or membrane. The membrane does the task of the electrolyte. Electrons migrate to the cathode via the external circuit. At the cathode; hydrogen ions, electrons and oxidant

combine. As a result of this union, water is released and energy (electricity and heat) is produced as the electrical charge balance is achieved. Electrons are in a stable state and they are particles that perform electrical and chemical interactions [5]. Hydrogen ions in fuel cells duty as protons. The proton is in a stable state, that is, when the particle retains its protecting properties for a long time without undergoing physical and chemical changes.

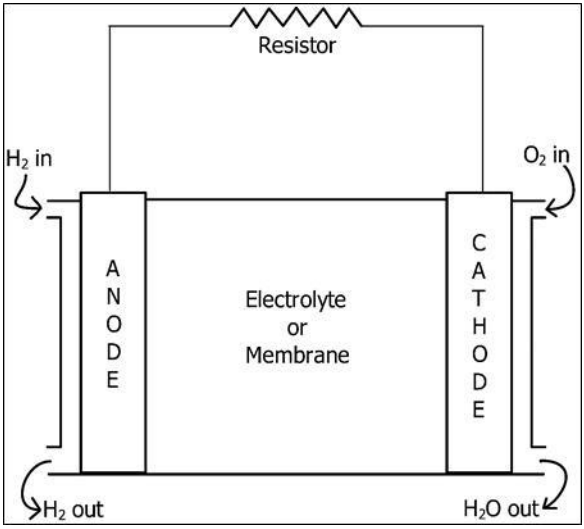

Fig 1: Example schematic diagram of fuel cell

Fuel cells were classified according to their application areas as follows

- Applications with high power reliability.
- Applications related to emission minimization or elimination.
- Applications covering locations with insufficient access to the electricity grid.
- Biological waste gas management applications.

Activities establishing the principle of "high power reliability" include:

- Facilities of high technology fabricating.
- Activity of data processing and call centres.
- Action of telecommunication.

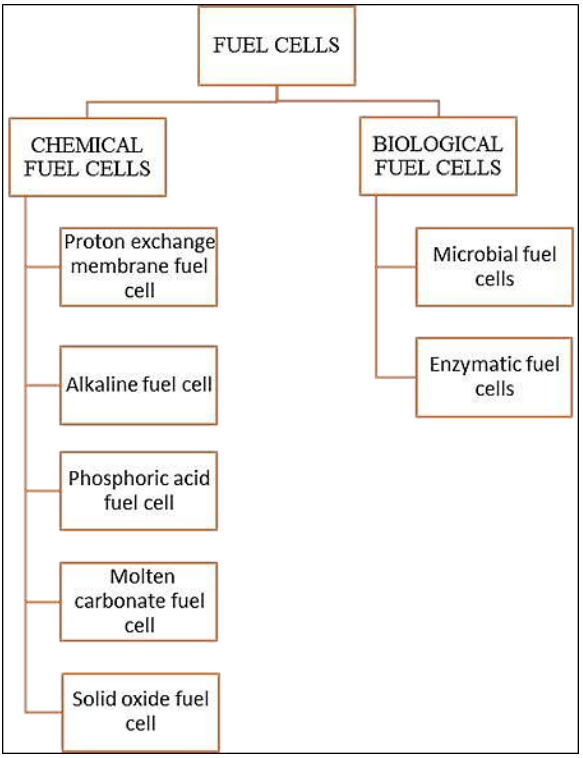

Fig 2: Fuel cells and their subcategories

Applications related to emission minimization or elimination following covered:

- Town like locations
- Vehicles
- Industrial foundations
- Air stations

Applications for areas with limited access to the electrical grid following contain:

- Portable applications.
- Remote areas.

The biological type waste gas governance practices have prioritized only one thing:

- Waste treatment plants.

Fuel cells are divided into two main categories, chemical and biological. The most mentioned chemical fuel cells in the literature are alkaline fuel cell, proton exchange membrane fuel cell, molten carbonate fuel, phosphoric acid fuel cell and solid oxide fuel cell. Biological fuel cells have been mentioned in the literature in two basic categories, these are enzymatic fuel cell and microbial fuel cell.

Microbial fuel cells are fuel cell systems that convert the chemical energy stored in the chemical structures of organic substances directly into electrical energy through microorganisms. While hydrogen is employed as fuel in fuel cells, the fuel source of biological (microbial and enzymatic) fuel cells is biomass (organic substances). Enzymatic fuel cells are systems that turn the chemical energy of organic materials straight into electrical energy through enzymes. Various biomass is utilized as fuel sources in enzymatic fuel cells. Because biomass is an abundant and renewable resource and it contains approximately 66% (w/w) sugar.

3. Environmental impact of chemical fuel cells

The main factor that reveals the need for fuel cells is the increase in the want for energy due to the increment in inhabitants. The need for energy has paved the way for the rapid depletion of energy resources. Most of the energy is still supplied from fossil sources. However, there are many harmful aspects of fossil fuels, which are given below:

- Their prices fluctuate erratically and unstable.
- It causes global warming and other more serious health problems.
- It is a limited resource that harms the environment.

Chemical fuel cells need hydrogen to operate, that is, they need hydrogen for producing electricity. Hydrogen does not exist in nature in pure form. Therefore, it is necessary to purify hydrogen from various sources. For this, carbon-containing sources are generally preferred and special production methods are used. It is stated that proton exchange membrane fuel cells (PEMFCs), one of the chemical fuel cells, do not spread noxious gases to the nature due to their structure. However, it is obvious that there is a serious greenhouse gas emission due to the production functions of hydrogen used as fuel. Hydrogen production methods and greenhouse gas emissions are given in Table 1. As can see here, the hydrogen production employment has a significant effect on global warming. In addition, even if renewable resources (solar and wind) are used for hydrogen production, the emergence of greenhouse gas emissions is an indirect problem for fuel cells, although not directly.

Table 1: Hydrogen production sources and greenhouse gas emissions

Hydrogen production source	Greenhouse gas emissions quantity
Gasoline and crude oil	84 g/MJ
Solar energy	30.6 g/MJ
Wind energy	20.55 g/MJ

In a study in which the environmental effects of the molten carbonate fuel cell (MCFC) are investigated in detail, raw materials and energy cover of the following topics:

- Fuel
- Water
- Minerals
- Plastics
- Metals
- Solvents

In literature, considering the raw material and energy relationship, raw material and energy input flows were investigated in detail for the MCFC with a maximum power of 500 kW. Table 2 presents the various findings from this MCFC.

Table 2: Raw material and energy input events for MCFC

Fuel cell type	Global warming potential (CO_2-eq/kWh)	Terrestrial acidification (kg SO_2-eq)	Water consumption potential (m^3)	Fossil resource scarcity (kg oil-eq)	Mineral resource scarcity (kg Cu-eq)
MCFC (unit/kWhel)	5.49E-01	5.06E-04	8.54E-02	1.87E-01	6.12E-04

One of the application areas of fuel cells is automotive. The comparison of fuel cell automotive and other technologies in a study comparing the environmental impacts associated with automotive production stages is given in Table 3 [20]. As can be understood from here, fuel cell automotive technology causes higher greenhouse gas effect and higher air pollution than others. Therefore, more environmentally friendly production technologies should be developed for the materials that make up the fuel cells. In order to produce hydrogen, which is the fuel of the fuel cell, more environmentally friendly and sustainable technologies should be discovered.

Table 3: Automotive production stages and environmental impact relationship

Automotive (car) type	Curb mass (kg)	Greenhouse gas emissions (kg)	Air pollution emissions (kg)	[a]100 km of vehicle travel (100 km)	100 km of vehicle travel (kg per 100)
Conventional	1134	3595.8	8.74	1.490	0.00362
Hybrid	1311	4156.7	10.10	1.722	0.00419
Electric	1588	4758.3	15.09	1.972	0.00625
Fuel cell	1678	9832.4	42.86	4.074	0.0178
a) During vehicle's life time (10 years), an average car drives 241,350 km					

4. Materials used in fuel cells

Although chemical fuel cells mainly consist of an anode, cathode, electrolyte or membrane, they also contain structures such as catalysts, gas diffusion layers and bipolar layers. The performance of the fuel cell decreases as mechanical, chemical or thermal degradation occurs over time. Therefore, the durability of the materials is a very important factor.

The gas diffusion layer is a microporous layer fabricated from a carbon fibre-based macroporous substrate. This layer is coated with carbon nanoparticles and a hydrophobic material (commonly polytetrafluoroethylene (PTFE)). The gas diffusion layer is situated between the coils of the bipolar sheet and the electrode. It operates both the water entering the cell with moistened reactants and the water produced by the electrochemical activities. Therefore, proper water management of fuel cells is critical to ensure their proper operation and continued efficiency. Gas diffusion layer's chemical degradation can be caused by polymer degradation or carbon corrosion. Therefore, a slight decrease in hydrophobicity occurs. Concentration polarization losses must be minimized in order to limit the water production due to the anode and cathode reactions and to acquire higher overall efficiency. For this, low current density values should be preferred.

Bipolar sheets act as a barrier between the various cells that make up the fuel cell stacks. However, it prevents the reactants from mixing inside the cell and does its job to help remove heat. In this way, it prevents a local accumulation of thermal energy in the fuel cell. It is mostly made of stainless steel, copper, aluminium and carbon-based materials (carbon black, graphite flakes or lumps, carbon fibres, graphene, expandable graphite, carbon nanotubes, expanded graphite, polymer-carbon composites, etc.). Corrosion products (for example metal ions) emerging in bipolar layers degrade the membrane and fuel cell anode and reduce fuel cell performance. Although coating the surfaces of the bipolar layer with a protective coating is one way to prevent corrosion, this process leads to a serious cost increase.

In proton exchange membrane fuel cells, there is no liquid electrolyte, herein polymeric membranes such as solid Nafion/solid composite, Nafion is used. In solid oxide fuel cells, ceramics like solid yttria-stabilized zirconia is used as electrolyte. Liquid carbonate (lithium, sodium, potassium-based carbonates, etc.) solution is used as the electrolyte in molten carbonate fuel cells. In phosphoric acid fuel cells, liquid phosphoric acid is used as the electrolyte. Liquid-state sodium hydroxide (NaOH) or liquid-state potassium hydroxide (KOH) is used as electrolytes in alkaline fuel cells. Recently, there has been talking of anion exchange membrane alkaline fuel cells introduced more contemporary.

Platinum is used as the anode material in proton exchange membrane fuel cells and alkaline fuel cells. While nickel is used as the anode material in alkaline fuel cells, nickel and yttria-stabilized zirconia cermet materials are used in solid oxide fuel cells. Nickel, chromium and aluminium alloys are used as anodes in molten carbonate fuel cells. Cathode materials used in proton exchange membrane fuel cells, alkaline fuel cells, solid oxide fuel cells and molten carbonate fuel cells are respectively; nickel, activated carbon, platinum, perovskite and porous nickel have been reported.

The catalyst is very important for efficient hydrogen oxidation reactions at the anode of fuel cells and for efficient oxygen reduction reactions at the cathode. Carbon-based materials, metal-based materials (platinum, palladium, ruthenium, gold, silver, cobalt, copper, iron, nickel, etc.) and various metal oxides (Co_3O_4, manganese oxides, nickel oxides, etc.) are widely used catalyst materials in fuel cells.

Carbon-based (graphite, carbon fiber, carbon felt, etc.) materials and metal-based (platinum, zinc, copper, aluminium, titanium, silver, etc.) materials are used as anode or cathode materials in microbial fuel cells.

Looking at recent studies, metal-based and carbon-based electrodes have been tested in enzymatic fuel cell research. The best example of metal-based materials used in the electrodes of enzymatic fuel cells is gold. In addition, carbon nanotubes have emerged as the best example of carbon-based materials used in the electrodes of enzymatic fuel cells.

5. Power management circuits used in fuel cells

Fuel cells produce direct current (dc) power. The power management of fuel cells can be done using a dc-dc converter. Besides the power management of fuel cells can be done without the need for a dc-dc converter. The fuel cell stack and ultracapacitor voltage level matching system are shown in Figure 3. It should be noted that the voltage provided by the fuel cell systems is equivalent to the ultracapacitor voltage. In this way, there is no need to use a bidirectional dc-dc converter.

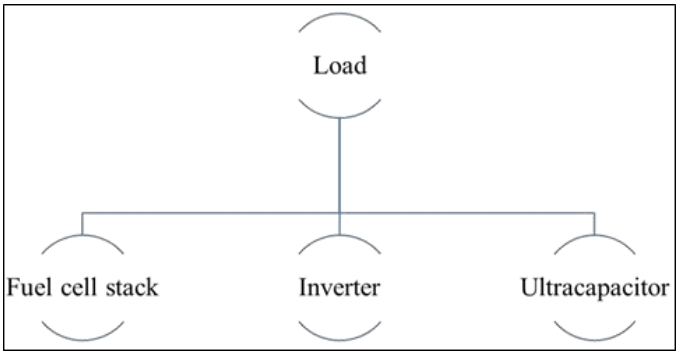

Fig 3: Example diagram of the energy management system of the energy produced by the fuel cell

The use of a bidirectional dc-dc converter is beneficial when a low- voltage battery and high-voltage fuel cell system are present. The circuit diagram in question is shown in Figure 4. Here, the bidirectional dc-dc converter does the duty as the core of the energy management system.

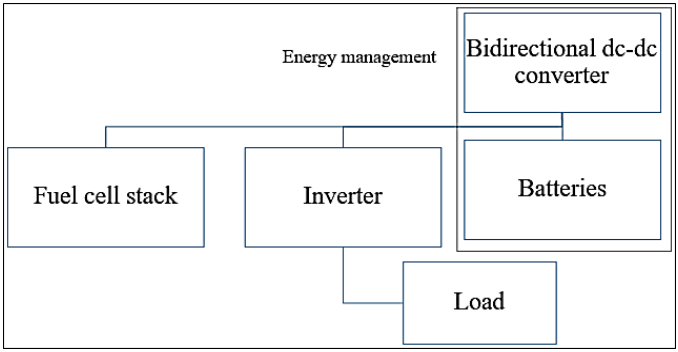

Fig 4: Use of a bidirectional dc-dc converter in fuel cells and energy management

DC-DC converters are very important for power management of fuel cells. Isolated major login range dc-dc converters are available for fuel cell power conditioning. The dc-dc converter operation, which can be an example of this, is given in Figure 5. Fuel cell systems demand an alternative energy source to provide energy in the face of sudden load demands. Ultracapacitors are of great importance in fuel cell power management circuits as they are a feasible aspirant for energy storage. The dc-dc converter developed for fuel cells and support for power conversion covers of two segments to power up the energy. The first segment includes providing low ripple as well as reducing voltage and current fluctuations of power devices. For this, it consists of two current-fed boost converters depended in parallel to have a smaller inductor dimension. Initial boost and regulation of the fuel cell module voltage is succeeding owing

to the first boost part. Herein pre-regulation of the voltage to 80 volts is achieved. In these simulations, voltage of fuel stack is regulated in a wide range from 40 volts to 60 volts, up to about 70 volts, due to possible switching and conduction losses over the circuit components. The first boost stage was operated at a frequency of 100K Hz with less than 50% duty cycle for the power switches. Cum this design, approximately 97% efficiency was achieved for the first step-up converter. In addition, the efficiency of the converter has increased significantly, with a mission cycle almost 50%. An ultracapacitor is used after the first boosting stage to supply energy during spike load needs. If the module cannot supply the power required by the load, the ultracapacitor temporarily maintains the voltage of the first step-up converter. The second stage is the process in which the upgrading job takes place. Here it is used with an isolated two-inductor step-up converter covering of two coupled inductors L1 and L2 to provide a certain voltage boost with switches S5 and S6. At the output of the second boost converter, galvanic isolation with 1:3 turns for the firstly and secondary windings assures an additional signal boost. The rectification of the signal is provided by the synchronous switches S5' and S6' at the load end. A decisive high dc voltage is achieved. Synchronous switches are preferred over diodes. Because MOSFET turn-on voltage losses are much lower confronted to diodes. Thus, it helps to obtain higher efficiency. The second boost converter is used at frequencies of 20 KHz succeeding with a converter efficiency of almost 94%.

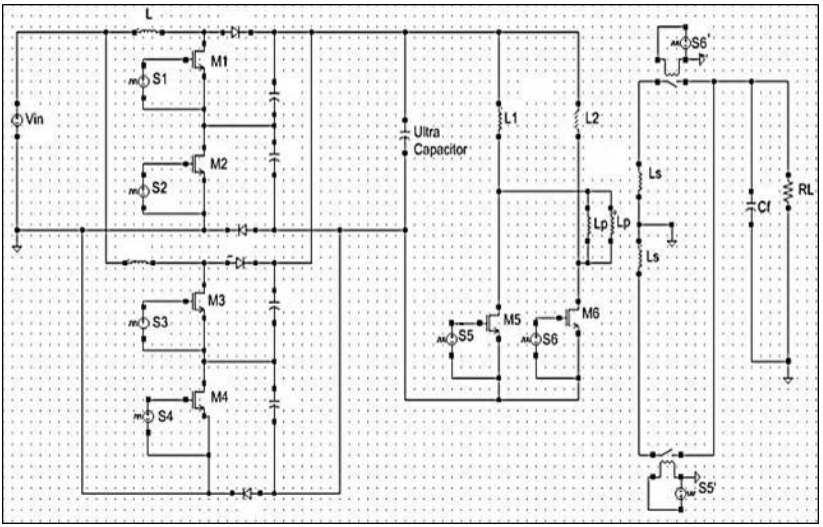

Fig 5: Example of equivalent circuit of major login range dc-dc converter [35]

The energy management strategy (EMS), which includes fuel cells, is divided into two main headings. These

1) Rule-based EMS.
2) Optimization-based EMS.

Rule-based EMS is again divided into two groups and is as follows [36]:

a) Deterministic approach: Thermostat on/off approach, filter-based approach, state machine approach and others.

b) Fuzzy approach: Conventional approach and adaptive fuzzy approach.

Optimization-based EMS is again divided into two groups and is as follows [36]:

a) Global optimization: Dynamic programming etc., stochastic search (genetic algorithms, particle swarm optimization, etc.).

b) Real-time optimization: Equivalent consumption minimization strategy, EDMS, etc., model predictive control, intelligence (neuro network, reinforcement learning).

Direct current to direct current (DC-DC) converters are used to control the output power of the fuel cell system. A unidirectional DC-DC converter that can control only one direction is generally preferred for fuel cells, electric machines or photovoltaic solar cells. There are DC-DC converters with the ability to control bidirectional power flow, usually applied to batteries or super capacitors (SC) and other energy storage devices. These are called bidirectional DC-DC converters. An example of a unidirectional DC-DC converter circuit is given in Figure 6(a) and an example of a bidirectional converter circuit is given in Figure 6(b). In Figure 6(a); L_1 is the inductor used in the fuel cell circuit, S_1 is a transistor used in the fuel cell circuit, C_1 is a capacitor used in the fuel cell circuit, V_{FC} is the fuel cell voltage (input) and V_{bus} is the output voltage of the circuit. In Figure 6(b); L_2 is the inductor used in the fuel cell circuit, S_2 is a transistor used in the fuel cell circuit, C_2 is a capacitor used in the fuel cell circuit, V_{bat} is the battery input voltage and V_{bus} is the output voltage of the circuit.

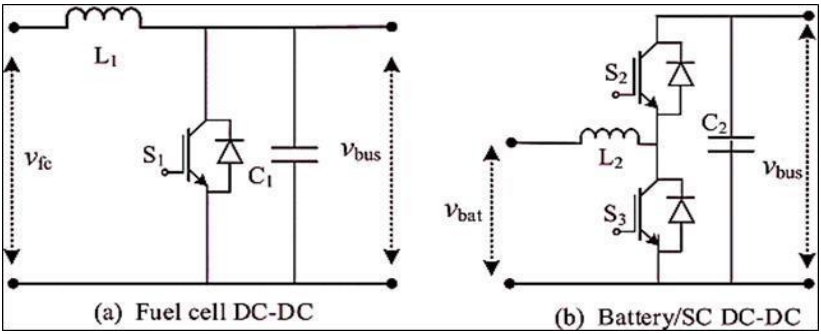

Fig 6: Schematic examples of fuel cell and hybrid power systems DC-DC converters

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Chapter - 6
Bureaucracy, Corruption and Civil Society and a Village Craftsman Community in Jharkhand, India

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Chapter - 6

Bureaucracy, Corruption and Civil Society and a Village Craftsman Community in Jharkhand, India [i]

Dr. Ravi Shankar Mishra

Abstract

In the craft sector of India, the role of the development agencies is to identify the traditional crafts of the craft communities, and to provide them with the various kinds of financial and logistic support. However, due to the underdevelopment of Jharkhand region where most of the craftsmen are still illiterate, the lax and apathetic bureaucracy comes in their way and the craftsmen are not able to make best use of the various initiatives. Though craftsmen often benefit from these interventions, the craft sector too seems to be not free from corruption. Despite the state policy to provide loans to the poor people at low rates of interest, the Jadupatias, a craft community which specializes in dhokra craft, still largely depends on the local Mahajans (money lender) for loans that have high interest rates. Why the craftsmen do not approach these financial institutions that promise low interest rates? Through the interviews of the craftsmen and the officials in the two villages of Dumka district in Jharkhand, India, this paper seeks to understand this reluctance and the nature of the relationship between the village craftsmen and the different agencies (government as well as non-government agencies) thereby exploring the intermeshed phenomena of bureaucracy, corruption and civil society. Supplementing the interviews are ethnographic descriptions of the villages where Jadupatias reside and the premises of various organizations in the nearest towns of these villages where they have to confront bureaucracy.

Keywords: Bureaucracy, civil society, corruption, craft community, red-tapism, communicative action, patronage, morality

[i] This paper is a result of the field work conducted during 2012-2014 with regard to my Ph.D. thesis, although the issues discussed here is quite different than that of the Ph.D. work which focused on the aesthetic and process of making of the Dhokra craft. This paper was further present at the 46th All India Sociological Conference in 2021.

Introduction

In the ideal type bureaucracy of Weber [1], there is no place for corruption, if one interprets his work narrowly. If one interprets it liberally and extends it to Merton's [ii] concern of an unanticipated force/consequence that makes any system dysfunctional, one can see sufficient warnings from Weber where the ideal type bureaucracy fails [2]. Unlike the ideal type bureaucracy of Weberian framework where corruption is an unanticipated force that makes a system dysfunctional, many of the writings on bureaucracy have drawn attention towards the issue of corruption as a concomitant feature to the bureaucratic system [3]. While there are only a handful of recent works which still follow the thread of the ideal type of bureaucracy and consider bureaucracy as valuable system for governance and state formation [4], there have been plethora of works producing consistent critiques of bureaucracy and state. However, some of the former kinds of work have argued against too much criticism of bureaucracy and have identified certain writings as anti-bureaucratic and anti-state [iii]. Their arguments come in the backdrop of the Western scholarship and seem to be a general critique against the prevailing scholarship in the west, unaware of the Indian context.

Along with these almost seemingly simultaneous phenomena of bureaucracy and corruption, civil society significance is to keep a check on the two. In fact, the very sense of civil society is in itself quite vast and broad with regard to state-society relationship [5]. While one of the aspects of civil society is that it encourages the formation of various kind of associations by the people and enhances their role in self-governance, the other aspect is that it encourages complete independence of these associations from that of the state and plays a role of an avid critique of state and resists its wholesome authority. The theories of civil society have thus been broadly theorized at these two levels, and again there have been a plethora of contributions from western scholarship in this regard too.

In the Indian context, the phenomenon of civil society is still considered to be non-existent or at its best at infancy stage where most of the activities from peoples' groups is considered to be based on 'identity politics' and hence characterized as 'political society' than bringing forth the individual rights of

[ii] It was Merton who used first the concept of manifest function, latent function and dysfunction in his book Social Theory and Social Structure. For him, the purposive actions always have unanticipated consequences which can be negative. These negative consequences are what he calls 'dysfunctions' of a system of social actions.

[iii] For instance, works of Castells, Giddens, Leadbeater, Peters, Heckscher and Donnellon on the issue of bureaucracy are identified as anti-bureaucratic by Gay.

the people- an essential attribute of the civil society [6]. Even if there have been some kind of activism in this regard by some peoples' associations in the recent times, especially with regard to the corruption, they have been very meagre and urban based. Indian scholarship also recognizes this lack of broad-based civil society activism, especially in the context of the newly formed states like Jharkhand. Though the formation of such states has been itself after a long and protracted agitation by people's group, they have been largely political in nature and any deep involvement of the people over variety of rights and other issues, is still lacking broad base in strength and force.

In the Indian context, thus there have been different kinds of analyses on the above issues from different perspectives, and those cannot be confounded within the dual categorization of anti-state or anti-bureaucratic literature on one hand and pro-bureaucratic and pro-state literature on the other hand, thereby reducing the diverse contexts of arguments of their work. In this regard, we have works of scholars, such as Jonathan Parry, Akhil Gupta, Alpa Shah, Shiv Viswanathan and Sethi etc. The objective of this work has been thus to discuss the issues of bureaucracy, corruption and civil society as raised by some of these scholars in their works and locate these issues in the context of the *dhokra* craftsman community called by the name Jadupatia, which resides in the district of Dumka in Jharkhand.

So, it becomes imperative to know who the Jadupatias are and how they are confronting bureaucracy and corruption in their day to day lives and then deliberate on their position in the context of the notions and the needs of any civil society. Whether such communities can be benefitted from an active engagement with the activities of civil society that is mainly non-existent or at the most can be said to be at its infancy in the state, especially in the context of craft? In the beginning of this paper while there is a brief introduction of the community, the work engages with the narratives of the craftsperson (especially the Jadupatias), with the ethnography of places or offices where the craftspeople have to deal with the officials. The ethnography of the different places-villages, towns and offices in the cities-are necessary to understand: the habitat in which the Jadupatias live; the towns and the offices where these Jadupatias do their transactions with the officials; and the level of penetration of the state in these places and in the lives of the people.

The Jadupatias are very small community of *dhokra* craftspeople (hardly comprising of 20-25 families), who mainly reside in the two villages of Jagudih and Jabardaha of Dumka district in Jharkhand that have majority of the population from the various tribal groups. The Jadupatias are engaged in one of the most traditional methods of metallurgy called as (cire-perdue or lost

wax) technique through which they make their products. Thus, they are very much a part of the traditional craft communities who have been one of the subjects of the state policies for development since the formation of Indian Republic.

When I visited their villages, the Jadupatias expressed their unhappiness over the shifting of the Government Handicraft office from Dumka to Jasidih which is 65 km away from their villages than the former that is just 25 km away from their residence. Yet they regularly visit Santiniketan[iv] in Bengal, which is over 100 km away from their places. They often visit the place because their products have a demand in the markets of Santiniketan. Also, these people have a saga of complaints against the apathy of administration and their grievance redressal seems to be slow in this direction.

My ethnographic study of the various premises of the government offices in Dumka and Jasidih was quite helpful to understand the dealings of the craftsperson with the various agencies and bureaucracy. However, all the ethnographies cannot be presented here. Still, a few of them would be crucial along with the interviews of the some of the craft officers and craftspeople.

A series of journeys in pursuit of the jadupatias

My journey started with visits to the places where the offices of the craft agencies are located and from where the Jadupatias are often receiving support (financial as well as logistical). These are expanding towns and cities. Dumka is an old city and perhaps one of the oldest districts from colonial times. During British rule, it included other districts (such as Pakud, Sahebganj, Deoghar etc.) of the present time and was the headquarters of the Santhal Pargana region; however, now it is a commissionary headquarter of this region which comprises of six districts. Deoghar is a place of pilgrimage and is rapidly expanding as business and administrative activities seem to be proliferating here. It is gradually relieving the administrative burden that Dumka in a wholesome way was once responsible for. In accordance to this administrative arrangement, many of the district offices of Dumka have been relocated to Deoghar. The government's handicraft office has also been relocated to Jasidih-the twin town of Deoghar. The Jadupatias are primarily receiving support from the government agencies; however, there are also a number of non-governmental organizations operating in these places which are either funded by the government or other donor agencies.

[iv] Santiniketan is a popular University town in West Bengal named by Devendranath Tagore, the father of one of the doyens of Indian literature, Rabindra Nath Tagore.

Dumka: Dumka is a sleepy city, though it is the hub of the administrative activities of the Santhal Pargana. My visit to the place was in the starting of the summer season and the offices and the schools and the colleges were running at their full pace. Still, the environment of the city seemed to be engulfed in a kind of lethargy and sultriness. It was very much conspicuous on the faces of the employees of the offices who wore a tired and sleepy look even in the very early and busiest of the hours. The employees present there wore a friendly smile but were helpless in the absence of the materials that I inquired about. I wanted to collect some official data about the place and so I was looking for the District Gazetteer. I also wanted to know whether the Jadupatia community had been accounted in it or not? But to my disappointment, I only drew a blank at every possible office and library where one could have expected the documents.

The only public library wore as sleepy a look as the city. The librarian was not available in the supposedly very busy hours of the day but there were other employees working in the other block of the premises. The employees did not seem to be having too much work and were quite relaxed and friendly, unlike some of the government employees in the bigger cities who most often wear a busy look and sometimes unfriendly at the simplest inquiry. They offered me a seat when they came to know that I have come from Delhi- that too- from none other than an institution which churns out people for the industries and who are paid a hefty salary. Their eyes spoke about the respect they had for the institution. One of them pointedly asked me-"You are just at the right place. How much would you earn? At least 10-12 lac per annum? Am I right?" It was embarrassing for me to be mistaken with the engineers and technocrats and to be evaluated just on the basis of the salary package that one can command. The people here were seemingly unaware of diverse interests and fields of study that an institution promotes. Also, certainly they were aloof of the very notion of "development". The development agenda is not just one-sided growth. "Development" is a value-loaded term and it does not just mean economic well-being, but an all-round development where all other "basic functions" of life—health and education are also covered. To this, one can also add the "complex functions" of right to participation in politics and participate and promote diverse dimensions of culture, such as art, literature, philosophy, ritual, etc. It was initially shocking for me to hear such a thing from the people belonging to the one of the scheduled backward regions of the state where 65-70% people are still below poverty line (BPL) but I understood later that they cannot be blamed. "Income" or "money" often occupy such an importance in the narratives and practices of the people.

The staff at the office could not entertain me anymore because they could not fulfill my requirement and hence, I was asked by them to come by the end of the day when the closing-time of the library approaches. My second visit too did not yield any result. Not only the Gazetteer was not available here, there were no books on either the Santhal tribes or the other such communities of this area. I was further directed to the District Commissioner's office for the Gazetteer. There also, I was directed from one section to another and was finally told that the only Gazetteer has been taken away by the new trainee (administrative) officer. I was left with the only hope to try my hands at the well-known university of the area.

Though the classes were running at their full strength, the library was in utter darkness with no light inside the rooms. The two in-charges (even though they wanted to help me out with my requirements) showed ultimately their helplessness because they could not provide anything related to my work. Forget about the Jadupatias, these institutions did not seem to have even the most fundamental books on the community (Santhals) on which the place (Santhal Pargana) is named.

Deoghar: Deoghar is a famous place for pilgrimage. It has a famous *sanctum sanctorum* of Hindus, in which is enshrined the *Shiva lingam* which pulls pilgrims and tourists from all over Jharkhand and neighboring states. However, the inflow of the pilgrims is mainly in *Shravan* (a specific month dedicated to the worship of Lord Shiva according to the Hindu calendar). The offices of many NGOs could me noted in this place, as it falls within one of the most backward regions of the state. The government agencies also provide fund to these agencies. Also, there seems to be a plan to develop a full-fledged *urban haat* in this place. The area allotted for this purpose is named as *Silpogram*, spread over a large area near a hilly region called as Nandanpahar. The premise is beautiful and large but I was told that the materials used to build the buildings are not of good quality and it is needed to be rebuilt. At present there was hardly any activity going on, except a training class for the making of the *agarbati* (joss sticks). This place was also inhabited by only few employees. A middle-aged man who seemed to be the senior most amongst its entire strength of the employees claimed his designation as an economic investigator. He told me about the various endeavors that the government and other development agencies have taken so as to provide employment to the poor people. Most of such efforts seemed to be efforts from outside and the people who are being provided training are not amongst those who have been practicing craftsmen since generations. Thus, the economic investigator was not classifying the *agarbati* making under a work of art or craft or under its Hindi nomenclature-"*laghu shilp".*

The government's handicraft office has been relocated to Jasidih from Dumka. So, the Jadupatias have to sometimes visit the place for one or the other reasons with regard to their work (craft). My visit to Jasidih was to inquire about the status of the Jadupatias (basically the dokra craftsmen) in the region. The board outside the office declared that the centre was a marketing and service extension of the handicrafts industry. The Development Officer (Assistant Director) was on leave and the only employees present in the office were an accountant and a care taker. The accountant did not show any kind of discomfort nor was he reserved in dispensing me with the information about the office, the crafts and the craftsmen. Rather, he was extravagant in giving his own opinion-

"We have a lot of work here but the staff here is very less. Other centers have more staff. Craftsmen of nine districts are affiliated to this centre but nobody (amongst the staff) wishes to come here in this zone". With regard to the craftsmen, he had a mixed opinion-"The craft work is a labor-intensive work and some of the craftsmen are simple village people. The craftsmen need support because they do not know about the market. For example, the clusters created by our initiatives help the craftsmen to work in an organized manner rather than to work in isolation and suffer the vagaries of the market. The Jadupatias are one of the shyest communities. No matter how many times we have told them to stay in groups in the cities or the towns; they remain in the jungles and work in an isolated manner. I can never understand them".

"I asked them to form bigger groups and remain alert with respect to the market. But they are basically village people. They do not seem to be provident enough-*Chilam laga liya aur us me hi dhut rahte hai* (they are very fond of their drugs and remain intoxicated under its effect)." With regard to the craft products, he was cynical-"Our store rooms are full. The products are spilling everywhere. Time and again huge supplies of production come to us. We employ designers who are paid decently and design programs are often held for the benefit of the craftsmen. But where is the sale? I do not understand who will buy these things of daily need at such a heavy cost which used to be readily available in our villages once. It is another matter they are now more decorative and stylish. The markets here at Dumka and Deogarh are not well developed. It is another matter that when some of the craftsmen go to some well-developed cities, some are able to cover their cost". With regard to the other agencies operating in the area, he was reproachful-"There are large number of non-governmental agencies which are operating here in this region. I do not know what these agencies are doing here. We have also often provided them with funds but they have not yielded satisfactory results". With regard

to my work, he was pessimistic that it could hardly yield any fruitful results- "You have chosen a community (Jadupatias) which is on the verge of extinction. There was a foreigner who was working on them for a long time and God only knows that whether the project was successful or not. I am highly doubtful that your project will be a success".

I met the Assistant Director on the second day. He was reserved, unlike his co-worker. However, like him, he was also surprised that why I have come to gather information about the Jadupatias who are now an almost extinct community. Actually, the moment one mentions about their name, people think about the *Chitrakars (Jadopatias)*-or the painters about whom I have dealt in the second chapter. The Jadupatias are lesser known because as an occupational-group of dokra making craft they hardly form a group of 15-20 families.

The officer told me about the various kinds of projects that the office was running in the area but he was not hopeful that any project could be successful with the Jadupatias in the near future. He told me about the failure of the last such project with them- "We need at least 300 units to promote any kind of craft cluster. But they hardly form a group of 35-40 people." The Jadupatias, as dokra craftsman community are thus on the verge of extinction as a practitioner of the occupation. Already, many of them have taken to other kinds of labour work.

Saga of complaints: Apathy of the bureaucrats or the violence of the state?

There was a saga of complaints by the Jadupatias on my every visit about both the dishonest craftsmen who are interested in making fast money and the officers who could not fulfill their promises. Kasim, a young Jadupatia in his 20's, considering me as one amongst the lots of the officers who occasionally visit them was initially not talking to me. But the moment he came to understand that I am not one amongst them, bursts out-"*saheb log badmash hain* (the officers are notorious). There was recently an event named National Games held in Ranchi and we were called through an official letter. One of the officers came with tall promises that this would be a great opportunity for us craftsmen. He asked us to collect as many people as we can as the work was plenty. Since all of us know the work, women and children also accompanied us and we had to leave our fields unattended for almost a month. At each house, only one or two old members were left behind to take care of whatever meager livestock we have. It took 13-15 hours to reach there and it is true the work was too much. We used to work from early in the morning

from 7 am till 12 pm in the night. Sometimes it stretched till 2 am and we worked like this for 22 nights. Yet the work never finished..."

A middle-aged person further narrated his experience at the site of production-"We were asked to make mementos for the games. The model of the memento was quite beautiful. But you know our work is of hand and of *bhatti*; we cannot endlessly stand near the heat and our hands also need rest. But we worked at a stretch because the officer told us that if we are not able to deliver then the new founded state will earn a bad name. But then, there were other craftsmen as well from the other states-Orissa and West Bengal and there was hardly any cooperation. Most of the craftsmen were trying to influence the officers and gain a personal edge over the others. How can anyone appreciate such an environment? On the other hand, the officers were missing when we needed travelling fare to return back to our village. *Jab bhi yeh sab sochte hain to pair jamin par nahin tikta hai; bahut gussa aata hai sahib logon par; bade bade vaade karte hain aur phir mukar jaate hain* (Whenever I recollect this event, I feel immense outrage; I feel a lot of fury against these officers; they have tall promises but can hardly fulfill those)".

Another middle-aged Jadupatias told me about an incident where the craftspeople have also been the defaulter. He narrated his sour experience of an occasion when he was called to Kolkata City in a reputed institution to make some products-"There were craftsmen from different states on this occasion. It was perhaps an assemblage especially for dokra craftsmen. Some craftsmen behaved in a pricey manner. But when they had to deliver, they failed to do so. Not only this, there were some who just allowed the things to be just wasted. When I pointed out about the wastage, they got offended and retorted that there is "government" to take care of it. As if government has an endless supply of such things… Some went down to the level of stealing oil, wax etc. In fact, the clay that I carried from the village was also purloined by somebody. Though there was enough clay in the premises, it was not of the quality that our lands back at the village have. I was totally upset and complained to one of the officers that under such a situation, I cannot work. The officers were also in a fix because of these cases of theft, wastage and poor cooperation amongst us. I was asked to make a specific product, which I felt could not be done without the clay that I got from my village. The officers here were considerate and made arrangements so that I could visit a nearby village and fetch the same kind of clay. The product was finally delivered to the officers' satisfaction. But they were definitely unhappy with the situation". He continued with an exasperation- *"isliye hum kalakar bina khaye mar jaate hain* (that is why we artists often perish in hunger…)"

Observation, Comparison and Analysis

The problem of corruption is never accepted by the social scientists as a simplistic problem to be merely understood through statistical indicator or within a universalistic western idea of bureaucratic norms. Parry, Alpa Shah, Akhil Gupta, Vishvanathan and Sethi are some of the scholars who have contested these norms in the Indian context [7]. Parry argues that the crisis of corruption in India must be seen more as a sign of extension of the reach of the state rather than consider it as a failure of the state [8]. Taking cue from Parry, Shah argues that the reports of World Bank and Transparency International do not take consideration of the structural reality of a region [9]. Instead of making us understand the problem of corruption in a particular country, they simply pronounce that corruption is undesirable for development. Thus, this view point carries with itself the load of universalistic moral norms of bureaucracy. Shah observes that the local elites in a remote village of Jharkahand do not consider their action as illegal in appropriating a major portion of resources meant for poor because they claim their traditional power relationship over them and yet consider themselves as benevolent actor. Further, they give an impression to the poor people that the state is exploitative.

Similarly, Gupta does not appreciate the stereotypical depiction of bureaucracy in a universal Weberian framework where corruption is treated from a western universal criterion of ethicality or moral failure by the bureau officials [10]. However, in his ethnography, the poor people do not doubt on the intent of the state but on the dishonesty of the multiple tiers of state officials who according to the villagers are the real culprit swindling the resources. However, Gupta argues that the villagers' interpretation is based on their immediate interaction with the officials at the local level. They are unaware of the pressure put by the senior officials at top on the local officials. Thus, he traces the problem of failure of bureaucracy not so much in the apathy of bureaucratic officials but in the very 'modalities' of the state in which the idea of 'care' is inbuilt for the poor people but ends up in perpetrating structural violence against them. The local officials here are considered merely an expedient cause for such paradox to exist. Through in-depth ethnographic descriptions of the behavior of the officials at work at their own home-based offices in Uttar Pradesh, India, that Gupta calls 'performativity' and through the narratives and discourses on corruption in popular culture, he shows how the state is constructed by the ordinary people in their everyday life. His work is thus also a trenchant critique of the state [11].

In the same way but with a slightly different area of focus, Vishvanathan and Sethi's book is a collection of articles by various authors. The book has traced some major cases of graft (excluding the most recent ones in the neo-liberal economy) at the top since independence in the country and speaks at length about how the state can be constructed through these discourses [12]. Vishvanathan also does not believe that the issue of corruption could be tackled through sermonizing on integrity and morality, by charting a character building or nation building agenda, but in understanding how corruption operates in the system and constitutes the very system[v].

In the particular context of craft, there are people who have worked in the sector and have drawn our attention towards the arbitrary ways in which the sector has been treated by the state as well as the unscrupulous agents operating in the sector on behalf of the state [13]. However, there are some recent historical works which have particularly emphasized that bureaucracy in the craft sector has been a part and parcel of state bureaucracy since colonial time [14]. These works further argue that the state bureaucracy received as a legacy from the colonial rule has continued and can be seen reflected in the nationalist politics of the post-independence era, albeit in a different form. Thus, McGowan argues that the formation of Indian 'nation' can be understood through the nationalist ideology about craft in the pre-independence era and the practices that were carried afterwards, which unfortunately was proceeded by many unwanted consequences in terms of corrupt practices.

Thus, most of the above works emphasize on the need to understand the system (both the bureaucracy and the modalities of the state) which has inbuilt loops and holes or constraints rather than on the need to treat corruption as moral failure on part of individual or state. In the context of some of the above discussed works of scholars on corruption, bureaucracy and civil society in India, let's now consider the Jadupatias and analyze their situation.

The Jadupatias of Santhal Pargana are quite interested to sell their products in the urban markets of big cities as they get good price out there. As such opportunities are not available in their nearby town of Dumka and Jasidih, they go to *haats* of Santiniketan and even as far as Ranchi, Dhanbad

[v] As a response to Acharya Kripalani's article in *Seminar (NO. 8 April 1960)* which appeals to the people of country to develop moral integrity in order to remove the disease of corruption, Viswanathan presents a sardonic poetic description of corruption arguing about the various reasons due to which it has been almost indispensable with the system. (See http://www.india-seminar.com/2008/590/590_shiv_visvanathan.htm)

or the metropolis of the country such as Delhi and Kolkata. The inputs about the design are often planned by the development agencies who train the craftsmen in the camps. The craftsmen come in contact with the officials and designers in these camps or in their transaction in the offices of the nearby towns. In fact, when there are some big events such as international or national games, the officials or agents of development themselves reach to the villages of these craftsmen. Some of the experiences of these events have been earlier described in the paper.

The practice of patronage that the state extends to the craftspeople have been there since the precolonial times in India. C.A. Bayly has very effectively analyzed this aspect and nature of state patronage from the pre-colonial times to that of the colonial times and to the time of freedom struggle [15]. Though his analysis is with respect to the cloths, his analysis of state patronage is applicable in general to all the craftspeople. Thus, according to him while state patronage to the indigenous artisans and craftspeople sustained the communication between the state and the society in the precolonial time, it fell off in the colonial period due to the colonial state's lack of concern for the indigenous industry and thus created a crisis in the state society relationship. So, the frequent transaction between the King and its people (artisans and craftspeople) that sustained the internal economy and bureaucratic engagement of king officials in the pre-colonial time was absent in the colonial time except for the few statesmen and scholars who may have volunteered to document about the craft. Also, those engagements were mainly a romantic account of the crafts aesthetic in its purity. Dutta and McGowan have drawn attention towards the state bureaucracy through which craft and designs have been administered during the colonial time in India to the independent India. While Dutta basically focuses on the colonial times and draws the contradiction of the colonial policies that arbitrarily used its bureaucratic power [16], McGowan talks about the independent Indian state's engagement with the craft and the unwanted consequences of bureaucracy in craft [17].

Similarly, in the context of Jadupatias, what is conspicuous is the arbitrariness in the operation of bureaucratic function. The local officials are bound by the duties to implement the programs and schemes that have been handed over to them from the officials higher up in the hierarchy, who may not be aware of the ground realities. While an urban *haat* has been constructed in Jasidih, the materials used in the making of the same turn out to be of bad quality only after the entire infrastructure has been built. Even though, some kinds of activities have started in the premises, most of the rooms are empty. The *haat* has been mainly constructed to cater to the craft work of the

craftspeople of the region. But it is obfuscated with the other livelihood-based activities such as making of jos stick (*agarbatti*) etc.

The dhokra work is one of the traditional crafts of the country but the fund cannot be made available for its development in the context of the Jadupatias because they are less in numbers. The designers are often engaged to train the craftspeople by either the government agencies directly or through outsourcing the services to the NGOs. The accountant at the Handicraft office of Deoghar complains that nine districts fall under the responsibility of their office. But there is a crunch of staff there. In his words-"In contrast to other offices, such as Patna which has approximately 200 staffs, Madhubani which has 150 staffs, the Deoghar office has only 3-4 staff members". The accountant explains that since the region is in the interior part of the country and still undeveloped, nobody (staff) wants to work there. Besides the Assistant Director of the office, the only full-time employee is the accountant himself who audits the expenditure and spending in the development activities. But he is not happy with the work of the NGOs. He is also not happy with the undeveloped market in the region. There are enough supplies of production but there is little sale. The products are lying in the store of the office. The accountant's pessimism may be traced partially in his own cynicism and apathy. But partially it can be also traced in the arbitrary way in which the systems operate-that is in the initiatives taken by the government to promote craft. Further, there seems to be a serious crunch in the accountability of some of the officials in the various offices, especially in the district office where the only District Gazetteer is missing.

The state enters in the lives of all the village people through the local offices-the ethnography of some of which shows that their functioning carries a lot of arbitrariness. However, as mentioned earlier, as the villages are deep inside from the nearest city, the village people are not so often involved with the officials in their daily transactions. The villages have their own lives with the inhabitants either engaged in different kinds of occupations-such as fishing, farming, poultry, making of the local beer, collection of woods from the forests etc. or in the daily chores. Thus, the reach of the state is not penetrative enough though not insignificant. The state enters into the lives of these people through the block offices and the various schemes that these blocks may have to offer to the village people besides the various kinds of development work that are so often run through the NGOs. One can thus see the influence of the state slowly penetrating in the lives of the village people.

The Jadupatias have also very little transaction with the Handicraft Office or the District Industrial Centre, even though they are registered in the

registers of these offices. This registration of the names of the village craftspeople helps both the officials and the craftspeople to remain in touch with each other. It is especially important for the officials in locating the shy Jadupatias who are not in regular transactions with the Offices. Thus, to claim that the state can be constructed through the narratives of the few craftspeople would be an overstatement. The craftspeople and other villagers are aware that there is one or the other schemes run by government for the poor people. But, as they are illiterate and have limited social capital, they do not dare to go to these offices so often. Thus, the Jadupatias prefer to take loans from the local *Mahajans* than to go to the banks in the city. In the words of one of the Jadupatias-"We are illiterate people. We therefore do not know much about the schemes that the government says is for us. We also do not know how to get our work done in the banks. They (officials) make us to do endless visits to the offices. I can never understand the reasons behind delay. We cannot afford to make endless rounds of the offices, especially when one has to attend other works in the village".

However, one of the lower officials at the handicraft office at Jasidih told me-"There are so many schemes for them. They can draw 15000/annually for their treatment under *Rajiv Gandhi Swastha Yojana*. They can draw 100000/on death of their near and dear ones. But they do not draw the benefit of the government schemes even when they are being told about them".

No doubt, the Jadupatias are shy and reluctant to do transaction with outsiders unless the terms are clear to them. One can say that illiteracy may be a major hindrance for them to understand the various schemes of government. But then, it is also required to be pointed out that illiteracy may be also the only reason due to which they must have been taken on easy ride by the officials. And perhaps, that would have resulted in their endless visits to offices bearing no benefits to them.

As a concept, state acquires an abstract position. While represented ethnographically, it may turn out as the main culprit responsible for arbitrariness in the bureaucratic systems. The paradox is that in the entire effort of care that is planned on behalf of the state, the state may be once again identified as the major culprit of the violence on the poor people. But then, these efforts of state are built by people of diverse professions and specializations where the ordinary people (this includes people of no-specialization or people who have the skill of craftsperson but still remain poor) also participate. The agency of these marginalized people cannot be always called weak, especially when they have a significant role to play in influencing the policies of state. As Gupta points out that the poor people

encounter the state either by being a beneficiary of the state policies or by educating their children who may later get a government job, thereby having a role in the state formation [18].

As in Gupta's work which point towards the arbitrariness of the modalities of state, my own observations and interviews of the officials and the narratives of craftsperson indicate that there is some kind of arbitrariness in which the schemes or programs of the state are carried out. According to Gupta, this arbitrariness causes 'structural violence' to the poorest of poor. But Gupta does not locate the main cause of this violence in the erring officials. His work is embedded more in the everyday life of the people where they come in regular contact with the state officials. He effectively shows through his ethnography that it is the expediency of these officials to deliver under this system that causes violence on the poor and the officials themselves cannot be blamed of causing deliberate harm to the poor people.

On the other hand, Shah locates corruption in the gap between the state's policies and its interpretation by the local elites who by default embedded in a set-up of moral economy, do not see anything illegal in their act of appropriation of the state resources meant for the poor [19]. Shah's work is ethnography of the different kinds of politics that are played by people of different heterogeneous classes and communities in a village called Tapu near Ranchi in Jharkhand. Here poor tribal people have a negative impression about the state because that is what is supplied to them by the rural elites. Thus, rural elites (which include people who are tribal) appropriate the resources made available by the state for the poor. Taking cue from Partha Chatterjee's concept of 'political society', she argues that in the Indian context the notion of civil society as a whistle blower and watchdog can only be applied to a narrow group of people who are actively operating in the context of the city. The different heterogeneous groups in the villages who are not part of this politics can be said to be operating within their own sets of politics. Thus, in Tapu, the local elites have their own politics where they paint a violent image of the state for the poor people, so that the poor continue with their sacral polity[vi] and keep away from the state activities. The local elites do not interfere with their polity and so the whole affairs of the state are handled by the elites only. The local elites exercise their rights over the state resources by claiming

[vi] Alpa Shah describes the process of the selection of village level authorities amongst the Oraon and Mundas of Jharkhand very well. This is a traditional indigenous system of governance. She calls it a 'sacral polity' because here secular and sacred aspect of tribal life is connected and almost the same. The rural elite do not interfere with this system and the poor villagers do not show interest in the politics of elites for the position in government.

their privileges in the old moral economy and thus consider nothing amoral or illegal in their appropriation of the state resources. Thus, the poor people remain outside the ambit of the larger public sphere where they could have otherwise participated and claimed for the resources of the state.

The villages in which the Jadupatias reside may have their own politics as I came to know during my field work that the Panchayat election was due and the Jadupatias had their own favorite. However, as they do not belong to a tribal group, they cannot be a part of the internal politics of any of the major tribes that live in this area. With the announcement of resumption of Panchayat election after a huge gap of 32 years, there were enough signs of a new kind of politics to emerge in this area as it would be set on the sharing of the state resources than based on the traditional local polity. And the Jadupatia may get involved in this wider public sphere. However, until now, the Jadupatias are not the beneficiaries of local block level development programs because they do not fall in the category of the so called "socially backward" groups, even though they are from a religious minority group (Muslim) and their possessions may be as meager as a scheduled caste or scheduled tribe group. Nor, do they have BPL (Below Poverty Line) card. They have been mostly engaged in the development programs of the District Industrial Centre or through the Handicraft Board of the government.

Thus, the Jadupatias are not in regular touch with the state officials. They are roped in the service only when there are some programs for them. It is another matter that with the growing possibility of the development of the market situation, there is an increased possibility for the Jadupatias to come in touch with the development officials more often. It cannot be denied that there is often arbitrariness in the bureaucracy, in the implementation of schemes and delivery of the services. However, neither can the narratives of the craftsperson be ignored nor can the behavior of some of the officials. They clearly point towards the moral bankruptcy of some of the officials in contrast to some others who have been honest and empathetic towards craftspeople.

Individual narratives may be one-sided, but the act of selection of narratives coming from various sources and their analysis need to be always a dispassionate act. Thus, in the present work, the official versions have also been corroborated to understand the role of bureaucracy and hence the state. It may be also argued, that too many narratives of complaints from craftspeople as against the meager interviews of officials may only paint the officials as the main culprit and thus render the analysis biased against the officials. However, my ethnography carries more numbers of narratives of craftsperson than that of the interviews from officials not because they have

to be painted as the only erring party. But, since the (in) actions of the officers have been incredulous and reckless-sometimes full of greed and heinous[vii], their (in) actions speak volumes about their apathy. This further adds to the character of the state as a perpetual violent state where care and respite for the poor is only in its welfare promises. No doubt, there are also narratives about erring craftspeople which together with the narratives about the erring officers weave the arbitrary operation of the schemes of state. But then, most of the craftspeople are the poorest of the poor.

The officials who are supposed to work for the craftspeople or for that matter any other officials, who work for poor, cannot be the main culprit if they are merely acting out of expediency of an arbitrary system. But then, their role in making the state a violent state is no less insignificant than there can be blame on the policy makers and ultimately on the modalities of the state. In fact, they are part of the emerging middle class towards whom even Gupta's compass of analysis points. As Gupta puts the responsibility of the plight of poor in the rising consumerist aspirations of the middle class and the elites and the pressure that the global capitalism has built on them, the officials falling in the bracket of middle-class category cannot be excused of their rash and reckless approach towards the poor craftspeople [20].

Similarly, even though Shah rejects the universal moral norm of bureaucracy, based on which the reports of corruption for third world countries are prepared by World Bank and Transparency International, Shah still appeals for stronger ethical standards which can transcend the local moral economy of the political society [21]. Also, though Vishvanathan has decried the recent Intelligence Bureau report that development is halted to 2-3% by the NGOs in India and considers it as a 'text of suspicion' against the NGOs, he appeals for the audition of the NGOs[viii]. Vishvanathan calls the Intelligence Bureau reports as unwanted 'paranoias' of the state doubting on the state's intention that it may want to pursue its development agenda by curbing all the dissent. Yet, he appeals for transparency in the ways of working of the bureaus. Thus, it is clear that without bureaucracy and state intervention, there cannot be governance and delivery of the services. Paul du Gay argues that in

[vii] After all, the officials are people in authority and they cannot conceal their own act of commissions and omissions in the name of inadequacy of system. The saying "all the responsibility but no authority" is more suitable for the craftsmen and not the officials who still have substantial amount of authority to act and deliver. But, in some of the above cases it is clear that there has been a gross repudiation of the responsibilities.

[viii] See http://www.thehindu.com/todays-paper/tp-opinion/the-songlines-of-secula. Accessed on: 6/30/2014

the recent times, there has been domination of anti-bureaucratic and anti-state writings which have argued for doing away with the bureaucracy. He brings out a collection of writings that reinstate the role of bureaucracy, thus asserting that there is no essentialist condition of bureaucracy that curbs the freedom of the bureaucrat and should make her/him cold [22]. In fact, it is the very freedom of authority that enables the bureaucrat to tackle chaos or inaction in the system.

Conclusion

The purpose of the present work is not to categorize any work discussed above as anti-bureaucratic or pro-bureaucratic. Even though Akhil Gupta's work is a strong critique of state, it cannot be branded as anti-state writing. His criticisms of state and bureaucracy, is to develop a nuanced understanding of the Indian bureaucracy and the state, so that relevant measures can be taken to correct the modalities of state and the violence can be minimized on poor people. Likewise, Visvanathan's inquiry in the problem of corruption may be sardonic but it effectively delineates the gravity of the problem and demands serious and sincere efforts for minimizing it. Also, Gandhian Kriplani's appeal for moral integrity that make people alert in the dispensation of their duty and Gay's revisit to the very concept of bureaucracy and its positive values in governance cannot be understated or mocked.

This paper thus aims for a balanced analysis of the two-way relationship between the system and the people who constitute it. No doubt, corruption can only be understood through a fine grain analysis but it must not ignore the flaws in the personalities that make the system itself problematic. The policies and programs of development are required to be practical and clearly communicated to the officials who implement it for the people and further communicate them. The people must further be able to respond to it and express their satisfaction or dissatisfaction towards it. They are to be actively involved in their path of development and this can happen through communicative action that may involve resistance or even refusal to cooperate. But that is how civil society and democracy can evolve. Thus, a need of development of civil society with developed civic sense is necessary to counter the systemic failures and corruption at large and not just indulging in hypercriticism of state.

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Chapter - 7
Cloning: Creating Genetic Duplicates

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Chapter - 7

Cloning: Creating Genetic Duplicates

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Abstract

The field of cloning has witnessed remarkable progress in recent years, ushering in a new era of possibilities in genetic duplication. This paper provides a comprehensive overview of the latest breakthroughs in cloning technology, highlighting the methods and advancements that have paved the way for the creation of genetic duplicates. Key focus areas include somatic cell nuclear transfer, induced pluripotent stem cells, and emerging CRISPR-based techniques.

The paper explores the ethical considerations surrounding cloning and addresses the potential applications of genetic duplication in various fields, such as regenerative medicine, agriculture, and conservation. Case studies demonstrate successful cloning endeavors, showcasing the practical implications and challenges faced by researchers in the quest for precision and efficiency.

As cloning technology evolves, the paper discusses the integration of cutting-edge tools like artificial intelligence and machine learning to enhance the accuracy and speed of genetic duplication processes. The review emphasizes the ongoing dialogue between scientists, policymakers, and the public to navigate the ethical and societal implications of creating genetic duplicates.

Keywords: Cloning, genetic duplication, somatic cell nuclear transfer, gene cloning, molecular cloning

Introduction

Cloning is a biological process that involves the creation of a genetically identical copy of an organism, cell, or DNA molecule. This copy, often referred to as a "clone," has the same genetic makeup as the original source. Cloning can occur naturally or be induced through various scientific techniques. The concept of cloning involves creating genetically identical copies of organisms, cells, or DNA.

The key principle behind cloning is the replication of genetic material. Depending on the type of cloning and its intended purpose, different techniques and methodologies are employed. Cloning techniques can range from nuclear transfer to the amplification of DNA through polymerase chain reaction (PCR) in gene cloning.

Cloning has various applications in agriculture, medicine, genetics, and biotechnology. It can be used to preserve valuable genetic traits, understand genetic mechanisms, and develop medical treatments. However, cloning also raises ethical, legal, and safety concerns, especially in the case of human reproductive cloning. These concerns have led to restrictions and regulations in many countries.

History of cloning

The history of cloning encompasses both the cloning of organisms and the cloning of DNA and genes. Cloning technology has continued to evolve over the years, with advancements in various fields, including animal cloning, gene cloning, and therapeutic cloning. Here is an overview of key milestones in the history of cloning:

Early theoretical concepts

The idea of cloning, or creating exact copies of organisms or genetic material, has been contemplated for centuries, with early conceptual discussions dating back to the 19th century.

Frog cloning (1952)

Robert Briggs and Thomas King successfully cloned frogs using a process called nuclear transplantation. This marked one of the earliest experimental demonstrations of cloning in animals.

Sheep cloning (1986)

Steen Willadsen cloned a sheep using a technique known as nuclear transfer, laying the foundation for future mammalian cloning experiments.

Dolly the sheep (1996)

Dolly, a sheep, was the first mammal cloned from an adult somatic cell using somatic cell nuclear transfer. This experiment, conducted by scientists at the Roslin Institute in Scotland, marked a significant breakthrough in cloning technology and garnered global attention.

Animal Cloning Advances (Late 1990s-Early 2000s)

Following Dolly, other animals, including cows, pigs, cats, and more,

were successfully cloned, demonstrating the feasibility of cloning various species.

The Human Cloning Debate (Late 1990s-Early 2000s)

The successful cloning of Dolly raised ethical and moral concerns about human cloning. The debate over the ethics, safety, and legality of human cloning led to widespread opposition, and many countries enacted bans on human reproductive cloning.

Gene Cloning (1970s-Present)

The development of recombinant DNA technology and gene cloning techniques allowed scientists to manipulate and clone specific genes. This has been fundamental to genetic research, biotechnology, and the production of valuable proteins like insulin.

Advancements in Therapeutic Cloning (2000s-Present)

Therapeutic cloning, which aims to produce tissues and organs for medical purposes, has continued to advance, showing potential in regenerative medicine and the study of various diseases.

The ethical and legal aspects of cloning, especially in the context of human reproductive cloning, have been subjects of significant debate and regulation. While cloning has produced important scientific achievements, it has also raised complex ethical, moral, and practical questions.

Types of cloning

There are several types of cloning:

1. **Reproductive cloning:** This type of cloning involves the creation of a new, whole organism that is genetically identical to the donor organism. In this context, it's often associated with creating copies of animals or even humans. Reproductive cloning is highly controversial and ethically complex.
2. **Therapeutic cloning:** This form of cloning is primarily used for medical or research purposes. It is aimed at generating cells, tissues, or organs that can be used for transplantation or to study diseases. The goal is not to create a whole organism but to produce specific cell types.
3. **Molecular cloning:** Molecular cloning is a laboratory technique used to create copies of specific DNA sequences or genes. This technique is widely used in genetic research, biotechnology, and the production of recombinant DNA for various applications.

Reproductive cloning is a type of cloning that involves the creation of a new, whole organism that is genetically identical to a donor organism. This process results in the birth of an organism that is essentially a genetic duplicate of the original source. In the context of reproductive cloning, it often refers to the cloning of animals or, controversially, even humans.

Key steps in reproductive cloning

Reproductive cloning has been successfully conducted in animals, most notably with the cloning of "Dolly the sheep" in 1996, which was a significant milestone in the field of cloning. However, the success rate in reproductive cloning has been relatively low, and many cloned animals have experienced health issues.

It's important to note that human reproductive cloning is widely considered unethical and is illegal in many countries due to numerous ethical, legal, and practical concerns. It raises significant moral and ethical questions, including issues related to individual identity, consent, and potential health risks for the cloned individual.

In all these cases, cloning aims to produce copies with identical genetic material. Cloning has significant ethical, legal, and practical implications, and its use and acceptance can vary depending on the context and the organisms involved.

Cloning in gynecology, or reproductive cloning, is a controversial and ethically complex topic. It involves using cloning techniques to create a genetically identical copy of an individual. In the context of gynecology, this could refer to the cloning of a human being, which is currently illegal and widely considered unethical in most countries. Cloning involves creating an embryo that is genetically identical to a donor individual and allowing it to develop into a full-fledged organism.

Reproductive cloning is a type of cloning that involves the creation of a new, whole organism that is genetically identical to a donor organism. This process results in the birth of an organism that is essentially a genetic duplicate of the original source. In the context of reproductive cloning, it often refers to the cloning of animals or, controversially, even humans.

Reproductive cloning, which involves creating a genetically identical copy of an organism, often involves a technique known as somatic cell nuclear transfer (SCNT). SCNT is the most common method used for reproductive cloning.

Here's an overview of the reproductive cloning technique using SCNT:

1. **Donor selection:** The process begins with the selection of a suitable donor organism. In the context of animal cloning, this could be an adult animal with desirable genetic traits. In the case of human cloning (though it is illegal in many countries), it would involve selecting a human donor.
2. **Egg cell retrieval:** Egg cells, or oocytes, are collected from a female of the same species. These eggs will serve as the recipients for the nucleus transfer.
3. **Nucleus removal:** The nucleus of the egg cell is carefully removed, leaving behind the cytoplasm and the egg's organelles. This step is crucial because the nucleus contains the DNA of the egg donor, which needs to be replaced with the DNA of the donor organism.
4. **Somatic cell collection:** A somatic cell is collected from the donor organism. This somatic cell contains the complete set of genetic information (DNA) of the organism to be cloned.
5. **Somatic Cell Nuclear Transfer (SCNT):** The nucleus of the somatic cell is extracted and transferred into the enucleated (nucleus-free) egg cell. This step combines the DNA of the donor organism with the egg cell's cytoplasm and organelles.
6. **Stimulation:** In some cases, the egg cell is stimulated to start dividing and developing into an embryo. This may involve chemical or electrical stimulation to initiate cell division.
7. **Embryo culture:** The resulting cell, now containing the combined DNA of the donor organism and the egg cell's cytoplasm, is allowed to develop into an early-stage embryo in a laboratory setting. This embryo can then be used for implantation.
8. **Implantation:** If the goal is to create a new individual, the early-stage cloned embryo is usually implanted into a surrogate mother's womb (in the case of animals) or a woman's uterus (in the case of human cloning).

The surrogate mother carries the embryo to term, and a

It's important to note that human reproductive cloning is widely considered unethical and is illegal in many countries due to numerous ethical, legal, and practical concerns. It raises significant moral and ethical questions, including issues related to individual identity, consent, and potential health risks for the cloned individual.

Advantages of cloning

Cloning, whether in the context of reproductive, therapeutic, or gene cloning, has both potential advantages and disadvantages. It's important to note that the advantages of cloning may vary depending on the specific type of cloning and its intended application. Here are some potential advantages of cloning:

1. **Reproductive cloning**
    - **Preservation of genetic material:** Reproductive cloning can preserve the genetic material of endangered or valuable species, ensuring their continued existence.
    - **Animal breeding:** It can be used to propagate high-quality livestock or animals with desirable traits for agriculture and research.
    - **Reproductive assistance:** Cloning might help individuals or couples with fertility issues to have genetically related children.
2. **Therapeutic cloning**
    - **Organ transplants:** Therapeutic cloning has the potential to produce tissues and organs that are genetically matched to patients, reducing the risk of rejection in organ transplantation.
    - **Disease research:** It allows researchers to study and develop treatments for a wide range of diseases, such as Alzheimer's, Parkinson's, and diabetes, using cloned cells or tissues.
    - **Drug testing:** Cloned human cells and tissues can be used for drug testing, potentially reducing the need for animal testing and making drug development more efficient.
3. **Gene cloning**
    - **Biotechnology:** Gene cloning is fundamental in biotechnology for producing valuable proteins, like insulin and growth hormones.
    - **Scientific research:** It enables scientists to study the functions of specific genes and better understand genetic mechanisms.
    - **Gene therapy:** Cloning techniques can be used in gene therapy to correct genetic defects and treat genetic disorders.

However, it's crucial to consider the disadvantages and ethical concerns associated with cloning as well, such as potential health risks to cloned individuals, the potential for misuse, and the complex ethical and moral issues related to human cloning. Ethical and safety considerations should always be carefully evaluated before pursuing any form of cloning.

Ethical, social and medical concern related to cloning

Reproductive cloning is a highly controversial and ethically complex topic, and it is associated with numerous ethical, social and medical concerns. Some of the key issues and concerns include:

Ethical concerns

1. **Identity and individuality:** Cloning raises questions about the uniqueness and individuality of cloned individuals. Clones may face challenges in developing their own identities, as they are genetic duplicates of existing individuals.
2. **Autonomy and consent:** Cloned individuals do not consent to their creation, which raises concerns about autonomy and consent. They may be born into circumstances they had no say in, potentially leading to ethical dilemmas.
3. **Safety and health risks:** Cloning has a high rate of failure, and many cloned animals have experienced health problems and developmental abnormalities. There are concerns about the safety and well-being of cloned individuals.
4. **Psychological and social impact:** Cloned individuals may face stigma, discrimination, and psychological challenges. Society may also have to grapple with complex issues related to family, relationships, and social acceptance.

Social concerns

1. **Family dynamics:** Reproductive cloning could disrupt traditional family structures and dynamics. For example, a cloned child might share an identical genetic heritage with an existing sibling.
2. **Social acceptance:** Society may struggle with accepting cloned individuals, potentially leading to discrimination or exclusion based on their method of conception.
3. **Cost and accessibility:** Cloning is an expensive and complex procedure. Concerns about the cost of cloning and its accessibility could lead to social inequalities.

Medical concerns

1. **High rate of failure:** Cloning often results in a high rate of failure, with many cloned embryos failing to develop or leading to unhealthy offspring.

2. **Health risks to cloned offspring:** Cloned animals have shown a higher likelihood of suffering from health problems, including organ abnormalities, accelerated aging, and other medical issues.
3. **Ethical dilemmas for healthcare professionals:** Healthcare professionals may face moral and ethical dilemmas when asked to participate in the cloning process.
4. **Regulation and oversight:** Ensuring the ethical and safe use of cloning technologies requires robust regulation and oversight. The development of appropriate regulatory frameworks can be challenging.

Given these concerns, many countries have implemented strict legal and regulatory prohibitions on human reproductive cloning. While research into cloning techniques continues for various purposes, including therapeutic cloning and gene editing, the ethical and moral debate surrounding reproductive cloning remains complex and largely opposed by many segments of society.

It's important to distinguish reproductive cloning from other forms of cloning, such as therapeutic cloning, which is used for medical research and the development of stem cells. Therapeutic cloning is intended to create cells or tissues for potential medical treatments and is less ethically controversial than reproductive cloning.

Advancements and developments in reproductive cloning

Reproductive cloning, which involves creating genetically identical copies of organisms, has seen some advancements and refinements since the birth of Dolly the sheep in 1996. While it remains ethically and scientifically controversial, researchers have made progress in the field. Here are some of the advancements and developments in reproductive cloning:

1. **Improved techniques:** Over the years, researchers have refined the techniques used in reproductive cloning. They have gained a better understanding of the processes involved, such as somatic cell nuclear transfer (SCNT) and have improved the efficiency of cloning.
2. **Cloning of additional species:** Beyond Dolly the sheep, scientists have successfully cloned other animals, including cows, pigs, cats, and mice. This demonstrates that cloning can be applied to a variety of species.
3. **Endangered species conservation:** Cloning has been explored as a potential tool for preserving endangered and extinct species. For

example, scientists have worked on cloning efforts for the northern white rhinoceros and the black-footed ferret.

4. **Stem cell research:** Cloning techniques, especially SCNT, are used in the field of stem cell research. Researchers can generate embryonic stem cells that are genetically matched to a patient, potentially reducing the risk of rejection in transplantation.
5. **Understanding genetic diseases:** Cloning has contributed to the study of genetic diseases by creating animal models that mimic human conditions. This is particularly valuable for research on conditions such as Huntington's disease and cystic fibrosis.
6. **Reproductive cloning of prized livestock:** In agriculture, there have been efforts to clone prized livestock, such as cows with valuable milk or meat production traits. Cloning allows for the reproduction of animals with desired genetic characteristics.

Despite these advancements, it's important to note that reproductive cloning remains ethically and scientifically complex. The technology still faces significant challenges and has limitations, including a relatively low success rate and a higher likelihood of health issues in cloned animals. Additionally, the ethics of human reproductive cloning continue to be a matter of significant debate, and it is illegal in many countries. Regulations and ethical considerations play a crucial role in the advancement and application of reproductive cloning techniques.

Limitations and challenges of cloning

Cloning, in its various forms, has several limitations and challenges, which can vary depending on the type of cloning and the specific techniques used. Some of the general limitations and challenges associated with cloning include:

1. **Low success rate:** Reproductive cloning, such as somatic cell nuclear transfer (SCNT), often has a low success rate. Many cloned embryos fail to develop, and a significant percentage of cloned animals suffer from health problems and developmental abnormalities.
2. **Genetic diversity:** Cloning creates genetically identical copies, which can lead to reduced genetic diversity. A lack of genetic diversity can make cloned populations more vulnerable to diseases and environmental changes.

3. **Health risks:** Cloned animals, especially in the case of mammals, are more likely to experience health issues, including organ abnormalities, accelerated aging, and other medical problems.
4. **Ethical concerns:** Cloning, especially reproductive cloning, raises complex ethical and moral questions about identity, autonomy, consent, and the rights of cloned individuals.
5. **Regulatory and legal issues:** Cloning faces strict regulations and legal prohibitions in many countries, particularly when it comes to human reproductive cloning. Developing appropriate regulatory frameworks is challenging.
6. **Complex and costly:** Cloning is a complex and costly procedure. It involves specialized equipment and expertise, making it inaccessible to many individuals or entities.
7. **Social and psychological impacts:** Cloned individuals may face social and psychological challenges related to their genetic identity, and society may struggle to accept them.
8. **Research and development challenges:** In the case of therapeutic cloning and gene cloning, research and development can be time-consuming and require extensive resources.
9. **Environmental impact:** Cloning can raise concerns about the introduction of genetically identical organisms into the environment, which may have ecological consequences.
10. **Unpredictable outcomes:** The cloning process can lead to unpredictable outcomes, including unforeseen genetic mutations or epigenetic changes.
11. **Public perception:** Cloning is often met with skepticism and public concerns. Public perception and acceptance of cloning can affect its progress and applications.

Despite these limitations and challenges, cloning technologies continue to evolve, and they have applications in various fields, including agriculture, medicine, genetics, and biotechnology. Researchers and policymakers continue to address these challenges to maximize the benefits of cloning while mitigating its risks and ethical concerns.

Scope of cloning

The scope of cloning, encompassing various types of cloning techniques, has significant potential in several areas of science and medicine. While some cloning applications remain highly controversial and ethically complex, others

offer promising possibilities for research, medical advancements, and various practical applications. Here are some areas where cloning has a scope for potential impact:

1. **Therapeutic cloning:** Cloning techniques, such as somatic cell nuclear transfer (SCNT), are employed in therapeutic cloning to generate cells, tissues, and organs for medical purposes. This has the potential to revolutionize regenerative medicine by providing genetically matched tissues and organs for transplantation.
2. **Disease research:** Cloning can be used to create animal models of human diseases, allowing researchers to study and develop treatments for conditions like Alzheimer's, Parkinson's, and cancer. It contributes to a better understanding of genetic mechanisms and disease processes.
3. **Pharmaceuticals:** Cloning is used in biotechnology to produce proteins and enzymes essential in pharmaceuticals, including insulin and growth hormones. Cloned cells are valuable for drug development and testing.
4. **Agriculture:** Cloning can be applied to improve agricultural practices. It allows for the replication of high-quality livestock and crops with desirable traits, contributing to food production and sustainability.
5. **Endangered species conservation:** Cloning can aid in the conservation of endangered and extinct species. It offers the potential to revive populations of species that are on the brink of extinction.
6. **Stem cell research:** Cloning techniques are crucial in generating embryonic stem cells for studying diseases, developing therapies, and understanding human development. They offer insights into regenerative medicine and tissue engineering.
7. **Gene therapy:** Cloning is involved in the development of gene therapy, allowing for the correction of genetic defects and the treatment of genetic disorders.
8. **Biotechnology:** Cloning plays a pivotal role in the biotechnology industry. It allows for the manipulation of genes and the production of valuable compounds and proteins with numerous applications.
9. **Medical advancements:** Cloning offers the potential to create personalized medical treatments and therapies tailored to an individual's genetic makeup. This is particularly relevant in the field of cancer treatment.

10. **DNA and forensic science:** Cloning is used in forensic science for amplifying DNA samples, assisting in the identification of individuals and solving criminal cases.
11. **Education and research:** Cloning technologies are invaluable tools in education and research for studying genetics, cell biology, and molecular biology.

Despite the scope for advancement and innovation, it is important to consider the ethical, legal, and societal implications surrounding cloning. Public perceptions, regulatory frameworks, and ongoing research will continue to shape the scope and direction of cloning in the future.

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Chapter - 8
A Brief Study of Snail Culture and Mucin Development

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Chapter - 8

A Brief Study of Snail Culture and Mucin Development

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Abstract

The goal of this study was to optimize the production of sustainable food by analyzing the structural and managerial aspects of Coimbatore's snail farms. The identification of snails and the development of the snails in various environments are some objectives. A questionnaire was used to collect the information in 2023, and sampling was carried out at various farms that grew different types of snails spread out over six distinct places. We chose apple snail for our experiment. For continuous data, descriptive statistics were computed, and for categorical variables, frequencies. The typical farm operation lasted more than eight months, and the annual mean production of fresh, live snails was 1597 kg. Different features were found in the results of snail culture and growth. The geographical location of a farms' settlement affects productivity but also influences the duration of operation, especially in open field farms, due to their operation under a wide assortment of climatic types.

Keywords: Heliciculture, invertebrate livestock, environmental sustainability

Introduction

Heliciculture (Snail Farming), a relatively new area of agricultural production in Greece, is a great alternative to obtain edible snails (Hatziioannou, M *et al*. 2008, Berillis, P *et al*. 2013). Heliciculture has grown over the past ten years as a result of favourable climatic circumstances and a high level of interest, particularly among young people, in this sector. Since the beginning of time, people have raised snails. Land snails were consumed by the Greeks, Phoenicians, and other pre-Roman Mediterranean nations; this practice has persisted in modern Mediterranean cuisine (Duhart, 2009).

As evidenced by the large number of shells discovered at numerous ancient sites, Rome created snail preserves about 50 B.C. (Lubell, 2004).

The fact that "Wall Fish" was consumed in Britain during the Roman Empire's growth shows how the uses of snails were expanded beyond its borders. The Middle Ages had reports of snail consumption as well, with convents permitting the eating of their meat during fast days (Duhart, 2009). From the 19th Century, snails were introduced in America, Africa and some Asian countries.

"A Virginia Farmer" (Davis, P.R. *et al*., 1996) described keeping snails in a cool, moist and shady environment, supplying artificial dew if necessary, containing them on an "island" surrounded by water to prevent escape, supplying vegetation as feed, and fattening them on corn meal. Numerous and sophisticated techniques for growing snails have been developed in France, Italy, Spain, and Australia as well (Elmslie 1989, Iglesias *et al*. 1996).

Over 100,000 metric tons of snails are consumed annually in Europe, and imports of snails into the continent increased by 49% between 1995 and 2010 (Morei, V 2012, Oikonomou, S *et al*. 2012). According to (Anonymus, 2012), there are currently 136 farms for snails in Greece, totalling 575 acres. While foreign experts are interested in tropical and developing countries, no economic study on snail farming in Greece has yet been published (Chaitanawisuti, N *et al*. 2002, Cobbinah, J *et al*. 2008, Ogunniyi L.T., 2009), where the use of mini livestock can be less resource-intensive and, if managed properly, could be analternative to the existing technique of raising livestock (Paoletti, M. G., 2005).

Despite the fact that humans have long consumed snails as food, the majority of scientific research on snails in West Africa has been conducted from the perspective of animal parasitology, where snails serve as an intermediate host for harmful nematodes. (Wosu, 2003). But in recent years, researchers have investigated the use of snails as livestock and human food (Imevbore and Ademosun, 1988; Simpson, 1990; Thompson, 1996; www.weightlossforgood.co.uk, 2003). Snails have enormous economic and medical benefits, ranging from their shells to the tissue in their feet (Wosu, 2003). Snails have great yields on low input and are inexpensive to rear at both the subsistence and commercial levels. With higher quantities of protein, iron, lysine, leucine, arginine, calcium, and phosphorus, as well as lower levels of sodium, fat, and cholesterol when compared to chicken and other livestock, they are great sources of nourishment for both humans and animals (Imevbore and Ademosun,1988; Simpson, 1990; Thompson, 1996; Wosu, 2003).

Snail is traditionally used to make components for treating small pox, reducing labor pains, and preventing blood loss after childbirth (Akinnusi, 1998). It is also used in the treatment of anaemia, hypertension, highblood pressure and other fat-related conditions (Wosu, 2003; Imevbore and Ademosun, 1988 and Adegbola 1998).

Snails have been devoured by humans since the beginning of time and are still considered a delicacy in some nations, such as Escargot (commonly refers as *Helix aspersa* or *Helix pomatia*) (Pissia *et al*., 2021; Conte, 2015; Massari & Pastore, 2014). Land snail mucus includes active ingredients that are advantageous for skin health and beauty, wound healing, and other factors that are currently a new trend in the cosmetics market. (Rosanto *et al*., 2021; Ferdian, 2020;Laneri *et al*., 2019; Pitt *et al*., 2015; Ehara etal., 2002).Snail farming, also known as heliculture, tries to maximize snail output to increase profitability. This includes harvesting snail meat, creating snail caviar and secreting snail mucus. (Conte, 2015; Massari & Pastore, 2014).

Morphology of the snail

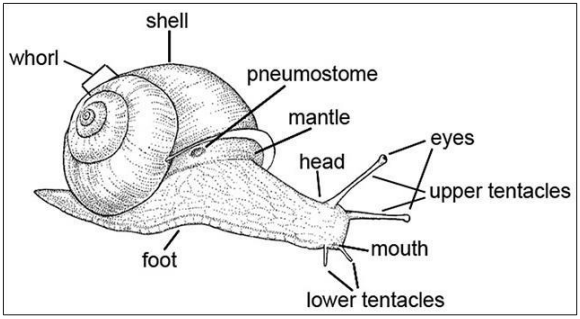

Fig 1: Structure of snail

Head: The head of the snail has a pair of eyes, a pair of upper and lower tentacles and mouth.

Eyes: The snail has a weak organ of vision, which is placed at the end of the eyestalk.

Upper and lower tentacles: Long and retractable little muscular appendage with a tactile function.

Mouth: To feed on plants, the anterior canal of the digestive tract has a jaw and a rough tongue (radula).

Foot: Flat, muscular lower portion used for the locomotion.

Mantle: A layer of tissue found between the outer shell and the body.

Shell: The hard outer covering which covers the smooth body surface and helps to protect from predators.

Whorl: The complete 360^0 spiral structural formation in the shell.

Pneumostome: A small pore used for respiration, also called Breathing pore.

Mating and Reproduction

Snails have both sexes. Despite having both male and female reproductive organs, before they can lay eggs, they must mate with another snail of the same species. One season, some snails may behave as male, and the following, as females. Other snails perform both functions concurrently and fertilize one another. In order to lay their eggs, snails require soil that is at least 2 inches deep. The soil should be at least three inches deep for H. pomatia. Keep out insects like ants, earwigs, millipedes, and other pests. It is not advisable to prepare a nest on dry dirt or soil that is excessively heavy. Because the snails can't bury their eggs and the hatchlings have trouble leaving the nest, reproduction rates in clay soil that hardens may drop. Egg hatchability is influenced by factors such soil temperature, humidity, and composition. It is ideal for soil to contain 20% to 40% organic matter. Keep the soil between 65 and80 degrees Fahrenheit, preferably 70. Maintain 80% soil moisture (Rebecca Thompson, 2008). Land snail survival and growth rate depend on temperature and air humidity, respectively. (Pawson & Chase, 1984; Panha, 1988).

Morphology of egg

Eggs of the *H. aspersa* species are white, spherical, 3mm-diameter and are laid 5-3 weeks after mating. (Data varies greatly as a result of regional changes in habitat for snails and climatic variables). In a nest that is 1 to 1 ½ inches deep, *H. aspersa* typically lays 85 eggs. Data ranges from 30 to over 120 eggs, but high numbers may result from many snails laying eggs in the same nest. *H. aspersa* may lay eggs as frequently as once per month from February through October in warm, humid settings, depending on the location and weather. When there are at least 8 hours of daylight, mating and egg-laying start, and they continue until the days start to get shorter. The eggs hatch in approximately two weeks if it's warm enough, or four weeks if it's chilly (Rebecca Thompson, 2008).

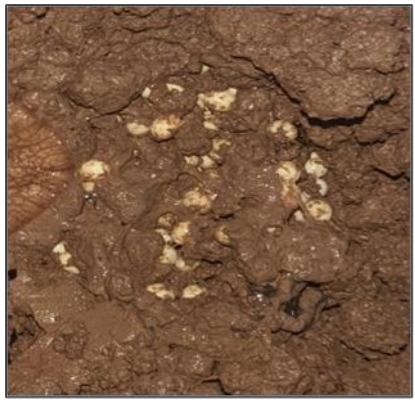

Fig 2: Snail egg

Reproduction

Hermaphrodite Cornu aspersum, also known as Helix aspersa, is a type of pulmonated gastropod mollusc that lives on land. Mature shells (shell height> 27 mm) develop a thickening, recurving lip at the margin of the shell opening. (Daguzan 1982; Begg 2003). The snails' reproductive behaviour involves touching their tentacles, which causes a hardened dart to emerge, the genital vebt to be pushed out, and copulation to occur. (Avagnina, 2012). The local climate had a significant impact on the life cycle of *C. aspersum* (Chevallier 1977) and farming system. According to Lucas & Davis (1961), a pH of 7.2 or higher implies that the soil is calcium-rich. A calcium-rich soil is a favorable characteristic since it promotes snails' shell growth in snail culture.

Since C. aspersum has a high reproductive capacity and can adapt to any climatic or farming situation, it is commonly employed in snail farming (Avagnina, 2012).

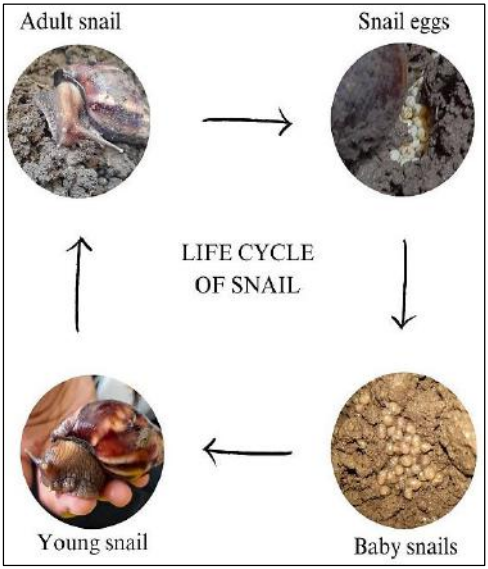

Fig 3: Life cycle of snail

Climatic and Environmental conditions

It is evident from the descriptions of the three main GALS species that snails, being cold-blooded creatures, are sensitive to variations in air temperature and humidity. GALS, particularly Achatina fulica, can withstand a variety of circumstances, but when temperature When the temperature and/or humidity are not right, they enter dormancy. The Snail closes the aperture to its shell by pulling its entire body back inside with a white, calcareous layer to stop the body from losing water. (Dr. Joseph R. Cobbinah, 1993)

Temperature: There is a constant annual range of 25-30 °C, with little variation between daytime and nighttime temperatures.

Daylength: Throughout the year, the photoperiod is roughly consistent at 12 hours a year.

Air humidity: 75 to 95 percent relative air humidity throughout the year. (Dr. Joseph R. Cobbinah, 1993)

Temperature and Humidity

Being cold-blooded, snails do best in environments with high humidity and moderate temperatures. In West Africa, temperatures are generally stable in the regions where the majority of edible species are found. There are substantial variations in air humidity, though, and these have a noticeable

impact on the GALS species included in this book. Snails hibernate in their natural habitats during the dry season.

It is not advisable for relative air humidity to be close to saturation because doing so would promote the growth of dangerous germs and fungus. It is obvious that climatic conditions cannot be controlled in outdoor settings. However, in locations with reasonably dense vegetative cover or relatively undisturbed forests, temperature and humidity changes are less extreme. Such locations ought to be chosen over open grassland or farmland. (Dr. Joseph R. Cobbinah, 1993)

Soil characteristics

A snail's environment primarily consists of soil. When choosing a site, it's necessary to take into account the texture, water content, and soil composition. The majority of the calcium in the snail's shell comes from the earth. (Dr. Joseph R. Cobbinah, 1993)

- Snails get the majority of the water they need from the soil.
- To lay their eggs and to rest during the dry season, snails dig in the ground.
- It is not a good idea to have heavy, clayey soil that gets saturated during the rainy season and compacts during the dry season. Additionally, very sandy soil is undesirable due to its poor ability to retain water.
- Snails can grow and flourish on soils with a lot of organic materials. Generally speaking, a soil is suitable for snail farming if it promotes healthy development of cocoyam, tomatoes, and green vegetables.
- Snail activity, including eating, predominates at night and peaks 2 to 3 hours after the onset of darkness. The overnight dew makes it easier for the snail to move, and the cooler weather promotes activity. Snails like to hide in safe places for the majority of the day. Shredded, semi-dry banana leaves are placed in the bottom of snail enclosures in Nigeria, where the snails use them as cover during the day.
- Since snail shells contain between 97% and 98% calcium carbonate, they must have access to calcium, either from the soil or another external source (such ground limestone, egg shells, etc.). Organic matter in the soil is essential, just like carbonates. Soils rich in exchangeable calcium and magnesium are the best at accelerating growth. If you'd like, you may also leave calcium out for the snails to eat in a feeding dish or trough.

- Over time, mucus and droppings will contaminate the soil in the snail enclosures. Also possible are chemical alterations. As a result, the soil must be replaced every three months.

Fig 4: Types of soil

MUCIN

Fig 5: Mucin extraction

The fascination with the mucus slime trails made by snails and slugs dates back to ancient Greece, when the mucus was used to alleviate inflammation and the effects of aging (Ekin, 2018). Despite having practical uses, the study of mucus is still relatively neglected. The majority of animals' secreted mucins, a family of extensively glycosylated proteins made in epithelial cells, are the main component that gives mucus its characteristics. Mucins are either secreted from the cell or attached to the plasma membrane, and each form has distinct capabilities and roles (Dhanisha *et al*., 2018).

Membrane-bound mucins are glycolipids that serve as indicators for cell signaling and shield the cell from external aggressors like infections and physical stress that could cause damage (Van Putten and Strijbis, 2017). Mucosal membranes make about 99% of the body's surface area in humans (Sompayrac, 2012; Ma *et al*., 2018; Cerullo, 2020). Each type of snail secretes a variety of different, useful mucuses. An inverted snail can attach to or move across any surface because to the mucus secreted by its foot, which also serves as lubrication.

The mucus that the snail produces on its back is also employed for tissue hydration and germ protection. Mucus is used in unique ways by some snail species. For instance, Tikoconuscostarricanus (Costa Rican Land Snail) uses mucus for load-bearing tasks, such as hiding from the Sun on the underside of leaves during droughts, and Falsilunatiaeltanini (Moon Snail) uses mucus to protect their eggs (Gould *et al*., 2019; Barrientos, 2020). Snail mucus' antibacterial qualities are being used to treat a variety of human diseases, including post-surgical infections and gastric ulcers (Amah *et al*., 2019; Gentili *et al*., 2020).

Helix aspersa mucus has a significant number of natural compounds with medicinal and therapeutic qualities for human skin, including as allantoin and glycolic acid, according to recent studies on the composition of snail secretions (El Mubarak *et al*., 2013). According to the species and the function it serves, such as adhesion or trailing, the content of snail mucus varies, but for these purposes, it normally contains between 90% and 99.7% water by weight (Denny M, 1983). Proteoglycans, glycosaminoglycans, glycoprotein enzymes, hyaluronic acid, copper peptides, antimicrobial peptides, and metal ions make up the remainder of mucus that isn't water (Gabriel UI *et al*., 2011, Skingley D 2010, Sallam AA *et al*., 2009, Greistorfer S *et al*., 2017).

Various firms still employ snail mucus in skin care products today, and the market for these goods is expanding. By 2025, it is predicted that the industry will be worth around $770 million (Coherent Market Inisghts, 2018).

Shell

Fig 6: Structure of the shell

The color of the snail shell is brownish, with dark brown patterns. The typical snail shell is quite hard and shields the animal from physical harm, predators, and dehydration. In this region, snail shell is used to make jewelry, buttons, and art collections (Jatto O E, 2010). The shell's base can range in color from light yellow to dark brown, and it has dark, elongate bands that are different sorts and shades of color. When it comes to the farmed subspecies of C. a. aspersum and C. a. maxima as well as wild species, differences in size, weight, and other morphometrical properties of the shell can be explained by the species, age of the snails, the period of collection, the breeding conditions, and food (Gomot A, 1998, Barker, G.M., 2001, Milinsk, M.C. *et al*., 2006, Kougiagka, E. *et al*., 2022).

Numerous studies particularly link this polymorphism to climate or predational factors (Johnson, M.S., 2001). Snails that are growing at low temperatures tend to have dark banding, whereas snails that are growing at temperature levels over 25 ^{o}C have red banding (Lecompt, O. *et al*., 1998). The assumption that darker snail shells have a higher warming capacity should be viewed with caution. Instead, other potentially selecting factors and correlations have been suggested, such as humidity and the higher prevalence of parasites in humid environments in northern and/or sheltered habitats.In the paper business, snail shell powder plays a significant filling role. The mechanical qualities of paper can be improved by adding shell powder because of its calcium carbonate and chitin content.

These qualities include opacity, abrasion resistance, machine flowability, brightness, and strength. In the ceramics industry, shells in the powdered form are used to make breakable plates, pipes, and kitchenware. Nearly 98% of the mineral calcium carbonate may be found in snail shells (Cobbinah J R, *et al*., 2008). It can consequently be utilized as a biological source of calcium for animal nutrition.

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Chapter - 9
Utilizing Machine Learning to Investigate the Role of Carotenoids in Augmenting Reproductive Capacity in Aquatic Organisms

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Chapter - 9

Utilizing Machine Learning to Investigate the Role of Carotenoids in Augmenting Reproductive Capacity in Aquatic Organisms

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Abstract

Carotenoids have long been recognized as vital components for enhancing reproduction in marine animals. Notably, the supplementation of Astaxanthin in cultured salmon and red sea bream has demonstrated significant benefits in promoting ovary development, fertilization rates, hatching success, and larval growth. Furthermore, carotenoids play a crucial role in aquaculture, where they are commonly utilized for enhancing the coloration of various fish species. Both synthetic and natural sources of Astaxanthin, derived from Phaffia yeast and Haematococcus algae, are widely employed to achieve vibrant hues in salmon, trout, and red sea bream. Additionally, Lutein sourced from marigold is employed to impart a rich yellow coloration to cultured marine fish, including yellowtail and red sea bream. Notably, Spirulina-derived zeaxanthin is utilized to achieve striking red coloration in goldfish and ornamental carp. This study employs a machine learning approach to investigate the intricate role of carotenoids in the reproduction of aquatic animals.

Keywords: Carotenoid pigments, immunity, reproductive system, machine learning

Introduction

Carotenoids are a group of natural pigments that contribute to many of nature's hues. The basic structure of a carotenoid is the asymmetrical tetraterpene skeleton formed by the conjugation of two C20 units, which could be deemed the backbone of the molecule. Based on their composition, carotenoids are subdivided into two groups. Carotenoid, which comprises carbon and hydrogen atoms, is collectively assigned as carotenes. Most natural carotenoids contain at least one oxygen functional group, referred to as xanthophylls. Only plants, bacteria, fungi, and algae can synthesize

carotenoids; animals cannot biosynthesize them; thus, they must be obtained from the diet. Carotenoids play a critical role in the photosynthetic process, and they carry out a protective function against damage by light and oxygen. Antioxidants, immunoregulators, and pro-vitamin A are the distinct roles of carotenoids. Furthermore, the mobilization of the pigment from muscle to ovaries implies a purpose in reproduction. It has similarly mentioned that fishes with a significant content of carotenoids are further resistant to microbial diseases. The long conjugated double-bond system is the central feature of carotenoid, which makes it possible to absorb light of wavelength 400-500nm from the electromagnetic spectrum (Chien, 1996). The chemical structure of the carotenoids plays a vital role in their oxygen scavenging properties.

Influence of carotenoids on reproductive success in aquatic animals through MI

Carotenoids refer to the most critical natural pigments found in photosynthetic organisms, with colors varying between yellow and dark red. One of the most critical traits of carotenoids is their physiological function as vitamin A precursors to animals. Vitamin A deficiency is a leading cause of morbidity and mortality, especially in young children and pregnant and lactating women. Food-based interventions focused on alleviating vitamin A deficiency in susceptible populations have advantages over supplementation and fortification programs, especially in rural areas, because they can provide a sustainable source of various nutrients and other phytochemicals without the recurring transport and administration costs of these other methods. It is estimated that about 50 can act as precursors of vitamin A in mammals among all known carotenoids. However, only α-carotene, β-carotene, γ-carotene and β-cryptoxanthin are common in fruits and vegetables. Cassava genotypes with high contents of provitamin A carotenoids have been identified as a strategy to reduce the prevalence of deficiency of this vitamin (Arredondo-Figueroa *et al*., 1999).

Cassava genotypes with high pro-vitamin A activity have been identified as a strategy to reduce the prevalence of deficiency of this vitamin. The color variability of cassava roots, which can vary from white to red, is related to the presence of several carotenoid pigments. The present study has shown how CIELAB color measurement on cassava roots tissue can be used as a non-destructive and swift technique to quantify the levels of carotenoids in cassava root samples, avoiding the use of more expensive analytical techniques for compound quantification, such as UV-visible spectrophotometry and the HPLC. For this, we used machine learning

techniques, associating the colorimetric data (CIELAB) with the data obtained by UV-vis and HPLC, to obtain models of prediction of carotenoids for this type of biomass. Best values of R2 (above 90%) were observed for the predictive variable TCC determined by UV-vis spectrophotometry. When we tested the machine learning models using the CIELAB values as inputs, for the total carotenoids contents quantified by HPLC, the Partial Least Squares (PLS), Support Vector Machines, and Elastic Net models presented the best values of R2 (above 40%) and Root-Mean-Square Error (RMSE). For the carotenoid quantification by UV-vis spectrophotometry, R2 (around 60%) and RMSE values (around 6.5) are more satisfactory. Ridge regression and Elastic Network showed the best results. It can be concluded that the use of colorimetric technique (CIELAB) associated with UV-vis/HPLC and statistical techniques of predictive analysis through machine learning can predict the content of total carotenoids in these samples with good precision and accuracy (Petit *et al*., 1997).

Carotenoids are a group of natural pigments that contribute to many of the hues in nature. The basic structure of a carotenoid is the asymmetrical tetraterpene skeleton formed by the conjugation of two C20 units, which could be deemed the backbone of the molecule. Based on their composition, carotenoids are subdivided into two groups. Carotenoid, which comprises carbon and hydrogen atoms, is collectively assigned as carotenes. Most natural carotenoids contain at least one oxygen functional group, referred to as xanthophylls. Only plants, bacteria, fungi, and algae can synthesize carotenoids; animals cannot biosynthesize them; thus, they must be obtained from the diet. Carotenoids play a critical role in the photosynthetic process, and they carry out a protective function against damage by light and oxygen. Antioxidants, immunoregulators, and pro-vitamin A are the distinct roles of carotenoids. Furthermore, the mobilization of the pigment from muscle to ovaries implies a purpose in reproduction. It has similarly mentioned that fishes with a significant content of carotenoids are further resistant to microbial diseases. The long conjugated double-bond system is the central feature of carotenoid, which makes it possible to absorb light of wavelength 400-500nm from the electromagnetic spectrum. The chemical structure of the carotenoids plays a vital role in their oxygen scavenging properties.

Aquaculture is the farming of aquatic organisms, including fish, mollusks, crustaceans, and aquatic plants. Farming intends some intrusion in the rearing method to improve production. The feed choice and feed management practices have a significant impact on the economic performance of a production system. Several feed additives have been

incorporated in shrimp feed to generate resistance against various stressors and increase aquaculture production. Carotenoid is one such compound that plays a significant function in industrial aquaculture. Carotenoids are chiefly employed in the diets of crustaceans, salmonids and other farmed and ornamental fishes, being pigment sources for desirable coloration (Tode *et al*., 2001). Besides, carotenoids will serve as an antioxidant that helps to mitigate oxidative stress. Various studies have reported the influence of carotenoid pigment on the development and survival of aquatic organisms (Table: 1). The carotenoid source of these studies varies from synthetic carotenoids to natural carotenoids. Chien reported a 77% increase in survival rate for shrimp fed a 100mg/kg astaxanthin supplemented diet compared to shrimp enriched with βcarotene, which equated to 40%. An 88.2% increased survival was observed in fed 350 ppm carotenoids enriched diet (*Tagetes erecta*) for five weeks, contrasted with 76.5% in control. I noticed that feeding an astaxanthin-based diet at 60 mg kg-1 over eight weeks showed a notable decrease in mortality of adult shrimp (Penaeus japonicas) to those receiving carotenoid-free diets (Maoka, *et al*., 2005) Yamada proclaimed an increased survival rate of 91% for P. japonicas supplemented with 100 pm carotenoid contrasted to 57% in the control group. The authors further elucidated that astaxanthin is more effective than β-carotene or canthaxanthin as a pigment source in P. japonica. P. indicus larvae exhibited a markedly greater survival rate (88%) from the PZ1 stage until metamorphosis when fed the astaxanthin-enriched nematodes *Panagrellus redivivus* (1.43 µg astaxanthin g-1 dry weight of nematode). At the same time, neither larval growth nor development was affected. Survival (100%) was more significant in shrimp (*L. vannamei*) fed paprika (*Capsicum annuum*) than in those fed basal diets (80.5%). *Hyphessobrycon callistus* was supplied with nine pigmented diets containing AX-astaxanthin, BC- β-carotene, and MX-1:1 mixture of AX and BC at different concentrations (10, 20, and 40 mg/kg). No differences in growth and survival of the fish among treatments were found after eight weeks of rearing.

Immunity

Early research revealed that dietary intake between 230 and 810 mg astaxanthin kg-1 diet for four weeks improved the immunity of postlarvae giant tiger prawn P. monodon against salinity shock. Another study pointed out that astaxanthin (200 mg kg-1 diet) effectively increased the endurance of *P. monodon postlarvae* to low salinity stress. Additionally, Chien noticed that dietary inclusion of astaxanthin (360 mg kg-1 feed) for one week appeared to induce optimal tolerance in the larval stages of P. monodon upon

exposure to 4 h of low dissolved oxygen level (<1 mg L^{-1}). The observations made when different stress factors were tested on P. monodon juveniles that received astaxanthin (80 mg kg-1 diet) over eight weeks also exhibited enhanced antioxidant defence capability, better hepatopancreatic function, and subsequent improvement recovery against osmotic and thermal stresses. Similarly, *P. monodon juveniles* fed a diet supplemented with 71.5 mg astaxanthin kg-1 feed displayed a sounding antioxidant status and elevated resistance to ammonia stress (Tsushima *et al*., 1997). Supamattaya found that P. monodon supplemented 200–300 mg Dunaliella extract kg1 diet were more endurable to hypoxic conditions (0.8–1 mg L -1) and significantly more excellent resistance to white spot syndrome virus (WSSV). At the same time, measures of phenoloxidase assay and total hemocyte count were negatively correlated. Wang studied antioxidant activities of *H. callistus* modified with dietary carotenoid type *viz*; astaxanthin, β-carotene, and a combination of both (1:1) at 0, 20, and 40 mg/kg concentrations. Dietary astaxanthin had more numbers of negative correlations with antioxidant parameters in fish than β-carotene. Pham authenticated lesser liver and plasma SOD activities in *Paralichthys olivaceus* supplemented with carotenoid than the control group.

Pigmentation

In a study, 318% increase in carotenoids from the tissue of the carotenoid fed group than those fed the commercial diet without carotenoids had a carotenoid increase of only 14%. A noticeable increment of carotenoid content in the exoskeleton was reported when animals were provided with Spirulina-supplemented diets, and a carotenoid supplemented diet influenced that pigmentation (Maoka *et al*., 2010). Abdomen coloration produced by 200 ppm chlorophyll and an unesterified marigold diet is insignificant. Red porgy (*Pagrus pagrus*) were fed with 100 ppm astaxanthin obtained 27.7 µg g-1 carotenoid from the skin, while fish fed non-carotenoid supplemented diet (control) had 4.33 µg g-1 skin. Nine pigmented diets, including carotenoid diet (CD) and its combination (AX-astaxanthin, BC- β-carotene, MX-1:1 combination of AX and BC) at three concentrations (10, 20, and 40 mg/kg) were used for feeding. Body AX and BC content increased with increasing dietary CD concentration. Skin coloration and total carotenoid content of olive flounder (juvenile) are increased by dietary supplementation of carotenoid discovered that 30% inclusion of *Arthrospira platensis* in feed as carotenoid supplement improved fish color in Red tilapia (*Oreochromis* sp.) The reproductive performance provided insight into the improved fecundity, ovarian development, and spawning of P. monodon broodstock

when fed with astaxanthin (100 mg kg-1 diet) for 61 days. In another related study, performance assessed in spermatozoa in male shrimp and the number of eggs in gravid females was greatly enhanced when fed with a 500 mg astaxanthin kg-1 diet. Dietary intake of 150 mg astaxanthin kg-1 feed (compared to 50 and 100 mg levels) for 150 days significantly promoted the hematocrit value, sperm concentration, motility, osmolality, and fertilization rate goldfish Carassius auratus. In rainbow trout, O. mykiss, astaxanthin supplementation is necessary for optimum reproduction. Supplemented carotenoids from paprika oleoresin on gilthead seabream broodstock performance seem to significantly improve broodstock performance via egg viability, hatching rates, and fecundity.

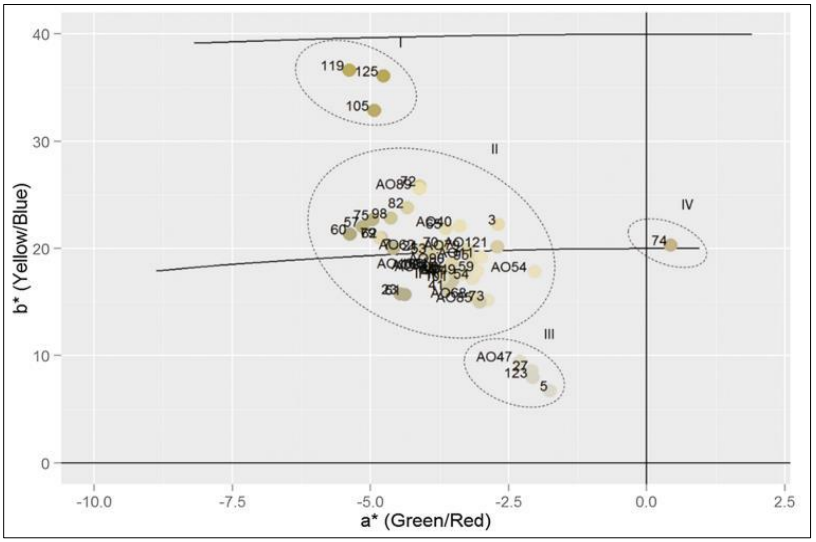

Fig 1: Depicts the location of the cassava samples in the CIE L* a* b* plane according to their root pulp colors. The* value characterizes the coloration in red (+a*) regions to green (−a*). The b*, value b* indicates coloring from yellow (+b*) to blue (−b*). The L indicates the luminosity, varying from white (L = 100) to black (L = 0)

Table 1: Depicts the Performance values (RMSE and R2) associating UV-vis scanning spectrophotometry (400-500 nm) with the total carotenoids contents determined by HPLC (TCC HPLC), total carotenoids contents determined by Lambert-Beer formula (TCC Spectrophotometry) and the majoritarian carotenoids of cassava roots samples (trans-β-carotene)

	UV-vis. 400–500 nm					
	TCC Spectrophotometry		TCC HPLC		*trans*-β-carotene	
	RMSE	R^2	RMSE	R^2	RMSE	R^2
Partial Least Squares (simpls)	**3.492**	**0.920**	5.789	0.572	4.309	0.362
Support Vector Machines (e1071)	**3.709**	**0.931**	5.844	0.597	4.218	0.399
PLS (widekernelpls)	**3.732**	**0.923**	5.779	0.570	4.324	0.453
Random Forest	**3.768**	**0.948**	7.275	0.359	5.753	0.239
Elastic Net	3.793	0.918	**5.934**	**0.634**	4.191	0.412
Partial Least Squares (pls)	3.800	0.952	**5.643**	**0.597**	**4.265**	**0.470**
Ridge Regression (w/FS)	3.855	0.947	**5.880**	**0.603**	4.159	0.356
Ridge Regression	3.877	0.928	7.282	0.616	4.407	0.316
SVM (kernlab)	3.928	0.940	5.907	0.589	4.230	0.466
PLS (kernelpls)	4.096	0.896	5.878	0.566	4.211	0.422
Linear Regression (Stepwise)	4.158	0.919	8.341	0.526	6.135	0.206
Linear Regression (Forward)	4.178	0.888	8.783	0.471	5.142	0.311
Linear Regression (Backwards)	4.392	0.871	6.373	0.522	5.355	0.278
K-Nearest Neighbors	4.732	0.922	6.277	0.445	4.597	0.224
Lasso	5.207	0.817	17.508	0.249	16.145	0.189
Conditional Inference RF	6.713	0.791	6.806	0.558	4.703	0.369
Conditional Inference Tree	7.363	0.711	6.916	0.480	4.894	0.288
Decision Trees	7.582	0.683	6.795	0.473	5.189	0.053

Table 2: Depicts the Performance values (RMSE and R2) associating CIELAB colorimetric data with the total carotenoid contents determined by Lambert-Beer formula (TCC Spectrophotometry), total carotenoid contents determined by HPLC (TCC HPLC), and the content of the majoritarian carotenoid found in cassava roots samples (trans-β-carotene)

	CIELAB Data					
	TCC Spectrophotometry		TCC HPLC		trans-β-carotene	
	RMSE	R^2	RMSE	R^2	RMSE	R^2
Partial Least Squares (simpls)	7.043	0.543	6.789	0.414	4.781	0.194
Support Vector Machines (e1071)	7.136	0.500	6.645	0.380	4.800	0.155
PLS (widekernelpls)	6.771	0.541	6.696	0.396	4.857	0.170
Random Forest	7.280	0.448	7.571	0.293	5.393	0.149
Elastic Net	**6.515**	**0.573**	**6.534**	**0.412**	**4.690**	**0.212**
Partial Least Squares (pls)	7.085	0.538	6.622	0.394	4.859	0.164
Ridge Regression (w/FS)	**6.469**	**0.608**	6.653	0.389	4.951	0.238
Ridge Regression	**6.497**	**0.590**	**6.584**	**0.421**	4.848	0.238
SVM (kernlab)	6.919	0.528	**6.534**	**0.366**	**4.745**	**0.201**
Partial Least Squares (kernelpls)	6.865	0.540	6.756	0.431	4.815	0.162
Linear Regression	6.651	0.558	6.749	0.400	4.945	0.220
K-Nearest Neighbors	7.267	0.525	7.278	0.256	4.956	0.153
Lasso	6.757	0.575	6.669	0.411	4.793	0.182
Conditional Inference RF	8.021	0.454	6.930	0.408	4.782	0.223
Conditional Inference Tree	9.636	0.339	7.307	0.384	4.929	0.130
Decision Trees	9.737	0.316	7.641	0.353	5.000	0.297

Conclusion

The present study has shown how CIELAB color measurement can be used as a fast and non-destructive method to calibrate the total carotenoid content of cassava genotypes roots with acceptable prediction error. With Machine learning, Investigations on supplementation of carotenoids to the diet of aquatic organisms came out with promising results that the dietary inclusion of carotenoids would enhance the growth and general performance of the animal simultaneously with a marked reduction in their mortality. In addition, a large amount of empirical data suggests that sufficient carotenoid supply is essential for the animal's well-being.

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Chapter - 10
Load Frequency Control of Two Area Interconnected Power System

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Chapter - 10

Load Frequency Control of Two Area Interconnected Power System

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Abstract

Frequency control in interconnected power systems is essential for maintaining grid stability and ensuring reliable electricity supply. This paper investigates the application of Proportional-Derivative (PD) and Proportional-Integral-Derivative (PID) controllers for frequency control in a two-area interconnected power system. The study aims to evaluate the effectiveness of PD and PID controllers in regulating system frequency following disturbances or changes in demand. The research begins with an overview of frequency control challenges in interconnected power systems and the principles behind PD and PID control strategies. Analytical methods and optimization techniques for tuning controller parameters are discussed, highlighting the importance of selecting appropriate gains to achieve desired performance objectives. A detailed analysis of PD and PID controller performance in frequency control scenarios is presented, considering factors such as response time, overshoot, settling time, and stability margins. The study examines the robustness of PD and PID controllers under various operating conditions and explores potential limitations and areas for improvement.

Keywords: PID, PD, 2-area control

I. Introduction

In a two-area interconnected power system, each area typically consists of generators, loads, and transmission lines. The primary objective of frequency control is to balance generation and load in each area to maintain system frequency within acceptable limits following disturbances or changes in demand. PD controllers are characterized by their proportional and derivative terms, which provide control action proportional to the error (deviation from the desired frequency) and its rate of change, respectively. The proportional term ensures a response to the current error, while the derivative term anticipates future trends and helps damp out oscillations. PID

controllers, on the other hand, incorporate an additional integral term, which integrates the error over time and helps eliminate steady-state errors. PID controllers offer improved performance compared to PD controllers by addressing both transient and steady-state response requirements.

Enhancing the stability of a power system during random load disturbances and minimizing power imbalances between generating resources and loads are critical tasks. Such efforts involve selecting and designing secondary controllers. These controllers play a pivotal role in maintaining system frequency close to its nominal value by addressing active power imbalances. Extensive literature discusses the importance of secondary controllers in Automatic Generation Control (AGC).

The widely used Proportional-Integral-Derivative (PID) controller finds frequent application in AGC for interconnected power systems. Additionally, researchers explore the use of Artificial Neural Networks (ANN) as intelligent controllers to address AGC challenges during load perturbations. Studies present intelligent ANN controllers applied to both two-area and extended six-area systems, leveraging neuro-fuzzy techniques for enhanced performance. Furthermore, a novel approach integrates fuzzy logic with PID control, utilizing Hybrid Particle Swarm Optimization and Differential Evolution (HPSODE) to achieve superior AGC outcomes compared to traditional methods. These intelligent controllers collectively represent a category of advanced control strategies aimed at optimizing power system performance under varying operational conditions.

In contrast, most AGC-related works are based on optimization techniques to tune optimal parameter gains of the controllers used in secondary control loops. Ant Colony Optimizer (ACO) is used for multi-area interconnected power system frequency control with different cost functions. In PSO utilized for PID tuning of a single area power system. In Ant Lion Optimizer (ALO) applied for secondary controller tuning for classical power system models and modern power system model with renewables, Whale Optimization Algorithm (WOA) is introduced to find optimal gains of the controllers at different loading and parameter uncertainties. Inline, Genetic Algorithm (GA), Differential Evolution (DE), Harris Hawk's Optimizer (HHO) and Bacteria Foraging (BF) optimization are also applied for identifying gains of the controller to minimize the frequency and tie-line power changes.

2. PD-ID controller for AGC application

During load perturbations, the frequency profile of the power system is improved using primary and secondary controls. Primary control depends on

the regulation constant of the machine and the secondary controller is selective.

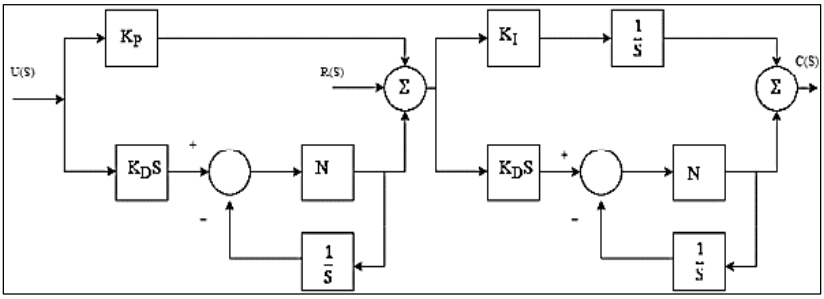

Fig 1: PD-ID controller block diagram

PID controller is used in earlier AGC-related articles. To improve the performance specifications of the power system during active power imbalances, other cascade controllers are alternative solutions to the PID controller. In this aspect, the PD-ID controller is considered in this chapter. The schematic diagram of the PD-ID controller is presented in Figure. 1.

In contrast to the PID controller, the PD-ID controller necessitates data on both the Area Control Error (ACE) and the change in frequency (Δ□). Its derivative components comprise filter elements with filter coefficients □1 and □2. As a result, the total tuning parameters for the AGC problem amount to 6 in single-area scenarios and 12 in situations involving two regions.

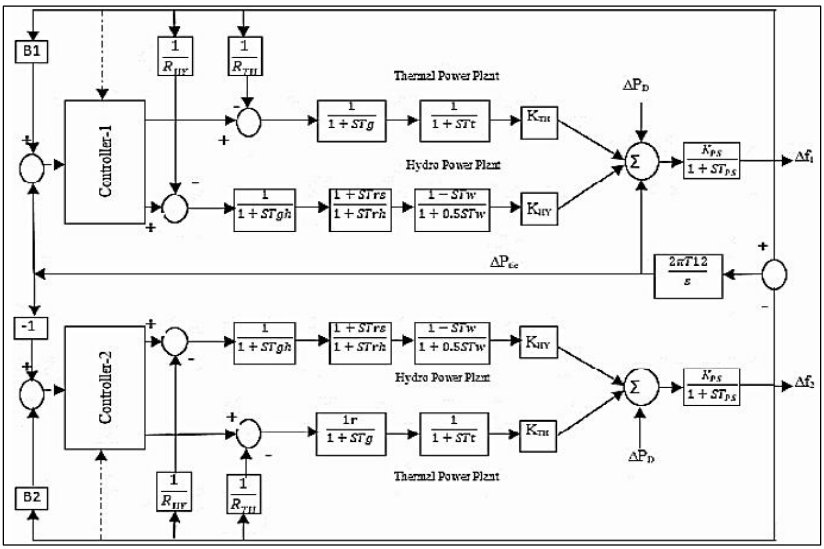

Fig 2: Two area interconnected system block diagram

3. Outline of invasive weed optimizer for AGC

The Invasive Weed Optimizer (IWO) is a metaheuristic optimization algorithm inspired by the behavior of invasive weeds in spreading, growing, and producing seeds. It has been adapted and applied to solve optimization problems, including those encountered in AGC systems. IWO operates based on the principles of natural selection and evolution, where candidate solutions evolve iteratively towards optimal or near-optimal solutions. In the context of AGC, IWO aims to find optimal parameter values for controllers to effectively regulate system frequency and maintain grid stability.

In Automatic Generation Control (AGC), the optimization of controller parameter gains is a critical task where metaheuristic optimization algorithms prove effective. This study employs an Invasive Weed Optimizer (IWO) to determine optimal values for the controller's gain parameters. The IWO algorithm draws inspiration from the spreading, growth, and seed production mechanisms of invasive weeds, initially proposed by Alireza Mehrabian and Caro Lucas (2006) for benchmark functions and subsequently extended to various engineering applications.

The IWO operates through three main phases: Initialization, reproduction, and spatial dispersal. During initialization, all solutions are dispersed randomly across the entire search space. In the reproduction phase, a select few plants generate seeds for the subsequent generation based on their functional values. Finally, in the spatial dispersal phase, seeds are dispersed with statistical parameters, featuring a mean value of zero and variable variance, positioned near the parent plant.

4. Simulation results

The study examines a two-area power system equipped with a PD-ID controller through four distinct case studies involving load variations on the demand side. In Case-1, a 10% load variation is introduced in area-1, and subsequent changes in frequency and tie-line power deviations are monitored and compared with those under a PID controller setup. Case-2 replicates this scenario but initiates the load change in area-2 instead.

In Case-3, random load perturbations are simulated to simulate load disturbances, while Case-4 explores the impact of noise and simple load changes. Tuning parameters for the area-1 controller across all case studies are detailed in Table. 1, while those for the area-2 controller are outlined in Table. 2. Through these analyses, the efficacy and advantages of the PD-ID controller over the PID controller are elucidated and discussed.

Table 1: Optimal parameter gains of PD-ID in area-1

Parameter	Casewise Description			
	I	II	III	VI
k_{p1}	-1.9992	-0.7671	-1.9994	-1.9772
k_{i1}	1.9990	0.0005	1.9944	1.9916
k_{d1}	-1.9887	-1.5590	-2	-1.9996
N_1	171.38	197.84	89.91	198.55
k_{d2}	0.6770	-0.4356	0.9530	0.7637
N_2	1.65	0.24	1.28	1.66

Table 2: Optimal parameter gains of PD-ID in area-2

Parameter	Casewise Description			
	I	II	III	VI
k_{p1}	-0.3799	-1.9861	-0.9666	-0.5644
k_{i1}	0.0022	1.9980	0.0032	0.0039
k_{d1}	-0.0997	-2	-1.9448	-1.6645
N_1	57.42	24.68	166.74	73.09
k_{d2}	-0.3969	0.7723	0.0024	-0.0522
N_2	8.36	1.55	173.23	106.13

In Case 1, the fluctuations in frequency for each area and the alterations in inter tie-line power are illustrated in Figures 3,4, and 5 respectively.

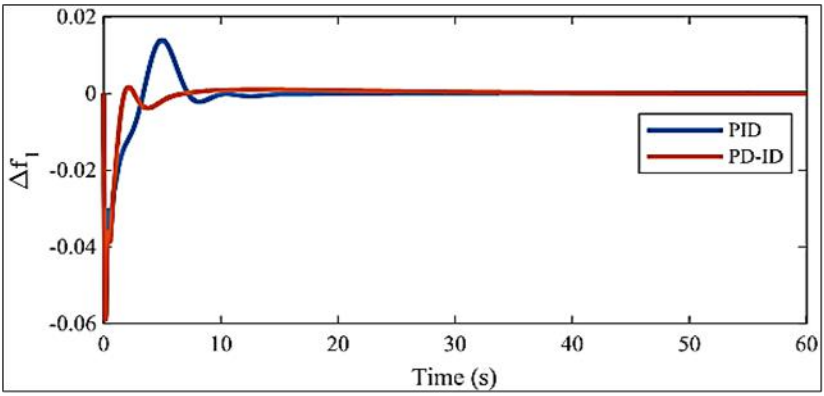

Fig 3: System change in frequency of area-1 for 10% load disturbance

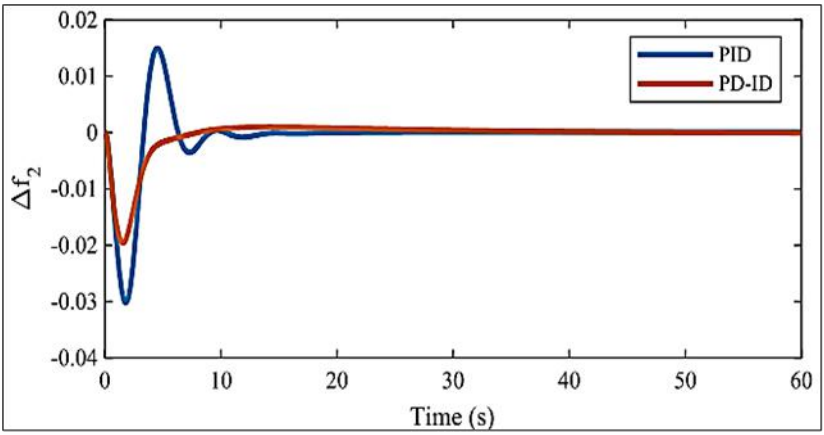

Fig 4: System change in frequency of area-2 for 10% load disturbance

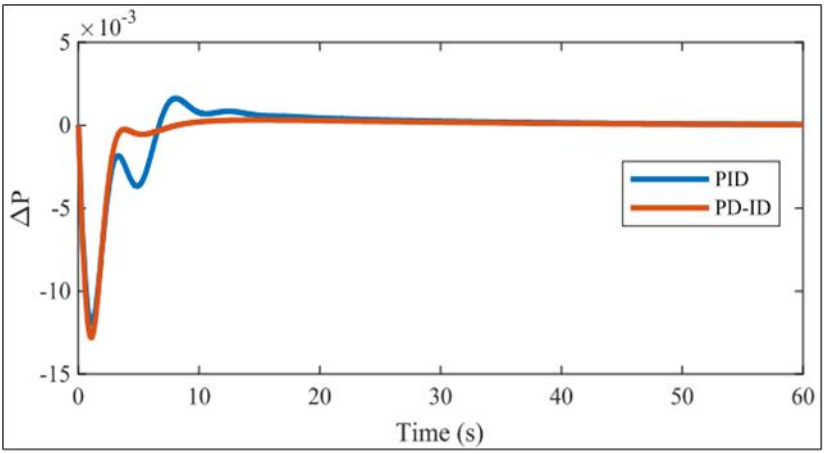

Fig 5: System change in tie-line power for 10% load disturbance

The findings indicate an improvement in the frequency profiles of each area upon replacing the secondary PID controller with the PD-ID controller. For comparison, the parameter gains of the IWO-tuned PID controller are considered. The optimal proportional, integral, and derivative gains for area-1 are -1.938, -1.938, and -1.982, respectively. Meanwhile, for area-2, the optimal gains for the PID block are 0.812, -0.037, and 0.255.

Conclusion

Upon reviewing the achieved outcomes, the proposed PD-ID controller exhibits superior performance. This controller, introduced within this study, targets the minimization of frequency deviations within interconnected power systems during load perturbations. It consistently surpasses the PID controller

across diverse load change scenarios. The utilization of the IWO algorithm facilitates the swift acquisition of optimal parameter gains for the controllers. As a result, the proposed controller emerges as the prime option for ensuring frequency stability, as evidenced by the intricate case studies scrutinized in this research.

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Chapter - 11
Family Planning

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Chapter - 11

Family Planning

Kesani Vanaja Lakshmi Durga Bhavani

Abstract

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Keywords: Family planning, temporary methods, permanent methods, hormonal methods, spacing

Introduction

Throughout the world are becoming increasingly aware of and concerned about the rising People the Maternal and Child Health Programme. The term contraception includes temporary population and the effect that will have on the quality of life. In the year 1952, India became the first country to launch a government-sponsored Family Planning Programme, which was later integrated with and permanent measures designed to prevent pregnancy from coital acts. Ideal contraceptive methods should be highly effective, acceptive, safe, reversible, cheap, having non-contraceptive benefits, simple to use, and requiring minimal motivation, maintenance and supervision.

Definition of family planning

Family planning is a way of thinking and living that is adopted voluntarily, upon the basis of knowledge, attitudes, and responsible decisions by individuals and couples, in order to promote the health and welfare of the

family group and thus contribute effectively to the social development of the country.

- Expert Committee (WHO)

Objectives of family planning

Family planning can also be defined as the practices that help individuals or couples to attain certain objectives

Objectives of family planning

- To avoid unwanted births.
- To bring about wanted births.
- To regulate the interval between pregnancies.
- To control the time at which births occur in relation to the ages of the parent.
- To determine the number of children in the family.
- Methods of Contracepttion:

Methods of contraception

- Methods
  - Temporary methods
  - Permanent methods
    - ✓ Tubal occlusion
    - ✓ Vasectomy
  - Barrier method
  - Natural contraception
  - Intrauterine contraceptive devices
  - Steroidal contraception

Temporary contraceptive methods

Temporary contraceptive methods

(Spacing Methods)

Temporary methods of contraception are commonly used to postpone or space births. Different temporary methods are listed below.

1. Barrier methods

a) Mechanical

- Condom
- Diaphragm
- Cervical cap

b) Chemical

- Creams: Delfen, Velpar
- Foam tablet: Durafoan tablet
- Aerosol foam: Nonoxynol-9
- Contraceptive sponge

c) Combination

Combined use of mechanical and chemical methods.

2. Natural contraception

a) Rhythm/calendar method
b) Ovulation method
c) Temperature
d) Coitus interruptus/withdrawal
e) Lactational amenorrhea

3. Intra uterine contraceptive devices

a) Non-medicated
b) Medicated
    - Copper releasing
    - Hormone releasing

4. Steroidal/Hormonal contraception

- Oral
- Parenteral
- Device
- Patch

Barrier methods

- Barrier methods prevent sperm deposition in the vagina or sperm penetration through the cervical canal.

- The objective is achieved by mechanical devices or by chemical means which produce sperm immobilization or by combined means.

5. Mechanical

Male condom: Condoms are made with polyurethane or latex.

A widely marketed brand in India is Nirodh.

The efficacy of condoms can be augmented by adding spermicidal agents during its use. Advantages:

- Easily available and inexpensive.
- No contraindications or side effects.
- Easy to carry, simple to use and disposable

Disadvantages

- It reduces sexual pleasure to a small content.
- May accidentally break or slip off during coitus.

Female condom

- It is a pouch made of polyurethane, which lines the vagina and external genitalia.
- It is about 15cm in length with one flexible¬ polyurethane ring at each end.
- The condom is inserted into the vagina in¬ such a manner that the closed inner end is anchored in place by the polyurethane ring, while the open outer edge lies flat against the vulva.
- The inner ring is smaller compared to the¬ outer ring.

Advantages

- Protection against STDs and PIDs.

Disadvantages

- Not acceptable.

Diaphragm

- It is an intravaginal device made of rubber with a flexible metal or a spring ring at the margin.
- Its diameter varies from 5 to 10 cm
- It requires a medical person to measure the size required

- The device should be introduced up to 3 hours before coitus and kept for at least 6 hours after the last coital act.

Advantages

- Inexpensive
- Can be used repeatedly for a long time
- Highly effective if used properly.

Disadvantages

- Requires the help of a physician to measure the size required
- Risk of vaginal irritation and UTI
- Not suitable for women with uterine prolapse.

Cervical cap

- It is shaped like a thimble with a raised rim and is made of rubber or plastic and covers the cervix at its base.
- Not popularly used in India.

c) Chemical

Spermicides

- Spermicides are harmless, easy to use, and fairly effective chemical contraceptives.
- The cream or jelly is introduced high in the vagina with plastic applicators at least 15 minutes before sexual intercourse.
- Foam tablets are to be introduced high in the vagina at least 5 minutes prior to intercourse
- Modern spermicides contain surface-active agents that damage the sperm cell membranes
- The agents currently used are nonoxynol 9, octoxynol 9, benzalkonium chloride
- Made up in the form of foam tablets, creams, pastes, jellies or aerosols.
- The spermicide is released in the vagina.

Contraceptive sponge

- Vaginal contraceptive sponge (Today) is made of polyurethane impregnated with 1 g of nonoxynol 9 as a spermicide.

- It releases spermicide during coitus, absorbs ejaculate and blocks the entrance to the cervical canal
- It should be kept for 6 hours after intercourse.

Advantages of the chemical barrier method

It does not require the help of a physician to administer.

Disadvantages

- Less effective and more expensive.
- Allergic reactions are common.
- Does not give protection against STDs.

Natural method rhythm/calendar method

- It is also referred to as safe period or temporary abstinence.
- This method is based on the fact that a woman is fertile only around the time of ovulation and if she abstains from intercourse during that time, she is unlikely to conceive.
- The woman maintains a record of first day of menstruation by marking on a calendar for 6 months and notes the longest and shortest cycle.
- The first unsafe day is calculated by subtracting 18 days from the shortest cycle while the last unsafe day is calculated by deducting 11 days from the longest cycle.

Temperature method

The users of the temperature method (recorded in the morning on awakening) avoid intercourse until the third day of the rise of temperature.

Cervical method

The users of the cervical mucus method (Billing Method) avoid intercourse during the fertile phase 2 of the cycle when the mucus is copious, translucent, thick, and can be easily stretched between the testing fingers.

Advantages

- There are no physical side effects.
- The method is economical.
- It does not interfere with natural fertility.
- There are no health risks involved.

Disadvantages

- The failure rate is high.
- The method offers no protection against STDs.
- It can inhibit spontaneity and places a mental strain on the couple.

Coitus interruptus

It is the oldest and most probably the most widely accepted contraceptive method used by men requiring withdrawal of penis shortly before ejaculation.

Advantages

- No device is used.
- No money required.

Disadvantages

- Failure rate is high.
- Precoital secretions may contain sperms.
- It is stressful and hampers sexual pleasure.

Lactational amenorrhea method

This is appropriate for 6 months postpartum in women who are fully breastfeeding their infant and who are preferably amenorrheic as during lactation, ovulation is suppressed and the cervical mucus is thick.

Advantages

No device is required.

- Free of cost.

Disadvantages

- Protection diminishes when the infant is not fully breastfeeding.
- Not reliable.

Intrauterine contraceptive devices

IUCD is a reversible birth control device placed in the uterine cavity for contraception.

Types of devices

IUCDs are divided into different types according to their shape and content.

Classification based on the content of IUD

1. Inert (non-medicated)

Also called first generation IUDs and are made of plastic, e.g. Lippe's Loop.

It required a push-out technique for insertion and is not used anymore.

2. Medicated devices

i) Copper releasing IUDs

Also called second-generation IUDs

For example, Copper T 200, Multiload 250,

Copper T 375 and Copper T 380 A.

ii) Hormone releasing IUDs

Also called third-generation IUDs.

For example, Progestasert (progesterone releasing) and levonorgestrel intrauterine system which releases levonorgestrel.

WHO categorization of IUDs

WHO divided IUDs in three groups according to the pregnancy rate, indicating their contraceptive efficacy.

1) **Group I:** Where pregnancy risk is more than 2 per 100 women years, e.g. Lippe's Loop, Copper T, Copper T 200, Copper T 200 B and SAF-T-COIL.
2) **Group II:** Where pregnancy rate is between 1.0 and 2.0 per 100 women years, e.g., NOVA T, Multiload, Copper 250, Copper T 220C.
3) **Group III:** Where pregnancy rate is less than 1.0 per 100 women years, e.g. Copper T 380 A, Multiload copper 375, LNG IUS.

Description of devices

Copper T-200

- This is a widely used medicated device.
- It carries a 215 mm2 surface area of fine copper wire wounded around the vertical stem of the device.
- The stem of the T-shaped device is made of a polyethylene frame.
- It has a monofilament tied at the end of the vertical stem.

- These two threads are used for detection and removal.
- The device contains 120mg of copper.
- This device is to be removed after 3 years.

Copper T- 380A

- Carries 380 mm2 surface area of copper wire wound around the stem (175mg) and sleeves on the horizontal arms (65.5mg).
- Replacement is after 10 years.

Multiload Cu-250

- This device is available in a sterilized, sealed Packet with an applicator.
- The device emits 60-100 μg of copper per day.
- It has to be replaced in every 3 years.

Multiload Cu- 375

- It has 375 mm2 surface area of copper wire wound around its vertical stem.
- The device is to be replaced in every 5 years.

Progestasert

- Bioactive core-containing microcrystals of progesterone (38mg) enclosed within the plastic wall, which releases about 65μg of progesterone daily into the uterine cavity.
- It should be replaced after 1 year.

Levonorgestrel intrauterine system

- It is a T-shaped device, with a polydimethylsiloxane membrane around the stem, which contains levonorgestrel.
- It releases the hormone at the rate of 20 μg/day.
- The device is to be replaced every 5 years.

Timing if insertion

1) **Interval insertion:** Insertion of IUD at least 6 weeks after parturition or MTP or abortion.
2) **Insertion during the lactational period:** During the lactational period after ruling out pregnancy.
3) **Post abortal:** Immediately ater D&C.

4) **Immediate postpartum or post placental insertion:** After delivery of placenta both in normal delivery and caesarean section.
5) **Post coital insertion:** Copper devices (excluding LNG-IUS) can be used for post coital contraception up to 5 days after unprotected coitus.

Technique of insertion of copper T 380A

- No sedation or anesthesia is required. To reduce cramping pain, tablet drotaverine or with mefenamic, or ibuprofen may be given 30 minutes before insertion.
- No touch insertion method is preferred.
- To load the Cu T in the inserter while both parts are in the sterile packets.
- Cleaning the cervix with antiseptic before IUD insertion.
- Avoid touching the vaginal wall or speculum blade with the uterine sound or loaded IUD inserter.
- Passing both the uterine sound and the loaded IUD inserter only once through the cervical canal.

Insertion of multiload 250 and 375

- It is performed by withdrawal technique.
- The wrapping is removed and the inserter tube with the preloaded IUD is carefully inserted into the uterus until it reaches the fundus.
- When the IUD touches the fundus, it is released into the uterine cavity by withdrawing the inserter tube.
- During removal, the thread is just pulled out and the multiload comes out easily with the multi load bending in opposite direction.

Insertion of LNG-IUS

- Grasp the upper lip of the cervix with a tenaculum and apply gentle traction to align the cervical canal with the uterine cavity.
- Carefully sound the uterus to measure the uterocervical length.
- The uterus should sound to a depth of 6 to 9 cm.
- Insertion of LNG-IUS into a uterine cavity less than 6.0cm by sounding may increase the incidence of expulsion, bleeding, pain, perforation and possibly pregnancy.

Complications

Immediate

a) Cramp like pain.
b) Syncopal attack.
c) Partial or complete perforation.

Remote

a) Pain.
b) Abnormal menstrual bleeding.
c) Pelvic inflammatory disease.
d) Spontaneous expulsion.
e) Perforation of the uterus.

Advantages of 3rd generation IUDs

- Higher efficacy with lowest pregnancy rate.
- Longer duration of action.
- Low expulsion rate.
- Significant reduction in menstrual blood loss.

Disadvantages of 3rd generation IUDs

- Expensive (LNG-IUS).
- LNG-IUS is not available through government channel in India currently.
- Malpositioning with long duration of use may cause pregnancy or expulsion.

Hormonal contraception

Hormonal contraception are the steroidal hormones to prevent pregnancy.

1. Combined oral contraceptives

- Most effective reversible method of contraception.
- Commonly used progestins are either levonorgestrel, or norethisterone, or desogestral and the estrogens are principally confined to either ethinylestradiol or mestranol.
- Currently, desogestral, gestodene, norgestimate are available.

- Only Mala-N is distributed through government channels free of cost.
- Given orally for 21 consecutive days beginning on the 1st day of the cycle for new users, followed by 7 days break.
- Types of pills are: Mala N and Mala D.
- The patient should be examined after 3 months, then 6 months and then yearly.
- If a woman forgets to take one pill, she should take the missed pill at once and continue the rest as schedule.
- If she misses 2 pills, she should take the missed pills at once and continue the rest as schedule.
- If more than 2 active pills are missed, another form of contraception should be used as back up for 7 days. She should take the most recent missed pill immediately.

Contraindications

i) Circulatory diseases.
ii) Diseases of liver.
iii) Pregnancy.
iv) Genital tract bleeding.
v) Breast cancer.
vi) Obesity.
vii) Epilepsy.
viii) Age over 35.
ix) Smoking.

Advantages

- Most effective method if used properly.
- Excellent cycle control.
- Well tolerated by most womens
- There are many non-contraceptive benefits.
- Modern low-dose pills make the skin better looking with no gain in weight.
- They have immediate reversibility on stopping the pill and women can conceive quickly.

- The woman can now decide when to have a baby.

Disadvantages

- They require counselling and strong motivation.
- They require initial history taking and examination, and need regular follow up.
- Women have to remember to take the pills every day.
- Cannot be used by all the women with many Contraindications.
- Modern pills are expensive.
- They can have side effects and complications in some women.

2. Centchroman (Chhaya)

It is a non-steroidal compound with potent antiestrogenic and weak-estrogenic properties.

It is taken orally (30mg) twice a week for first 3 months then once a week.

Contraindications

i) PCOS.
ii) Cervical cell hyperplasia.
iii) Liver and kidney disease and TB.

3. Progestin only contraception

- Oral-POPs.
- Parenteral-DMPA, NET-EN, Implants.
- LNG-IUS.

Progestogen only pill (POP/Minipill)

- It contains very low dose of progestin in any one of the following forms-levonorgestrel 75µg, norethisterone 350 µg, desogestrel 75 µg, lynestrenol 500 µg or norgestrel 30 µg.
- It has to be taken daily from the 1st day of the cycle and then continuously.
- It has to be taken regularly and at the same time of the day. There must be no break between the packs.
- Delay in intake for more than 3 hours, the woman should have missed pill immediately and the next one as schedule.

- Extra precaution has to be taken for next 2 days.

Advantages

- Side effects attributed to estrogen in the combined pill are totally eliminated
- No adverse effect on lactation and hence can be suitably prescribed in lactating women and as such it is often called "Lactation Pill"
- Easy to take as there is no "on and off" regime
- It may be prescribed in patient having hypertension, fibroid, diabetes, epilepsy, smoking and history of thromboembolism
- Reduces the risk of PID and endometrial cancer.

Disadvantages

- There may be acne, mastalgia, headache, breakthrough bleeding, or at times amenorrhea.
- Simple cysts of the ovary may be seen, but they do not require any surgery
- Failure rate is about 0.5–2 per 100 women years of use.
- Failure is more in young compared to women over 40 years.
- Women using drugs that induce liver microsomal enzymes should avoid this method of contraception.

Contraindications

- Pregnancy
- Unexplained vaginal bleeding
- Recent breast cancer
- Arterial disease
- Thromboembolic disease.

Injectable progestins

- The preparations commonly used are depot medroxyprogesterone acetate (DMPA) and norethisterone enanthate (NET-EN).
- Both are administered intramuscularly (deltoid or gluteus muscle) within 5 days of the cycle.
- The injection (IM) should be deep, Z-tract technique and the site not to be massaged.

- DMPA in a dose of 150 mg every 3 months or 300 mg every 6 months. NET-EN in a dose of 200 mg given at 2-monthly intervals.
- Depo-Sub Q provera 104, contains 104 mg of micronized preparation of DMPA. It is given subcutaneously over the anterior thigh or abdomen. It suppresses ovulation for 3 months as it is absorbed more slowly.

Advantages

- It eliminates regular medication as imposed by oral pil
- It can be used safely during lactation. It probably increases the milk secretion without altering its composition
- No estrogen related side effects Menstrual symptoms, e.g. menorrhagia, dysmenorrhea are reduced
- Protective against endometrial cancer Can be used as an interim contraception before vasectomy becomes effective
- Reduction in PID, endometriosis, ectopic pregnancy and ovarian cancer.
- The non-contraceptive benefits: DMPA reduces the risk of salpingitis, endometrial cancer, iron -deficiency anemia, sickle cell problems and endometriosis.

Disadvantages

- Failure rate for DMPA-(0-0.3/HWY).
- There is chance of irregular bleeding and occasional phase of amenorrhea.
- Return of fertility after their discontinuation is usually delayed for several months (4-8 months).
- However, with NET-EN the return of fertility is quicker.
- Loss of bone mineral density (reversible) has been observed with long-term use of depoprovera.
- Overweight, insulin-resistant women may develop diabetes.
- Other side effects are: weight gain and headache.

Contraindications

- Women with high-risk factors for osteoporosis.
- Pregnancy.
- Unexplained vaginal bleeding.

- Recent breast cancer.
- Arterial disease.
- Thromboembolic disease.

Implant

- Nexplanon is a progestin only delivery system containing 3-ketodesogestrel (etonogestrel).
- It is a long-term (up to 3 years) reversible contraception.
- It consists of a single closed capsule and contains 68 mg of etonogestrel.
- It releases the hormone about 60 μg, gradually reduced to 30 μg per day over 3 years.
- It does not cause decrease in bone mineral density.

Insertion

- The capsule is inserted subdermally, in the inner aspect of the nondominant arm, 6-8 cm above the elbow fold.
- It is inserted between biceps and triceps muscles.
- Preloaded sterile applicator is available. No incision is required.
- Removal is done by making a 2 mm incision at the tip of the implant and pushing the rod until it pops out. It is done under local anesthetic.
- It is ideally inserted within D 5 of a menstrual cycle, immediately after abortion and 3 weeks after postpartum.

Removal

- Within 3 years of insertion.

Advantages

- Highly effective for long term use and rapidly reversible.
- Suited for women who have completed their family but do not desire permanent sterilization.

Drawbacks

- Frequent irregular menstrual bleeding
- Spotting
- Amenorrhea

Norplant-II (Jadelle)

- Two rods of 4 cm length with diameter of 2.5 mm are used.
- Each rod contains 75 mg of levonorgestrel.
- It releases 50 mcg of levonorgestrel per day.
- Contraceptive efficacy is similar to combined pills.
- Failure rate is 0.06 per 100 women years.
- It is used for 3 years.
- The rods are easier to insert and remove.

Long-acting reversible contraception (LARC)

It is currently being recommended for lactating women.

LARC includes:

a) Levonorgestral intrauterine system (LNG-IUS).
b) Cu-IUD.
c) Progesterone only injectables.
d) Etonogestral implant.

Emergency contraception

Includes hormones, copper IUD, and antiprogesterone

Indication

- Unprotected intercourse.
- Condom rupture.
- Missed pills.
- Delay in taking POP more than 3 hours.
- Sexual assault.
- Rape.

Hormones

Morning after pill

- It prevents conception in case of unprotected exposure around the time of ovulation.
- Drugs used are levonorgestrel, ethinyl estradiol 2.5mg.
- The drug is taken twice daily for 5 days, beginning soon after the exposure but not later than 72 hours.

Levonorgestrel (*E. pills*)

0.75 mg, two doses given at 12 hours interval.

- The two tablets can be taken as a single dose also (1.50mg).
- The first dose should be taken within 72 hours may be taken up to 120 hours.

Drawbacks

- Nausea and vomiting Copper IUD.
- Introduction of a copper IUD within a maximum period of 5 days can prevent conception following accidental unprotected exposure.
- This prevents implantation.
- Failure rate is about 0-1%.

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