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Editorial Board

Editorial Note

Science and People

Science is a way to look into the problems of the society and find amicable solutions to resolve it. New concepts and methodologies are discovered and new innovations result to more useful technologies. The application of science is decided as per the emerging needs of the society, which is regulated under the national science policies of the contemporary Governments. Science as concept, as methodology of investigation and analysis, as policy, as technology and as governance mechanism can help the rapid growth of the human mind and its society to exist in the close co-ordination with mighty nature and the biosphere around us.

This issue covers various aspects of the science and the society contributed by the scientists, academicians and professionals from the different corners. We hope this journey will contribute with its own mile stones in the growth of Indian Science.

Rana Ratap

Rana Pratap Singh
Editor-in-Chief

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RESEARCH ARTICLE

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Experimental Investigation of Horizontal Gasifier

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ABSTRACT

Vertically fixed-bed updraft gasification systems are well established, however, due to vertical orientation, the thermal zones of the gasifier are fixed, i.e. the residence time in a vertical gasifier is fixed, which sometimes creates clinkers of biomass materials having higher ash content and are responsible for discontinuation of gasification process. Considering the above problem, it was thought to move the zones (All the gasifiers has four zone named as drying, pyrolysis, reduction and combustion). Their positions are changing as per the temperature of the gasifier rather than moving the biomass. In order to overcome the limitations of a vertically fixed-bed updraft gasifier, a batch type 10 kW_{th} capacity horizontally fixed-bed updraft gasifier concept was introduced.The system was designed, developed and successfully tested to prove that the concept was viable. The horizontally fixed-bed configuration of gasifier resulted in an increased particle residence time as compared to a vertical fixed-bed system, in which gravitational forces create lower residence time. Additionally, it enhances particle to metal surface contact which results in enhanced heat transfer to the particle, thus increasing fuel conversion efficiency. A horizontal gasifier produces less tar and particulate matter compared to a vertical updraft gasifier.

1. INTRODUCTION

Among the different renewable energy technologies, biomass gasification is a promising technology for biomass and waste thermo-chemical conversion. Gasification has the advantage of low environmental impact, high effective conversion and reduced global CO_2 emissions (Devi *et al.,* 2003).

It has also been confirmed by a number of researchers that energy efficiency of gasification is higher than that of combustion (Zhang *et al.,* 2010). Gasification is a process in which carbonaceous feedstock (biomass) is heated in a closed chamber (gasifier) with a controlled amount of oxygen supply to produce a raw gas with components of CO, H_2, H_2S, CH_4, CO_2 and N_2 which could be converted into syngas (H_2 & CO) (Hindsgaul *et al.,* 2000). Most of the gasifiers used in the fields are vertically oriented.

The design of a vertical gasifier is simple with few moving parts and provides ease of control. This design results in high on-line availability, with an exception of time required to "clean out" the ash system. The gasifier operates at slightly lower pressure, which provides two benefits –

1) The fuel feed system does not have to overcome a significant pressure differential, which results in a basic, dependable feeding system.

2) Any leakage is due to ambient air entering into the controlled process conditions and not leakage of combustible Syngas out into the atmosphere, thus maintaining safe operating conditions (DST, Project Report, 2015).

However, despite these benefits, these units must go off-line for maintenance of the ash beds much more frequently. Additionally, waste fuels that are introduced in vertical systems must be limited to light weight homogeneous feed stocks or the materials will drop too rapidly through the gasification zone. Beyond the efficiency losses, this creates ash removal issues and disposal problems due to un-burnt carbon in the ash. Moreover in the existing vertically fixed-bed gasifier the thermal zones are fixed, i.e. the residence time in a vertical gasifier is fixed (based on the travel time driven by gravity as the fuel "falls" through the unit), which may sometimes lead to clinker formation for biomasses having higher ash content and are responsible for discontinuation of gasification process. Considering the above problems, it was planned to move the zones of the gasifier instead of the biomass. This may solve several problems encountered with the existing vertically fixed-bed gasifiers. It may provide more fuel flexibility and control. The control may be provided using a mechanical system or manual system that moves the fuel

through different zones in the gasifier. This allows the gasifier operation to be tuned to deliver the residence time in the gasification zone based on specific fuel chemistry (Balwanshi *et al.,* 2015).

2. MATERIALS AND METHODS

2. 1 Experimental investigation of horizontal updraft gasifier

After a critical study of available literature, it was decided to design a 10 kW_{th} horizontally fixed-bed gasifier. For fixing out the dimensions of the gasifier, the output energy and input energy available in the biomass was considered. From literature 10 kW_{th} is equivalent to 8598.452 kCal which is approximately 8600 kCal. Mostly sun dried biomass is used for gasification, which have about 12- 15% moisture. Maintaining moisture content of about 12- 15% is also required for gasification process. Therefore, considering the energy content of dried biomass as 4000 $kCalkg^{-1}$ and moisture content of 15%, energy content of biomass= 4000 x (100 -15)/100=3400 $kCalkg^{-1}$. Thus the quantity of biomass required to produce 8600 kCal energy=8600/3400 = 2.53 kg. This is the theoretically calculated quantity of biomass required; however thermal efficiency of gasifier is generally taken as 70% as or more than that (Elango and Chung, 2012), (Duttaa *et al.,* 2014) depending upon the design of gasifier and operating conditions. Here for calculation purposes efficiency of gasifier is taken as 70%. Therefore, actual quantity of biomass required to produce 8600 kCal energy = 2.53/0.7= 3.61 kg.

According to Kaupp and Goss, 1984, for agriculture residues, the specific gasification rate should be between 100 - 250 $kgh^{-1}m^{-2}$, and as suggested by Jain and Goss, 2000 (Jain and Goss, 2000)specific gasification Rate (SGR) = (Weight of dry biomass, kgh^{-1})/ (Cross sectional area of reactor, m^2). Therefore cross- sectional area of reactor, m^2 = 3.61/100= 0.0361 m^2, which will give the diameter of the reactor as 0.21m. In general, density of the fire wood may be taken as 256 kgm^{-3}(Iyer *et al.,*1997), which gives the volume of the reactor required to accommodate this mass of biomass= 3.61/256 = 0.014 m^3. Hence the length of the reactor=0.39 m ≈ 0.40 m. Again, most of the researchers (Jayah *et al.,* 2003; Lamarche *et al.,* 2013; Simanjuntak and Zainal 2015), have found that for effective gasification, diameter to length ratio of the reactor should be about 1:2. More over space is also required to accommodate the grate and plenum chamber for oxidizing any medium i.e. air and for inner side insulation of the reactor. Hence, it was decided to fabricate the reactor with dimensions 0.5m diameter and 1.0 m length. It would also provide space for optimization of the reactor dimensions.

2.2 Experimental Setup and Measurement

The experimental setup consists of a 10 kW_{th} capacity horizontally fixed-bed updraft gasifier (Insulated from inside), producer gas piping, flow measuring device (orifice plate) and burner for flaring of gas (Figure1). Furniture Industry waste *Tactona grandis* fire wood blocks (30x 30 mm to 60x60mm, diagonal length) were used for producer gas generation. The characteristics of biomass (moisture content, ash content, volatile matter, fixed carbon, calorific value) were carried out as per the ASTM standards (American Society for Testing of Materials (ASTM). For estimation of zones and producer gas temperature K type thermocouples along multichannel indicator were used, however for sampling of tar in the raw producer gas, known volumes of sampling bottles (500ml) were used. Fuel consumption of biomass was measured by topping method; however for quantifying the amount of producer gas a calibrated orifice plate was used. After collecting the tar sample from raw gas it was placed in an incubator (maintaining a constant temperature of 5°C) overnight. Later, the sampling bottle was taken out from the incubator and gas was released from the bottle. The tar deposited on the inner surfaces of bottle was washed with acetone. The washed material was drained on to pre-weighed cotton

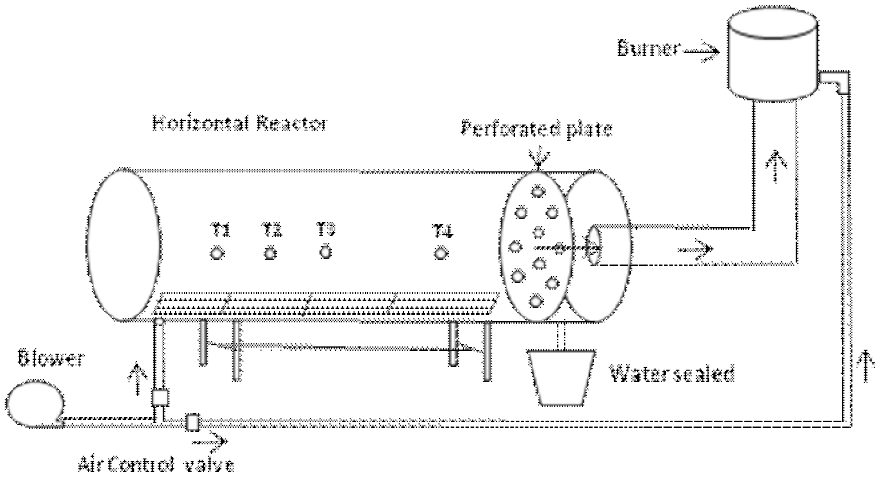

Fig.1. Schematic of the horizontally fixed-bed Updraft gasifier

placed inside the Petri dish. In order to ensure removal of tar completely from the sample bottle, it was washed two to three times. Acetone was allowed to evaporate using hot air oven, resulting in tar and pre-weighed cotton. Weight of cotton along with tar minus weight of cotton gave the amount of tar in the known volume of producer gas. Gasifier was operated as per the method suggested by Parikh and Arikkat, 1985 and Reed and Das, 1998.

3. RESULTS AND DISCUSSION

3.1 Performance evaluation of horizontally fixed-bed Updraft gasifier

A 10 kW_{th} horizontally fixed-bed updraft gasifier with dimension 0.5 m dia. and 1 m length was tested with a number of combinations such as - for gasification air supply was made tangential through a nozzle making an angle of 45° with the upper half circumferential portion of the gasifier reactor. On doing so, the gasifier produced gas for a period of 15-20 minutes. Later, the reactor was modified and air supply was made axial through a nozzle of 25 mm diameter. Even after this change no improvement was observed in the production of producer gas quality. It was observed that air was following the shortest route due to which pressure was not developed inside the reactor. To overcome this problem a perforated (2 mm diameter hole) metal sheet of 1 mm thickness was placed in front of the air inlet and another perforated (8 mm diameter hole) metal sheet of 4 mm was placed on the opposite side of the reactor. Even after these modifications no improvement was noticed. A trial run was performed by inserting a perforated pipe having dimensions of 50 mm × 850 mm with anaxial hole of 8 mm diameter throughout the centre of the reactor. Within 8-10 minutes, combustible gas was available at the burner; however the producer gas could not sustain for more than 20-25 minutes.

Finally it was decided to re-design and fabricate another reactor with dimensions of 0.32 m diameter, 1 m length and 5 mm thickness with a grate (13 mm) at the lower surface. Hopper arrangement was not provided in this reactor as the biomass feed was axial. To control the supply of air to reactor and to the burner, a blower (0.52 kW) with control valve arrangement was provided through a 38 mm diameter pipe. For uniform ignition of biomass five air vent pockets of 38 mm diameter were provided throughout the circumference of the reactor. A 63.5 mm diameter pipe was also provided for the collection of producer gas, which was mounted on the top centre line at the other end of reactor (Figure 2). A 0.31 m diameter perforated plate (8 mm dia. hole) was also inserted in the reactor before collection of the producer gas which ensured uniform flow of producer gas. To maintain the quality of biomass used in the gasifier, proximate analysis (ASTM, 1983) of biomass (*Tactona Grandis*) was carried out and the average results of five samples are tabulated in Table 1. Detailed performance of the gasifier is presented in Table 2.

Fig. 2. Horizontal gasifier in operation after insulation

To optimize the air - fuel ratio of the reactor, number of trial were taken at gasification air velocity 2.0 ms^{-1} to 3.6 ms^{-1}, however 2.5 ms^{-1} gasification air velocity was found optimum for fire wood (*Tactona grandis*) in a horizontally fixed-bed updraft gasifier. It was also noted that an increase in air velocity up to certain limits provided an increased oxidation of fuel and hence higher production of CO_2 and less production of combustible gases (CO, H_2& CH_4).

To confirm whether the reactor zones were moving forward or not, a temperature profile of the reactor was taken. Temperatures were recorded at different locations {T_1, at 0.33 meter from air supply to reactor; T_2, at 0.46 meter from

Table 1. Proximate Analysis of fire wood biomass

Sr. No.	Biomass	Moisture content, %, wb	Volatile matter, % db	Ash content, % db	Fixed carbon, % db	Calorific Value, $kCalkg^{-1}$
1.	Tactona grandis (Sagaun)	5.76	77.77	0.81	21.42	4445.22

Calorific Value of *Tactona grandis* at 5.76% moisture content = 4223.84 $kCal/kg^{-1}$

Table 2. Performance of Horizontal gasifier

Sr. No.	Parameters	Values
1	Weight of Biomass	17 kg
2	Charcoal	1 kg
3	Starting time of gasifier	12:40 pm
4	Flaring of Producer gas	12:50 pm i.e. 10 min
5	Operating time of gasifier	18 hours (Cumulative)
6	Quantity of Tar and SPM in producer gas	52 gNm^{-3}
7	Fuel consumption rate of gasifier	6.1- 6.3 $kg \cdot h$
8	Flame temperature of producer gas	750-800ºC
9	Calorific value of Biomass	4482 $kCalkg^{-1}$
10	Calorific value of producer gas	1010 kCal Nm^{-3}
11	Generation rate of producer gas	2.72 -2.95 $Nm^3\ kg^{-1}$ of biomass

air supply to reactor; T_3, at 0.58 meter from air supply to reactor, T_4, at 0.89 meter from air supply to reactor} and at different intervals. Variations in the value of the temperatures at each zone {Updraft gasifier have four zone; from Top to bottom, drying Zone temperature ranges 30°C -160°C; pyrolysis Zone temperature ranges 200°C -800°C; Reduction Zone temperature ranges 900°C -400°C and finally Combustion Zone temperature ranges 850°C -1200°C clearly indicated that zones were moving as its following the same trends, discussed by Kaupp and Goss, 1984 and Read and Das, 1988 and hence the concept was proved (Figure 3).

The average value of (seven samples) fuel consumption rate and producer gas generation rate obtained during different trial are tabulated in Table 3. The average calorific value of producer gas (Table 4) was considered for estimating the thermal efficiency of horizontal gasifier. A critical review of contents in Table 3&4 and Figure 3 reveals that though the developed gasifier is behaving as per the

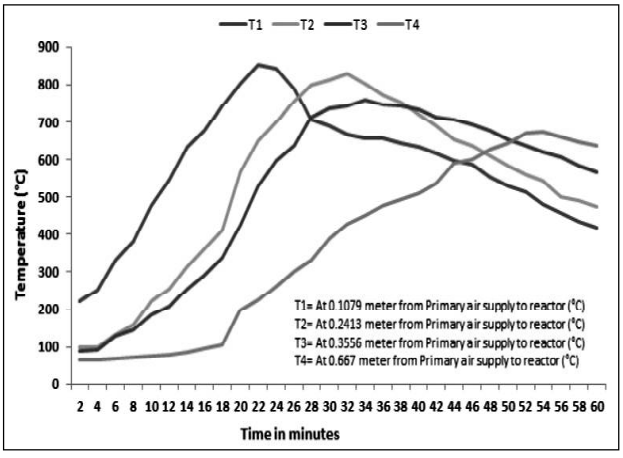

Fig. 3. Variations of gasifier Zone temperatures with time

expected concept i.e. zones of reactor are moving horizontally, still sustainability of combustible gas could not be maintained for longer durations throughout the experiment.

In order to improve its performance, the whole reactor was insulated (inside 10-12 mm fire-cement insulator and outside Cera-wool blanket) to enhance the life of the reactor and to maintain desired reactor temperature. Again a trial runwas carried out after insulating the reactor which provided encouraging results as well as sustainable quantity of combustible gas could be maintained throughout the duration of experiment.

The gasifier was later on operated for a cumulative period of about 18 hours using*Tactona Grandis*. The composition of producer gas obtained is tabulated in Table 4. For estimating the energy content of producer gas; standard energy content of gases (obtained from Gas chromatograph) such as CO, H_2 and CH_4 were multiplied with their composition in producer gas and summation of all gases provided the energy content of producer gas. Though producer gas contains CO_2, N_2 and other inert gases, for estimation of energy content of producer gas only combustible components were considered (Table 4). The energy content of producer gas was also verified with the help of Junker gas calorimeter, which gave the direct energy content of producer gas. Tar and SPM content of producer gas obtained from horizontally fixed-bed updraft gasifier was compared with that obtained from vertically fixed-bed updraft gasifier available in the department. It was observed that a horizontal gasifier produced less tar and particulate matter compared to vertical updraft gasifier (Table 5). This may be due to horizontally fixed-bed configuration of gasifier, which might have increased the particle residence time when compared to a vertical fixed-bed gasifier.

Table 3. Biomass consumption and Producer gas generation

Sr. No	Biomass consumption rate, kg/hr	Producer gas generation, $Nm^3 kg^{-1}$ of biomass	Producer gas generation rate, Nm^3h^{-1}	Thermal efficiency, ηth, %
1	6.1	2.902	17.70	68.3
2	6.3	2.722	17.15	64.1
3	6.1	2.993	18.25	70.5
4	6.2	2.677	16.60	63.1
5	6.3	2.722	17.14	64.1
6	6.1	2.721	16.60	64.1
7	6.2	2.945	18.26	69.4
				Average = 66.22

Table 4. Producer gas composition and its Energy content

Sr. No.	Producer gas Composition						Energy content of Producer gas, $kCalNm^{-3}$
	CO,%	H_2,%	CH_4, %	CO_2,%	N_2, %	O_2,%	
1	16.337	12.6	1.3	12.4581	54.3452	Balance	1036.357
2	18.037	12.2	0.83	12.0239	53.4592	Balance	1030.687
3	16.456	12.34	1.1	11.5651	58.289	Balance	1012.202
4	15.681	9.3	1.3	12.25	55.9025	Balance	911.7886
5	16.758	11.12	1.2	12.423	57.1146	Balance	993.028
6	16.12	12.1	1.1	12.1901	57.8572	Balance	994.1224
7	16.193	12.3	0.95	12.1035	55.8061	Balance	987.9512
				Average			**995.1625**

Table 5. Comparison of Tar and SPM in Horizontal Gasifier V/s Updraft gasifier

S. No.	Vertically fixed-bed Updraft gasifier	Horizontally fixed-bed Updraft gasifier
	Tar and SPM content, gNm^{-3}	Tar and SPM content, gNm^{-3}
1	90.73	85.09
2	85.13	74.85
3	88.21	66.73
4	78.95	64.18

4. CONCLUSION

A batch type 10 kW_{th} capacity horizontally fixed-bed updraft gasifier was designed, developed and successfully tested. Due to horizontally fixed-bed configuration of gasifier, there was an increased particle residence time as compared to a vertical fixed-bed system, wherein gravitational forces created lower residence time. Additionally, it also enhanced particle to metal surface contact resulting in promoted heat transfer to the particle, thus increasing fuel conversion efficiency. The horizontal gasifier produced less tar and particulate matter compared to a vertical updraft gasifier.

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RESEARCH ARTICLE

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Biofortification to combat Vitamin A deficiency sustainably through promoting Orange-fleshed Sweet Potato in eastern Uttar Pradesh

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ABSTRACT

India is among top few countries for Vitamin A deficiency as 60,000 children go blind annually. Other than blindness, a number of eye diseases like night blindness, bitot spot, xerothalmia and others are caused by vitamin A deficiency. More than 6% children in Uttar Pradesh suffer from clinical vitamin A deficiency. Vitamin A deficiency among poor children in Gorakhpur average to 42% (as high as 65% in 3 year age group). Government of India, supported by CIDA, Helen Keller International, Micro-nutrient Initiative, UNICEF, USAID and the World Bank distributed free vitamin A capsule. Results were positive and dramatic but met failure due costs involved, problem in distribution, and corruption. Sustainable solution with no costs to government is popularization of Orange Fleshed Sweet Potato (OFSP) varieties, which have yellow or orange flesh due to very high level of â-carotene (precursor of Vitamin A). OFSP also supply required quantity of Potassium, dietary fibre, and energy. OFSP produces more edible energy per unit and people can grow, store and consume throughout the year. Supported by Tata Trusts since last 3 years, PRDF tested more than 50 OFSP varieties and identified ST-14, CIP-440127 and VA-43 adapted to the region now popularizing its growing and consumption enjoining hundreds of farmers and thousands of school children. A cycle of multiplying healthy vines has been perfected and being practiced. A number of products of leaf and tuber like Pakora, chips, juice etc have been developed. More needs to be done on research and awareness fronts.

1. INTRODUCTION

1.1. Malady of Vitamin a Deficiency

Vitamin A deficiency is one of the most damaging forms of undernourishment (WHO, 1996). Among infant and children vitamin A deficiency results into eye problem and blindness. An estimated 190 million pre-school children and 90 million pregnant women are affected globally. In India 60,000 children go blind each year due to vitamin A deficiency (www.microneutrient.org). Other than complete blindness, a number of eye diseases like night blindness, partial blindness, bitot spot, Xerothalmia, stunting, inadequate energy uptake, subnormal functioning of the immune and reproductive systems are caused by vitamin A deficiency. More than 6% children in Uttar Pradesh suffer from clinical vitamin A deficiency, which is highest even among Indian states.

Regarding malady of vitamin A deficiency, India is lumped with African countries while the developed world is almost free of it. Medical College Gorakhpur did excellent studies during 1985 – 1998. Gupta (1987) estimated the prevalence of vitamin A deficiency in different age groups at Gorakhpur, based on hospitalized children for diarrhoea related diseases (Table 1). Sharma (1985) estimated the prevalence of vitamin A deficiency among children of 3 – 5 years' age group of Gorakhpur at 10.97%. Night blindness in children observed was 5.5%, conjuctival xerosis in 15.74%, Bitot's spot in 4.72% cases with active corneal involvement in 14.94% children (Gupta, 1987). Kansal (1997) studied the prevalence of vitamin A deficiency among rural and urban population at Gorakhpur. Overall prevalence of vitamin A deficiency was 6.8% under 5 years of age and it was more prevalent in rural areas (9.3%) than urban areas (3.1%).

1.2. OFSP a Possible Solution for the Malady

Sweet potato (*Ipomoea batatas* L. Lam), the second most important root tuber of the world, but in India categorized as "poor man's food" or "famine crop", has tremendous potential to contribute to a food based approach to promote food and nutrition security. It has diverse range of positive

Table 1. Vitamin A deficiency among hospitalised children suffering with diarrhoea in Medical College Gorakhpur (Gupta, 1987)

Age group	Children suffering from vitamin A deficiency
2 month-1 year	10%
1-2 year	43.3%
2-3 year	45.8%
3-4 year	61.9%
4-5 year	53.8%
5-6 year	55.3%
Average	**40.9%**

attributes like high yield with limited inputs, short duration, high nutritional value and tolerance to various biotic and abiotic stresses. Orange-fleshed sweet potato (OFSP) is now emerging as an important type of sweet potato to tackle the problem of vitamin A deficiency (Mukherjee *et al.* 2003). Apart from being rich source of vitamin A in the form of β-carotene (Table 2), benefits may also occur from other health enhancing features of sweet potato like adequate calories, vitamin C, vitamin D and micronutrients such as iron and zinc. The various preparations of OFSP tubers and tender leaves and vine could also be eaten (Chaudhary, *et al.* 2015b). Thus, the poor people having only limited access to the expensive vitamin A rich animal foods like fish oil, egg, and cow milk or plant products like papaya, mango, carrot etc. can consume it. As a biofortified crop many African countries are using it to alleviate Vitamin A malnutrition (CIP 2015).

Orange-fleshed Sweet Potato (OFSP) is potential solution and (Purcell and Walter, 1968; Simonne *et al*., 1993; Takahata *et al*., 1993; Mukherjee *et al.* 2009; and Laxminarayana, 2013) with rich β-carotene, which is converted to vitamin A by the human body.). 100 g of sweet potato may supply enough â-carotene to satisfy 0 to 100% of the daily-required amount of vitamin A, depending on the â-carotene content of the sweet potato variety used (Mukherjee *et al.* 2009). It is estimated that 300-450 micro-gram equivalents of retinol per day satisfy the daily requirements for infants up to 10 years old, which is equivalent to about 2100-2400 micro-grams of β-carotene. Usually a ratio of 4:1 to 8:1 is used to convert β-carotene into retinol since not all β-carotene can be converted by the human body. Therefore 100-120 g of a yellow flesh sweet potato containing 2500 micro-gram/100 g fresh weight of β-carotene is adequate to meet the daily requirement of Vitamin A (Tsou and Hong 1992). Regular intake of 100g per day orange-fleshed sweet potato roots provides the recommended daily dose of vitamin A for children (Hagenimana and Low, 2000, Low *et al.* 2001, Mitra, 2012).

2. MATERIALS AND METHODS

Available exotic and indigenous cultivars of OFSP were

Table 2. Nutritional value of Golden Sweet Potato (per 100 g of fresh tuber); mg = milligram; % indicates daily dietary requirement of an adult (Data source: USDA 2012, CTCRI, 2014).

Nutrient	Value	Nutrient	Value
Energy	359 kJ (86 kcal)	Sugars	4.2 g
Carbohydrate	20.1 g	Dietary fibre	3 g
Starch	12.7 g	Fat	0.1 g
β-carotene	20 mg (283%)	Protein	1.6 g
Thiamine (B1)	0.078 mg (7%)	Calcium	30 mg (3%)
Riboflavin (B2)	0.061 mg (5%)	Iron	0.61 mg (5%)
Niacin (B3)	0.557 mg (4%)	Magnesium	25 mg (7%)
Pantothenic acid (B5)	0.8 mg (16%)	Manganese	0.258 mg (12%)
Vitamin B6	0.209 (16%)	Phosphorus	47 mg (7%)
Folate (B9)	11 ug (3%)	Potassium	337 mg (7%)
Vitamin C	2.4 mg (3%)	Sodium	55 mg (4%)
Vitamin E	0.26 mg (2%)	Zinc	0.3 mg (3%)

Table 3. Baseline survey of vitamin A deficiency in the project area in Gorakhpur and Sant Kabir Nagar districts (Dr. Anita Khan and Dr. K. P. Singh) project Area in November, 2015

	Gorakhpur: Ramnagar – Karjaha				Sant Kabir Nagar: Kataya Primary School			
Age Group	Beneficiaries + Students	Normal	Bitot Spot	VAD	Primary Student	Normal	Bitot Spot	VAD
00 – 10	67	47	20	-	118	45	2	71
11 – 20	10	7	3	-				
21 – 40	52	14	-	38				
41 – 60	31	17		14				
61- Ab.	2	1	0	1				
Total	162	86 (53%)	23 (14%)	53 (33%)	118	45 (38%)	2 (1%)	71 (60 %)

tested in two locations during Kharif 2014-15 and Kharif 2015-16 in randomized block design with two replications. Plot size for each test entry was 2.5m X 1.35 meters = 3.375 m^2 and normal crop care was taken. The crop was dug out after 120 days and tuber yield (kg/plot) was recorded. After washing, peeling and slicing 100 gram tubers of each test variety were dried at 70°C for about 48 hours to determine the dry matter content. The prevalence of Vitamin A deficiency was surveyed in the project areas in Gorakhpur and Sant Kabir Nagar districts of eastern U.P. using qualified Ophthalmologists. They based their observations on the presence of "Bitot Spot" and general symptoms Vitamin A Deficiency (VAD). School children and beneficiaries were examined for it to create a baseline.

3. RESULTS AND DISCUSSION

3.1. Baseline survey for Vitamin A deficiency

To create a baseline of current status of vitamin A deficiency in the project a survey was conducted in Gorakhpur and Sant Kabir Nagar districts. Beneficiaries and school, children were examined by qualified ophthalmologists. Though the period conceded with the season when green leafy vegetables are consumed maximum, still the vitamin A deficiency was noticeable (Table 3) in form of Bitot's Sport and Vitamin A Deficiency syndrome (VAD). It was surprising to note that in Ramnagar Karjahan primary school, 23% children were spotted with Bitot's Spot and 33% with VAD. In Kataya Primary school though Bitot Spot was only 1% yet 60% children were diagnosed with VAD.

3.2. Varietal introduction and testing

During the years 2003 to 2005 more than 50 varieties were introduced through CIP New Delhi office and tested by PRDF in farmers' fields but none of these were found to have acceptable level of yield and â-carotene. Thus these were rejected and the project was halted. After due verification trials a manual on cultivation of OFSP was developed (Chaudhary *et al.* 2015a). During the year 2014 out of 11 breeding lines and varieties tested at 2 locations ST-14, PRDFS-1, PRDFS-2, Shree Kanaka, CIP440127 and Gauri yielded satisfactory (Table 4). Significant variations in yield of the tubers were observed among the genotypes of orange-fleshed sweet potato (Table 4). Based on the yield NCS and β-carotene content ST-14, Shree Kanaka, PRDFS-1 and CIP440127 were repeat tested during Kharif 2015 along with the new introductions (Table 5). Kharif 2015 was drought year thus yield levels were low yet ST-14, CIP440127 and VA43 showed promise. These varieties were selected for further multiplication and distribution among farmers.

3.3. Popularising OFSP

Sweet potato can be grown three times annually using the poor soils and rainfed agriculture. In the selected villages farmers are well aware of sweet potato growing. Thus introduction of OFSP simply meant change of the variety. Sweet potato weevil is the most serious pest, which was controlled by supplying pest free planting material. Nurseries and multiplication systems have been developed (Chaudhary *et al.* 2015a) using farmers in varied locality to produce maximum quantity of planting material. Farmers

Table 4. Yield (kg / plot) of OFSP test varieties at two locations in Gorakhpur and Sant Kabir Nagar districts, 2014 – 2015

S. N.	Variety	Gorakhpur: Ramnagar Karjahan	Sant Kabir Nagar: Khairgar
1	ST-14	2.705	8.268
2	ST-13	0.032	1.075
3	PRDFS-1	4.099	14.518
4	Ranchi local	3.901	17.568
5	Shree Kanaka	2.245	7.299
6	CIP-440127	5.558	44.643
7	PRDFS-2	2.047	6.047
8	Gauri	3.816	7.975
9	PRDFS-3	0.999	1.65
10	Local Hybrid	0.0	10.188
11	Local White	6.048	2.446
	CD	1.131	4.188

were trained and demonstrations were done on their fields. Most importantly a system of round the year cultivation and variety multiplication using normal land to river beds and riversides were amalgamated for moving around the planting for making available the planting materials. A system of using vine multipliers was developed by supplying them clean planting material grown in project's screen houses.

3.4. Product and Production

Schools were chosen as the entry points for popularization of the new product as the trained girls will prepare at their homes and the chosen product will move from home to homes and village to village. OFSP product development entrepreneurs and whole sellers are vital to the profitability of the beneficiaries. In shortest run it will encourage some ladies to produce commercial quantity of the products and local entrepreneurs will develop for Orange fleshed sweet potato products. A total of 15 of products using leaves (*pakora*, green vegetable) and tubers (chips, cutlets, *gulab jamun*, *halwa*, jam, juice, *kheer*, noodles, pickle, *sabji*, salty fries, *samosa*, sauce sweet dimons, and sweet fries) were developed (Chaudhary *et al.,* 2015b). Home Science students in the local intermediate colleges were trained (Table 6). This made excellent entry point for the new products to become popular. More needs to be done on research and awareness front.

4. CONCLUSIONS

Malady of Vitamin A is rampant in eastern part of U. P. and awareness need to be generated about its ill effects and ways to ameliorate through consuming OFSP. Many breeding lines were introduced and tested for 2 years in Gorakhpur and Sant Kabir Nagar districts of U. P. Superior

Table 5. Yield (kg / plot) of test varieties at two locations in Gorakhpur and Sant Kabir Nagar district, 2015 – 2016

S. N.	Variety	Gorakhpur: Ramnagar Karjahan	Sant Kabir Nagar: Khairgar	Dry Matter in tubers
1	CIP 440127	2.084	10.145	18.23
2	VA 43	1.849	6.122	18.97
3	VA 44	0.413	3.046	19.69
4	ST-14	1.718	2.886	28.55
5	Shree Kanaka	0.951	0.00	23.52
6	Local Red	0.156	0.061	-
7	Kanpur Hybrid	0.046	3.248	-
8	PRDFS-1	0.211	0.653	22.42
9	GSP-15	0.118	0.614	-
10	Ujjawal	0.00	1.587	25.42
11	Roshani	0.065	00	-
	CD	0.308	0.905	-

Table 6. Farmers participated and students trained during 2014 - 2016

District	2014-15		2015-16		Total
	Farmers participated	Students trained	Farmers participated	Students trained	
Gorakhpur	54	86	140	48	140
Sant Kabir Nagar	53	58	94	250	455
Total	107	141	234	298	595

ones like ST-14, CIP 440127, VA 43, and PRDF S1 were identified and being distributed to farmers on large scale. System of vine multiplication was streamlined to supply healthy planting material on a sustainable basis. More than 300 farmers were involved. Introducing a marginal change in the diet like switching varieties is likely to be easier than introducing a completely new food. Thus, replacing the white-fleshed sweet potato varieties consumed with new OFSP cultivars like ST-14, CIP 440127, VA 43, and PRDF S1 having high â-carotene would be helpful in alleviating vitamin A deficiency. Production of OFSP was linked to consumption by developing 15 different products in addition to roasting and boiling to promote in diets. Awareness generation among masses and training of school students on Vitamin A malnutrition *vis-a-vis* different food products of OFSP was generated. Sustainable and cheapest solution to combat vitamin A deficiency is through the use of Orange fleshed Sweet Potato (OFSP) or Sunhri Shakarkand (Golden Sweet Potato). Many African and Latin American countries where Vitamin A deficiency is severe are promoting use of OFSP and have strong research and development projects for it. India must follow the same path if it has to eradicate Vitamin A deficiency by biofortification. Once with the farmers, no cost is involved to the government, and no room for corruption and mismanagement.

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RESEARCH ARTICLE

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Growth enhancement of medicinal plant *Withania somnifera* using phosphate solubilizing endophytic bacteria *Pseudomonas* sp. as bioinoculant

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ABSTRACT

Withania somnifera, commonly known as ashwagandha, is a wildly growing highly valuable medicinal plant, found throughout India. Ashwagandha has high medicinal value due to its antioxidant, antitumor, anti-inflammatory, immuno-modulatory, anti-ageing and rejuvenating properties. Since use of synthetic agrochemicals in the cultivation of medicinal plants is highly restricted due to their harmful effects on human health and environment, present study was aimed to explore the role of endophytic bacteria in enhancing the nutrient level in soil and growth of ashwagandha. In this study, growth promoting potential of endophytic bacterial strain PSE-1 was explored which was isolated from the roots of *W. somnifera* and identified as *Pseudomonas* sp. on the basis of 16s rRNA gene sequencing. Results obtained from the study suggest that endophytic bacteria *Pseudomonas* sp. plays important role in improving the nutrient level in soil and displayed beneficial effects on plant growth.

1. INTRODUCTION

Phosphorus (P), an important component of soil, serves as macronutrient for plants and plays key functions in their growth and development (Sharma et al., 2013). Despite its abundance in agricultural soil, P is a growth limiting factor for plant growth because of its slow diffusion and high fixation rate in soil (Miller et al., 2010). P deficiency in Indian soils is widespread as 98% of agricultural land in India is poor in soluble P (Kanwar and Grewal, 1990). Plants require approximately 30 µmol L^{-1} of phosphorus for maximum productivity, but only about 1µmol L^{-1} is available in many soils (Daniels et al., 2009). To support plant growth, P is added by farmers in the form of chemical fertilizers in soil but repeated use of fertilizers deteriorates soil quality (Tewari et al., 2004). Intensive cropping and current agricultural practices have also resulted in deficiency of P. Though various methods are being employed to manage P in agricultural lands but all are costly and practically difficult as soil pH and chemical fixation by soil minerals determines the quantity of available P. To improve mineralization and solubilization of chemically-fixed P, microbially mediated P management is an ecofriendly and cost effective approach.

Microorganisms are integral to the soil P cycle, regulating P mineralization by various mechanisms such as production of extracellular phosphatases, secretion of organic acids, production of siderophores to enhance P availability by chelating cations such as Fe, Al or Ca that are involved in the formation of insoluble phytates (Singh et al., 2011). Phosphatases have been extensively studied in soil as they catalyze the hydrolysis of ester-phosphate bonds, leading to the release of insoluble P (Tabatabai, 1994; Sharma et al., 2013). To enhance P availability in soil, present scenario is shifting towards more sustainable agriculture system by using phosphate solubilizing bacteria. Hydrolysis of organic P by microbes is highly influenced by environmental factors as well as physicochemical and biochemical properties of the molecules (Rodríguez and Fraga, 1999). Among plant-associated microorganisms, endophytes are gaining considerable importance as bioinoculants because of their ability to colonize plant tissues thus are less affected by fluctuating environmental conditions. Endophytes possess the potential to mineralize complex and insoluble forms of macro- and micronutrients by secreting extracellular hydrolytic enzymes and enhance the availability of nutrients to plants. Several reports are available on phosphate solubilizing potential of endophytic bacteria and their positive impact on plant growth (Wakelin et al., 2004; Oteino et al., 2015).

In present study, endophytic bacteria from medicinal plant *Withania somnifera* were investigated for their phosphate-solubilization potential as well as other PGP traits to investigate their role in enhancing plant growth and soil fertility. *W. somnifera* is a popular and traditional Indian medicinal herb, belonging to family Solanaceae and is also known as Ashwagandha or Indian ginseng or winter cherry. It possesses high medicinal value due to its antitumor, anti-inflammatory, immunomodulatory, anti-ageing and rejuvenating properties. Ashwagandha has high demand worldwide for its alkaloids and other phytochemicals thus overexploited from natural habitats whereas cultivation is comparatively low, because of which it has reached near extinction (Sivanesan and Jeong, 2007). *W. somnifera* is known to acclimatize easily to degraded lands therefore its cultivation on waste lands using suitable bioinoculants could meet the increased demand of phytochemicals as well as rehabilitation of the medicinal plant.

2. MATERIALS AND METHODS

2.1. Sample Collection

Healthy plants of *W. somnifera* were collected from the Babasaheb Bhimrao Ambedkar University campus and adjoining areas of Lucknow district (26° 45' N, 81° 0' E) to explore the diversity of endophytic microorganisms. Ashwagandha plant were brought to laboratory in sterile bags and processed within a few hours for sample collection.

2.2. Isolation of endophytes

The collected plant material used for the isolation of endophytes was first cleaned by washing under running tap water to remove the adhering soil particles. Surface sterilization was performed according to the method of Santos et al. (2003). Leaves, stems and roots of ashwagandha were cut into small segments using sterilized razor blade and then rinsed with 70% ethanol for 30 seconds, followed by 0.01% mercuric chloride for 5 minutes and 0.5% sodium hypochlorite for 2 minutes. After surface sterilization, plant material was rinsed several times with sterilized distilled water under aseptic conditions. Sterility test was also performed to assure the complete sterilization of plant material for which 0.1 ml of aliquots of water from the last rinsing were spreaded on nutrient agar media (McInroy and Kloepper, 1994). No microbial growth after 24 h incubation on nutrient agar plates confirmed the surface sterilization. Surface sterilized small, thin sections of roots, stems and leaves of ashwagandha were placed on nutrient agar media. For the isolation of endophytic bacteria plant segments were placed on nutrient agar (NA) media. All the plates were incubated at 28°C and monitored regularly for any microbial growth. After 4 to 5 days of incubation, bacterial colonies appeared on nutrient agar plates which were streaked and maintained as pure cultures at 4°C.

2.3. Screening of isolated endophytes to determine phosphate solubilization potential

Phosphate solubilization test was conducted qualitatively by inoculating the isolated endophytes on Pikovskaya's agar media. Plates were incubated at 28°C for 5 days. After incubation, inoculated plates were observed for clear zone around bacterial colonies. Phosphate solubilisation index (PSI) was evaluated according to the ratio of the total diameter (colony diameter + halo zone) and the colony diameter (Edi-Premono et al., 1996).

2.4. Alkaline phosphatase activity of phosphate-solubilizing endophytes

Alkaline phosphatases play key role in solubilizing organic P at neutral and alkaline soils. Since pot study was conducted in alkaline soil (pH 8.2), alkaline phosphatase activity of isolated endophytes was also investigated.

To determine alkaline phosphatase activity, phosphate solubilizing endophytes were inoculated in Pikovskaya's broth containing 5g/L of tri-calcium phosphate as a phosphorus source and incubated for 5-6 days. Phosphatase activity of endophytes were assayed according to the method of Tabatabai and Brammer (1969) in which *p*NP linked substrate and enzymatic activity is determined from colorimetric measurement of *p*NP released in buffered substrate solution during incubation and results were reported in units of µmol *p*NP released in reaction mixture. The cultures were filtered after centrifugation at 8000 rpm for 10 minutes and supernatant was separated for phosphatase assay. To 3 ml of the supernatant, 1 ml of Tris–HCl buffer (pH 10.0) was added, followed by addition of 100 µl of *p*NPP solution. Reaction mixtures were incubated for 20 min at 37^0C. Reaction was then terminated by addition of 2 ml of 1M NaOH solution. Uninoculated broth was used as control. Release of *p*NP was measured spectrophotometrically at wavelength 410 nm (Verchot and Borelli, 2005).

2.5. Plant growth promoting activities of endophytic bacteria

Most effective phosphate solubilizer strain PSE-1 was also screened for other plant growth promoting traits including indole acetic acid (IAA), ammonia and siderophore production.

2.6. Indole acetic acid production

For IAA production, endophyte PSE-1 was grown in liquid medium containing glucose 5.0 gm, yeast extract 0.025 gm, L-tryptophan 0.204 gm per litre of solution. Uninoculated tubes were kept as control. Tubes were incubated in dark for 72 h at 27° C. After incubation, tubes were centrifuged at 10,000 rpm for 10 minutes. To 1 ml. of culture filtrate from each tube 4 ml of Salwoski reagent was added and tubes were kept for 30 minutes. After incubation, tubes were observed for the development of pink color which indicates presence of IAA (Sarwar and Kremer, 1995).

2.7. Siderophore Production

Siderophore production by PSE-1 was assayed on the Chrome azurol S (CAS) agar medium as described by Schwyn and Neilands (1987). CAS agar plates were inoculated with test organism and uninoculated plates were kept as control. All plates were incubated at 28 °C for 48–72 h. Development of halo zone around the growth was considered as positive for siderophore production.

2.8. Ammonia production

Strain PSE-1 was tested for the production of ammonia in peptone water. Freshly grown culture was inoculated in 10 ml peptone water and incubated for 48–72 h at 28°C. After incubation, Nessler's reagent (0.5 ml) was added in each tube. Development of brown to yellow color was a positive test for ammonia production (Cappuccino and Sherman, 1992).

2.9. Screening of isolated endophytes for other extracellular enzymatic activities

Extracellular enzymes play an important role in hydrolyzing organic and inorganic compounds to release macro and micronutrients thus isolated bacterial endopytes were also screened for the production of extracellular amylase, protease, lipase, cellulase and chitinase enzymes.

Amylase activity was assayed on starch agar media. Endophytes were inoculated on starch agar plates and incubated at 28°C for 2-5 days. After incubation, plates were flooded with iodine solution and observed for clear zone around the colonies (Aneja, 2005). For proteolytic activity, endophytes were inoculated on skimmed milk agar (SMA) media and inoculated SMA plates were incubated at 28°C for 4 days. After incubation period, SMA plates were observed for the clear zone around bacterial colonies (Aneja, 2005). For lipase activity, endophytes were inoculated on tween 20 agar media and incubated for 3 days at 28°C. After incubation, plates were observed for the zone of precipitation around colonies (Lee et al., 2015). To determine the extracellular cellulase activity, screening was done on Czapek-mineral salt agar (CMSA) media. CMSA plates were inoculated with endophytes and incubated at 28°C for 5-7 days. After incubation plates were flooded with an aqueous solution of 1% congo red solution for 4-5 minutes (Kasana et al., 2008). After removing the iodine solution, plates were observed for sharp distinct zone around the colonies. All endophytes were screened for chitinase activity on chitin agar plate in which 1% of colloidal chitin was used. Plates were incubated at 37 °C for 5-7 days and observed for clear zone around colonies (Aneja, 2005).

2.10. Pot experiment and growth observation

After screening of P mineralization potential of endophytes and other plant growth promoting traits, most promising strain PSE-1 was evaluated for its effect on plant growth of *W. somnifera* and P level in inoculated soil by pot experiment. Inoculums of endophytic bacterial strain PSE-1 was prepared by inoculating the bacteria in nutrient broth for 24 h at 210 rpm at 28°C. After incubation, bacterial suspension was centrifuged at 8,000 rpm for 15 min., supernatant was discarded and pellets containing bacterial cells were suspended in 500 ml of 100 mM phosphate buffer. Microbial count in the suspension was $2x10^8$ per ml buffer suspension.

Pot study was conducted during 2014 in the month of October for 90 days in green house (each treatment in three replicates). Each pot was filled with 6.5 kg of sterilized soil. Soil with pH 8.2 and electrical conductivity 187.1 µs contained 90.125 kg ha^{-1} of available phosphorous. Plant height, root length, number of branches, fresh weight and dry weight for each treatment were recorded after harvesting. Total organic and available form of P in soil before and after harvesting was determined using method of Bray and Kurtz (1945) and measured by ascorbic acid method.

2.11. Identification of selected strain PSE-1 on the basis of 16s rRNA gene sequencing

Bacterial genomic DNA of isolate PSE-1 was isolated using InstaGene™ Matrix Genomic DNA isolation kit and identified on the basis of 16s rRNA gene sequencing. DNA sequence of strain PSE-1 has been submitted to gene bank NCBI and accession number was obtained.

3. RESULTS AND DISCUSSION

Total 17 endophytic bacterial strains were isolated from different plant parts of *W. somnifera,* which were screened for their phosphate solubilization potential. Isolated endophyte PSE-1 showed various PGP traits including IAA production, phosphate solubilization, siderophore

production and production of extracellular hydrolytic enzymes to enhance the availability of minerals. On the basis of 16s rRNA gene sequencing, most promising phosphate solubilizing strain PSE-1 was identified as *Pseudomonas sp.* Gene sequence has been submitted in gene bank NCBI with accession number KT761191.

Microbes mediate nutrient cycling in soils in which, extracellular enzymes e.g. protease, lipase, amylase, cellulose, phosphatases, chitinase, urease etc. play a significant role by mineralizing organic compounds (Das and Varma, 2011). Soil enzyme activity measurements have been used as indicator of soil quality and health (Bandick and Dick, 1999; Badiane et al., 2001). In present study, isolated endophytes showed various enzymatic activities among which 52.9% strains showed positive activity for amylase, 41.17% for lipase, 70.58% for protease, 29.41% for cellulase, 35.29% for phosphatase and 5.88% for chitinase. Alkaline phosphatases secreted by microorganisms have an important role in phosphate solubilization in neutral or alkaline soil (Richardson et al., 2011). Strain PSE-1, which was selected for pot study showed positive enzymatic activity for amylase, protease, cellulase and chitinase. Enzymatic activities of *Pseudomonas* have been investigated by many researchers. Significant production of amylase, protease and cellulase enzymes by endophytic fluorescent pseudomonads (FLPs) was observed by Sunkar and Nachiyar (2013) which was isolated from *Brassica oleracea*. FLPs are potent lipase and protease producers. Grbavcic et al. (2009) found *Pseudomonas* sp. as potent lipase and protease producer. Chitinase enzymes possess nematicidal potential as well as play important role in carbon cycling. Chitinase activity of FLPs and its role in biocontrol of phytopathogenic fungi (Arora et al., 2007) and nematodes was studied by Chen et al. (2015).

P solubilization by FLPs and its role in plant growth promotion is widely studied (Cattelan et al., 1999; Pandey et al., 2006). In present study, endophytic bacteria *Pseudomonas* strain PSE-1 showed significant potential for phosphate solubilization with PSI value of 3 and phosphatase activity at pH 10.0. Alkaline phosphatase activity (at pH 10.0) of PSE-1 was 300 mg L^{-1} *p*NP. PSE-1 also efficiently enhances soil P level from 90.125 kg ha^{-1} (as recorded in uncultivated soil) to 125.45 kg ha^{-1} in PSE-1 inoculated soil.

PSE-1 also showed positive results for IAA, siderophore and ammonia production. IAA is an important phytohormone which is essential for plant growth and development. Positive impact of IAA-producing bacteria on plant growth has been widely investigated (Khare and Arora, 2010; Rana et al., 2011). Denitrification, aminization and ammonification are positive processes that make nitrogen compounds available for plant uptake via the root system (Przemieniecki et al., 2015). Ammonia production as a PGP trait was studied by many researchers (Rana et al., 2011, Przemieniecki et al., 2015). Siderophores are iron-chelating compounds which promote plant growth by facilitating iron uptake by plant roots. Siderophore production by plant-associated bacteria and their growth promoting potential has been extensively explored (Arora et al., 2001; Grobelak et al., 2015). FLPs are efficient plant growth promoting organisms even under stress conditions. Tewari and Arora (2014) investigated FLPs in growth enhancement of sunflower under saline stress. In present study, *Pseudomonas* strain PSE-1 showed multiple PGP characters *in vitro* and also exhibited promising plant growth promoting potential under field condition as observed in the form of increased plant height, fresh and dry weight and number of branches (Table 1). PSE-1 treated plants showed 51% increase in plant height, 41% increase in fresh weight and 56% increase in dry weight in comparison to control.

The role of endophytes in plant growth enhancement, nutrient availability, yield and quality of medicinal plants is demonstrated by many researchers and there are increasing interests in the use of endophytes for the cultivation of medicinal plants without using synthetic agrochemicals (Keû et al., 2015). A wide variety of endophytic bacteria and fungi have been recognized that have high significance in plant nutrient acquisition and secondary metabolite alteration of medicinal plants (Tewari et al., 2010; Qadri et al., 2013). The results described in this study show that endophytic *Pseudomonas* strain PSE-1 possesses good phosphate solubilization activity and can be used as a biofertilizer under phosphate limiting conditions.

Finding promising results using endophyte *Pseudomonas* strain PSE-1, further research is recommended to better understand the diversity and function of endophytes and their uses in the production of medicinal plants.

4. CONCLUSION

The use of endophytic microorganisms as bioinoculants provides a promising alternative to synthetic fertilizers, especially for the cultivation of medicinal plants. In present study, phosphate solubilizing endophyte *Pseudomonas* PSE-1 strain showed great potential in enhancing growth and yield of *W. somnifera* under nutrient limiting saline conditions and may be used as microbial biofertilizer for the cultivation of medicinal plants.

Table 1. Effect of endophyte *Pseudomonas* PSE-1 on growth of *W. somnifera* (values expressed are mean of three replicates)

Treatment	Plant height (cm.)	Root length (cm.)	No. of branches	Fresh weight (gm)	Dry weight (gm)
Control	46.32(± 1.1)	13.76 (± 0.60)	4.33 (± 1.52)	643.3 (± 28.3)	383.3 (± 31.4)
Strain PSE-1	70.10 (± 0.90)	16.88 (± 0.80)	5.66 (± 1.15)	910.0 (± 32.57)	596.66 (± 34.05)

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RESEARCH ARTICLE

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Effects of kitchen waste biofertilizer on growth and development of Wheat (*Triticum aestivum* L.) crop

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ABSTRACT

The growth and development of Wheat (*Triticum aestivum* Linn.) plant has been studied using self-prepared kitchen waste biofertilizer. The experimental plants which were grown using the biofertilizer prepared using the kitchen biodegradable wastes excelled on all the parameters tested (rate of seed germination, root – shoot ratio, chlorophyll contents in leaves and Nitrate Reductase activity) in comparison to traditional chemical fertilizers and therefore, the prepared biofertilizer has been found to be more effective nutrient supplier than the traditional chemical fertilizers.

1. INTRODUCTION

Every house-hold generates approximately 1.5 to 2.0 kg of solid waste which comes to 168.13 tonnes per day on 8.0 lac of urban population (GEAG Report, 2010 a, b). The urban residents dispose the wastes on the roads or in dust-bins either packed in polythene bags or loose. The wandering ruminant cattle or animals like dogs ingest their desired materials and in so doing scatter the matter in wider areas which becomes the den of several disease causing microorganisms and, at times, results into the outbreak of cholera and other infectious diseases. About 72% of the total solid wastes are biodegradable which may be transformed into biofertilizer. The biodegradable materials, by undergoing the process of decomposition using microbial consortia and composting, are transformed into high quality biofertilizer (Richa *et al*., 2016). Such biofertilizers have been found to be better than the traditional fertilizers; however, no scientific data regarding its quality assessment is available on crop plants.

During the present investigations the growth and development of Wheat (*Triticum aestivum* Linn.) plant has been studied from seed germination to the maturation leading to flowering using self-prepared kitchen waste biofertilizer.

2. MATERIALS AND METHODS

2.1 Preparation of kitchen waste biofertilizer

2.1.1 Segregation of solid waste: Following the separation of the house-hold solid waste the basic categories will come out to be:

a) Different grades of non-biodegradable recyclable plastic materials.
b) Non-biodegradable recyclable thick-paper cartons.
c) Non-recyclable inert plastic materials.
d) Aluminum / metal cans; and
e) Biodegradable kitchen wastes.

Out of these five, the first four comprise the non-biodegradable types and may either be recycled or used in land-fillings. However, the fifth type, i.e., the wet kitchen wastes, requires special attention and proper scientific intervention so that it may quickly be biodegraded into a dry powdered organic manure of high quality. In case a quick biodegradation is not done, these wet raw organic materials may become the best place for the luxuriant growth

of pathogenic micro-organisms and, in turn, function as the source of several infectious human diseases like cholera, dysentery, diarrhoea and tuberculosis.

The agricultural solid wastes are mostly dry and need to be moistened for their use as wet solid wastes for the process of biodegradation.

Fig. A: Segregation.

Fig. B: Segregated biodegradable waste in Composting pit.

Fig. 1 A-B. Segregation of biodegradable wastes.

2.1.2 Biodegradation process: The process of conversion of wet organic kitchen waste into nutritious organic manure requires the following three steps:

a) Decomposition of the wet organic kitchen waste in a decomposition-bed using micro-organisms' culture(s) which will require a period of 30 – 35 days to convert the matter into black decomposed mass. Two types of cultures will be used for the study: one the traditional cultures and, the second will be the culture mixtures prepared in the laboratory for comparison.

b) Composting process of the decomposed matter in concrete composting-pits where the entire mass is rotated on alternate days using the spade to provide proper aeration in composting phenomenon. It further requires a period of 30 – 35 days for completing the process.

c) Final drying and packaging of the prepared granular organic manure (biofertilizer).

2.2 Quality assessment:

The process of quality testing has been done in two steps:

2.2.1 Quality of manure and its comparison with chemical fertilizer: The prepared manure will be tested for its Nitrogen, Phosphorus, Potash and Organic carbon contents; and the carbon – nitrogen (C/N) ratio has been calculated for its quality assessment (Table 1).

Table 1. Quality assessment of the prepared fertilizer

Nitrogen (N):	1.00 g / 100 g
Phosphorus (P):	0.60 g / 100 g
Potash (K):	1.50 g / 100 g
Organic carbon:	11.6 g / 100 g
Org. C/N ratio:	11.6: 1

2.2.2 In vivo tests on crop plants: The manure has been tested on crop plant, viz., Wheat on the parameters like percentage seed germination, root-shoot ratio in plantlet stage, chlorophyll content in matured leaves and Nitrate Reductase activity. The plants, developed using traditional fertilizers (chemical fertilizers) were taken as "Control".

a) Seed germination study

The seeds of Wheat were kept in DDW (control) and 1% biofertilizer solution (experimental) for 24 h for soaking

Fig. 2. Finally prepared Organic Fertilizer.

and later, the seeds were kept in Petri plates with soaked filter papers separately.

b) Root-Shoot Ratio:

Following germination, the germinated seeds were placed in plastic pots containing thoroughly washed and sterilized sand separately for control and experimental conditions. Control pots were irrigated with 10 ml DDW and experimental pods with 10 ml of 1% mixed manure solution at an interval of 24 hrs. After 15 and 30 days the plantlets were carefully removed from the sand, thoroughly washed with hot water, dried on filter- paper and the length of root and shoot were measured for 50 plantlets in mm. for the assessment of root-shoot ratio. The root-shoot ratio was assessed on 15 and 30 days separately and average values of 50 plantlets were recorded.

c) Chlorophyll estimation:

The estimation of chlorophyll has been done as per the method suggested by MacLachlan and Zalik (1963).

Formula (MacLachlan and Zalik (1963)

Total chlorophyll = $20.2\ (A_{645}) + 8.02\ (A_{663})$ x V/ 1000 x W

Chlorophyll A = $12.7\ (A_{663}) - 2.63\ (A_{645})$ x V/ 1000 x W

Chlorophyll B = $22.9\ (A_{645}) - 4.68\ (A_{663})$ x V / 1000 x W

Carotenoid content was calculated in mg/g fresh weight using formula given by Duxbury and Yentsch (1956).

Formula-

Carotenoid = $7.6\ (A_{480}) - 2.63\ (A_{510})$ x V / 1000 x W

Where A_{663}, A_{665}, A_{510} & A_{480} = Absorption at the wavelength (nM),

V = final extract volume

W = weight of samples in gm.

d) Assay of Nitrate Reductase activity:

The assay of Nitrate Reductase enzyme has been done according to the protocol suggested by Streeter and Bosler (1972) and Srivastava (1990). Nitrate reductase activity was assayed in mature leaves harvested after 30 days.

3. RESULTS

3.1 Seed germination

Wheat seeds germinated after 48 h which was 75% in control and 90% in experimental conditions (Fig. 3).

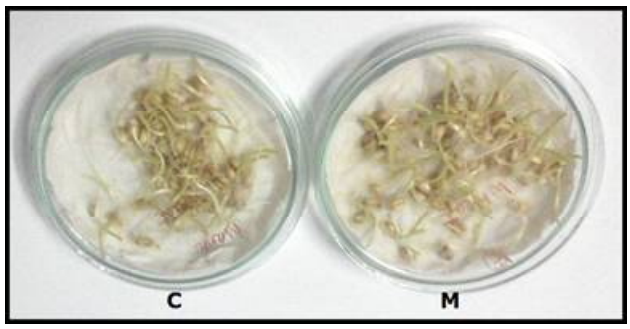


Fig. 3. Effect of prepared biofertilizer on germination of Wheat (*Triticum aestivum*) seeds.

C: Control (traditional fertilizer)

M: Prepared biofertilizer (Organic manure from biodegradable waste)

3.2 Root – Shoot Ratio

Following seed germination, the developed plantlets showed a very significant difference in root-shoot ratio between the control and the experimental plantlets (Fig. 4).

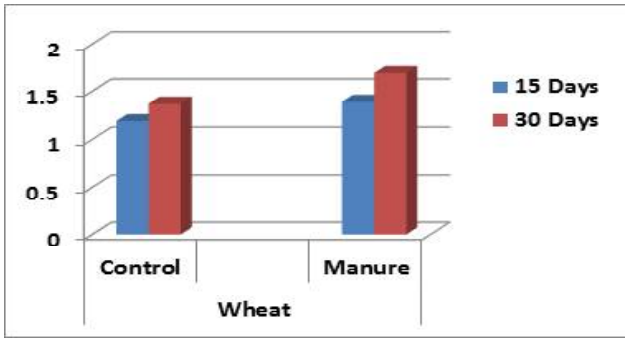


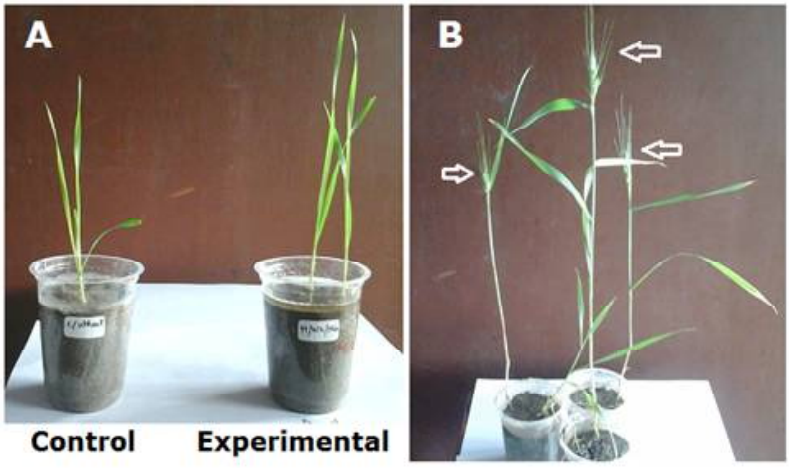
Fig. 4. Root-shoot Ratio in Wheat.

3.3 Developmental changes and flowering

The development of control and experimental plants were minutely observed during the study. It has been found that there was clear cut difference in development of control and experimental plants. The length of the shoot, the development of leaves and its healthy nature was clearly evident in experimental plants over control plants in wheat. The plantlets received more nutrients in experimental conditions and resulted into the development of ears (flowering condition) in wheat. (Figs.5 A-B).

3.4 Chlorophyll estimation

The chlorophyll estimation in control and experimental



Figs. 5 A-B: Early development and flowering in Wheat plants using biofertilizer. A: The healthy control and experimental potted plant of Wheat. B: Ear development in the healthy potted plant of Wheat.

plants showed a significant difference (Fig. 6). These differences were recorded less after 15 days, however, after 30 days it was recorded to be significant. The changes in Chlorophyll A and Chlorophyll B were almost identical after 15 days as well as after 30 days, but the variation in Carotenoids was too less. In case of total Chlorophyll the variations were very significant in experimental plants after 30 days.

3.5 Nitrate Reductase activity

The assay of Nitrate Reductase activity in control and experimental plants after 30 days exhibited an enormous change (Fig. 7). Nitrogen is one of the important requirements of the plants which are usually taken by soils as nitrates. Following reduction by Nitrate Reductase (NR) enzyme the fate of most of this nitrate is to be incorporated into proteins and nucleotides.

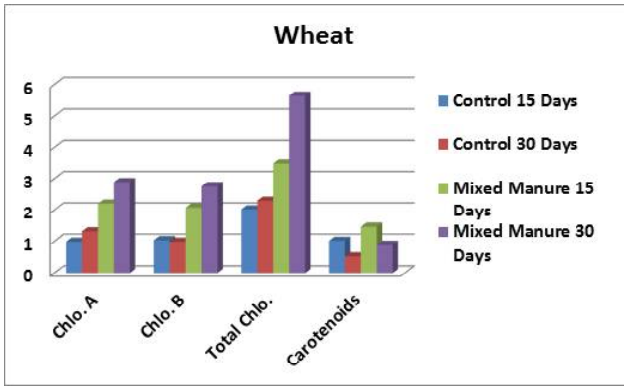


Fig. 6. Chlorophyll (Chlorophyll a, Chlorophyll b, Total Chlorophyll and Carotenoid) estimation in Wheat.

4. DISCUSSION

The results indicate that the experimental plants which were grown using the biofertilizer prepared using the kitchen biodegradable wastes excelled on all the parameters tested (rate of seed germination, root – shoot ratio, chlorophyll contents in leaves and Nitrate Reductase activity) in comparison to traditional chemical fertilizers used as control. The two most important conclusions were – firstly a significant change in Nitrate Reductase (NR) activity which is responsible for the enhancement in protein contents and secondly, with the significant input of nutrients the plants exhibited early flowering developed healthy ears in small plastic pots. This indicates that the biofertilizer, prepared using the kitchen biodegradable wastes, has been far more nutrient supplier than the traditional chemical fertilizers.

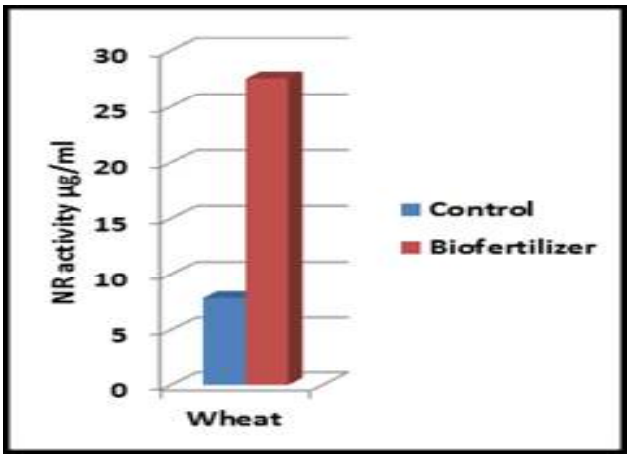


Fig. 7. Nitrate Reductase activity in the healthy plants of leaves of Wheat following 30 days incubation.

5. CONCLUSIONS

The growth and development of Wheat (*Triticum aestivum* Linn.) plant has been studied from seed germination to the maturation leading to flowering using self-prepared kitchen waste biofertilizer. The experimental plants which were grown using the biofertilizer prepared using the kitchen biodegradable wastes excelled on all the parameters tested in comparison to traditional chemical fertilizers and therefore,

the prepared biofertilizer has been found to be far more nutrient supplier than the traditional chemical fertilizers.

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RESEARCH ARTICLE

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Phytoremediation of flashlight manufacturing effluent through aquatic macrophytes

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ABSTRACT

Three aquatic macrophytes viz. *Eichhornia crassipes*, *Pistia stratiotes* and *Lemna gibba* were studied for their potential to remove heavy metals from Flashlight manufacturing industry effluent. Plants were exposed to 100%, 75%, 50%, 25% and 0% (distilled water) concentration of effluent for 5 weeks. Results revealed that the macrophytes under study were highly efficient in the removal of Hg, Mn, Zn and Pb. Translocation factor expressed that metals were largely retained in the roots of *Pistia stratiotes* and *Lemna gibba* while *Eichhornia crassipes* concentrated most of the metals in shoots. Analytical results showed that *Eichhornia crassipes* removed approximately 67.535, 89.30, 80.84 and 69.80% of Hg, Pb, Zn and Mn, respectively, from 100% concentrated effluent which shows its higher metals removal efficiency compared to *Pistia stratiotes*(65.44%, 87.109%, 70.23%, 63.242%) and *Lemna gibba* (71.84%, 89.074%, 70.97%, 73.97%,), respectively. These plants were also subjected to toxicity assessment and no symptoms of metal toxicity were found. Therefore, these macrophytes can be applied on the large scale treatment of waste water where volumes generated are very high and concentrations of pollutants are low.

1. INTRODUCTION

Large numbers of industries like tannery, battery, textile, electroplating, iron steel, pesticides, paints etc. use high quantity of water and chemicals and subsequently discharge it into water bodies such as river, lakes, ponds, and canals and cause water pollution. This pollution leads to major concern especially in developing country like India, where most of the activities are water dependent. Among various water pollutants heavy metals are major concern due to its persistence and accumulative nature. (Change et al. (2009), Yadav et al. (2009), Sood et al. (2012). These metals are added into water through discharge untreated or partially treated effluent directly into the water bodies. Hence, restoration of polluted water bodies needs cost effective and eco-friendly remediation technologies.

Phytoremediation is an attractive and applicable method for metal removals from the water using plants. It is cost effective, less destructive, being applicable in large range and environmental friendly technology. In the presented study these macrophytes viz. *Eichhornia crassipes*, *Pistia stratiotes* and *Lemna gibba* are selected and tested for their heavy metal removal efficiency from flashlight manufacturing industry effluent. These macrophytes have been tested due to their easy availability and their adaptability to local climate change. *Eichhornia crassipes* was emerged aquatic macrophyte commonly known as water hyacinth, found all over the world. In the last few years great interest has been shown for the research of water hyacinth because it is a good candidate for pollutant removal and even as a bioindicator of heavy metals in aquatic ecosystems. *Lemna gibba* is free floating, fast growing macrophytes and adapts easily to various aquatic conditions, globlly distributed in lakes, ponds, wetlands and some effluents lagoon. The capacity of duckweed (*Lemna* sp.) to remove toxic heavy metals from water plays an important role in removal and accumulation of metals from contaminated water. *Pistia stratiotes*is genus of aquatic macrophytes in the family Araceae, commonly called as water lettuce. It Float on the surface of the water and root are hanging beneath floating leaves. They are natural hyperaccumulators of many toxic heavy metals.This paper is enlightening Zn, Mn, Hg and Pb removal abilities of three macrophytes viz. *Eichhornia crassipes*, *Pistia stratiotes* and *Lemna gibba* from flashlight manufacturing industry effluent.

2 MATERIALS AND METHODS

2.1 Study Location- The wastewater sample for the study was collected from outlet pipes of a Flashlight

manufacturing industry situated at Aishbagh Park, Lucknow, U.P., India. Effluent sample was collected in pre-cleaned 10L plastic containers.

2.2 Plant sampling - *Pistia stratiotes, Eichhornia crassipes* and *Lemna gibba* were collected from river Gomti, Lucknow, U.P., India. All the collected plants were put in hydroponic system containing tap water for one week acclimatization before being exposed to heavy metals.

2.3 Experimental setup and Data Analysis

Experimental setup was carried out in 25 plastic tubs. All 25 tubs were setup in five lines like stairs and each line contains five tubs including 100, 75, 50, 25 and 0% effluent, after a week treated effluent was transferred to next tubs with fresh plants and determination of Zn, Pb, Mn and Hg was carried out by atomic absorption spectrophotometer (Varian, AA240FS). All the plants samples were washed by distilled water and cut into small pieces and dried in oven at 60ºC temperature and then homongeniged using mortal pestle. One gram of powdered sample digested with aquaregia (HNO_3 and $HClO_4$ acid in 3: 1 ratio v/v) until sample became clear and white, fumes of $HClO_4$ appeared and then diluted with 0.1 N HNO_3 and filter with 0.45 µm filter paper before analysis on AAS.

2.4 Removal Efficiency (RE)

After five weeks of treatment metals concentration in the effluent was analysed and the removal efficiency was calculated following the formula giving by Tanhan et al (2007); Khellaf and Zerdaoui (2009).

$$\text{Removal efficiency (\%)} = \frac{\text{initial concentration - final concentration}}{\text{initial concentration}} \times 100$$

2.5 Translocation factor (TF)

Translocation factor (TF) is the ratio of heavy metal in root to shoot, and is used to determine the plants potential for heavy metals accumulation (Gupta et al. (2008).

$$TF = \frac{\text{Concentration of metal in plants in shoots}}{\text{Concentration of metal in corresponding plant roots}}$$

2.6 Enrichment coefficient (EC)

Enrichment coefficients are a very important factor, indicate the relationship of metals in macrophytes and water also named as bioconcentration factor (Sasmaz et al. 2008).The Enrichment coefficient (EC) was calculated as follows-

$$\text{Enrichment coefficient} = \frac{\text{Metal accumulated in plants parts}}{\text{Metal concentration in water}}$$

2.7 Statistical Analysis

Statistical significance of removal efficiency for heavy metals was examined by one-way ANOVA by using IBM SPSS 20 computer software. Treatment means were compared using Duncan's 95% simultaneous test. Differences were statistically significant when $p < 0.05$.

3 RESULTS AND DISCUSSION

3.1 Heavy metal removal from wastewater

Hg, Zn, Mn and Pb are common metals in flashlight manufacturing industry effluent. It was found that the initial concentration of these metals in the effluent to be Zn = 1.752 mg/l Pb = 2.27 mg/l Hg = 6.33 mg/l Mn = 1.09 mg/l, which are further found in decreasing order up to 5th weeks of analysis indicate the continuous absorption of metals by macrophytes. *E. crassipes, P. stratiotes and L. gibba* used in this study showed wide range of metals tolerance and also indicated effluent did not affect the growth of macrophytes.Occurrence of variation of metal accumulation in macrophytes perhaps associated with difference in absorption efficiency of metal, duration and plant growth. Analysis of variance indicates removal efficiency of metal in different experiment setup significantly ($p<0.05$) varied.

Zinc is an essential micronutrient used in activation of enzyme and protein synthesis in plants, actively taken up by roots (Deng and Wong (2004). Concentration of Zn in effluent after 5th week are 0.44, 0.37, 0.246, 0.14; 0.34, 0.271, 0.201, 0.11; 0.544, 0.417, 0.321, 0.21 mg/l by *E.crassipes*, *L. gibba, and P. stratiotes* at 100, 75, 50 and 25% effluent concentration respectively. Maximum removal efficiency of Zn showed at 25% effluent concentration which is >90 by all studied macrophytes. Zn concentration depends on the modification of the chemical in the root system caused by the availability of different metals in the water (Cacador et al. (2000).Hg accumulation in macrophytes is highest may be due to its concentration in effluent compared to other metals. Hg is non-essential and toxic metal which are harmful for photosynthesis and oxidative metabolism of plants. *E. crassipes, P. stratiotes* and *L. gibba* removed>60% of mercury from the effluent, but *E. crassipes* good accumulator

considered because the concentration of mercury in their tissues are higher due to higher biomass, broad leaf and fibrous roots. Highest removal efficiency was found *L.gibba* (75%) at 50% concentration effluent whereas lowest efficiency found in *P. stratiotes* (62%) at 25% concentration. *L. gibba* removed 4.33, 4.11, 3.15, 2.43 mg/l; *P. stratiotes* removed 4.16, 3.76, 2.87, 2.18 mg/l and *E. Crassipes* removed 4.16, 4.03, 3.05, 2.33 mg/l after five weeks from 100, 75, 50 and 25% effluent concentration.

Mn is another essential metal for plants and also involved in Photosynthesis and enzyme activity (Bonanno and Giudice (2010). Concentration of Mn in *E. crassipes, P. stratiotes* and *L. gibba* varied with duration and concentration. *E. crassipes* removed 69.80, 69.42, 75.45, and 77.36% of Mn from effluent, *P. stratiotes* removed 70.23, 69.80, 71.56 and 81.72% while *L. gibba* removed 70.23, 67.46, 70.90 and 95.07% Mn from effluent to 100, 75, 50 and 25% of effluent. Highest Mn removal efficiency was noticed at 25% effluent concentration while lowest of 69% was observed at 100% effluent concentration. This result showed that if the metal concentration is lower removal efficiency was increased. Mn easily moves within plants, and accumulates mainly in green parts of plant organs and its permissible limit 30 ppb as per WHO (Demirezenv and Aksoy (2006). Lead is one of the toxic and non-essential metals for plants growth (Demirezen and Aksoy 2004). Concentration of Pb in

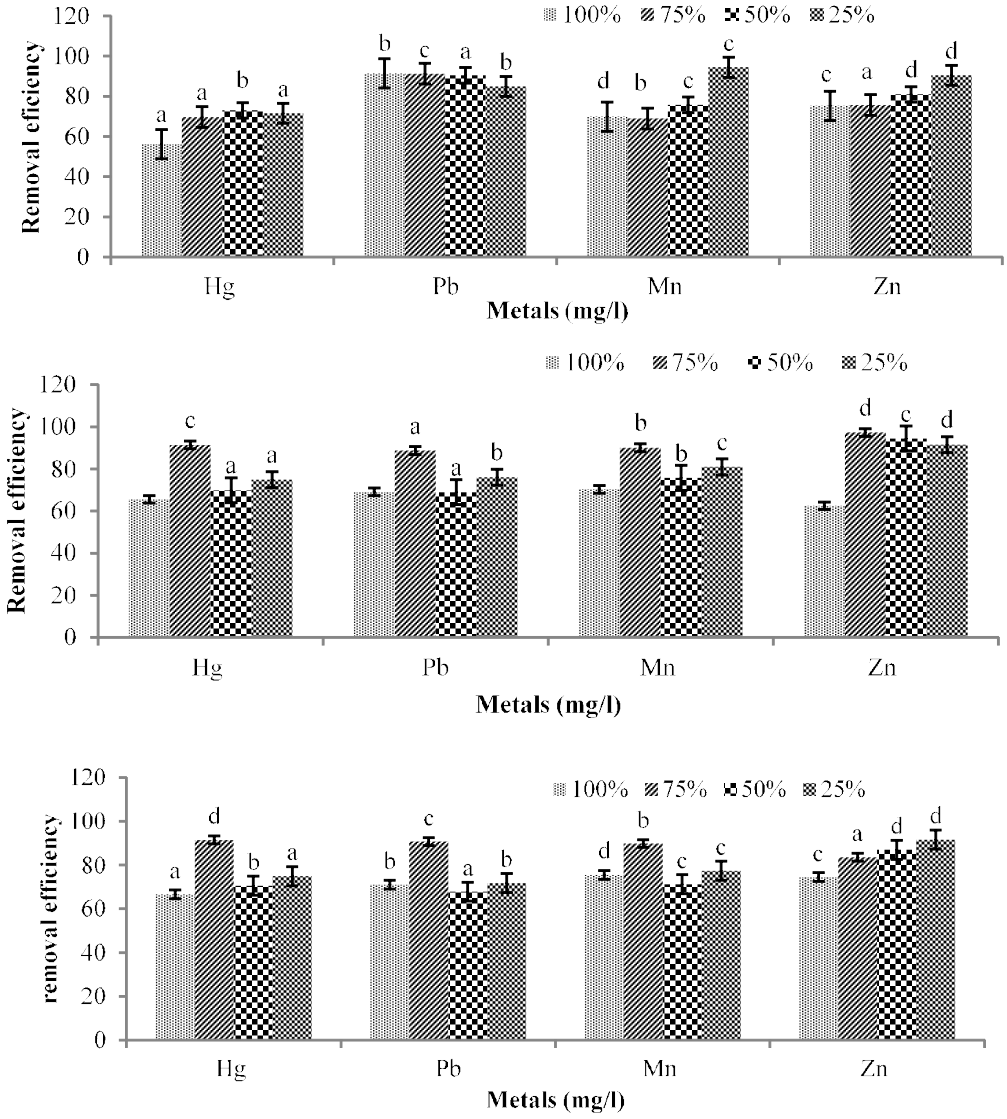

Fig. 1. Efficiency of *E.crassipes, P. stratiotesand* L. *gibba* for removing metals.

Table 1. Enrichment coefficients (EC) and Translocation factor of metal (TF) for root and shoot of studied macrophytes in flashlight manufacturing effluent.

Effluent	1st week			2nd week			3rd week			4th week			5th week		
Concentration	**ECR**	**ECS**	**TF**	**ECR**	**ECS**	**TF**	**ECR**	**ECS**	**TF**	**ECR**	**ECS**	**TF**	**ECR**	**ECS**	**TF**
Eichhornia crassipes															
Zn															
100%	0.95	0.74	0.78	0.77	0.72	0.94	0.57	0.65	1.14	1	0.9	0.9	0.73	0.73	1
75%	0.99	0.48	0.48	0.81	0.76	0.94	0.53	0.74	1.39	0.86	0.8	0.93	0.74	0.71	0.95
50%	0.68	0.37	0.54	0.73	0.78	1.08	0.52	0.62	1.19	0.91	0.81	0.89	0.94	0.95	1.02
25%	0.63	0.38	0.59	0.86	1	1.16	0.65	0.62	0.95	1	1	1	0.81	1.89	2.35
0%	0.86	0.86	1.01	0.92	0.85	0.93	0.28	0.3	1.06	0.76	0.76	1.01	1.23	1.22	0.99
Hg															
100%	0.9	0.86	0.96	1.02	0.86	0.85	0.96	0.9	0.93	0.71	0.64	0.9	0.93	0.94	1.02
75%	0.94	0.87	0.93	0.96	0.88	0.92	0.91	0.85	0.93	0.72	0.7	0.97	0.82	0.85	1.05
50%	1.03	0.86	0.84	0.98	0.79	0.8	0.94	0.98	1.04	0.67	0.66	0.98	0.89	0.82	0.93
25%	1	1.17	1.17	0.9	0.76	0.85	0.96	0.93	0.97	0.5	0.53	1.05	0.86	0.72	0.84
0%	0.02	0.02	1.05	0.01	0.02	1.53	0.04	0.02	0.6	0.02	0.18	9.94	0.01	0.01	0.96
Mn															
100%	1.03	0.93	0.9	0.9	1.26	1.4	0.88	0.84	0.96	0.86	0.85	0.98	0.74	0.73	0.99
75%	0.74	0.75	1.02	0.64	0.97	1.53	0.71	0.69	0.98	0.69	0.72	1.04	0.88	0.93	1.06
50%	0.77	0.74	0.95	0.68	1.02	1.51	0.84	0.75	0.89	0.74	0.82	1.12	0.83	0.76	0.91
25%	0.94	0.98	1.04	0.92	1.46	1.58	0.87	0.89	1.02	0.92	1.02	1.11	0.72	0.06	0.08
0%	7.78	6.78	0.87	7.78	6.89	0.89	0.88	0.75	0.86	0.78	0.56	0.71	0.4	4	1.18
Pb															
100%	1.18	0.89	0.75	1.89	1.8	0.95	2.23	1.62	0.73	2.1	1.47	0.7	5	3.34	0.67
75%	0.96	0.98	1.01	2.13	1.95	0.92	2.29	2.06	0.9	2.28	1.37	0.6	4.82	3.1	0.64
50%	0.98	1.13	1.15	1.91	2.24	1.17	3.33	2.94	0.88	3.08	1.6	0.52	4.9	3.29	0.67
25%	1.02	1.02	1	2.91	3.4	1.17	2.07	1.8	0.87	5.95	1.75	0.29	5.99	3.44	0.57
0%	0.98	1.31	1.33	1.15	1.14	0.99	1.35	1.19	0.88	1.51	1.13	0.75	1.36	1.08	0.79
Lemna gibba															
Zn															
100%	1.38	1.38	1	1.3	1.31	0.99	1.59	1.49	1.06	1.62	2.01	0.81	0.96	1.37	0.7
75%	1.1	1.24	0.89	1.13	1.23	0.91	1.65	1.19	1.39	1.16	0.89	1.3	1.72	1.42	1.21
50%	1.45	1.83	0.79	1.22	1.36	0.9	2.68	1.63	1.64	0.99	1.07	0.93	1.35	1.23	1.1
25%	1.49	2.43	0.61	0.84	1.17	0.72	2.88	16.98	0.17	2.01	1.69	1.19	0.57	0.49	1.16
0%	1.05	1.06	0.99	1.04	1.15	0.9	9.45	10.96	0.86	9.21	9.35	0.98	1.03	0.82	1.25
Hg															
100%	1.12	1.09	1.04	1.13	1.16	0.98	1.1	1.08	1.02	1.13	1.1	1.03	1.04	0.99	1.07
75%	1.23	1.16	1.06	1.04	1.13	0.92	1.21	1.12	1.09	0.97	1.06	0.92	1.14	1.14	1.15
50%	1.05	0.93	1.14	1.01	1.26	0.8	1.07	1.02	1.05	1.14	1.15	0.99	0.9	1.04	1.17
25%	1.23	1.1	1.12	1.03	1.17	0.88	0.98	1.06	0.93	1	1.02	0.98	1.06	1.09	1.04
0%	20	12.79	1.56	23.94	24.32	0.98	22.27	24.36	0.91	24.91	24.4	1.02	25.57	22.97	23.9

Effluent	1st week			2nd week			3rd week			4th week			5th week		
Concentration	**ECR**	**ECS**	**TF**	**ECR**	**ECS**	**TF**	**ECR**	**ECS**	**TF**	**ECR**	**ECS**	**TF**	**ECR**	**ECS**	**TF**
Mn															
100%	0.75	0.75	0.99	1.27	1.15	1.11	12.58	1.49	8.46	1.66	2.18	0.76	1.28	1.35	0.94
75%	0.91	0.92	0.99	1.39	1.22	1.13	16	1.66	9.62	1.68	1.72	0.98	1.21	1.24	0.97
50%	1.15	0.96	1.19	1.46	1.23	1.19	12.74	1.34	9.52	1.24	1.35	0.92	1.14	1.07	1.06
25%	2.94	3.3	0.89	1.09	1.1	0.99	11.41	1.19	9.58	1	1.17	0.86	0.14	0.16	0.86
0%	9.08	1.06	8.57	12.86	1.5	8.57	11.43	13.33	0.86	8.57	12	0.71	10	10	1
Pb															
100%	1.5	1.67	0.9	2.23	1.59	1.4	1.29	1.35	0.96	1.15	1.17	0.98	1.29	1.3	0.99
75%	3.25	3.18	1.02	2.88	1.88	1.53	1.67	1.71	0.98	1.43	1.37	1.04	1.67	1.58	1.06
50%	3.53	3.71	0.95	2.98	1.97	1.51	1.73	1.94	0.89	1.24	1.11	1.12	1.74	1.92	0.91
25%	2.8	2.68	1.04	3.43	2.17	1.58	1.98	1.94	1.02	1.5	1.35	1.11	2.24	28	0.08
0%	1	1.15	0.87	0.97	1.1	0.89	0.94	1.1	0.86	8.71	12.2	0.71	10.12	1.47	6.9
Pistia stratiotes															
Zn															
100%	1.05	1.07	0.98	1.12	1.15	0.97	1.15	1.21	0.95	0.87	0.95	0.92	0.9	0.89	1.01
75%	1.16	1.21	0.96	1.65	1.52	1.08	1.06	1.05	1.01	0.66	0.89	0.75	0.89	0.91	0.97
50%	1.54	1.86	0.83	2.06	1.47	1.4	1.46	1.61	0.9	0.61	0.98	0.62	0.94	1.01	0.94
25%	2.56	2.7	0.95	2.38	3.05	0.78	2.5	1.73	1.44	0.61	0.88	0.69	0.92	0.91	1.01
0%	10.11	11.03	0.92	10.07	11.67	0.86	12.08	9.33	1.3	11.44	12.19	0.94	10	8.9	1.12
Hg															
100%	1.13	1.13	1	1.09	1.14	0.95	1.07	1.13	0.95	1.11	1.16	0.96	1.1	1.17	0.93
75%	1.07	1.05	1.01	1.04	1.06	0.98	1.15	1.14	1.01	1.16	1.45	0.8	1.08	1.48	0.73
50%	1.1	1.34	0.82	1.17	1.04	1.12	1.12	1.11	1.01	1.24	1.57	0.79	0.97	1.54	0.63
25%	2.02	1.78	1.14	1.74	1.77	0.98	2.14	1.54	1.39	2.07	2.01	1.03	1.53	2.7	0.57
0%	2.81	22.99	0.12	28.85	28.85	1	35.91	28.14	1.28	29.11	32.88	0.89	34.93	3.11	11.22
Mn															
100%	1	1.04	1.04	1.23	0.78	0.63	0.84	0.52	0.62	0.83	1.24	1.49	0.83	0.81	0.97
75%	1.11	1.01	0.91	1.13	0.79	0.7	0.89	0.45	0.5	0.69	0.66	0.96	3.57	0.84	0.24
50%	1	1.12	1.12	0.86	0.78	0.91	0.75	0.43	0.57	0.86	0.88	1.02	0.61	0.69	1.12
25%	1.36	1.26	0.93	0.97	0.95	0.98	0.79	1.21	1.53	0.74	0.71	0.97	0.76	0.59	0.78
0%	7.78	6.67	0.86	7.78	6.67	0.86	8.75	7.5	0.86	5.56	5.56	1	4	4	1
Pb															
100%	1.18	1.18	1	2.01	1.6	0.8	2.24	2.09	0.93	2.06	1.45	0.7	3.18	2.13	0.22
75%	0.95	1.04	1.09	1.97	1.33	0.68	2.35	2.55	1.08	2.27	2.14	0.95	4.06	2.62	0.23
50%	0.95	1.1	1.15	1.4	1.1	0.79	3.34	3.74	1.12	3.12	2.46	0.79	3.94	3.08	0.2
25%	1.02	1.21	1.18	2.02	1.27	0.63	2.27	2.11	0.93	3.54	2.72	0.77	2.28	2.32	0.34
0%	0.1	0.1	1	0.1	0.07	0.69	0.05	0.05	1	0.05	0.05	1	0.05	0.05	18.57

ECR= Enrichment coefficient for root, ECS= Enrichment coefficient for shoot, TF= Translocation factor

effluent after 5th week of treatment are 0.175, 0.165, 0.14, 0.11; 0.178, 0.168, 0.15, 0.11; 0.27, 0.19, 0.15, 0.12 mg/l at 100, 75, 50 and 25% effluent concentration respectively by *E.crassipes*, *L. gibba, and P. stratiotes*. Brix (1993), has observed that *E. crassipes* has been used successfully in wastewater treatment system to improve the water quality by reducing the levels of Pb. Thus, water hyacinth would probably have high tolerance and should be capable of removing large amounts of Pb. Results revealed the maximum Pb removal at 25 and 50% and minimum at 100% and 75% effluent concentration, which indicates that higher concentration of metal in effluent slow down the phytoremediation process.

3.2 Translocation factors and Enrichment coefficient (EC)

There were slight differences in metal concentration between shoot and root, which indicates internal transportation of metal from root to shoot. Baker (1981) explains that metal immobilized in root and emphasized by the root or shoot >1 is related to an exclusion strategy. All the metals Zn, Hg, Pb and Mn are accumulated in *E. crassipes, P. stratiotes* and *L. gibba* and it was found that all macrophytes showed higher translocation ability for Zn and Mn and lower for Pb and Hg probably because Zn and Mn are essential element for plants while Hg and Pb are not. Results showed that root of macrophytes have higher metals concentration. Kuperberg et al. (1999) explained that plants with higher concentration in shoot known as phytoextractors while other plant which maintain metal in root known as rhizofiltrator in phytoremediation classification. Thus selected macrophytes translocation factor suits for rhizofiltration for Hg and Pb. Data presented in table1 represents the value of translocation factor of Hg, Zn, Mn, and Pb in root and shoot of the *E. crassipes, P. stratiotes* and *L. gibba*.

Enrichment coefficient is important measures for considering the potential macrophytes and basically depends on the soluble fraction of metals in water and there translocation in tissues (Khan et al. 2006). *E.crassipes* and *Lemna gibba* recorded higher enrichment coefficient value for Pb after 5th weeks which are: 5.00, 4.82, 4.90, 5.99, 1.36; 3.34, 3.10, 3.29, 3.44, 1.08; 3.18, 4.06, 3.99, 2.28, 0.05; 2.13, 2.62, 3.08, 2.32, 0.05 respectively for root and shoot but *P.stratiotes* showed higher value for Mn after 3th week only for root which are 1, 1.11, 1, 1.36 & 7.78 respectively at 100, 75, 50, 25 and 0% effluent while Hg showed lower value by all macrophytes.

4. CONCLUSION

Present study provides an eco-friendly approach for the removal of Hg, Zn, Mn and Pb from flashlight industry effluent. Three macrophytes proved highly effective in removing these four metals during 5 weeks experiment. *Lemna gibba* is appreciably to removed Hg, *Pistia stratiotes* effectively removed Zn and Pb and *Eichhornia crassipes* significantly removed Mn from effluent. The results of present study also indicated that metal removal efficiency were highest at 25% effluent concentration for all the three macrophytes for most of the times. Translocation factor also revealed that roots of the macrophytes is better accumulator of metals contains higher Zn, Pb and Hg in root and Mn in shoot of macrophytes which indicate that low transportation of metal from root to shoot. The tested macrophytes can be used for the treatment of wildly contaminated wastewater. However, it should be varified with on-field trials for best application.

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RESEARCH ARTICLE

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Women's health status in Rural India: A Sociological study of Deoria District of Uttar Pradesh

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ABSTRACT

The present study was undertaken to study Women health status in Rural India: A Sociological study of Deoria District of Uttar Pradesh. The study highlighted to understand the problem related to women health status in India and concept of health and nutrition and theories of gender. Uttar Pradesh is one of the largest, densely population and backward state of India. Which has a socio-economic and thus health problems for women? To understand the real challenges micro level sociological studies are urgently needed. This thesis analyzed health scenario and its related issues and challenges in a rural pocket of distantly located backward district of Uttar Pradesh. The health care of women is an emerging area of sociological studies which need investigations and analysis of available health facilities, health manpower health concerns, health related programs. The operations and actual execution of programme in fields at micro level is to draw a picture of the present health related problems of rural women in terms their caste, class and religion, size of family, education of the family, culture of the area in which they are residing. It is very essential to understand the impact of various social, economical, cultural factors which are varied in terms of regional differences.

1. INTRODUCTION

Health is defined by the World Health Organization (WHO) as a state of complete physical, mental and social well being not merely absence or infirmity. Health care system in India, found a concern in ancient India has evolved though ages with many ups and downs. After independence various health infrastructures, health manpower and focus to specific priority areas were planned and implemented on recommendations of various review committees through the different five year plans. Women, though most important section of society, were largely ignored especially in rural India for their health concerns.

Uttar Pradesh is one of the largest, densely populated, and backward states of India which has a socio-economical and thus health related problems for women. To understand the real challenges micro level sociological studies are urgently needed. This work has analyzed health scenario and its related issues and challenges in a rural pocket of distantly located backward district of Uttar Pradesh. No such study is available with sociological perspective for understanding the concern of women.

Table 1. Health system and Human Resource in India

Health system	Number	Year
Number of Hospital Beds	633545	2002
Hospital beds per 10,000 population	9	2006
Number of Health Sub Centers	137371	2006
Primary Health Centers	22824	2001
Community Health Centers	3043	2001
Physicians per 10,000 population	7	2005
Nurses per 10,000 population	7.85	2004

(Source: WHO World Report, 2005)

When we look into the data available in public domain or health system and human resource in India during the recent years, the resources are too meager in relation to the ever increasing population (Table 1). According to WHO and World Bank Reports only 2006 beds were available for 10,000 whereas only 7 physician and 7.85 nurses were available for this population (WHO, 2005).

In their study Kumar and Khan (2010) found that maternal mortality is a major health concern. India has a high maternal mortality ratio approximately 450 deaths per 100,000 live births in (ICMR, 2003). This ratio is 56 times higher than in the United States. Malnutrition is another serious health concern that Indian women face. It threatens their survival as well that of their children. Due to malnutrition, many women never achieve full physical development imposes a relatively large risk for women by increasing the hazard of obstructed deliveries. One of the reasons for the poor health of Indian women is the discriminatory treatment against girls and women receive as compared to boys and men. Violence against women is one of the causal factors related to health problems; and this kind of violence also germinates health related problems. Women are relatively more vulnerable to HIV/AIDS pandemic than men on account of a number of social, economic, culture, religious and psychological factors and underlying circumstances.

Sankar and Katharia (2004) focused on the efficacy of the rural public health systems in improving the health outcomes of rural areas and the relative performance of various states in India. Relative efficiencies differ across states and this is due to differences not only in the health sector endowment, but also in its efficient use. It shows that states should not only increase their investment in health sector, but also manage it efficiently to achieve better health outcomes. Roy *et al.* (2004) highlight that inequalities in nutritional status and health care in different states exists with a focus on caste and tribe. They reflect that caste hierarchy becomes a serious handicap for utilization of health services.

The paper by Das Gupta and Bisht (2010) throws light on National Urban Health Mission. National Urban Health Mission is introduced to address the health problems and needs of urban people. However, large proportion of homeless and people living in slum areas one deprived of the health care insurance are becoming obstacles in delving health care services to the urban poor.

In his study, Tikku (2004) find out the nutritional status of mothers and under five children belonging to the tribal in Bihar years of about physiologies. The functioning of NGOs and their role in combating nutritional and health problems prevalent among children, adolescent and women in three states of Northern India *i.e.,* Delhi, Haryana and Rajasthan. The NGOs also dealt with other related areas to supplement and complement their main focus on health and nutrition. However, not many of them are involved in tackling endemic and emerging diseases. These should be giving more emphasis. It was found also there is no proper mechanism for obtaining and analyzing information on health and nutritional services providing by voluntary organization. Each state should have district-wise data-base on nutritional and health.

Health and education of all human beings are precious assets of the nation. It is nation's moral, legal and constitutional responsibility to promote, restore or maintain the health status of its population through meticulously designed policy, plans and programs; effectively implementing, monitoring and evaluating them to yield targeted results in respect of health care infrastructure, manpower support, and provision of clean drinking water, sanitation and hygiene, besides a host of other interrelated activities. In this background an attempt has been made here to underline the present status of health service infrastructure, its impact with sharp focus on UN Millennium Development Goals and need to integrate health service infrastructure with the Self-Help-Groups promoted, nurtured and linked with rural financial institutions to empower poor rural women socially, economically and politically and lift them above poverty line.

Table 2. Health Indicators in India 2011

Health Indicators	India (Per thousand)
Crude Birth Rate	20.97 birth/ 10,000 population
Crude Death Rate	7.48
Total Fertility Rate	2.62 children born/women
Maternal Mortality Rate	212
Infant Mortality Rate	53
Child Mortality Rate	2.54
Life Expectancy at Birth	66.71 Years

(Source: Economic Survey, 2011)

Health indicators in India in year 2011 (Table 2), show crude rate at 20.97 per thousand crude death rate 7.48 per thousand, total fertility rate 2.62 per thousand, maternity rate 2.54 per thousand (Economic Survey, 2011).

A focus was also made on child mortality which was a major indicator for socio-economic growth of the country; and with these efforts many specific health concerns related to women and specially women in rural India and that too in vulnerable and underprivileged socio-economical groups were realized. In some recent five year plans the health concerns have been focused to women and child health

and various objectives, plans and programs have been included in these plans. The rural India is not a homogenous structure. It has much social economical, cultural and geographical variability. The women are more vulnerable groups within the rural areas and within the various regions in same political state of the country.

The health care of women is an emerging area of sociological studies which needs investigations and analysis of available health facilities, health manpower health concerns, health related programs. The operations and actual execution of programme in fields at micro level is to draw a picture of the present health related problems of rural women in terms their caste, class and religion, size of family, education of the family, culture of the area in which they are residing. It is very essential to understand the impact of various social, economical, cultural factors which are varied in terms of regional differences. This study is an effort to understand the health concerns, health infrastructure, health manpower and effectiveness of health programs for the women of different groups in a rural population of remote, backward district of eastern Uttar Pradesh, named Deoria which is located near Bihar and Nepal.

2. METHODOLOGY AND DATA COLLECTION

The present study was selected as no such study is available in rural area in Uttar Pradesh of Deoria district, which reveal Women's Health status in Rural India.

The data were obtained by the interview schedule, Primary data was collected through field work by using both quantitative and qualitative research techniques and Secondary data was collected through reports, Newspaper, etc. from different Libraries and also from Hospitals reports, Health centers and State Government statistical office.

3. RESULTS AND DATA COLLECTION

3.1 Health Indicators

The data in Table 3 shows Health indicators. Many of the health problems of Indian women are related to or exacerbated by high level of fertility. The total fertility rate (2005-2006) has gone down to 53, (SRS, 2008), whereas maternal mortality rate was found to be 414 (2004-2006), which is higher than the National average. The Sex Ratio in the State is 908 (as compared to 940 for the country). Comparative figures of major health and demographic indicators are as follows:

However, there are large variations in fertility level as per state, education, religion, caste and place of residence. 3.8 fertility rates in Uttar Pradesh and Bihar, the most populated states in India, have total fertility rate of over 4 children per women. High levels of infant mortality rate 6.5, 440 maternal mortality rate per 100,000 births, cured birth rate 29 of every 1,000 girls born 93 die before turning five (SRS, 2008 and Census of India, 2011).

Table 3. Health Indicators in Uttar Pradesh

Health Indicators	Uttar Pradesh
Decade Growth Rate	20.5
Crude Birth Rate	28.7
Crude Death Rate	8.2
Total Fertility Rate (RHS 2008)	3.8
Sex Ratio Per Thousand	908
Maternal Mortality Rate	440
Female Literacy Rate	59.26

(Source: Cense of India, 2011)

3.2 Health Infrastructure

Table 4 highlights the shortfall in health infrastructure in Uttar Pradesh. There is a lot of difference in the present position and the required position of infrastructure *i.e.*, at present there are only 186 gynecologist, 1945 pharmacist

Table 4. Health Infrastructure of Uttar Pradesh

Health Facilities and Health Men-Power	Required	In position	Short Fall
Sub- Centers	26344	20521	5823
Community Health Centers	4930	3690	700
Primary Health Centers	1097	515	582
Health Worker Female	24211	21024	3187
Health Assistant Female PHcs	3640	3509	181
Gynecologist at CHcs	515	186	329
Pediatricians at CHcs	515	135	380
Pharmacist	4205	1945	2251
Laboratory Technicians	4205	1085	3120
Nurse/ Midwife	7295	3340	3955

(Source: RHS Bulletin, March 2008, M/O Health and FW: GIO)

and 135 pediatricians at community health centers, while the requirement is that of 515 gynecologists, 4205 pharmacist and 515 pediatricians. Total numbers of nurses/midwife are 3340, health female worker are 21024. This table 4 shows that there is a severe shortfall of health facilities and health manpower.

3.3 Medical Health Institutes in the State

Table 5 highlights the health institutions of Uttar Pradesh State. There are 16 Medical Collages, 1771 Ayurvedic hospitals, 340 Ayurvedic dispensaries, 8 Homeopathic hospitals and 210 Unani hospitals in the state.

Table 5. Medical Health Institutes in the State

Health Institutes	Number
Medical	16
District Hospital	71
Referral Hospital	-
Ayurvedic Hospitals	1771
Unani Hospitals	340
Unani Dispensaries	49
Homeopathic Hospitals	8
Homeopathic Dispensaries	1482

(Source: RHs Bulletin March, 2007 M/O Health and F.W. GIO)

3.4 Health Facility in Deoria District

The rural health care system is three tier structures. It has 'sub-center' at the most peripheral level and primary health centre at the Secondary level and community health centre at the third level. The population covered by a sub centre, Primary Health Centre and Community Health Centre are 3,000-5,000; 20,000-30,000 and 10,00,000 respectively. In addition there are Private Voluntary Health Facilities, also. The district is headed by the chief medical officer followed by an Additional (CDMO) as second-in-command. The Chief Medical Superintendent looks after the Uttar Pradesh Government hospitals in the district.

Table 6 highlights the kind of health infrastructure in Deoria district. It has one District hospital, 9 community health centers, 15 primary health centers, 61 additional primary health centers, 317 sub centers, 49 Ayurvedic hospitals and 27 Homeopathic hospitals (District Profile Deoria: 2010).

Table 6. Health Infrastructure in Deoria District

Health Facility	Number
District Hospital Male/Female	1
Community Health Centre	9
Primary Health Centre	15
Additional Primary Health Centre	61
Anganwadi Centers (AWCs)	2,513
Sub Centers	317
Female Hospital	1
Ayuryedic Hospital	44
Homeopathic Hospital	27
ANM Training School	1

(District Profile Deoria, 2010)

Table 7 highlights the health infrastructure in Dumari village. It has one government hospital, 4 private clinics, and 5 medical stores. Number of anganwadi workers and Asha are 4 and only 1 nurse was there (through Sarpanch of the Dumari village, 2011).

Table 7. Health Infrastructure in Dumari Village

Health Facilities	Number
Government Hospital	1
Private (Clinic) Hospital	4
Medical Stores	5
Anganwadi Worker and Asha	4
Nurse	1

(Source: Village Sarpanch of Dumari Village, 2011)

3.6 Health Man Power in the Deoria District

Table 8 shows the total health manpower in Deoria district. It has 196 medical officers. There are 87 Pharmacist; 190 male and female health supervisors, 544 health male and female workers and 2495 accredited social activist (www.nrindia.org>Activities>Uttar Pradesh, 30 Nov 2010 and District Profile Deoria, 2010).

Table 8. Health Man Power in the Deoria District

Category	Approved Number	In Position
Medical Officers	196	136
Pharmacist	87	84
Health Supervisor Male	104	40
Health Supervisor Female	86	83
Health Worker Female	160	21
Health Worker Male	384	383
Non Medical Supervisor	10	8
Accredited Social	51	53
Accredited Social Activist	2,495	2,495

(Source: www.n/rIndia.Org>Activities>Uttar Pradesh, 30th Nov 2010, (DP) District Profile Deoria, 2010)

3.7 Availability of Medicine in Government Hospital

Table 9 shows that, 158 (73.14 per cent) women told that medicines are available in government hospital. Only 10 (4.62 per cent) women told that medicines are not available in government hospital whereas 48 (22.22 per cent) women didn't responded.

Table 9. Availability of Medicine in Government Hospital

Availability of Medicine in Government Hospital	Number of Respondents	Percentage
Yes	158	73.14
No	10	4.62
No Response	48	22.22
Total	216	100,00

3.8 Source of Drinking Water

Drinking water quality is important in deciding health of a person as many water born diseases of human beings are related to it. In rural areas of eastern Uttar Pradesh presently hand pumps are almost sole source of drinking water. Governments have provided deeper strata of underground water which is considered safer.

Table 10 shows that about 200 (92.59 per cent) women respondents informed that they drink water from hand pump, 9 (4.16 per cent) respondents said that they drink water from well. Only 7 (3.24 per cent) of them had drinking water from tube well and government drinking water supply was not available to respondents.

Table 10. Source of Drinking Water

Source of Drinking Water	Number of Respondents	Percentage
Well	9	4.16
Hand Pump	200	92.59
Tube Well	7	3.24
Water Supply of Govt.	0	-
Total	216	100,00

3.9 Toilet Facility

Sanitary facilities and safe toilet disposal system is also a major criteria for women health and important in preventing many infectious diseases related to sanitation exposures. However, good quality toilets are still not available to many families in this part of the rural India.

Table 11 shows that most of the women, 100 (46.29 per cent) conveyed that they don't have any toilet facilities in their house while 94 (43.51 per cent) said that temporary arrangement has been made in their houses. Only 22 (10.18 per cent) respondent's families have permanent structure for toilet.

Table 11. Availability of Toilet Facility

Availability of Toilet Facility	Number of Respondents	Percentage
Temporary	94	43.51
Permanent	22	10.18
Not Available	100	46.29
Total	216	100,00

3.10 Type of Health Services Provider

The present inquiry tries to understand the health delivery system and utilization pattern system in the studied area. The data for the inquiry are related to the rural communities of Dumari village in Deoria district of eastern Uttar Pradesh. The official poverty line-is nothing short of poor quality of life in Uttar Pradesh despite the state being endowed with abundant natural resources. Among Indian states, Uttar Pradesh has some of the worst health indicators. For every 1,000 babies born, 73 die within a few days. Many of the health problems of Indian women are related to or exacerbated by high level of fertility. However, there are large variations in fertility level according to education,

religion, caste and place of residence. Fertility rate in Uttar Pradesh is 3.8, the most populated states in India have a total fertility rate of over 4 children per women. Overall 100,000 Indian women die every year due to pregnancy related factors.

It is clear from the table 12 that during sickness, 204 (94.44) women go to government hospital, 6 (2.77 per cent) didn't, 8 (3.07 per cent) didn't respond about this. 130 (60.18 per cent) use allopathic hospitals, 80 (37.03 per cent) didn't. 20 (9.25 per cent) uses homeopathic hospitals, 168 (77.77 per cent) didn't. 60 (27.77 per cent) uses ayurvedic hospital, 114 (66.66 per cent) didn't. 62 (28.70 per cent) used maternity homes, 144 (66.66 per cent) didn't, 20 (9.25 per cent) didn't respond about this. 120 (55.55 per cent) go to doctor, 92 (42.59 per cent) didn't, 90 (4166 per cent) call midwife, 106 (49.07 per cent) didn't, 20 (9.25 per cent) didn't respond about this, 148 (68.51 per cent) call Anganwadi worker, 62 (28.70 per cent) didn't, 6 (2.77 per cent) women didn't respond about this, 28 (12.96 per cent) use other organization services.

Table 12. Type of Health Services Provider

Type of Health Service Provider	Number of Respondents			Total Percentage
	Yes	No	No Responses	
Government Hospital	204 (94.44)	6 (2.77)	8 (3.07)	216 (100,00)
Allopathic Hospital	130 (60.18)	80 (37.3)	6 (2.77)	216 (100,00)
Homeopathic Hospital	20 (9.25)	160 (77.77)	28 (12.96)	216 (100,000
Ayurved Hospital	60 (27.77)	114 (66.66)	12 (5.55)	216 (100,00)
Dispensary	80 (37.03)	124 (57.40)	12 (5.55)	216 (100,00)
Maternity Home	62 (28.70)	144 (66.66)	20 (9.25)	216 (100,00)
Doctor	120 (55.55)	92 (42.59)	4 (1.85)	216 (100,00)
Midwife	90 (41.66)	106 (49.07)	20(9.25)	216 (100,00)
Anganwadi worker	148 (68.51)	62 (28.70)	6 (2.77)	216 (100,00)
Others	28 (12.96)	78 (36.11)	110 (50.92)	216 (100,00)

In the villages, water is mostly obtained from the hand pump. Drinking water quality is detrimental in deciding health of person as many water-borne diseases of human being are related as majority of them don't have any toilet facility in their house. Even toilet facility is not available to many families in this part of rural India. Most of the women are using government hospitals during pregnancy and for other health related issues as they are not in a position to pay hefty bills of the private hospitals. Further, to understand the needs of the people in terms of health care, the availability of physician or doctors was the most important items of the analysis.

Health is an important aspect for the survival of human. The concepts, knowledge, skills and infrastructure for healthcare have been evolved through the evolution of human civilization in various societies. However, due to gender bias the health priorities for men and women have been different in different traditions and different societies. Thus, this study makes an attempt to understand the problems related to women health.

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www.n/India.Org Activities Uttar Pradesh 30 Nov 2011 Graph 1, 2 and 3: Essential Leprosy Indicators of Deoria profile Deoria.

RESEARCH ARTICLE

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Student Practices on Internet in Engineering Colleges in the District Solan, Himachal Pradesh (India)

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ABSTRACT

An essential element of Internet literacy for college students is the ability to locate, select, evaluate, synthesize, and cite sources in their study. This study began with the assumption that there are stumpy Internet competency and a big digital divide among the students in the engineering colleges in Solan District of Himachal Pradesh, (India). A survey was conducted to know the student practices on Internet. A questionnaire was designed and distributed to 480 students. After filling up, a total of 424 questionnaires with a response rate of 87.2% were received. The objective of this study was to identify the preferred criteria of using the Internet in the engineering colleges. This paper examines the digital competencies of the students and discusses on different aspects of Internet usage. However, the study limits only a few colleges, yet it represents an overview of the real condition and impact in broader prospects.

1. INTRODUCTION

The Internet has emerged as the most powerful tool for an instant access to information where information is just a 'finger touch' away from the end user and it has become the biggest global digital information library that provides the fastest access to information promptly at anywhere and anytime (Kumar and Kaur 2005). It influenced the information seeking behavior of users, where maximum information gained through online sources rather through the conventional information sources. According to Luambano and Nawe, 2004,The Internet enables access to a wide range of information, such as up to date research reports, current trends, etc. for the scholars. Academic institutions disseminate information amongthe audience around the globe through web sites and provides a way to search and organize output (Biradar, et al. 2006). There are various search techniques available that help to find the most precise and relevant information. In this study, an attempt has been made to know what the techniques of information searching and retrieval are being used by the students among the engineering colleges. Madhu Rani (2007) revealed that Boolean logic, truncation, and wildcards are the most often used search techniques, while web directories, subject gateways are least used navigational tools for information retrieval. An academic library can play an important role to make the student aware of the Internet searching techniques. Particularly, by organizing orientation and information literacy programs on how to access electronic resources. Faizul Nisha and Ali, (2013) in a study originated that most of the users were aware of e journals and they were not only using them for building and updating their knowledge but also for collecting relevant material for their study and research. Further, Faizul Nisha and Ali, (2013) also found that aim of consulting electronic journals includes: retrieving information to publish their research papers and manuscripts, assignments, presentations, seminars, and largely to update their knowledge. The study focused on finding out challenges, issues and problems associated with Internet use and discussing remedies. Use of Internet in the educational institutes comprises several problems and influences. Madhusudhan (2007); and Faizul and Ali (2013) discussed that slow Internet speed, inadequate computers with Internet facilities, fatigue and lack of training, etc. are

the major problems associated with the use of Internet. The purpose of this paper is to analyze the techno-educational background of the district.

Although engineering colleges are playing a significant role in imparting technical education in the region and the students in undergraduate engineering colleges have extensive exposure to technology, yet many students do not gain proficiency especially in computer technologies. The recent technological changes forced to adopt the new technologies in education. The origin of smart classrooms, interactive- online discussions, and online submission of an assignment, etc. are usual for a student nowadays, therefore, the educators would expect from the students to be technologically proficient (Kumber and Shirur, 2003). The study reveals how the region influenced with these changes, especially in engineering education. In the era of information explosion, students are depending more and more on the Internet resources for their educational needs and spending a considerable amount of their time for teaching, learning and research on The Internet. Even, the government offering considerably good financial assistance to the educational institutions and these colleges also invest a good amount on Internet facilities from their budget. In this situation, the study seems relevant to find out role, importance and how the internet is being used by these institutions. Therefore, the investigation focused on the students enrolled in the Engineering intuitions in Solan, a district in Himachal Pradesh (India) that came into existence on 1st September 1972. During last decade, several private and public educational institutes came into existence, serving the society and imparting education. (H.P.Govt. http://himachal.gov.in/).

2. SCOPE OF THE STUDY

The present study covered the following engineering colleges offering degree level courses and functioning within the jurisdiction of the State of Himachal Pradesh (India), particularly in the district Solan. The four educational institutes namely *Green Hills Engineering College* (GHEC), *L.R. Institute of Engineering and Technology* (LRIET), *Baddhi University* (BU), and *Shoolini University* (SU) were selected for the study. Since these institutions have good reputation and impact on the local regional population. Moreover, these institutes setting up bench marks in the

Table 1. Profiles of the Engineering Institutes under Study

S. No.	Name of College	Year of Establishe ment	Address	Website	Email
1	Green Hills Engineering College, Gandhi gram, Kumarhatti, Nahan Road, P.O. Bohli,Distt. Solan (HP)	2003	Nahan Road, Gandhigram, Kumarhatti P.O. Baholi, District Solan – 173229 Himachal Pradesh, India Telephone: +91-1792-645771-72, 266772-73, 266097, Fax: +91-1792-266086	http://www.ghec.co.in	E-mail: contact@ghec.co.in
2	L.R. Institute of Engineering & Technology, Village Jabli-Kyar, P.O. Oachghat, Sultanpur Road, Distt. Solan. (H.P.)	2004	Village Jabli Kyar, PO Oachghat, Distt. Solan H.P. Contact No: 01792-252851,252852	http://www.lrinstitutes.com/edabt.php	info@lrinstitutes.com
3	School of Engineering & Emerging Technologies (SEET) Baddi University	2002	Baddi, Distt. Solan, PIN: 173205 Himachal Pradesh, India Contact No: 01795-247353, 247884 Fax No. 01795-247352	http://www.baddiuniv.ac.in/	registrar@baddiuni.ac.in
4	Institute of Engineering and technology. Shoolini University	2012	Bajhol,Solan-Oachghat-Kumarhatti HighwayPost Box 9, Head Post Office, The Mall,	http://shooliniuniversity.com/	info@shooliniuniversity.com

Engineering education, therefore, these were selected for the present study. The brief profiles and the subject branches offered by these institutes are given below in Table1 and Table 2 respectively.

Table 2. Engineering Branches offered by the Institutes of Study

S. No.	Course	Name of Institutes			
		GHEC	LRIET	BU @	SU
i	Applied Sciences	A	A	A	-
ii	Bioinformatics	-	-	-	A
iii	Biotechnology	-	-	-	A
iv	Civil Engineering	A	A	A	A
v	Computer Application	-	-	A	-
vi	Computer Science	A	A	A	A
vii	Electrical Engineering	A	A	A	A
viii	Electronic and Communication	A#	A	A	A
ix	Food Technology	-	-	-	A
x	Information Technology	A	-	A	-
xi	Mechanical Engineering	A	A	A	A
xii	Nanotechnology	-	-	-	A
	Total	07	06	08	09

Electronic Engineering, @ Under School of Engineering and Emerging Technologies (SEET), A= Available.

3. OBJECTIVES

The present study is an attempt to find out the pattern of using the Internet to the students of engineering colleges. The study was conducted with the following objectives:

1. To know the frequency, time consumed and periodicity of using the Internet by the students in engineering institutesin the district under study.
2. To identify the Internet resources, services and search techniques used to accessthe internet.
3. To identify the purpose, tools and the most preferred internet browser and preferred location using to access the internet.
4. To examine the influence of Internet on students and satisfaction from the available facilities and infrastructure for internet facility.
5. To identify the problems encountered by the students using the Internet.

4. RESEARCH METHODOLOGY ADOPTED

Students of the Bachelor of Technology (B. Tech.), Master of Technology (M. Tech.) and Ph.D. Research Scholars studying under different subject branches at the *Engineering* institutes in district Solan of Himachal Pradesh was the population for this study. Since it was a large population, hence, the random sampling was adopted to collect data for the study. The received data has been processed, analyzed and presented in the tabulation form. The study is based on survey methods of research, conducted using questionnaire and interviews. A questionnaire was administered to a convenience sample of 480 undergraduate, postgraduate students and Ph.D. scholars. Total 120 respondents were randomly selected from each Engineering college under study. Questionnaires were distributed physically and the duly filled questionnaires were received from the respondents from January 2015 to June 2015. A total of 424 duly filled questionnaires with a response rate of 88.4% were received from the respondents. Since the region is geographicallyscattered, therefore, wherever required, e-mail notifications, interviews and schedule for thesurvey were also used to get requisite information. It is stated that for the convenient of the study, the words respondents, users and students while the words institutes, colleges, and university are used interchangeably in this study.

5. ANALYSIS,INTERPRETATION, AND DISCUSSION

I. RESPONDENT DEMOGRAPHY

The study covered the students of *engineering* institutes available in the district Solan, Himachal Pradesh, India. The limitations of this study include the use of a convenience sample, and the unequal representation of gender *(Male = 63.4%, Female = 36.6%).* The analysis of the responses received from the sample population is given below under subsequent Tables. The gender wise distribution is given in Table 3.

During the analysis of responses, the categories of the users were identified and presented in Table 3. The table reveals that 51.6% respondents were *Under Graduate*, while 36.5% were *Post Graduate*, whereas 11.9% were *Research Scholars* among the population selected randomly. A total of 63.6% respondents were *Male* while 36.6% were *Female* respondents who participated in this study. In the continuation, the subject branch wise details of the respondents were also identified which is given below in Table 4.

Table 3. Category and Gender –wise breakup of Respondents

S. No.	Category	Name of Institutes								Grand Total			Percentage
		GHEC		LRIET		BU		SU					
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Category	
i	UG Students	45	10	25	16	47	17	36	23	153	66	219	51.60%
ii	PG Students	20	11	26	24	19	16	25	14	90	65	155	36.50%
iii	Research Scholars	7	9	6	4	11	3	2	8	26	24	50	11.90%
Total		**72**	**30**	**57**	**44**	**77**	**36**	**63**	**45**	**269**	**155**	**424**	
Percentage		70.50%	29.50%	56.40%	43.60%	68.10%	31.90%	58.30%	41.70%	63.40%	36.60%	100%	

The Table 4 shows that the respondents belong to different filed of engineerings such as *Computer Science*, *Civil Engineering*, *Electrical Engineering, Information Technology* and *Mechanical Engineering* who have contributed and participated largely in the study than other branches *Food Technology* and *Nanotechnology*.

II. USE OF INTERNET

This study is based on an investigation of students who are usingThe Internetamong the selected Engineering institutes in district Solan, of Himachal Pradesh. The analyses of the responses received through questionnaire are presented in the subsequent tables.

Table 4. Subject Branch-wise Break-up of Respondents

Courses	Respondents				Total	
	Male	%	Female	%	No.	%
Applied Sciences	17	6.31	6	3.87	23	5.4
Bioinformatics	20	7.43	6	3.87	26	6.1
Biotechnology	4	1.48	9	5.8	13	3
Civil Engineering	41	15.24	18	11.61	59	13.9
Computer Application	4	1.48	2	1.29	6	1.4
Computer Science	46	17.1	26	16.77	72	16.9
Electrical Engineering	40	14.86	18	11.61	58	13.6
Electronic and Communication	25	9.29	12	7.74	37	8.7
Food Technology	2	0.74	12	7.74	14	3.3
Information Technology	25	9.29	27	17.41	52	12.2
Mechanical Engineering	35	13.01	14	9.03	49	11.5
Nanotechnology	10	3.71	5	3.22	15	3.5
Total	**269**		**155**		**424**	

5.1. Experience of Internet Use

To know how longer the students using The Internet, five options (as given in Table 5) were given to the respondents. The analysis in Table 5 reveals that 30.66% respondents are using The Internet from *2 to 4 years* while 28.53% from *more than four y*ears whereas 23.11% respondents using from *1 to 2 years*. The Table also reveals that 7.3% new users of the internet who are using the internet from *less than six months.*

Table 5. Experience of Internet Use

Experience	Respondents				Total	
	Male	%	Female	%	No.	%
Less than 6 months	16	5.94	15	9.67	31	7.31
6 months to 1 year	22	8.17	22	14.19	44	10.37
1 to 2 years	56	20.80	42	27.09	98	23.11
2 to 4 years	83	30.85	47	30.32	130	30.66
More than 4 years	92	34.20	29	18.70	121	28.53
Total	**269**	**100**	**155**	**100**	**424**	**100**

5.2. Frequency of Internet Use

In response to the frequency of Internet use the Table 6 reveals that majority of *Male* (68.77%) and *Female* (85.8%) use *Daily*. While overall responses show that 75% of respondents use the Internet *Daily*. This indicates that The Internetis becoming the 'life line' of the college students. It also shows that The Internet is becoming a useful and important tool to access information in an academic institution. Such amount of internet use forced the college

Table 6. Frequency of Internet use

Frequency	Respondents				Total	
	Male	%	Female	%	No.	%
Daily	185	68.77	133	85.8	318	75
2 -3 Times in a Week	43	15.98	10	6.45	53	12.5
Every Week	28	10.4	8	5.16	36	8.4
Twice a Month	7	2.6	4	2.5	11	2.5
Once in a Month	4	1.48	0	0	4	0.9
Occasionally	2	0.74	0	0	2	0.4
Total	**269**	**100**	**155**	**100**	**424**	**100**

administration to support and fulfil appetite of the students for internet use. The Table also reveals that only 12.5% respondents' use internet *2 to 3 times in a week*. Whereas, there is very less response of the respondents who use the Internet *once in a month* and *occasionally* as the responses could not reach in double digits. In an educational institution, it is rare to find a student who occasionally use the internet since students depend on the internet up to a large scale.

5.3. Amount of Time Spent on the Internet Use

To find out how much time these users spend on Internet use per day, a question, containing four options (as given in Table 7) was asked. Table 7describes that 43.1% of the respondents use the Internet for *2-4 hours per day*, 23.8% for *5-7 hours per day*, 17.2% *more than7 hours*, however, only 15.8% use the Internet for *less than 2 hours* per day. This is a significant number of respondents who use the Internet from 5 to more than 7 hours that indicates a kind of addiction. It is a serious concern about which the administration should take adequate steps because it may harmful for the students.

Table 7. Amount of Time spent on the Internet Use.

Amount of Time Spent	Respondents				Total	
	Male	%	Female	%	No.	%
< 2 Hours/ Day	32	11.8	35	22.5	67	15.8
2- 4 Hours/Day	121	44.9	62	40	183	43.1
5 -7 Hours/Day	67	24.9	34	21.9	101	23.8
>7Hours/Day	49	18.2	24	15.4	73	17.2
Total	**269**	**100**	**155**	**100**	**424**	**100**

5.4. Location of Internet Use

The analysis in Table 8 reveals the location preferred by the students for access Internet. The majority of the respondents i.e. 70.7% preferred to access the internet at their colleges, whereas 20.7% respondents access the internet at their homes although only 8.4% respondents preferred other places such as *cyber café*. Since colleges provide them adequate facilities and IP-based resources for their educational need, therefore, it is essential for the student to access the internetin the colleges itself. It is clear by the responses that colleges has utmost pressure for internet use. Hence, they need to support and ensure internet facilities. As it proved that the internethad become an essential part of academic set up, that has multiple uses.

Table 8. Most Frequently used Location of Internet Use

Location	Respondents				Total	
	Male	%	Female	%	No.	%
College	190	44	135	40	325	42.3
Home	157	36.4	148	43.9	305	39.7
Any Other	84	19.4	54	16	138	17.9
Total	**431**		**337**		**768**	

In the continuation, a multiple choice option (as in Table 9) to know the most preferred place in the college was also given. The analysis in Table 9 reveals that 66% respondents preferred *Computer Center* to access Internet while, 57% preferred *Library*. This shows that the *Library* also has a significant place popular among users along with computer center to support Internet access and academic activities. However, the *Departmental Computer Lab* is also used by 17.6% respondents. The responses show that these places in the colleges are the hub to access The Internet and these especially libraries must be equipped with the

Table 9. Preferred Place for Using the Internet in the Institutes

Place of Access The Internet	Respondents				Total	
	Male	%	Female	%	No.	%
Computer Center	236	40.1	133	39.8	369	40
Departmental Lab	95	16.1	68	20.3	163	17.6
Library	210	35.7	108	32.3	318	34.4
Any other	47	7.9	25	7.4	72	7.8
Total	**588**		**334**		**922**	

latest technological instruments for learning and research.

5.5. Tools for Browsing Internet

The analysis in Table 10 illustrates that maximum of respondents (i.e. 44.5%) used *Desktop* while *Laptop* used by 12.7% respondents to access The Internet. Use of *Mobile* used by 35.9% *Female* and 32.9% *Mal*e respondents that indicate the incremental change in the trend of using latest gadgets for Internet use. However, for accessing The Internet from the *Tablet* are also noticed that is used by 9.9% and 13% among *Male* and *Female* respectively. It is expected that the use these small gadgets will increase in the near future.

Table 10. Tools for Browsing Internet

Tools for Internet use	Respondents				Total	
	Male	%	Female	%	No.	%
Desktop	210	44.5	123	46	333	45.1
Laptop	59	12.5	35	13.1	94	12.7
Mobile	155	32.9	96	35.9	251	34
Tablet	47	9.9	13	4.8	60	8.1
Total	**471**		**267**		**738**	

5.6. Web Browser for Use to Access Internet

Table 11 discloses that 79% respondents use *Mozilla Firefox*, 57% *Google Chrome*, 15.3% *Internet Explorer* whereas 14.1% respondents use *Opera* browsers to access The Internet. However, the responses received under any other options show that *Netscape* and *UC Browser* are also used up to some extent. The responses indicate that the *Mozilla Firefox* browser is the most preferred by the engineering students. The Mozilla browser is freely available in open source environment that getting popularity among students.

Table 11. Frequently Used web Browsers

Web Browser Used	Respondents				Total	
	Male	%	Female	%	No.	%
Google Chrome	172	63.9	70	45.1	242	57
Internet Explorer	25	9.2	40	25.8	65	15.3
Mozilla Firefox	229	85.1	106	68.3	335	79
Opera	35	13	25	16.1	60	14.1
Any other	22	8.1	3	1.9	25	5.8
Total	**461**		**241**		**702**	

5.7. Purposes for Internet Use

To know the purpose of using The Internet, a multiple choice question was asked in which nine possible purposes were given. Table 12 depicts that all the respondents' use Internet primarily for their *Education* as it received 100% response. While 77.1% respondents use Internet significantly for *Chatting* while 67.4% for checking *Email*, 63.2% for *Finding Information*, 44.8% for *Reading News*, 42.9% for *Downloading Multimedia* files such as music, lecture videos, etc. A trend for *Online Shopping* and *Playing games* on The Internetis noticed from the Table 12. The college and Library administration together need a check and balance to restrict the objectionable download in the campus.

Table 12. Purposes for Internet Use

Purpose for Internet use	Respondents				Total	
	Male	%	Female	%	No.	%
Chatting	215	79.9	112	72.2	327	77.1
Download Multimedia	101	37.5	81	52.2	182	42.9
Education	269	100	155	100	424	100
E-Mail	240	89.2	46	29.6	286	67.4
Finding Information	144	53.5	124	80	268	63.2
Online Shopping	54	20	14	9	68	16
Play Games	32	11.8	22	14.1	54	12.7
Reading News	145	53.9	45	29	190	44.8
Research for Dissertation	96	35.6	14	9	110	25.9
Total	**1296**		**613**		**1909**	

5.8. Use of Internet Resources

The main purpose of installation of computer facilities in the libraries is to access electronic resources available in different formats. In the present study, an attempt has made to find out the usage of electronic resources by the respondents. Table 13 indicates that 29.2% of the respondents use the Internet for consulting *Databases*, 25.3% for access and download *e-Journals*, 13.7% for viewing *Theses and Dissertations*, 5.3% for *e-Books,* 12.1% for conference proceedings, 13.9% for theses and dissertations. The number of respondents who use the Internet for consulting *Technical Reports* and *Standards*

Table 13. Use of Internet resources

Use of Internet Resources	Respondents				Total	
	Male	%	Female	%	No.	%
Conference Proceedings	74	12.3	59	11.8	133	12.1
Databases	183	30.6	138	27.6	321	29.2
E-books	24	4	35	7	59	5.3
E-journals	154	25.7	124	24.8	278	25.3
Standards and Patents	14	2.3	32	6.4	46	4.1
Technical Reports	67	11.2	42	8.4	109	9.9
Theses and Dissertations	82	13.7	69	13.8	151	13.7
Total	**598**		**499**		**1097**	

and *Patents* are significantly less i.e. 9.9% and 4.1% respectively. The analysis suggests that Libraries need to build up their reference collection.

5.9. Awareness of Search Techniques

Since the user finds it difficult to search their relevant information, therefore, an attempt to find out whether they are aware of different search techniques has made. Table 14 highlights that majority (i.e. 90%) of the users search their information on the internet by *Keywords* that knew as *Basic search*. However, the *Phrase Search* technique is also used by 44.3% respondents whoare further an extension of the basic search. 35.1% users use the Advance Search option, rest searches i.e. *Truncated and Boolean* searches are least used by the user and ranges those received 5.1% to 20% response respectively. There is a need of orientation among the students about searching and information retrieval techniques on the internet.

Table 14. Awareness on Search Techniques

Search Technique	Respondents				Total	
	Male	%	Female	%	No.	%
Basic (Keywords)	247	91.8	135	87	382	90
Boolean	57	21.1	28	18	85	20
Truncated	17	6.3	5	3.2	22	5.1
Phrase	145	53.9	43	27.7	188	44.3
Advanced	83	30.8	66	42.5	149	35.1
Any other	19	7	4	2.5	23	5.4
Total	**568**		**281**		**849**	

5.10. Use of Internet Services

Keeping in mind the objectives of this study, a question about the use of internet services used by the students was asked to the respondents. There were eight most preferred services were identified and given in the questionnaire. The responses received are given in Table 15.

Table 15 shows that *e-mail* is the most popular service among the respondents. All of the respondents use the Internet for checking and sending e-mails followed by *Chatting* (76.8%), the World Wide Web used by 72.6% respondents whereas *File Transfer Protocol* used by 70.2%

Table 15. Use of Internet Services

Internet Services	Respondents				Total	
	Male	%	Female	%	No.	%
Chatting	216	50.9	110	7.1	326	76.8
Download Multimedia	102	24	48	42.9	150	35.3
Electronic Mail (E-mail)	269	63.4	155	100	424	100
File Transfer Protocol (FTP)	240	56.6	58	9	298	70.2
Frequently Asked Questions (FAQs)	145	34.1	80	67.4	225	53
Information Bulletin Board	56	13.2	39	63.2	95	22.4
Discussion on Social Networking	35	8.2	16	16	51	12
World Wide Web	155	36.5	153	12.7	308	72.6
Total	**1218**		**659**	44.8	**1877**	

and 53% respondents used for *Frequently Asked Questions*. The use of the other services such as *Download Multimedia*, *Information Bulletin Board,* and *Discussion on Social Networking* ranges from12% to 35.3%. The table reveals that email and chatting are the integrated elements of internet services for users for which the students access Internet.

5.11. Site Preferred for E-mail

As discussed above, that the email is one the most used services on Internet, therefore, it is essential to know the most favorite email site that used by the respondents. Table 15 discloses that *Gmail* is the most preferred site for the email account on the internet that is used by 84.6% respondents. However, the *Yahoo* email service that received 57.7% responses also popular among respondents. Whereas, other email sites are relatively least preferred by the users that range from13.2% to 31.7%. *Gmail* is the most

Table 16. Site Preferred for e-mail

Preferred Email	Respondents				Total	
	Male	%	Female	%	No.	%
Gmail	239	88.8	120	77.4	359	84.6
Hotmail	40	14.8	16	10.3	56	13.2
Rediff mail	76	28.2	58	36.9	134	31.6
Yahoo Mail	150	55.7	95	60.9	245	57.7
Any other	60	22.3	21	12.9	81	19.1
Total	**565**		**310**		**875**	

user-friendly and interactive services that and provides additional facilities to its users. The response received under any other option reveals that *the respondents also use Indiatime*s.

5.12. Problems faced by the Users

One of the main purposes of s of this study is to find out the major problems faced by the students during internet use. By the preliminary literature search, major problems associated with the internet were identified, those are listedinTable 17.

Table 17 highlights that using the Internet is not free from problems. The majority (71.6%) of the respondents believe that *Slow Speed* of the Internet is the major problem for respondents while using the Internet. Slow Internet access speed takes a lot of their slotted time to retrieve the relevant information. Another important problem faced by

Table 17. Problems Faced by the Users

Problems	Respondents				Total	
	Male	%	Female	%	No.	%
Slow Speed of Internet	176	65.4	128	82.5	304	71.6
Data Security	179	66.5	106	68.3	285	67.2
Authenticity of Information	118	43.8	75	48.3	193	45.5
Privacy Problem	49	18.2	109	70.3	158	37.2
Difficulty in finding information	46	17.1	86	55.4	132	31.1
Overflow of Information	56	20.8	55	35.4	111	26.1
Missing of desired webpage	36	13.3	43	27.7	79	18.6
Total	**660**		**602**		**1262**	

the (67.2%) users is related to *Data Security*. Whereas, 45.5% users believe that *Authenticity of Information* is not sure over The Internet. The table also shows that *Overwhelming of Information* over Internet caused *Difficulty in finding* relevant information. However, the majority of female respondents feels that *Privacy* is a significant problem while using The Internet. The above-mentioned problem are natural phenomena associated with The Internet, although up to some extent these problems may be reduced, depend upon the administration.

5.13. Benefit of Internet over Conventional Documents

Although, there are problems with internet use, yet there are lots of benefits. To know the benefits of the internet, several possible benefits were identified and included in the questionnaire as multiple choice option. These are given below in Table 18.

Table 18 exhibits that more than 80% of the respondents feel that in comparison to conventional documents, the Internet is *Easy to Use* (87.2%), more informative (99.7%), *Time Saving* (100%) and *More Useful*(91.9%) and 58.4% of the respondents admit that it is less expensive in comparison to conventional documents.However, 62% of respondents preferred Internet resources than traditional documents for their study. 50% respondent believe that the Internet covered the latest information on their relevant subject. The Table also reveals other important benefits of the internet such as Anywhere, Anytime and quick access to information, etc.

5.14. Influence of the Internet on Academic Efficiency

The internet has influenced every aspect of human life from birth to death where birth and death certificates are issued and verified online.

The table 19 reveals the influence of Internet use and find that *Anywhere, Anytime Access to Information* and *Easy Sharing of Information* are the major influences that responses by 17.9% respondents. However, 16% respondents think that due to the availability of latest and instant access to information on the Internet, *Dependency on The Internet has increased*. Whereas 15.1 % respondents' response that the influence of Internet resulted regarding *Fatigue and Sleeping Problems*. The table also reveals some positive that included *E-Access to Library Resources* and *More Research Output* in a prompt manner. Many of the respondents' responses that the Internet has improved their *Professional Competence*, and also admit that The Internet has expedited their research process promptly. However, the advent of Internet resulted in increased facilities such as readymade syllabus for the

Table 18. Benefit of Internet over Conventional Documents

Benefit	Respondents				Total	
	Male	%	Female	%	No.	%
Covered latest information	175	65	37	68	212	50
Easy to use	244	90.7	126	46.8	370	87.2
Less expensive	92	34.2	156	47	248	58.4
More Informative	235	87.2	188	69.8	423	99.7
More preferred	175	65	88	32.7	263	62
More useful	216	80.2	174	64.6	390	91.9
Time saving	219	81.4	205	76.2	424	100
Any other	37	13.7	104	38.6	141	33.2
Total	**1393**		**1078**		**2471**	

students which is available to consult frequently that resulted in decreased in the habit of searching hard copies of library resources. Nowadays, students preferred to seat before their Computers and Laptops rather go outside for physical activities and reading books in the Library. They kept a library within their pen drive and access whenever they want. Earlier, using the internet was assumed to wastage of time, but the result of this study reveal that only 7.4% responses believed that using the internet is Time Consuming. The study reveals that searching is convenient on the Internet.

Table 19. Influence of Internet on Academic Efficiency

Influence of Using The Internet	Respondents				Total	
	Male	%	Female	%	No.	%
Anywhere, Anytime Access to Information	201	17.5	137	18.6	338	17.9
Easy Sharing of Information	210	18.3	128	17.3	338	17.9
Dependency on Internet Increased	185	16.1	117	15.8	302	16
Fatigue and Sleeping Problems	179	15.6	106	14.4	285	15.1
E-Access to Library Resources	148	12.9	95	12.9	243	12.9
More research output	100	8.7	51	6.9	151	8
Time Consuming	78	6.8	62	8.4	140	7.4
Convenient Searching	46	4	40	5.4	86	4.5
Total	**1147**		**736**		**1883**	

5.15. User Satisfaction with Internet Facilities

Since the government as well as the educational institutes, invest a huge amount in building infrastructure in providing internet services, hence, it seems appropriate to know about the satisfaction among the students about available infrastructure and services under the engineering colleges. This study provides an overview of the satisfaction level of the students.

Table 20 confirms that the majority i.e. 89.3% of respondents are *Least Satisfied* with the Internet facilities being provided by these institutions in the district as this received rank 1st among the other options. However, there is a large number of students who are *Not Satisfied* with the facilities of Internet among the Engineering Institutes, it received rank 3rd on the other hand, 35.3% respondents are *Strongly Satisfied*with a 4th rankfor the Internet facilities among the engineering institutes under study, however, 83% respondents are *Satisfied* that ranks 2nd for the facilities of the Internet among institutions. It is a mixed response. However, the majority biased towards less satisfaction, hence, the administration of these colleges need to adopt adequate measures to satisfy the users.

6. FINDINGS OF THE STUDY

Nature, age and the qualification of the sample population of the study were mixed. Since they were random sampling for the data collection, hence we received mixed responses too. More than 50% of the respondents were undergraduate. Similarly, there was gender wise unequal distribution that participated in the study. It was also found that many sub-branches of subjects and courses are being offered by these engineering institutes in the district. The micro-classification of the subjects ensures different opportunities for the students. The findings of the questionnaire based responses about the use of the internet is given below:

Table 20. User Satisfaction with Internet facilities

User Satisfaction	Respondents				Total		Rank
	Male	%	Female	%	No.	%	
Least satisfied	260	96.6	119	76.7	379	89.3	1
Not satisfied	121	44.9	85	54.8	206	48.5	3
Satisfied	217	80.6	135	87	352	83	2
Strongly satisfied	100	37.1	50	32.5	150	35.3	4
No comments	32	11.8	29	18.7	61	14.3	5
Total	**730**		**418**		**1148**		

- It is found that maximum students are using the internet from 2 to 4 years' experience and spent 2 to 4 hours daily for internet access. There was a significant percentage of respondents who have more than four years' experience of using the internet. However, it is not clear either they heave internal or external experience. The students' usually spent their 2 to 4 hours daily on the internet. The phenomenon fixed for the students enrolled for 1 to 4 years for 6 to 8 semesters in their complete duration of course.
- The students prefer to access the internet at their respective colleges rather their homes. The computer center is the most preferred place for using the internet among the students of the respective colleges; however, the libraries are also a significant and popular place among students to access the internet. Thus, these places supplement each other for imparting education.
- The majority of the students use desktop computers as a preferred tool to access the internet. However, a trend for using laptops and other gadgets such as mobiles and tablets are also found from the study. As regards to internet browsers, Mozilla Firefox is the most usable browser that is preferred by the majority of the students. Although, Google Chrome and Internet Explorer have also registered its presence among the students.
- It is found that all the students using internet primarily to supplement their education as a whole. It is also found that the students like email services for chatting, checking and sending emails on the internet. Also, the students use internet for another purpose such as chatting, checking and sending emails. It is found that Gmail is the most used electronic mail service which is popular among students. Whereas, Yahoo is also preferred and used by the users. It is found that the electronic databases and e-journals are the main resources concern by the students using Internet in the libraries. However, theses and dissertation, standards and patents and technical reports, etc. are relatively less preferred resources that used on the internet.
- Keyword or basic search for finding information on the internet is most preferred search technique among the students used to search their information. It is found that the students are not aware of other different kinds of search techniques.
- It is found that majority of the students are agreed upon the statement that Internet resources have greater benefits than traditional documents in the libraries.
- The major positive influence of Internet use is that one can access any information from anywhere at any time. Moreover, The Internet has ensured easy sharing of information. However, it caused fatigue and difficulties in sleeping among the students that need to be takencare, and the students should avoid long hours sitting before a computer screen.
- It is found that maximum students are not satisfied with the internet facilities under the institutes. A need of betterment is seemed to be appropriate that could satisfy the students.
- The slow speed of internet, data security and authenticity of information are the major problems found from the study. Privacy is another issue before the majority of the female students.

7. SUGGESTIONS

Based on the observation and findings of the study, the suggestions to improve the use of the internet among the students are as follows:

- The engineering colleges in the district Solan should enhance the computer infrastructure; theespecially server should be strengthened so that a high speed of the internet could be ensured. The administration should focuson the development of the department computer laboratories; this could prevent lots of time of the students.
- The institutions should enhance the use of mobile and its associated technologies for internet use. The management of these institutions should think about the positive use of the internet services like chatting, online gaming, social networking sites, etc. the interactive session through video conferencing should be established under these intuitions.
- The libraries should be given freedom to make the students aware through orientation and information literacy programs on enhancing the use of resources available. This willfacilitate easy and convenient retrieval and location of relevant information.
- The intuitions should ensure the data security and privacy of the users who access the internet in the campus. The institutes should also make awareness about the harms of long hours sitting before the computer screen. The users should restrict themselves and avoid excessive use of the internet.
- The internet should encourage their respective library

to build their electronic collection. Since it is convenient to access and easy to search and use.

- A significant number of students are not satisfied with the internet facilities among the colleges. Hence, the administration should try to identify the reasons to get 100% users satisfaction with internet facilities.

8. CONCLUSION

The use internet in an academic environment has ensured easy and convenient access to information. The internet has become an essential and integral part nowadays that supplement and supported the library resources. The libraries are setting up new facilities in the form of cyber sections and providing users a pleasant atmosphere of accessing online information sources. The technological changes and developments have been noticed in the field of education particularly in engineering education in the region. The population from the neighboring across India are attracting for getting an education from here. The result of the study present before the educational institutions with both opportunities and challenges. The opportunity exists because the guardians think that educational institution is doing a good job regarding internet facilities. This allows the institutions to use the Internet in creative and progressive ways. The challenges exist in the same ways; the parent expectsthat intuition will provide the internet facilities in a well thought out educational values. The fact is that the dependency of both the students as well as institutions depends on the internet. The result also suggests coordination between the computer centers and libraries of the institutions. A common cooperation among the regional libraries should also consider for sharing of online information.

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RESEARCH ARTICLE

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Studies on trends in use of pesticides and fertilizers for tomato cultivation in the vicinity of Lucknow, India

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ABSTRACT

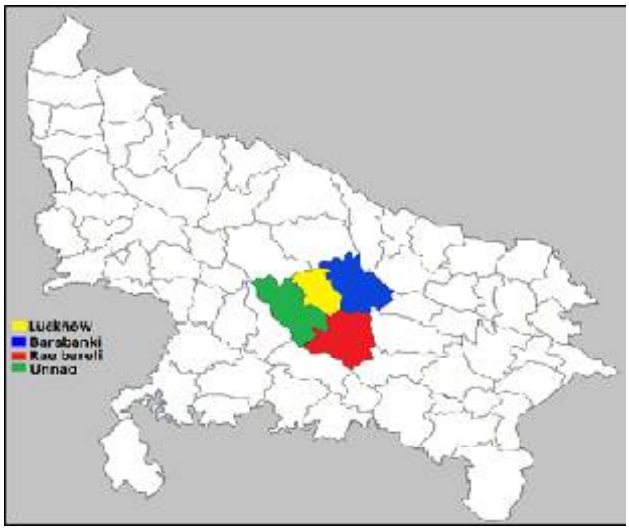
The present work was undertaken to study the trends in use of chemical pesticides and fertilizers for tomato cultivation in vicinity of Lucknow city, India; to gather information regarding knowledge among farmers related to use of biological fertilizers and pesticides; and the constraints faced by them during tomato cultivation through questionnaire based survey. The study revealed the high consumption rate of agrochemicals suggesting farmer's sole dependency on them to protect tomato crop from pests and diseases, and to enhance productivity. The knowledge pertaining to biofertilizers and biopesticides among farmers was negligible. Most of the farmers were either illiterate or having low education level which was the major cause for indiscriminate use of agrochemicals. The area under tomato cultivation was observed to be reduced due to land fragmentation, urbanization, biotic and abiotic stresses. Biotic factors like occurrence of fungal and viral diseases, pest infestation and abiotic factors like scarcity of water, fluctuation in temperature conditions were major reasons for productivity loses.

1. INTRODUCTION

Food security is a prior concern for policy makers of the world. Climate change and gradually depleting non-renewable resources has ramified the problem of adequate food production. India, a developing country is also not unaffected with crisis of food insecurity. Uncertainty in climatic phenomenon, land fragmentation, resource degradation, poor market linkages, low monetary returns to farmers, poor access to technology and lack of knowledge has detrimentally impinged on agricultural production in many states of India. In Western India, yield of many rainfed crops have been reported to be reduced once in three years due to water stress (Raju and Chand, 2010; Kurothe et al., 2014).

India holds second position in tomato cultivation, next to potato among cultivated vegetable crops. Uttar Pradesh is one of the major Indian states that produce tomato. The area for tomato production and its productivity in 2010-2011 was recorded 6690 hectare and 248633 tonnes respectively in U.P. and in Lucknow, 807 hectares and 31159 tonnes respectively, by State Horticulture Mission, Government of Uttar Pradesh (Vanitha et al., 2013). The productivity of tomato is highly influenced by pests and diseases infestation and is also sensitive to environmental stress including very high or low temperature, dry or water logging conditions.

Heavy inputs of agrochemical by farmers in India is a common practice, however, excessive use of agrochemicals has raised questions in terms of sustainability of soil to support plant growth in future. Increasing demand of water for irrigation has raised another question to sustainability of agriculture when water has been a resource for conservation. Negative effects of agrochemicals and scarcity of water with continuously changing environmental conditions has urged to shift toward organic farming practices. But before shifting toward sustainable approach there is a need to understand the problems being faced by farmers, approaches being used by them and their level of knowledge. Keeping in view these aforesaid facts, present study was undertaken on a small scale to analyze the scenario of tomato cultivation with specific objectives: 1) Assessment of agrochemicals loads on tomato fields, 2) Evaluation of factors affecting productivity of tomato and 3) knowledge pertaining among farmers regarding benefits



Map Source: Google

Fig. 1. Map of Uttar Pradesh showing study areas

and use of biofertilizers, biopesticides and safety measure taken during pesticides application.

2. MATERIALS AND METHODS

The primary data was collected through a random field survey based on questionnaire to reveal out the present scenario of tomato cultivation in study area and problems encountered by farmers. Personal interviews with farmers were conducted randomly in and around Lucknow city, Uttar Pradesh, India, including districts Unnao, Raebareli and Barabanki during different tomato growing seasons, 2014-2016. The data collected were statistically analyzed using MS Excel 2007.

3. RESULTS AND DISCUSSION

The data collected from different fields including Mohanlalganj, Chinhat, Bakshi ka Talab, Sarojini nagar blocks of Lucknow district along with other districts comprising Unnao, Raebareli and Barabanki. The sample size of the study was n=97.

3.1. Age and education of farmers

The maximum numbers of farmers growing tomatoes were generally belong to the age group 21-50 years (Table 1).

Table 1. Age group of farmers cultivating tomatoes in vicinity of Lucknow city

Age group (in years)	≥ 20	21-30	31-40	41-50	51-60	>60	Data unavail-able
Percentage (%) of farmers	3.09	22.68	27.84	24.74	13.40	1.03	7.22

The data on education level of farmers presented in table 2. The data show that maximum numbers (~56%) of farmers were illiterate or having education below primary level i.e. having education upto or below 5th grade.

Table 2. Education level of farmers cultivating tomatoes in vicinity of Lucknow city

Education level (in grades)	Illite-rate	≤5th	>5th-8th	High school	Inter-mediate	Gradu-ate	Post gradu-ate
Percentage (%) of farmers	40.21	15.46	15.46	9.28	9.28	9.28	1.03

The data showed that there was a relation between age group and education level of farmers (Fig. 3). The farmers above the age of 30 years were basically having low level of education or were illiterate, however 16% of farmers belonging to age group below 30 years were well educated suggesting that the new generation is actively heading toward education and participating in agricultural activities which could have significant impact on Indian agriculture.

3.2. Area under tomato cultivation and socio-economic status of tomato growers

Through data it was observed that most of the farmers were cultivating tomatoes in small areas. Around 23% data for acreage under tomato cultivation was unavailable. Farmers were growing tomato randomly in small patches. 55.67% of total tomato cultivation was done in area ranged between

Fig. 2. Showing tomato fields and infected plants

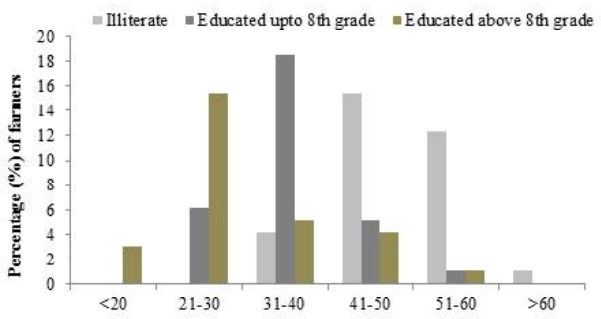


Fig. 3. Showing relation between age group of farmers and education level

1.27 x 10^{-2} – 12.7 x 10^{-2} hectares (Table 3). However, only 2.06% farmers were cultivating tomato in an area above 127 x 10^{-2} hectares.

Table 3. Area under tomato cultivation in vicinity of Lucknow

Area under tomato cultivation (hectare)	≥ 12.7 x 10^{-2}	12.7-25.5 x 10^{-2}	25.5-127 x 10^{-2}	>127 x 10^{-2}	Data unavailable
Percentage (%) of farmers	55.67	4.12	15.46	2.06	22.68

On the basis of survey it was found that land under tomato cultivation in vicinity of Lucknow was reduced due to land fragmentation, plotting of agricultural field for commercial and residential purpose, low productivity and lower market returns. Most of the tomato growers were marginal farmers holding land below one hectares suggesting poor socio-economic status of the farmers.

3.3. Variety of seeds used and timing for cultivation

Hybrid and Non-hybrid, both types of tomato seeds were used by the farmers for cultivation; however hybrid were preferred over non-hybrid (Fig 4a). Around 51% farmers were using only hybrid seeds, 38% farmers were using non-hybrid seeds in their fields and rest 11% farmers were using both hybrid as well as non-hybrid seeds for tomato cultivation (shown as error bar in fig 4a). The choice for variety of seeds preferred was also dependent on availability with ease in the market and timing of cultivation. Data revealed that tomato was cultivated in all three seasons i.e., Rabi, Kharif and Zaid. The most preferred season for tomato cultivation was rabi season (Fig 4b) and seeds sown during months of October-November, may be due to prevailing temperature and humidity conditions suitable for tomato productivity.

3.4 Biotic stress and trends in use of pesticides and fertilizers

Diseases and pests infestation were the most common biotic factors affecting tomato productivity in study areas. Many farmers also reported intervention of Nilgai (*Boselaphus tragocamelus*) in fields destroying crops. The common tomato diseases, use of pesticides by farmers reported in study area and their toxic effect on human as well as on other biota is presented in table 4.

To protect crops from biotic damage farmers were heavily reliant on chemical pesticides. The most common pesticides being used were new generation pesticides including synthetic pyrethroids, organophosphates and carbamates. Indiscriminate use of pesticides was very high.

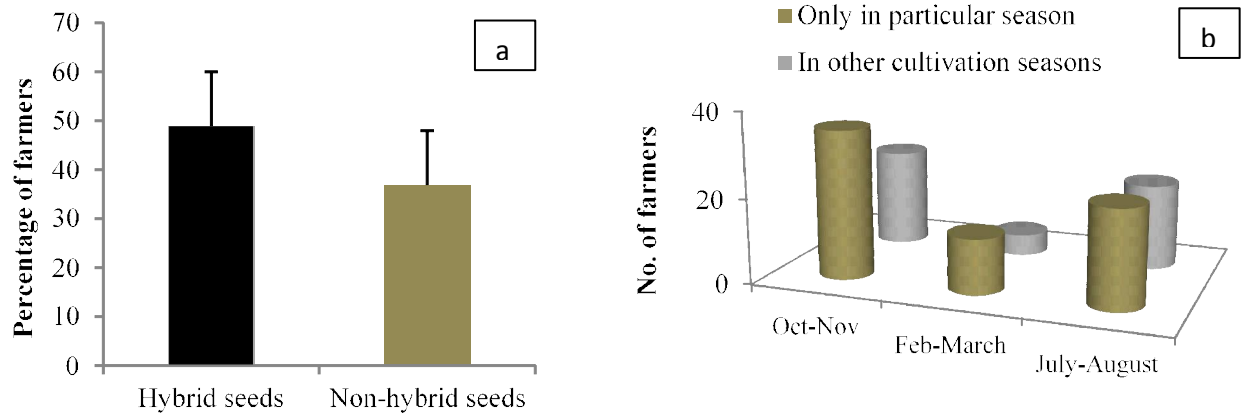


Fig. 4. a-Variety of tomato seeds preferred by the farmers for cultivation; b- percentage of season preferred for tomato cultivation by the farmers in vicinity of Lucknow city

Table 4. List of biotic stresses, pesticides used by farmers in study area and their toxicological effect

Types of diseases reported in study areas	Major Pesticides used by farmers in study areas	Toxicological effects of these chemical pesticides
Fungal and bacterial diseases like wilting, necrosis, damping off, black spots on leaves and fruits	Mancozeb (Dithane M-45), Metalaxyl, Carbendazim, Thiram, Copper oxychloride (Blitox), Chlorothalonil (Docket) etc.	Mancozeb have potential to impair thyroid functioning; birth defect; carcinogenic in nature (Dabrowski et al., 2014) and hepatotoxic (Pirozzi et al., 2016). Thiram is known to have toxic effect on hepatic and reproductive systems as well as on non-pathogenic bacteria and fishes (Xue et al., 2014). Copper oxychloride is well known for its toxicity to earthworms (Yologlu and Ozmen, 2013; Helling et al., 2000).
Viral diseases like leaf curl and dwarfness & Pests infestation- caterpillar, aphids, termites and bugs	Imidacloprid, Carbosulfan (Marshal), Chloropyrifos, Quinolphos, Phorate, Acephate (starthene), Lambda Cyhalothrin (Corolambda), etc.	Acephate is considered as an Endocrine disrupting chemical (Dabrowski et al., 2014). Lambda cyhalothrin is a neurotoxic pyrethroid that has been reported to disrupt normal functioning of nervous system of mammalian and aquatic invertebrates (Ansari et al., 2012; Tomar et al., 2015) including fishes and honeybees. Imidacloprid is reported to be highly toxic to earthworms (Alves et al., 2013). Chlorpyrifos has carcinogenic effect on mammals (Mostafalou and Abdollahi, 2013).

Application of pesticides was done as recommended by the sellers. Through study it was also observed that in some areas farmers were being gullied by the sellers to make their own profits. Use of biopesticides by farmers was negligible however some farmers were reported to use other alternatives such as use of flyash, removal of diseased plants, rotation of crops, etc. (Fig 5a). Lack of knowledge among farmers about the use of pesticides, quantity required and their health impacts were the main reasons for indiscriminate use and could probably be related to low productivity due to harmful effect on density and activity of beneficial soil microflora.

In present study single respondent was reported having higher education (Table 2) and involved in agriculture as part time work or for leisure. The use of biopesticides and proper safety measures were documented. It was concluded through study that well educated farmers or opting farming as part time activity by educated people can play significant role in agricultural sustainability by successfully implementing their knowledge in fields and encourage other farmers to opt sustainable and safe farming methods.

3.5. Input of fertilizers to increase productivity

Inputs of chemical fertilizers were high in study areas owing to general belief that high inputs could results in higher yield. Di-ammonium phosphate (DAP) and Urea were the most common chemical fertilizers used while other chemical fertilizers were also used in smaller portion including Potash, Zinc, Sulphur, and NPK. No data was obtained related to use of biofertilizers by the farmers but cow dung and compost were reported to be used by around 9% of the farmers in study areas (Fig 5b).

3.6. Abiotic stress and their management

Temperature, rainfall and water availability were major factors affecting tomato productivity. Extreme temperature conditions were reported to reduce the total yield of tomato especially the high temperature at night. High mean temperature is known to affect the physiological and biochemical processes of tomato leading to lower productivity (Gunawardena and De Silva, 2015) leading to disorders like sunscald whereas low temperature causes darkening of leaf and stem tissues leading to stunted growth and disorder like catfaced fruits.

Heavy rainfall was also complained to be a reason for damaging tomato crop resulting in lower yield. Tomato requires well drained soil for proper growth. Poor drainage and high moisture in soil can enhance the susceptibility of plants to various pathogenic diseases. Similarly scarcity of water was another major problem for tomato cultivation. Water scarce conditions result in plant wilting and finally leading to plant death. Due to increase in problem of water scarcity, cost for irrigation has hiked. In many areas fields were irrigated using tubewell engines that run at the cost of Rs. 110-150 per hour. This extra cost increase the burden on shoulders of farmers already suffering with other agricultural problems.

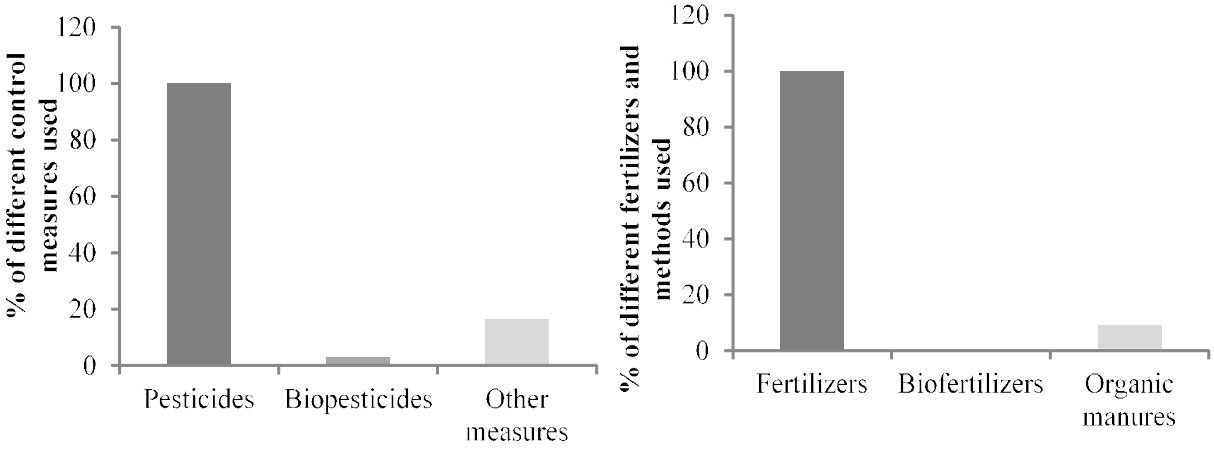


Fig. 5. a- Percentage of different control measures used for controlling biotic stress; b- Percentage of different fertilizers and methods used for growth and yield production of tomato in vicinity of Lucknow city.

3.7. Total benefits received by farmers

No exact estimate regarding total cost input and returns was documented. In general for tomato production in 1.27 x 10^{-2} - 12.7 x 10^{-2} hectare acreage, the total input cost of Rs. 15,000 to 20,000 was roughly estimated. In case of good productivity, without major loses, profit in monetary terms was documented to be around 5,000 to 10,000 whereas in case of loses it become hard for farmers to cover input cost.

3.8. Safety measures taken by the farmers

As knowledge pertaining to ill effects of pesticides use among farmers was low, very few farmers (~36%) were found to take safety measures while spraying pesticides in field (Fig 6). And among them, for most of the farmers safety measures were only limited to covering their face using cloth instead of mask available in market. Another measure frequently used by farmers includes use of gloves in hand. Among 97 farmers interviewed only 1 farmer was documented to use safety suit and study the direction of air flow before pesticide spraying as a step toward safety measure.

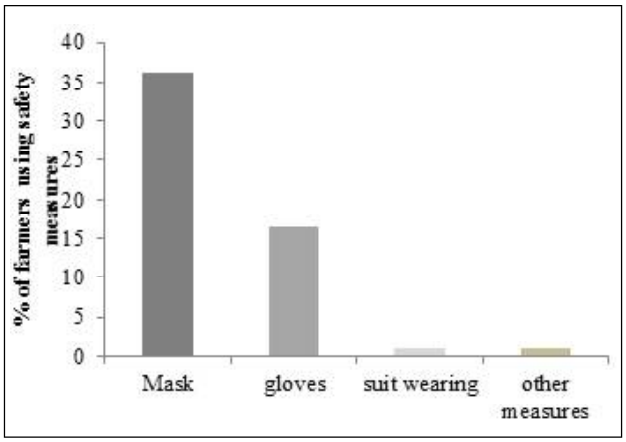


Fig. 6. Percentage of farmers using different safety measures during pesticide application

4. CONCLUSION

Through present study it was concluded that biotic stress like disease and pest infestation, wild animal intervention and abiotic stresses including extreme temperature conditions, water scarcity, high intensity rainfall and land fragmentation were the major constraints for tomato growers. Input of chemical pesticides and fertilizers was high whereas use of biopesticides and biofertilizers was negligible. To overcome such problems, there is a need for government as well as private sectors to focus on problem of farmers with deep insight. Availability of biofertilizers and biopesticides should be made free of cost with purchase of seeds by farmers. Fragmented agricultural land should be consolidated which could reduce the cost of irrigation and promote use of modern agricultural practices. Some awareness camps should be arranged at regular interval of time for farmers to provide them knowledge and information about harmful aspects of use of agrochemicals, importance and benefits of biofertilizers and biopesticides to control plant diseases and pests along with need to take proper safety measures before using agrochemical in fields.

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REVIEW ARTICLE

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Women and Ethics in Medicine: Historical Perspective and Contemporary Concern

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ABSTRACT

The purpose of this paper is to provide an historical overview of the developments in the field of ethics concerning medicine and health. The discourse also focuses on morals and ethics. We summarize major principles around which much of ethics debates concerning medical and health care have been organized. Following this our paper connects the medical ethics in India with the contemporary concern. The present paper is divided into two parts. The first part attempts to discuss historical development of medical ethics at global level. In particular, western philosophy has been profoundly shaped by three theories of ethics: Aristotelianism, deontology and utilitarianism. Each of these three theories can in turn be seen as essentially a product of the times in which it was originally born. The medical ethics have come a long way and still a continuing process. Ethical discourse is generated out of and applied in local worlds, however, so that it gets taken up in moral processes that are inseparable from local elations and conditions. The discourse of ethics and moral concludes that they are inseparable from local relations and conditions and at the same times aspires for trans-local perspective. Importantly, the four principles of ethics i.e. , autonomy, beneficence, non-maleficence, and justice) are prima facie and binding for each individual to follow. In the second part of paper, an effort has also been made to discuss the historical aspects of medical ethics in India. Medical ethics are not merely a moral code but a legally sanctioned code of conduct acceptable and normal within the medical profession. A broad range of issues can be covered under the rubric of ethical issues, however, specific concerns related to the globalization, equity in health, technology and ethics, informed consent, emergency and health care and reproduction are the major concern of ethics. The ideas enshrined in the doctrine of informed consent though not legally binding yet, continue to percolate into the medical and lay discourse. The doctrine of informed consent is complicated and needs to be addressed in socio-cultural and other constraints of the society. Advances in bio-sciences and bio-technology, such as surrogacy, sex selection, genetics etc. widened the scope of medical ethics. Ethics are the bridge between health policy and values. Health policy is related with the equity and justice to its people in receiving the health care, and thus medical ethics examines the moral validity of it. There is a need to develop an ethical culture in society. Ethics, equity and respect for humanity must be incorporated in all aspects of health care. Ethics has to be institutionalized wherever it is needed. Given the events of the last decades it is a sad reality that at least in the Indian health care set up ethics are losing their sight and has been moving towards commercialization than science and healing.

1. INTRODUCTION

Numerous indicators reflect a growing interest in ethical issues in medical and health care. Increasingly media coverage includes discussion of ethical issues surrounding such developments as has been the case with reproductive technologies such as surrogate motherhood, cloning of human beings etc. Moreover, professional organizations are devoting more time at their meetings and more space in their publications to discussion of ethical issues (Gottlieb, Burdine and McLeory, 1987). Against this background one night suspect an equivalent development of sociological interest in medical ethics. This is so because many issues in medical ethics are sociological topics of major interest. For example, work in the area of medical care ethics, particularly work focusing on the rights and duties of medical professionals and patients, bears directly on the evolving nature of the doctor-patient relationship (Stacey:1985). Ethical analysis of medical and health care public policy has significant implication for such macro sociological issues as equality in access to care and the role of the

professions in determining the availability of medical and health care services (Mechanic, 1979). Internationally, human rights and ethics became more visible as a driving conceptual framework for defining health and rights and ethics to health. Further this will stage for examining the effects of global process as women's health such as globalization, migration, urbanization and conflict (Pat and Pederson, 2015).

A review of recent medical sociology works reveals some coverage of an array of ethical issues in medical and health care (Mechanic, 1983; Susser *et al.*, 1985; Mechanic and Atken, 1986; Simmons and Canio, 1979). Much of this has focused on micro-ethical issues, such as the doctor-patient relationship and treatment decisions for critically ill patients (Crane, 1975). More recently there has been an extension to societally focused issues, such as the rationing of medical care (Mechanic, 1979). Lesser attention has been devoted to exploring ethical issues in the interactions between institutions and professionals to studying the dynamic relationships between the professions and society (Freidson, 1970). Some sociological attention also has been given to the rise and current interest in bioethics (Fox, 1974). The number of specific medical and health issues that have received ethical analysis is very large; they include such topics as death and dying, kidney dialysis, organ transplantation, clinical research, genetic counselling and screening, decision to extend or terminate life support system, allocation of scarce medical resources, cost containment, and ethical issues in the development of for-profit hospitals.

In India, not much work has been done on medical ethics, however, Desai (1988) try to see the medical ethics in the continuity of indigenous and classical folk traditions. Wig (1985) discusses the forced population control measures as a medical and ethical issue. Desai and Chand (2007) lamented on the lacunae and absence of laws specifically with the duties of health facilities and personnel to provide medical treatment in emergency cases. Sriram et al (1991) and Minocha(2010) have studied the discourse of informed consent in medical ethics along with field observation. There is not much work at the theoretical and empirical level which has been done on the medical ethics particularly in the Indian context.

The purpose of this paper is to provide an historical overview of the developments in the field of ethics concerning medicine and health. The discourse also focuses on morals and ethics. We summarize major principles around which much of ethics debates concerning medical and health care have been organized. Following this our paper connects the medical ethics in India with the contemporary concern.

2.1. History of Medical Ethics

Since the beginning of human history, concern for medical ethics has been expressed in the form of laws, decrees, assumptions and "oaths" prepared for or by physicians. Among the oldest of these are the Code of Hammurabi in Babylonia (approximately 1750 BCE), Egyptian papyri, Indian and Chinese Writings, and early Greek writers, mostly Hippocrates (lived between 460 and 377 BCE). Early medical ethical codes were written by individuals or by small groups of people, usually physicians. The oath of Hippocrates is considered historically to be the first such code written in an organized and logical way which describes the proper relationships between physician and patient. During the Middle ages, other medical codes were written. In recent times, Thomas Precival's writings, disseminated in 1803, represent one of the first ethical codes in the United States and the Western World (Lustig *et al.*,1993).

Beginning in the second half of the nineteenth century medical organization begins writing codes of medical ethics. The first ethics code of the American Medical Association (AMA) was published in 1847. This was the first ethical code of a professional organization which outlined the rights of patients and caregivers. In the 19th Century, medicine along with university teaching, law and the Ministry underwent professionalization. The medical profession succeeded, after prolonged agitation, in getting recognition for their status and prestige, in 1858 when the Act creating the General Medical Council was passed in the U.K., Initially, the Medical Councils of developed countries paid almost exclusive attention to reducing competition from outside and within. Thus, traditional practitioners and quacks were forcibly eliminated in the later part of the 19th century. Elaborate codes were made to restrict or eliminate unhealthy competition within the profession. Entry to the profession was restricted by getting control over the medical education and registration of doctors. To these were gradually added the internal regulations or disciplinary procedures to curb misuse of power detrimental to patients' well being.

The World Health Organization (WHO) issued the Declaration of Geneva in 1948. This is the first world wide ethical code and is modelled after the oath of Hippocrates. Many other medical organizations throughout the world have issued medical ethical codes.

2.2. Meaning of Ethics

Ethics involves normative questions, reasoning, and decision- for example, how one should act or ought to do, both as a moral ideal and in an actual situation? Normative ethics, as a discipline, is not synonymous with law or the social sciences.

Ethics is the branch of philosophy that has traditionally concerned itself with examining the worth or value of conduct, with developing and defending views on what might be meant by a 'worthwhile' and with how such a life could be led. Different ethical traditions have developed separate- and conflicting views on the purpose of ethics (metaethical views) and the on the kind of in which we should actually engage (normative views). In particular, western philosophy has been profoundly shaped by three theories of ethics: Aristotelianism, deontology and utilitarianism. Each of these three theories can in turn be seen as essentially a product of the times in which it was originally born. These theories are based on trying to determine

- What is meant by leading a good or virtuous life (the focus particularly of Aristotelianism)
- What kinds of duty or obligation we owe each other (the focus particularly of deontology)
- How we might take account of consequences when deciding, a particular course of action (the focus especially of utilitarianism).

2.3. Aristotelianism

Aristotle's ethics is representative of ethical theories that aim to work out what a good (moral) life might mean and how the development of such life can be encouraged. He attempted to do this by looking at the nature of the world and the individuals within it in order to assess what being virtuous might mean. For this reason Aristotle is frequently thought of as an empiricist. In viewing the world, he argued that we become virtuous by performing virtuous actions. What is most important is not simply the identification of the mean (the virtuous) in all aspects of human actions. It is the idea that, through reflection and contemplation, we should develop our lives so that we know how to at according to the mean- in other words, how to act virtuously (or morally). We thus become more morally expert, reflection and the consequent performance of virtuous action determining, what it means to lead t' the worthwhile (good) life'.

2.4. Deontology

Immanuel Kant developed ideas representative of deontology- thinking based on the notion that we owe each other particular duties or obligations. Kant claimed the existence of a reality independent of our experience. Part of his justification for his claim lay in his analysis of our experience as humans. We live in a world subject to scientific laws of causation, yet we retain freedom of will, having the capacity to act morally or otherwise. Out moral choices must therefore, be framed within an independent reality. Kant argued that reasons exist independently of experience and that the right use of reason is directed towards moral ends. Reasons move us to act out of duty for its own sake and independently of any thought about the consequences. How then, is the difficulty overcome? One way (which of course the strict deontologist could not accept) is to allow that consideration of consequences to play an important part in making moral decisions. This leads to the third ethical tradition to be considered- utilitarianism.

2.5. Utilitarianism

According to J .S.Mill careful thought needs to be given to the consequences of any action, and if those consequences are likely to adverse for some, the reason for the action must be robust. Utility, or the greatest happiness principle, holds that actions are right in proportion as they tend to promote happiness, wrong as they tend to produce the reverse of happiness. By happiness is intended pleasure, and the absence of pain; by unhappiness, pain, and the privation of pleasure (Mill: 1962). Utilitarianism and consequentialist ethical theory in general- corresponds with a belief held by many that whereas there are important moral duties, action simply for the sake of duty, whatever the consequences, is problematic. In addition, a deliberation about consequences may well include thoughts about the level of 'happiness' or 'unhappiness' likely to accrue from a particular course of action.

2.6. Ethical and Moral Discourse

In the ethnographic terms, moral processes differ in a fundamental way from ethical discourse. Whereas moral experience is always about practical engagements in a particular local world, a cultural space that carries political, economic, and psychological specificity- a view from somewhere and actions and reactions that are partisan- ethical discourse is a globally elaborated abstract articulation of and debate over translocal values. It strives for an acontextual universality and objectivity: a view from nowhere. Ethical discourse is generated out of and applied in local worlds, however, so that it gets taken up in moral processes that are inseparable from local elations and

conditions. The institutions, relationships, and lived experiences that serve ethical deliberations are themselves grounded, of course, in the oral processes of local worlds. So that in actual practice, the distinction has blurred boundaries with overlapping components. But for heuristic purposes it is still useful to draw the distinction between local and moral processes that are inseparable from local relations and conditions and ethical discourse that brings, or at least aspires to, a translocal perspective (Kleinman: 2004).

The other side of the duality is that ethics can be (and all-too-frequently are) irrelevant to local moral worlds. Thus structural positioning of poverty and wealth systematically distributes health and health care resources inequitably as part of what defines the moral reality of a local world. To talk about universal ethical formulations of justice and equity, without beginning with the local moral condition of real people who experience the systematic injustices of higher rates of ill health and fewer health care resources owing to their positioning in local social structures of power is to make those formulations utopian and irrelevant to the local world (Daniels *et al.*: 1999). When for example, informed consent in bioethics is made into the overriding ethical condition of international health research, say in vaccine trials of HIV in impoverished African villages where few people are literate and there is no equivalent in local knowledge of ideas of randomised controlled trials, placebo controls, or perhaps even individual autonomy in deciding about participation in a community-wide activity, while the systematic injustice in the global economy that has deepened these people's poverty and suffering via structural adjustment programmes and the local conditions of absence of the most basic health care resources to treat AIDS are also absent from ethical discourse, then application of the ethical in the local setting of the oral is highly suspect (cf. Farmer : 1999).

2.7. Theoretical and Methodological Perspectives in Ethics

The territory of ethics- the examination and discussion of the values underpinning conduct- is largely conceptual, and in the case of many of the concepts discussed in ethics, there is a large degree of dispute, or contestedness. Some philosophers have attempted to suggest that value ('ought') judgements have a status roughly equivalent to those concerning empirical fact, that in asserting, for example that 'killing is wrong' someone is suggesting an undeniable truth. Aristotle, Kant and Mill are very important representatives of philosophers attempting normative moral projects. In more recent times, contemporary thinkers viewing health care have tried to suggest that there are important principles that should underlie work in this field of activity. Among others, Beauchamp and Childress (1994) and Gillon (1994) have suggested that the following principles are particularly important for health care workers

- Autonomy: It is the capacity to be in charge yourself of your actions and your destiny. The principle of respect for autonomy asserts that we have a moral obligation to allow this capacity to individuals to the extent that it does not infringe on the equal rights of others. The obligation to respect the autonomy of others- for example patients or clients- to the extent that this is compatible with the autonomy of all who are likely to be affected by the action being considered.
- Beneficence: This is frequently regarded as a moral obligation that ought to be held by health care workers and clearly connects with beneficence. The ethical commitment in health care to produce benefit for patients or clients.
- Non-maleficence: The obligation not to harm patients or clients, closely linked to the previous principles, because any given action has the potential to result in both benefit and harm. The obligation on health care professionals is to ensure that the balance is always in favour of benefit in any given situation.
- Justice: The obligation to act fairly when dealing with competing claims to do with, for example, resources or rights.

Importantly, the four principles are prima facie, which means that each is binding unless it conflicts with another, in which case a choice must be made between the competing principles as to which one should be followed. Those who support the four principles argue that whereas they cannot yield a definitive ethical judgement in all health care situation, they do provide a framework for considering, and reasoning about obligations.

Medical ethics is an area of applied ethics concerned with health and illness and health care and medical care. Ethics applied to health care and medicine has a number of roles to play and a number of limitations (Beauchamp and Childress: 1983). Most people involved in medical ethics would agree that it is a useful but rather imprecise 'diagnostic' and 'prescriptive' tool when brought to bear on real-life situations. "Moral action guides" but seldom offers ready solutions to the hard choices that confront providers, patients, or policy-makers. This is so, in part, because medical ethics most often deals with dilemmas in

which no set of moral reasons for a given view or action is obviously the correct one. Porter (2014) argues against the idea of any singular moral system, but for an understanding of plurality and diversity. Nevertheless, she discusses particular principles such as justice, care equality and rights which guide moral behaviour but upon which a feminist perspective throws a better light. She assumes that women's socialization, cultural expectations, gendering and life experiences typically are different to the experiences of men.

3.1. History of Medical Ethics in India

The beginnings of recorded medical practice in India date back to the advent of Aryan invaders. Much useful information is also be found in the seminal Ayurvedic classics- ***Caraka Samhita, Susruta Samhita*** and ***Bhela Samhita*** (around 600 BC). In these classics, ethical principles were enunciated and steps taken to ensure that they were followed. Teacher and student were reminded that the profession existed for the welfare of the patient. Whilst fair compensation was not frowned upon, the physician was constantly reminded that the primary goal was not fortune for self and family but the care of the sick. The healthy human body is essential to the realization of life's tasks, including the ethical. Health-seeking was a religious obligation. Ayurveda was created before the creation of the world, so that the potential for protection of health and removal of disease were built into the act of creation. Ethical laws were natural laws, and the Ayurvedic world-view was a part of the Hindu conception of humanity and its place in the universe.

The advent of the Portuguese, French and most significantly, the British into India witnessed in the system of medicine that continue to dominate the sub-continent. The officers of the Indian medical Service introduced the principles of medicine and western concept of medical ethics. To this day, discussion on ethics in India start with the enumeration of the principles of beneficence, non-malevolence, autonomy and justice (Pandya: 2000). Questions about medical ethics in India interact with local customs and tradition in everyday practice. Unusual occurrences may be resolved by a reference to mythology or folklore. This is not to suggest that Indian medicine does not address the problems of ethics. They are intertwined in medical texts, and mythical figures are seen as models of exemplary ethical behaviour. Ethical solutions may be inferred and derived from scriptural texts. This is particularly so in the context of modern and recent medical technologies, with which medicine in India has no prior contact (Desai: 1988). In the era of globalization health trainees often report having felt inadequately prepared to deal with ethical dilemmas they encountered during outreach clinical work (Logar, Phuoc Le, and Hirrison:2015)

In India, the formal process of medical profession begun in 1912 when the Bombay Medical Act was passed. This was followed in 1914 by the Madras Medical registration Act, Bengal Medical Act and so on. In 1933, the Indian Medical Council Act brought higher education in medicine under the purview of a national level medical council. After independence, separate National level and state level Councils were created for allopathy, homeopathy and the Indian System of Medicine (ISM). The Medical Council of India under its Medical Council Act, 1956 has recently i.e. in 2002 has made the regulations relating to the professional Conduct, Etiquette and Ethics for registered medical practitioners. We will discuss them in the ensuing pages

3.2. Functioning of Medical Council

The national level councils have control and supervise medical education whereas the state councils maintains registers of doctors and have powers to discipline doctors whose conduct was found to be unethical. Under section of the MMC Act, the Medical Council is empowered to hold an enquiry of any registered doctor suo moto (on its own) or any complaint made to it. This is properly codified in the Chapter VI, rules No. 62 to 75 of the Rules of the MMC Act. Thus, the medial council can act against the erring doctor even if no complaint is filled by the patient(s).

Further, the Council has the power to punish who are found guilty of much misconduct in a properly held enquiry. Accordingly, the Council can warn a doctor, or can temporarily or permanently remove the name of the doctor from the register. But the Council has no power to award compensation to the patient of the complaint. When there are persistent reports of unethical practices in the profession (e.g. organ trade, cut practices), the Council cannot advance a pretext that there is no specific complaint filed. The Council has suo moto power to investigate. This also provides scope to patients' organizations and social organizations in filing complaints and in pressurising the Councils to play a more active role.

3.3. Importance of Medical Ethics

Medical ethics are not merely a moral code but a legally sanctioned code of conduct acceptable and normal within the medical profession. This does not mean that morality or moral theories do not influence medical ethics, but medical ethics must be understood, analysed and practised from a rational standpoint. This rational component of professional

conduct is legally codified under the code of medical ethics of the legally constituted medical council with which all qualified medical practitioners must be registered.

The registrations as well as the conduct as per the code of ethics are essential because, "Doctors use technical skills and expertise which the untrained person does not possess. Possessing these skills gives him great power over his patients who by the very fact of being patients are dependent, ill and vulnerable. In caring for his patients, a doctor makes a series of judgements and decisions which patients have the right to expect are made fairly in the light of the doctor's knowledge and experience" (British Medical Association : 1988). Thus, although the code of medical ethics is for the self-regulation of the profession, it is there in order to fulfil certain rights and expectations of the patient. In a nutshell, the code describes the doctor's duties towards the patient. If these rights are not fulfilled or duties are not performed, then the doctor in question loses his or her right to be part of the profession.

3.4. Code of Medical Ethics

The Medical Council of India under its Medical Council Act, 1956 has recently i.e. in 2002 has made the regulations relating to the professional Conduct, Etiquette and Ethics for registered medical practitioners. We will discuss them below

- **Declaration**: Each applicant at the time of making an application for registration under the provisions of the Act, shall be provided a copy of the declaration and shall submit a duly signed Declaration. The applicant shall also certify that he/she had read and agreed to abide by the same.
- **Duties and responsibilities of the Physician in General**: Doctors with qualification of MBBS or MBBS with post graduate degree/diploma or with equivalent qualification ain may medical disciplines shall uphold the dignity and honour of medical profession. The prime objective of the medical profession is to render service to humanity, reward or financial gain is a subordinate consideration. Who so ever chooses his profession, assumes the obligation to conduct himself in accordance with its ideals. He shall keep himself pure in character and be diligent in caring for the sick; he should be modest, sober, patient, prompt in discharging his duty without anxiety, conducting himself with propriety in his profession and in all the actions of his life.

  No person other than a doctor having qualification recognised by Medical Council of India and registered with Medical Council of India/State Medical Council (s) is allowed to practice Modern System of Medicine or Surgery. A person obtaining qualification in any other system of medicine is not allowed to practice Modern system of medicine in any form.
- **Maintaining Good Medical Practice**: The principal objective of the medical profession is to render service to humanity with full respect for the dignity of profession and man. Physicians should merit the confidence of patients entrusted to their care, rendering to each a full measure of service and devotion. Physicians should try continuously to improve medical knowledge and skills and should make available to their patients and colleagues the benefits of their professional attainments. The physician should practice methods of healing founded on scientific basis and should not associate professionally with anyone who violates this principle.
- **Maintenance of Medical Records:** Every physician shall maintain the medical records pertaining to his/her indoor patients for a period of three years from the date of commencement of the treatment in a standard Performa laid down by the Medical Council of India. If any request is made of medical records either by the patients/authorised attendant or legal authorities involved, the same may be duly acknowledged and documents shall be issued within the period of 72 hours. Registered medical practitioner shall maintain a Register of medical Certificates giving full details of certificates issued. When issuing a certificate he/she shall always enter the identification marks of the patient and keep a copy of the certificate.
- **Display of Registration Numbers:** Every physician shall display the registration number accorded to him by the State Medical Council/ Medical Council of India in his/her clinic and in all his prescriptions, certificates, money receipts given to his/her patients. Physicians shall display as suffix to their only recognized medical degrees or such certificates/diplomas and memberships/honours which confer professional knowledge or recognizes any exemplary qualification/ achievements.
- **Use of Generic Names of Drugs**: Every physician should, as far as possible, prescribe drugs with generic names and he/she shall ensure that there is a rational prescription and use of drugs.
- **Highest Quality Assurance in Patient Care**: Every physician should aid in safeguarding the profession against admission to it of those who are deficient in

moral character of education. Physician shall not employ in connection with his professional practice any attendant who is neither registered nor enlisted under the Medical Acts in force and shall not permit such persons to attend, treat or perform operations upon patients wherever professional discretion or shill is required.

- **Payment of Professional Services**: The personal financial interests of the physician should not conflict with the medical interests of patients. A physician should announce his fees before rendering service and not after the operation or treatment is under way. Remuneration received for such services should be in the form and amount specifically announced to he patient at the time the service is rendered. It is unethical to enter into a contract of "no cure no payment".
- **Obligation to the Sick**: Though physician is not bound to treat each and every person asking his services, he should not only be ever ready to respond calls of the sick and the injured, but should be mindful of the high character of his mission and hte responsibility he discharges in the course of his professional duties. In his treatment, he should never forget that the health and the lives of those entrusted to his care depend on his skill and attention. No physician shall arbitrarily refuse treatment to a patient. However, for good reason, when a patient is suffering from an ailment which is not within the range of experience of the treating physician may refuse treatment and refer the patient to another physician.
- **Patience, delicacy and Secrecy:** Patience and delicacy should characterize the physician. Confidences concerning individual or domestic life entrusted by patients to a physician and defects in the disposition or character of patients observed during medical attendance should never be revealed unless their revelation is required by the laws of the State.
- **Prognosis:** The physician should neither exaggerate nor minimize the gravity of a patient's condition. He should ensure himself that the patient, his relatives or his responsible friends have such knowledge of the patient's condition as will serve the best interests of the patient and the family.

L. **Unnecessary Consultation should be avoided:** However, in case of serious illness and in doubtful or difficult conditions, the physician should request consultation, but under any circumstances such consultation should be justifiable and in the interest of the patient only and not for any consideration. Consulting pathologists. radiologists or asking for any other diagnostic lab investigation should be done judiciously and not in a routine manner. Differences of opinion should not be divulged unnecessarily but when there is irreconcilable difference of opinion the circumstances should be frankly and impartially explained to the patient of his relatives or friends. It would be opened to them to seek further advice as they so desire.

- **Treatment after Consultation**: No decision should restrain the attending physician from making such subsequent variations in the treatment if any unexpected change occurs, but at the next consultation, reasons for the variations should be discussed/explained. The same privilege, with its obligations, belongs to the consultant when sent for in an emergency during the absence of attending physician. The attending physician may prescribe medicine at any time for the patient, whereas the consultant may prescribe only in case of emergency or as an expert when called for.
- **Patients referred to Specialists:** When a patient is referred to a specialist by the attending physician, a case of summary of the patient should be given to the specialist, who should communicate his opinion in writing to the attending physician.
- **Fee and other Charges**: A physician shall clearly display his fees and other charges on the board of his chamber and/or the hospitals he is visiting. Prescription should also make clear if the physician himself dispensed any medicine. A physician shall write his name and designation in full along with registration himself dispensed any medicine. A physician shall write his name and designation in full along with registration particulars in his prescription letter head. However, in government hospital where the patient-load is heavy, the name of the prescribing doctor must be written below his/her signature.
- **Advertising**: Soliciting of patients directly or indirectly, by a physician, by a group of physicians or by institutions or organisations is unethical. A physicians shall not make use of him/her (or his/her name) as subject of any form of any form or manner of advertising or publicity through any mode either alone or in conjunction with others which is of such a character as to invite attention to him or to his professional position, skill, qualification, achievements, attainments, specialities, appointments,

associations, affiliations or honours and/or of such character as would ordinarily result in is self aggrandizement. A physician shall not given to any person, whether for compensation or otherwise, any approval, recommendation, endorsement, certificate, report or statement with respect of any drug, medicine, nostrum remedy, surgical, or therapeutic article, apparatus or appliance or any commercial product or article with respect of any property, quality or use thereof or any test, demonstration or trial thereof, for use in connection with his name, signature, or photograph in any form or manner of advertising through any mode nor shall he boast of cases, operations, cures or remedies or permit the publication of report thereof through any mode.

- **Running an Open shop (Dispensing of Drugs and Appliances by Physicians):** A physician should not run an open shop for sale of medicine for dispensing prescriptions prescribed by doctors other than himself or for sale of medical or surgical appliances. It is not unethical for a physician to prescribe or supply drugs, remedies or appliances as long as there is no exploitation of the patient. Drugs prescribed by a physician or brought from the market for a patient should explicitly state the proprietary formulae as well as generic name of the drug.
- **Rebates and Commission**: A physician shall not given, solicit or receive nor shall he offer to give solicit or receive, any gift, gratuity, commission or bonus in consideration of or return for the referring, recommending or procuring of any patient for medical, surgical or other treatment. A physician shall not directly or indirectly, participate in or be a party to act of division, transference, assignment, subordination, rebating, splitting or refunding of any fee for medical, surgical or other treatment.
- **Euthanasia**: Practicing euthanasia shall constitute unethical conduct. However on specific occasion, the question of withdrawing supporting devices to sustain cardio-pulmonary function even after brain death, shall be decided only by a team of doctors and not merely by the treating physician alone. A team of doctors shall declare withdrawal of support system. Such team shall consist of the doctor in charge of the patient, Chief Medical Officer/Medical Officer in charge of the hospital and a doctor nominated by the in-charge of the hospital from the hospital staff or in accordance with the provisions of the Transplantation of Human Organ Act, 1994.

4.1. Contemporary Concerns of women in Medical Ethics

This section will specifically deal with respect and equal treatment, communication and informed consent, decision making for incompetent patients, confidentiality, women and reproductive issues, medical ethics and emergency, technology and ethics.

The problem of the treatment of women cannot be underestimated when we consider health ethics, equity, human dignity and cultural diversity. In many cultures even in industrialized countries, women receive less education, less health care and are less involved in decision making at the family, community or national level than men. In India, generally a woman cannot commit herself to an informed consent unless she takes permission from her husband. In many African countries where AIDS is prevalent, a woman cannot refuse an unsafe sexual relationship with her husband who is infected with AIDS without escaping his punishment. In many religious and ethnic groups a woman cannot use family planning methods without her husband approval. Recently Iranian policy makers shifted away from a birth control of policy towards a pro-natalist policy. This policy packages raises serious concern health, socio-economic, environmental and ethical concerns(Aloosh and Saghai: 2016). These are examples of cultural issues related to women's health, which exists in spite of the UN convention on elimination of all forms of discrimination against women. They challenge our principles on ethics, equity and human dignity and need more sociological enquiry to empower women through education. We present below a case of women which will explain the ethical concern for women in health care practice.

Dr. Q is an experience and skilled Gynaecologist, is about to leave the government hospital as he has finished his duty hours. A young woman enters and brought to the hospital by her mother and relative. Patient is bleeding vaginally and is in a great deal of pain. Dr. Q examines her and decides that she had either a miscarriage or a self-induced abortion. Doctor decides this of his own without asking the patient and her relative about the history of the illness. He does a quick dilatation and curettage and tells the nurse to ask the patient to get her bed for further treatment. Doctor is in hurry; therefore, he immediately leaves the hospital without replacing another doctor. He also writes medicines and other tests without asking anything from the patient.

The above case study is an example of physician-patient relationship and in turn of medical ethics. The Declaration of Geneva requires of the physician that "the

health of my patient will be my first consideration" and the International Code of Medical Ethics states, "A physician shall owe his/her patients complete loyalty and all the scientific resources available to him/her".

The traditional interpretation of the physician relationship as a paternalistic one, in which the physician made the decision and the patient submitted to them has been widely rejected in recent years, both in ethics and law. The constitution provides equality in all respect to men and women, therefore, each individual can make his or her own decision. However, in the patriarchal structure of Indian society, most of the women patients are either unable or unwilling to make decisions about their medical care, thus female patients autonomy is often questioned. We turn below some of the areas which are of contemporary concerns of women in the area of ethics.

4.2. Respect and Equal Treatment for Women

The intimate nature of physician-patient relationship can give rise to sexual attraction. A fundamental rule of traditional medical ethics is that such attraction must be restricted. The oath of Hippocrates includes the following promise" whatever houses I may visit, I will come for the benefit of the sick, remaining free of all intentional injustice, of all mischief and in particular of sexual relations with both female and male persons". In recent years many medical associations have restated this prohibition of sexual relations between physicians and their patients. The reasons for this are as valid today as they were in Hippocrates' time, 2500 years ago. Patients are vulnerable and put their trust in physicians to treat them well. They may feel unable to resist sexual advances of physicians for fear that their treatment will be jeopardized. Moreover, the clinical judgement of a physician can be adversely affected by emotional involvement with a patient.

4.3. Women and Communication and Informed Consent

Informed consent is one of the central concepts of present-day medical ethics. The right of the patient to make decision about their health has been enshrined in legal and ethical statements in our code of ethics. It states that

"The patient has the right to self-determination, to make free decisions himself/herself. The physician will inform the patient of the consequences of his/her decisions. A mentally competent adult patient has the right to give or withhold consent to any diagnostic procedure or therapy. The patient has the right to the information necessary to make his/her decisions. The patient should understand clearly what is the purpose of any test or treatment, what the result would imply, and what would be the implications of withholding consent."

The 1964 Helsinki Declaration by the World Health Assembly has been revised a number of times to ensure the safety and rights of human subjects participating as volunteers in drug trials. The Declaration clearly states that the interests of humans should take precedence over the interest of science and society. Freely given informed consent" is one of the basic clauses of this code of ethics and should be obtained from each volunteer prior to the clinical trials. The Declaration also lays down that volunteers should be assured of treatment for any injuries resulting from the trials and have the right to withdraw from the research at any point. This is possible if they are informed of the purpose of the research and its risk and potential benefits.

Even the 1994 ICMR document on the clinical trials of contraceptives has very little to contribute in terms of ethical issues. While the mandatory steps for contraceptives approval are delineated, there is no mention, of the manner in which trial participants should be recruited, consent should be obtained or long term follow up should be done (Srinivsan: 2001). The new ICMR guidelines, on clinical trials are salient about contraceptive research. They not addressed the concerns arising out of their specificities and ensured adequate safeguards. This is essentials, firstly because the bulk of the contraceptive research is targeted towards women, a section of our society that already has lower nutritional levels and poor access to health facilities. Secondly, most of the emerging contraceptive technologies have multi-systemic effects, and require more careful studies in order to ensure their long-term safety vis-a-vis women's health. In addition, of course, is the fact that the impact of such technologies/devices/drugs is not limited only to the health of the research subjects but extends much further and affects the health of future generations (Saheli Women's Resource Centre: 1999). ICMR code of 2000 on Ethical Guidelines on Biomedical Research Involving Human Subjects has watered down the provisions for mandatory informed consent. In the section on International Collaboration /Assistance in Biomedical Research it talks about the "best possible nationally available care" instead of international standards thereby bypassing adequate safeguards against exploitation of research volunteers from developing countries. The code thus apparently follows the recent pressures to modify the Helsinki Declaration to make clinical research easier in developing countries. Among the significant changes sought is to permit "proxy

consent" that would eliminate the need for the individual trial participant's consent by obtaining permission from a government or non-governmental agency. The second change sought in the Declaration is regarding the standard of care to volunteers: it need not be the "best-proven care" but rather "best care available in the country" (Dasgupta: 2004).

Abortion is legal in India but only qualified, registered practitioners are allowed to conduct the operation. Since government clinics are absent in many areas, rural practitioners are keen to offer abortion service and make money out of that. At the same time abortion for women remains social stigma and taboo, the quick and secret services are provided by the rural practitioners make them popular. Dasgupta (2004) found in her study that Quinacrine (it is a synthetic anit-malarial chemical used for permanent sterilization which does not require surgery), the women who seek quinacrine sterilization are neither informed that they are " volunteers " for a drug trial, nor are they told about the experimental nature of the method and its unknown long-term risks. Doctors simply take advantage of their desperate need for contraception and their ignorance.

The Quinacrine Sterilization is unethical as the trials for the contraceptives like Net-en and Norplant in India. The only difference is that that the latter trials were legal and conducted by scientific bodies like the ICMR. But the women who were the "volunteers" for the Net-en and Norplant trials were recruited through family planning clinics and he experimental nature of the contraceptives and the transaction was hidden from them (Gupta: 2000). Sarojni *et al.* (2015) found in their study that the laparoscopic sterilization performed on women in Bilaspur is a complete violation of all standard operating procedures and ethical norms, amounting to grave violation of the very basic health rights of the affected women.

In India, the ideas enshrined in the doctrine of informed consent though not legally binding yet, continue to percolate into the medical and lay discourse. Many a doubt could be raised about the applicability of such a doctrine to a highly illiterate traditional society such as India, having limited exposure to modern medicine. In such a society the sick person is treated as someone dependent on others, with the family playing a crucial supportive role in the treatment as well as in the patient's interaction with the doctor. The concepts of individual autonomy and freedom of choice in the medical domain, by and large, still remains extrinsic and alien to the Indian thought process. Women Patients in India are especially dependent on male relatives when negotiating the external impersonal domain, such as hospital, and dealing with the strangers. It is the family members who take important decisions on their behalf, especially if the decisions are to rest on possessing medical knowledge. During the illness of woman, she is expected to let others assume responsibility for her welfare. (Minocha: 2010). Sriram *et al.* (1991) found that patients felt that the details of the investigations and prognosis need not be always told to them. As for Japan, imposing informed consent on people who do not want medical information and decision-making is ethically wrong and paradoxically paternalistic (Asai: 1996:91). Mapplsc *et al.* (2015) found that information on over detection of breast cancer provided within a decision and increased the number of women making an informed choice about breast screening. Becoming better informed might mean women are less likely to choose screening. Health literacy has a significant bearing on the level of comprehension of health information. Kamath *et al.* (2014) found that approximately two third of both males and females were able to recollect the health information after their treatment/surgeries. Comprehension of the information seemed to improve with increasing eduction. Dependency on the social and cultural settings female patients may not readily give their consent to participation in a trial as they not be in a position to take independent decisions (Gitanjali *et al.* :2003:109).

4.4. Women and Reproductive Ethical Issues

Many of the most pertinent issues in medical ethics relate to the beginning of human life. These pertinent issues are contraception, assisted reproduction, prenatal genetic screening and abortion etc. The woman has right to control her fertility, including the prevention of unwanted pregnancies, physicians still have to deal with difficult issues such as requests for contraceptives from minors and explaining the risks of different methods. For couples and individuals who cannot conceive naturally, there are various techniques of assisted reproduction, such as artificial insemination and in-vitro fertilization and embryo transfer. Surrogate is another alternative.

Genetic tests are now available for determining whether an embryo or foetus is affected by certain genetic abnormalities and whether it is male or female. Depending on the findings, a decision can be made whether or not to proceed with pregnancy. Physicians need to determine when to offer such tests and how to explain the results to patients. It is also pertinent to note that there is a rampant use of sex-selective technology, which has resulted in skewed sex-ratio. Abortion has long been one of most divisive issues in medical ethics, both for physicians and

for public authorities. Women who cannot conceive naturally are offered artificial forms of reproduction. The desperation to have a child in part reflects social pressures that make women feel incomplete without until they are a mother. Feminists are alarmed ways in which women are treated as disembodied creatures with wombs, eggs, cells, embryos. Contract motherhood raises ethical worries regarding the commercialization of the body. Bodily parts become commercial property, making poor women vulnerable to contractual arrangements with minimal regard to their full personhood (Porter: 2014).

4.5. Woman, Medical Ethics and Emergency

One of the situations experienced by the woman in the different health care facilities will explain the ethical dimension during the time of emergency of health care.

"A woman who was supposed to deliver a child was given first aid in a sub centre and referred to a primary health centre for treatment. The woman was examined at the preliminary level and showed her condition to be serious. Immediate admission for further treatment was recommended. However, she was not admitted in the primary health care facility as there were no vacant beds, and was referred to another district hospital. There too, she was refused admission as there were no vacant beds. Thus, the woman kept on shuttling between different hospitals and at last she went to the private hospital where she had to pay a large amount of money which was difficult for her to pay."

The above incident concludes that woman is denied admission in the different state health care facilities and that too in the emergency, while the state cannot avoid its obligation in the regard of no bed vacancy. It has to have an alternate arrangement for the emergency cases.

4.6. Womanhood, Technology and Ethics

Great progress has been achieved in the biomedical field during the last few decades. More is expected in the following decades. Advances in diagnostic imaging and biological testing techniques as well as in medical forecasting based on genetic testing are continuing. The human genome is now deciphered. Advances in surgical and medical cures, organ and tissue plantation, xeno transplantation (i.e. organ transplantation from animals), artificial organs, cloning tissues culture techniques, molecular biology and information technology are reported almost daily. Many ethical issues have been raised and new ethical codes adopted.

Advances in bio-medical field are putting challenges on ethics in terms of parenthood, genetic ordering, cloning and organ transplantation. Informed consent should be obtained from each volunteer/patient prior to his/her treatment or clinical trial. However, clinical trials are silent about contraceptive research and they do not address the concerns arising out of their specificities and ensure adequate safeguards. The concept of patient autonomy and freedom of choice is silent as most of the patients are illiterate and dependent on others or on family members. India is a society seems to refuse to recognize the ethical issues associated with denying women their right to be safe at their workplaces (Nair: 2016).

The pace of ethical studies needs to be hastened to cope with these rapid advances that may carry serious ethical consequences. As an example, with the advances in fetal surgery; if the mother refuses intervention, because of potential risk to her life, to save her offspring from a fatal or moribund disorder, what are the ethical issues here? The situation is even more complicated if the foetus needing intervention is carried in the womb of a surrogate mother and surrogate mother refuses access through the body while the true mother (who is not carrying the foetus) approves it. Other issue in terms of technology is that the information about patient which comes under individual genetic privacy right has many openings for research. Should this information about an individual be made public to employer firms, insurance companies, the courts and so on? How can we keep privacy and confidentiality of patient health data that is processed through computers and other machines? Is anonymity a sufficient guarantee for confidentiality? Should we block future epidemic research by blocking all these data? There is a need to revise continuously our concepts on ethics.

5. CONCLUSION

A broad range of issues can be covered under the rubric of ethical issues, however, specific concerns related to the globalization, equity in health, technology and ethics, informed consent, emergency and health care and reproduction are the major concern of ethics. The ideas enshrined in the doctrine of informed consent though not legally binding yet, continue to percolate into the medical and lay discourse. The doctrine of informed consent is complicated and needs to be addressed in socio-cultural and other constraints of the society. Advances in bio-sciences and bio-technology, such as surrogacy, sex selection, genetics etc. widened the scope of medical ethics. Ethics are the bridge between health policy and values. Health policy is related with the equity and justice to its people in receiving the health care, and thus medical ethics examines the moral validity of it.

There is a need to develop an ethical culture in society. Government should sensitize their own decision-making procedures in the light of ethics. Ethics, equity and respect for humanity must be incorporated in all aspects of health care. Ethics has to be institutionalized wherever it is needed. Independent ethical organizational entities should be established. These entities should be continuously working to develop new codes of guidelines which follow advances in and changes in health-related determinants.

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REVIEW ARTICLE

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Climate change and Disasters : Issues and concern of Proposed Sharda –Yamuna Link

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ABSTRACT

Climate is a measure of changes in meteorological variables. Sudden changes arise due to increasing deforestation, pollution, population, depletion of natural resources, global warming and industrialization etc. Uneven monsoon and irregular rainfall distribution causes great variations in climatic conditions which cause disasters; drought and flood. During monsoon season, flood occurs in several river basins of U.P and U.K states. According to Indian Meteorological Department, the average annual rainfall in U.P and U.K is more than other states; 100-120 cm and 120-400 cm respectively. Uttarakhand is among one of the highest rainfall states of India. Sharda river; a tributary of river Ganga overflows many times, causes flood in surrounded regions. Sharda-Yamuna link (S-Y) is one of the proposed links of National Perspective Plan to minimize flood in U.P and U.K states and drought in western parts such as Haryana, Rajasthan, and Gujarat of the country. Excess water will be transferred through S-Y link towards the drought regions of India. Approx 11,680 m^3 of surplus water is estimated to transfer from river Sharda to river Yamuna to avoid flood in U.P and U.K states. The lining of the link passes through two states Uttarakhand and Uttar Pradesh. The S-Y may also help in maintaining the water balance in its Enrouted and Command regions. This paper highlights the climate change, flood and drought disaster issues and role of proposed Sharda-Yamuna link.

1. INTRODUCTION

1.1. Climate change in relation to Flood and Drought

Climate change is the overall change in environment. Gross (2002) described the current state of health impacts of global warming, climate, vulnerability and indirect consequences of climate change etc. Bhattacharya and Das (2007) focused on three climate extremes such as repeatedly drought, floods and cyclones in India. India is prone to natural disasters such as droughts, cyclones, floods, landslides and earthquakes (Ayalasomayajula *et al*., 2014). Amarsinghe (2012) focused on flood and drought disasters in India. Drought and Flood are the major water concerns happen due to improper rainfall water distribution. The study on causes of flood was done by Nautiyal and Bhandari (2012). Dass *et al*. (2012) discussed the impact of drought in Rajasthan, one of the severe drought affected states. Drought affects the scarcity of drinking water. Possible mitigation plans and many others issues related with great disaster flood in Uttarakhand and the geographical causes were focused by Das (2013). Elliott *et al*. (2013) discussed the agricultural impacts of drought which not only affects the regions of India but other countries also. Drought condition generally occurs due low rainfall for a very long time. It causes water scarcity in the river basins. Some regions of Rajasthan, Bundelkhand, Karnataka, Orissa, Chhattisgarh, Punjab and Haryana states in India are the examples of severe drought. Flood is an overflow of surplus water in an area which is dry. It is basically, a natural hydrological phenomenon. The main cause of flooding is heavy monsoon, rainfall over the region for a long duration.

1.2. Improper Rainfall Distribution in North India (U.P and U.K States)

In India, several parts have faced improper rainfall distribution, which varies from heavy to low. Due to irregular fluctuations in rainfall and climate change during the monsoon season, some parts of the northern region are facing acute drought and some are flooded. According to Indian Meteorological Department, rainfall in India was rise with 6.3% excess in the year 2013. Western, Central and North eastern regions were faced high rainfall in India and regions such as Bihar, Jharkhand faced drought. The average annual precipitation is 11,871 mm. According to Indian Meteorological Department (IMD), the maximum rainfall occurs in the months of June to September in the country.

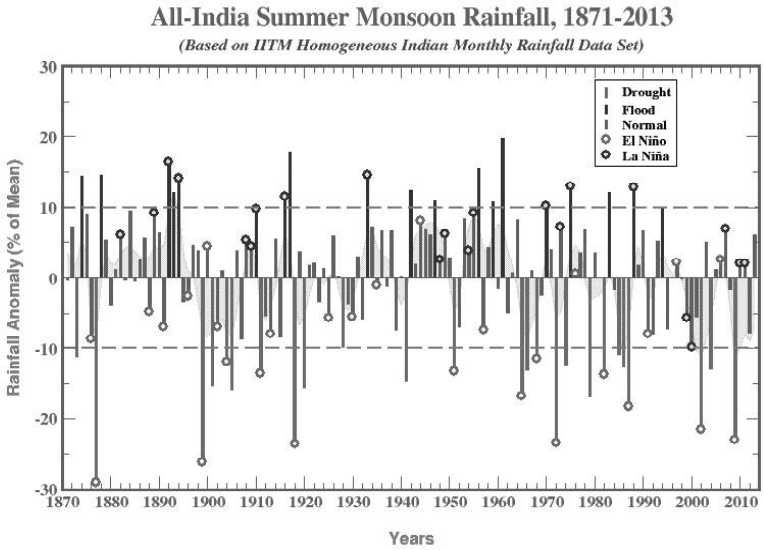

Fig. 1. All-India Summer Monsoon (June-September) Rainfall (AISMR Anomalies during (1871-2013) (Source: India Meteorological Department)

Annually average rainfall occurs in the country is approx. 125 cm. The highest annual rainfall in the world has been recorded is around 1141.9 cm at Cherrapunji in Meghalaya in India. Rainfall generally increases with height towards east direction. Study on the temperature changes in Dehradun city in doon valley of Uttarakhand state in India was done by Singh *et al*. (2013). Several districts of Uttarakhand state including Uttarkashi, Chamoli and Rudraprayag were faced with heavy rainfall. The study on the devastation caused by flood in the Brahmaputra basin was done by Pal *et al.* (2012). Extremely erratic rainfall, unevenly distribution and very heavy precipitation in short time resulting in flash floods and inundation in India became usual phenomena in recent years (Rao *et al*. 2012). Problem and potential of water pricing are increasing day by day (Sridhar and Mathur, 2011). Flood happened in Kedarnath valley in Uttarakhand due to heavy rainfall (Sharma *et al*. 2013). On the basis of NIDM, in June 2013, the state Uttarakhand was affected by heavy rainfall resulted great loss to life and properties of the people. Mann (2012) carried out studies on disaster management of Uttarakashi district, which is the most sensitive zone of the Himalaya. Rising sea levels, development and other factors increase the flood situations (Thilagavathi *et al.*, 2011). Different states in India such as Rajasthan, Gujarat, Tamil Nadu, Orissa and Bihar etc are facing droughts and floods due to hydrological ignorance (Gaurang *et al.*, 2014). Jain (2014) discussed the problem of water scarcity in Indian scenario. Jain and Kumar (2012) explained the trends of rainfall and temperature all over India. The surplus water transfer of the region of north east part towards the drought affected areas of west and southern part is based on river linking plan in India (Joshi, 2013). Practices should be needed for the water resource management.

1.3. Flood and Drought management

The Government of India has developed a proposal to minimize the problems of drought and flood by proposing "Large Scale Inter Basin Water Transfer" or "Interlinking of Rivers" to provide an equal distribution of water. Pant and Pande (2012) explained different disasters, their impacts in Uttarakhand state in India and disaster management through disaster risk analysis and case studies. The impacts of drought, its management, data management and monitoring were described by Gupta *et al*. (2011). Flood is a major problem, which causes lots of damage each year (Pata, 2012). Zlatanova *et al*. (2014) focused on the need of flood management in India. The study on management of drought, its prevention, mitigation and preparedness was done by Rahore *et al.* (2014). Valli *et al.* (2013) studied the rainfall pattern with its Precipitation Concentration Index in several climatic parts in the state Andhra Pradesh.

1.4. National Perspective Plan (NPP)

The inter basin water transfer plan has a long history. Sir Arthur Cotton prepared a plan to link rivers in southern parts in India, then Captain Dinshaw J. Dastur given a proposal for the "Garland Canal" system (Sangwan, 2016). About 30 large scale Inter- Basin Water Transfer Links are proposed under this plan in 1980 by the Central Water

Fig. 2. Rainfall Variation in U.P and U.K States (Source: Irrigation Department U.P)

Commission and Indian Ministry of Water Resources to reduce water irregularity and to face the problem of flood and drought in respect of both Peninsular Rivers and Himalayan Rivers of the country. (Mehta and Mehta, 2013) focused on the environmental impacts, issues and challenges of Inter- Linking of Rivers in India.

1.5. Large Scale Inter-Basin Water Transfer or "Interlinking of Rivers" (ILR)

Interlinking of Rivers proposal is a mega water transfer project proposed by Indian Ministry of Water Resources for flood and drought management (Avadhut, *et al.* 2016). It is required to transfer the surplus water to deficit basins of the country for proper water distribution, sustainable use of water and control of flood and drought (Urfi, 2004). The purpose of the large-scale project is to divert the surplus water towards the places which are water deficit. (Boroujeni and Saeedinia, 2013) highlighted the importance of the diversion of surplus water from one river basin to other or sub basin through available natural drain from the catchment area of one reservoir to other. George *et al.* (2014) highlighted the concept of inter basin water transfer links with its impact on economic and ecological benefits

1.6. Proposed Sharda-Yamuna Link

Proposed Sharda-Yamuna link (S-Y) is a part of Himalayan river development component and one of the proposed river interlinks in India. The link is for transferring the surplus amount of water form Sharda river to water deficit Yamuna river and further towards drought prone western states of the country such as Uttar Pradesh, Haryana, Rajasthan and Gujarat. The purpose of S-Y link is to manage flood and drought disasters in U.P and U.K states in India. Except flood and drought control, it will also help in increasing the water quantity in its Enrouted and Command regions for other useful purposes.

Table 1. Rainfall Status: Enrouted and Command regions (mm)

Years	May	June	July	August	September
Champawat District (mm)					
2009	0.0	205.4	462.1	790.4	186.8
2010	72.0	83.8	810.1	791.0	490.5
2011	104.0	369.0	584.7	656.5	175.5
2012	1.0	23.0	404.7	391.5	401.5
2013	12.0	537.0	391.5	215.5	76.0
Nainital District (mm)					
2009	51.4	62.6	226.2	493.7	301.0
2010	57.7	120.3	819.0	703.4	702.5
2011	64.1	334.2	551.6	656.1	250.9
2012	2.1	62.9	596.9	472.1	310.9
2013	15.2	741.0	482.1	411.7	136.0
Udham Singh Nagar District (mm)					
2009	0.0	0.0	119.1	201.3	112.6
2010	90.0	7.0	748.5	497.9	604.6
2011	74.6	116.8	517.7	699.3	209.9
2012	0.0	11.7	248.5	324.8	161.9
2013	1.1	412.8	329.8	279.8	70.4
Haridwar District (mm)					
2009	17.2	67.3	315.0	257.2	222.7
2010	35.3	39.9	551.0	283.2	456.1
2011	62.7	225.9	482.4	484.4	126.8
2012	0.5	34.8	171.7	514.5	186.9
2013	6.6	387.8	304.7	412.8	48.2
Bijnor District (mm)					
2009	16.8	43.6	99.3	262.3	230.0
2010	20.3	7.9	568.0	299.8	347.5
2011	52.2	154.5	188.0	368.1	62.2
2012	0.7	1.6	179.3	212.3	175.2
2013	0.0	208.1	219.3	383.6	63.3
Muzzafarnagar District (mm)					
2009	3.0	1.9	81.8	28.1	113.5
2010	9.0	17.1	189.5	186.1	146.3
2011	37.1	76.0	142.7	105.0	51.6
2012	1.1	0.0	191.3	217.7	48.4
2013	11.0	219.1	95.0	385.5	67.3

Years	May	June	July	August	September
			Rampur District (mm)		
2009	0.0	2.7	66.1	160.5	95.7
2010	0.8	7.7	242.2	293.1	299.0
2011	29.3	107.9	130.5	221.1	49.5
2012	0.0	0.0	111.0	169.1	75.4
2013	0.0	151.5	224.8	226.1	53.2
			Moradabad District (mm)		
2009	5.7	13.3	145.6	195.9	171.2
2010	45.7	18.7	555.1	450.9	436.1
2011	43.4	193.6	242.7	518.6	134.3
2012	1.1	4.2	190.4	288.6	137.2
2013	0.5	364.3	340.6	311.8	54.4
			J. P. Nagar District (mm)		
2009	11.5	0.0	161.5	223.7	92.7
2010	7.0	1.5	564.3	295.3	397.3
2011	30.5	180.5	255.0	411.2	128.5
2012	0.0	2.0	260.1	296.4	70.4
2013	0.0	86.1	130.0	235.5	34.0
			Bareilly District (mm)		
2009	8.6	44.1	174.5	384.9	159.8
2010	25.6	9.1	50.8	427.9	425.9
2011	37.5	141.1	369.7	432.3	166.7
2012	0.2	12.7	166.2	248.5	148.5
2013	8.1	371.1	428.8	244.6	90.7
			Badaun District (mm)		
2009	16.0	0.0	154.6	296.2	102.5
2010	1.6	2.0	219.3	269.8	230.1
2011	30.8	162.9	253.2	198.8	72.4
2012	0.0	3.3	169.4	190.4	68.9
2013	0.4	166.7	190.5	117.2	75.0

(Source: India Meteorological Department)

2. STUDY AREA AND DATA COLLECTION

The area of the project comes under the state's Uttarakhand and Uttar Pradesh in India. Enrouted and Command regions are the two main parts of project. Proposed S-Y link will cross through Enrouted districts such as Champawat, Nainital, Udham Singh Nagar and Haridwar in Uttarakhand State and Bijnor, Muzaffarnagar districts in Uttar Pradesh and Command areas are Bareilly, Rampur, Moradabad, Badaun and Bijnor districts in Uttar Pradesh and Udham Singh Nagar district in Uttarakhand. Current Information is based on India Meteorological Department to study the climate change, flood and drought disaster issues.

3. RESULTS AND DISCUSSION

According to Indian Meteorological Department, during winters, U.P faced excess rainfall which is 18.2 mm in western

region and 16.8 mm in eastern part. In U.K, about 52.1 mm of rainfall occurs which is normal. During monsoon rainy season, U.P faced normal rainfall 66.9 mm in east and 65.6 mm in western part. While in U.K 107.4 mm of rainfall occurs this is normal. During March month, both U.P and U.K states faced excess rainfall, which are 47.6 mm and 8.9 mm in western U.P and 7.2 mm in eastern U.P.

During October, both U.P and U.K states faced from drought, low rainfall due to the climate change, which is 41.4 mm in western U.P and 48.8 mm in eastern U.P. and in U.K state, the rainfall is 56.8 mm. There will be no impact of S-Y Link Canal on the climate and rainfall status of U.P and U.K, but due to surplus water transfer, S-Y Link will provide an equal distribution of water in states U.P and U.K. Excess water during monsoons will be transferred through S-Y link to the drought regions of India. S-Y link is quite helpful in minimizing the risk of flood in U.P and U.K regions by proper distribution of water.

3.1. District wise Rainfall status for Last Five Years (mm): Enrouted and Command regions

On the basis of last five years rainfall data, it seems that Enrouted and Command areas of S-Y link such as in U.P (Bijnor, Muzzafarnagar, Rampur, Moradabad, J.P. Nagar, Bareilly and Badaun) and in U.K (Champawat, Nainital, Udham Singh Nagar and Haridwar) have faced excess rainfall during the monsoon seasons, the S-Y link will helpful in maintaining water balance in such regions (Table 1).

3.2. Climate of Uttar Pradesh

The state Uttar Pradesh has a climate of extremes. The temperatures of the state ranges from 0 °C to 50 °C in various parts causes droughts and floods due to irregular rains. The state has humid subtropical climate (warmer summers) and some areas are the semi arid regions. The summer season is very hot; winters are cold and rainy season sometimes very wet or very dry. Average high temperature varies from 38 °C in May and June to lower about 20 °C in January month. Maximum rainfall occurs from June to September month. Annual rainfall ranges from 1,000 to 2,000 mm in the east to 600 to1, 000 mm in the west. Rainfall variations occur due to the presence of Indo-Gangetic Plain, which is the plain of river Ganga and its tributaries.

3.3 Climate of Uttarakhand

Uttarakhand state is a region, which is covered by beautiful Himalayan peaks and glaciers, a part of the great Himalayan. The state gives rise to two important holy rivers Ganga and Yamuna in India. The climate varies from tropical to severe cold depends on altitude. The state has mountainous and humid Subtropical climate. The climate of Uttarakhand is affected by tropical monsoons and seasonal variations in temperature.

3.4. Variation in the Rainfall

Rainfall in India is highly uneven, so the distribution of water is not proper. In some places heavy rainfall occurs during the normal monsoon time causes flood. The scarcity of water in river basins is increasing fast with rise in population. According to Indian Meteorological Department, the irregular distribution of rainfall in last year's, causes great variation in climatic conditions causes disasters drought, flood etc (Fig.1).

3.5. Uneven rainfall distribution in North India (U.P and U.K)

Climate change affects many factors such as melting of glaciers, loss of life, loss of natural resources, winter rains, irregular rainfall, flora and fauna diversity etc. Climate change has increased over the last three decades due to the developmental activities. With the variations in temperature, rainfall flood and drought occurs in many areas of the north India (Fig. 2).

3.6. Rainfall distribution in Uttarakhand

Uttarakhand state is affected by the climate change. According to Uttarakhand Disaster Recovery Project 2013, heavy rains affect many regions of the state which is recorded of about 124.5 to 244.4 mm. This unprecedented rainfall resulted in increase in water levels and raises the flood situation in the river basins such as Mandakini, Alakananda, Bhagirathi caused extensive landslides at various locations such as Bageshwar, Chamoli, Pithoragarh, Rudraprayag.

3.7. Rainfall Distribution in Uttar Pradesh

The climate of Uttar Pradesh state is a humid subtropical with dry winter type and in some areas of the eastern part has semi-arid climate. In north India, several damages are caused by flood. The state U.P is situated in an Indo-Gangetic Plain, which is the plain of River Ganga and its tributaries. The summers are very hot; winters are so cold and rainy season is wet or very dry. If we see current map of variation in annual rainfall status in India (Fig.3), the average annual rainfall in U.P and U.K states is more than other states, which is in U.P (100-120 cm) and U.K (120-400 cm).

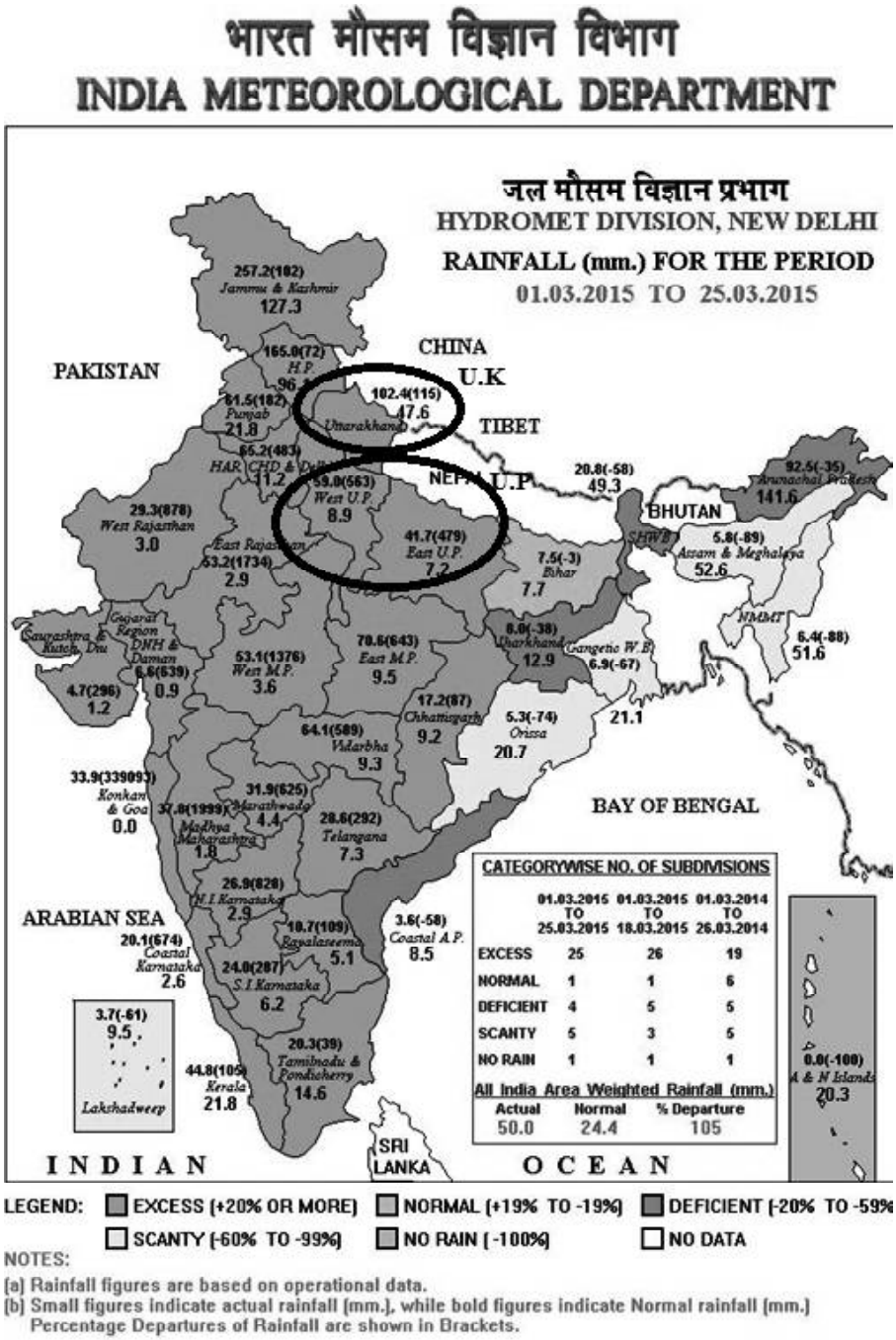

Fig. 3. Current Rainfall Status in India (March month) (Source: India Meteorological department)

4. CONCLUSION

It is beneficial to know the climatic conditions and rainfall status of U.P and U.K states and the role of proposed S-Y link in management of flood and drought disasters. The state Uttar Pradesh has a climate of extremes and humid subtropical climate and the Uttarakhand state is a part of Great Himalayan. It has mountainous and humid subtropical type of climate is present. The climate of Uttarakhand and Uttar Pradesh affected by seasonal variations in temperature and tropical monsoons. On the basis of India Meteorological department, the average annual rainfall in U.P is 100-120 cm and U.K is 120-400 cm respectively, which is more than other

states. Irregular monsoon results flood and drought in northern region of India. S-Y link is an inter basin water transfer plan, which is for minimising the risk of flood in U.P and U.K. There will be no impact of the link canal on climatic conditions of U.P and U.K states due to construction, but the link may be helpful in managing flood and drought by surplus water transfer. Surplus water during monsoons will be transferred through the S-Y link towards the drought regions of India. The link will provide an equal distribution of water in the states.

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GENERAL ARTICLE

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International Politics of Climate Change: A Study of Issues and Challenges

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ABSTRACT

The problem of Climate Change has become an enormous political and policy issue, at the same time it is also a conceptual and deliberative challenge. Global temperature is increasing day by day because of human caused greenhouse gases (GHG) emissions, and this warming is affecting both nature and human wellbeing. There is an urgent need to address the problem of climate change with all its related issues. While international environmental law has achieved notable successes and International legal programs to deal with climate change are already well underway. Indian climate politics continues to be focused on climate change as a foreign policy concern, and centred on climate negotiations; in a manner that is consistent with India's development needs and foreign policy concerns. The present paper explores the international climate change politics; negotiation process and domestic policy. It also investigates the issues of fairness and equity in the international climate change law and policy.

1. INTRODUCTION

Climate change has become the greatest environmental threat, facing humanity. Scientific evidence proves that human activities have been contributing to substantial increases in the atmospheric concentrations of greenhouse gases. The Intergovernmental Panel on Climate Change (IPCC) defines climate change as 'any changes in climate over time, whether due to natural variability or as a result of human activity'. The IPCC worked on various issues relating to climate change such as; assessing scientific information related to the various aspects of climate change; assessing the environmental, economic and social impacts of climate change and formulation of strategies for the management of global climate change. The Second World Climate Conference focused further consideration on climate change in 1990. The world's climate is changing and it will keep on changing all through the 21st century and beyond. Rising temperatures and other changes are already affecting many aspects of human society and the natural world. Climate change is changing eco systems on a remarkable scale. Further, the climate change crisis will cause increased floods, droughts, storms and sea-level rise leading to starvation, increases in the range and spread of diseases exacerbating current health problems, further water scarcity and massive displacement– affecting the right to food, health, subsistence, and the right to life for people around the world.

Climate change is not just an environmental issue, but is fast becoming the greatest human rights challenge of our time. The worst effects of climate change and associated human rights violations, however, can be prevented. The science of what is expected to prevent dangerous climate change is clear. The global temperature rise must keep as far below 2°C as possible compared to pre-industrial levels. As recognized by the United Nations Framework Convention on Climate Change (UNFCCC), UN Human Rights Council and numerous scientific bodies and governments, the impacts of climate change - as well as the responses taken to address climate change - are already affecting the enjoyment of fundamental, internationally recognized human rights. The climate crisis will lead to rising sea levels, thereby, causing the displacement of millions of people from their homes and means of making a living. For example, in the Indian subcontinent, if global temperature rises to 4-5°C, rising sea level and drought will displace about 125 million migrants from Bangladesh and other coastal areas. Thus, Climate change is a serious challenge for developing countries like India that face substantial climate changeability and are exposed to enhanced dangers from climate change. Climate change will also significantly

impact the economic growth and social development of India.

The present paper is an attempt to highlight the international climate change politics; negotiation process, issues of fairness and equity in the international climate change law, domestic policy framework and development.

2. RESEARCH METHODOLOGY

The research methodology followed in this work is purely doctrinal and does not involve any empirical approach. The major portions of sources for the completion of this study are taken from secondary sources such as the books on subject, newspaper articles, periodicals, internet sites. The paper has been mainly based on the authoritative texts on the United Nations Framework Convention on Climate Change. Besides, other important International Treaties, Conventions and Protocols have also taken into consideration for completion of this work.

3. INTERNATIONAL LEGAL FRAMEWORK ON CLIMATE CHANGE

The United Nations recognised the problem of climate change and adopted UNFCCC to address the issue of climate change on the worldwide level. It entered into force on 21 March 1994. As of October 2016, there are 197 Parties (196 States and 1 regional economic integration organization) to the UNFCCC. The scientific community frequently provides comprehensive and government affirmed assessment reports on climate change under the IPCC. These assessment reports exhibit mounting scientific evidence of a global climate crisis resulting in the increase of weather extremes, for example, droughts and floods caused by changing climate patterns. Evidence presented by the IPCC demonstrates that the human effect on the planet over the past two centuries led to environmental degradation and atmospheric modification that result in climatic changes and loss of biodiversity with irreversible patterns. Natural and social researchers concur that mankind is entering another age named the *Anthropocene*, in which human impact has become so significant that it results in "unacceptable environmental and social change". This contribution examines the condition of international climate change politics in 2012.

In 1997 governments agreed on the Kyoto Protocol as the first global climate treaty requiring industrialized countries to reduce their greenhouse gas emissions by a total of 5 percent over the 5 year period from 2008-2012 based on their 1990 emissions. The Kyoto Protocol had various shortcomings and these are; the early expiration date, the US withdrew its participation and the path-dependent agreement to only account for the emissions of countries considered as industrialised countries in the early 1990s, the so-called Annex-1 countries. This way reliance makes it difficult to consider the significant emitters of greenhouse gases of the 21st century; for examples, in 2010 China represented for 29 percent and India for 6 percent of global emissions, while the EU-27, Russia and Japan, as the three major actors covered under the Kyoto Protocol, joined record for just 20 percent of global emissions.

Given the lapse date of the Kyoto Protocol, nations agreed in the 2007 Bali Roadmap to negotiate a post-2012 climate agreement until the 15th Conference of the Parties (COP-15) to be held in December 2009 in Copenhagen. In Bali Action Plan, all developed country Parties consented to quantified emission limitation and reduction objectives, while ensuring the comparability of efforts among them, taking into account differences in their national circumstances. Developing nation Parties concurred to "Nationally Appropriate Mitigation Actions (NAMAs) context of sustainable development, supported and empowered by technology, financing and capacity-building, in a measurable, reportable and verifiable manner." Many parts of the Copenhagen Accord were brought into the formal UNFCCC process as part of the Cancun agreements. The 2010 Cancun Agreement fortified the substance of the Copenhagen Accords. These mark the initial steps on the way towards a global climate design that includes both developed and developing countries and in this way signals a departure from the selective Kyoto Protocol approach of setting the sole responsibility for mitigation on the industrialised countries' shoulders. States agreed for the first time that global temperature increase is to be kept below 2°C and that all, even the developing countries, should contribute to achieving this objective, within the limits of common but differentiated responsibilities, by nationally appropriate mitigation activities and stronger action on forests. To accomplish this target, industrialised countries provide financial assistance by means of the Global Climate Fund; encourage the transfer of low carbon technologies and support capacity-building. Therefore, a patchwork of different mitigation and adaptation efforts is emerging referred to as climate regime complex or as building block of diffuse, disintegrated individual actions setting humanity on an emission trajectory towards 3-5 degree temperature increases by the end of the 21st century. The 2011 negotiations in Durban, South Africa resulted in a second commitment period of the Kyoto Protocol (however, without the participation of the United States, Canada and Japan)

and the "Durban Platform on Enhanced Action". This was made conceivable by the European Union that consented to a second commitment period of the Kyoto Protocol – the major demand of the G77 developing countries – in exchange for India, China and the United States agreeing to negotiate a subsequent treaty by 2015 producing results in 2020, which includes all major emitters of greenhouse gases.

The international climate politics and negotiations have too long been viewed as an unsolvable problem in a deadlock circumstance, particularly after the apparent disappointment of the Copenhagen summit. Eventually, this study comes at an important juncture in international climate diplomacy, as on 12 December 2015 in a historic accord to end COP 21 in Paris, 195 nations approved a deal to keep global temperature rise below 2 degree Celsius. According to the UNFCC, pledges from the 148 countries to cut GHGs by 2030 are inefficient to limit global warming to 2°C above pre-industries levels. Thus, the Paris Agreement on climate change marks a milestone in preserving the earth's temperature and provides a floor on which to ambition and action. The Paris Agreement was opened for signature on 22 April 2016 at a high-level signature ceremony convened by the Secretary General in New York. The Agreement will enter into force on 4 November 2016, thirty days after the date on which at least 55 Parties to the Convention accounting in total for at least an estimated 55 % of the total global greenhouse gas emissions have deposited their instruments of ratification, acceptance, approval or accession with the Depositary. Presently, there are 191 signatories to the Paris Agreement. Of these, 74 Parties to the Convention have also deposited their instruments of ratification, acceptance or approval. A total of 58.82 % of the total global greenhouse gas emissions has been achieved. The latest instrument of ratification was received on 5 October 2016.

4 ISSUES AND CHALLENGES IN CONTEMPORARY GLOBAL CLIMATE CRISIS

There are number of issues and challenges at international and national levels faced by the parties to UNFCCC, while addressing the global climate change problem. For the purpose of convenience of study, the following points are discussed as below;

4.1. Equity and Fairness in negotiation on global climate change law and policy framework

The issue of equity in assigning state obligations to mitigate climate change and help i0n climate adaptation has come to the forefront of global climate change negotiations and the adopting legal framework. The principle of "Common but Differentiated Responsibilities" (CBDR), as specified in Principle 7 of the Rio Declaration on Environment and Development and in Article 3 of the UNFCCC envisages these equity dimensions. It recognizes common responsibilities shared by all States for protecting the global environment, the need to consider the varying levels of historical and present contributions to the climate change problem, and States' differing capacities to respond to climate change effects. The substance of this principle has turned into a profoundly contested battleground in climate negotiations, especially between developed and developing nations. As the ultimate objective of UNFCCC and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner. Fairness claims and discourse are a main part of the climate change regime. For as far back as a quarter century, developing countries contended for equity, framed as reasonable distribution of the Earth's capacity to absorb human greenhouse gases. However, position has remained to a great extent a political stance, instead of a basis of for discourse in negotiations. The UNFCCC, which is the multilateral reason for action to combat climate change, itself, assigns a prominent place to equity. Therefore, it is desirable to enhance our comprehension of the dimensions and application of fairness concepts in climate negotiations. Understanding fairness in climate change is all the more essential as negotiators, policy makers, and supporters turn to consider extending and expanding the climate change regime after the end of the first commitment period of the Kyoto Protocol in 2012. Fairness can be expected to come to the fore even more in light of the fact that the future phases of the international effort to battle climate change will require some form of GHG control for all countries, not only the group of industrialized countries covered under the Kyoto Protocol. Questions of equity and fairness are very crucial to the challenge of tackling global climate change. The unpredictability of the question emerges from the global and long term nature of the issue. Some observers have argued that questions of fairness are of secondary, largely rhetorical significance: willingness to pay is what matters. Such perspectives develop from a realist point of view on the relations between states and scepticism about international law.

The way that UNFCCC came into force three years after the fact in 1994, is the foundation of the global response to climate change. The agreement itself set no binding limits on greenhouse gas emissions for individual countries and contains no enforcement mechanisms. In that sense, the treaty is considered legally non-binding. Instead, the treaty provides a framework for negotiating specific international treaties that may set binding limits on greenhouse gases. Thus, it does not contain binding emission targets. For this reason, nations initiated a negotiating process that culminated in the adoption of the Kyoto Protocol in 1997. The Protocol, which entered into force in February 2005, commits industrialized countries to reduce their GHG emissions by an average of 5.2 percent from1990 levels during the first commitment period from 2008 to 2012.

The discourse on fairness is woven into the political process of the climate change regime. It has been observed that international environmental negotiations among developing countries have regularly cast their contentions in terms of justice and fairness. Developing countries have viewed climate change with regards to their economic and social development. Imposing limits on their growth is regarded as unfair, given that they have not yet accomplished the level of development of industrialized countries. Therefore, Developing countries do not want to be held responsible for remedying a problem largely not of their making. Accordingly, they emphasize industrialized countries' dominant share of cumulative carbon dioxide emissions 76 percent. Meanwhile, 140 countries are responsible for only 10 percent of annual emissions. The argument from historical responsibility has evident attractions in the international climate change discourse. At face value, essential ideas of fairness appear to propose that the main contributors to a problem should be the ones carrying out abatement.

The UNFCCC also addresses issues of equity and solidarity, providing that vulnerable countries, especially Small Island Developing States and Least Developed Countries (LDCs), because some countries are more vulnerable and less ready to take adaptive measures than others, and should be helped in adapting to the adverse impacts of climate change. Due to their vulnerability to climate impacts, over the long term, LDCs stand to gain from stringent emission limitations by major emitters. In fact, the individual and total GHG emissions of this group of countries are almost negligible. The issue is even more pressing for small Island countries and have been the most vocal in calling for strict emission limitations. And their claim for fairness is directly or indirectly based on the existential threat posed by climate change. They have enhanced their own bargaining power by using hard and soft strategies. The evolving negotiating strategies in Russia, India and the Association of Small Island States (AOSIS) have been examined in this special issue in order to focus on the current hurdles and opportunities in the negotiation process and to analyse the changing country and coalition techniques and strategies.

The above negotiations take place between state actors and within the scope of the law of treaties and the formal rules of procedure that operate within the UN system, the analysis also make use of the relevant legal literature. It is contended that a fundamental problem in climate change negotiations has been disagreement about the principles assign to allocate responsibility between nations. This difference needs to be confronted and dealt with if any progress is to be made in the climate change negotiations. Thus, Climate change law is a new and rapidly developing area of law.

4.2. Climate Change and Development

As discussed earlier, developing countries have seen climate change with regards to their economic and social development. Imposing limits on their development is viewed as out of line, given that they have not yet accomplished the level of development of industrialized nations. While not discounting supposed cleaner types of improvement, they don't wish to manage any extra cost, especially when the developed countries accomplished their status with few, assuming any, environmental constraints. From the point of view of creating nations, the guarantee of these arrangements has not been satisfied. And Developing countries do not want to be held responsible for remedying a problem largely not of their making. At Berlin, Cancun and Durban, the development needs of developing country parties were repeated. For instance, the Durban Platform reaffirms that social and economic development and poverty eradication are the first and abrogating needs of developing country Parties, and that a low-emission development strategy is a key to sustainable development, and that the share of global emissions originating in developing countries will grow to meet their social and development needs. At the G20 inaugural session in Antalya (Turkey), 0n November 15, 2015 it was said that India has anticipated a solid result at the Paris conference on climate talks within the framework of UN convention on climate change that should have an appropriate balance of collective action: equity and common but differentiated responsibility and respective capabilities. Further, it declared that while it had 'ambitious' plans for addressing the challenges of climate change, it did not see

development and climate change as a competing objectives.

By a few assessments, emissions from developing countries of carbon dioxide, the most important GHG, will in the next decade exceed the share from industrialized countries. Developed countries contend that reduction measures therefore are only meaningful if developing countries are set up to trim their emissions. In turn, developing countries look forward, battling that they should not to bear the burden of abatement at this basic stage in their development. They point also to the historical responsibility of the developed countries, invoking the polluter pays principle. Small islands and other especially helpless developing countries seek to emphasize worldwide solidarity and fairness when pressing claims for assistance to adapt to the unfavourable effects of climate change. These are just a portion of the issues weaved in the debate on climate change that lead, directly or indirectly, to the question of fairness. As Climate change comes from the exercises at the very heart of our economies and lifestyle. Around 85 per cent of world energy is supplied from fossil fuels. Altogether, carbon dioxide from the burning of fossil fuels is responsible for more than half of all GHG outflows; approximately another quarter originate from carbon dioxide discharged during the time spent deforestation and from different gasses discharged from agricultural and other activities. Numerous environmental issues originate from human activity, but none relate so directly to the driving force of modern economies.

4.3. Domestic politics and Climate Change

India's emissions are ranked the third highest in the world today but as a developing economy whose industrial process began only in the latter half of 20th century, it does not bear historical responsibility for emission reduction targets. Further, India's contribution to the combined global CO2 emissions is just 5 per cent. India is a party to both the UNFCCC and the Kyoto Protocol. Although neither the Protocol nor UNFCCC obligate India to check its greenhouse gas emissions, the administration is undertaking several voluntary measures to curb its emissions. As a developing country, India has no binding emissions limits under the Protocol. India is an active participant in the Clean Development Mechanisms (CDM) established under the Protocol. Over several decades India has pursued policies and publicly funded programs focused on energy conservation and deployment of renewable energy technologies. This has been backed by legislation, regulation and tariffs arrangements. India has pledged to reduce the emissions intensity of its GDP by 20-25% below 2005 by 2025.

Much of Indian climate politics continues to be focused on climate change as a foreign policy concern, and focused on climate negotiations. The long-held Indian negotiating position has contended that India cannot sensibly be interpreted as a 'major emitter' of GHG, that equity contemplations should frame the foundation of a global climate regime, and subsequently, that Indian domestic policy should a great extent be offended from the prerequisite of climate negotiation. Instability over the international negotiations process also leads sustainable development realists to control their dynamic nature to forcefully advance a local co-advantage plan. The most facilitators of this move is the confining of India's domestic climate policy within the structure of 'co-benefits'. Initially brought into policy discourse through the National Action Plan on Climate Change, co-benefits are 'measures that promote our development objectives while also yielding co-benefit for addressing climate change effectively.' The prioritization is deliberate and unequivocal: development objectives are primary and climate change is secondary co-benefit. Most vital, a co-benefit approach is consistent with India's core negotiation principle of 'common but differentiated responsibility and respective capacities'. It permits exploration of domestic policy changes, but in manner that is driven by domestic development objectives. The challenges ahead for sustainable development advocates; whether of the realists or internationalists sort, is to deepen and operationalize the concept of climate co-benefits, and work it into a broader political vision of a sustainable and inclusive society? Only such broad vision can be effectively brings climate change closer India's political standard.

In India, the climate change debate has firmly been joined. While North-South parts of climate equity have dominated the Indian discourse, but the presentation of intra-country equity across income classes- 'the Hiding behind the Poor' debate- as a significant new development in Indian climate change politics. Since 2007, the Indian Parliament has witnessed many and heated debates over what India's role should be in the global climate negotiations. In the last couple of years, climate change concerns have turned out to be more standard, to some degree driven by the growing attention to national policies in the global negotiations. Accordingly, enthusiasm for climate change has broadened, as policy makers, journalists, business leaders and civil society activists all try to comprehend what climate change implies for their areas of focus. From various perspectives, the debate has shifted from whether to engage with climate change, to how to do so in a manner that is

consistent with India's development needs and foreign policy concerns.

Climate change is an enormous political and policy issue, at the same time, it involves a conceptual and deliberative challenge. Diverse frames for climate change can prompt distinctive political and policy solutions. Remarkably, environment versus development frames of the problem, which frequently guide to northern versus southern perspectives, give altogether different political and policy focuses. As far as degree, it covers both the worldwide negotiation process and domestic policy and politics. The international negotiations process has dominated the previous decade and a half of climate debate. The following, Copenhagen (2009) and Cancun (2010) climate negotiations, the global regime seems to be moving relentlessly toward discovering methods for recognizing, sanctifying and accounting for national actions, instead of driving national change through international agreement in spite of the fact that there is savage contradiction in the global debate on whether this good or bad result. However, paying attention to domestic policy goes beyond a perusing of tea leaves on the course of the global regime. Eventually, policies addressing climate change have to be internalised within national political economies and institutionalized within national laws, policies and regulations, in a way consistent with domestic politics and aspirations. In Paris conference on climate talks within the framework of UN convention on climate change, India has followed the principles of equity and common but differentiated responsibility and respective capabilities. Further, it affirmed that while India had 'ambitious' plans for addressing the challenges of climate change, it did not find development and climate change as a competing objectives. Thus, it is important for India to adhere to the principle of common but differentiated responsibility in its negotiations and to take forward the concept of equalising per capita emissions of countries proposed by the Prime Minister of India. On 2 October 2016, India ratified the Paris Agreement on Climate Change by depositing the instrument of ratification with the United Nations and it is the 62nd Country to ratify the agreement, which will enter into force one month after 55 countries that account for 55 per cent of global emissions ratify the agreement. India's decision to join, overcoming a reticence that was apparently linked to the failure to enter to the Nuclear Supplier Group, is commendable. However, India has denied the allegation that there is any link between the ratification of Paris Agreement and membership issue of Nuclear Supplier Group.

5. CONCLUSION AND SUGGESTIONS

Extreme weather are expanding because of global warming and Climate change is turning out to be progressively certain with more extraordinary events happening around the world. The issue of equity in allotting state obligations to mitigate climate change and help in climate adaptation has come to the front line of global climate change negotiations and the adopting legal framework. The principle of CBDR, as articulated in Principle 7 of the Rio Declaration on Environment and Development and Article 3 of the U.N. Framework embodies these equity aspects. It recognizes common responsibilities shared by all States for ensuring the global environment, the need to consider the varying levels of historical and present contributions to the climate change problem, and States contrasting capacities to react climate change impacts. The content of this principle has turned into a profoundly challenged battleground in climate negotiations, particularly between developed and developing countries. All developed country parties have consented to measured emission limitation and reduction objectives, while guaranteeing the equivalence of endeavours among them, considering contrasts in their national conditions as a component of the Bali Action Plan embraced in 2007. Developing country Parties agreed to nationally appropriate mitigation actions setting of sustainable development, supported and empowered by technology, financing and capacity-building, in a quantifiable, reportable and evident manner. As part of the Cancun agreements, developed and developing countries have submitted mitigation plans to the UNFCCC. These arrangements are accumulated with those made as a component of the Bali Action Plan. Thus, the 2010 Cancun Agreement strengthened the substance of the Copenhagen Accords. These mark the initial steps on the way towards a worldwide atmosphere engineering that incorporates industrialized and developing countries alike. And in this manner, signals a departure from the selective Kyoto Protocol approach of setting the sole responsibility for mitigation on the industrialised nations' shoulders. The Countries agreed that global temperature increase is to be kept below 2°C and to this end; even the developing countries should add to achieving this objective, within the breaking points of common but differentiated responsibilities, by nationally appropriate mitigation activities and stronger action on forests. To accomplish this objective, industrialised countries give financial assistance via the Global Climate Fund; facilitate the transfer of low carbon technologies and support capacity-building. From the outside point of view, it is conceivable to construe

on the present condition of climate politics that progress is slow and there is still no legally binding global agreement that dependably confines greenhouse gas emissions to safe models proposed by the IPCC, in this way climate change politics has failed. From the insider viewpoint acquainted with the UNFCCCs administration structure just prepared to do extremely steps because of national sovereignty and state's self-interest, the COP-17 result denote a break through. As on 12 December 2015 in a historic accord to end COP 21 in Paris, 195 countries affirmed an arrangement to keep global temperature rise below 2 degree Celsius. Government of India in its Intended National Determined Contribution expressed ahead of the COP-21 in Paris made a commitment to create an additional forest cover by 2030 through existing different projects. Small islands and other especially vulnerable developing countries try to stress worldwide solidarity and decency when pressing claims for help to adapt to the adverse impacts of climate change.

The following are suggestions to address and improve the problems of climate change:

- Legally restricting global agreement as per limitations prescribed and to safe standards proposed by the IPCC that reliably limits global greenhouse gas emissions.
- All countries should enact a comprehensive national legislation on climate change to address climate change problem.
- Adopt urgent and aspiring mitigation action and provide scaled-up support and resources as means of preventing the most catastrophic effects of climate change.
- Establish safeguards and accountability procedures to guarantee that climate policies are outlined, executed and monitored in a manner that protects the privileges of affected people and groups.
- It is desirable to apply the concept of equity and fairness in climate change law, policies and negotiations.
- Immediately, industrialised countries should provide different aids to developing countries like financial assistance; facilitate the transfer of low carbon technologies and support capacity-building.
- All countries should adopt the concept of sustainable development. Further, they should take steps at national level by nationally appropriate mitigation activities and extensive action on forests. For India to accomplish an extra forest cover has to implement the existing programmes and schemes, undertaken by the Central Government and States Governments.

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COMMENTARY

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Non Sacchariferous Super Sweet Plant Species to Combat Sugar and Energy Crisis, Sugar Caused Health Disorders and Environmental Warming

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ABSTRACT

There are 15 super sweet plants spicies in India which are 100-10,000 times sweeter than sugarcane sucrose (saccharide) and accumulate non saccharide super sweet principles like proteins, terpenoids, flavonoids, coumerin etc and their 100 mg provide little or no calorie and sweetness equivalent to 1kg sucrose. Consequently these are becoming useful to diabetic, cardio vascular, kidney, obesity and dental caries patients and are reducing their disorders and mortality significantly. The ingrained higher microbial activities in such plants have been found to deplete CO2 fast through active carbonic anhydrase enzyme and thereby help in combating environmental warming. Similarly because of high potency for bio-fuel production and intense sweet principles accumulation, these plants species appears to be most suitable to solve energy and sucrose crisis and save about 4.5 million ha land of sugar cane for the use of agriculture, industry and housing in India.

Untamed burgeoning population and unplanned human activities pertaining to industrialization, agricultural practices, tourism, urbanization, food habit etc. are causing fast shrinkage in arable land, environmental degradation, soil sickness, and depletion of the natural resources including fossil fuel. Due to these provisos, arable land is declining @ 10 ha/min at global level (Buringh, 1987), 0.1 million ha/yr at national level (MOA2013), and that of N fertilizer response decline to a level of 60% of intensively cultivated Indian soil (Dwivedi and Dwivedi 2005). The addition of 2.1 billion tonnes of carbon /year in the atmosphere in India excluding that of per person carbon release in the environment at the rate of 17t in America, 16.6t in Australia, 7.4t in China etc have been recorded as pollutant (Annon.2015). All these factors are congruently resulting food, sugar and energy crisis, sugar caused health disorders and environmental warming. At this juncture, there is need to examine the potentiality of non saccharifirous super sweet (NSSS) plants which are reported to be 100-10000 times sweeter than sugarcane, efficient alcohol fuel producer (Dwivedi 2016) embedded with micro-organism possessing most efficient CO_2 depleting enzyme carbonic anhydrase, with a view to obviate aforesaid problems including environmental warming.

1. Sugar Requirement

Sugar is most favourite dietary gradient and its requirement is increasing day by day. Hence, it is most arduous task to meet 35-40 million tonnes of sweeteners (sucrose) requirement of India and 210 million tonnes globally by 2020 under aforesaid situations through sacchariferous sweet crops specially when the break though in the technology of sugar production is not offing and arable land is shrinking. This could be met through the sweeteners of non saccharifirous super sweet (NSSS) plants, which are 100-10,000 times sweeter than Sugar (Table-1). These sweeteners are non sugars with lower intrinsic energy and plants producing such sweeteners are called non sacchariferous super sweet plants (Dwivedi 1999). About 0.1-10 mg of NSS sweeteners would provide sweetness equivalent to 1000 mg sugars which in term would provide less than 30 cal and more than 4,000 cal energy respectively (Dwivedi 2016).

2. Sugar Mediated Health Disorders

The sweeteners are most tasty integral part of human's daily diet and consumed by human – being in an uncontrolled manner. Consequently, the health disorders like diabetes, cardiovascular diseases, dental carries, kidney disorder and diseases, hypertension etc. are caused which could only be mitigated by using very small amount of vegetal non – saccharide super (NSS) sweetener e. g. terpenoids, dihydrochalcones, dihydroisocoumerin, protein, steroidal saponine, (kinghorn & Seojarto 1986) which are 100-10,000 time sweeter than the sucrose (Table 2). The consumption

Table 1. Sugar and non saccharide super sweeteners (NSSS) "Stevioside" requirement of India.

Year	Area required for sugarcane cultivation (million ha)	Amount of sugar required.(million t)	NSSS requirement (t)		Area required for NSSS production (ha)	
			50% replacement of sugar	100% replacement of sugar	50% replacement of sugar	100% replacement of sugar
2015	5.01*	30*	37500	75000	9375	18750
2020	5.50*	40*	50000	100000	12500	25000

*Sugar requirement and sugarcane crop area (cooperative sugar 2016)

NSSS quantity and land area requirement calculated by authors.

of 0.1-10 mg of such sweeteners would provide sweetness equivalent to 1 g of sucrose and there by negligible calorie/ zero calorie (energy) to human body.

Already, Indian is importing a huge amount of non saccharide super sweet principles worth about Rs. 650 millions mainly from Japan, china, USA and Australia (Dwivedi 2016) to meet the sweeteners requirements of 72 millions diabetic patients (kurup2007) and 240 million cardiovascular disease people and two hundred million high blood pressure patients (London, PT-2016) The human death due to diabetes alone is about 10 lakhs/ year, hence the use of non saccharide super sweet principles and cultivation fo super sweet plants are the only options left to meet the challenges. The potentiality of super sweet plants, their identification, habitat, cultivation practices and extraction of super sweet principles have not been given attention in India, so far. Consequently these plants are becoming extinct due to ignorance.

3. Super Sweet Plant Species in India

The following super sweet plant species and their super sweet principle were reported by Dwivedi (1999) (Table 3).These plant species are growing under natural habitat in different parts of India.

4. Environmental warming

This is a seriously growing problem throughout the world. The green house gases viz. CO2, Methane and nitrogen oxide and chlorofluro carbon, fine lead particles, water vapors etc are raising evironmental temperature. Annual addition of 2.1 billion tonnes of carbon at global level in the atmosphere is the main reason of warming. Super sweet plants are embedded with alcohol, methane and formic acid farming bacteria (Dwivedi 2016).These micro-organisms including micro-algae, *Bacillus subtilis and other Bacillus species, E.coli* etc which have carbonic anhydrase (CA) enzyme with very high turnover rate (Kcat) ranging between

Table 2. Some Indian non sacchariferous super sweet (NSSS) plants species, their sweet principles, sweetness and calorific values as compared to sacchariferous sugarcane sugar (Dwivedi 2005).

Sl No.	Sacchariferous Sweet (SS) saccharifeous super principles sweet (NSSS) sweet	Plant and Non Plant Species	Sweetness Compared to sucrose	Calorific Values (Cal/g)
NSSS Plants				
1	*Perilla frutescene L;* Ban Tulsi	Perillartin	1000 -2000	3600-3800
2	*Abrus precattorius L* Rati / Ghunghchi	Abrusoside	100-200	3800-3900
3	*Glycyrrhiz glabra L.;* Licorice	Glycyrrhizin	100-200	3850-3900
4	*Stevia rebaudiana Bertoni; L.;* Stevia	Stevioside	300-400	3800-3900
5	*Polypodium glycyrrhiza L.;* Sweet fern	Olsadin	800-1000	3600-3900
SS Plants				
6	*Saccharum officinarum L.;* Sugarcane	Sucrose	1	3950-4050

Table 3. Non-saccharide Super (NSS) Sweeteners and Non Sacchariferous Super Sweet (NSSS) Plants of India (Dwivedi 1999).

Non-saccharide super sweet sweeteners (100-10,000 times sweeter than Sucrose)	Non Sacchariferuos Super Sweet Plants
Mono terponoides : Perillartine	*Perilla frutescens L*
Sesque terpenoids : Harmadulcin	*Lippia dulcis Trev.*
Diterpenoids : Steviosides	*Stevia rebaudiana Bertoni*
Triterpenoids : Glycyrrhizin	*Glycyrrhiza glabra L.*
Abrusoside	*Abrus precatorius L.*
Osladin	*Polypodium glycyrrhiza L. And P. Vulgaris L.*
Phyllodulcin	*Hydrangia macrophylla Seringe*
Neohesparidin	*Citrus auruntium L.*
Glycyphillin	*Smilex glycyphylla Sm*
Naringin	*Citrus paradise Macl*
Hesperetin	*Citrus sinensis L.*
Trilobatin	*Symplococus paniculata Miq.*
Protein – Monellin	*Diascoreophyllum commuinsii Stapf*
Protein-Curculin	*Curculigo latefolia L.*

10^4 and 10^6 per second for catalyzing reversible conversion of CO2 to bicarbonate. (Faridi and Satyanarayanan 2015).

$$CO2 + H2O \rightleftharpoons HCO3 + H^+$$

Carbonic hydrase is an mtetallo-enzyme in which zinc is present at reaction site between enzyme and substrate (Dwivedi and Randhawa 1974, Dwivedi and Singh 1991, Faridi and Satyanarayan 2015 and Dwivedi 2016). This enzyme is being used in bioreactors for converting CO2 to bicarbonate and thereby cement and building material formation. Furthermore, HCO3 produced after CO2 capture can also be used to generate bio fuel by serving as carbon source for the cultivation of algae (Faridi and Satyanarayan 2015).

5. Bio-Fuel

As mentioned in Table – 3, super sweet plants have protein, terpnoids, osladin etc. sweet principles. These can be converted into fuel with similar energy, density, freezing point and hydrocarbon molecule present in petroleum fuel utilized in jet, as has been done on other oil and protein rich plants (Wosken 2008).The plants as mentioned in Table 3, except *Citrus paradise* Macl. are neglected and growing in the forest, valleys, on mountain and under stress environment in a wild manner. Most of the non sacchariferous super sweet plants are found to grow under stress environment at their natural habitat. Field experiments conducted at IISR, Lucknow during the year 2002-2005 vouched that *Abrus Precatorius* and *Glycyrrhiza Glabra* could be cultivated on alkali soil at ESP 25-30 and ESP 20-25, respectively under sole and intercropping system and thereby blooming of waste alkali and improving farmers and national economy (Dwived 2005). If these two (*A.precatorius* L. and *G. glabra* L.) are preserved under wild condition the amount of bio-fuel production would be as follows : (Table 4)

Table 4. Estimated production of Bio-fuel by combined biomass of *Glycyrrhiza glabra L.* and *Abrus precatoriu L.* Under protected and natural conditions.

Sl. Nl.	Conditions	Bio-Fuel Production (million litres)			
		World		India	
		2007	2020	2007	2020
1	100% protection	110	210	22	20
2	Natural/50% protection	55	105	11	15

(Dwivedi 2005)

6. Saving of Land

The super sweet plants cultivation would help in two ways in saving /squeezing 5.0 million ha of land used for sugar cane cultivation, which in fact is not sufficient, to meet the

sugar requirement of country even by 2030.

1. The recovery of super sweeteners ranges between 10- 14 % like that of sugarcane. Super sweeteners would be amalgamated with sugar to raise their sweetness by5 to 10 times. Thus 2-0 3.5 million ha land of sugar cane would be required to meet sugar requirement of country.super sweet plant would require only ten thousand ha land to produce super sweeteners for amalgamation.
2. If 100% and 50% requirement of sugar is met by super sweet principle then it will require 0.5- 1.0 million ha land respectively to feed sugar to nation. Consequetly saving of 4.0 to 4.5 million ha of land would be possible (Table 1).

7. Saving of Water

NSSS plants require less water as they are adapted to drought and salt stress conditions (Table 5). Hence as campared to sugarcane a great saving in water consumption is expected. However no detailed studies on water use efficiency in NSSS plants have been done like that of sugarcane where WUE (mole of water used/mole of CO_2 fixed) has been found to be 295 (Dwivedi, 2016a).

Table 5. Water requirement of Sugarcane and NSSS plants in tropical and subtropical areas.

Plants	(mm rainfall essential for good growth)	
	Tropical	subtropical
Sugarcane	2500-3000	1500-2000
NSSS Plants	1500-2000	1000-1500

NSSS – Non sacchariferous super sweet

Utilization of waste land

Most of the NSSS plants are growing under stress conditions on salt affected land, range and mountain in the forest and grassland and under waterlogged and dry conditions. It has been noted that *Abrus precatorious* and *Stevia rebaudiana* can grow on ESP 25-30 and ESP 20-25 respectively (Dwivedi 2005). Hence under planned conditions, the waste land could be utilized for for growing these plants; the good lands could be utilized for oilseeds and pulse crops as they are required most today.

Visualizing the ongoing facts, it may be mentioned that if the super sweet plants species are protected and nurtured under natural habitat, little good additional land would be required for their cultivation to meet sugar requirement of the people. All these would congruently help in rectifying sugar and energy crisis and improving sugar mediated human health disorder and mitigating environmental warming effect with little cost and efforts.

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COMMENTARY

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Bougainvillea: A Long Journey from Rio to Lucknow

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ABSTRACT

Bougainvillea, native of South American sub-tropics, was first collected by Commerson, a French Botanist, from Rio de Janeiro, Brazil, who named it after Louis Antoine de Bougainville, the French navigator with whom he went on voyage around the world during 1766=1769. From its native sub-tropical regions, bougainvilleas were introduced to temperate regions of European countries, where these were grown in the glasshouse. The history of domestication of bougainvillea is 250 years old and in this period there have been many landmark in the bougainvillea cultivation. In India, *Bougainvillea spectabilis* was first introduced in Kolkata in 1860 from Europe and the improvement work on bougainvillea started in early 20th century, with the introduction of a few cultivars by the Agri-Horticultural Societies, Kolkata and Chennai. But it achieved its popularity in 1920 with the introduction of the cultivar 'Mrs. Butt' in Kolkata from Royal Botanic Gardens, Kew, England. Out of 10 species, only *B. glabra* Choisy, *B. spectabilis* Willdenow, *B. peruviana* Humboldt & Bonpland and a natural hybrid *B. x buttiana* Holttum & Standley, are of horticultural importance. Today, a large number of *Bougainvillea* cultivars (500 cvs.) are available from three to multibracted ones in various colour and shades to variegated foliage as aresult of natural selection and breeding. 50% of the *Bougainvillea* cultivars have been evolved in our country. India has been recognized as the International Registration Authority for Bougainvilleas. The Botanic Garden of CSIR-National Botanical Research Institute, Lucknow has rich germplasm collection of *Bougainvillea* (200 species/cvs) and serves as the reference centre.

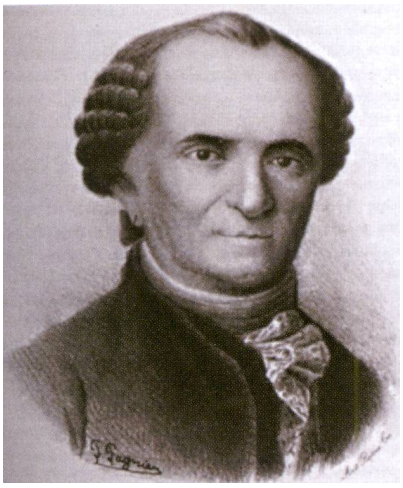
Centre of origin of many plant species like wheat, potato, tomato, gladiolus, chrysanthemum, and bougainvillea may be far away from their centre of collection, documentation and improvement.. *Bougainvillea* an ornamental plant is from Rio de Janeiro but it has flourished and gained importance in India and other tropical countries in the South East Asia.

Bougainvillea, a native of South American tropics and subtropics, was first collected by Commerson a French Botanist from Rio de Janeiro, (Brazil). Commerson named the plant after Lois Antoine de Bougainville, the renowned French Navigator and the trusted General of Napoleon Bonaparte, Emperor of France with whom he went on voyage to South America during 1766-1769. It was the time when europeans were frequently exploring the planet Earth for discovering the new regions, conquering and bringing the plant wealth to their nations.

From its native, tropical and subtropical regions, Bougainvilleas were first introduced in the temperate regions of European countries, where they were grown in the glass houses. However, in the warmer parts of Mediterranean, Canary Islands (Spain), African countries

and India the environment was akin to what they had in their native place. The history of documentation of Bougainvillea is ca 250 years old. In this period there have been many **land marks** in the Bougainvillea cultivation. In India, *Bougainvillea splendens,* was first introduced in Kolkata in 1860 from Europe. The improvement program on the taxa was umdertaken in early 20th century with the introduction of a few more cultivars by the Agri-Horticulture

Napoleon Bonaparte
Emperor of France



Philibert Commerson
French Taxonomist

L.A. de Bougainville
French Navigator

Society (AHS), Kolkata and Chennai. Bougainvillea achieved its popularity in 1920 with the introduction of 'Mrs. Butt' in AHS, Kolkata from Royal Botanic Gardens, Kew, England. The cultivar *B.* 'Scarlet Queen', named by S. Percy Lancaster in 1920, is probably the first *Bougainvillea* cultivar, which was raised in India. This was selected from the population of the cultivar 'Mrs. Butt' which was collected from Caribbean island, Barbados (West Indies).

Out of ten species, only *B. glabra* Choicy, *B. spectabilis* Willdenow, *B. peruviana* Humboldt & Bonpland and a natural hybrid *B. x buttiana* Holttum & Standley, are of the horticultural importance. Other *Bougainvillea species* have smaller bracts of duller shades and shy bloomer, are of botanical interest.

All the cultivated plants have arisen from their wild relatives. The popularity of *Bougainvillea* an ornamental climbing shrub, gained importance by the release of the first beclouded cultivar 'Mary Palmer' evolved by S. Percy Lancaster in 1949. It was a sport of 'Mrs. H.C.Buck' detected in the bungalow of Lady Mary Palmer in Kolkata. The evolution of this cultivar was a breakthrough in the floriculture and a land mark in the history of Bougainvillea cultivation. Since then many more bicoloured cultivars have been added. A unique cultivar 'Thimma', having conspicuous variegated foliage with yellow and green patches and bicoloured bracts, was reported from Lal Baugh Gardens, Bangalaru in 1960. This sport of 'Mary Palmer' was observed and isolated by a gardener working at the Botanical Gardens. The new cultivar was christened after the name of the gardener 'Thimma' as recognition to his valuable services.

A very interesting group of attractive cultivars known as Million Dollar or Multibracted Bougainvilleas were reported from Los Banos (Phillipines) during 1963-1967. Later, in early nineteen seventies, 'Mahara', 'Los Banos Beauty', 'Cherry Blossom' and 'Roseville's Delight' were introduced in the Lal Baugh Gardens, Bangalaru.

The evolution of 'Shubhra' in 1969, fulfilled the long felt desire of having large, white-bracted, profuse and recurrent blooming, hardy and easy to multiply *Bougainvillea* cultivar. S.C.Sharma, the then Superintendent, National Botanical Gardens, Lucknow (1964-1969), observed the parchment white sport on the flowering branches of the cultivar 'Mary Palmer' in the Garden. The sport was isolated, vegetatively multiplied and the plants were disseminated in various gardens in different regions of the country for getting the feed back from the leading Horticulturists. When it was ascertained that the cultivar has achieved the desired result, it was published in the leading Journal 'Indian Horticulture'. 'Shubhra' was registered as a new cultivar in the Check list of the International Registration Authority for Bougainvilleas, in the Department of Floriculture and Landscaping, Indian Agriculture Research Institute (IARI), New Delhi. 'Shubhra' has proved to be a highly popular cultivar globally in the floriculture industry and bio-aesthetic planning for giving an impressive effect when punctuated with bright and gaudy *Bougainvillea* cultivars.

There are nearly four hundred *Bougainvillea* cultivars evolved from the four basal species through natural and planned hybridization and spontaneous and induced mutations. It is encouraging to note that nearly fifty percent

of the total cultivars of the Bougainvilleas have been evolved in India. Some cultivars of *Bougainvillea glabra* and *B. splendens,* produce seeds occasionally. The plants raised from the seeds do not breed true to the type. Planned hybridization between the cultivars producing seeds and those having fertile pollen, is the normal practice for evolving new cultivars. A cross between *B.* 'Trinidad' and *B.* 'Formosa' has produced a very attractive mauve coloured, profuse blooming and dwarf cultivar 'Dr. Harbhajan Singh' at IIHR, Bangalaru.

In the last 45 five years National Botanical Research Institute Lucknow have evolved many novel cultivars e.g. 'Shubhra', 'Arjuna', 'Begum Sikander', 'Wajid Ali Shah', 'Mary Palmer Special', 'Palekar', 'Chitra', 'Los Banos Variegata', 'Aruna', 'Dr. P.V. Sane' which are always in great demand in the international market.

At the beginning of the present century, a very curious *Bougainvillea* cultivar 'Pixie' was introduced in the floriculture trade. The plant grows vertically with close internodes, thorn less, small leaves and pink bracts. Afterwards many cultivars of 'Pixie' having variegated leaves and red, orange and purple bracts have been evolved.

On the plant collection tour (2002) to Yercaud (Chennai) in 2002, I came across a grove of Tree Bougainvilleas growing near a resort. My friend Shri Vasant Pusalkar a local Botanist and passionate plant explorer, informed me that this unusual Bougainvillea is *B. arborea* from Brazil. *Bougainvillea arborea is* thorn less with scented brats and attains the height of 15 meters with a thick trunk of 7 meters dia. These Bougainvilleas must have been introduced by some English Botanist during the British era and need to be multiplied and conserved properly in the Botanical Gardens.

It is interesting to note that Bougainvillea which was collected from its centre of the origin Rio de Janeiro (Brazil), has travelled a long journey to India and flourished very well in our country.

In nineties CSIR-National Botanical Research Institute (NBRI), Lucknow was maintaining a rich germ-plasm collection of 250 Bougainvillea spp. /cvs in the Botanic Garden. It is a great loss of the plant genetic resources that basal species and cultivars introduced and evolved in the CSIR-NBRI, Botanic Garden, have been lost, which is difficult to be recovered.

The need of the hour is that the CSIR-NBRI, Lucknow and Bougainvillea Society of India (BSI), New Delhi should establish world class Bougainvillea Gardens in Lucknow, Capital City of Uttar Pradesh and New Delhi, the Capital city of India. The Bougainvillea Gardens should procure and conserve all the available species and cultivars all over the world, with proper documentation and bio-aesthetic planning. CSIR-NBRI, Lucknow should arrange the supply of the authentic and healthy Bougainvillea plants to the nurserymen and garden lovers for promoting the Bougainvillea Culture.

Bougainvillea is a drought and pollution tolerant ornamental plant, which can be safely used in the construction of urban ecology of the metro cities. In Uttar Pradesh (2003) first Bougainvillea Garden was established in Nirala Nagar, Lucknow, which was an attraction for Lucknowites and visitors coming to Lucknow but it needs restoration. Efforts should be made that Lucknow City of Gardens should be declared as the City of Bougainvilleas.

SUGGESTED LITERATURE

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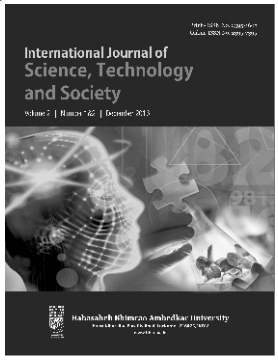

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