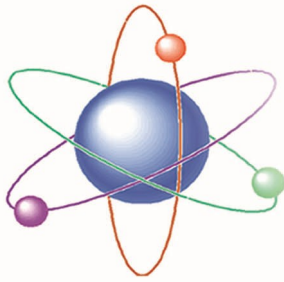


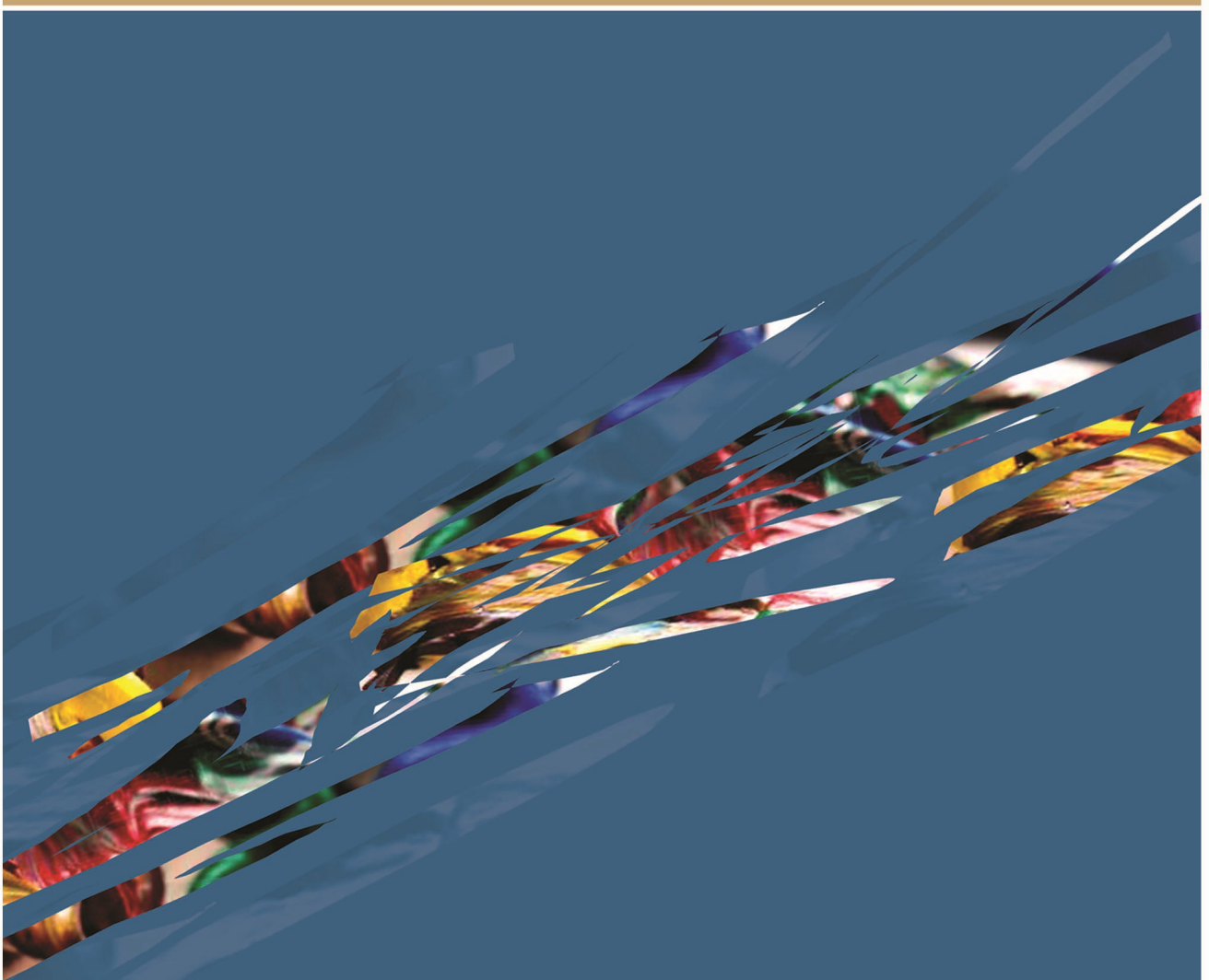
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Editorial

Private Higher Education System: India and the World

In this globalised world after 1990s, there has been tremendous growth in private higher education which is unprecedented. The growth of self financing colleges has been phenomenal; the number of private colleges in several states grew from a few in the late 1980s to several hundreds, particularly in case of engineering colleges, in management and medical institutions and it grew to such a level that in relative size, the public sector became infinitesimally small. It even spread to arts and science colleges and even to intermediate colleges and polytechnics. If such trend continues to occur on a large scale, we will soon end up with no public institutions of higher education.

Compared to the more developed capitalist countries having role in global market like the US, the UK, Canada and Australia, India is more privatized. Currently we have more than 100 private deemed universities, a large number of private aided colleges and even large number of self financing colleges in addition to many unrecognized private institutions, which do not necessarily offer recognized degree programmes and are basically Coaching Centers of different kinds and all these make the private sector in India as one of the largest in the world.

According to one study by Altbach (2009), one fifth to one fourth of the total number of students in higher education and about 30% of the global enrollment in higher education, are in private institutions; the remaining students go to public universities. On average, only 15% of the enrollment in tertiary education system in Organization for Economic Co operation and Development Countries, and a meager 8% in the countries of the European Union 21group, are enrolled in independent Private institutes, with a vast majority everywhere studying in public sector. In contrast, in India, 66% of the students in general education and 75% -80% in the technical education are enrolled in private self financing institutions (Planning Commission, 2013). It is also very interesting to find that contrary to the general impression that Western countries have large private higher education systems, they actually strongly advocate privatization of higher education not for themselves, but for the developing countries and they have strong public higher education system, while we are being encouraged to resort to private institutions.

The massive private higher education system in India has been detrimental to the character of education as a public good. Private education essentially views education as a private good, yielding benefits to individual students and is not concerned with social values or national concern. The social responsibility of higher education needs to be valued, protected and nurtured and this is not possible in a system dominated by profit motivated private higher education system. Here the argument that education is a right not a commodity is to emphasize and guarded.

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Mathematical Modelling of ill-effect of mobile phone on teenagers

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ABSTRACT

In this paper a mathematical model is proposed and analyzed to study the ill-effect of mobile phone on teenagers. By analyzing the model we have found that if inter-specific interference co-efficient of negative influence of mobile phone on teenager and specific growth rate/production rate co-efficient of mobile phones are not controlled, equilibrium is not exist. Also if Alsoif specific growth rate of manufacturing mobile phone due to the increased use by teenagers, inter-specific interference co-efficient of negative influence of mobile phone on teenagers is too high then it leads to instability. So we along with the government should take proper steps to control the manufacturing rate which gives profit to the company but loss to our society by effecting our future generation and so to the development of our country.

Key words: Autonomous Differential Equations, Equilibrium point, Local Stability, Global Stability.

INTRODUCTION

Mathematical models in ecology discuss about the dynamical behavior of the ecological or environmental system. Biodiversity is the combination of species, genetic and ecological diversity (World Conservation Monitoring Centre (1992)). Environment is the sum total of all the conditions as well as influence that effect the development and life of the organisms- lowest to the highest including human beings. Along with the diversity, stability and complexity which affect the development of a society were discussed by many researchers (Deka, 2015, Deka, 2015, Dubey *et al.*, 1999).

Mobile Phones- the main means through which people gets a platform to various elements of the outside world. These days it has become a necessity in our day to day lives without which daily activities turns lame. We cannot deny the fact that it is useful at times but the negative effects have outdone the positive ones. It has become a serious issue causing many negative effects not only on the children but also on the elderly people. One such is the higher use of social media. It gives rise to cyber bullying- an organization “Enough is enough” conducted a survey that found that due to use of cell phones

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cyber bullying has increased, 95% of teenagers who use social media have witnessed cyber bullying and 33% have been victims themselves. Easy use of social media due to increased use of mobile phones made users unhappier than who used these sites lesser. (Sources: University of Michigan). Mobile phones also have reduced learning and research capabilities; it has become a mere wastage of time for most teenagers. There is lesser motivation in the teenagers and the academic grades too are decreasing for them. So here we have tried to form a model

through which we shall try to depict the ill effects of mobile phones on the teenagers. We are conducting a survey by asking few questions (see Annexure) about the use of mobile phone to the students of different departments of Darang College and find out some information regarding the use and effect of mobile phone on them. Teenagers who are the future of our society are badly affected by the Smart phones largely available nowadays.

MATHEMATICAL MODEL

We consider an ecosystem to model the ill-effect of mobile phone on teenagers. We assume that the dynamics of the system can be governed by the following differential equations:

$$\begin{aligned}\frac{dT}{dt} &= T \left[(a_{11} - a_{10}\frac{T}{K}) - a_{12}M \right] \\ \frac{dM}{dt} &= M \left[(a_{21} - a_{22}M) + a_{23}T \right] \\ T(0) &\geq 0, M(0) \geq 0.\end{aligned}$$

Where

T = Density of teenagers.

M = Density of mobile phones.

K = Carrying capacity of teenagers.

a_{11} = Specific growth rate of teenagers.

a_{10} = Intra-specific interference co-efficient of teenagers.

a_{12} = Inter-specific interference co-efficient of negative influence of mobile phone on teenagers.

a_{21} = Specific growth rate/production rate co-efficient of mobile phones.

a_{22} = Intra-specific interference co-efficient of mobile phone.

a_{23} = Specific growth rate of manufacturing mobile phone due to the increased use by teenagers.

$$a_{ij} > 0; i = 1, 2, j = 0, 1, 2, 3.$$

Existence of equilibria

Putting $\frac{dz}{dt} = 0$ ($z = T, M$) and solving the equations for T and M we get the following non-negative equilibria, namely- $E_0(0, 0)$, $E_1(\bar{T}, 0)$, $E_2(0, \bar{M})$, $E^*(T^*, M^*)$.

1. The equilibrium $E_0(0, 0)$ is obviously exist.

2. The equilibrium $E_1(\bar{T}, 0)$ is exist as for $\bar{T} \neq 0$, $(a_{11} - a_{10}\frac{\bar{T}}{K}) = 0 \Rightarrow \bar{T} = \frac{a_{11}}{a_{10}} K > 0$;

3. The equilibrium $E_2(0, \bar{M})$ is also obviously exist as for $\bar{M} \neq 0$, $(a_{21} - a_{22}\bar{M}) = 0 \Rightarrow \bar{M} = \frac{a_{21}}{a_{22}} > 0$;

4. Existence of the equilibrium $E^*(T^*, M^*)$:

Since $T^*, M^* \neq 0$,

$$\begin{aligned} \therefore (a_{11} - a_{10}\frac{T^*}{K}) - a_{12}M^* &= 0 & \text{and} & & a_{21} - a_{22}M^* + a_{23}T^* &= 0 \\ \Rightarrow \frac{a_{10}}{K}T^* + a_{12}M^* - a_{11} &= 0 \dots\dots\dots(2.1) & \Rightarrow & & a_{23}T^* - a_{22}M^* + a_{21} &= 0 \dots\dots\dots(2.2) \end{aligned}$$

Solving the equations (2.1), (2.2); we get

$$\Rightarrow \quad T^* = \frac{(a_{11}a_{22} - a_{21}a_{12})}{(a_{23}a_{12} + \frac{a_{22}a_{10}}{K})}, \quad M^* = \frac{(\frac{a_{21}a_{10}}{K} + a_{23}a_{11})}{(a_{23}a_{12} + \frac{a_{22}a_{10}}{K})} > 0 \text{ (obvious).}$$

But T^* is positive, if $a_{11}a_{22} > a_{21}a_{12} \dots\dots\dots(2.3)$

Also, we have

$$\frac{dT}{dM} = -a_{12} < 0, \quad \frac{dT}{dM} = a_{23} > 0$$

Hence two isoclines intersect at a unique point E^* .

E^* exists only if the condition (2.3) is maintained. Thus if a_{12} -inter-specific interference co-efficient of negative influence of mobile phone on teenager and a_{21} - specific growth rate/production rate co-efficient of mobile phones are not controlled, equilibrium of E^* is not exist.

MATERIALS AND METHODS

Stability analysis of the equilibria

The local stability of the equilibria can be studied by computing variational matrices corresponding to each equilibria by using Gershgorion's Theorem and Routh–Hurwitz criteria (La Salle and La Salle J. and Lefschetz S., 1961, Freedman, 1978, Rao, 1981).

RESULTS AND DISCUSSION

Variational matrices:

$$J(T, M) = \begin{bmatrix} a_{11} - 2\frac{a_{10}}{K}T - a_{12}M & -a_{12}T \\ a_{23}M & a_{21} - 2a_{22}M + a_{23}T \end{bmatrix}$$

$$J^*(T^*, M^*) = \begin{bmatrix} -\frac{a_{10}}{K}T^* & -a_{12}T^* \\ a_{23}M^* & -a_{22}M^* \end{bmatrix}$$

Characteristic equation:

$$|J - \lambda I| = \begin{vmatrix} a_{11} - 2\frac{a_{10}}{K}T - a_{12}M - \lambda & -a_{12}T \\ a_{23}M & a_{21} - 2a_{22}M + a_{23}T - \lambda \end{vmatrix} = 0$$

i. Characteristic equation at $E_0(0, 0)$,

From these matrices we note the following results.

$$\begin{vmatrix} a_{11} - \lambda & 0 \\ 0 & a_{21} - \lambda \end{vmatrix} = 0$$

$$\Rightarrow (a_{11} - \lambda)(a_{21} - \lambda) = 0$$

$$\therefore \lambda_1 = a_{11} > 0, \lambda_2 = a_{21} > 0$$

Equilibrium $E_0(0, 0)$ is unstable by Gershgorion's Theorem

ii. Characteristic equation at $E_1(\bar{T}, 0)$

$$\begin{vmatrix} -\frac{a_{10}}{K}\bar{T} - \lambda & -a_{12}\bar{T} \\ 0 & a_{21} + a_{23}\bar{T} - \lambda \end{vmatrix} = 0$$

$$\lambda_1 = -\frac{a_{10}}{K}\bar{T} < 0, \lambda_2 = a_{21} + a_{23}\bar{T} > 0 \text{ as } \bar{T} > 0.$$

$E_1(\bar{T}, 0)$ is a saddle point, so it is unstable.

iii. Characteristic equation at $E_2(0, \bar{M})$,

$$\begin{vmatrix} a_{11} - a_{12}\bar{M} - \lambda & 0 \\ a_{23}\bar{M} & -a_{22}\bar{M} - \lambda \end{vmatrix} = 0$$

$$\Rightarrow \lambda_1 = a_{11} - a_{12} \bar{M} < 0, \text{ if } \bar{M} = \frac{a_{21}}{a_{22}} > \frac{a_{11}}{a_{12}} \text{ i.e. } a_{11}a_{22} < a_{21}a_{12}, \text{ but } a_{11}a_{22} > a_{21}a_{12} \text{ by (2.3)}$$

Also $\lambda_2 = -a_{22} \bar{M} < 0$ as $\bar{M} = \frac{a_{21}}{a_{22}} > 0$. So $E_2(0, \bar{M})$ is stable if $\bar{M} > \frac{a_{11}}{a_{12}}$ holds, and is a saddle point if (2.3) holds.

iv. Characteristic equation at $E^*(T^*, M^*)$

$$|J^* - \lambda I| = \begin{vmatrix} -\frac{a_{10}}{K}T^* - \lambda & -a_{12}T^* \\ a_{23}M^* & -a_{22}M^* - \lambda \end{vmatrix} = 0$$

$$\begin{aligned} \Rightarrow & \left(-\frac{a_{10}}{K}T^* - \lambda\right)(-a_{22}M^* - \lambda) + a_{12}a_{23}T^*M^* = 0 \\ \Rightarrow & \lambda^2 + \left(\frac{a_{10}}{K}T^* + a_{22}M^*\right)\lambda + \left(\frac{a_{10}}{K}a_{22} + a_{12}a_{23}\right)T^*M^* = 0 \end{aligned}$$

$$\lambda_1 = \left(\frac{a_{10}}{K}T^* + a_{22}M^*\right) > 0 \text{ if } T^* > 0,$$

$$\lambda_2 = \left(\frac{a_{10}}{K}a_{22} + a_{12}a_{23}\right)T^*M^* > 0, \text{ (by Routh-Hurwitz Criteria)}$$

Both the conditions are satisfied if $T^* > 0$, that is, if the condition (2.3) is satisfied.

Global stability:

In order to investigate the global stability behavior of the interior equilibrium E^* , we first establish the following lemma which establishes a region of attraction for the system (1),

LEMMA: The set $\Omega = \{(T, M): 0 \leq T \leq T_m; 0 \leq M \leq M_m\}$ attracts all the solutions initially in the positive orthant.

Where,

$$T_m = \frac{a_{11}K}{a_{10}}, \quad M_m = \frac{a_{10}a_{21} + a_{11}a_{23}K}{a_{10}a_{22}}$$

THEOREM: If the following inequality holds, the equilibrium E^* is globally asymptotically stable with respect to all solutions initially in the positive orthant. (For proof see Appendix)

$$4a_{12}a_{23} < \frac{a_{10}a_{22}}{K}$$

Then the system is globally asymptotically stable.

Survey report:

ACADEMICS	52
ENTERTAINMENT	68
TOTAL STUDENTS	120

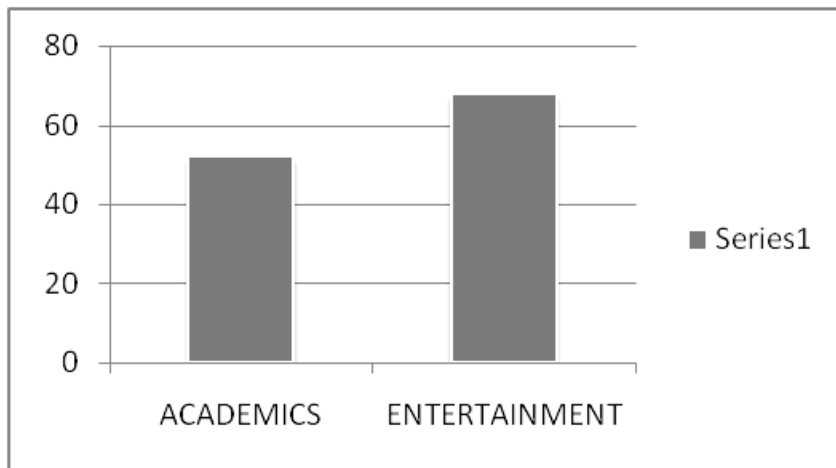


Figure 1. Reflects entertainment is the major priority.

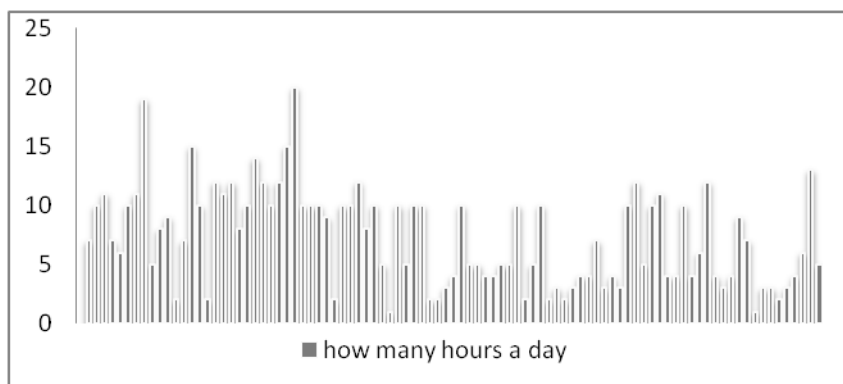


Figure 2. Use mobile phone at average 10 hours a day. Some students use it maximum of 15 hours per day.

III-Effect of Mobile Phone on Teenagers

NO OF STUDENTS ADDICTED	59
NO OF STUDENTS NOT ADDICTED	33
SUM	92

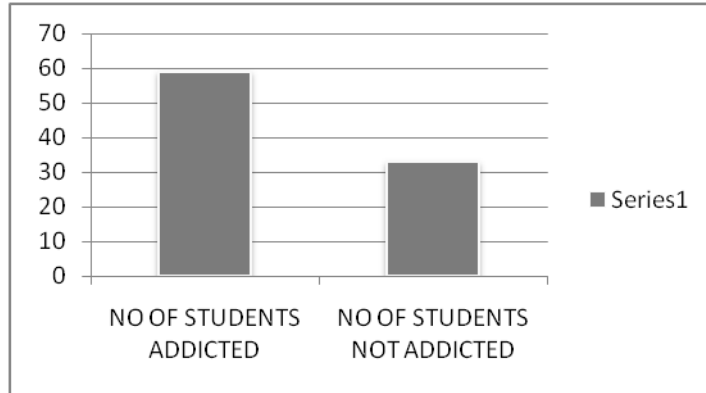


Figure 3. More number of students are addicted.

By analyzing the model we have found that if a_{12} -inter-specific interference co-efficient of negative influence of mobile phone on teenager and a_{21} - specific growth rate/production rate co-efficient of mobile phones are not controlled, equilibrium of E^* is not exist. Also if a_{23} -specific growth rate of manufacturing mobile phone due to the increased use by teenagers, a_{12} -Inter-specific interference co-efficient of negative influence of mobile phone on teenagers is too high then it leads to instability. So we along with the government should take proper steps to control the manufacturing rate which gives profit to the company but loss to our society by effecting our future generation and so to the development of our country.

APPENDIX

Proof of the Lemma: We have

$$\begin{aligned} \frac{dT}{dt} &= T \left[\left(a_{11} - \frac{a_{10}}{K} T \right) - a_{12} M \right] \\ \Rightarrow \frac{dT}{dt} &\leq T \left(a_{11} - \frac{a_{10}}{K} T \right) \Rightarrow \frac{dT}{T \left(a_{11} - \frac{a_{10}}{K} T \right)} \leq dt \end{aligned}$$

$$\begin{aligned}
&\Rightarrow \left(\frac{1}{T} + \frac{a_{10}/a_{11}K}{\left(a_{11} - \frac{a_{10}}{K}T\right)} \right) dT \leq dt \\
&\Rightarrow \frac{1}{a_{11}} \log T - \frac{K}{a_{10}} \frac{a_{10}}{Ka_{11}} \frac{d(a_{11} - \frac{a_{10}}{K}T)}{(a_{11} - \frac{a_{10}}{K}T)} \leq dt \\
&\Rightarrow \frac{1}{a_{11}} \left[\log T - \log(a_{11} - \frac{a_{10}}{K}T) \right] \leq dt \\
&\Rightarrow \log \frac{T}{a_{11} - \frac{a_{10}}{K}T} \leq a_{11} dt \\
&\Rightarrow \frac{T}{a_{11} - \frac{a_{10}}{K}T} \leq e^{a_{11}t} \\
&\Rightarrow T \leq (a_{11} - \frac{a_{10}}{K}T) e^{a_{11}t} \\
&\Rightarrow T(1 + \frac{a_{10}}{K} e^{a_{11}t}) \leq a_{11} e^{a_{11}t} \\
&\Rightarrow T \leq \frac{a_{11} e^{a_{11}t}}{1 + \frac{a_{10}}{K} e^{a_{11}t}} = \frac{a_{11} e^{a_{11}t}}{e^{a_{11}t}(\frac{1}{e^{a_{11}t}} + \frac{a_{10}}{K})} \\
&\Rightarrow T \leq \frac{a_{11}}{e^{-a_{11}t} + \frac{a_{10}}{K}}
\end{aligned}$$

Therefore, when $t \rightarrow \infty$, $T \leq \frac{a_{11}}{\frac{a_{10}}{K}} = \frac{a_{11}K}{a_{10}} = T_m$

$$\Rightarrow \lim_{t \rightarrow \infty} \sup T(t) = T_m$$

Also

$$\begin{aligned}
\frac{dM}{dt} &= M[a_{21} - a_{22}M + a_{23}T] \leq M \left[\left(a_{21} + a_{23} \frac{a_{11}K}{a_{10}} \right) - a_{22}M \right] \\
\Rightarrow \frac{dM}{dt} &\leq \left(a_{21} + \frac{a_{11}a_{23}K}{a_{10}} \right) M \left[1 - \frac{a_{22}M}{a_{21} + \frac{a_{11}a_{23}K}{a_{10}}} \right] \\
\Rightarrow \frac{dM}{M(1 - a_{22}M/P)} &\leq \left(a_{21} + \frac{a_{11}a_{23}K}{a_{10}} \right) dt = Pdt, \text{ where } P = a_{21} + \frac{a_{11}a_{23}K}{a_{10}}. \\
\Rightarrow \left(\frac{1}{M} + \frac{a_{22}/P}{1 - a_{22}M/P} \right) dM &\leq Pdt \\
\Rightarrow \log M - \log \left(1 - \frac{a_{22}M}{P} \right) &\leq Pt \\
\Rightarrow \log \frac{M}{1 - a_{22}M/P} &\leq Pt
\end{aligned}$$

$$\Rightarrow \frac{M}{1-a_{22} M/P} \leq e^{Pt}$$

$$\Rightarrow M \leq \left(1 - \frac{a_{22} M}{P}\right) e^{Pt}$$

$$\Rightarrow M \leq \frac{1}{e^{-Pt} + \frac{a_{22}}{P}}$$

Therefore, when $t \rightarrow \infty$, $M \leq M_m = \frac{P}{a_{22}} = \frac{a_{10}a_{21} + a_{11}a_{23}K}{a_{10}a_{22}}$.

Proof of the Theorem: Let us consider the following positive definite Liapunuvfunction around E^*

$$V(T, M) = \left[T - T^* - T^* \ln \frac{T}{T^*} \right] + C \left[M - M^* - M^* \ln \frac{M}{M^*} \right]$$

$$\Rightarrow \dot{V}(T, M) = \left[\frac{dT}{dt} - 0 - \frac{T^*}{T} \frac{1}{T^*} \frac{dT}{dt} \right] + C \left[\frac{dM}{dt} - \frac{M^*}{M} \frac{1}{M^*} \frac{dM}{dt} \right]$$

$$= \left[1 - \frac{T^*}{T} \right] \frac{dT}{dt} + c \left[1 - \frac{M^*}{M} \right] \frac{dM}{dt}$$

$$\Rightarrow \dot{V}(T, M) = \frac{1}{T} [T - T^*] T \left[a_{11} - \frac{a_{10}}{K} T - a_{12} M \right] + \frac{C}{M} [M - M^*] M [a_{21} - a_{22} M + a_{23} T]$$

$$= (T - T^*) \left(a_{11} - \frac{a_{10}}{K} T - a_{12} M - a_{11} + \frac{a_{10}}{K} T^* + a_{12} M^* \right) + C (M - M^*) (a_{21} - a_{22} M + a_{23} T - a_{21} + a_{22} M^* - a_{23} T^*)$$

$$= (T - T^*) \left\{ -\frac{a_{10}}{K} (T - T^*) - a_{12} (M - M^*) \right\} + C (M - M^*) \{ -a_{22} (M - M^*) + a_{23} (T - T^*) \}$$

$$= -\frac{a_{10}}{K} (T - T^*)^2 - a_{12} (T - T^*) (M - M^*) - C a_{22} (M - M^*)^2 + C a_{23} (M - M^*) (T - T^*)$$

$$= -\frac{a_{10}}{K} (T - T^*)^2 + (a_{23} C - a_{12}) (T - T^*) (M - M^*) - C a_{22} (M - M^*)^2$$

$$= -A_{11} (T - T^*)^2 + A_{12} (T - T^*) (M - M^*) - A_{22} (M - M^*)^2.$$

$$\text{Where } A_{11} = \frac{a_{10}}{K}, A_{12} = (a_{23} C - a_{12}), A_{22} = C a_{22}$$

$$\text{Let us choose } C = \frac{a_{12}}{a_{23}}$$

Then $\dot{V}$ is a negative definite if $A_{12}^2 < A_{11} A_{22}$, i. e., if $4a_{12}a_{23} < \frac{a_{10}a_{22}}{K}$

Then the system is globally asymptotically stable.

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Dragonflies and Damselflies of Hazara Pukhuri, Sonitpur, Assam, India

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ABSTRACT

The study is an attempt to provide description of Odonate species (Insecta: Odonata) commonly known as Dragonflies (Odonata, Anisoptera) and Damselflies (Odonata, Zygoptera) collected from the 'Hazara Pukhuri', a large perennial pond in Tezpur, Sonitpur, Assam, India. The attractive group of aquatic insects forms an important component of freshwater macroinvertebrate fauna. Collection of both adult and naiads reveals altogether 12 species belonging to 3 families and 7 genera. The dragonflies represent 6 species under the single Family Libellulidae and the damselflies also represent 6 species under the Families Coenagrionidae and Platynemididae. Most of the nymphs are found sluggish, dull in colour and collected from the top soft layer of bottom soil near littoral zone of the ponds and also in association with aquatic macrophytes such as *Eichhornia crassipes* and *Hydrilla verticillata*. The adults are beautifully coloured with long and slender 10-segmented bodies and are collected from the vegetation stands around the ponds.

Key words: Dragonflies, damselflies, ecology, Hazara Pukhuri, Sonitpur, Diversity

INTRODUCTION

Dragonflies (Suborder- Anisoptera) and Damselflies (Suborder- Zygoptera) collectively called as Odonates (Order- Odonata) are hemimetabolous exopterygotes. Nearly all the odonates pass their immature stages of their life cycle in water. Adults are aerial. Both the adults and the naiads are predatory in nature, having characteristics feeding habit. The adults are beautifully coloured with long and slender 10-segmented bodies. The damselflies are differed from dragonflies by their slender, delicate bodies and slow flights. The dragonflies are comparatively larger. Both damselfly and dragonfly naiads are usually brown or green in col-

our to camouflage them from predators and for ambushing prey. The habitat specificity makes the odonates a good indicator of wetland health (Subramanian, 2005) and their large size makes them valuable for quickly assessing water quality and for the study of insect behaviour (Asaithambi and Manickavasagam, 2002). The dragonfly and damselfly are true enemies of mosquitoes as the larvae of these insects are able to utilize mosquito larvae as food, and the adults are efficient predators of adult mosquitoes (Moore, 1997).

India with its unique geography and diverse bioclimatic regions, support a rich odonate fauna. Odonata of India is represented by 488 species and 27 subspecies in 154 genera

and 18 families (Subramanian, and Babu, 2017). The Suborder Zygoptera Family comprise of 211 species under 59 genera and 9 families Anisozygoptera one species under one genus and one family; Anisoptera 276 species under 94 genera and 8 families.

Survey on dragonflies and damselflies in North-eastern part of India mainly pertains to the work of Joshi & Kunte (2014) in Nagaland representing 90 species under 53 genera and 14 families; Prasad (2007) in Mizoram, recorded 64 species belonging to 41 genera and 12 families; Srivastava & Sinha (2004) in Manipur - 68 species belonging to 41 genera and 8 families; Mitra (2003) in Sikkim - 65 species under 34 genera and 11 families; Majumder (2014) in Tripura - 53 species under 37 genera and 9 families; Mitra (2006) in Arunachal Pradesh - 92 species under 50 genera and 11 families and in Srivastava & Sinha (1995) in Meghalaya, documented 151 species under 79 genera and 14 families. In Assam, Kalita & Ray (2015) reported 39 species with 22 genera from Deepor Beel Bird Sanctuary of Kamrup (Metro) district; Borah (2012) recorded 7 species of damselflies from Gauhati University campus, Kamrup (Metro); Basumatary *et al.* (2015) reported 34 species from the Bodoland University, Kokrajhar; Baruah *et al.* (2016) recorded 82 species belonging to 51 genera and 10 families from Kaziranga National Park and Karbi Hills of Assam; Gupta and Veeneela (2016) reported 14 species from Cachar district, Neog and Rajkhowa (2016) reported 17 species from Assam University, Silchar. The present investigation is the first one of these kind in Tezpur, Sonitpur, Assam.

MATERIALS AND METHODS

The present investigation is carried during the period of April, 2017 to March 2018. Standard literatures have been followed for collection and identification of the species.

Study area

Hazara Pukhuri is located within the

geographical range of $26^{\circ}37'37''$ N - $26^{\circ}37'58''$ N and $92^{\circ}46'54''$ E - $92^{\circ}46'47''$ E at an elevation of 245 ft (Figure 1 & 2). Covering an area of 28.5 ha, it is the largest perennial pond in the city Tezpur of Sonitpur District (about 175 kms from Guwahati), Assam. The pond was constructed during the day of Ahom King Harjjar Barman (ruled Assam during 815 AD - 835 AD) after whom it was named (Harjjar = Hazara; Pukhuri = Pond). The pond attracts tourists from different places for its historic background and an important habitat for migratory and residential aquatic birds. The pond is maintained by the District Fishery Department, Sonitpur, Assam.

Collection and Identification

Random survey is carried out by walking along the different zones of the selected habitats in daytime. Individuals of the species are photographed and identified in their natural habitats, but in few cases when assessment was difficult, they are collected with a specially designed hand operated net with long handle for further identification. The species were identified with the help of keys provided by Subramanian (2017), Mitra (2006), and Prasad and Varshney (1995).

RESULTS

Collection of both adult and immature forms of the individual belonging to the Order Odonata reveals 12 species from the studied ponds which are among the common Indian dragonflies (Suborder Anisoptera) and damselflies (Suborder Zygoptera). The dragonflies are represented by 6 species under the single Family Libellulidae and the damselflies also represented by 6 species under the Family Coenagrionidae and Family Platycnemididae.

Systematic enumeration of the species

Phylum: Arthropoda

Class: Insecta

Order: Odonata

Suborder: Zygoptera

Family: Coenagrionidae

1. *Ceriatagrion olivaceum* (Laidlaw)
2. *Ceriatagrion coromandelianum* (Fabricius)
3. *Ischnura aurora aurora* (Brauer)
4. *Ischnura senegalensis* (Rambur)
5. *Rhodischnura a nursei* (Morton)

Family : Platycnemididae

6. *Calicnemia eximia* (Selys)

Order : Odonata

Suborder : Anisoptera

Family : Libellulidae

7. *Orthetrum Sabina sabina* (Drury)
8. *Orthetrum luzonicum* (Brauer)
9. *Orthetrum pruniosum neglectum* (Rambur)
10. *Neurothemis tullia tullia* (Drury)
11. *Neurothemis sp.*
12. *Rhyothemis sp.*

DISCUSSION

Dragonflies and damselflies are amongst the prominent and colourful insects in tropical landscapes. In addition to providing aesthetic pleasure, studying them could give us valuable insights about ecosystem health, especially of wetland (Subramanian, 2005). Odonates, being predators both at larval and adult stages, play a significant role as natural biocontrol agent of mosquito vector. Many species of odonates inhabiting in agro ecosystems play a crucial role controlling pest populations. In addition to the direct role of predators in ecosystem, their value as indicators of quality of the biotope is now being increasingly recognized. The present investigation reveals 12 species of odonates which are among the common Indian dragonflies (Suborder Anisoptera) and damselflies (Suborder Zygoptera). The dragonflies represent 6 species under the single Family Libellulidae and the damselflies also represent 6 species under the Families Coenagrionidae and Platycnemididae are significant in respect of pond ecosystem management. Occurrence, abundance and distribution of invertebrates with longer life cycles

and metamorphosing larva may be influenced directly by span as well as timing of the hydroperiod (Taylor *et al.*, 1999) in freshwater ecosystem. The studied pond is a perennial water body, 100% water holding in a year. As a result, the pond brings up a community of insects having long life cycles such as dragonflies and damselflies. Indeed, due to higher water stagnation the groups constitute higher representation with their prolonged life cycles. Except from some scattered literature, studies on the diversity and ecology of this important group of aquatic insects including their taxonomic detail in Assam in general and Sonitpur district in particular is limited. The occurrence of 12 species in presently studied pond signifies the rich diversity of this insect group in the state. However, there may be many more species of this group as the larval forms are found to be extremely difficult to separate and identification is mainly supported by the adult forms collected from vegetation around the ponds tentatively simulating with larval forms.

CONCLUSION

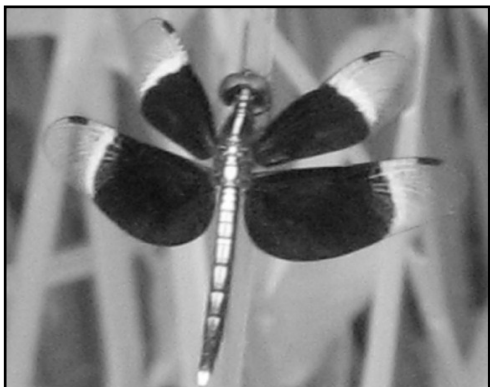
Though the Indian odonate fauna is well described in terms of adult taxonomy, their ecology is poorly known (Subramanian, 2009). Large scale habitat destruction and alterations is the major threat to odonate fauna of India in general and Assam in particular. The ecological information of both the adult and larval forms of odonates is of utmost importance for designing any conservation measure. This can be attempted only by fresh field surveys to know the threat status. Future studies on dragonflies in Assam in general and Sonitpur district in particular may be directed to have a comprehensive understanding of their ecology and their value as a biomonitoring tool.

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**Photo plate 1 (A-F). Adult morphs of the
Dragonflies (Order- Odonata)**



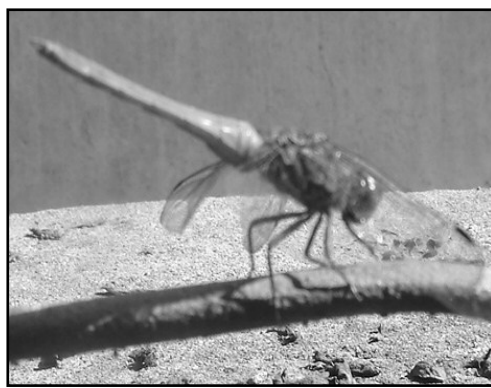
A. *Neurothemis tullia tullia*



B. *Rhyothemis sp.*



C. *Orthetrum luzonicum*



D. *Orthetrum pruniosum neglectum*

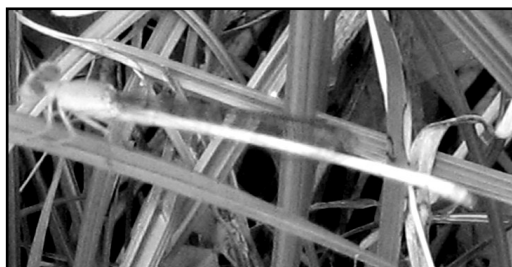


E. *Neurothemis sp.*



F. *Orthetrum sabina sabina*

**Photo plate 2 (G-L). Adult morphs of the
Damselflies (Order- Odonata)**



G. Ceriagrion coromandelianu (Fabricius)



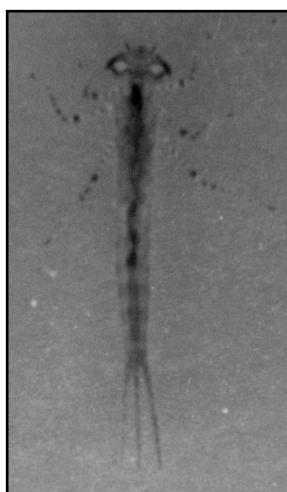
H. Ceriagrion olivaceum (Laidlaw)



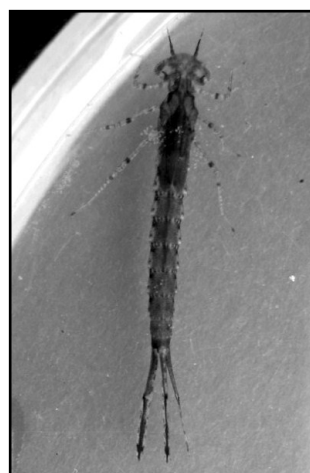
I. Ischnura aurora aurora



J. Ischnura senegalensis



E. Neurothemis sp.



L. Rhodischnura nursei (Larva)

Morphometric and Meristic characterization of Golden Mahseer (*Tor putitora*) from Jiabharali River, Assam, India

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ABSTRACT

Golden mahseer (*Tor putitora*) is one of the endangered species of game and food fish that is found in rapid streams, riverine pools, and lakes in the Himalayan region and southern Asia. Keeping in view, the basic necessity of having a knowledge on the biology of *T. putitora* (Actinopterygii: Cypriniformes: Cyprinidae) indigenous to the highlands of North-Eastern India, coupled with its great economic importance and also because of the gaining popularity of culturing, the present investigation has been undertaken. The results showed considerable differences in several morphometric parameters between male and females of *T. putitora*. The study revealed intra-specific difference as well as sexual dimorphism, at least in some morphometric characters, viz., number of lateral line scales, gape, rostral barbell length, pectoral fin height. The results of the biometric characters for *T. putitora* revealed that eye diameter becomes smaller in relation to head length. The trends of growth of girth in relation to total length were found to be isometric. The growth of head length in relation to total length is allometric in the case of *T. putitora*.

Keywords: Golden mahseer, Morphometry, Meristic coun, Jiabharali River

INTRODUCTION

Morphometric characters are used frequently in the identification of species of fish (Day, 1878, 1889; Jayaram, 1981; Shafi and Quddus, 1982; Bhuiyan and Biswas, 1984; Rahman, 1989; Talwar and Jhingran, 1991). McConnel (1978) stated that the information on morphometric measurements of the fishes and the study of statistical relationships could play an important role in the taxonomic studies of fishes. On the other hand the morphometric characters of wide and

medium range contribute in the indication of population of a species inhabiting the different water bodies or in different geographical regions. It is well known that ecological conditions of a water body have great impact on morphometric characters.

The term 'Mahseer' refers to a group of freshwater cyprinid easily distinguishable by relatively larger size of scales on their body compared to the other cyprinid fishes. The members of Mahseer belong to two genera, viz., *Tor* and *Neolissochilus*. They inhabit in the

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mountain streams and distributed in the range throughout Southern Asia to Southeast Asia. Among the Mahseer of the Indian subcontinent, *Tor tor*, *Tor putitora* is widely distributed in India, Nepal, Bhutan, and Pakistan; while *Neolissochilus hexagonolepis* is distributed in Nepal, Bhutan, North India and Northeast (NE) India (Laskar *et al.*, 2013).

T. putitora has been assessed as Endangered in the IUCN Red List (Jha, IUCN, 2016). The threatened species, viz., *Tor putitora* is regarded as the flagship species in NE India (<http://www.nbfgr.res.in/>). A few studies suggest that the angling of Mahseer provides superlative thrills than any other sport fishes except European Salmon. They are highly sought-after because of great attraction to recreational anglers and are important components of the Angling-tourism pursuit. (Laskar *et al.*, 2013). *T. putitora* is a highly valued food and game fish. Moreover, it has also been reported to have medicinal values (IUCN Red List of threatened species, 2016).

Keeping in view, the basic necessity to have knowledge on the general biology of the Mahseers indigenous to the North-Eastern India, a study has been undertaken on the identification, biology and propagation of *Tor putitora* at morphometric and meristic levels. The information on morphometric measurements of the fishes and the study of statistical relationships play an important role in the taxonomic studies of fishes. The morphometric characters of wide and medium range contribute in the indication of population of a species inhabiting the different water bodies or in different geographical regions.

Hamilton (1822) first classified mahseers and placed *Tor* species under the genus *Cyprinus*. He recognized three species of mahseers; *Cyprinus tor*, *C. putitora* and *C. mosal*. Gray (1833) created genus *Tor* to accommodate these. Sykes (1838) in his valuable work on “the fishes of Deccan” described three new barbels under the genus *Barbus* *cuvier* namely *Barbus mussullah*, *Barbus khudree* and *Barbus kolus* of

which first two species were subsequently included under genus *Tor gray* while *B. kolus* with its two barbels and an uninterrupted labial groove has been recognized as *Puntius kolus* by the recent taxonomists.

From the years, 1943 to 1944, MacDonald in his series of articles “Circumventing the Mahseer and other sporting fish in India and Burma” described Mahseer from different localities of Assam without any specific scientific names. Menon (1974) in his extensive survey work reported *Tor putitora* (Ham) from Nepal. In 1982, Das and Day described the prevalence of *Tor putitora* (Ham) and *Tor tor* (Ham) in the Jia Bharali river of Assam. While working on the fish fauna of Meghalaya, Sen (1982) reported *Tor putitora* (Ham) from the rivers Umium and Umtrew and *Tor tor* (Ham) from the rivers Umium and Simsang. Both the species are locally called as “kha-mahseer”. Nath (1986) described *Tor putitora* (Ham) and *Tor tor* (Ham) from the rivers Barak, Chiri, Jiri, Madhura, Jatinga and Sonai of Barak drainages. Das (1989) studied the systematic and bio-ecology of the Ichthyospecies belonging to the genus *Tor gray* from Jia-Bharali drainages of Assam. Dasgupta (1991) carried out Biometry of the Mahseer *Tor putitora* (Hamilton) collected from Garo Hills, Meghalaya. Zafar *et al.* (2002) carried out studies on meristic and morphometric measurements of Mahseer (*Tor putitora*) from a spawning ground of Himalayan foothill river Korang of Islamabad, Pakistan. Langer *et al.* (2013) studied morphometric and meristic study of Golden Mahseer (*Tor putitora*) from Jhajjar Stream (J and K), India and found Positive correlation has been observed between total length and external body parts. Thus, population appeared to be relatively uniform in all the characters examined, thus followed an isometric pattern. However, little is known about identification, characterization and conservation of the *Tor putitora* from Jiabharali river, Assam. Therefore the present study has been conducted for morphometric and meristic characterization of Golden Mahseer *Tor putitora* from Jiabharali River, Assam, India

MATERIALS AND METHODS

The study area: The present study focuses on the morphometric and meristic characterization of the golden Mahseer (*Tor putitora*) in the Jiabharali river (Tributary of River Brahmaputra) of Assam including The GPS location of the study area is $26^{\circ}48'51''$ N latitude and $92^{\circ}52'05''$ E longitude.

Sample collection: Mahseer sampling (*Tor putitora*) was done from March 2018 to May, 2018 (Figure 1). Altogether three survey stations had been selected after straight forward approach of normal random sampling (Rao *et al.* 1966) for the river Jia Bharali covering upper (Bhalukpong), middle (Toubhanga) and lower (Chowkighat) reaches amongst all the possible sites including characteristic of bottom conditions. A total of 60 specimens of Mahseer were collected from different sections of Jiabharali river. *Tor putitora* in the size range of 85.0 to 250.0 mm were utilized for the study were collected from the fishermen catch by various types of nets from the three survey stations of the Jiabharali river during the period.

Total weights have also been recorded to the nearest 0.1 gm in a digital balance. The

meristic and morphometric measurements were done with the help of magnifying glass model 50 mm. dia (China), stage microscope, electric balance, scales, divider and digital Vernier caliper (Brand- MITUTOYO), weight was taken using digital balance etc.

In the well-equipped Fish and Fishery Biology Laboratory of the Zoology Department of Darrang College, Tezpur, the species were morphologically and morphometrically studied and identified from various authoritative sources including Day (1878, 1889), Misra (1959), Menon (1974), Dey (1976) and Jayaram (1981) and classification was followed after Hamilton (1822) and McClelland (1839). For the morphometric and meristic characters the procedures Jayaram (1981) was followed.

Study of phenotypic character

Measurements of various body proportions were taken with utmost care. All are straight point to pint measurements taken with digital calipers and with fine pointed needles and dividers. 22 morphometric characters has been considered for phenotypic characterization of *Tor putitora* (Table 1. Figure 1.)

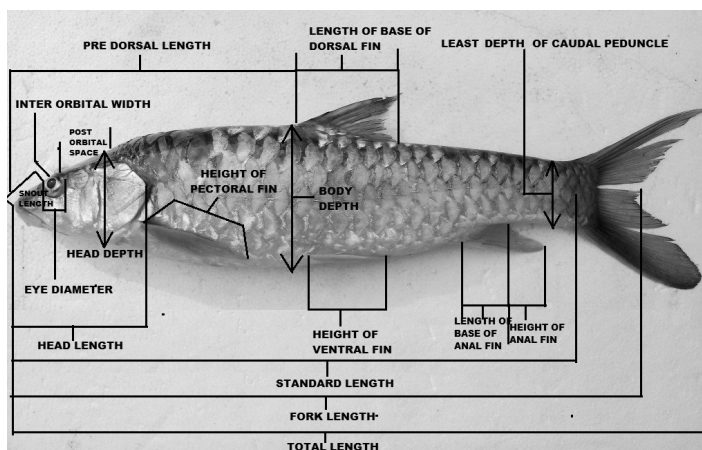


Figure 1. Morphometric parameters followed for study of *Tor putitora*

Morphometric Characters**Table 1.** The morphological characters measured

Sl No.	Characters	Description
1	Total length (TL)	Distance from the tip of the snout to the end of the caudal fin
2	Standard Length (SL)	Distance from the anterior part of the head to the end of vertebral column
3	Head length (HL)	Distance from the tip of the snout to the posterior margin of the opercula
4	Pre dorsal length (PDL)	Distance from the snout tip to the anterior base of the dorsal fin
5	Snout length (SL)	Distance from the tip of the snout to the front margin of the orbit
6	Eye diameter (ED)	Distance between margins of the eye ball across the cornea
7	Post-orbital space	Distance from hind margin of the orbit to the posterior edge of the opercular bone.
8	Inter-orbital width	The least bony width from orbit to orbit
9	Length of upper jaw	Distance from the anterior most point of the premaxillary to the posterior point of the maxillary.
10	Gape	Distance between the upper and lower jaw with the mouth widely open
11	Length of the barbels	Distance from base to the proximal end of the barbels
12	Head depth	Vertical distance from the end of the nape to the ventral side of the head
13	Body depth	Vertical distance between the dorsal and ventral surface to the body at its greatest depth
14	Least height of the body	Shortest vertical distance between the dorsal and the ventral surface of the caudal peduncle.
15	Length of the dorsal fin	Distance between the anterior and posterior end of the dorsal fin taken along the base
16	Length of free margin of dorsal fin	Distance from the anterior to posterior end of the dorsal fin taken along the free margin
17	Height of dorsal fin	Height of the longest fin ray of the dorsal fin
18	Height of pectoral fin	Height of the longest fin ray of the pectoral fin
19	Height of the ventral fin	Height of the longest fin ray of the ventral fin
20	Height of the anal fin	Height of the longest fin ray of the anal fin
21	Length of the base of the anal fin	Distance between the anterior and posterior end of the anal fin taken along the base
22	Girth	Circumference of the body at its deepest point

Meristic Characters: The following meristic counts were made according to methods as outlined by Jayaram (1981).

a) Number of rays in the dorsal fin; b) Number of rays in the pectoral fin; c) Number of rays in the ventral fin; d) Number of rays in the anal fin; e) Number of rays in the caudal fin; f) Number of lateral line scales; It represents the number of pored scales on the lateral line. The count was taken from the scale in contact with the shoulder girdle, to the structural caudal base; and g) Number of lateral line transverse scales: Scales above lateral line have been counted from the origin of the dorsal fin and counted downward and backward to (but not including) the lateral line scale. Scales below the lateral line have been counted upward and forward from the origin of the anal fin.

All the above mentioned measurements and counts were made on the left side of the fish. The specimens of all the three species taken up for the present study were grouped into 50.0 mm length groups for convenience sake by pooling the data together, viz., Group I: 50.0 - 100.0 mm, Group II: 101 - 150 mm and so on. However, only 4 groups of *T. putitora* could be made.

Biometric Index

The number of times each character

went into the reference length of the fish was considered as the Biometric Index (Tobor, 1974). The characters taken were: Head length (H.L), Inter-orbital length (I.O.L), Eye-diameter (E.D), Gape (G), and Girth, for each character a mean index for each 50.0 mm length group has been calculated to see whether it is constant or varying with the increase in total length, Biometric index was calculated for *T. putitora*.

RESULTS AND DISCUSSION

A total of 60 specimens of Mahseer were collected from different sections of Jiabharali river. A monthly average of 20 specimens of *Tor putitora* utilized for the study were collected from the fishermen catch by various types of nets from the three survey stations of the Jiabharali river during the period.

MORPHOMETRIC AND MERISTIC CHARACTERS OF *Tor putitora*

Morphometric Characters:

The morphometric and meristic observation has been listed in Table 2 & 4. The difference in the morphometric parameters between males and females of *T. putitora* are well defined (Table 3). The Fin formula of *Tor putitora* is found as: D iv 8; A ii 5; P i 16-17; V i 8

Table 2. Morphometric measurements of *Tor putitora*. (N=60)

Parameters	<i>Tor putitora</i>	
	% standard length (in mm)	
	Mean	Range
Total length	131.32	129.65-137.64
Fork length	12.24	111.88-115.32
Predorsal length	52.89	52.07-56.10
Head length	31.34	29.03-31.99
Head depth	18.46	17.73-23.36
Body depth	25.65	24.52-29.01

Least height of caudal peduncle	11.18	10.22-13.05
Length of caudal peduncle	17.44	15.45-18.29
Dorsal fin length	13.74	13.39-15.17
Length of free margin of dorsal fin	19.29	17.89-21.13
Dorsal fin height	24.05	22.83-28.57
Pectoral fin height	20.24	19.62-24.85
Ventral fin height	17.83	17.73-21.87
Anal fin height	21.05	18.92-23.36
Anal fin base	7.69	6.62-8.92
Girth	61.87	59.05-73.36
% Head length (in mm)		
Parameters	Mean	Mean
Snout length	41.31	41.31
Eye diameter	21.21	21.21
Post- orbital head length	46.87	46.87
Inter-orbital length	13.14	13.14
Length of Upper jaw	29.92	29.92
Gape	36.11	36.11
Rostral barbel length	29.09	29.09
Maxillary barbel length	37.57	37.57

MORPHOMETRIC COMPARISON OF THE MALES AND FEMALES OF *Tor putitora*

Table 3. Morphometric analysis of the male and female of *Tor putitora*

PARAMETERS	% Standard length (in mm)	
	Male	Female
Total length	132.43	133.23
Fork length	114.18	115.21
Predorsal length	54.05	54.80
Head length	31.75	32.00
Head depth	19.59	19.79
Body depth	25.00	25.23
Least height of caudal peduncle	11.48	11.63

Length of caudal peduncle	16.21	17.31
Dorsal fin length	14.86	15.05
Length of free margin of dorsal fin	19.59	19.89
Dorsal fin height	25.00	25.36
Pectoral fin height	20.94	21.25
Ventral fin height	19.59	20.11
Anal fin height	20.94	20.13
Anal fin base	7.43	7.53
Girth	67.56	68.17
Snout length	34.04	34.50
Eye diameter	17.02	17.36
Post- orbital head length	51.06	51.16
Inter-orbital length	38.29	38.51
Length of Upper jaw	31.91	32.05
Gape	40.42	40.53
Rostral barbel length	21.27	21.47
Maxillary barbel length	34.04	35.32

Table 4. Meristic characters of *Tor putitora*

Parameters	<i>Tor putitora</i>	
	Mean	Range
No. of dorsal fin rays	4/8	4/8 (Const.)
No. of pectoral fin rays	17.50	17-18
No. of ventral fin rays	9	9 (Const.)
No. of anal fin rays	3/5	3/5 (Const.)
No. of caudal fin rays	19	19 (Const.)
No. of lateral line scales	27.6	25-28
No. of lateral line transverse scales	4/2	4/2 (Const.)
Pre-Dorsal scales	11.5	10-13
Circumpeduncular scales	13	12-14

REGRESSION EQUATIONS:

The regression equations for various morphometric parameters studied for *Tor putitora* have been presented in Table 5.

Table 5. Regression Equations of Morphometric measurements of *Tor putitora*.

Parameters	Regression equations	Correlation -
Total length (Y) on Standard length (X)	$Y = 7.8493 + 1.2559 X$	0.9994
Fork length (Y) on Standard length (X)	$Y = 35.3946 + 1.4643 X$	0.9781
Predorsal length (Y) on Standard length (X)	$Y = 2.0832 + 0.5278 X$	0.9994
Head length (Y) on Standard length (X)	$Y = 2.5112 + 0.2787 X$	0.9983
Snout length (Y) on Standard length (X)	$Y = -0.9645 + 0.2477 X$	0.4033
Eye diameter (Y) on Standard length (X)	$Y = 2.6924 + 0.0409 X$	0.9933
Interorbital dist (Y) on Standard length (X)	$Y = 1.5151 + 0.9935 X$	0.9935
Gape (Y) on Standard length (X)	$Y = 0.8394 + 0.1007 X$	0.9351
Rostral barbel length (Y) on Std length (X)	$Y = 2.2731 + 0.0615 X$	0.9996
Head depth (Y) on Standard length (X)	$Y = 4.5722 + 0.1622 X$	0.9972
Body depth (Y) on Standard length (X)	$Y = 10.0129 + 0.2134 X$	0.9501
Length of Caudal peduncle (Y) on Std length (X)	$Y = -1.5977 + 0.1825 X$	0.9837
Dorsal fin length (Y) on Standard length (X)	$Y = 1.8418 + 0.1298 X$	0.9881
Dorsal fin height (Y) on Standard length (X)	$Y = 2.6880 + 0.2458 X$	0.9976
Pectoral fin height (Y) on Standard length (X)	$Y = 5.6000 + 0.1678 X$	0.9964
Anal fin height (Y) on Standard length (X)	$Y = 5.3555 + 0.1608 X$	0.9933
Anal fin base (Y) on Standard length (X)	$Y = 2.5068 + 0.0534 X$	0.9699
Girth (Y) on Standard length (X)	$Y = 11.9981 + 0.5794 X$	0.9975

Biometric index in *T. putitora*:

For each character a mean biometric index for each 50 mm length groups has been calculated and presented in Table 6. The growth of girth in relation to total length is isometric whereas the growth of head length in relation to total length and growth of inter-orbital distance and gape in relation to head length is allometric showing wide variations. The growth of eye diameter in relation to head length shows negative allometry with slight variation in length group IV (201-250 mm (Table 6.)

Table 6. Mean biometric indices in different length groups of *Tor putitora*

PARAMETERS	Gr. I 50-100 (mm)	Gr II 101-150 (mm)	Gr. III 151-200 (mm)	Gr. IV 201-250 (mm)
TL/HL	4.30	4.41	6.13	6.92
HL/Sn.L	2.79	2.60	1.89	1.57
HL/POL	2.26	2.41	1.63	1.39
HL/ED	3.91	4.22	1.66	4.50
HL/IOD	2.26	2.95	1.93	1.81
HL/G	2.68	2.95	1.93	1.81
HL/RBL	3.30	3.54	2.76	2.49
HL/MBL	2.98	2.92	2.13	2.21
HL/AFB	3.58	4.04	2.76	2.85
TL/GIRTH	1.88	1.99	1.99	1.99

The results of the present study showed high morphological variation in total length, head length and maxillary barbell lengths between male and female *T. putitora*. In *T. putitora*, the growth of head length in relation to total length is allometric. In *T. putitora* the growth of inter-orbital distance in relation to head length was found to be allometric and showed wide variations.

Nikolsky (1963) stated that males and females often differ in the length and shape of the fins, according to him, in the males of many Cyprinoids, both the paired and the unpaired fins are slightly larger than the females. Hence, such a difference in the morphometric characters of males and females may be regarded as sexual- dimorphic characters. According to Gould (1966) ratios between morphological characters will not necessarily be constant for the organisms of the same species due to variation resulting from differences in sex, race and

nutrition and/or other environmental factors, Therefore, in the present study too, variations in morphometric measurements may be attributed to the diverse environmental factors.

Goswami *et al* (2012) reported the commonly found Mahseers belonging to *Tor* species are : *Tor progeneius*, *Tor putitora*, *Tor chelynooides*, *Tor mosal*, *Tor tor*, and from *Neolissochilus* species are *Neolissochilus hexagonolepis*, *Neolissochilus hexastichus*. Various authors have shown that morphometric characters of fish can vary under the influence of environments and in particular the thermal factor during the period of incubation and the beginning of larval life (Taning, 1944; Lindsay, 1954; Barlow, 1961). Variations in the body proportions in the same species according to hydrographic conditions have also been recorded by various authors (Hubbs, 1922; Barlow, 1961). They associated these variations with the effect of the duration of periods of growth and

of the relating differentiations which determines the number of vertebrae and of segments. Many authors (Schmidt, 1921; Vladykov, 1934; Barlow, 1961) have reported that meristic characters exhibit plasticity under the influence of environmental factors, as has also been seen in the present study.

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Bioaccumulation of Lead In Freshwater Fish *Channa punctatus*

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ABSTRACT

Bioaccumulation of Lead in the freshwater fish *Channa punctatus* was investigated after exposure to a sub lethal concentration of 5ppm of Lead acetate in the aquarium containing 41L of water and was examined after 30 days of exposure. The maximum level of accumulation of lead was observed in the liver whereas the lowest level of lead was observed in the muscle tissues at the end of 30 days of exposure period. It thus exhibits that accumulates primarily in the liver tissues of *Channa punctatus* exposed to sublethal concentration of lead acetate.

Key words : Bioaccumulation, Lead and *Channa punctatus*.

INTRODUCTION

The aquatic environment plays a vital role for functioning of ecosystem and is intimately related with human health. The increasing human population and industrial development has worsened the problem of disposal of anthropogenic chemicals and wastes in the aquatic environment.

Among all types of aquatic pollutants, heavy metals are of greatest concern because after reaching in the aquatic bodies they not only deteriorate the life sustaining quality of water but also cause damage to both flora and fauna. Heavy metal contaminants in aquatic ecosystems pose a serious environmental hazard because of their persistence and toxicity. Study of toxicology pertaining to aquatic animals has become important in water pollution studies in the present days.

Metals can accumulate in aquatic organisms, including fish, and persist in water and sediments (Luoma and Rainbow, 2008). Since fish occupy the top of the aquatic food chain, they are suitable bioindicators of metal contamination. Fish take up metals through the gills, digestive tract and body surface (Tao *et al.*, 2001; Kamunde *et al.*, 2002). Various metal ions are involved in oxidative stress in fish. The most important and most studied metals are Fe, Cu, Cr, Hg and Pb and metalloids As, Se. Among the heavy metal pollutants, Lead is a major environmental pollutant in many parts of the world. It is one of the most toxic and non-biodegradable elements. Lead accumulation in sediment is of significance for aquatic organisms. Lead can induce oxidative damage through direct effects on the cell membrane, interactions between lead and hemoglobin, which increase the auto-oxidation of hemoglobin. The toxic effect of lead is primarily the

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inactivation of enzymes and proteins by the binding with sulfhydryl group etc. It is an immunotoxicant which through human exposure results in immune function changes and has the potential to adversely affect human health.

Fishes absorb lead by different ways through gills and skin or by ingestion of contaminated water and food; and may lead to high mortality rate or cause many biochemical and histological alterations in survived fish (Coetzee, L. 1998). The accumulation of heavy metals in the tissues of fishes may cause various physiological defects and mortality (Torres *et al.*, 1987). The pattern of bioaccumulation of metals in animals differs from metal to metal and organ to organ during their functional status. Most of the investigations pertaining to heavy metals contaminants in aquatic systems are dealt either with toxicity or with accumulation (Rushforth *et al.*, 1981; Khadiga *et al.*, 2002). Heavy metals have been shown to be concentrated in the liver of various fishes (Sorensen, 1991; Rao *et al.* 1998). In the present study, the bioaccumulation of Lead in the different tissues is evaluated in the fish, *Channa punctatus* exposed to sub-lethal concentration of lead for 30 days.

MATERIALS AND METHODS

Sexually immature healthy specimens of freshwater teleost *Channa punctatus* having length between 14-18 cm and weight of about 40-55 g were selected for lead exposure. The fishes were treated with 0.05% KMnO₄ solution for 2 minutes to avoid any dermal infection before left for acclimatization for 7 days in the laboratory in glass aquarium containing 41litre non-chlorinated tap water. Proper aeration was done during the period and the fishes were fed with Spirulina special fish food. Feeding was stopped 24 hour prior the commencement of the experiment. The water of the aquarium was changed after every 48 hour leaving no faecal matter, unconsumed food or dead fish if any. The water quality parameters of aquarium and a 12h photoperiod were maintained.

The acclimatized fishes were separated into two groups consisting of 8 fishes in each aquarium. One group served as the controlled group and the other as the experimental group. The experimental group of fishes was exposed to a sub-lethal concentration of 5ppm lead acetate for a period of 30 days in the aquarium tank filled with 41 litres of water.

C.punctatus were sacrificed after the exposure period and the tissues like liver, kidney, gills and muscle were dissected out from the experimental and control groups and samples were prepared to determine the accumulated lead by atomic absorption spectrophotometer.

The tissue samples were prepared by taking about 0.2g of each sample which is digested with 3:1 ratio of nitric acid and perchloric acid. The samples are then heated up to 60°C for about 1hour until a pale yellow colour solution is appeared which is then cooled to room temperature and the final volume is made up to 50ml by distilled water.

The concentration of the accumulated lead in the tissues samples is then determined by measuring in Atomic absorption spectrophotometer. Values were expressed as mg / g wet wt.

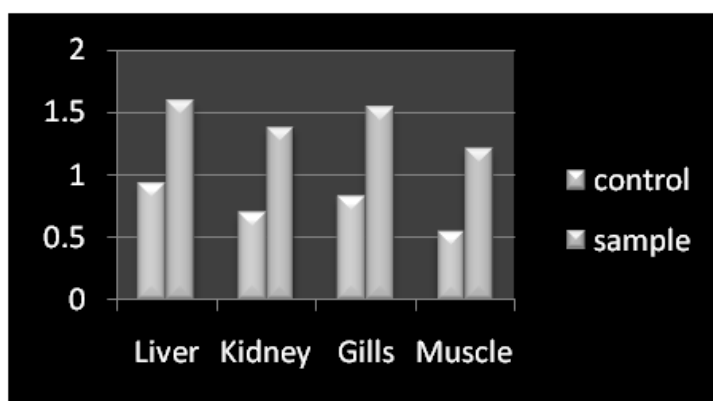
RESULTS AND DISCUSSION

The levels of lead accumulation in the different tissues such as liver, kidney, gills and muscle of *Channa punctatus* exposed to sub-lethal concentration of lead acetate for a period of 30 days are shown in Table 1. A comparison of the tissues of the experimental group with the controlled group are shown in Fig 1. In the present investigation the highest accumulation of Lead was found on the liver (1.585 ± 0.265) followed by Gills, kidney and muscles. Muscles accumulating the lowest level (1.205 ± 0.255). The same was reported for arsenic in *Labeo rohita* (K. Pazhanisamy *et al.*, 2007; Swati *et al.*, 2012) and for lead in *Labeo rohita* (Pandi prabha *et al.*,). This will lead to liver damage.

Sexually immature healthy specimens of freshwater teleost *Channa*

Table1. Comparison of accumulation of lead in different tissues of controlled group and experimental group of *Channa punctatus*

Fish tissues	Controlled group(mg/g)	Experimental group(mg/g)
LIVER	0.93±0.010	1.585±0.265
KIDNEY	0.70±0.005	1.38 ±0.25
GILLS	0.82±0.007	1.535±0.245
MUSCLE	0.54±0.004	1.205±0.255

Tissues of *Channa punctatus***Figure 1.** comparison of concentration of lead in different tissues of controlled and lead exposed *Channa punctatus*

The reason behind the liver damage was due to decrease in the level of protein, lipids, glycogen and metabolic enzymes (Zodape, 2010). The liver of fish was important organ for ecotoxicological study and it was the prime site for accumulation of lead (Ahmed and Bibi, 2010; Vinodhini and Narayanan, 2008; Lal Shah and Ahmed Altindau, 2005). Accumulation of lead in Gill comes next in the order due to its large surface area's contact with the water. Since, Kidney is the doorway for heavy metal detoxification in the body, accountable amount

of lead accumulation was observed. Heavy metals were uniformly spread over the body muscles. Hence, the muscles are known to have less accumulation of lead than other. The heavy metals were uniformly spread over the body muscles. Hence, the observed values were relatively lower than the other potential organs. The presence of higher amounts of heavy metals in any parts of the body will definitely induce changes in biochemical metabolisms and other induced stresses (Vinodhini and Narayanan, 2008).

CONCLUSION

Studies on the accumulation of heavy metals in various organs of the fresh water fish exposed to sublethal concentrations were very much important. The information can be used to evaluate the biochemical changes in the fish metabolism

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A practical design of a low voltage electronic power supply in its primitive form and its efficiency analysis at a few representative values of loads

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ABSTRACT

A primitive low voltage electronic power supply has been designed and its efficiency, corresponding to different classes commonly used of diodes, at a few reasonable load values are calculated. Measurements are done by using Digital Oscilloscope – ‘Aplab D36100C’ and a sophisticated Source Meter – ‘Keithley 2401’ with high accuracy in our laboratory. Capacitor has no rule in μF efficiency calculations apparently and hence only one capacitor of 16 volt and 330 capacitance is used throughout these measurements. The measured values of the efficiencies of the rectifier are in accordance with the theoretical predictions hence well acceptable.

Key words : Electronic power supply, Load.

INTRODUCTION

A power supply unit (PSU) or commonly known as power supply (PS) is an electric or electronic device that empowers the electrical loads or electronic devices (Kelley, A. W. and Yadusky, W. F., 1992).

The power supply that has been designed in the our laboratory is a very primitive full-wave centre-tap type power supply which consists of a step down centre-tap transformer

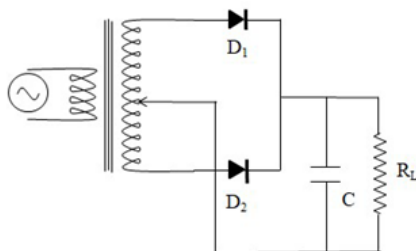


Figure 1. Centre tap full-wave rectifier.

and only a few components such as two diodes for rectification and a capacitor for filtration of voltage fluctuations

THEORY

The A.C. voltage is applied to the primary of the centre tap transformer. The reduced a.c. voltage appeared across the secondary of the transformer is feed to the two diodes D₁ and D₂.

The rectified output, i.e., d.c. voltage is extracted from the capacitor terminals (<http://www.circuitstoday.com> and <http://visionics.a.se/html>) for practical uses – mainly to recharge rechargeable batteries as the output from such power supplies produces moderately fluctuating d.c. because of its poor filtration quality with less number of filtering components which in our design, is only a single capacitor (<https://www.popsci.com>).

The efficiency of a full-wave rectifier (Sze, S. M. and Lee, M. K., 2010) is given by,

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$$\begin{aligned}\eta_f &= \frac{P_{dc}}{P_{ac}} \\ &= \frac{I_{dc}^2 R_L}{I_{rms}^2 (r_f + R_L)}\end{aligned}$$

where, r_f and R_L are the diode forward resistance and load resistance.

No diode, in practice, is an ideal diode. That is, a diode neither acts as a perfect conductor (when forward biased) nor it acts as an insulator (when it is reverse biased). A practical diode possesses a some resistance under forward biased condition. Such resistance of a diode is known as forward resistance.

In a full-wave rectifier, the output average current (which is also called d.c. current) is given by (Rashid, M. H., 2001),

$$I_{av} = I_{dc} = \frac{1}{T} \int_0^T I dt$$

where I is input a.c. current.

Taking the input a.c. current be $I = I_0 \sin \omega t$,

$$I_{av} = I_{dc} = \frac{1}{T} \int_0^T I_0 \sin \omega t dt$$

Simplifying,

$$I_{av} = I_{dc} = \frac{2I_0}{\pi}$$

In a full-wave rectifier, the input r.m.s. current is given by,

$$\begin{aligned}I_{rms} &= \sqrt{\frac{1}{T} \int_0^T I^2 dt} \\ &= \sqrt{\frac{1}{T} \int_0^T (I_0 \sin \omega t)^2 dt}\end{aligned}$$

$$\text{Simplifying, } I_{rms} = \frac{I_0}{\sqrt{2}}$$

Thus the efficiency of a full-wave rectifier becomes,

$$\begin{aligned}\eta_f &= \frac{\left(\frac{2I_0}{\pi} \right)^2 R_L}{\left(\frac{I_0}{\sqrt{2}} \right)^2 (r_f + R_L)} \\ &= \frac{0.812}{\left(1 + \frac{r_f}{R_L} \right)}\end{aligned}$$

The efficiency will be maximum if r_f is negligible as compared to R_L .

The efficiency of a full-wave rectifier is double that of a half-wave rectifier. That is, a full-wave rectifier is twice as effective as half-wave rectifier.

MATERIALS AND METHODS

The designed power supply has been tested with four different popular types of diodes, viz., 1N4007, 1N5401, 6A4 and 10A6 with different forward resistances and current capacities (<https://www.alldatasheet.com>).

Also three representational load values, viz., 10 Ω , 50 Ω and 100 Ω of moderate importance are used with each type of such diodes.

Resistances are measured using Digital Oscilloscope – ‘Aplab D36100C’ and a sophisticated Source Meter – ‘Keithley 2401’ with high accuracy in our laboratory.

Capacitor has no rule in efficiency calculations apparently and hence only one capacitor of 16 volt and 330 μF capacitance is used throughout these measurements.

RESULTS AND DISCUSSION

Experimentally measured efficiencies at a few representative load resistances 10Ω , 50Ω and 100Ω and their comparison with theoretical values are enlisted in table 1. The measured values of the efficiencies of the rectifier increases with decrease in forward resistances of the different types of diodes. The efficiencies also increases with increase in loads. These are in accordance with the theoretical predictions and hence well acceptable within the regime of this primitive design of the rectifier.

These measurements also reveal that diode class 1N5401 is slightly better performer in terms of their rectification efficiencies. Similarly, it may be noted that the diode class 1N4001 is a bit less efficient

Table 1. Experimentally measured efficiencies and their comparison with theoretical values

Diode (from a family of diodes)	Forward Current I_f (in Amp)	Forward Voltage V_f (in Volt)	Forward Diode Resistance r_f in Ω		Repre- sentativ e Loads R_L in Ω	Efficiency η_f in %		Error %
			$r_{f(th)} = \frac{V_f}{I_f}$	$r_{f(ex)}$		$\eta_{f(th)}$	$\eta_{f(ex)}$	
1N4007	1	1.1	1.10	1.62	10	73.09	69.88	4.39
					50	79.45	78.68	0.97
					100	80.32	79.91	0.51
1N5401	3	1	0.33	0.38	10	78.61	78.23	0.48
					50	80.67	80.59	0.09
					100	80.93	80.89	0.04
6A4	6	0.9	0.15	0.21	10	80.00	79.53	0.59
					50	80.96	80.86	0.12
					100	81.08	81.03	0.06
10A6	10	1.1	0.11	0.20	10	80.32	79.61	0.88
					50	81.02	80.67	0.43
					100	81.11	81.04	0.08

CONCLUSION

Though not good or recommended for modern complex and costly electronic devices, such moderately fluctuating d.c. voltage is little more suitable for charging rechargeable batteries and can also safely be used to light up LED bulbs, small motors, devices run by small motors, etc. Lastly, the simple structure and low cost production is an added feature to be considered in such circuits.

The fluctuations in the output voltage can be minimized by inserting more filter sections such as L- and Pi-section filters across the output voltage of the power supply. These filters smoothes out the output voltage of the power supply making it more suitable for modern complex and costly electronic devices. Such studies have also been performed and the results may be published in future communications.

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Antifungal Activity of Some Ethnomedicinal Plants Against *Sclerotinia sclerotiorum* (Lib.) DE BARY

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ABSTRACT

In the present study ten different locally available plants *Mimosa pudica*, *Polygonum hydropiper*, *Leucas aspera*, *Solanum torvum*, *Mirabilis jalapa*, *Xanthium strumarium*, *Solanum nigrum*, *Nyctanthes arbor-tristis*, *Mikania micrantha* and Citrus leaves were taken for study of antifungal activities. Plants extract were prepared by smashing fresh plant material and mixed with the concentrated ethanol in a waring blender for 10 min. Fungal pathogen *Sclerotinia sclerotiorum* was used in this study. Among the ten plants taken *Mimosa pudica*, *Mikania micrantha*, *Mirabilis jalapa*, *Polygonum hydropiper* and *Solanum nigrum* was most effective against *Sclerotinia sclerotiorum*.

Key words: *Mimosa pudica*, *Polygonum hydropiper*, *Leucas aspera*, *Solanum torvum*, *Mirabilis jalapa*, *Xanthium strumarium*, *Solanum nigrum*, *Nyctanthes arbor-tristis*, *Mikania micrantha* and Citrus leaves Antifungal activity.

INTRODUCTION

Plant disease causes significant damage and economic losses in agriculture and horticulture crops every year. Global losses caused by plant pathogens are estimated to be 12% of the potential crop production, despite the continuous release of new resistant cultivars. As a consequence, management strategies including the use of chemical pesticides are often employed inappropriately and indiscriminately. Furthermore, fungi are continuously becoming resistant to fungicides and they are at risk of being withdrawn from the market. In addition to reducing crop yield, fungal pathogens often lower crop quality by producing toxin that affect human health. (Duraismy Saravankumar *et al.*, 2015). For disease management, several strategies have

been applied against the soil-borne pathogens to reduce the survival of the resting fungal structures such as sclerotia. Fungicide sprays can prevent infection by ascospores; however, due to difficulty in achieving spray penetration of the crop canopy, disease can still occur. Once the pathogen has become established in the soil, steam sterilization or fumigation with methyl bromide can be used to kill the sclerotia. The high cost of steam sterilization and pesticides, development of fungicides resistance pathogen isolates, governmental restriction on the use of fumigants with environmental concerns over regular use of fungicides and the difficulty in finding suitable rotation crops to reduce pathogen inoculum have led to increase in the search for efficient alternative to chemical fungicide management of *S. sclerotiorum* (Staub 1991;

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Köhl and Fokkema 1998; Zhou and Boland 1998). Based on the knowledge that plants develop their own defense against fungal pathogens (Gurgel *et al.* 2005), they appear as an interesting source for antifungal compounds. In a study, Fabricant and Farnsworth (2001) reported that 94 species of plants are utilized for the production of 122 single-agent natural products that are being used as single agent drugs around the world. Thus, even with this very incomplete database of global ethnomedicinal information, there is abundant opportunity for the discovery of new medicinal age.

MATERIALS AND METHODS

Study area: Tezpur is the headquarter of the centrally located Sonitpur district in Assam. Mythologically known as Sonitpur. Tezpur is located on the northern bank of the river Brahmaputra. The average temperature in summer is around 36 °C while the average winter temperature is around 13 °C. Latitude and longitude of tezpur is 26.6528 N, 92.7926 E. There are many rare and endemic plant species available in tezpur. It is also rich in biodiversity hence it is include in one of the biodiversity hotspot of the world. Among these plant some medicinal plant are also available, in some high medicinal value used for ages by the tribes there in ethnobotany.

Plant materials: Plant materials collected were- *Mimosa pudica*, *Polygonum hydropiper*, *citrus leaves*, *Leucus aspera*, *Mirabilis jalapa*, *Mikania micrantha*, *Solanum nigrum*, *Nyctanthes arbor-tristis*, *Solanum torvum*, *Xanthium strumarium*.

Chemicals: Chemicals used in the study were potato dextrose agar (PDA), dextrose, starch, distilled water, demethyl sulphoxide (DMSO) and ethanol.

Instruments: Instruments used in the study were Borosilicate glasswares- petridishes, Beaker, conical flask, Glass rod, Hot air oven, Balance, Heating mantel, Autoclave, Laminar air

flow, Forceps, Punching machine for making uniform circular discs, Inoculating loop, Spatula, Scale, Bunsen burner and Incubator.

Identification and collection of plant specimen: The leaves of the selected plant specimens were collected from Tezpur, Sonitpur district in the month of January, 2019 after that the selected plant specimen were properly identified and certified by Botany Department of Darrang college, Tezpur. The fresh leaves of selected plant species were then washed 2-3 times in running tap water to remove any dust particle on the surface of the leaves and air dried at room temperature.

Preparation of plant extract: Thoroughly washed fresh plant material (50 g) was smashed with 50 ml sterile 100% concentrated ethanol in a warring blender for 10 min. The plant material was first filtered through double-layered muslin cloth, and then filtered through Whatman No. 1 filter paper. The extract was preserved aseptically in a brown bottle at 5 °C until further use. The plants that showed antifungal activity were only selected for further work in solvent extraction.

Preparation of media:

Potato dextrose agar media: The media prepared was prepared by suspending 39 grams in 1000 ml distilled water. Heat to boiling to dissolve the medium completely. Sterilized by autoclaving at 15 lbs pressure (121°C) for 15 minutes. Mix well before dispensing.

Fungal stains: The phytopathogenic fungal strains were collected from the Defense Research Laboratory (DRL), Solmara, Tezpur.

Sub-culturing of fungal strain: To sub-culture fungi on new petriplates, freshly prepared agar plate is used. With the help of an aseptic needle or an inoculating loop prepared by dipping it in 90% ethanol and then putting it in flame of a spirit lamp, a loopful of inoculum from the culture plate is taken under an aseptic condition in

laminar air flow chamber and then inoculated on the fresh media plate. The freshly inoculated media is then incubated in BOD incubator at a temperature of $26 \pm 2^\circ\text{C}$ for the culture to grow.

Disk Diffusion Method (Kirby-Bauer Test)

: For determining the zone of inhibition on plates containing PDA media, disc diffusion method carried out. The discs of uniform diameter of 4mm are cut out of filter paper by punching machine and sterilized for several time. The discs were then dipped in 100% concentrated of ethanolic plant extract diluted with DMSO and left some time before being used. On freshly prepared PDA media on petridishes, a drop of fungal inoculum from PDB have been placed on each of the petridishes and spread with a spreader uniformly throughout the media. After that the discs left few time in the absolute concentration are then placed in the inoculated media and incubated in a BOD incubator for 48 hours for the respective fungi to grow. If the discs containing the extracts stop the fungus from growing or kill the fungus, there will be an area around the disc where the fungus have not grown enough to be visible. Zone of inhibition will be produced. Observe it carefully and measure the diameter of the zone to evaluate the effectiveness of that antibiotic against particular organism.

RESULTS AND DISCUSSION

The present study tested the antifungal activity of ethanolic leaf extracts of *Mimosa pudica*, *Polygonum hydropiper*, *Leucas aspera*, *Solanum torvum*, *Mirabilis jalapa*, *Xanthium strumarium*, *Solanum nigrum*, *Nyctanthus arbor-tristis*, *Mikania micrantha* and Citrus leaves against *S. sclerotiorum*. The antifungal activities of ethanolic plant extract were carried out for different concentration of plant extract i.e. concentration 1, 2, and 3. The result showed that the antifungal activity increases with the increase in concentration of the extract.

It has been seen that in concentration 1 antifungal activities against *S. sclerotiorum*, *Citrus leaves*, *Leucas aspera*, *Nyctanthus*, *Xanthium strumarium*, and *Solanum nigrum* and *Solanum torvum* did not show any inhibition zone. *Mirabilis jalapa* showed the highest inhibition zone of 8mm. Whereas *Polygonum hydropiper* showed the lowest inhibition zone of 4.3mm against *Sclerotinia sclerotiorum*.

In concentration 2 antifungal activities against *S. sclerotiorum*, *Leucas aspera* and *Nyctanthus* did not show any inhibition zone. *Mimosa pudica* showed the highest inhibition zone of 12.6mm. Whereas *Citrus* and *Solanum torvum* showed the lowest inhibition zone of 5mm against *Sclerotinia sclerotiorum*.

In concentration 3 antifungal activities against *S. sclerotiorum*, *Leucas aspera* and *Nyctanthus* did not show any inhibition zone. *Mikania micrantha* showed the highest inhibition zone of 19.6mm. Whereas *X. strumarium* showed the lowest inhibition zone of 8mm against *Sclerotinia sclerotiorum*. Plants are important source of potentially useful structures for the development of new chemotherapeutic agents. It was revealed in this study, that increase in the antifungal activity of the extracts was enhanced by increase in the concentration of the extracts. This finding agrees with the report of Bansa *et al.* (1999) that higher concentration of antimicrobial substance showed appreciation in growth inhibition.

Plants generally produce many secondary metabolites which constitute an important source of microbicides, pesticides and many pharmaceutical drugs (Ogundipe *et al.*, 1998 and Ibrahim *et al.*, 1997). It may be concluded that keeping aside the environmentally hazardous commercial fungicides, these leaf extracts could be a suitable substitute for controlling the fungal pathogens. However, further evaluation in field conditions is needed.

Table 1. Zone of inhibition against *sclerotinia sclerotiorum* of concentration 1 ethanolic plant extracts.

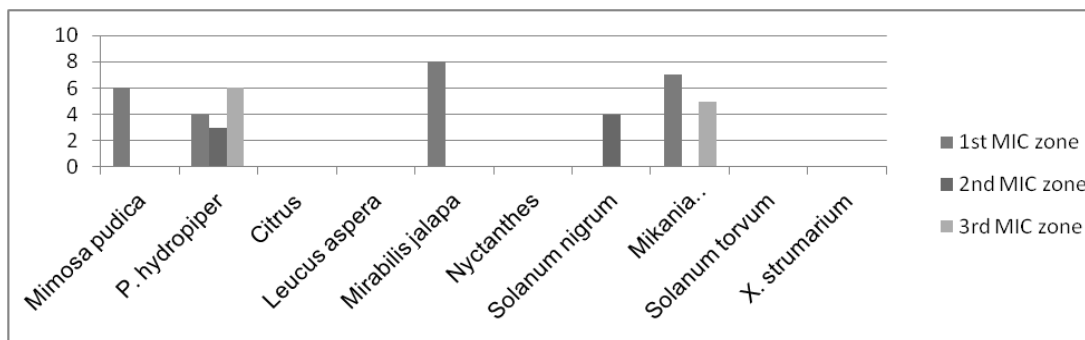
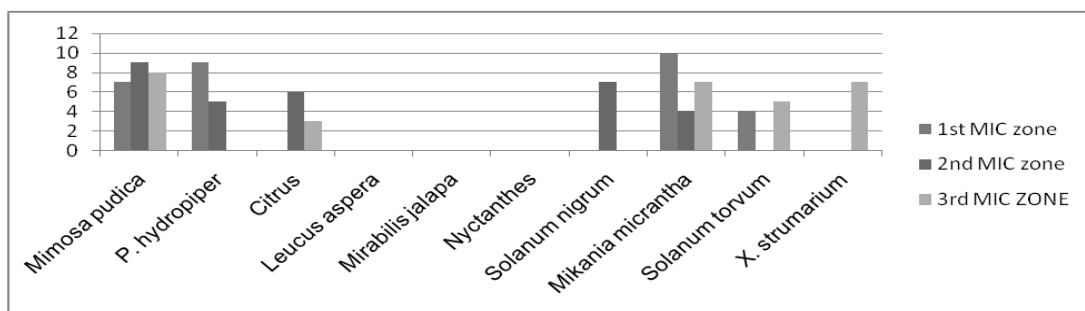
PLANT EXTRACT	1 st ZONE OF IN- HIBITION [mm]	2 nd ZONE OF IN- HIBITION [mm]	3 rd ZONE OF IN- HIBITION [mm]	AVARAGE [mm]
<i>M. pudica</i>	6mm	—	—	6
<i>P. hydropiper</i>	4mm	3mm	6mm	4.3
<i>Citrus leaves</i>	—	—	—	—
<i>L. aspera</i>	—	—	—	—
<i>M. jalapa</i>	8mm	—	—	8
<i>N. arbor-tristis</i>	—	—	—	—
<i>S. nigrum</i>	—	—	—	—
<i>M. micrantha</i>	7mm	—	5mm	6
<i>S. torvum</i>	—	—	—	—
<i>X.strumarium</i>	—	—	—	—

Table 2. Zone of inhibition against *S. sclerotiorum* for concentration 2 of ethanolic plant extracts.

PLANT EXTRACT	1 ST ZONE OF IN- HIBITION [mm]	2 nd ZONE OF INHIBITION [mm]	3 rd ZONE OF INHIBITION [mm]	AVARAGE [mm]
<i>M. pudica</i>	7mm	9mm	8mm	8
<i>P. hydropiper</i>	9mm	5mm	—	7
<i>Citrus leaves</i>	—	6mm	3mm	4.5
<i>L. aspera</i>	—	—	—	—
<i>M. jalapa</i>	—	—	—	—
<i>N. arbor-tristis</i>	—	—	—	—
<i>S. nigrum</i>	—	7mm	—	7
<i>M. micrantha</i>	10mm	4mm	7mm	7
<i>S. torvum</i>	4mm	—	5mm	4.5
<i>X. strumarium</i>	—	—	7mm	7

Table 3. Zone of inhibition against *S. sclerotiorum* for concentration 3 of ethanolic plant extracts.

PLANT EXTRACT	1 ST ZONE OF INHIBITION [mm]	2 nd ZONE OF INHIBITION [mm]	3 rd ZONE OF INHIBITION [mm]	AVERAGE [mm]
<i>M. pudica</i>	10mm	7mm	8mm	8.3
<i>P. hydropiper</i>	12mm	10mm	18mm	13.3
<i>Citrus leaves</i>	9mm	5mm	—	7
<i>L. aspera</i>	—	—	—	—
<i>M. jalapa</i>	—	10mm	4mm	7
<i>N. arbor-tristis</i>	—	—	—	—
<i>S. nigrum</i>	—	8	—	8
<i>M. micrantha</i>	10mm	13mm	19mm	14
<i>S. torvum</i>	8mm	—	10mm	9
<i>X. strumarium</i>	—	6mm	10mm	8

**Figure 1.** For concentration 1 of plant extract:**Figure 2.** For concentration 2 of plant extract:

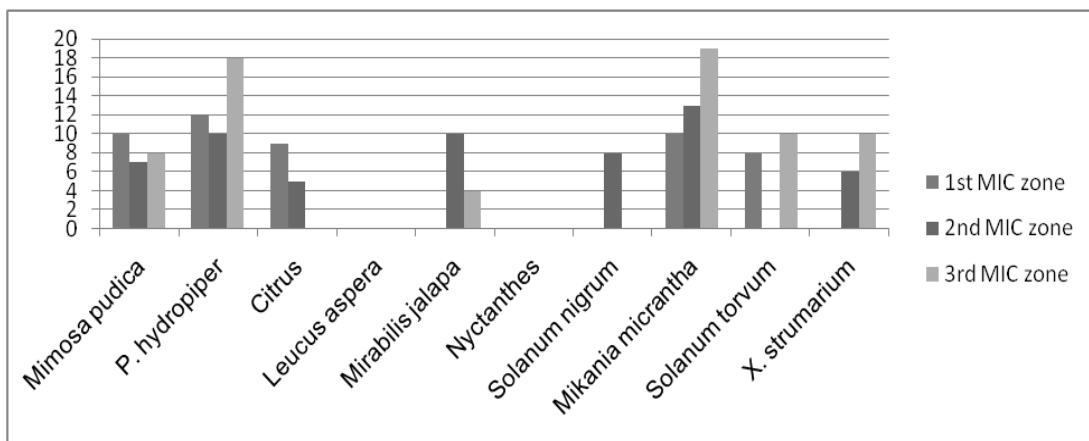


Figure 3. For concentration 3 of plant extract :

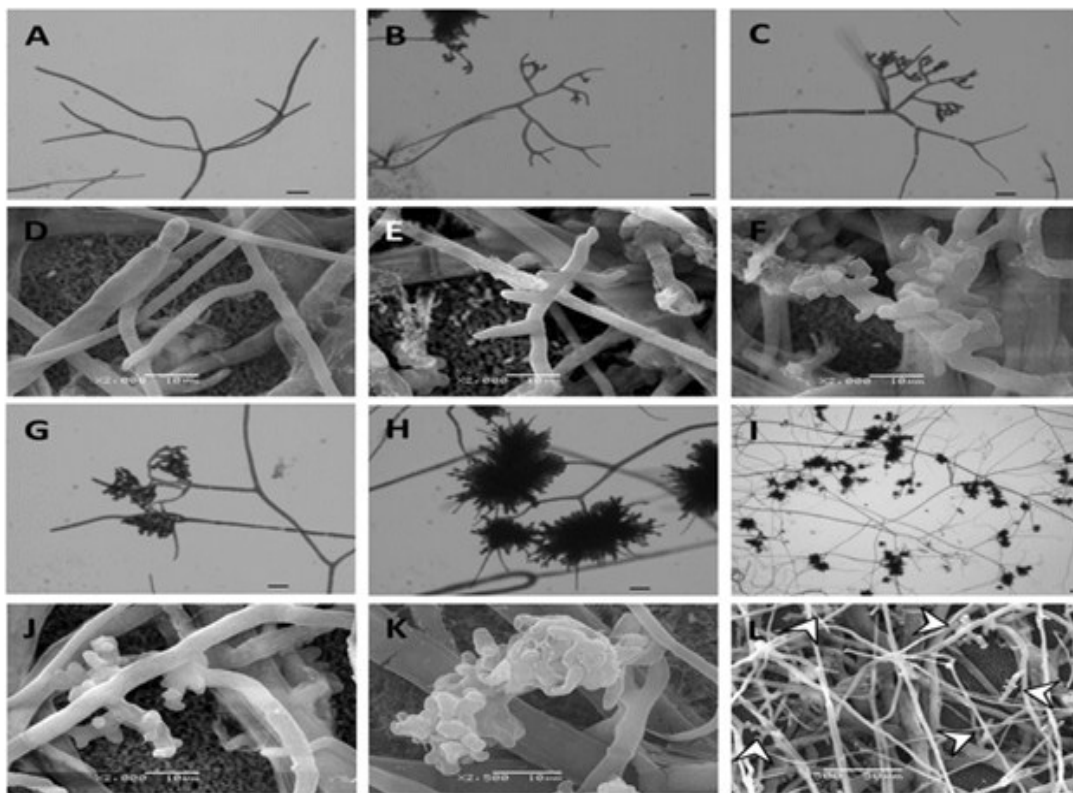


Plate 1. Microscopic views of Fungi

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Present Educational Scenario of the Namasudra Community in Karkha and Gerul village of Dakshin Dinajpur District, West Bengal, India: A Critical Synthesis

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ABSTRACT

The present work attempts to look into the present educational condition of the members of Namasudra community in Karkha and Gerul village of Banshihari block under Dakshin Dinajpur District of the Indian state of West Bengal. The study is basically based on primary data although some books, journals, research articles, research reports have been used as a source of secondary data. The primary data has been collected by interview technique with the help of standard questionnaires and participant observation technique in the year 2018. For this purpose multi-stage stratified random sampling have been applied. The collected data first be tabulated, processed and then presented and interpreted using different cartographic techniques and diagrams. The analysis reveals that there is a significant variation in terms of male female literate and illiterate percentage, educational attainment, dropout rate of the children, and rate of enrolment, Preference of School for Primary Education of Children in the Karkha and Gerul village. The result show that the Namasudra community in Karkha village is to some extend forward in the field of education in comparison to the Gerul village almost in all level of education. An attempt has been made in this present work to make some sort of recommendations for equitable participation and educational development of the Namasudra community in the field of education in respect with the study area and also for regional and national levels.

Key words : Educational Scenario, Namasudra Community, Equitable Participation, Critical Synthesis, Development.

INTRODUCTION

As a welfare state, India is committed to growth with social justice. The most important objectives of India's economic planning are to eliminate poverty and raise the standard of living of its people including the weaker sections of its population. A section of such weaker section of

India's population has been constitutionally categorized under the category called Scheduled castes; vide Government of India Act 1935. Before the Act of 1935, these categories of marginalized people were called "Depressed Class". One such community of Depressed Class or Scheduled Caste is known as the 'Namasudra' in the state of Bengal. This work attempts to look

into the present educational condition of the members of Namasudra community in Karkha and Gerul village of Banshihari block under Dakshin Dinajpur District of the Indian state of West Bengal.

In our Indian constitution, peoples of Namasudra community are recognized as socio economically backward and belong to schedule caste group mainly found in Assam, West Bengal, Orissa, Manipur, Tripura, Meghalaya, Mizoram and Arunachal Pradesh of India and the six eastern districts of Faridpur, Dacca, Mymensingh, Jessore and Khulna of Bangladesh. These communities have a great history of emergence or evolution and they are very poor in comparison to the other caste. James Wise and Herbert Risely- two prominent ethnologists believed that the word "Namasudra" was derived either from the Sanskrit word 'namas' or 'adoration' which means the people who were bound to show obeisance even to the Shudras or the Bengali word 'namate' i.e. below or underneath which means a lower grade of Shudras. According to Sashi Kumar Badoi Biswas the word "Namasudra" represents two things: first-namaskar or paying obeisance i.e. the people who paid obeisance to the Shudras (Shudrang namati) and second-to be avoided that means avoided by Shudras (Namah Shudrena). Another Namasudra commentator, Naresh Chandra Das, claimed that the word "Namasudra" means the Shudras who were paid obeisance to an explanation which seems to be the most plausible of all. 'Naman' means respected and shudra is a classified section of people who holds the lower strata in the caste society. Sekhar Bandyopadhyay in his study entitled "Caste, Protest and Identity in Colonial India: The Namasudras of Bengal, 1872-1947" claimed that 'The Namasudra community was earlier known as Chandala or Chandals, who mostly inhabited the district of East Bengal (at present Bangladesh), were forced to migrate to West Bengal during the partition of India in 1947. The different synonymous of the Namasudras are Chan-

dal, Charal, Namasud and Namah (Singh, K. S, 1995)..

Now a days, education is a fundamental human need and it is considered as the most powerful instrument to achieve one's goals in life and also socio-economic change and development. Educated people are more active, sufficient and healthier comparing to uneducated people. The Namasudras, the second largest Hindu caste (after Rajbanshi) in the province of Bengal, has a great history of their emergence, consolidation and move-ments for social and political recognition. At the beginning of twenty-first century the Namasudras in West Bengal had made an important educational and social improvement, notwithstanding politically they remained marginalized.

In the context of social science research, review of literature and pre-assessment of studies is very important as it provides not only the information about subject and sub-topics of the research but also smooth management procedure. It is well established fact that each social problem has the relation with the country, time and situation and from this point of view old studies are not only significant but essential too.

A study entitled, "The Problem of Non-Attendance in Schools of the Children (6-14 years) of Scheduled Castes in Haryana" was made by Pimpley, (1981). The author highlights that the spread of education among females was considerably lower than among males and among employers, most of the children were attenders. Among those engaged in small business all were non-attenders. The level of education of the head of the household seemed to have a positive bearing upon the school attendance of children. Awareness of reservation policy and attendance of students are positively co-related to each other. Dana Dunn (1993) in her paper "Gender Inequality in Education and Employment in the Scheduled Castes and Tribes of India" highlights the descriptive profile of the status of women in the scheduled castes and tribes

in India on the basis of ethnographic and statistical view point. She also points out that the Scheduled Caste people are more far from the educational and employment opportunity comparing to General Caste.

In the book entitled, "Dalit society and Challenge of Development" (1996) by Om Prakash Sangwan described the Socio-economic scenario of depressed classes, social structure, evolution of classes, politics of reservations and the educational development of scheduled castes and their struggle for liberation.

Mishra (1997) analyzed the level of literacy among dalit population in Atarra teshil of Uttar Pradesh and emphasized that Dalit populations are back warded in terms of literacy compared to non-Dalit populations mainly due to – (a). Literacy does not take place any significant role in their daily chores. (b). they considered their child as an essential tool of the family's day to day activities than sending him/her to school. (c). the physical distance between their habited area and school.

Chatterjee's (2000) book 'Educational Development of Scheduled Castes Looking Ahead' highlights educational development with social integration, educational inequalities, enrolment ratio, disparities in educational attainments, effect of education on marriage and constitutional provisions related to education of the Scheduled Caste population. N. B Biswas, (2004) in his pioneer work entitled "Emergence of Namasudra as a sub-caste: an Ethnological view" had attempted to work on the ethnological view of the emergence of Namasudra community as a sub scheduled caste, consolidation and move-ments for social and political recognition. He also highlights their social and economic position in the society and how they are exploited by the upper caste Brahmin.

A.P.J. Abdul Kalam (2005) in his article "For Dignity of Human life" highlights that education is the most powerful element for growth and prosperity of a nation. India is in the process of transforming itself into a developed

nation by 2020. Yet we have 350 million people, who need literacy and many more that have to acquire employable skills to suit the emerging modern India and the globe. Children who belong to weaker section of our society are malnourished and undernourished, and only a small percentage of them manage to complete eight years of satisfactory education (Based on President Dr. A.P.J. Abdul Kalam's address, to the nation on the eve of Independence Day, 04).

Anand and Yadav (2006) in their study "The Inclusion of SC Girls in Education: A Long Path Ahead" describe the issue related to education of the Scheduled Caste particularly educational status of SC girls. A large number of SC girls do not have access to successive stages of education. The authors describe not only the drop-out rate of the Scheduled Caste Girls, factors responsible for the low female literacy and non-participation of SC girls in education but also makes an attempt to improve the situation with the help of suggests strategies and under the different governmental schemes.

Singh and, Parveen (2006) in their pioneer work entitled "Educational Empowerment of Scheduled Castes: A Study on the Working Patterns of Training Schemes" describes the statistics of scheduled caste educational attainment in schools, colleges and universities in India. The study also reveals that there has been tremendous discrimination in the field of education although there is an increasing trend in the enrolment of scheduled castes children in higher education.

Ghosh (2007) in his research paper entitled "The Gender Gap in Literacy and Education among the Scheduled Tribes in Jharkhand and West Bengal" discussed the gender gap in literacy and education among the Scheduled Tribes in Jharkhand and West Bengal with the help of gender disparity index. The study reveals that female literacy rates of Ho, Mahali, Lodha tribe in Jharkhand and West Bengal are low, compared with other tribes and gender disparities increase at the higher level of school ed-

ucation. The author also highlights the enrolment ratios, dropouts of female children, and discusses the issues related to tribal education.

Wankhede (2008) in his paper “Accessing Higher Education: Affirmative Action and Structured Inequality – The Indian Experience”, opined that education is considered one of the significant means of development of weaker sections like the Scheduled Castes in the contemporary period of globalization. The accessibility, performance and sustenance in education are hampered mainly due to their traditional socio-economic status. Although government committed itself to compensate their deprivations through various measures but there are several weaknesses in implementing the scheme. The author suggested that the scheme needs to be revamped in a big way.

Chandrashekar and S.B Akash (2011) in their paper “Educational and Occupational Aspirations of Scheduled Caste College Students: An Empirical Study” highlighted that the education plays an important role in transformation of socio-economic situation of the people of society. The authors conducted the study with the help of questionnaire covering 225 students belonged to the scheduled caste community studying in different Degree College of Raichur district. The study clearly depicts that the career aspirations of most of the scheduled caste students are want to become teachers and lecturers rather than KAS or IAS officers. This may be due to their backward economic conditions.

Shailaja Paik’s (2014) book entitled “Dalit Women’s Education in Modern India Double Discrimination” emphasis the everyday experience of ordinary Dalit women in western India at the center of her analysis of Dalit access to education in the twentieth century. Shailaja Paik gives us a very clear look at education, what it means, how Dalits enter in to it, and how negotiable their attitude about education is. She has given us a Multi-Faceted study of discrimination in terms of the field of education. Shailaja Paik highlighted in her study that Dalit wom-

en suffered from dual discrimination since they were neither welcome in the public schools – though these institutions were supposed to be for all children –nor necessarily sent to them by their parents.

The major objectives of the present study are:

1. To make a comparative analysis of educational status of the Namasudra community in Karkha and Gerul village under Banshihari Development Block of Dakshin Dinajpur District of the Indian state of West Bengal.
2. To find out the causes of educational backwardness and problemes regard to education of the Namasudra people in the study area.
3. To make some sort of recommendations for equitable participation in education of Namasudra caste within the scheduled communities in respect of the study area and also for regional and national levels.

MATERIALS & METHODS

Study area

Dakshin Dinajpur District, is a part of Jalpaiguri division of West Bengal State, came into existence from 01-04-1992 when the erstwhile district west Dinajpur was bifurcated to form two separate districts; Utter Dinajpur with its headquarters at Raiganj and Dakshin Dinajpur with its headquarters at Balurghat. Karkha and Gerul village under Banshihari Development Block of Dakshin Dinajpur District of the Indian state of West Bengal has been selected for in deep study on present educational status of Namasudra Community. Karkha village is located under Shibpur Gram panchayet of Banshihari Tehsil of Dakshin Dinajpur District. The Karkha village covering a total geographical area of 138.36 hectares and it is bounded by Sayestabad village on the East: Amai village on the south west and Kail village on the North West. The village bears a total population of 1256 with an

average population density of 896 persons per square km, population growth rate 11.50% and sex ratio 967 females for every 1000 males according to the census of India 2011. Gerul village with population 443 is Banshihari sub districts, the 56th least populous village, located in Banshihari sub district of Dakshin Dinajpou district in the state of west Bengal in India. The

total geographical area of Gerul village is 0.49 km² surrounded by Anilas village on the west; Mirahati village on the east and south east and Deogaon village on the south respectively. The density of population is 904 per km²; population growth rate 12.2% and sex ratio 1014 females for every 1000 males according to the census of India 2011. (Figure 1.)

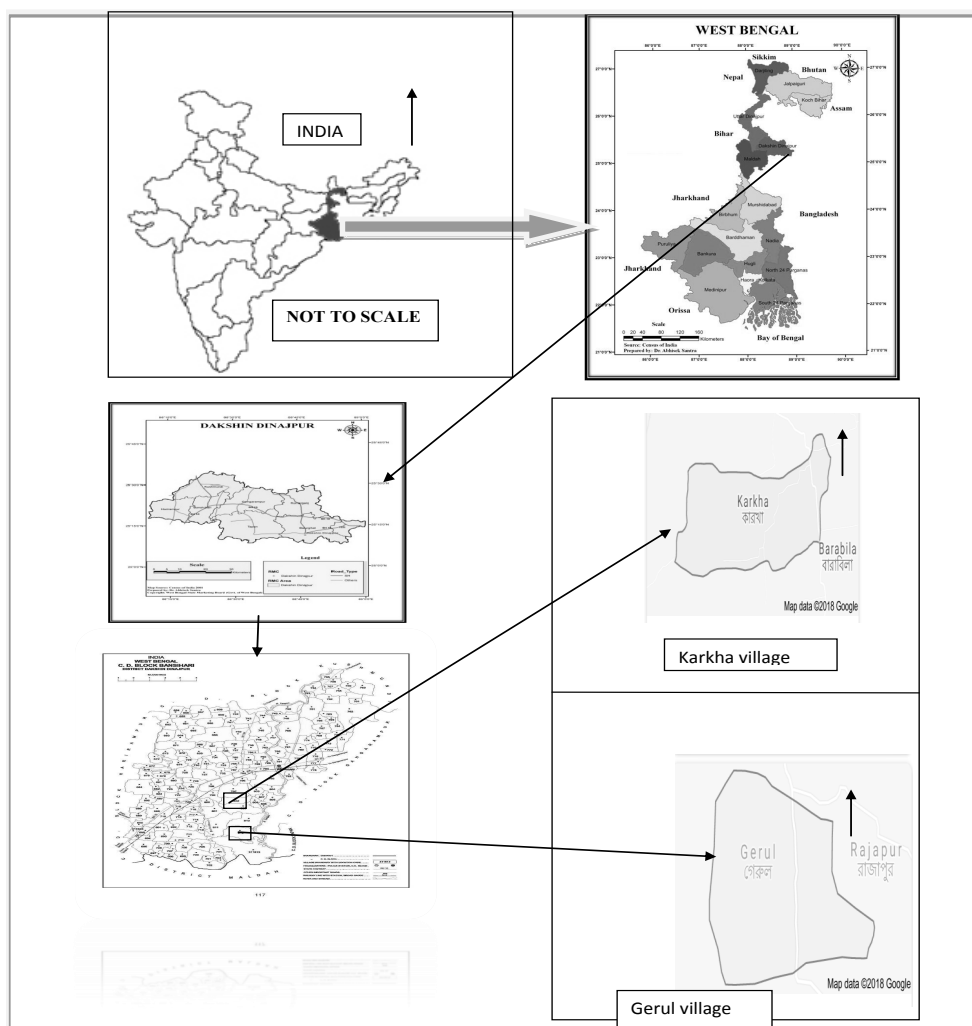


Figure 1. Location Map of the Study Area

DATA COLLECTION AND ANALYSIS

Primary data as well as Secondary data sources have been used in the present study to depict and analyze the present educational scenario of Namasudra Community in Karkha and Gerul village of Dakshin Dinajpur District. The primary data has been collected by interview technique with the help of standard questionnaires which have been collected from the field (study region) i.e. Karkha and Gerul village by using the multistage stratified random sampling method. And also, participant observation technique is conducted directly having participation with the respondents. Secondary sources of data are gathered from different published and unpublished materials such as books, journals, re-

search article, research report, Ph.D thesis, Dissertation etc. The obtained data were presented and interpreted using different cartographic techniques and diagrams.

RESULTS AND DISCUSSION

This study highlights the Present Educational Scenario of the Namasudra Community in Karkha and Gerul village of Dakshin Dinajpur District of West Bengal. Here the author tries to describe the comparative analysis of male female literate and illiterate percentage, educational attainment, dropout rate of the children, rate of enrolment, Preference of School for Primary Education of Children and Number of Educational Institutions with in the study area.

Table 1. Literate and Illiterate population

Name of the village	Category	Frequency			Percentage		
		Total	male	Female	Total	Male	Female
Gerul	1	2	3	4	5	6	7
	Literate	132	82	50	57.39	59.42	54.35
	Illiterate	98	56	42	42.61	40.58	45.65
	Grand Total	230	138	92	100.00	100.00	100.00
karkha	Literate	196	114	82	82.00	80.85	83.67
	Illiterate	43	27	16	17.99	19.15	16.33
	Grand Total	239	141	98	100	100	100

Source: Prepared by Researcher based on Field Study- 2018.

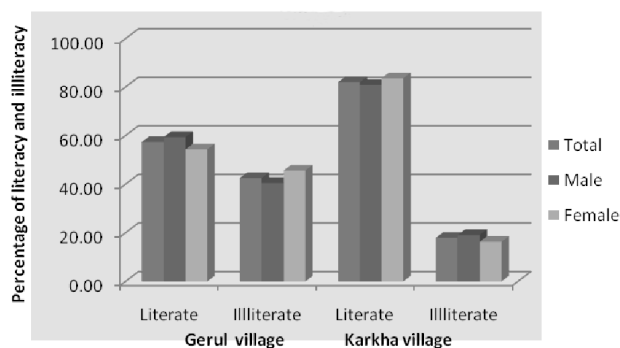


Figure 2. Literate and Illiterate population of Gerul and Karkha village

Figure 2. Literate and Illiterate Population

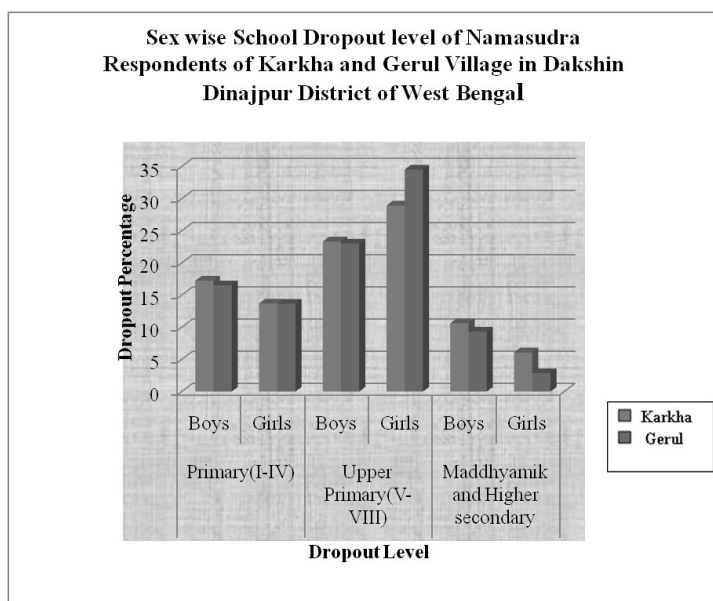
A person who is more than 7 years old and able to read and write with understanding in any language is recorded as literate. Education is considered to be one of the most important instruments through which a society socializes all members and it helps for nations building. In Gerul village 59.42% male and 54.35% female are literate while 40.58% male and 45.65% female are illiterate. The literacy rate in Karkha village is very high (80.85% male and 83.67% female are literate) in comparing to Gerul village. Therefore the gap between male and fe-

male literates in Karkha village is about 2.82%. In comparison to the Gerul village the male female literates and illiterates gap is 5.07 % and 5.07 % respectively. The major factor behind the difference of literate and illiterate rates in Karkha and Gerul Village are lack of educational facilities, lack of awareness dependency on child labour, untouchability practices, location of the village, economic status of the population etc. It is necessary to create awareness among the Namasudra community and effective planning for the upliftment of female population at this point of time. (Table 1 and Figure 2)

Table 2. Dropout Levels of Namasudra Respondents in Karkha and Gerul Village

Source: Prepared by Researcher based on Field Study-2018.

Name of the Village	Primary(I-IV)		Upper Primary(V-VIII)		Maddhyamik and Higher secondary	
	Boys	Girls	Boys	Girls	Boys	Girls
Karkha	17.25	13.70	23.35	28.93	10.65	6.09
Gerul	16.54	13.66	23.02	34.53	9.35	2.87

**Figure 2.** Sex wise School Dropout Level of Namasudra Children's in Karkha and Gerul village.

The school dropout scenario of Namasudra children of Karkha and Gerul village in Dakshin Dinajpur district of West Bengal is not so good. Although, during the last few decades, the school enrolment rate of Namasudra children have increased ,particularly at primary level, but the dropout rates among these children continue to be very high. The dropout rate (both boys and girls) in Karkha and Gerul village is high at Upper-Primary (V-VIII) level comparing to Primary (I-IV) and Maddhyamik and Higher secondary level. Out of total 197 dropout students in Karkha village majority (23.35% boys,28.93% girls) are of Upper primary level and remaining

15.47% and 8.78% children are of primary and higher secondary level. In case of Gerul village, out of total 139 dropout students majority (23.02% boys, 34.53% girls) are of Upper primary level and remaining 15.01% and 6.11% children are of primary and higher secondary level. The major factor behind these type of dropout of children are illiteracy of families, Poor economic condition Early Marriage of daughters, lack of awareness, children are considered labour force to supplement meager family income etc.

(Table 2 and Figure 3)

Table 3. Rate of enrolment of Namasudra children in school

Name of the village	Response	Frequency of response		Percentage of response	
		Male	Female	Male	Female
Gerul	Enrolled	146	121	80.22	84.62
	Not enrolled	36	22	19.78	15.38
	Total	182	143	100	100
Karkha	Enrolled	157	149	88.20	90.30
	Not enrolled	21	16	11.80	9.70
	Total	178	165	100	100

Source: Prepared by Researcher based on Field Study-2018

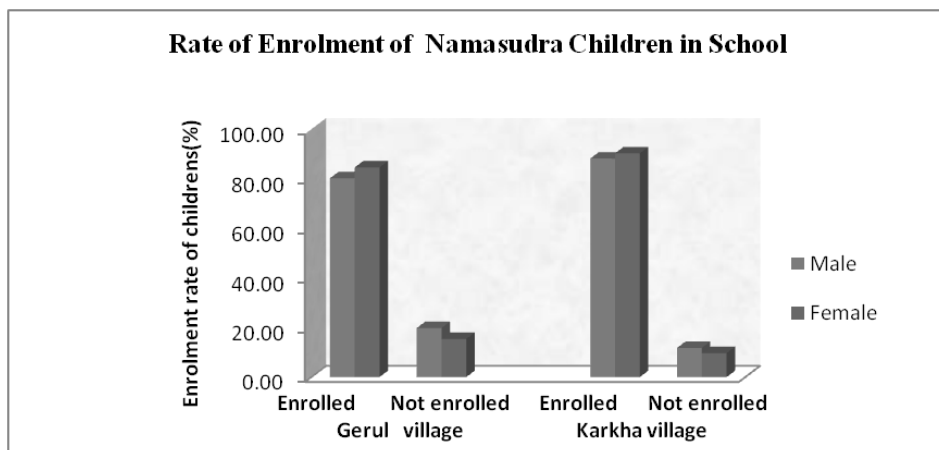


Figure 3. Rate of Enrolment in Namasudra Children in School

Most of the School dropout Children (boys and girls) are engaged in paid work activities inside homes at Gerul and Deuria village of Dakshin Dinajpur district of West Bengal and work for 8-10 hours a day. Analysis of 1993-94 National Sample Survey data found that the proportion of child labour was two to three times higher among the Dalits and Adivasi than the rest of the population (Throat, 1999). Relative exclusion and inequality among Namasudra (Dalits) boys and girls is higher than the general and

scheduled caste population in terms of universalisation of elementary education. As a result, their overall educational environment remains lower. In Gerul village the rate of enrolment of Namasudra children in School is 80.22% male and 84.62 % female where as in Karkha village the school enrolment of Boys and girls are 88.20% and 90.30% respectively. It is also noted that the girl's enrolment rate in both villages is quite higher comparing to male enrolment rate. (Table 3 and Figure 4).

Table 4. Educational attainment of Namasudra Community of Karkha and Gerul village

Name of the village	Gerul			Karkha		
Category	Percentage			Percentage		
	Total	Male	Female	Total	Male	Female
Primary(I-IV)	58.93	55.99	63.05	47.39	45.42	47.86
Upper primary(V-VIII)	26.90	25.00	29.56	21.98	20.77	22.50
M.P	8.62	11.97	3.94	16.04	15.49	19.29
H.S	3.08	3.87	1.97	7.57	8.45	6.43
Graduate	1.44	1.76	0.99	3.78	5.28	2.14
Post-Graduate	0.62	0.70	0.49	1.98	2.82	1.07
Others	0.41	0.70	0.00	1.26	1.76	0.71
Total	100.00	100.00	100.00	100.00	100.00	100.00

Source: Prepared by Researcher based on Field Study-2018

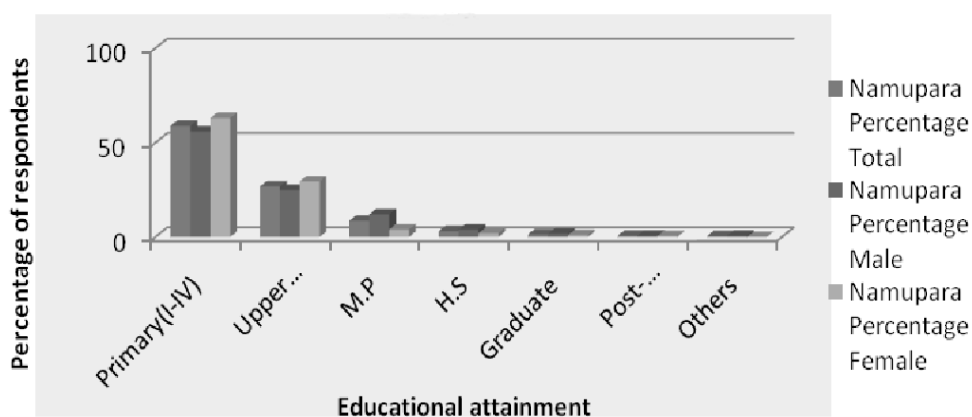


Figure 4. Educational attainment of Namasudra Community of Gerul village

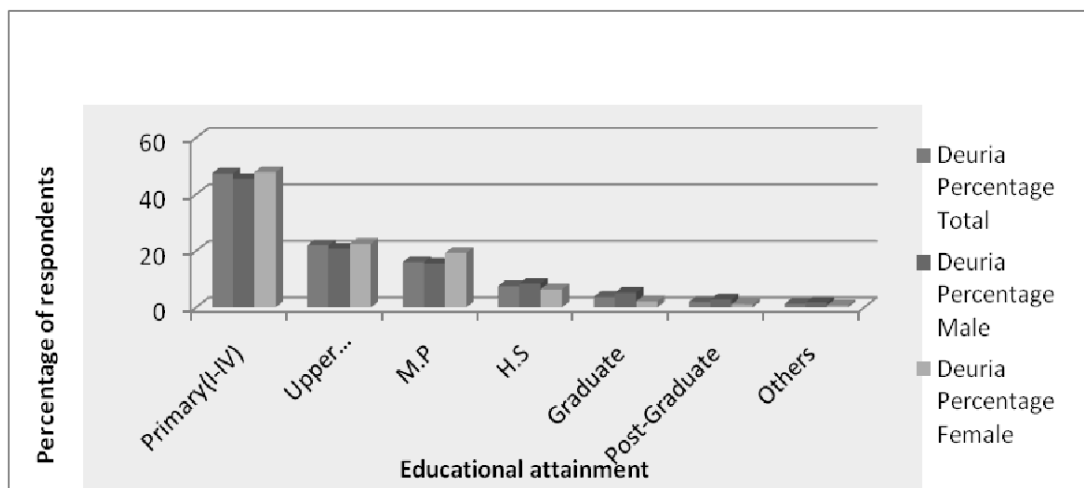


Figure 4. Educational Attainment of Namasudra Community in Karkha and Gerul village

Educational attainment means the percentage distribution of different levels of educational attainment in the literate population of an area or a region. The study of educational attainment of male and female population is a significant instrument for the analysis of population characteristic of a particular community or a group. The scenario of educational attainment of the members of Namasudra community in Karkha and Gerul village reveals that there is a significant variation for the attainment of higher education. Regarding educational level among the Namasudra people (Table-04) shows that 55.99% of the literate males and 63.05% of the literate females of Gerul village are of the primary level (iv standard) while in Karkha village 45.42% of the literate males and 47.86% of the literate females are of the primary level (iv standard). The percentage of educational attainment of M.P and H.S level in Gerul village are 8.62%(11.97 % male and 3.94% female) and

3.08%(3.87% male and 1.97% female) respectively where as in Karkha this scenario are more than double. Disparity also observed in terms of educational attainment in Graduation, Post-graduation and Others level in male and female of Karkha and Gerul village of Dakshin Dinajpur district. Only 1.76% male and 0.99% female of Gerul village are graduates whereas 5.28 % of male and 2.14% of female of Karkha village are graduates. The status of post-graduate (2.82% male and 1.0% female) and Others (1.76% male and 0.71% female) level of education in Karkha village is quite higher comparing to the Gerul village. The gap in post - graduation level between Karkha and Gerul village is 2.12% for male and 0.58% for female. Therefore it may be concluded that the participation at higher education (graduation, post-graduation and above) of the members of Namasudra community in both villages is very poor. (Table 4 and Figure 5)

Table 5. Preference of School for Primary Education of Children and Number of Educational Institutions

Name of the village	Category	Frequency	Percentage	No of Educational Institution
Karkha	Private Nursery School	142	67.3	4
	Government School including ICDS	79	37.44	2
	Total	211	100	6
Gerul	Private Nursery School	62	34.25	0
	Government School including ICDS	119	65.75	1
	Total	181	100	1

Source: Prepared by Researcher based on Field Study-2018

Out of total 211 respondents in Karkha village 142(67.3%) preferred private nursery school and 79 (37.44%) prefer government schools for their children .Whereas in Gerul village out of total 181respondents'62(34.24%) have preferred private nursery school and 119(65.75%) prefer government schools for their children. It is also observed that only one ICDS are found in Gerul village where as 2 government school including one ICDS and 4 private nursery schools are located in the Karkha village. (Table 5 and Figure 6)

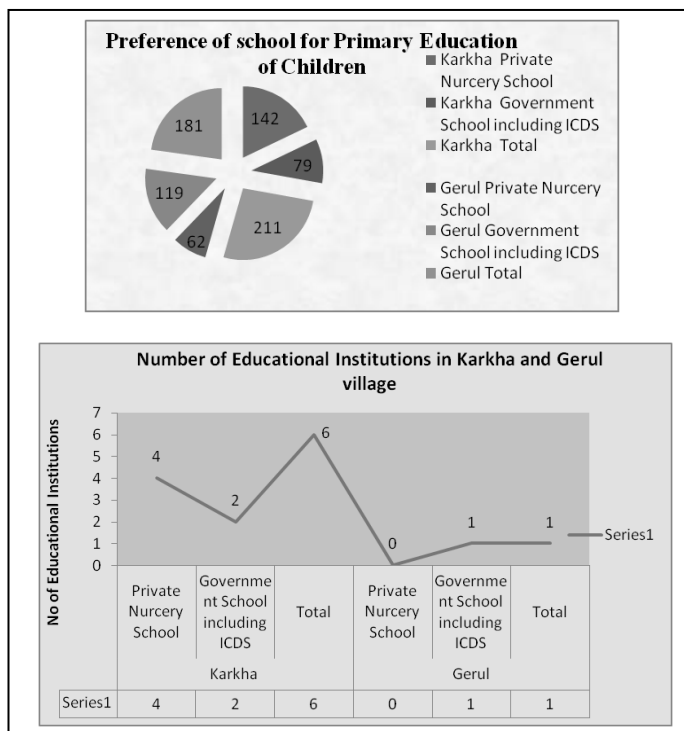
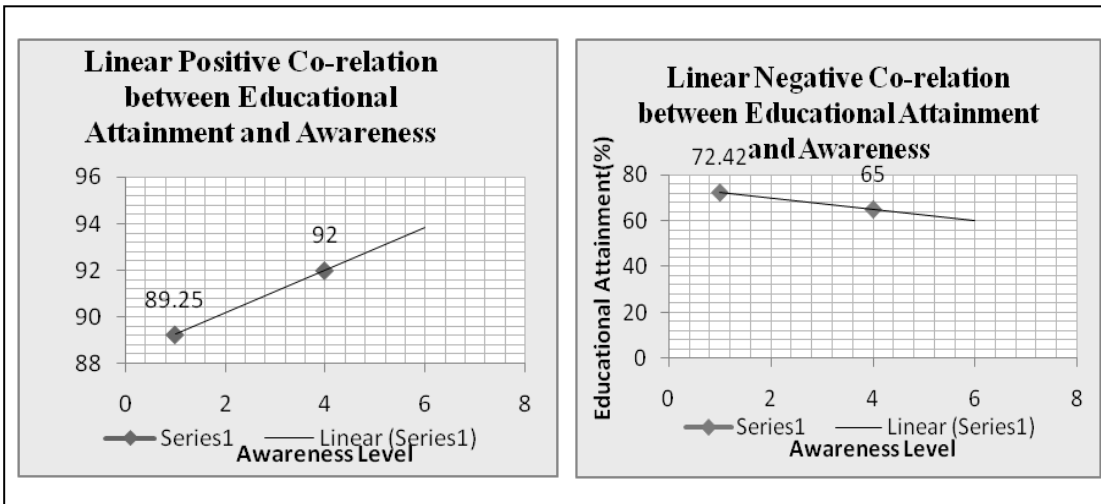


Figure 6. Preference of School for Primary Education and Educational institutions.

Table 6. Co-relation between Level of Educational Attainment and Awareness about Education

Name of the village	Level of educational attainment	Awareness related to education
Karkha	89.25	92
Gerul	72.42	65

Source: Prepared by Researcher based on Field Study-2018

**Figure 6.** Relationship between Educational Attainment and Awareness

While analyzing the relationship between level of educational attainment and awareness of the members of Namasudra community the results show that (Table 6) increasing the awareness about education decreasing the dropout rates in the Karkha village, i.e. there exists a positive relationship between the level of educational attainment and awareness. But in case of Gerul village the relationship between the level of educational attainment and awareness are negative. The guardians of Karkha village are very much aware about the quality education of their children comparing to the guardians of Gerul village.

(Table 6 and Figure 7)

The major findings of the present study are-

1. It is observed that the percentage of literate population among the Namasudra community in Karkha village is higher(82.00%) than the Gerul village(57.39%).The male –female illiterate percentage in Karkha village are 19.15% and 16.33% respectively where as in Gerul village it is 40.58% and 45.65% respectively. Therefore, Karkha village is quite higher in the field of education comparing to Gerul village.
2. Most of the Namasudra children in both villages drop their school education in upper primary level. Due to poor economic conditions most of the boys are engaged as a la-

bour force to supplement meager family income. Large numbers of girls work as a bidi binding in home and they drop their education for their early marriage, lack of awareness and illiteracy of family.

3. The educational attainment of the Namasudra children in all classes in Karkha village is found higher than the Gerul village, except from class I-IV and class V-VIII.
4. The rate of enrollment of Namasudra children in school is higher in Karkha village comparing to Gerul village mainly due to educational awareness, availability of educational institutions, stability of economy etc.
5. The guardians of Karkha village are very much aware about the education of their children and they are sending their children to private school and are willing to spend more money for quality education. Their opinion is that the govt. primary schools are presently suffering by the lack of teachers and they are busy to maintain mid-day meal Scheme. But in Gerul village parent's preference is government school for the free education and free Mid-day meal from the government mainly due to their lower economic income.

CONCLUSION

Form the present study it is reveal that the Namasudra community in Karkha village are to some extend forward in the field of education in comparison to the Gerul village almost in all level of education. The literacy percentage and their participation level or trends in education of Karkha village the Namasudras are found in better position than the Gerul village. Further, the Namasudra students of Gerul village are facing more problems in the field of schooling process than the Karkha village. As financial problem is the main factor for perusing education by the members of Namasudra community therefore it is necessary to improve the economic condition of Namasudra people families in both villages for the active participation in the field

of education. It is urgent to make the guardian appreciate about the significance of education, enrolment and continuation of study, at any cost by their children. For the proper development of education establishment of linkages between schools and the community is necessary. Improvement of parents-teacher association; Close collaboration among concerned entities like schools; government and non govt, agencies, parents and teachers; teachers and community plays a vital role for the overall educational development. In the planning of any educational programme of an area or region, involvement of teachers, head of the institution and community members is important. Some sort of guidance and counseling may be arranged for the Namasudra parents to make them aware about the importance of education in life, so that they can understand their responsibilities of provide all arrangement for their child's education. Extra coaching classes and extra care should be organized free of cost for the deficient students during week-ends and holidays. Create more awareness about the harmful effects of the Child labour is necessary. Government may introduce the facility to provide dress, Books and other materials such as pen, paper, pencil and slate should be given free to the scheduled caste (Namasudra community) students up to secondary level of education. Residential type of education, Practical programmes in education, like sanitations, health education, and cottage industry should be adopted in the institutions for them. Central and State Government effort is not sufficient for the development of the scheduled caste (Namasudra) welfare programmes, projects and schemes rather than, public involvement is indispensable.

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Empowering Women through Food Processing Home Based Enterprises: A study in Sonitpur District of Assam

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ABSTRACT

The food processing sector is poised for enormous growth and already contributes about 12.7 percent of the country's GDP and provides nearly 60 percent of all job opportunities by directly employing around 1.6 million workers. The industry is the 5th largest sector in the country in terms of production, consumption, export and growth. The growth of Indian food processing was USD 91 billion in 2017 and it is growing at the rate of 13 percent per annum. By 2024, it is expected to touch USD 223.7 billion. Today, India is largest producer of milk in the world for 105 million tons per annum and second largest producer of fruits and vegetables next to China on account of 150 million per annum. Economic development of a nation can be achieved only if all human resources are being fully utilized at optimum level. Women constitute about half of the population in most of the nations and therefore it is not possible to attain fullest development with one part of the available human resource of any nation. According to the Census of India 2011, women constitute nearly 50 percent of population, perform two-thirds of the work and produce 50 percent of food commodities of our country. But they earn one-thirds of remuneration and own only 10 percent of property or wealth of the country and are still dominated by male in the society. It is generally speaking that one can tell the condition of a nation by looking at the status of its women. The status of the women is based on their empowerment. Economic empowerment increases women's access to economic resources and opportunities including jobs, financial services, property and other productive assets, skills development, decision making and market information. Most of the women are associated with home based enterprises due to the ability of a home based enterprise is to attract young women/mothers to work with the family and create a new concept of entrepreneurs, 'momprenuers'. The enterprise enables them to keep up their professional, intellectual or artistic interest and earn income for the family without compromising the needs of the family. A home based enterprise is a modern form of cottage industry with new definition. Only difference of cottage industries and home-based enterprises is that the location of cottage industries is restricted in villages whereas the home-based enterprises are also located in urban and semi-urban areas. Women generally prefer to engage in food processing home based enterprises in the state due to availability of resources. Sonitpur district

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of Assam is rich in horticultural crops like, Pineapple, Banana, Orange, Mango, etc. The World Bank project APART has been selecting Sonitpur district under 16 selected districts of Assam for developing agro-based industries in the state on Feb. 2016. In this regard, a study was conducted in Sonitpur District of Assam by selecting 50 samples of women food processing home based enterprises by applying snowball sampling method from the different parts of the district.

Key words: Food Processing, Women Empowerment, Home Based Enterprise.

INTRODUCTION

“Women are the largest untapped reservoir of talent in the world.”

– Hillary Clinton

The food processing industry is an important industry in India which has an interlink between agricultural products and industries. This industry is the second fastest growing industry in world by following the tourism industry. The food processing sector is poised for enormous growth and already contributes about 12.7 percent of the country's GDP and provides nearly 60 percent of all job opportunities by directly employing around 1.6 million workers. The industry is the 5th largest sector in the country in terms of production, consumption, export and growth. The growth of Indian food processing was USD 91 billion in 2017 and it is growing at the rate of 13 percent per annum. By 2024, it is expected to touch USD 223.7 billion. The availability of raw materials, changing lifestyles and relaxation in regulatory policies is fuelling the growth of this industry. In Assam there are tremendous opportunities for developing food processing industries. To give a major boost to the food processing sector by adding value and reducing wastage and loss at each stage of the supply chain, the Ministry of Food Processing Industries established a mega food park, “North East Mega Food Park” at Nathkuchi Village near the Tihu town ship of Nalbari District in Assam on 28 May 2015. Moreover, six Primary Processing Centres (PPCs) are also proposed to be set up in the region at Nagaon, Badarpur,

Tinsukia, Barapani, Krishnai and Kajalgaon which will provide facilities for primary processing and storage near the farms. Besides that, the World Bank came forward to invest 200 billion US dollars in the project, ‘Assam Project on Agri-business and Rural Transformation’ (APART) on Feb 2016. The women entrepreneurs were closely associated with the food processing industries due to their inherent interest and custom of cooking. Women participation in the development work is important from the point of their empowerment. Empowerment generally refers to the process of improving the quality of life and economic wellbeing of women by eliminating gender inequality. Women's economic empowerment is a prerequisite for sustainable development and pro-poor growth of the society. Economic empowerment is the capacity of women to participate in development activities. It recognizes the value of their contributions, respect their dignity and make it possible to negotiate a fairer distribution of the benefits of growth (Eyben *et al.*, 2008). It increases women's access to economic resources and opportunities including jobs, financial services, property and other productive assets, skills development, decision making and market information.

Economic development of a nation can be achieved only if all human resources are being fully utilized at optimum level. This implies that both men and women must participate to achieve that goal. Women constitute about half of the population in most of the nations and therefore it is not possible to attain fullest devel-

opment with one part of the available human resource of any nation. According to the Census of India 2011, women constitute nearly 50 percent of population, perform two-thirds of the work and produce 50 percent of food commodities of our country. But they earn one-thirds of remuneration and own only 10 percent of property or wealth of the country and are still dominated by male in the society. According to a report by the United Nations Industrial Development Organization (UNIDO), "Despite evidence that women's loan repayment rates are higher than men's, women still face more difficulties in obtaining credit," often due to discriminatory attitudes of banks and informal lending groups (UNIDO, 1995b). As per the Gender development Indicators, India ranked 108th in the world. A nation can be built when its women are given ample opportunities to develop themselves. It is generally speaking that one tells the condition of a nation by looking at the status of its women. Women entrepreneurship comes to be the best alternative for women empowerment due to lack of guaranteed employment. It provides women to take initiative, organize and operate a business or industry and to take various decisions independently and also provide employment opportunities to others. It is a catalytic process by which resources can be mobilized and put them into effective use. Development of women develops the family, society and hence the nation. Women in India are still home bound and feel insecure in outside development activities, especially in rural India. Today, India is the largest producer of milk in the world for 105 million tons per annum and second largest producer of fruits and vegetables next to China on account of 150 million per annum. But the development of food processing industries is far behind the expectation. Though the topography of Assam is climatically suitable for the development of horticulture, but there are a few num-

bers of units for processing fruits, vegetables and other horticulture products. The growth of the food processing industries is not at all satisfactory in the state.

In the above context, the topic entitled, "Empowering women through Food Processing Home Based Enterprises: A study in Sonitpur District of Assam" has been selected for the study.

MATERIALS AND METHODS

The study was conducted on food processing home based enterprises of Sonitpur district of Assam with following objectives:

To study socio-economic status of women running food processing home based enterprises in the district;

To study the attitude of family and society towards women engaged in food processing home based enterprises;

To examine the employment opportunities offered by the food processing units.

To identify the problems faced by the enterprises in case of finance, production and marketing.

The study is empirical in nature and based on primary and secondary data. The primary data were collected through sample survey. The primary data were obtained by applying both schedules and questionnaire methods from the respondents. Schedules were filled up by the researcher to observe the depth of the study. Parameters like social status, educational qualification, training etc of the owners and earning, production, marketing etc of the enterprises are included in the schedules.

The secondary data were collected from Books, Research Papers, Articles in the Net & Newspapers, E- Journals and official websites of various agencies to establish the authenticity of the study.

Coverage: The study covered entire Sonitpur district of Assam, which was sub-divided into 5 study zones viz. Tezpur, Dhekiajuli, Rangapara, Biswanath Charali and Gohpur.

Period of the study: The study was conducted for the period of June 2017 to Dec. 2017.

Sampling Method: The non-probability Snowball Sampling method was used in collecting primary data for the study, since sampling frame was not available.

Sample Size: Total number of 50 women food processing units was selected as sample size for the study, which includes all types of food processing enterprises run by women from different locations of the district.

Data Interpretation & Analysis: The collected data were classified, interpreted and analyzed by using various statistical tools and computer software like MS

Excel, SPSS 16.0.

RESULTS AND DISCUSSION

The primary data of the study revealed that, out of 50 samples of women food processing enterprises in the district, majority of these enterprises were established at home i.e. 48 units (96 percent).

From the analysis of primary data, it was found that the majority of women engaged in food processing home based enterprises were married (68 percent), middle age i.e. 21-40 years (62 percent) with minimum educational qualification (24 percent under matriculation, 48 percent matriculate, 20 percent HS passed & only 8 percent graduate) and their annual average earning was Rs. 62,500 (average monthly earning Rs. 5,600).

Out of the 50 women food processing enterprises, 16 percent women were belonged to

SC, 8 percent were belonged to ST, 34 percent were belonged to OBC and 42 percent were belonged to general caste.

Most of the food processing enterprises were run by Bengali women (52 percent) followed by Assamese women (34 percent) and 14 percent from other communities.

The primary survey also revealed that 86 percent women were encouraged by the family to start their enterprise, 76 percent have respect in the family for running an enterprise, 72 percent got family support to run the enterprise and 4 percent women got negative attitude from the family for running an enterprise due family burden.

The study revealed that women entrepreneurs, especially those who engaged in food processing enterprises in the district faced financial problem (56 percent) due to unequal women's property rights problems, marketing due to heavy competition (40 percent) followed by lack of self confidence (18 percent).

Regarding awareness of the government policies, 68 percent of women totally unaware of government policies and schemes, and only 30 percent got training.

Out of the 50 samples of food processing enterprises in the district, 44 units (88 percent) could provide employment opportunities to others along with self. Out of these 18 units (36 percent) food processing home based enterprises employed more than 5 workers.

The study also revealed that majority of food processing home based enterprises in the district had started without taking loan i.e. 44 enterprises (88 percent) had started with their own fund. Only 6 (12 percent) women entrepreneurs started their enterprises by taking loan and most of the enterprises (80 percent) taking loan from the Rural Banks (AGV & PG Bank).

88 percent women used traditional method in their production and packaging of

their products and only 12 percent used sophisticated modern technology in the food processing enterprises.

In the study, there were some common problems observed with the women running food processing home based enterprises in the district like lack of industrial knowledge, self under estimation, inadequate financial resources and working capital, incapable of getting external finance due to absence of tangible security and credit in the market, dependence on the middlemen for marketing, discontinuation of enterprises due to seasonal family burden etc.

Food Processing Home Based Enterprises in Sonitpur District of Assam:

The undivided Sonitpur District of Assam, before the bifurcation of Biswanath District, is located in the middle of the state covering the area of 5,204 sq. km which is 6.6 percent of the total area of the state. Sonitpur district is the second largest district of Assam after the district of Karbi Anglong according to the geographical area. There are 3 sub-divisions, 14 Development Blocks and 1,876 villages in the district. The District topography is climatically suitable for the development of horticulture. The area wise production and yield of important horticulture crops for the development

of food processing enterprises are presented in the Table 1.

A home based enterprise is a modern form of cottage & village industry with new definition. The Home-Based Enterprises (HBEs), Home-Based Business (HBB) & Household Industries (HIs) are synonymous and these types of enterprises are belonged to micro enterprises, since the heavy industries are not allowed to establish along with the home or in the residential area by the government regulations. Micro enterprises are those enterprises where total investments are not more than Rs.25 lakhs in case of manufacturing sector and not more than Rs.10 lakhs in case of service sector according to the Micro, Small & Medium Enterprises Development (MSMED) Act, 2006. Earlier (Before May 2007) these industries belonged to the cottage industries and came under the purview of 'Ministry of Small Scale Industries'. Only difference of cottage industries and home-based enterprises is that the location of cottage industries is restricted in villages whereas the home-based enterprises are also located in urban and semi-urban areas. These enterprises are based on locally available resources, which are employment potential at low cost of capital. Generally, HBEs are run by the members of the family to meet the local require-



Fig. 1. Bamboo Shoot, Amora & King Chilies Pickles



Fig. 2. Making of Muri Laddu

Table 1. Area and Production in Different Horticulture as on 31-03-2017

Name of the Horticulture Crop	Area in Hector	Production in MT	AverageYield MT
A. Fruits:			
Banana	2000	3880	0.19
Pineapple	535	8025	15
Orange	130	1300	10
Lime & Lemon	475	1650	6
Papaya	370	4810	13
Guava	220	3018	13
Litchi	505	2048	4
B. Fruits (Nut crop)			
Aeronaut	4430	3322	0.75
Coconut	1325	8944	7
C. Spice			
Black pepper	125	200	1
Ginger	1450	8700	6
Turmeric	550	4124	7
Coriander	1035	2070	7
Chilies	690	4140	8
Garlic	136	629	5
Onion	300	1365	3
D. Ravi Vegetable			
Potato	6100	54,910	9
Tomato	2736	40040	15
Brinjal	2200	33600	18
Cabbage	4731	10965	15
Curly flower	2321	23210	10
E. Kharif Vegetable			
Ladies Fingers (Bhendi)	663	9950	15
Ridge gourd	1330	13500	10
Cucumber	495	2490	4
Pumpkin	72	720	10
Bitter gourd	392	3920	10
Pointed gourd	570	3060	5

Sources: District Agriculture Office, Sonitpur, Tezpur

ments. Census definition of 'Household Industry' (Home-based Enterprise) provides that as an industry conducted by the head of the household himself/herself and/or by the members of the household at home or within the village in rural areas, and only within the precincts (boundaries) of the house where the household is in urban areas. Home-based enterprises cover artisans, skilled craftsmen and technicians who can work in their own houses if their work requires less than 300 square feet space. Home-based enterprises are sustainable in nature where power and fuel consuming plant and machineries are hardly used.

HBEs greatly create the employment opportunities for low-income households especially for women who are very much low ebb in the society. Traditionally, women are home-bound in our country and they are more secure and safe to run a business from the home. The HBEs provide a great opportunity to the women to earn for their family from the home itself. Since it provides a flexible routine work for women, women can look after their children and can perform other day to day house hold activities by managing the enterprise. The ability of a home based enterprise is to attract young women/mothers to work with the family and create a

new concept of entrepreneurs, 'mompreneurs'. The enterprise enables them to keep up their professional, intellectual or artistic interest and earn income for the family without compromising the needs of the family. Most of the food processing home based enterprises in the district run by the women due to some inherent advantages. Different types of locally available raw-materials help to boost food processing home based enterprises in the district. Pickle from fruits, bamboo shoot, King Chilies (*Bhoot Jalakia*) and vegetables, juice, jams, 'Behuwai' / 'Kharoli' (mustard seeds), masalas, traditional cake (*Laddu & Pitah*), *chira & muri laddu* etc. are very famous in Assam and near-lying states (Figure 1 & 3). King Chilies and Litchi of Tezpur in the district are world famous. Now a day the '*Laddu & Pitha*' (typical Assamese cake) become very popular and demandable items. These items are not only demanded in the seasonal festival but also for different types of occasions like meeting, conference, seminar, work-shop, marriage party etc. *Muri Laddu & Chira Laddu* of the district has a great demand in local market as well as in the neighbouring state like Arunachal Pradesh (Figure 2).

Government policies toward development of food processing industries:

The government of India instituted various policies to boost the development of food processing industries in Assam, some of key policies and schemes are enumerated below:

Scheme for technology upgradation, establishment and modernization of food processing industries: The scheme is initiative by the Central Ministry of Food Processing Industries. The food processing industry in India was traditionally a labour intensive sector without using modern technology and now the government is trying to modernize it. The scheme covers setting up technology up-gradation/modernization/establishment of food processing industries in fruits and vegetables, milk prod-

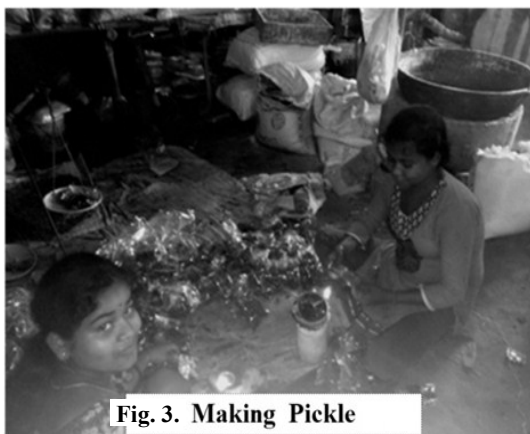


Fig. 3. Making Pickle

ucts, coconut, mushroom etc and also provided financial assistance.

North East Mega Food Park: The Ministry of Food Processing Industries established a mega food park, “North East Mega Food Park” at Nathkuchi Village near the Tihu town ship of Nalbari District in Assam on 28 May 2015. The Mega Food Park is an inclusive concept which is aimed at establishing direct linkages from the farm to processing and to the consumer markets, through a network of Collection Centres (CC), Primary Processing Centres (PPC) and Central Processing Centre (CPC). The scheme was launched to help to achieve the Vision 2015 of the Ministry of Food Processing Industries, which aims at increasing the processing of perishables from the current 6% to 20%, value addition from the current 20% to 35% and at increasing India’s share in global food trade from the current 1.5% to 3%. The primary objective of the scheme is to provide adequate infrastructure for food processing along the value chain from the farm to the Market. It includes creation of infrastructure near the farms, transportation, logistics and centralized processing centres. The main feature of the scheme is a cluster based approach. The scheme aims at facilitating the establishment of a strong food processing industry backed by an efficient supply chain, which will include collection centres, primary processing centres and cold chain infrastructure. The food processing units would be located at a central processing centre. It is expected that each mega food park would have about 30 – 35 food processing units with collective investment of about 250 crores that would eventually lead to a annual turnover of 400 – 500 crores and generate employment (Direct and Indirect) for about 30,000 people. The scheme provides for a grant of 50% (75% for the NE region) of the capital

cost excluding land cost, subject to a ceiling of Rupees Fifty Crores.’

APART: The World Bank invested 200 billion US dollars in the project, ‘Assam Project on Agri-business and Rural Transformation’ (APART) on Feb 2016. The proposed Project aims to 'increase value added and improve resilience in the production and processing of selected agriculture commodities, focusing on small farmers and agro-entrepreneurs in targeted districts'. The project inter alia would give thrust on enhancing agglomeration of producers to improve economies of scale in producing, processing and marketing. The project will support agriculture and livestock productivity through essential technology transfer in production and improved post-harvest and market operations, and explore and pilot possible financing modalities to support entrepreneurship and agri-business. APART will leverage the natural resource advantages of State of Assam as well as improve the investment climate and in particular, focus will be on processed food, food safety, agribusiness, logistics and infrastructure, MSME finance, and insurance. Project beneficiaries will include farmers and entrepreneurs especially in the MSME segment. Total 16 districts of Assam, including Sonitpur District had been selected for the project out of the total districts of Assam.

Suggestions for the Growth of Women Food Processing Enterprises in the State:

The following measures may be adopted to solve the problem faced by the women food processing enterprises in Assam.

Training Facilities: Skills development trainings like managerial, technical and marketing are essential for the development of women food processing home based

enterprises to create self confidence. Training should be provided near to the location of the farms and daily stipend should be given, because most of the women depend on their daily income to run the family.

Awareness programmes: Most of the women of this sector in Assam are totally unaware of govt. scheme and policies and they also hesitated to come forward. Therefore, awareness programmes of the schemes and policies and their benefits become inevitable part of implementing these policies.

Special Finance cells: Special finance cells may be opened at different location to cater various financial services at the local level that owners get easy financial supports and services at their door steps. These special cells may provide finance to women entrepreneurs at low and concessional rates of interest and on easy repayment facilities. "Material/machinery as loans" are more effective than "Cash as loans". These finance cells may be managed by women officers and clerks to create friendlier atmosphere.

Marketing Co-operatives: Marketing co-operatives should be established to encourage and to assist women entrepreneurs. These marketing cooperatives will help the women entrepreneurs to sell their products on remunerative prices. This will help in eliminating the problem of middlemen. Government should give preference in purchasing of HBEs products while purchasing government's requirements.

Introduce Modern Technology: Most of the food processing units could not fulfill the market demand of their product due traditional and outdated technology used in production and packaging their product. Government may supply modern sophis-

ticated equipments like mixture, grinder, oven, dryer, bottling and packing machinery to these enterprises at concessional rate through their agencies..

Change of Social Attitude: It is necessary to change negative social attitude towards women. Unless the social attitudes are made positive, the development and progress cannot be attained by the women entrepreneurs. Women have the potentiality and will power to establish and manage enterprises of their own but they needs only encouragement and support from the family and society as well as from the government.

Equal Property Right: Equal share in the parental property to access to private capital and create self confidence to take risk of liabilities becomes necessity. It will also create tangible securities for getting financial assistances from the banks and market.

CONCLUSION

The topography of Sonitpur district of Assam is climatically suitable for the development of horticulture. Major fruits grown in the District include Pineapple, Banana, Orange, Lime, Papaya, Mango and other miscellaneous fruits. During last few years the farmers are also well acquainted with many crops like Broccoli, Capsicum etc. There are tremendous scopes for developing Jam, Jelly, Pickles, and Traditional Biscuits manufacturing units in the district. The Ministry of Food Processing Industries recently initiated a number of schemes to promote food processing enterprises in the state in general and the district in particular. It is also clear that to achieve complete economic development, both the human resources, viz men and women, of the nation should be properly utilized. Women's empowerment requires more and better jobs, a secure business climate that supports them to start and run an enterprise, and needs easily as-

sessable financial services to fulfill their financial needs. Securing women's land rights has a direct impact on their financial capability. 'United Nations Development Programme' also initiated women's economic empowerment by advocating implementation of women's legal rights to property and to participate in decision-making form. On the other hand, an enterprise which can be started without investing establishment capital from the home itself, which may provide more security and flexibility in the daily routine of an Indian typical woman, is the home based enterprise. Therefore it can be concluded that food processing home based enterprises are the most possible means for empowering women in the state.

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An Assessment of the Performance of MGNREGA: *the Gap between Potential and Practice in Reducing Poverty*

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ABSTRACT

The Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), 2005 envisions management of and addressing the problem of chronic poverty all across India. It aims to guarantee 100 days of work per year in local public works to each rural household. For its implementation, it receives substantial amount of budget allocation, however, the bigger question that looms around in discussions and in practice is whether it is able to bring down levels of poverty among the targeted population group. The result has been remarked as to have shown 'mixed performance'. As promised, the Act has not been able to make much of an impression in respect to reducing rural poverty. Overall the study suggests that there exists a gap between the potential merit of the Act and what has been in practice so far. However, there is always hope and scope for improvement in the execution of the Act.

Key words: Local Public Work, Rural Household, Budget Allocation, Population, Rural Poverty, Act

INTRODUCTION

The National Rural Employment Guarantee Act, passed in 2005, guarantees to each rural household 100 days of work per year in local public works. With over 3.4 crore household beneficiaries and budget allocation constituting 0.5-1% of India's GDP, the scale of impact has been impressive and is regarded as one of the largest anti-poverty program in the world. Although public works programme had been in existence in India for long, but the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) introduced a 'guarantee' element for the first time. MGNREGA provides for a seasonal work that provides supplementary income during lean agricultural season.

The main objective of this paper is to assess the performance of MGNREGA with special emphasis on explaining the gap between the potential merit of the Scheme and its reaped outcome over the years in reducing poverty.

METHODOLOGY

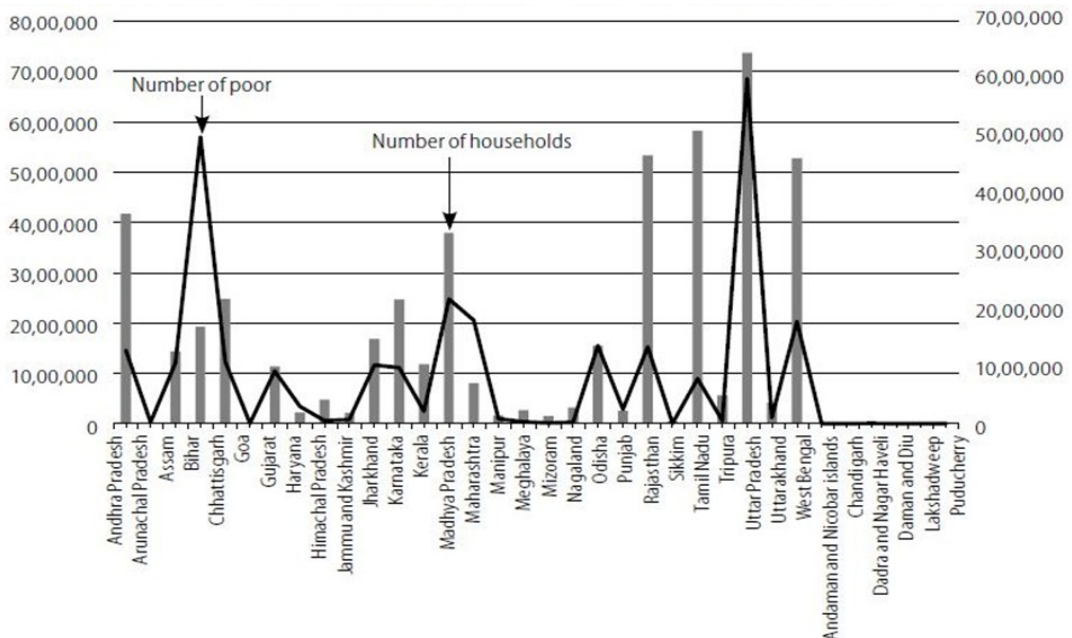
The assessments and analyses of the study are based on data collected from various sources. The study is primarily based on secondary data collected from several government reports, published works by different scholars, websites, conference papers, case studies, articles of leading newspapers, magazines and various other reports, etc. These have been thoroughly ana-

lyzed for the purpose of the present study.

RESULTS AND DISCUSSION

MGNREGA has the potential to reduce poverty in many ways. The most direct route is by providing extra employment and income to the poorest in the rural areas. Other means is by creating assets of value to the poor, by generating jobs through creation of rural infrastructure such as roads. A secondary impact of the scheme is that it acts as a private bargaining chip to the casual labors in wage negotiations to secure higher wages for similar activities without any direct participation in the Scheme. If all these

benefits are realised, the scheme has the potential to drastically cut poverty, however, in reality, the performance records are a mix. The argument however is that whether the Act could eradicate poverty of those who are employed under it? Sources have however reported that it only helps the poor section for mere sustenance at a level just below the poverty line (BPL) but the aimed benefits and sanctions do not always and necessarily reach them despite the claims made by the keen supporters of the Act. Figure 1 shows poverty levels and average annual number of households provided employment in states.



Source: Report No-6 of 2013—Union Government (Ministry of Rural Development).

Figure 1. Poverty Levels and Average Annual Number of Households Provided Employment in States

Gap between its potential and practice-some empirical evidences:

Paradoxically, the scheme has worked lesser in the poorer states where its demand is high such as is evident in the state of Bihar as compared to that of Andhra Pradesh. At one hand, the scheme has fared well for the poorest in the state of Andhra Pradesh on a range of indicators from consumption to nutrition to savings. On the other hand, the impact of the Scheme in Bihar has been only 1% as compared to a potential reduction of 14% in reducing poverty, signifying the scheme has fallen far short of its potentials. It is also noteworthy that while in the poorer states, not all the poor households could be covered, while, in contrast in the richer ones most of the households covered were not poor.

In the same way, there are a number of reasons why the potential impact has not been realised. One reason is that, the supply side has fallen short to meet the required demand. Other reasons are- delays in wage payments, corruption at different levels of implementation and the assets generated aren't durable and productive due to adoption of highly labor intensive techniques of production.

The Controller and Auditor General of India (CAG) report on MGNREGA—Report no. 6 of 2013—observed that even though the average wage cost or wages paid was rising, the benefits to a rural household was annulled by the decline in employment provided per household. While the average wages increased from nearly Rs.80 to Rs.120 per person-day between 2007–08 and 2011–12 respectively, the employment per household increased from around Rs.40 per person-day to Rs.60 in 2009–10 and then again declined to around Rs.40 in 2011–12. About the so-called “durable assets,” the CAG report has observed that while the number of works taken up increased steadily from about 20 lakh in 2007–08 to more than 80 lakh in 2011–12, the number of works actually completed increased from about 1 million in 2007–08 to only about 2.5 million in 2010–

11 and then declined to 2 million in 2011–12; most of the funds were still locked up in works in progress. An asset is created only after the corresponding works are completed, and 80% of the works taken up under MGNREGA remained incomplete.

A gender perspective

The gap between the potential and practice of MGNREGA can also be assessed through a gender perspective. The Act has the potential to promote empowerment of women as three important clauses in the Act make legal provisions relating specifically to women. Schedule II (6) specifies priority to be given for women for work, and to have at least one-third of workers at the worksite to be women. Schedule II (28) demands child-care facilities to be provided at worksite if children below the age of six are accompanying their working mothers. Schedule II (34) provides legal space for prohibiting gender discrimination in wages. All over India, in most of the MGNREGA worksites, women's participation is higher than it is as laborers on private farms. Some obvious reasons for this are the fact that the programme offers equal wages to both women and men, unlike private employers. The legal provision of equal wages itself is an important transformative mechanism. In addition, women do not have to bargain with private employers, as they have to when dealing with farm-owners who are employing them. This relationship often has potential for sexual exploitation. Finally, the work for MGNREGA is likely to be located close to women's homes. The policy also has a provision that if the work is located at a distance, workers have to be paid for transportation charges.

In spite of all these promising provisions provided by the Act, a study based on the state of Andhra Pradesh has concluded implementation failures towards providing for empowerment. Andhra Pradesh has been cited as an empirical evidence because, according to an inter-state comparison of Indian states using the

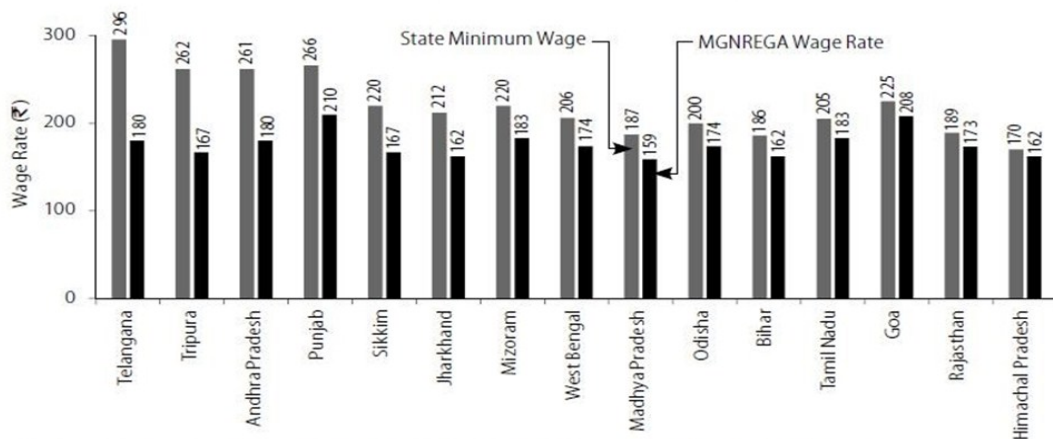
Gender Empowerment Index, Andhra Pradesh is the best performing state with an index score of 0.509 (Ministry of Women and Child Development 2009, 13); and secondly, according to information on the financial expenditure and work status of MGNREGA, Andhra Pradesh is outperforming all other states in India (<http://nrega.nic.in/>). MGNREGA presents an employment opportunity that has aided women's choice to stay back in the village and to gain income. However, many such women complained about the fact that the work was not regular, but only seasonal. As far as the impact on children of MGNREGA is concerned, the MGNREGA law clearly prohibits child labor. However, there are reports emerging from social audits that child labor is employed in different states at MGNREGA worksites, and in addition there are reports that the mother's lost labor at home is compensated by female children.

Implementation bottlenecks:

Focusing on the key bottlenecks in the area of implementation, reports have claimed the followings:

If the Scheme worked in practice as was provisioned in the Act, there would not have been

any cases of unmet demand for work, but, an all-India level study in the year 2009-10 based on NSSO data found that a great deal of unmet demand (rationing) do exist. 46% households reported that one or more members of the household were willing to work; however, only 25% could secure any work in a financial year. In Bihar for that matter, unmet demand alone accounted for nearly 3/5th of the gap between potential and realized poverty impacts. The extent of rationing has also imposed severe limitations onto the bargaining power in the private wage labor market. Since 2009, wages under the Mahatma Gandhi National Rural Employment Guarantee Scheme have been delinked from the Minimum Wages Act and have not changed from their real value in that year. As a result, MGNREGA workers have been victims of stagnating real wages. In some states, they are paid even less than the minimum wage. This raises serious questions of legality and fairness. Figure 2 illustrates states with minimum wage higher than the MGNREGA wage in the year 2015-16.



Source: Respective state governments for minimum wages and nrega.nic.in for MGNREGA wage rates.

Figure 2. States with a Minimum Wage Higher than the MGNREGA Wage in 2015-16

Also, growth in rural wages has been in low single digits since 2015-16, according to data compiled by Center for Monitoring Indian Economy (CMIE). It has also been found that in 33 out of 34 States and Union Territories, the wages are below the corresponding minimum wages. As per govt. data, the average days of employment provided per household under MGNREGA between FY16 and FY 19 stand at 47, which is not even half of the 100 days of guaranteed work. Wages under the program also have been kept low, which has resulted in fewer workers opting for it. Bihar records the lowest wage of Rs. 171. The 2017-18 Periodic Labor Force Survey (PLFS) estimates show that private market wages for males were higher than MGNREGA wages by 74% and for females by 21%. Clearly, no male worker is going to demand MGNREGA work when he can get a much higher daily wage with the same effort. However, women continue to participate under MGNREGA though market wages are higher, because of non-availability of work and discrimination as well as exclusion from the private labor market. It has also been observed that, even participation rates in the scheme are not high in the poorer states. There have been incidences of greater demand but lower capacity to meet the demand.

Another point of consideration has been that MGNREGA is posed/plagued with several leakages such as inflated records of number of days worked per person or proxy registering to draw more funds than required, etc. For instance, in Bihar, in the year 2007-08, there was a 70% gap between actual enrolment and recorded enrolments. Yet another aspect that contributes to the gap between potential and realised impact of the Scheme is the existence of discrepancies between stipulated wage rates and actual wages received by the workers. More recently, delay in payments has also emerged as another major bottleneck in implementation of the scheme.

CONCLUSION

All these forces taken together create a strong disincentive among the workers to participate in the scheme. The poor do not overcome their poverty until they are empowered to do so, and empowerment comes only through education, health and attainment of employable skills. Programmes like MGNREGA do not facilitate any of these and merely provide subsistence-level aid, which may alleviate their poverty only temporarily. In fact, instead of addressing the roots of poverty, they only prolong it by denying the poor the only tools—education, health and skill—that can eradicate poverty through generation of wealth in the economy and providing productive employment while ensuring economic growth.

The aforesaid discussed gaps can be overcome if the above bottlenecks can be minutely taken care of. Studies have found that undoubtedly, MGNREGA attains better targeting however, because the gap is also evident hence, for mitigating the bottlenecks, stricter norms of implementation needs to be followed as was envisaged by the Act.

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Badola, H. K. 1994. Bud phenological studies as an aid to forestry research: an overview. Pp. 163-169. In *Forestry Research and Education*. (eds Dogra, P. D. and Dhiman, R. C.), Diamond Jubilee Publication, Indian National Science Academy, New Delhi.

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Chung, S-T., Morris, R. L. 1978. Isolation and characterization of plasmid deoxyribonucleic acid from *Streptomyces fradiae*. In: *Abstracts of the 3rd international symposium on the genetics of industrial microorganisms*, University of Wisconsin, Madison, 4-9 June 1978.

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An Assessment of the Performance of MGNREGA: the Gap between Potential and Practice in Reducing Poverty Nishibrata Hazarika	67-72