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MOBILISATION OF BIOMASS AND BIOMANAGEMENT OF ENVIRONMENT TO INCREASE SOIL PRODUCTIVITY AND PRODUCTION UNDER DRYLAND AGRICULTURE

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INTRODUCTION

India has the largest percentage of total land area under crops (57%), next only to Bangladesh (74%) in the Asian continent. However, the productivity of the soil is very low because of low organic matter content of the soil. India has 16% of the world's population and owns 15% of the world's livestock, but possesses only 2% of the world's geographical area, 1% of forest area and 0.5% of the pasture land.

Problems : Seventy percent of the total cultivated area in India comes under rain fed agriculture and supply only 40% of the total food production. The organic matter content of these soils range from 0.4 to 0.6%. For most part of the year the soil is exposed to sun, mineralising the organic matter very fast, and the wind and rain remove the fertile topsoil, necessitating application of organic manure for every crop. It is even difficult to grow green manure crop and mulch.

It is estimated that nearly 700 million tonnes of agricultural residues and municipal wastes are lost annually. In addition, several million tonnes of Agro Industries wastes like sugarcane begasse, press mud, rice mill waste, coir pith, oil cakes, coffee husks are unutilized. Large quantity of dung, the age-old source of soil nutrient in India, is still being burnt as fuel. Inspite of owning 15% of the world's live stock, their excreta are wasted by it throwing open, thereby loosing much of its nutrient content.

The current fertilizer use of 15 million tonnes of N P K in our country falls short of 8-10 million tonnes and this gap can be staggering if the proposed target of doubling the present production of 200 million tonnes by the year 2020 is to be achieved. The ill effects of continuous use of fertilizer without adequate quantity of organic matter have caused concern to the planners and farmers.

Prospect : In recent years, several techniques have been evolved in mobilising the biomass and enriching by scientific composting. Farm yard manure, still the major source of plant nutrient, can be enriched 3 to 4 times from its present level of 0.5% in addition to supply of essential micronutrients, by scientific composting.

Paper presented at the National Symposium on 'Emerging Issues of the Biological Sciences in the New Millennium' held at Vidyasagar University, West Bengal during 23-25 March, 2000.

Crop residues and municipal wastes are now being composted commercially, using suitable cultures and additives and wormy composting. Even the sugarcane trash, once considered a waste and fit to be burnt, is now either mulched in situ, adding cowdung slurry, press mud or fertilizer mixture or composted using Pleurotus fungus, Trichoderma and urea to get a stable compost in a month's time.

India being the largest sugar producing country with over 580 sugar mills, annually produce 5 million tonnes of press mud (containing 1.2% N; 3.83% p205 and 1.42% k20) and 11 billionlitres of spent wash (containing N.P.K. to the extent of 2.0; 0.30 and 9.0% Respectively) These are now being treated and used in several crops with great advantage, particularly in sodic soils. The coir pith, coffee husk, rice mill waste, once burnt are now being used in various proportions in making compost to be used as a source of organic manure having the capacity to conserve moisture.

The best way of sustainable management of soil organic matter including animal excreta is to scientifically compost to enrich, store and use at the right time to get the maximum benefit. Although these methods involve labor and are time consuming, there is no other easy method available now under tropical conditions to manage scarce organic matter to build soils for better crops.

STATUS OF OUR DRY LAND AGRICULTURE

It was only in 1880, the first Finance Commission suggested measures to tackle draught. It was not until 1923 that the first systematic and scientific approach to the problem of dry farming was made when Bombay provincial Agricultural Department initiated research on dry farming. Subsequently, the Imperial Council of Agricultural Research (ICAR) started similar scheme for Madras, Hyderabed and Punjab in 1933. Based on the studies made during 1933-1943, a package was developed for better crop production under dry farming situation, which included addition of moderate quantities of farm yard manure to maintain the fertility and physical conditions of soils.

After the termination of dry farming research in 1943, more prominence was given to soil conservation problem by contour bunding, that provided employment during scarcity period. Enormous amount of money was spent on soil conservation on 39.0 million acre land without increasing the production significantly (Venkateshwaralu, 1999).

During 1970, the All India co-ordinated Research project on Dryland Agriculture was launched at 23 locations and a new slogan was created, which reads "Beat the drought by fertilizer application".

The characteristics of dry land soils are : a generally low level of organic matter, alkaline to slightly acid reaction in the surface, weak to moderate profile development and low biological activity (Dregne, 1976). The modest quantities of organic

residues are rapidly oxidized due to high temperature, allowing very little humification because of less than 1% organic carbon content. Since organic matter in the storehouse of many plant nutrients dryland solis are deficient in N. P. Z. N. and P, therefore the dry lands are not only thirsty, but hungry too.

SOURCES OF BIOMASS

The watershed projects developed during 1980s & 1990s became the focal point of not only conserving run off water and soil but a means of productive propositions in terms of fruits, fodder, fuel, wood, etc. However, not much attention has been given for production of green biomass for composting. If a minimum of 20 percent green biomass is used in composting agricultural residues and municipal waste using animal excreta at 4:1 or 5:1 ratio the CN ratio will be reduced hastening digestion, and the compost becomes nutritionally rich. (Singh. etal, 1998). In this way one tonne of cowdung can be converted into 5 tonnes of compost and still enough cowdung will be available even after using as fuel. In an area of over 90 million ha, available for watershed developments, about 400 million tonnes of green biomass can be obtained which in turn can produce 2000 million tonnes of compost when combined with available FYM & agricultural waste. Even at a conservative estimate of one percent of N and other nutrients including micronutrients, this amounts to 20 million tonnes of nutrients, which is equivalent to the present day demand of fertilizers.

According to an estimate, the waste generated in agro-industries in India amounts to about 105 million tonnes. These include sugarcane bagasse, press mud, Rice mill wastes, wastes from fruit processing industry, coir pith, oil cakes, and wastes of coffee industry. (Moorthy and Rao, 1997).

According to Gaur (1996), more than 2000 m.t. of animal waste and 400 m.t. of crop residues are available annually in this country.

A human being generates about 100 grams of solid matter a day which would amount to about 35 m.t. per year in India. A chicken which weighs only 1/25 of a human being, evacuates 120 grams of solid matter, a pig evacuates 3 kilograms of faeces a day and a cow 25 kilograms, an amount equal to faeces of 250 people (Matisuzaki, 1989). In India there are 193 million cattle, 79 million buffaloes, 45 million sheep, 118 million goats, 12 million pigs and 435 million poultry (FAO Quarterly Bulletin of Statistics, 1995). India with 16% of the world population and owning 15% of the world's livestock can be made productive only if we know how to convert 'filth into wealth'.

Growing green manure and *in situ* mulching are not practicable in our dry land agriculture. On the other hand enough green manure can be grown along with the main crop either as strip crop or all along the bund and on the bund and harvest at the right stage and compost along with farm waste and F.Y.M. At least 20 to 30 m.t. of

green manure can be generated in this way. Common leguminous green manure crops that can be grown are sunhemp *(Crotolaria juncea)* dhaincha *(Sesbania aculeata)*, mungbean *(Phaseolus)*, cowpea *(Vigna sinensis)*, khesari *(Lathyrus sativus)*, berseen *(Trifollium alexandrium)*, etc. These green manure yield per ha. varies from 8 to 28 tonnes.

On the other hand, some common perrenial shrubs and trees which yield valuable green matter for composting can be grown on the bund and harvested periodically without interfering with the main crop. They include *Glyricida maculata, G. sepium, Pongamia glabra, Azadirachta indica, Leuccaena leucocephala, L. glauca, Cassia auriculata, C. tora, C. accidentalis, C. pistula, Deria indica, Ipomoea cornea, Tephrosia purpurea* etc. In addition, many weed plants like water hyacinth, Eupatorium, Ipomoea, Lantana, Cassia spp., which have spread menacingly threatening agriculture and environment, can supply large quantity of rich biomass. About 3 m.ha of land occupied by water hyacinth (Randhawa, 1981) will be rich in plant nutrients, if used properly (Bharadwaj, 1993). Eupatorium *(Chromolaena oderata)*, a perennial weed, widely found in all high rain fall areas, yields about 25 t/ha/annum, comparable to glyricidia or pongamia, with 0.62 percent N, 0.2 percent p2 05 & 0.46% k20 on dry weight basis. Application of eupatorium @ 10 tonnes per ha. to wet land paddy, can reduce 50% fertilizer with less incidence of blast disease (Anwarulla, 1966).

Tea pruning yields considerable quantity of biomass. The foliage and twigs amount to about 10 t/ha with low CN ratio (11.1 & 16.9), which is ideal for composting (Ranganthan, 1995).

From the above, it could be seen there is enough biomass, agricultural waste, animal excreta available in the country, but most of it is not pooled and properly recycled or enriched. Now several techniques are available to digest even materials like coir pith, coconut fronds, rice husk, sugarcane trash etc., which were considered fit to be burnt.

METHODS OF COMPOSTING

Composting is the art and science of combining available organic waste so that they decompose to form uniform and stable finished product. Microorganisms that do much of the work need high temperature, plenty of oxygen and moisture. These heat loving or thermophylic organisms work best between 45-55 degree C. Above 60 degree C temperature these can develop in compost piles, but the process slows down. At temperature below 45 degree C the less active types of microorganisms take over and the rate of composting again slows down.

Composting can occur most easily if the average CN ratio of the material is about 25-40 parts of carbon for every part of nitrogen, which means addition of green leaves to the dried farm waste would become necessary to get a good compost.

Crop residues are usually pretty close to 40% Carbon showing not much change from plant to plant, but N content varies greatly depending on the type of plant used of different stages of growth. Microorganisms using materials containing 1% or less N need extra nitrogen for their growth and reproduction, addition of animal excreta encourage quick build up of microorganisms. If dairy manure stays on the soil surface, about 25% of the nitrogen is lost after one day and 45% is lost after 4 days. To get maximum benefit it should be immediately put to compost or keep covered until it is composted.

The scientific aspect of composting was initiated at the Rothamsted experimental station during early part of last century. In India Howard in collaboration with Wad and Jackson experimented in compost making at Indore during 1924 - 26 and it became known as Indore method of composting (Gaur 1996).

In this method, plant residue was mixed with animal dung, urea, earth. wood ash and put into pits of 1 m deep, 1.5 to 2 m wide and of suitable length. During rainy season heap method was adopted.

The Bangalore method of composting developed by Acharya (1950), which basically consists of composting night soil and city garbage, is suitable for areas with scanty rainfall. A layer of 15-20 cm thick refuse is followed by a layer of night soil and repeated till the pit is covered and kept without turning and watering for about 6 months.

The composting technology has been refined from time to time particularly to solve urban and rural wastes. The most commonly used method of composting the farm waste and animal excreta in rural India is to go on adding into the pit or heap, whatever waste to be disposed of every day and removed once or twice a year and transported to the field. In this process, the bottom layer gets heated up and most of the microorganisms are killed. The upper layer is not digested for want of moisture or is not properly pressed. This 'manure' is spread in the field much before sowing or planting time, most of this is lost in sun and rain and eaten by termites. The availability of nutrient to plant becomes negligible.

Good compost can be obtained by judicious mix of crop residues, green matter with animal excreta in 3:1 or 4:1 proportion maintaining 60% moisture and composting should be done in a day or two and laid layer by layer on hard surface, barricaded on either side at 1.5 m apart to a height of 1-1.5 m and to any convenient length. When the column is filled up it should be covered. After a month, it should be turned over and again the moisture is maintained at 60% either by adding, if dried, or drying the excess moisture. Once again it is turned over after a month. In about 3 and a half months a good compost well digested humus is formed. Monthly turning over can be avoided if the compost heap is provided with perforated tubes at one to two feet intervals in the middle for aeration. Best results are obtained when fresh cowdung slurry

is poured layer by layer on the biomass. This method is adopted extensively in Japan, China and Korea.

VRF method of composting developed by Moorthy and Rao (1997) consists in using plastic lining underneath as well as to cover the heap of any convenient size. Agro based industrial waste such as coir pith, rice mill waste, sawdust, coffee husk, areca husk, cocoa product waste, forest litter are used in various combinations and mixed with bio-degrading micro-organisms, free living N-fixers, p-solubilizers etc. This method is found to be useful in areas where the Agro industrial waste mentioned above are available in plenty and in rainy season for a prolonged period.

ADVANTAGES OF COMPOST

A good compost provides all the nutrients that a plant needs from growth to maturity. It is well known that compost rectifies several soil ill health including alkalinity, improves the soil physical condition, aeration, water holding capacity, withhold of nutrients, increases soil's biological properties, encourages microbial activities, suppresses the outbreak of plant pathogens. It adds to the nutritional quality of food and feed. People have become more conscious of organically grown food and their advantages.

The end product of compost — the humus is a treasure which has been stored by our ancestors for many centuries. It is just like humanity's fixed bank deposit. We have been drawing too much from it without recuperating. We must go on adding as much as we have drawn for the security of our future generation.

Problems faced with mobilization of biomass and scientific composting

Once it was thought that it would be an impossible task to mobilise enough biomass to get the required quantity of plant nutrients. Now we realise that there is enough biomass, both of plant origin and animal excreta available in the country. There are a number of ways and means to increase plant biomass and green manure. Unfortunately, no organizational set-up in the mission mode is available to mobilise the biomass and convert it into plant nutrients. If even a part of the efforts and investment made in fertilizer production, transport and distribution is diverted to mobilisation of biomass and composting, our soils would have been much happier and healthier now. After the advent of fertilizer use in dryfarming in early 1970's there has been a tendency of our farmers to use less and less organic manure. Even the most commonly used organic manure, the FYM is very poor in the nutrient quality compared to a good compost. The storage and application of FYM is so unscientific that most of the available nutrients are lost before the crop could make use of it. Naturally, the yields are low where such FYM is applied.

There are no sustained efforts to imporve the techniques of composting and enriching the biomass at the national level. All our trials in the field of agronomy are biased

towards experimenting with standardising fertilizer application and recommending NPK requirement of each crop without supplementing with organic manure. Wherever organic manure is mentioned, it is only a couple of tons of FYM and not compost of definite consistency. Even with crude FYM, our long term experiments have shown that continuous use of FYM has given sustained yield of finger millet in the long run, compared to only fertilizer application which registered higher yields in the beginning but started declining drastically after 8 years of continuous application. Fertilizer and FYM when used in equal proportion in terms of nutrient content, result in highest yields with a fair degree of consistency (Hegde and Gajanan, 1996).

The plant breeders have been concentrating on breeding varieties that respond to fertilizer for high yielding. We seem to have left behind the varieties responding to organic source of nutrient. A syndrome has been created to make believe that without fertilizer, high yielding varieties that respond to fertilizer and pesticides, it is not possible to sustain the production. However, this belief is belied in the eighties and nineties as the yields have stagnated inspite of using recommended dose of fertilizer, high yielding seeds, pesticides and irrigation in several parts of the country. Slowly the farmers are realising that they have erred in not using adequate quantity of organic manure by neglecting mobilisation of agricultural waste and animal excreta including their own for composting. Integrated plant nutrient management is the best option available for sustaining production without polluting the environment.

STRATEGY FOR MOBILIZING BIOMASS AND SCIENTIFIC COMPOSTING

1. At the national level a policy frame work is needed to give thrust for mobilising biomass and scientific composting. A mission mode approach is needed to tackle the problem of urban and rural garbage, to asses the availability of plant biomass and animal excreta, around every village or groups of villages in a radius of 5 km.
2. Total plant nutrient requirement of all the cultivable land according to the cropping pattern has to be documented so that the source of the nutrient to supply recommended dose of fertility can be identified.
3. There is an urgent need for reforming composting system. We are in a mind set that composting is simple and every one knows about it. In all our extension activities attempts are being made to transfer difficult technologies other than scientific composting techniques. There are no organized training to train the trainers or the extension personnels exclusively meant for this purpose. It is learnt that the State Departments of Agriculture, praticularly in Karnataka, have schemes to give subsidy of Rs. 250/- for every tonne of compost prepared. There is no agency to verify the ingredients, the quality and nutrient content of compost. A well intended scheme may go without serving the cause for which it has been planned.
4. A number of NGOs and individuals have taken up composting or wormy

composting on a commercial scale to meet the increasing demand, but there is no set standard or specification to grade the compost and fix rates as is done for other agricultural inputs including fertilizers. Although there is great demand for good compost, farmers hesitate to buy for want of quality certification. There is need to formulate policy for inspecting and certifying the compost and biofertilizers. This would encourage more and more demand for good compost.

5. NGO's or unemployed youths in the village should be motivated to produce compost on industrial line, providing land and infrastructure with buy back arrangements. The farmers should be encouraged to supply all the raw materials for composting on cost and buy back with subsidiary. A part of subsidiary given to fertilizer can be diverted to buy compost. The technical advise, pooling of raw material, fixing the quality and rate should be done by the Department of Agriculture. This scheme would provide employment for local people. Several thousands tones of agricultural waste now being wasted or burnt would be converted into productive wealth, turning the local 'filth into wealth' and reduce cost of long distance transport of fertilizers.
6. Local schools can take up compost making as one of the field parctical or social service. The children will learn soiling their hand and learning the dignity of labour. Once a week half a day spent on this could fetch them enough money for their urgent need. The Department of Education could make suitable policy and perks for mobilising rural agricultural waste, and enriching it.
7. Farmers should be encouraged to grow, some minimum green manure crop depending upon their holdings. The green manure crop can be sold to compost making agency either on barter exchange or on cost.
8. Efficient management of organic matter to increase the productivity and production not only reduce the burden on fertilizer demand but also opens up new vista for organic farming, the product of which will be in great demand nationally and internationally in the 21st Century.
9. Burning of all agricultural waste and leaf litter should be banned.

CONCLUSION

Converting the grayer areas of our agricultural land into greener areas should be the priority of the 21st century agricultural policy. If we have to go from green revolution to evergreen revolution to meet the food production of 240 mt by 2010, the best bet is our 70% of rain fed agriculture. This area has a great potential combined with many problems and risks which are not insurmountable. It is like fighting war at the Himalayan heights for which special preparation, training, equipment and finance are required. So also fighting in the food front in the plains of India, which is wrought with many problems of which improving the productivity and production of our hungry and thirsty soils is the major one. The key to productivity lies in augmenting the organic matter of soil and supplying enriched compost with judicious use of fertilizer.

This needs total reorientation of our thinking about mobilising biomass. Not only that, scientific composting has to be ensured in every village. It helps to sustain our production and keep our environment clean.

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APPLICATION OF INITIAL SCREENING TOOL TO IDENTIFY OCCUPATIONAL RISK FACTORS DURING MEAT CUTTING OPERATION

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ABSTRACT

Manual meat cutting is a strenuous occupation. During meat cutting, meat cutters have to work in awkward postures for a long period by handling heavy tools with forceful and repetitive exertions. For this purpose, 25 male subjects were included in this study, out of which 15 meat cutters were included in the experimental group and the rest of 10 subjects (librarians) were taken as the control group.

For symptom survey, a questionnaire and checklist method was implemented and a detailed time study was performed among workers during different activities in total work cycle.

It was observed from the results that a significant association was present between repetitiveness of work and feeling of discomfort by the meat cutting workers. It was further observed that there was a high significant association between non-neutral wrist posture and discomfort feeling of workers.

Finally, it was concluded from the study that there was a clear association present between occurence of CTD and the different type of risk factors among the meat cutters of West Bengal.

KEYWORDS : Cumulative trauma disorder, Meat cutting, Repetitiveness, Awkward wrist posture, Tool use.

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INTRODUCTION

Meat cutting is one of the most primitive jobs, which evolved as profession ever since the development of society. Since then, though this profession has been in service to mankind, little or no notice has been given to its development. In developing countries like India, no attention is given to the health and safety of the workers in unorganized sectors like meat cutting.

Meat cutting has long been associated with a high incidence of upper extremity cumulative trauma disorders. Kurpa et al. in 1991 observed upper limb cumulative trauma disorders to be one of the major work related complaints among the meat cutting operators. The works of Putz Anderson in 1988 also revealed that cumulative trauma disorders are highly prevalent among meat cutters.

The present investigation was aimed at assessing the prevalence of CTD among the meat cutters and to bring to the forefront the unsafe working conditions of these workers.

MATERIALS AND METHODS

The methodology which was undertaken for this study were : 1) the symptoms survey through the questionnaire method, 2) the check list analysis and, 3) the time study of the different activities performed during one work cycle.

SELECTION OF SUBJECTS

Twenty-five male subjects were included in this study, out of which fifteen were included in the experimental group and the rest of the ten subjects were taken as control.

QUESTIONNAIRE FUNDAMENTALS (APPENDIX I)

The questionnaire was developed on the basis of the symptoms of cumulative trauma disorder. It consisted of a series of objective questions with multiple-choice responses. (Kurianka et al, 1987)

CHECKLIST FUNDAMENTALS (APPENDIX II)

The checklist was developed on the basis of the checklist as designed by Keyserling etl in 1993 for the evaluation of ergonomic risk factors associated with upper extermity CTD.

TIME ANALYSIS

The time taken by the participants for performing different activities were recorded with the help of electronic stopwatches. The time recorded was utilized for the analysis of repetitiveness/non repetitiveness of a particular activity.

STATISTICAL ANALYSIS

A two-tail-chi-square test of independence was applied to determine whether or not the test item had any significant association with discomfort.

RESULTS

Physical characteristics :

The average height, weight, body mass index and body surface area of the meat cutters and their control groups, the librarians are shown in Table 1.

Table 1. Physical characteristics of Meat-cutters and Librarians.

	HEIGHT (CM)		WEIGHT (Kgs)		BMI		BSA (cm^2)	
	Meat-Cutters	Libra-rians	Meat-Cutters	Libra-rians	Meat-Cutters	Libra-rians	Meat-Cutters	Libra-rians
MEAN	170.11	170.30	67.46	58.60	23.46	20.31	18541.27	17439.71
±STANDARD DEVIATION (SD)	± 5.96	± 5.13	± 5.07	± 7.63	± 1.92	± 1.98	± 819.82	± 12823.44
RANGE	161.54 to 177.75	160.79 to 176.78	55 to 75	48 to 69	18.37 to 26.23	17.30 to 23.53	17239.696 to19857.11	15639.71 to 19205.80

The librarians were selected as control group as because they used their hands extensively staying in a non hazardous condition in a same thermal condition.

Among the experimental group, 6.66% had a working experience of less than 5 years, 20% had an experience of 5 to 10 years and 73.33% had an experience of more than 10 years.

1% of the control group had less than 5 years of experience, 20% had 5 to 10 and 70% had more than 10 years of working experience.

Subjective response on the musculoskeletal discomfort :

Table 2. Response of Meat-cutters (n=15) and Librarians (n=10) on discomfort feeling in different parts of the upper extremity.

	MEAT CUTTERS		LIBRARIANS	
	Number	Percentage	Number	Percentage
UPPER ARM	9	60.00	—	—
LOWER ARM	8	53.33	—	—
WRIST	11	73.33	—	—
HAND	11	73.33	1	10
FINGERS	11	73.33	1	10
OTHER PARTS	7	46.60	—	—
NONE OF THE ABOVE	4	26.66	9	90

Table 2 is the response of meat cutters and librarians on discomfort feeling in different parts of the upper extremity. 60% of the meat cutters reported of discomfort in the upper arm. 53.33% had suffered pain in the lower arm in the recent past. 73.33%, who were placed in the discomfort group, felt sensation of pain, numbness etc. in the wrist, hands and fingers. Contrary to the responses of the meat cutters, majority of the librarians (90%) reported no discomfort.

More specific probe into the responses of the discomfort feeling in the wrist among meat cutters as presented in Table 3 revealed that 73.33% suffered from pain at night. 40% of them had sensation of numbness and swelling. 53.33% had a stiff feeling of the wrist.

Table 3. Response of Meat-cutters on discomfort feeling in the wrist.

	MEAT CUTTERS	
	Number	**Percentage**
Pain	11	73.33 %
Numb/Tingle	6	40.0 %
Swell	6	40.0 %
Stiff	8	53.33 %
Others	2	13.33 %
Pain at night	11	73.33 %
Strength of hands decreased	8	53.33 %
Intensity of pain increased	6	40.0 %
Frequency of pain increased	4	26.66 %

Time analysis :

The time recorded during different activities of the meat cutters and librarians were presented in Table 4 and 5 respectively. Analysis of the time measurement revealed that for the meat cutters the average time for 1 cycle was 82.82 secs. Chopping was found to be the major activity as it occupied major portion of the work cycle, amounting to 45.55 secs. The frequency of chopping was found to be 1.48/secs.

Table 4. Time taken (in secs.) in different activities by the Meatcutters during meat cutting operation.

	Collecting Material (Secs)	**Chopping (Secs)**	**Weighing (Secs)**	**Packeting (Secs)**	**Time for 1 cycle (Secs)**	**Frequency of chopping (in secs.)**
Mean	18.00	45.55	15.34	8.38	82.82	1.48
± S. D.	± 5.00	± 6.35	± 8.11	± 2.94	± 17.08	± 0.34
Range	13 - 29	34.05 to 50.59	5.2 to 13.5	5.6 to 13.5	54.75 to 123.50	0.96 to 2.06

Table 5. Time taken (in secs.) in different activities by Librarians during different library work.

	Collecting Books	Taking out Cards	Writing Down	Putting the Card Back	Putting Back the Books	Other Activities	Total Cycle Time
Mean	19.91	12.34	28.90	10.72	14.99	12.83	83.34
± S. D.	± 7.83	± 2.89	± 13.04	± 3.37	± 6.81	± 3.83	± 20.70
Range	10 - 38.33	9.0 - 18.50	17.5 - 65.0	5.0 - 15.5	06.66 - 27.00	9.0 - 16.66	62.65-134.66

The total work cycle time for the librarians were recorded to be 83.34 seconds. For the librarians activity of writing occupied the major portion of the work cycle.

Checklist analysis :

Repetitiveness and nonrepetitiveness of a particular activity were judged on the basis of criteria put forward by Silverstein in 1987. According to the definition of Silverstein, jobs which had a basic cycle time of 30 sec or less and/or jobs in which 50% of the work cycle involved similar upper extremity motion patterns were considered to be repetitive.

In the present study, 73.33% of total meat cutters fulfilled the criteria for repetitive work (R) and 26.67% completed the cycle of meat cutting in less than 50% of the total work cycle. The librarians were found to have non repetitive in their job from the same table (Table 6).

Table 6. Analysis of repetitive & non-repetitive work amongst Meat cutters and Librarians.

	REPETITIVE (R)		NON–REPETITIVE (NR)	
	Number	Percentage	Number	Percentage
MEAT-CUTTERS	11	73.33 %	4	26.67
LIBRARIANS	0	0	10	100 %

Table 7. A 2.2 contingency table showing relation between feeling of discomfort and repetitiveness of work of Meat cutters and Librarians.

	DISCOMFORT = 12 (D)		NO DISCOMFORT = 13 (ND)		TOTAL (fr)
	Number	%	Number	%	
REPETITIVENESS	8 (B)	32 %	3 (A)	12 %	11 (A + B)
NON-REPETITIVENESS	4 (D)	16 %	10 (C)	40 %	14 (C + D)
TOTAL (fc)	12 (B + D)		13 (A + C)		25 (N)

$0.02 < p < 0.05$

Table 7 showed the contingency table on the basis of relation between the repetitiveness/non repetitiveness and feeling of discomfort among the meat cutters and librarians. A significant positive relation was observed between feeling of discomfort and repetitiveness ($p<0.05$).

Another contingency table on the relation between non-neutral wrist posture and discomfort feeling was shown in Table 8.

Table 8. A 2.2 contingency table representing the relation between feeling of discomfort and Non-neutral wrist posture.

	DISCOMFORT = 12 (D)		NO DISCOMFORT = 13 (ND)		TOTAL (fr)
	Number	%	Number	%	
NEUTRAL WRIST POSTURE	1 (B)	4 %	9 (A)	36 %	10 (A + B)
NON-NEUTRAL WRIST POSTURE	11 (D)	44 %	4 (C)	16 %	15 (C + D)
	12 (B + D)		13 (A + C)		25 (N)

$0.001 < p < 0.01$

This table revealed that there was a high significant relation between discomfort and non-neutral wrist posture ($p<0.01$).

DISCUSSION

The questionnaire and checklist along with the method of time analysis was designed to function as a sensitive, rapid screening tool so as to identify the activities and other risk factors that may contribute to the development of upper extremity cumulative trauma disorders. Responses on the subjective symptoms of upper extremity musculoskeletal disorders showed that majority of the meat cutters had at least one kind of discomfort in the upper extremity of

the body. Data revealed that there is a possibility of the occurrence of upper extremity musculoskeletal disorders showed that majority of the meat cutters had at least one kind of discomfort in the upper extremity of the body. Data revealed that there was a possibility of the occurrence of upper extremity musculoskeletal disorders amongst the meat cutters; and that, wrist, hand and finger discomfort were higher than the other parts of the body. Accepting the responses to be true, it was seen that maximum percentage of the meat cutters suffered from at least one kind of discomfort in the upper extremity. The control group (librarians) showed no signs of discomfort.

The feeling of pain, numbness and tingle of the wrists, all indicate chances of more specific cumulative trauma disorders like carpel tunnel syndrome, tenosynovities etc. The above findings also bear some relation with the data obtained by the Bureau of Labor Statistics in 1986 that observed that 480 of every 10,000 meatpacking worker suffered from cumulative trauma disorders. Kurpa etal in 1991 also noted that upper limb CTDs were the major work related complaints among meat cutters. Survey of upper extremity stresses caused due to repetitiveness was also carried out with the help of time motion study. Applying the definition of Silverstain (1987), it was found that workers on repetitive jobs had more than a five fold greater risk of developing upper extremity CTDs when compared to workers on low repetition, low force jobs. It can be tentatively concluded from this present study that the occurrence of discomfort was due to repetitiveness and that the no discomfort was due to non-repetitiveness because subjects with discomfort and repetitiveness (32%) represented a greater proportion of the total sample as compared to discomfort and non repetitiveness (16%).

During meat cutting along with flexion and extension, radial and ulnar deviations of wrists were also observed. Continuous and repetitive uses of the hands in an awkward posture for long periods are the causatives of impingement and entrapment of nerve and disorder of the tendons. Thus awkward wrist posture is another factor for the onset of CTDs.

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APPENDIX - I

Questionnaire Fundamentals

Name : Age : Sex : Monthly Income : Height : Weight :

Duration of work everyday : No. of working days in a week :

How long are you associated with this job ? ☐ Less than 3 Mths ☐ 3 Mths. to 1 Yr.

☐ 1 Yr. to 5 Yrs. ☐ 5-10 Yrs. ☐ More than 10 Years

In which part of the day you feel maximum pain. ☐ Morning ☐ Noon ☐ Afternoon

☐ Evening ☐ Night

Is there any rest / pause between 2 working periods ☐ Yes ☐ No

Do you feel any kind of pain ☐ Yes ☐ No. If yes, then, please shade the area where the pain is felt.

Is the pain felt during work ? ☐ Yes ☐ No

Is the pain felt during rest ? ☐ Yes ☐ No

Have you ever felt pain during sleep, at night ? ☐ Yes ☐ No

Has the frequency of pain increased since it first started ? ☐ Yes ☐ No

Has the strength of your hands decreased since you started ? ☐ Yes ☐ No

Has the intensity of pain increased since it first started ? ☐ Yes ☐ No

Any previous history of accidents ? ☐ Yes ☐ No. If yes, No. of accidents

Type of Accidents : ☐ Amputation ☐ Laceration ☐ Avulsion

☐ Contution ☐ Cut ☐ Irritation ☐ Sprain

Activities during accidents :

No. of days lost during accidents :

Body parts involved :

Frequency of accidents :

Any previous history of diabetes ? ☐ Yes ☐ No

Any previous history of High B. P. ☐ Yes ☐ No Low B. P. ☐ Yes ☐ No

Back Pain ☐ Yes ☐ No Bodyache ☐ Yes ☐ No

Respiratory problem : ☐ Yes ☐ No

Cardiac problem : ☐ Yes ☐ No

What kind of discomfort do you experience ? Shade the area of discomfort :

Pain – P ☐

Numb / Tingle – NT ☐

Pain / Numb / Tingle – PNT ☐

Ache – A ☐

Burning – B ☐

Swell – SW ☐

Stiff – ST ☐

Others – O ☐

Do you have any problems in dropping things : ☐ Yes ☐ No

Which portion of the body is maximally involved ?

APPENDIX - II

Checklist Fundamentals

WORKING ENVIRONMENT :

Illumination : ☐ Poor ☐ Adequate : Noise : ☐ High ☐ Low

Dust : High ☐ Low ☐ Temperature : ☐ High ☐ Low

REPETITIVENESS :

1. Does the job involve repetitive use of hand & wrist ☐ Yes ☐ No

2. Does the hand repeat the same motion / exertions for more than half of the work cycle.

☐ Yes ☐ No.

AWKWARD-POSTURE :

Is there frequent wrist deviation ☐ Yes ☐ No

MECHANICAL STREES :

Do hard tools put localized pressure on the plam of the hand ☐ Yes ☐ No

FORCEFUL EXERTIONS AND TOOL USE :

Does the worker lift and /or use heavy tools ☐ Yes ☐ No

Are both the hands involved in lifting ☐ Yes ☐ No

NEW RECORD OF A RANID TADPOLE FROM MOULING NATIONAL PARK, ARUNACHAL PRADESH, INDIA

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ABSTRACT

The paper describes the morphology and morphometry of a ranid tadpole collected from the Mouling National Park, East Siang district of Arunachal Pradesh. Tadpoles were collected from still water bodies in the Ramsing area. It has been observed that the tail of the tadpole makes an angle of appoximately 40° to the body. Ten developmental stages could be identified from the collected tadpoles. Developmental stages were identified as described by Gosner (1960). The keratodont formula is 1:4+4/1+1:2.

Introduction

Descriptions of Anuran larval stages help in the exploration work in the remote areas like Arunachal Pradesh. As the area is a part of the Eastern Himalayan region, one of the biodiversity hotspot areas of the world, there is ample scope of finding many new records. Presence of many rare amphibians can be detected by identifying the tadpoles as collection of the adult is often difficult due to its nocturnal habit, difficult and hostile conditions of their habitat.

Mouling national park is located in the East Siang district (28°5′ Nlat. and 95°19′ 48″ E Long.) The altitudinal range of Mouling National park varies from 750 m to about 3000 m above msl and its adjoining areas beyond Tuting ranges upto 4500 m continuing upto Chinese territory beyond the Mc Mohan line.. The hilly mountainous rugged terrain is traversed by many rivulets. The present collection is from the Ramsing area. The tadpole shares the habitat with *Limnonectes limnocharis, Euphilctes cyanophlyctes* and *P. leucomystax* tadpoles.

Anuran tadpoles in the North Eastern region of India were studied by Annandale (1905), Sahu and Khare (1980, 1983, 1983), Ao and Khare (1986) and Sahu (1994). Published records of taxonomic details of tadpoles from Arunachal Pradesh will help in the exploration work in these remote areas.

Methodology

The spceimens were collected in the day time from still water bodies of Ramsing area with the help of aquatic net and were fixed in 10% formaldehyde solution. The measurements were made in mm. The staging of the tadpoles was done following Gosner (1960) and for description of the tadpole criteria Altig (1970) was relied upon.

Taxonomic description

The colour of the preserved specimens are not uniform throughout. The dorsal side is yellowish brown, but the region of the head is slightly lighter. The tail and the

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tail fins are also of lighter shade, while the abdominal region is transluscent. Live colouration is dark brown.

The tadpoles are of moderate size. The head is rounded in shape and the dorsal side is somewhat flattened. The snout is not pointed. The eyes are round and are of moderate size. They are dorso-laterally placed and the interocular distance is large. The nares are small, oval in shape and are placed in a depression. They are located nearer to the snout than to the eyes. The two nares are situated at a moderate distance from each other. The spiracle is quite distinct and it is sinistral. It is located nearer to the eye and is quite far from the nare and the snout. The muscle blocks on the dorsal side are not seen and the intestinal coils are also not distinct.

The tail musculature is well developed and the muscle blocks are distinct. The tail makes an angle of about 40^0 with the body. The height and thickness of the tail musculature is transparent though beautifully formed. The height of dorsal and ventral fins are the same. The vent is medically located. Table-I presents detailed morphometric measurements.

Table-I Morphometric features of the tadpoles

Sl No.		1	2	3	4	5	6	7	8	9	10
Stage		25	26	27	29	31	32	34	35	36	37
1	Total Length	24	26	27	21.7	25.5	32.3	32	41	37.5	38.7
2	Body Length	10	10	11	10.2	10	13.5	14	15.5	15	15.2
3	Body Weight	6.2	6	7.5	6.5	6.8	8.5	8.7	9	9	9.5
4	Body Height	5.5	6	6.8	6	6.5	8	8.5	8.5	8.7	9.0
5	Head Width	5.4	5	6	5.5	5.2	7	6.7	7.8	7.5	8.0
6	Head Height	4.2	3.7	5	5.0	4.5	5	5.5	5.5	4.6	5.5
7	Inter-Ocular Space	3.9	4	4.5	4.0	4.0	5.5	5.8	5.5	5.8	5.5
8	Inter-Naral Space	2.8	2.7	2.9	2.8	2.8	3	3.5	3	3.1	3
9	Diameter of Eye	1.7	1.7	2	2	1.7	2	2	2	2	2
10	Normal Eye distance	2	2	2.2	2.1	2	2.8	2.8	3	2.9	3
11	Mouth Width	3.2	3	3.2	3.2	3	3.5	3.5	3.5	3.5	3.5
12	Snout-Spiracle Distance	6.1	5.9	6.5	6.3	6.1	7.2	6.8	8.5	8.5	9.2

13	Snout-Nare Distance	2	2	2.1	2	2	2	22.2	2.5	2.5	2.5
14	Snout-Eye Distance	4.1	3.9	4.3	4.2	3.9	4.5	5	5.4	5.3	5.1
15	Spiracle-Eye Distance	2	2	2.1	2.1	2	3	2.5	3.3	3.2	3.5
16	Spiracle-Nare Distance	5.1	4.7	5.5	5.1	5.1	6.3	5	7.5	7.3	7.5
17	Tail Length	14	16	16	11.5	15.5	18.8	18	25.5	22.5	23.5
18	Tail Height	5.3	5.2	7.1	6.1	6	802	8.3	8	8	8
19	Diameter of Tail Muscle	3.1	3.8	4.5	4.1	4.1	5.5	5.8	5.8	5.2	5.2
20	Length of Hind Limb	0	0.2	0.5	0.5	1	1.5	2.4	4.5	4	5

The oral disc is very well developed and the rostral and mental gaps are distinct. The mental gap is much smaller than the rostral gap. The supra and infra rostrodonts are distinctly serated. The keratodont rows of the upper and lower labium are distinct. In the upper labium the first keratodont row is uninterrupted, while the second row is interrupted by a medial gap. The third, fourth and fifth keratodont rows are on either sides of the supra rostrodonts. In the lower or posterior labium the first kerotodont row is interrupted, while the last two rows are uninterrupted. The dental formula is 1:4+4/1+1:2. The oral papillae are distinct and well developed (Plate-I shows the description of stage 37 tadpole)

Discussion

Tadpoles collected during the present survey belonged to ten developmental stages (Stage 25 to stage 37). Staging was done with the help of Gosner (1960) and the study was based on the taxonomic keys given by earlier workers viz Von Dijk (1966) Sahu and Khare (1980, 1983, 1983), Khare and Sahu (1984), Inger and Tan (1990), Sahu (1994) and Roy (1999). Study of tadpoles belonging to ten stages (25-37) helped in the confirmation of the family as Ranidae, some of the characters of which are presence of oral disc with well developed rostrodonts and keratodonts, emerginate oral disc and spiraculum sinistral (placed on the left side). No doubt, study of all the stages upto completion of metamorphosis will help in the identification of the species.

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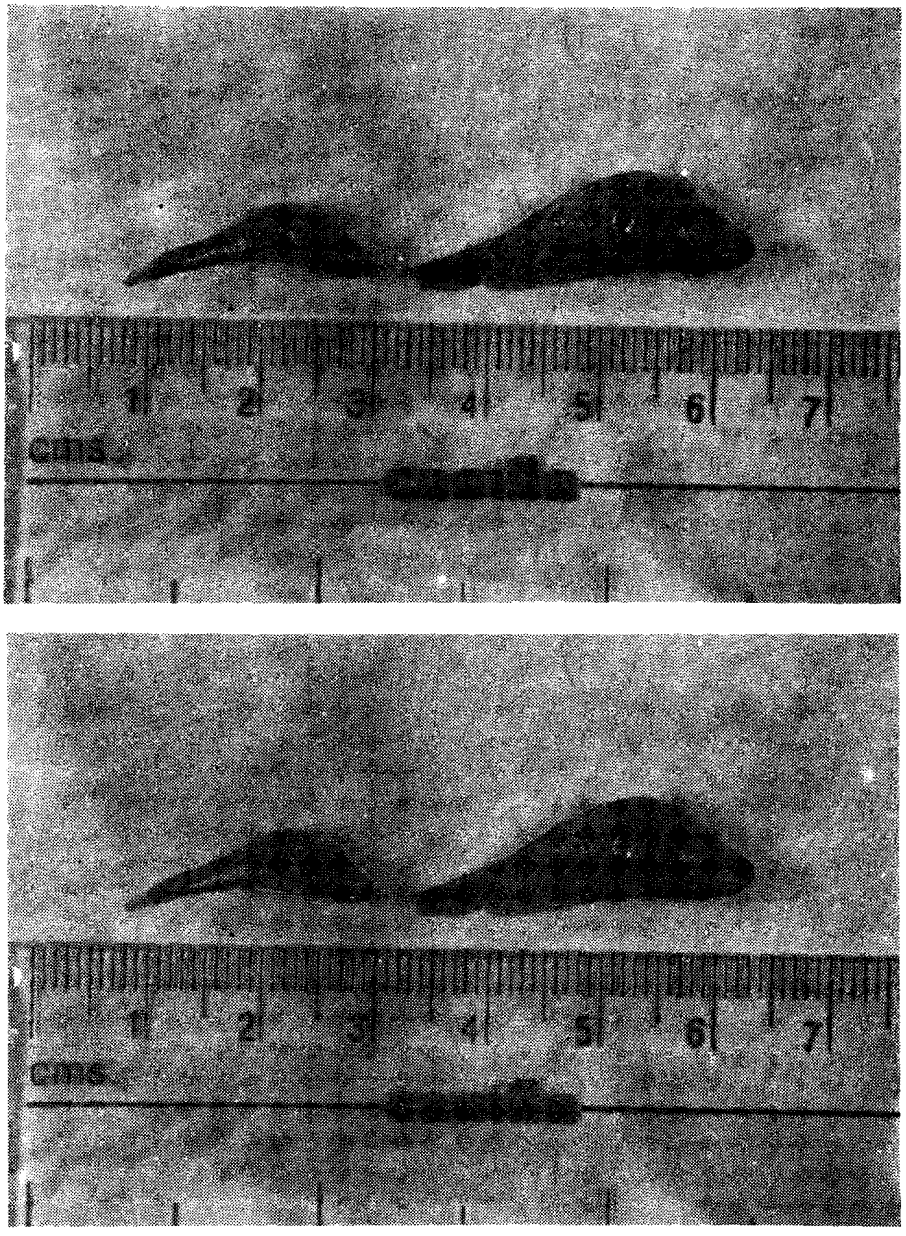
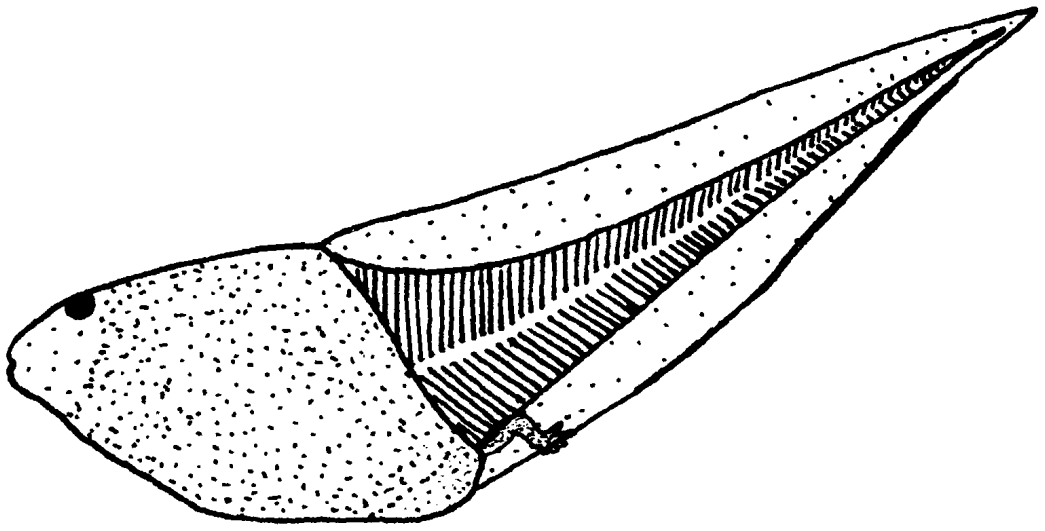
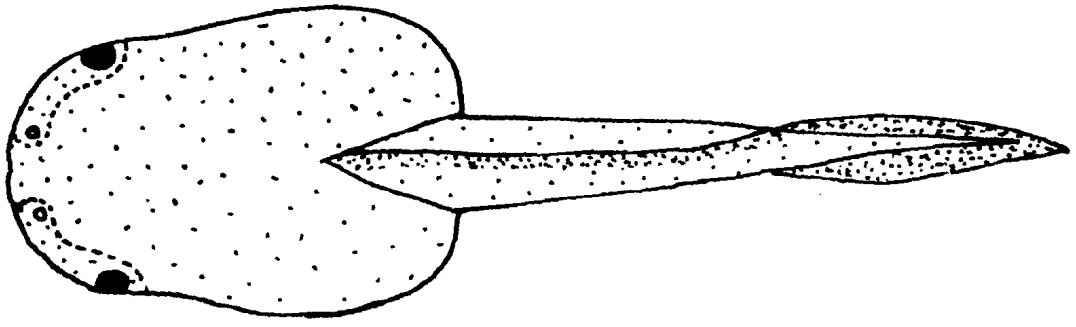


Lateral view of the tadpole



LATERAL VIEW



DORSAL VIEW

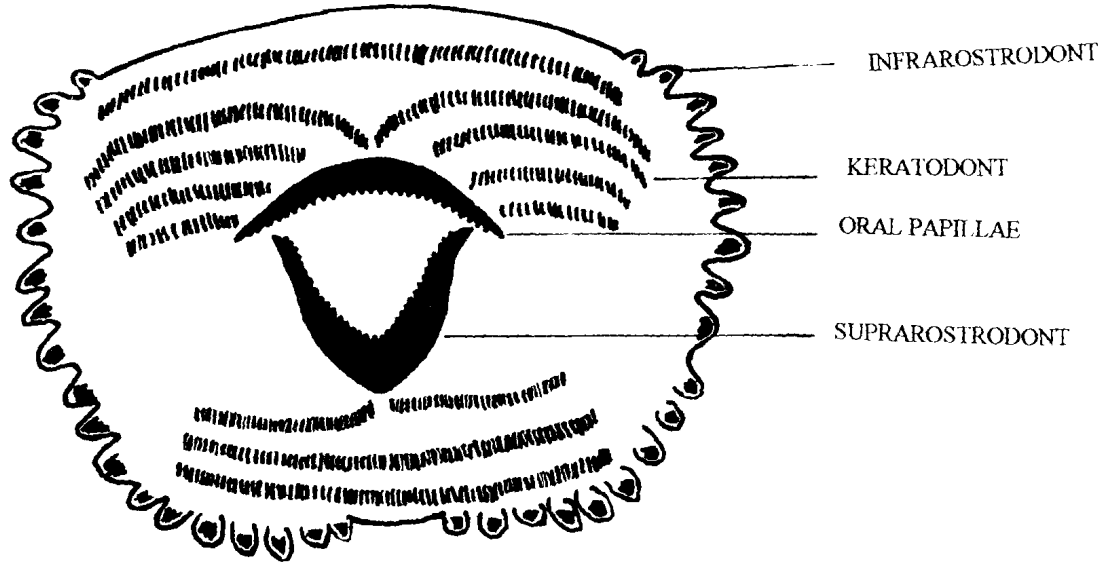


PLATE – 1 ORAL DISC

FAMILY PLANNING IN INDIA : ITS TARGETS AND ACHIEVEMENTS WITH REFERENCE TO WEST BENGAL

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ABSTRACT

At the the backdrop of a repidly increasing population in India there is little doubt about the importance of family planning in India. But even after 40 years, the programme has not achieved the desired result. No doubt, the motivation part has been neglected. Family planning needs to be viewed as a composite programme. In West Bengal too family planning has not yet taken the form of a mass movement.

Introduction

The population problem in the world as well as India is essentially a social problem that is related to the functioning of traditional family norms in a new sociopolitical situation. The burgeoning population continues to have an adverse impact on the economic condition and on the quality of life of the people. This has caused virtually an upsurge of interest for studying the problem of population growth with a least two action orientations : (1) to control or restrict the number of children born to couples through the use of contraception; (2) to understand the social, cultural, physiological and psychological factors affecting reproduction and use of contraception in India.

Under this general backdrop, family planning can be viewed as a composite programme involving contraceptive technology, people's reactions to them and impact of contraception on fertility. Research efforts, therefore, should be more diversified covering bio-medical, demographic and communication motivation aspect of family planning.

Growth of Population in India

It has been estimated that Asia contributes over 60 per cent of the world's population. Among the Asian countries, India comes next only to China. These two countries contribute roughly one-third of the population of the world.

India is the seventh largest and the second most populous country in the world. Although India accounts for only 2.4 per cent of the total area of the earth, it contains about 15 per cent of the total population of the world. The other top countries in terms of population are China with 21.72 per cent and U.S.A. with 5.04 per cent. The population of India on 1st March, 2001, was 1,027,015,247. The draft Eighth Plan

observed that the rate of growth of population during the eighties was around 2.1 per cent which implied an addition of 18 million to the country's population every year and at that rate India will cross the one billion mark by the turn of the century.

The following table (Table 1) gives the growth of Indian population from 300 B.C. to 1991 A.D.

TABLE - 1

Growth of Population of India

(From 300 B.C. to 2001 A.D.)

Year	Population (in crore) (appx.)	Geometric Growth Rate
300 B.C.	10.00	
1600 A.D.	13.00	
1750 A.D.	13.00	
1847 A.D.	13.30	
1871 - 72 A.D.	19.00	
1881 A.D.	20.60	(+) 0.84
1891 A.D.	23.67	(+) 1.49
1901 A.D.	23.83	(+) 0.02
1911 A.D.	25.20	(+) 0.56
1921 A.D.	25.13	(–) 0.03
1932 A.D.	27.89	(+) 1.04
1941 A.D.	31.86	(+) 1.33
1951 A.D.	36.10	(+) 1.25
1961 A.D.	43.92	(+) 1.96
1971 A.D.	54.81	(+) 2.20
1981 (a) A.D.	68.51	(+) 2.22
1991 A.D.	84.39	(+) 2.11
2001 A.D.	102.70	(+) 2.13

(a) Includes projected population of Assam where the 1981 Census could not be conducted owing to disturbed condition prevailing in that state then.

(+) The density has been worked out on comparable data.

Source : (i) Census of India 1991, Series – 1 India, Paper – 1 of 1991. Provisionla Population Totals by A. R. Nanda, Registrar General and Census Commissioner, India; Census of India 2001, Series – 20 West Bengal, Paper – 1 of 2001; Provisional population totals by Vikram Sen, Directors of Census Operations, West Bengal.

Table – 1 shows that the population of India remained stationary at almost 13 crores approximately from 1600 A.D. to 1847 A.D. From 1871 A.D. to 1941 A.D., the population of India increased at the rate of 0.60 per cent per annum, which was almost similar to the estimated growth rate (0.61 per cent per annum approximately) of the then world population. The table reveals that from 1901 A.D. the population increase was modest. The slow increase between 1901 A.D. and 1921 A.D. was due to the great influenza epidemic of 1918-1919. But the population growth between 1921 and 1951 was much greater. The rate of increase between 1921 and 1951 was nearly five times faster than the period betwen 1901 and 1921. During these 30 years, from 1921 to 1951, there was no major decline of population. This is why, the year 1921 was known as the 'great divide' in the history of Indian population. Before 1921 the population increased slowly, but since then it has increased rapidly. The current rate of growth of population indicates that 1951 is also a significant year. Since 1965, the growth seems to be even more than the previous years. Gopalaswamy has clearly shown that there has been a new trend in population growth in India since 1951, owing to the combined effect of three important causative factors. The first among these factors is the prevalence of normal conditions of freely available food supply. The second factor is accelerated progress in the prevention of premature deaths. The third factor is the continuance of traditional habits on uncontrolled child-bearing. Except for a slight fall in 1911-21, the population of India has been steadily growing for the last 80 years (1901-81). From 1951 onwards, the growth rate has been very high. The annual growth rate of population, which was constantly rising since 1941-51, attained the highest figure of 2.34 per cent during 1981-91 and has now declined to 2.13 per cent during 1991-2001. It implies an addition of 18 million to the country's population every year.

The growth of population or its reverse, is affected not only by fertility and mortality rates but also by migration. During the latter half of the nineteenth century, there was migration from India to Ceylon, Burma, Africa and other parts of the world. But though there numbers were quite high, they did not affect substantlially the population figures, since they formed a very small part of the total population. Since inde-

pendence, there has been hardly any scope for the excess population to migrate to other countries. On the other hand, there has been an influx of people from Ceylon, Burma, Africa and other countries. But even these figures do not really affect the rate of growth of population. Admittedly, international migration of population to India has been negligible (except during the partition between India and Pakistan in general, and East and West Bengal in particular).

Progress of Family Palnning since 1952 in India

After Independence, the Government of India recognised the urgency of controlling population growth through reduction in the birth rate. Beginning with the First Five-Year Plan (1951-56), it made some provision for family planning, research and experimentation. Mechanical and chemical contraceptives were adopted, a voluntary sterilisation programme was introduced in 1956, and the intra-uterine contraceptive device (IUCD) came into use in 1965.

India's First Five-Year Plan assumed a rate of population growth of 1.25 per cent per decade and this assumption was retained in the Second Plan also. However, it was assumed that the population may increase at the rate of 1.33 per cent during 1961-71. This assumption was based on the estimate of Kingsely Davis. In 1950, he estimated that the population may grow at the rate of 1.2 per cent per year. Gopalaswami, the Census Commissioner, on the basis of census figures of 1951, assumed that the highest growth rate may be at 1.32 per cent per year. Ajit Das Gupta and Murari Majumdar in their working papers for the Bandung United Nations Seminar on population for Asia and Far East held in 1954, worked out a growth rate of 1.1 to 1.4 per cent. However, Coale and Hoover suggested in 1958, that the population may be actually growing at a rate bordering on 2 per cent. The fourteenth round of National Sample Survey showed that during the year July 1958 to July 1959, the population increased at 1.9 per cent rate. As a result of these assessments and surveys, the members of the Seminar of India's population held in 1959 in the Institute of Economic Growth assumed that the rate of growth was 1.7 per cent between 1951 and 1956 and 2 per cent between 1956-1961. So, it was projected that the 1961 census may show that population would be 42.30 crores. Actually, it was 43.92 crores, according to Agarwala.

The four plan documents clearly show that in the beginning the programme was primarily in terms of concern for the health and welfare of the individual families, though the First Plan acknowledged the serious economic consequences of high fertility. The pilot studies carried out between 1952 to 1955 clearly shoed that there

was little resistance to the idea of birth control. In 1959, the Government favoured all recognised means of family limitation including sterilisation.

In the Fourth Five Year Plan, the programme of family planning assumed national importance and was accorded the highest priority. But it was soon realised that family planning would be more effective and acceptable, if maternity and child health services were to be integrated with it (Fifth Five Year Plan, Draft, Vol. I, p. 107).

With a view to achieving the objective of reducing the birth rate to 30 per thousand of the population by the end of the Fifth Plan, concerted efforts were made to ensure that the number of couples in the reproductive age-group (15 – 44 years) protected against conception was raised to 42 million.

The Fifth Plan approach was aimed at integrating family planning services with those for health, MCH, and nutrition. The principle of integration was extended to mass motivational efforts by making fuller use of existing channels like functional literacy, worker's education, health education, special welfare and other outlets.

The programme was implemented as a truly family welfare-oriented programme by extending the scope and coverage of immunisation and nutritional prophylaxis components so as to help reduction of the infant mortality rate and to improve the nutritional status of children in the 0-6 age group.

Growth of population in West Bengal

West Bengal is one of the most populous states in India. The six most populous states (Uttar Pradesh, Bihar, Maharashtra, West Bengal, Andhra Pradesh and Madhya Pradesh), which together accounted for 59.10 per cent of the total population in 1981, have contributed 62.49 per cent of the increase during the decade 1981-91. According to 1971 census, West Bengal accounts for 7.9 per cent of the total population of India and here the growth rate during 1961-70 was more than 25 per cent. While there is an absolute increase in most cases, it was noticed that West Bengal was among the few states where the percentage of decadal growth rate in the decade 1971-81 has been lower than that in the decade 1961-71. But it has again increased in the decade 1981-91, followed by a decrease in the next decade of 1991-2001.

The following table (Table 2) shows the growth of population in West Bengal from 1901 to 2001 :

TABLE – 2

Trend in Population Growth in Bengal

(From 1901 to 2001)

Year	Population	Geometric Growth Rate
1901	16,940,088	
1911	17,998,769	0.61
1921	17,474,348	(-) 0.29
1931	18,897,036	0.78
1941	23,229,552	2.06
1951	26,299,980	1.24
1961	34,926,279	2.84
1971	41,312,011	2.38
1981	54,580,647	2.10
1991	67,982,732	2.47
2001	80,221,171	1.78

Source : Statistical Abstract, 1985; Central Statistical Organisation; New Delhi; Census of India, 2001, Series – 2.0, West Bengal, Paper –1 of 2001, Porovisional Population Totals by Vikram Sen, Director of Census Operations, West Bengal.

Note : The state of West Bengal has taken its present shape since October 2, 1954.

The trend in population growth in Bengal reveals many ups and downs for the last 100 years (From 1901 to 2001). The growth rate of Bengal reached a peak of 2.84 per cent during 1951-61 (Table 2), whereas the growth rate of India reached a peak of 2.22 per cent during 1971-81 (Table 1). The table also indicates that the growth rate of Bengal during 1901-31 increased at a slow pace, but the growth rate of Bengal had shown a very sharp increase during the decade 1931-41, and in the next decade (1941-51) it decreased sharply. The growth rates of Bengal as well as India were

almost similar during the decade 1941-51; i.e.; 1.24 per cent and 1.25 per cent respectively (compare Table 1 and 2). The trend in population growth of Bengal again sharply increased during 1951-61 and reached a peak of 2.84 per cent and then showed a gradually declining tendency during the following decades, i.e. 1961-71 and 1971-81. Sample Registration System (SRS) indicated that the tendency of gradually declining growth rate of Bengal during 1961-71 and 1971-81 was due to the fertility decline coupled with mortality reduction, although the available fertility data for West Bengal are ambiguous as regards the possibility of fertility decline during the ten years prior to 1981 (Tim Dyson, 1981). The growth rate for Bengal has slightly increased in the last decade (1981-91), whereas it has slightly decreased for India in the same decade. The increase in the growth rate could be an account of a combination of different factors, such as, an increase in net in-migration, a slow decline or stagnation of the birth rate and a comparatively faster decline in the death rate. For West Bengal, the net in-migration is one of the crucial factors to increase the growth rate during 1981-91. The following tables (Table 3 and 4) are fair evidence in support of the increase of growth rate for West Bengal during 1981-91.

TABLE - 3

Net In - migration to India and West Bengal during 1981-1991

Year	Population (in crore)	Geometric Growth Rate
No. of Migrants in the State (West Bengal)	543,055	0.79% of 91 population of West Bengal
No. of Migrants in the rest India	4,646,796	0.59% of 91 population of rest of India
No. of Migrants in India	5,180,851	0.60% of 91 population of rest of India

Source : Journal of Family Welfare, Special Volume, No. 3, September 1991. Family Palnning Association of India, Bombay.

TABLE - 4

The Decennial Growth Pattern In India, West Bengal And Its Ten Border* Districts diruing 1981-91 and 1991 - 2001

	Geometric Growth Rate (%)	
	1981 - 91	1991 - 2001
INDIA	23.86	21.34
WEST BENGAL	24.73	17.84
North 24 Pargana	31.69	22.64
Darjiling	26.91	23.54
South 24 Pargana	30.24	20.89
Uttar Dinajpur	34.00	28.72
Dakshin Dinajpur	24.39	22.11
Nadia	29.95	19.51
Maldah	29.78	24.77
Murshidabad	28.20	23.70
Jalpaiguri	26.44	21.52
Koch Bihar	22.55	14.15

Note : * The ten border districts of West Bengal share common border with Bangladesh and it is assumed that the immigration from Bangladesh to the ten border districts of West Bengal has shown high decennial growth rate during 1981-91 & 1991-2001.

Source : Bose, A., 1992; Demographic Diversity of India; 1991 Census; B. R. Publishing Corporation; Delhi; Census of India 2001, Series - 20, West Bengal, Papers 1 to 2001 Provisional Population Totals by Vikram Sen, Director of Census Operations, West Bengal.

As pointed out by Ashish Bose, West Bengal is demographically a vulnerable state because of a constant flow of migrants from Bangladesh as well as from other parts of India and the decay of the city of Calcutta. The 2001 census has recorded the highest density of population in West Bengal i.e. 904 persons/sq.km. Earlier, it was in

Kerala. According to Bose, the demographically vulnerable states (Bihar, Uttar Pradesh, Rajasthan, Madhya Pradesh, Orissa, Assam, West Bengal and Hariyana) contribute to 56.08 per cent of India's population, of which West Bengal, Assam and Orissa account for 14.43 per cent.

Family Planning Programme in West Bengal

Like other states, the Government of West Bengal also implemented the family planning programme following the guideline fromulated by the Government of India since 1951. At the State level, the entire family planning programme is being organised by the "State Family Welfare Bureau" under the auspices of "Directorate of Health Serrvices" and occasionally, the "Demographic and Evaluation Cell" under the "State Family Welfare Bureau" evaluates the family planning programme. The following table (Table 5) shows the annual expenditure on family planning / family welfare programme from 1974-75 to 1986-87.

TABLE – 5

Annual Expenditure on Family Planning / Family Welfare Programme From 1974 - 75 to 1986 - 87

Year	Expenditure on Family Welfare Programme (Rs. in lakhs)
1974 - 75	270.38
1975 - 76	440.73
1976 - 77	1313.66
1977 - 78	-
1978 - 79	-
1979 - 80	523.24
1980 - 81	750-45
1981-82	868.68
1982 - 83	1310.03
1983 - 84	2253.56 (a)
1984 - 85	1878-87 (a)
1985 - 86	2347.71
1986 - 87	3047.31 (a)

(a) Provisional.

Source : Family Welfare Programme in India, Year Book, 1986 - 87; Ministry of Health and Family Welfare; Government of India.

During the Sixth Plan (1980-85), the State Government-provided plan outlay for faimly planning / family welfare programme was only Rs. 62.50 crores, whereas the expenditure in that head during the same plan period was only Rs. 22.56 crores. In that connection, performance regarding implementation of family welfare programme in West Bengal during the Sixth Plan was poor. West Bengal had a couple protection rate of 29 per cent against the national average of 32 per cent. The effective couple protection rate increased by 6.0 percentage points which was a little below the national average increase of 6.6 percentage points during the first four years of the Sixth Plan (1980-84). The estimation of couple protection rate as in April, 1983, indicated that West Bengal may reach a Net Reproductive Rate (NRR) of 1 by the year of 1996-97 and West Bengal stands in the category of 'Group B'.

The Government of India-provided plan outlay in the head of family welfare programme for West Bengal during Seventh Plan (1985-90) was Rs. 950.65 crores only or an average of Rs. 190.13 crores per year, whereas the State allocated Rs. 29.84 crores in 1985-86, Rs. 34.47 crores in 1986-87, Rs. 39.29 crores in 1987-88, Rs. 45.60 crores in 1988-89 and Rs. 47.08 crores only in 1989-90 in the same head.

The following table (Table 6) shows the per capita expenditure on family welfare programme from 1980-81 to 1989-90 in India and West Bengal.

TABLE - 6

Per Capita Expenditure (Rs.) on Family Welfare

Year	West Bengal	India
1980-81	1.56	2.14
1981-82	1.77	2.77
1982-83	2.79	4.30
1983-84	3.85	5.41
1984-85	3.65	5.88
1985-86	4.64	7.24
1986-87	5.01	7.61
1987-88*	5.31	N.A.
1988-89*	5.87	N.A.
1989-90*	6.60	N.A.

Source : Health Information India, 1990 (upto 1986-87) - CBHI, Government of India.

* Provisional (Estimated at SBHI, West Bengal)

The State of West Bengal achieved the highest percentage of target (224.86) during 1976-77 and the lowest percentage of target (18.36) during 1973-74 in 'sterilisation' (both male and female) operation. In 'IUD' insertions the lowest percentage of target (9.22) achieved by West Bengal was during 1977-78 and the highest percentage of target (139.56) was in 1965-66. In the head of 'conventional contraceptive users', the highest percentage of target achievement (27.62) took place in 1970-71. But the highest percentage of target achieved (245.65) in the head of 'Oral Pill Users' was during 1987-88 and the lowest percentage of target achieved (10.10) by West Bengal in the same head was in 1980-81. The highest number 'Termination of Pregnancy' (50.564) occurred in 1989-90 and the lowest number of 'Termination of Pregnancy' (2200) occurred during 1972-73.

The following table (Table 7) shows the cumulative acceptor rates in sterilisation programme, in IUD and in Conventional Contraceptive Programme in West Bengal and in India for the 1969-82 and 1982-87.

The sterilisation programme exhibited wide fluctuations during 1969-82 and it touched the peak during 1976-77.

TABLE – 7

Cumulative Acceptor Rates in Sterilisation Programme, In AUD and in Conventional Contraceptive Programme in West Bengal and in India for the periods 1969-82 and 1982-87

	West Bengal		India	
	1969-82	1982-87	1969-82	1982-87
Sterilisation Programme	31.16	18.60	28.79	17.72
IUD	2.94	3.12	6.27	9.79
Conventional Contraceptive Programme	17.29	8.14	21.06	17.19

Source : Singh, and et. al. (ed.); 1989; Population Transition in India Vol. I

It is important to note that the sterilisation programme during the special drive period of 1971-73 and 1975-77 succeeded well due to male sterilisation cases (July, 1978) in areas which were socially and/or econimically backward as against the even tempo maintained by the relatively successful states. The coverage of the IUD programme did improve in all the states during the special drive of 1971-73 and 1975-77, but generally it did not lead to births averated. In terms of birth averted (Jolly, 1986:3) in the total programme, some 82 per cent is on account of sterilisation, 8 per cent through IUD and 10 per cent through C.C. users during 1956-84.

The then Minister for Health, Government of West Bengal, Mr. Prasanta Sur admitted in a press conference that the family welfare programme had not yet been properly implemented in this State. He further advised that it was essential to incorporate the publicity for family welfare programme within the campaign for literacy [*Bartaman,* (Calcutta-based Bengali Daily), 13th May, 1992].

In case of sex ratio, West Bengal improved its rank by changing 917 females for 1000 males in 1991 to 934 females per 1000 males in 2001. It is definitely a positive indication of recognising feminine rights which will ultimately help in controlling growth rate of total population and family welfare programme.

One of the major indicators of decline in the population growth rate is generally the decline in the percentage of children in the 0 - 6 age group as compared to the total population. Since the death rate is actually going down all across the country and the life span of the people is generally increasing, the most prominent factor responsible for decline in the population growth rate will naturally be decline in the percentage of 0 - 6 age group in the total population. Of course, in some local areas the decline in the growth rate may be explained by other factors, particularly out-migration, but out-migration alone can not explain the general trend of state-wise decline in the population growth rate. The percentage of 0 - 6 age group population with male-female breakup as compared to the total population from 1951 to 2001 for West Bengal is given in the following table (Table 8) :

TABLE - 8

Percentage of 0-6 age group population as compared to the total population of West Bengal

Year	Percentage of 0-6 age group population against the total population	Percentage of 0-6 age group male population against the total male population	Percentage of 0-6 age group female population against the total female population	Decennial growth rate for the total population
1951	16.56	15.43	17.96	13.22
1961	21.97	20.55	23.59	32.80
1971	21.11	19.86	22.52	26.87
1981	17.39	16.77	18.06	23.17
1991	16.98	16.56	17.45	24.73
2001	13.88	13.67	14.10	17.84

Source : Census of India 2001, Series 20, West Bengal, Provisional Population Totals, Paper - 1 of 2001 by Vikram Sen, Sirector of Census Operations, West Bengal.

From the above table, it will be observed that there has been a distinct trend in the lowering of the percentage of 0 - 6 age group population in the total population since 1961. In the decade from 1951 - 1961, there was a sharp increase in the percentage of 0 - 6 age group population in the total population from 16.56% to 21.97%. The population growth rate also increased from 13.22% to 32.80%, which was for the trauma of partition of the country and large scale migration of poeple into West Bengal in between this period of demographic turmoil. In all subsequent censuses from 1961, it is evident that the precentage of 0 - 6 age group population in the total population has decreased steadily. This was also reflected in the decline in the decennial growht rate between 1961 to 2001, except in 1991.

Conclusion

In India, family planning programme has become adult without attaining maturity. During the last 40 years, the programme administrators have tried a number of strategies to increase the number of acceptores and to that extent they have been successful. But several aberrations in the programme have also taken place. The

motivational work is getting neglected due to overemphasis of family planning targets.

The way family planning programme has been implemented so far suggests that it is the Government of India's baby, while the states are its main beneficiaries. To achieve a low level of fertility, the family planning programme must become a mass movement, and for this its implementation and decision making process should be completely decentralised and the Government of India should act only as a provider of financial and IEC (Information Education and Counselling) support. Subramaniam (1987) has suggested that the involvement of people in the population programme is essential for its success. This can be brought about only by a decentralised approach. Each district should be made the unit of planning and each block should have a programme for taking into consideration the conditions prevailing in that block, whereas each village should be made its operational unit. There should be non-official committees at district, block and village levels, with substantial representation of women. Realistic targets sould be fixed and operational programmes are to be evolved to reach the targets (Vig. 1989).

Family planning programme in India has been projected as a mere process of preventing births, while its more important and positive role as a process of human development has been ignored and undermined by the programme administrators. So the family welfare programme is yet to become a people's movement in India. Community participation and contribution of voluntary sector are taking place only on a very limited scale. Moreover, there are also inadequacies in the quality of service, availability of male/female workers and shortage of basic infrastructural facilities, which hamper the progress of the programme.

To keep the population growth in the country within manageable limits, a well defined strategy has now been evolved by the Government. It lays emphasis on improving the quality of healthy services, strengthening health infra-structure, enhancing child survival rates through Universal Immunization Programme, intensifying population education, enhancing community participation, adopting improved communication approaches and involving voluntary organisations. Besides, schemes of reinforcement of training and retraining of personnel at the grass-root level, establishing and strengthening linkages with related development programmes like female literacy and improvement of women's status and adoption of area-intensive approach are being implemented and will be further strengthened. A number of projects for augmenting the infrastructure for health and family welfare service delivery system and the training of medical and paramedical staff have been taken up in selected states. Even within the background of a constraint of resources, no efforts are being spared by the Government to achieve the objective of reduction in the rate of growth of the population. As Bernard Berelson (1969) maintains, the family welfare programme should emphasize the need to go beyond "family planning".

Going beyond family planning means undertaking two important steps, which are mentioned below :

1) All efforts should be made to take out children from the labour force. From now onward, at least every child of school going age must be enrolled in the school and anti-child labour should be vigorously enforced.

2) Child Marriage Restraint Act, 1978 should also be vigorously enforced. In addition, vocational training centres should be established at a large scale in rural areas and urban slums to keep girls usefully involved till 18 years of age.

Above all, the family planning or family welfare programme of India needs a thorough reorientation, making the programme a mass movement instead of a Government-sponsored programme. Suffice it to say that in West Bengal too, family welfare programme has yet to take the form of a mass movement. Sincere attempts should be made towards making family planning a mass movement in West Bengal. Sooner it is done, the better for all concerned.

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AN INVENTORY OF THE NON-CONVENTIONAL FISH FEED RESOURCE AND THEIR NUTRITIONAL EVALUATION IN THE DISTRICT OF MIDNAPORE, WEST BENGAL

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ABSTRACT

Protein alternatives in diets for warm water and cold water fishes should replace their natural proteins not only in quantity but also in quality to provide adequate levels of essential amino acids (EAA). After making a thorough survey in the district of Midnapore, an inventory of non-conventional protein alternatives has been made. On the basis of nutritional value of 5 agro-industrial waste/by products, 12 aquatic macrophytes, 9 terrestrial macrophytes and 9 animal products/by-products have been indentified and evaluated to make a data bank of protein alternatives available in Midnapore district.

The primary aim of fish culture is to transform dietary protein into tissue protein efficiently. Until recently, the tendency has been for commercial feed manufacturers to utilize fish meal as the sole protein source in fish diets. As fish meal is expensive and difficult to obtain in many parts of the world, it is imperative that suitable alternatives are found ([1]NAS, 1976; [2]Hepher *et al.*, 1978; [3]Matty and Smith, 1978; [4]Beck *et al.*, 1979; [5]Tacon, 1981; [6]Jackson *et al.*, 1985; [7]Hajra and Tripathi, 1985; [8]Appler, 1985; [9]Hajra, 1987; [10]Wee and Wang, 1987; [11]Mishra *et al.*, 1988; [12]Patra and Roy, 1988; [13]De Silva and Gunasekera, 1989; [14]Patra *et al.*, 1999). Protein alternatives in diets for warm water and cold water fishes should replace their natural proteins not only in quantity but also in quality so as to provide for optimum growth, feed conversion and the well-being of the animal throughout its life cycle. In addition, to provide adequate levels of essential amino acids (EAA), through different non-conventional fish feed resource, an alternative protein source must of course be readily acceptable to the particular fish species under culture. The range of potential non-conventional protein sources can be divided arbitrarily into 4 groups :

(i) Agricultural by-products of plant origin, (ii) Animal products, (iii) Industrial waste products and (iv) Recent inclusion of aquatic and terrestrial macrophytes. The present study is one of a series aimed at developing least-cost technology using a data bank on the availability of non-conventional fish feed resource in the district of Midnapore, West Bengal and evaluating the nutritional influence of the plant and animal resources considering the economics on one hand and reducing the cost of feed on the other.

After making a thorough survey in the different Blocks of Midnapore district, an inventory of non-conventional and conventional fish feed resource have been made on the basis of dominance in a particular area (Table 1).

Table 1. Different non-conventional and conventional fish feed resource predominant in different areas (Block etc.) of Midnapore District.

Sl. No.	Name of the Fish feed resource	Source	Portion to be used	Area of occurrence (Dominant Block)
A.	**AGRICULTURAL WASTE/BY-PRODUCTS**			
1.	*Linum* sp. (Linseed oil cake)	Oil mill	Whole cake	Gorbeta, Jhargram, Chandrakona, Gopiballavpur
2.	*Arachis* sp. (Groundnut oil cake)	Oil mill	Whole cake	Debra, Ghatal, Panskura
3.	*Brassica* sp. (Mustard oil cake)	Oil mill	Whole cake	Township area
4.	*Oryza* sp. (Rice bran/ polishing)	Rice mill	Polishing	All the block
5.	*Triticum* sp. (Wheat bran)	Flour mill	Bran	Garbeta, Jhargram, Sankrail
B.	**AQUATIC MACROPHYTES**			
1.	*Eichhornia* sp.	Wet land & derelict water body	Leaves	Sabang, Panskura, Tamluk
2.	*Azolla* sp.	Fresh water area	Leaves / whole plant	Tamluk, Kharagpur, Midnapore
3.	*Spirodela* sp.Fresh water area	Leaves / whole	- do - plant	
4.	*Lemna* sp.	Fresh water area	Whole plant	- do -
5.	*Wolffia* sp.	Fresh water area	Whole plant	- do -
6.	*Pistia* sp.	Fresh water area	Whole plant	- do -
7.	*Trapa* sp.	Fresh water area	Whole plant / leaves	- do -
8.	*Nymphoides* sp.	Fresh water area	Leaves	- do -
9.	*Hydrilla* sp.	Fresh water area	Whole plant	- do -
10.	*Nechamandra* sp.	Fresh water area	Whole plant	- do -
11.	*Salvinia* sp.	Fresh water area	Whole plant	- do -
12.	*Valisneria* sp.Fresh water area	Whole plant	- do -	
C.	**TERRESTRIAL MACROPHYTES**			
1.	*Cynodon* sp. (Grass)	Grass land	Green parts	Garbeta, Chandrakona

2.	*Leucaena* sp. (Leguminous plant)	Residential area/ Forest area	Leaves	- do -
3.	*Musa* sp. (Banana)	Agricultural field	Leaves	Panskura, Moina, Tamluk, Ghatal
4.	*Bambusa* sp. (Bamboo)	Village & Forest area	Leaves	Jhargram, Binpur, Jamboni, Salboni, Goaltor, Garbeta, Chandrakona
5.	*Oryza* sp. (Green paddy)	Paddy field	Leaves	Blocks of East Midnapore
6.	*Brassica* sp. (Cauliflower)field	Agricultural	Leaves Keshpur,	Garbeta Chandrakona, Ghatal
7.	*Brassica* sp. (Cabbage)	Agricultural field	Leaves	- do -
8.	*Vigna* sp. (Beans)	Agricultural field	Leaves	- do -
9.	*Cucurbita* sp. (Gouard)	Agricultural field	Leaves	- do -
D.	**ANIMAL PRODUCTS/BY-PRODUCTS**			
1.	Trash fish meal	Marine/Coastal area	Whole fish	Ramnagar, Contai, Khejuri
2.	Mollusc mealMarine/Coastal	Whole mollusc area	Ramnagar,	Contai, Khejuri
3.	*Acatina* sp. meal	Pond banks/ Forest area	Meat	Salboni, Binpur, Jamboni Jhargram
4.	Feather mealPoultry	Feather	Township area	
5.	Carcass wastes	Slaughter house (Beaf)	Skin/meat, bone etc.	- do -
6.	Goat blood meal	Meat shop (Goat)	Blood	Municipality area/township area
7.	Slaughter house waste	Slaughter house (Goat)	Skin, meat, head, leg, bone etc.	- do -
8.	Silk worm pupae	Silk farm	Pupae	Debra, Jhargram, Midnapore
9.	Earthworm meal	Bottom of the household wastes	Whole earth -worm	Domestic area of different blocks

The ingredients of plant and animal origin were analysed for their proximate composition by the methods of [15]AOAC (1984) in triplicate: moisture, determined by hot air-oven drying at 85.0°C to constant weight; ash, determined from weighed samples in a porcelain-silica crusible placed in a Muffle furnance at 500.0+50.0°C for at least five hours; crude protein, determined indirectly from the analysis of total kjeldahl nitrogen (crude protein = N x 6.25) by the micro-kjeldahl method; crude lipid, determined by extraction with petroleum ether (60.0 – 62.0°C bp) for six hours in a soxhlet apparatus; fibre content, determined by using hot acid – alkali digestion and the energy content was calculated by the caloric conversion terms of [16]Jobling (1983) where 1.0 gram of protein, lipid and carbohydrate contains 5.45 kcal, 9.65 kcal and 4.10 kcal energy respectively.

Nutritive values of the different non-conventional and conventional fish feed resource are presented in Table 2.

Five (5) agro-industrial waste/by-products were analysed and observed that groundnut oil cake contains higher amount of protein (40.34%) although mustard oil cake contains higher amount of energy (4.764 kcalg $^{-1}$). Wheat bran contains higher amount of norogen free extract (62.38%) as compared to either oilcakes or rice polishing. Among twelve (12) aquatic macrophytes, highest protein and energy content were recorded from *Azolla* sp. (24.36% and 4.053 kcalg $^{-1}$) which are comparable with the others, particularly in energy values except in *Eichhornia* sp. (2.475 kcalg $^{-1}$). Highest lipid and carbohydrate content were recorded from *Hydrilla* sp. (9.56%) and *Wolffia* sp. (59.48%) respectively. Nine (9) terrestrial macrophytes including some vegetables were evaluated, of which highest protein, lipid, carbohydrate and energy were recorded from *Vigna* sp. (15.40%), *Vigna* sp. (6.22%), *Cucarbita* sp. (64.43%) and *Brassica* sp. (3.995 kcalg $^{-1}$, cabbage) respectively. Lowest protein and energy content was recorded from *Bambusa* sp. (13.25%) and 3.107 kcalg $^{-1}$). All together, nine (9) animal products/by-products were analysed for nutritional evaluation and highest protein, lipid, carbohydrate and energy were recorded from Earthworm meal (65.19%), Silk worm pupae (23.48%), Molluscan meal (30.06%) and Silk worm pupae (5.902 kcalg $^{-1}$) respectively. Lowest protein and energy were recorded from Molluscan meal (44.20%) and Feather meal (4.043 kcalg $^{-1}$) respectively.

After a comparison of the nutritional value with the results of different workers (1-14), the present study indicates that the different Blocks of Midnapore contain varieties of cheaper non-conventional and conventional fish feed resources which could be incorporated in the practical diets of Indian major carps as well as exotic carps on one hand and reduce the cost of feed on the other during feed formulation.

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Table 2. Nutritive value of the different non-conventional fish feed resource available in the district of Midnapore, West Benal (percentage dry weight basis)

Sl. No.	Resource / Ingredients	Moisture	Dry matter	Ash	Organic matter	Crude protein	Crude lipid	Crude fibre	Nitrogen free extract	Gross energy ($Kcalg^{-1}$)
A.	AGRO INDUSTRIAL WASTE/BY-PRODUCTS									
1.	Linseed oil cake	5.83	94.17	10.92	59.08	31.69	11.02	11.28	29.26	4.494
2.	Groundnut oil cake	4.98	95.02	8.36	91.64	40.34	9.78	8.30	28.24.	4.701
3.	Mustard oil cake	6.05	93.95	9.55	90.45	39.23	12.24	7.00	26.93	4.764
4.	Rice bran/polishing	4.38	95.62	21.41	78.59	13.03	5.14	25.50	30.54	3.519
5.	Wheat bran	8.98	91.02	4.47	95.53	13.29	3.20	7.38	62.38	3.913
B.	AQUATIC MACROPHYTES									
1.	*Eichhornia* sp.	82.85	17.15	26.50	73.50	12.08	5.17	24.40	31.85	2.475
2.	*Azolla* sp.	90.73	9.27	10.50	89.50	24.36	7.11	9.10	48.93	4.053
3.	*Spirodela* sp.	91.90	8.10	20.50	79.50	13.60	6.20	7.90	51.80	3.174
4.	*Lemna* sp.	92.10	7.90	11.36	88.64	16.12	7.12	8.66	56.74	3.909
5.	*Wolffia* sp.	91.77	8.33	12.27	87.73	14.36	6.35	7.54	59.48	3.850
6.	*Pistia* sp.	90.52	9.48	13.25	86.75	14.87	8.11	6.39	57.38	3.959
7.	*Trapa* sp.	87.88	12.12	20.54	79.46	14.92	8.29	6.85	49.40	3.651
8.	*Nymphoides* sp.	87.42	12.58	22.04	77.96	15.17	8.24	6.91	47.64	3.872
9.	*Hydrilla* sp.	92.51	7.49	21.29	78.71	14.67	9.56	6.90	47.58	3.966
10.	*Nechamandra* sp.	91.98	8.02	21.01	78.99	13.92	7.95	7.11	50.01	3.879
11.	*Salvinia* sp.	91.25	8.75	18.20	81.80	14.92	6.37	8.22	52.31	3.589
12.	*Valisneria* sp.	92.17	7.83	20.21	79.79	14.33	9.15	11.27	45.04	3.520

Sl. No.	Resource / Ingredients	Moisture	Dry matter	Ash	Organic matter	Crude protein	Crude lipid	Crude fibre	Nitrogen free extract	Gross energy ($Kcalg^{-1}$)
C.	TERRESTRIAL MACROPHYTES									
1.	*Cynodon* sp. (grass)	83.15	16.85	9.15	90.85	14.80	4.85	23.20	48.00	2.994
2.	*Leucaena* sp. (Leguminous plant)	83.37	16.63	9.85	90.15	15.17	5.12	20.10	49.76	3.381
3.	*Musa* sp. (Banana)	85.18	14.82	10.11	89.89	14.36	5.17	18.54	51.82	3.424
4.	*Bambusa* sp. (Bamboo)	84.55	15.45	11.29	88.71	13.25	4.32	23.57	47.57	3.107
5.	*Oryza* sp. (Paddy)	84.17	15.83	10.36	89.64	13.67	4.17	24.42	47.38	3.109
6.	*Brassica* sp. (Cauliflower)	88.17	11.83	8.25	91.75	14.25	6.10	7.92	63.48	3.984
7.	*Brassica* sp. (Cabbage)	88.10	11.99	8.09	91.91	14.30	6.15	7.88	63.58	3.995
8.	*Vigna* sp. (Beans)	85.16	14.84	9.14	90.86	15.40	6.22	8.10	61.14	3.964
9.	*Cucarbita* sp. (Gouard)	87.51	12.49	8.37	91.63	14.69	4.35	8.16	64.43	3.882
D.	ANIMAL PRODUCTS / BY-PRODUCTS									
1.	Trash fish meal	2.30	97.70	11.98	88.02	48.65	6.72	2.13	28.22	4.627
2.	Mollusc meal	3.05	96.95	16.50	83.50	44.20	5.99	3.25	30.06	4.295
3.	*Acatina* sp. meal (meat)	84.16	15.84	5.20	94.80	55.20	6.11	3.77	29.72	4.914
4.	Feather meal	6.73	93.27	15.11	84.89	47.12	7.11	13.35	17.31	4.043
5.	Carcass waste	4.75	95.25	16.30	83.70	53.59	15.71	5.05	4.60	5.569
6.	Goat blood meal	5.75	94.25	4.64	95.36	54.24	2.06	0.00	33.31	4.624
7.	Slaughter house waste	4.90	95.10	13.14	86.86	49.50	9.77	12.24	15.35	4.348
8.	Silk worm pupae	3.63	96.37	4.69	95.31	57.27	23.48	2.73	8.20	5.902
9.	Earthworm meal	3.84	96.16	4.68	95.32	65.19	11.21	6.74	7.62	5.054

THE GENUS *Ocimum* Linn. (Labiatae) OF INDIA

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ABSTRACT

A taxonomic study involving correct name, type specimen, distribution and uses has been done for the Indian genus *Ocimum* Linn. An artificial key to the species is provided to facilitate the identification of the studied taxa.

INTRODUCTION

The genus *Ocimum* Linn. (Labiatae) with about 150 species is widely distributed throughout the tropics (Mabberley, 1997). In India it is represented by only 6 species and 1 variety (Banerjee, 1996). The genus is very well known for its many medicinal important species, some are the source of camphor. Some of the species are considered to have religious significance to man (Ambasta, 1986).

The genus *Ocimum* Linn. is placed within sub-family Ocimodieae (as tribe) by Bentham (1848) along with 13 genera, out of which 11 genera are distributed in India including *Ocimum* Linn.

The present objective of this study of the genus *Ocimum* Linn. is to emphasise the proper identity of species as the identity of different species is often confusing due to wrong interpretation of proper taxonomic concept and for the nomenclatural prob lem. So, to provide proper taxonomic idea the present critical study has been undertaken. The study is also to provide the correct nomenclature, type specimens, distribution and uses, etc. The present circumscription is also provided to analyse the previous concept. The taxonomic notes or remarks are also provided for each species. An artificial key to the species is also given to facilitate identification and the principal diagonostic features of the studied species.

MATERIALS AND METHODS

The work is based mainly on the study of the dried herbarium specimens gathered in the Central National Herbarium (CAL) and the live specimens collected from the different localities of India by the authors. For each species a number of specimens are studied supplimented with type specimens whenever available and the authentic specimens determined by the previous taxonomists.

Study has been made under microscope and in all the cases drawings are done under camera lucida but the figures are not provided here due to paucity of time and space.

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Enumeration of species is arranged in alphabetical sequence with correct name, synonyms and basionyms, distribution, notes, uses and taxonomic remarks.

OBSERVATIONS

The genus *Ocimum* Linn. is well differentiated by the following characters from the rest of the related genera : i) Leaves simple; ii) Inflorescence though verticillate but lax-arranged on long elongated rachis; iii) Calyx 2-lipped (1+4) arranged with larger-ovate posterior one and smaller dentate subequal to unequal anterior 4-lobed condition; iv) Corolla 2-lipped (4+1) arranged with smaller, equal to subequal rounded-oblong posterior 4-lobed and the larger-ovate anterior one-lobed; v) Lower areolar space of nutlets distinct. Type species is *Ocimum basilicum* Linn. The following is an artificial key to the Indian species of *Ocimum* :

1a.	Median pair of anterior calyx lobe longer than the posterior lobe	5
1b.	Median pair of anterior calyx lobe smaller or equal to the posterior calyx lobe	2
2a.	Length of the pedicels as long as the length of the calyx	3
2b.	Length of the pedicels much smaller than the length of calyx	4
3a.	Bracts broadly ovate or cordate	*O. tenuiflorum*
3b.	Bracts lanceolate or oblanceolate or narrowly elliptic	*O. kilimandscharicum*
4a.	Leaves 1.5-2.5 cm long, obtuse, entire, or faintly toothed, glabrous	*O. adscendens*
4b.	Leaves 2-6 cm long, acute, crenate-serrate, pubescent	*O. gratissimum*
5a.	Flowers 6-9 mm long; fruiting calyx 6-8 mm long; tip of the upper lip of fruiting calyx obtuse	*O. basilicum*
5b.	Flowers 3.5-5.0 mm long; fruiting calyx 4-5 mm long; tip of the upper lip of fruiting calyx acute	*O. canum*

The enumeration of studied species :

1. ***Ocimum adscendens*** Willd, Sp. Pl. 3 : 166. 1800.

Type : India Orientalis, 11074.

Synonyms : *0. indicum* Roth, Nov. Sp. Pl. 273.1821. *Plectranthus indicus* (Roth) Spreng., Syst. Veg. 2 : 69131825. *Ocimum cristatum* Roxb. (Hort. Beng. 45.1814 *nom. nud.*), Fl. Indica ed. Carey 3 : 19.1832.

Distribution : India (Andhra Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Tamil Nadu, Uttar Pradesh); Sri Lanka.

Note : Flowering and fruiting throughout the year; grows in dry lands in the outskirts of forests and also around the falls up to 912 m altitude.

2. ***Ocimum basilicum*** Linn., Sp. Pl. ed. 1 : 597.1753.

Type : Herb. Linn. 749.5 (LINN *n. v.*) described from West Asia.

Key to the varieties :

1a. Herb or under shrub; stem and branches densely hirsute; inflorescence rachis much elongated with distant whorls of veriticilasters.

var. *basilicum*

1b. Herb, stem and branches glabrous to glabrescent; inflorescence rachis shorter having thyrsoid appearance.

var. *thyrsiflorum*

O. basilicum Linn. var *basilicum*

Synonyms : *O. americanum* Linn. Cent Icon. Pl. 15.1755 and Amon. Acad. 4:276.1759. :

O. album Linn. Mant. Pl. 1: 85 : 1767 (non Roxb. 1832)

O. minimum Burm. f., Fl. Indica. 129.1764.

O. hispidum Lam., Encycl. 1 : 348.1785.

O. integerrimum Willd., Sp. Pl. 3 : 162.1800.

O. barrelieri Roth, Nov. Sp. Pl. 278.1821.

O. caryophyllatum Roxb. (Hort. Beng. 45. 1814 *nom. nud.*),

Fl. Indica ed. Carey 3 : 16. 1832.

O. pilosum Roxb., Fl. Indica ed. Carey 1 : 16. 1832.

O. menthaefolium Benth. in DC., Prodr. 12 : 32. 1848.

Distribution : Throughout India including Andaman Islands; Africa, America, Bhutan, China, Malaya Peninsula, Mayanmar, Polynesia, Sri Lanka, Taiwan.

Note : Flowering and fruiting throughout the year; a very common and abundantly growing species found in plains, mostly along the railway tracts, wasteland, also reaches from 50m to 500m altitude and even upto 1800-3850 m in Jammu and Kashmir. Variously named as *Babui tulsi* (Bengal), *Sweet basil* (English), *Kali Tulsi* or *Gulal tulsi* (Hindi), *Tew-la-pong-nai* (Khasi), *Marva, Sabza* (Mar.), *Karpura Tulsi, Tirnixypachi* (Tam.), *Bhutulsi, Burdrajada, Vepudupachha* (Tel.)

Uses : Plant is aromatic in nature and the oil, Basil oil, obtained from the plant is used as flavouring agents, insect repelling agent. The plant is considered to be stomachic, anthelmintic, antipyretic, diaphoretic, expectorant, carminative, stimulant and pectoral. Roots are used in bowl complaints of children and febrifuge. Leaves are used in ear-ache and also ringworms. Seeds are used in gonorrohoea, dysentery, chronic diarrhoea, nephritis, internal piles etc. (Kirtikar and Basu, 1942, Nadekarni, 1954, Chopra *et al.*, 1956, Anon., 1966 and Ambasta, 1986).

Taxonomic remarks : It is very like to *O. canum* Sims. except the length of fruiting calyx and the length of flower. In *O. canum* the tip of the upper lip of fruiting calyx is acute while in *O. basilicum* it is obtuse.

O. basilicum Linn. var ***thyrsiflorum*** (Linn.) Benth., Labiat. Gen. Sp. 4. 1832.

Basionym : *Ocimum thyrsiflorum* Linn; Mant. Pl. 1 : 84. 1767.

Type : Herb. Linn. 7491 (HU *n.v.*).

Distribution : INDIA (Andhra Pradesh, Bihar, Haryana, Madhya Pradesh, Orissa, Punjab, Tamil Nadu, Uttar Pradesh).

Notes : Flowering and fruiting commonly from February to November. grows in wasteland, reaching upto 590m altitude.

Taxonomic remarks : Bentham (1832-1836) had retained some varieties like var. *pilosum* (Roxb.) Benth. and var. *purpurascens* Benth. based on the trichome nature and the texture of leaves. Hooker (1885) was in confusion

in maintaining such varieties. After examining many herbarium specimens collected from the different localities and varied habitat it is seen that the pilose nature as well as texture of lamina are the variable features and often present in some populations under different habitat and thus not containing a constant feature. So these varieties are included as synonyms.

3. *Ocimum canum* Sims. in Curtis, Bot. Mag : 51 : t. 2452. 1824.

Type : A native of China, raised from the seeds sent from China grown at Horicultural Garden, Chiswick, t. 2452 (Drawing of living plant).

Synonyms : *Ocimum album* Roxb. (Hort. Beng. 44. 1814, *nom. nud.*), Fl. Indica ed. Carey 3 : 15. 1832 (non Linn. 1767). *O. americanum* sensu auct. Jacq. Hort. Vind. 3 : t. 86. 1777 (non Linn. 1755).

Distribution : Throughout India, Africa, America, China, Java, Malagassy, Myanmar, Sri Lanka.

Notes : Flowering and fruiting throughout the year; found in open waste, sandy ground, along road sides, dry lowlands, sometimes cultivated in lower uplands upto 800m altitude.

Vernacular names : *Bharbari* (Beng.), *Hoary basil, Hoary tulsi* (Eng.), *Kala tulsi, Mamri* (Hindi), *Rama tulsi (Mar.), Naaitulsi, Nayitulsi* (Tam.) *Kukka tulsi* (Tel.).

Uses : The species is of high medicinal value having pleasant camphor-like scent. Leaves as juice are used during fever. The volatile oil is used in soaps and cosmetics. Seeds are diuretic, used as tonic and the preparation of soft drinks (Ambasta, 1986).

Taxonomic notes : Mukerjee (1940) had mentioned *Ocimum americanum* Linn. as synonym of *O. canum* Sims. But through examination of type specimens and authentic specimens it is cleared that *O. americanum* Linn. is synonymous to *O. basilicum* Linn. and *O. Canum* Sims. is a good species. *O. americanum* auct. Jacq.; 1777 (non Linn. 1755) is synonymous to *O. canum* Sims. It has often been wrongly identified and misinterpreted in its taxonomic status.

4. ***Ocimum gratissimum*** Linn., Sp. Pl. ed. 1 : 1197. 1753.

Type : Hortus Upsalensis 749.2 [LINN *n. v.*]

Synonyms : *O. citronatum* Buch.-Ham. in Herb. Wallich. (*nom. und.).*

O. robustum Heyne in Herb. Wallich (*nom. und.*).

Distribution : Throughout India including Lakshadeep Islands, Java, Malaysia, Nepal, Sri Lanka, Tropical Africa, Tropical America.

Notes : Flowering and fruiting during July to April. Found to be growing in the undershade by roadsides, or in full sunshine, or in waste grounds of both the lowlands and uplands; in loose sandy soil as well as in rocky soil, often planted in private garden; grown up to an altitude of 1020m.

Vernacular names : *Shrubby basil* (Eng.), *Ram tulsi* (Beng. and Hindi), *Perum tulasi* (Tam.), *Rama tulasi* (Tel.).

Uses : It yields volatile oil.; used as mosquito repellent, also used for releif from ear-ache, tooth-ache, etc. It is considered as digestive, tonic, stimulant, demulcent, diuretic, anthelmintic, antiseptic, etc. (Ambasta, 1986)

Taxonomic remarks : Hooker (1885) had maintained a variety *sauve* of *O. gratissimum* Linn. based on *Ocimum sauve* Willd, which is distributed in Sri Lanka and in Tropical Africa including Malagassy. Cramer (1981, p. 114) has mentioned its distribution in India, but after through examination of specimens of different herbaria the identity of this taxon is not yet possible to determine. Moreover, the characteristic texture as villous-hirsute, villous-tomentose to hoary-tomentose nature is not quite absent in our studied specimens and these are not anyway different in floral characters.

5. ***Ocimum kilimandscharicum*** Guerke in Engler, Pflanzenw. Ost. Afr. C : 34C. 1895.

Type : Kilimandscharo, *Johnston, s. n.;* Volk, n. 1637 (B *n. v.*).

Distribution : India (Jammu & Kashmir, Karnataka, Maharashtra, Manipur, Uttar Pradesh, West Bengal).

Notes : Flowering and fruiting occur mostly from February to October. The plant is cultivated and also found wild as naturalised on wasteland and in open escape, usually preferable under shade and partial shade.

Vernacular names : *Camphor basil* (Eng.), *Karpoor tulsi* (Beng.), *Kanpur tulsi* (Hindi).

Uses : The plant has attracted attention as a source of camphor; leaves contain maximum amount of oil and camphor followed by flowers. Camphor content varies from 61-80.5% (Ambasta, 1986).

6. ***Ocimum tenuiflorum*** Linn. Sp. Pl. ed. 1 : 597.1753.

Type : Herb. Linn. 749.8 (*n. v.*) and 749. 14 (*n. v.*).

Synonyms : *O. sanctum* Linn., Mant. Pl. 1 : 85. 1767.

O. sanctum Linn. var. *ciliata* Prain in J. Asiat. Soc. Bengal. 74 : 701. 1907.

O. sanctum Linn. var. *thyrsoidea* Prain in J. Asiat. Soc. Bengal. 74 : 701. 1907.

O. monachorum Linn., Mant. Pl. 1 : 85. 1767.

O. inodorum J. Burm., Thes. Zeylan. 174. t. 80. f, 2, 1736.

O. sanctum Linn. var. *hirsutum* (Benth.) Hook. f. in Hooker f., Fl. Brit. India 4 : 609. 1885.

O. hirsutum Benth. in Wallich, Pl. Asiat. Rar. 2 : 14. 1831.

O. vilosum Roxb., Fl. Indica ed. Carey 3 : 13. 1832.

Distribution : Throughout India, Australia, Bangladesh, Bhutan, China, Japan, Malay Peninsula, Myanmar, Nepal, Pacific Islands, Sri Lanka.

Notes : Flowering and fruiting time throughout the year. This species grows as a common weed in different places, in low land and up lands, even at an altitude of 1824m.

Vernacular names : *Tulasi* (Beng. & Tel.), *Sacred tulasi* (Eng.), *Kala tulasi, Tulas,* (Mar.), *Nalla tulasi* (Tam.).

Uses : The juice of leaves is used as a domestic remedy for catarrh and cough. It is also used as an insect repellent. Rosaries are made from \ the stem and worn largerly by Vaishnavas. Roots are used for diapha malaria (Anon., 1966).

Taxonomic remarks : The hairyness of plants throughout and the purple shade or purple-blackish colour are often used as taxonomic features to treat varieties. The hairyness and the colouration are not constant features for the delimitation of taxonomic treatment to variety.

This plant has long been known as *O. sanctum* Linn. but the correct name is *O. tenuiflorum* Linn.

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ENVIRONMENTAL ISSUE

BIOINVASION : A THREAT TO BIODIVERSITY

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Bioinvasion, the spread of alien organisms, is a recent threat to natural ecosystems in general and biodiversity in particular everywhere. It happens when an organism or its propagule arrives somewhere beyond its natural range. Nowadays, most invasions come from human actions, both deliberate and unintentional. Living organisms have always been transported beyond their original range, but because of the enormous growth in the transport systems world over in the last quarter to half a century, invasions now have unprecedented environmental and economic effects. The globalisation and the burgeoning world trade are accelerating the pace of invasions. On any given day some 3,000 aquatic species are moving around the globe via ships. And this seems to be the tip of the iceberg. But natural invasions happen too, from minor changes of environments to major changes of continents. Similarly, most invasions occur due to man-made habitat change that renders the environment less suitable for local species but more congenial for the development and spread of the exotic species. Invasions due to natural environmental changes are rare, and occur very sporadically and slowly.

Biological invasion thus represents broadscale biological pollution. Spread of species from one habitat to another where they have never been is a risky affair. Freed from the predators, pathogens, competitors or enemies, the invaders go on multiplying indefinitely and thus make the alien environment their own stronghold in no time. Their relationship and compatibility with the indigenous species deteriorate day by day and eventually they exert negative effects on them. They compete with the local species for food, shelter and other life supporting paraphernalia, and if the exotics themselves happen to be predators/pathogens, they try to push the indigenous organisms towards the brink. Thus, the invaders crowd out the natives, degrade the environment and may go on contaminating the gene pools of the indigenous species.

In addition to their impact in agriculture, forestry and fishery, pest control and health care, invasive species have proved to be one of the main drivers behind biodiversity loss in a wide range of ecosystems. The characters that have evolved with them and that control their population dynamics and spread in their native environment are generally lacking in their new habitats. Bioinvasion may thus be least predictable and equally disappointing of all forms of environmental disruptions. The disappointment stems from the fact that while a thoughtful management practice may heal a damaged environment in time, time does not heal bioinvasion; it may trigger re-invasion instead. An intense invasion reaches its nadir and may subside

after exhausting most of the local resources, but this does not mean that exotics/ invaders will go away. This process may recur as and when the life supporting resources recover or it may spread elsewhere. And herein lies the tragedy in dealing with exotics.

No ecosystem is immune to bioinvasion. Islands and isolated patches of undisturbed environments are particularly vulnerable because of their isolation and high levels of endemism having weak defence of species against invaders. And this lack of defense mechanisms that allow them fight the exotics may therefore drives the natives to extinction. Indeed, invasives are said to be the second most important threat to biodiversity loss, after habitat destruction.

Extinction is forever, and so extinction is in one sense the most severe effect that can result from invasion. The next two examples are of extinction caused by single introduced species. The first, the snake that reduced the biodiversity of Guam island is an accidental introduction, the second, a predatory snail, is a deliberate biological control agent.

About fifty years back, the brown tree snake *(Boiga irregularis)* from Papua New Guinea was accidentally introduced in Guam, an island in the West Pacific. Since then, the snake has eaten a good number of the island's birds into extinction in the wild and several lizard and bat species are in danger, thus making the place an avian desert. And virtually all native vertebrate species have been suppressed. But the snake itself is in no danger of dying out because it keeps its attention shifting to other exotic lizards and birds. It is not fatal for people, though nasty for infants. Being noctural animal, fond of hiding in crevices and above the ground, it is easily overlooked. The snake tends to hide here and there, and for this behaviour it is frequently found in cargoes moved by aeroplanes and ships. At Honolulu International Airport in Hawaii, the snake is often discovered in planes arriving from Guam. Since the snake is a skilled climber, it also causes many power cuts by climbing poles and shorting electrical lines.

The devastation caused by one species on one island is remarkable. From the rather scanty data, it would seem that the brown tree snake takes 15 years or longer to eliminate almost all birds species in forest. The ecological changes on Guam include the loss of vertebrate insectivores, pollinators, seed dispersers and a frugivore.

The next case is still more horrific and equally sad. To control the giant African snail *Achatina fulica,* a pest in crops and gardens in Pacific islands, there has been a foolish introduction of a predatory snail, *Euglandia rosea,* a native of Central America. *Euglandia* has eliminated a significant number of indigenous tree snails in Pacific islands — a cradle of allopatric and adaptive evolution of snails. On Moorea, it has driven all partulids in 10 years. It will probably eliminate all endemic tree snails throughout the Pacific.

What is happening in Guam is also happening in several other islands also. In

New Zealand, for example, roughly thirty per cent of the landscape is clothed with alien species. Sixty per cent of the plant species growing in the country are exotic, and new plants are encroaching at the rate of four a month. In this island an ornamental vine from Europe has been smothering and suppressing the stands of indigenous trees. This invader, old man's beard *(Clematis vitalba),* entangles the vegetation to death and further prevents any regeneration. Similarly *Passiflora mollissima,* a prolific climber from South America, has been strangulating the native forest vegetation of Hawail. It invades closed forests through gap-phase replacement by rapid growth in gaps created by fallen trees. This species tears branches of native trees which are poorly adapted to climbers.

Although there are few documented examples of invasion leading to extinction of another species as invasives are usually just one of a number of contributory factors. However, on islands some extinctions can be attributed almost entirely to plant invasion. An example is the extinct endemic genus *Astiria* of Mauritius, represented by the single species *Astiria rosea.* The last known site for this species is now a dense thicket of exotics and this is the most likely cause of its extinction. Similarly, the spread of *Acacia saligna* in South Africa is directly threatening several species listed as endangered by IUCN. In Mauritius, *Ligustrum robustum* and in Galapagos *Lantana camara* have invaded forests with many endemic species. Not only in islands, almost throughout the world the invasive exotic weeds are displacing existing flora and altering the nature of many ecosystems. Examples of serious threats to existing environmental make-ups include invasions of North American wetlands by purple loosestrife (*Lythrum salicaria*), encroachment of Florida Everglades by the paperbark tree (*Melaleuca quinquenervia*). This latter species invades the ecotone between the pine dominated drier land and bald cypress dominated swamps, suppressing the transitional stunted pines and pond cypresses. And there is no let-up in rainforests too. *Maesopsis eminii,* an invasive tree species, is threatening the rain forest of the East Usambara mountains of eastern Tanzania, which is a part of the global 24 hotspots. This species is able to invade even apparently undisturbed forest and it is estimated that, unless it is controlled, it will come to form a substantial proportion of the canopy over the next century, seriously threatening the survival of the many endemic species in this forest.

South Aftica is fighting a new sort of battle – an environmental war to contain the march of invasive exotic plants. Thousands of citizens are trying to eliminate and kill a good number of rapidly advancing and thirsty alien trees, shrubs and aquatic plants that thrive in South Africa's hilly watersheds, drainage basins and riverine zones, covering 10% of the land area. The Southwestern *Fynbos* (meaning "fine bush") which is "hottest of the hot spots" in terms of biodiversity having 8700 species, of which 68% are endemic is severely affected. Although there are several alien plants that have invaded South Africa only 15 species or so are creating problems. These plants, like *Acacia cyclops, A. longifolia, A. mearnsii, Pinus pinaster* and *Hakea sericea* etc. are

literally drinking the water that the local people need in this semiarid environment.

South Africa's environmental problem due to plant invasion is perhaps one of the biggest environmental stories of the last fifty years on the one hand, and the country's response to this problem may be the largest and most expensive of alien plant control evertaken on the other. Through a multiagency effort called the "Working for Water Programme", the government has hired thousands of citizens to control the obnoxious exotics. As early as the 1800s, South African botanists warned that introduced plants might competitively replace natural vegetation, finally turning the species-rich landscapes into a biological desert. But nobody took it seriously and there was scanty interest in alien plant control for another hundred years. In 1920s, controversy about the effect of exotic forest plantation ultimately prompted the decision-makers to review the South Africa's resource management practices. The government initiated a series of pilot experiments to assess and reassess the impact of commercial forestry on water resources in the mountain regions. In a good number of case studies, a direct relation between exotic plants and drying up of local water bodies was documented. Yet efforts to protect the sensitive watersheds and check the spread of invasive plants were not satisfactory and on piecemeal basis, losing importance when funds waned. Finally, ecologists galvanised support for change with evidences that water losses to uncontrolled invaders could be disastrous in terms of economy. With this, the impetus for alien plant control gained new momentum which received full support from a new democratically elected government in 1994.

What is being done in South Africa has been done in India too. Last year it took a military operation to halt march of an invasive aquatic weed – the water hyacinth (*Eichhornia crassipes*) — in Harike lake of Punjab. This lake is one of the six internationally protected wetlands in India, and is famous for a large nuumber of birds, both local and migratory. The invasive hyacinth problem was squeezing the life out of the forty-one sq.km waterspread area for sometime. Earlier efforts by the locals and the administration did not prove convincing. In May 2000 the army took up the battle and formed a "Harike Task Force" to preserve the lake. Upto October 2000 when the project was suspended, it removed nearly 1.25 lakh tonnes of water hyacinth from an 8 sq.km area – more than its initial target.

Water hyacinth, exported from its native South American regions for its striking beauty – it has arrestingly beautiful cluster of violet flowers perched atop floating leaves – now grows uncontrollably over the world's freshwater ecosystems. It may have been innocuous in its native range but the species is transformed into an aggressive weed that invades and dominates the alien environments within a span of hundread years or so. In a single growing season this species can reduce a thriving water community to destructive mass, halting transportation, killing fish and promoting disease. And that is why, it is generally referred to as the world's most troublesome weed. It's notoriety has surpassed all other earlier records and has become

legendary among biologists and ecologists. This stems from the fact that in one growing season about twenty-five plants can produce two million offsprings covering 10,000 sq.m. water surface. These plant colonies later coalesce forming continuous mats of free-floating islands as much as two meters thick. These mats then fill reservoirs, spoil water resources and infest rivers. It clogs pipelines and disturbs hydroelectric systems. The mats indirectly deplete the dissolved oxygen of the water, thus ashphyxiating the aquatic life. As the plant drives fishes away, it jeopardises human nutrition and livelihoods of river-based communities. It also provides an ideal microenvironment for pathogens of several human diseases like malaria, encephalitis and schistosomiasis.

Aquatic plant invasion may be a costly affair in yet another way. It can pump large quantity of water into the air, thus drying out the moist areas. A thick infestation of water hyacinth, for example, can drop the level of lake substantially as the actively growing plants drink in the lake and breathe it out through their leaves. In this way, this species has greatly reduced the area of Lake Dianchi in Southern China. The plant infestation has probably eliminated fifty per cent of the lake's fish species and the local climate has become more arid.

One of the best studied and often quoted stories of bioinvasion comes from the ecological study of Lake Victoria from Africa. It is the world's second largest lake and until relatively recently this lake was home to about four hundread species of small, colourful fishes known as cichlids (*Haplochromis* sp.). All these cichlids apparently evolved from a few ancestral stocks in the 15,000 years or so since the lake was formed. This lake thus is one of the fastest and most extensive examples of vertebrate speciation so far known.

Today, the aquatic community is very different in the lake. An unfortunate and disastrous fish stocking experiment has wiped out at least half of the cichlids in the last twenty years and set off a chain of reactions that is upsetting the ecology of the lake. Cichlids, once made up eighty per cent of the animal biomass in the lake, are reduced and marginalised today. These fishes, which thrived throughout the lake, provided much-needed protein to the diets of 30 million humans living in the lake's fringe areas. Local fishermen, who once caught hundreds of different types of fishes, now harvest only a few types.

Overfishing and pollution are factors though, the most important reason for the deterioration of the lake's ecology is the introduction of the Nile perch (*Lates niloticus*), a voracious exotic predator that grows upto two meter long, in the 1960s.

The perch devoured the cichlids so quickly and selectively that by 1980s two-thirds of their population became extinct. Today, eighty per cent of the lake's animal biomass comes from the perch. Because the perch is oily, local fisherman cannot sun dry them as they once did the cichilds. Instead, the perch bodies discarded by the local processing units are cooked over wood fires. And this necessitates cutting and de-

struction of local forests which in turn augments the eutrophication of the lake water.

This example of deliberate species introduction clearly shows how misguided development and short-sighted management plans can start and augment the process of ecological destruction in a brief stint.

Some of the most dramatic trade-offs between economic benefits and ecological costs involve introduction of aquaculture species like tilapia *(Oreochromis niloticus* and *O. mossambicus)* and the common carp *(Cyprinus carpio).* In lakes and rivers, where these species have been introduced, native species have suffered. They have been associated with the disappearance of native fishes in Argentina, India, Kenya, Mexico and elsewhere.

The world's two most publicised aquatic invaders are Leidy's comb jelly *(Mnemiopsis leidyi)* and zebra mussel *(Dreissena polymorpha).* Both of these creatures are released by ballast waters. While the former coming from the Atlantic coast of America has devastated the ecology and fishery of the Black sea, the latter, a native to the Caspian sea, is rearranging the ecology and economy of many North American waterways.

Apart from biological effects, exotics can exert social effects in terms of disease. Thus, the Asian tiger mosquito, now spreading throughout the globe, is a potential carrier of 18 viral pathogens. Epidemic cholera has recently returned to the Americas and yellow fever may be poised to invade Asia. In 1904, a nursery stock from China brought a fungal blight to the United States, and within forty years it destroyed all but few American chestnut trees *(Castanea dentata).* A similar disaster has devastated American and European elms (*Ulmus* sp.). The disease, dutch elm disease, might have come from Asia.

Of course, not all exotics cause serious problems. The proportion of newly arriving species that cause trouble, on an average, follows the 'Tens rule'. This means 10 percent of the introduced exotics get themselves established in the alien environment and 10 per cent of them become pests.

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