GM COTTON-AN OVERVIEW

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The conventional cultivation of cotton relies heavily on intensive application of powerful chemical pesticides that have an adverse effect on environment. It has been anticipated that transgenic cotton will be the possible solution to reduce farmers' dependence on harmful pesticides. But the studies conducted by scientists show that the benefits obtained by transgenic cotton are short lived. Regardless of what kind of cotton is planted there will be insect problems. The traditional insecticide treatments should not be overlooked, whether planting transgenic varieties or not.

INTRODUCTION

The conventional cultivation of cotton relies heavily on intensive application of powerful chemical pesticides that have an adverse effect on environment. It has been anticipated that genetically modified (GM) cotton will be the possible solution to reduce farmer's dependence on harmful pesticides and is probably the most important biological pest control technique, which has potential application worldwide. Bt cotton is a genetically engineered form of natural cotton. The toxin in Bt cotton exists in nature within the microorganism *Bacillus thuringiensis,* a common soil bacterium. Genetic engineers have developed Bt cotton that contain the insecticidal gene of Bt so that the plant itself makes the protein necessary for protection against pests.

India is a country with notoriously underachieving agricultural sector and cotton being a striking example of India's low agricultural productivity. Although India has highest acreage under cultivation (8.9 hectares), its yield of about 320 kilograms per hectares is under half the global average of around 650 kilograms. Biotechnology firms claim that this Bt cotton need lesser herbicides/pesticides than conventional varieties and increases the cotton yield per area.

GREEN LIGHT :

Though Bt cotton have been tested extensively in field trials througout the 1990s, on March 26, 2002, the government of India had approved Bt cotton for commercial release in India. India was much concerned about the dangers of Genetically Modified Organisms (GMOs) release into the environment but the decision to go ahead with the commercial production which opens the door for GM plant verities to enter India.

In India Monsanto and Mahyco have taken the responsbility of distributing Bt cotton varieties at the initials stage. Other seed producing firms have come forward with Bt type cotton for use of the farmers. The organization that wishes to develop a transgenic crop must first form an Institutional Biosafety Committee. The committee must have a representative of Department of

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Biotechnology who approve low risk contained research and must report to the Review Committee on Genetic Manipulation (RCGM). A monitoring-cum-evaluating committee has been appointed by the RCGM to visit and evaluate standards at these trial sites. However, the Genetic Engineering Approval Committee (GEAC), is the ultime authority in decisions regarding the commercialization and large-scale testing of GM crops. The three popular varieties approved by the GEAC are MECH-12, MECH-162 and MECH-184. All these are staple medium cotton. In the current year, the central apex body on transgenic is understood to have cleared one transgenic cotton hybrid from Rasi Seeds meant for use in the country's central and southern zones.

Both Rasi Seeds and Mahyco had knocked on GEAC's door for entry to the virgin north-Punjab, Haryana, and parts of Rajasthan but GEAC has taken a cautious approach and has not given a nod yet. So far, the Mahyco variety put to test for this area has proved too susceptible to the devastating cotton leaf-curl virus and Regulators perfer caution on the virus front.

RISKY BUSINESS :

Studies conducted by scientists show that the benefits of the genetically modified cotton containing the Bt-gene is short lived.

In the U.S., research on transgenic crops began in 1989 and these crops were grown commercially for the first time in 1966. Companies producing these transgnenic crops promote them as a way of reducing farmer's dependence on harmful pesticides and thereby, controlling the cost and environmental pollution. However, experience over the last few years reveal problems that place a question mark on this entire approach to pest control.

Report from the Teams led by Bruce Tabashnik (University of Arizona) and Fred Gould (North Carolina State University), who conducted rigorous field studies on Bt cotton, in the proceedings of National Academy of Sciences, U.S., provides solid evidence of insect resistance to Bt cotton. Since resistance has become a major worry, companies now insist that farmers follow resistance management plans (RMPs), which include ; "Refugia". "Refugia" is a method when non-transgenic cotton is allowed to grow along with Bt cotton so that the pests can thrive on the non-Bt cotton and breed with the pests that may have developed resistance, hence reducing the risk of resistance. However, Tabashnik's team has questioned two fundamental assumptions behind all Bt RMPs, that resistance to Bt is a rare recessive trait and that cross-resistance to Bt endo-toxins is uncommon. The idea that resistance could be delayed through the use of two or more endo-toxin has, thus, been seriously undermined.

Further, field data show that expression of toxins in Bt-transgenic crops can develop unevenly in different parts of the plant. In one report, Bt toxin expresssion was found to be 90-95% in the top part of the plant but only 20-25% in the lower nodes, making them more susceptible. Since the lower nodes often produce

the highest quality cotton, their loss is even more significant. Bt toxin expression also typcially starts out high in the early part of the season but tapers off over time.

It is also inadequate in harsh environmental conditions such as drought. This "sub-lethal dose" of toxin can facilitate the development of resistance over time, just as it happens with pathogenic bacteria when we fail to complete the necessary course of antibiotics. Uneven expression of Bt in the crop could also accelerate emergence of "behavioural resistance" (M. Harris, Science, 1996), because insects may sense which parts of the plant to avoid. In India, with so many difficult agro-ecological conditions and million of poor farmers, Bt-transgenic crops are likely to grow unevenly across farms leading to many cases of sub-lethal doses of the Bt toxin and, therefore, resistance might be endengered at an even faster rate. Estimates of how long resistance can be dealyed vary, but the average figure in most research, even in relatively favourable circumstances of the U.S., is not more than five years.

A new report by Charles M. Benbrook, Director of the U.S-based Non-Governmental Organization, Northwest Science and Environmental Policy Center shows that herbicide use of the U.S. agricultural sector-the chief supporter of biotechnology-has increased significantly due to GM crops. He analyzed pesticides/herbicide usage data provided by the U.S. Department of Agriculture, and found that in the first 3 years of their commercialization (1996-98), GM crops reduced the herbicide consumption of the nation by about 25.4 milion pounds as compared to the levels in 1995 (when transgenic crops were introduced in the nation). But in the last 3 years (2001-03), the herbicide use was 50.6 million pounds more than the 1955 levels, despite the acreage remaining constant. The increase can be attributed to the herbicide-tolerant (HT) varieties of GM crops since 2001, HT crops have increased herbicide use of nation by 70 million pounds, but BT varieties have reduced the usage by approximately 19.4 million pounds. Therefore, the net herbicide use has risen.

Far from improving the state of the environment, the GM crops are causing even more pollution. Benbrook stated that the biotech giants such as Mionsanto always tell half-truths about their products.

In India, a study conducted by K. Chandrasekar and G.T. Gujar Entomologists at Indian Agricultural Research Institute in New Delhi have cast doubt on the longterm benefits of transgenic cotton. They found that the protection afforded by Bt gene is at best for six years as the bollworms develop "31-fold resistance to the toxin 'Cry1AC' within six generations." The bollworms also developed cross-resistance to two more toxins called 'Cry1Aa' and 'Cry1Ab'. The study means that cotton farmers may have to go back to spraying pesticdes after six seasons unless scientist come out with Bt cotton hybrids that produce a high dose of the Cry1AC toxin.

CONCLUSION :

In the wake of these findings, India should adopt a cautious approach towards the adoption of GM Cotton. Regardless of what kind of cotton is planted, there will be insect problems. One thing seems clear from past experience that the traditional insecticide treatment should not be overlooked, whether planting transgenic varieties or not. Instead the government should promote bio-fertilizers and bio-pesticides as a possible solution to fight the problems.

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DO YOU KNOW?

Q5. For crocodile eggs what is the difference if an egg is hatched above or below 87° C.

Q6. How taste is related to smell?

PHYTOREMEDIATION : A POTENTIAL OPTION TO MITIGATE ARSENIC CONTAMINATION IN SOIL-WATER-PLANT SYSTEM

Indranil Das, Koushik Ghosh and S.K. Sanyal

Arsenic is of great environmental concern due to extensive contamination of groundwater in the Bengal delta basin with this toxin, thereby causing carcinogenic toxicity to millions of poeple. Soil contamination with arsenic input through the vehicle of contaminated groundwater being used for irrigation, may prove detrimental to plant through its uptake to the toxic level. Indeed, the possibility of such toxin entering the human food web, along with biomagnification up in the food chain, through plant uptake of arsenic is of immediate concern. In this regard, phytoremediation is a developing technology that offers a potential avenue to address the problem of arsenic contamination of soil-crop system. The latter may prove attactive due to its relative cost-effectiveness, coupled with its asthetic nature, namely the use of plants for "clean-up" activities. An attempt is made in this article to review the options of different phytoremediation and bioremediation techniques in mitigating the above estated arsenic pollution problem.

INTRODUCTION

There are reports of widespread arsenic contamination in serveral parts of the world, of which the scenario of arsenic contamination of groundwater in the Bengal delta basin seems to be the worst one affecting millions of people living in this region[1,2]. The genesis of this problem is proposed to be of geogenic origin. Upto the late nineties, the entire effort at the Government, Semi-Government and the NGO levels has been solely directed towards solving the problem of such contaminated groundwater-derived drinking water problem[2]. However, in the affected belt of West Bengal, hardly 10% of the groundwater is used for drinking purpose, leaving more than 90% of its use in the agricultural sector to meet the crop irrigational requirements[2]. Despite this, until rather recently, there has been hardly any study exploring the influence of arsenic on waters-soil-crop animal continuum[3]. However, what remains an essentially *point* source of contamination as for drinking water (e.g., a tubewell discharging contaminate groundwater), may easily become a *diffuse* source of contamination when arsenic finds its way into the food, web, along with possible biomagnification up in the food chain[2]. Indeed, there have been reports of elevated levels of arsenic build-up in agricultural produce obtained with contaminated groundwater used as the irrigation source[2,3].

Among the possible mitigation options/ interventions that are being examined in this regard, phytoremediation tends to offer a potentially useful avenue to address the problem of contaminated agricultural soils and crops.

The fact that the standard for the safe limit of arsenic concentration in drinking water has

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recently been reduced from 50 to 10 ppd by the USEPA[4] makes it all the more urgent to develop reliable and cost-effective technologies capable of reducing arsenic in groundwater to environmentally acceptable levels. The phytoremediation techniques seem to offer viable options, and are discussed herein.

DIFFERENT TECHNIQUES OF PHYTOREMEDIATION

Phytoremediation is defined as the use of vegetation or other macro-and microscopic biota for *in situ* treatment of contaminated soils, sediments and water where green plants degrade, assimilate, metabolise[5] or detoxify inorganic and organic chemicals in soils to environmentally acceptable levels ; in other words, it is equivalent to a bioremediation process that uses various types of plants to remove, transfer, stabilize, and/or destroy contaminants in the soil and groundwater.

There are several ways and means to regulate phytoremediation technique. These are the following :

(i) Rhizosphere biodegradation : In this process, the plant releases natural substance through its roots, supplying nutrients to microorganisms in the soil. The microorganisms, in turn, facilitate biological degradation through rhizosphere interactions. Substantial progress has been made towards an understanding of arsenic (As) transformation processes in soils. However, adequate information is not available addressing directly the issue of As in the rhizosphere. It is only rather recently that Fitz and Wenzel[6] developed a model which correlates the fate of As in the soil-rhizosphere-plant system.

(ii) Phyto-stabilization : In this process chemical compounds produced by the plants immobilize contaminants rather than degrade them. This is essentially a process of stabilizing contaminated land or the pollutants present in soil, and in so doing it prevents or reduces erosion, water flow and flow of pollutant. In this case metal-tolerant plant species that do not take up large quantities of metals are often used. As for example, apples, cabbage, carrots, tomato, potato, wheat, etc. are tolerant to arsenic[7], and may possibly be used for this purpose.

(iii) Phyto-accumulation : Mechanism of Metal Hyperaccumulation : Hyperaccumulation of heavy metals is likely to involve several steps, including metal transport across root cell membranes, xylem loading and translocation, Sequestration may involve both physical comparatmentalization and complexation with ligands[8]. Because of the multiple processes involved, metal hyperaccumulation is likely to be controlled by multiple genes. Indeed a metal hyperaccumulator must possess both genetic traits for its hyperaccumulation potential. Further metal hyperaccumulation appears to be a constitutive property, i.e., populations of the same hyperaccumulator species collected from both metalliferous and non-metalliferous sites are able to hyperaccumulate the metal similarly[8]. The following are the mechanisms of metal hyperaccumulation, especially for arsenic.

(a) Metal uptake

(b) Metal transformation from root to shoot

(c) Mechanisms of metal tolerance in hyperaccumulator plants which include—
(i) Cellular and subcellular compartmentalization

(ii) Complexation with ligands-which results in decreased free metal ion activity and thus decreased toxicity.

Based on the relationship between metal concentrations in shoot and in soil, plants growing on metaliferous soils can be grouped into three types, namely (i) excluders, where metal concentrations in shoot are maintained at a low level across a wide range of soil concentrations, upto a critical soil value, above which the mechanism breaks down and relatively unrestricted root-to-shoot transport results ; (ii) accumulators, where metals are concentrated in the above-ground plant parts from low to high soil concentrations, and (iii) indicators, where uptake and transport of metals to the shoot are regulated so that internal concentration reflects external levels, at least toxicity occurs[9].

A variant of phytoextraction, which is applied when the extracted elements are of high value, is phytomining. Exclusion of metals from the shoots is by far the most common strategy employed by many tolerant species[8]. On the other hand, metal accumulation can ocur in some plant species that grow mainly on metalliferous soil. In addition to the exceedingly high accumulation of metals in the shoots, hyperaccumulator plants are also characterized by a shoot to root metal concentration ratio exceeding 1.0, whereas non-hyperaccumulator plants generally have higher metal concentrations in roots than in shoots[9,10]. A highly efficient transport of metals from roots to shoots is one of the key features associated with all hyperaccumulator plants.

The efficiency of phytoextraction is ultimately the product of a simple equation : biomass $\times$ element concentration in biomass[8]. Both factors are important, but it is easy to show that high concentrations in the above-ground biomass is important. Harvesting roots or other below-ground organs is difficult and prevents regrowth if the "crop" is a perennial one. Such an investigation was conducted by us (Unpublished data, 2003) with several weed species normally found along with rice, potato, jute, mustard, etc., growing on arsenic-contaminated soils, and subjected to irrigation with (arsenic) contamminated groundwater (Table 1). The following table demonstrates an increased accumulation of arsenic by the above-ground parts of these weed flora growing in soils loaded with 2 to 14 mg As/kg.

Table 1. ARSENIC CONTENT OF DIFFERENT WEED FLORA IN SELECTED ARSENIC AFFECTED CROP FIELDS OF WEST BENGAL

	Arsenic content (mg As/kg)	
Weed floras	Stem	Leaf
Filmbristylis sp.	14.1	28.1
Ageratum conyzoides	4.50	14.1
Croton sparciflora	12.2	10.4
Lantana camara	8.40	10.2
Vitis trifolia	4.30	7.90
Asteracanthus longifolia	4.90	8.60

Thus, these weed species had accumulated larger amounts of arsenic in leaves than in stem, thereby translocating arsenic effectively from soil to the above-ground parts. These weed species may indeed possess great potentiality to act as good hyperaccumulator plants for arsenic. Further studies in these lines are warranted.

The unique property of arsenic hyperaccumulation by the newly discovered Chinese brake fern (Pteris vittata L.) is of great significance in the phytoremediation of arsenic contaminated soils[11,12]. This fern is extremely efficient in extracting arsenic from soils and translocating it into its above-ground biomass. On analyzing the sample of plant and soil from contaminated (18.8-1603 mg As/kg) and from uncontaminated sites (0.47-7.56 mg As/kg), the given brake fern was found to have accumulated 1442-7526 mg As/kg and 11.8-64.0 mg As/kg respectively, from the two sites, Besides, this brake fern can also take up large amounts of arsenic into fronds in a relatively short time span (Table 2). Arsenic concentration in fern fronds growing in soil spiked with 1500 mg As/kg increased from 29.4 to 15, 861 mg As/kg in two weeks.

The effciency of a given hyperaccumulator plant species in the context of phytoremediation of metal toxicity in soils ought to be also examined in the light of what it returns to soil once the given plant completes its life cycle. Thus, in the above stated experiment, when 20 weeks old plants were extracted using solution of 1 : 1 methanol-water[4], measurement through high performance liquid chromatography-cum-inductively coupled plasma mass spectrometry revealed that almost all the plant arsenic was present as relatively toxic inorganic forms, with little detectable less or non-toxic organoarsenic species13. The concentration of As (III) was greater in the fronds (47-80%) than in the roots (8.3%), indicating that As (V) was converted As (III) during translocation from roots to fronds, thereby leading to more toxic As form[4]. Thus, the inescapable conclusion is that phytoremediation does not necessarily lead to detoxification *per se* of the phyto-accumulated toxic metal.

Table 2. ARSENIC CONCENTRATION IN BRAKE FERN

Treatments	Soil arsenic loading (mg As/kg)	Plant arsenic content (mg As/kg)	
		2 weeks	6 weeks
Control	0	755	438
As-contaminated soil$^{\Delta}$	400	3525	6805
Low As*	50	5131	3215
Medium As*	500	7849	21290
High As*	1500	15861	22630

Break fern plants, collected from several contaminated sites (they are not commercially available), were planted in 2.5 litre pots containing 1.5 kg of soil (one plant per pot with four replicated) and grown for six weeks.

$^{\Delta}$ Arsenic contaminted soil was collected from the site where brake fern was discovered.

* Artificially contaminated soil spiked with three levels of water-soluble potassium arsenate.

An experimet, conducted in Thailand[14], where high arsenic concentration in soil and in groundwater resulted from tin minning, screened mine products for evaluation of arsenic in fronds. Two species of fern were found to contain elevated levels of arsenic in their fronds, namely *Pityrogramma calomelanos* (108-1156 ug/g dried weight) and *Pteris vittate* (79 ug/g dried weight). The accumulation of arsenic in *Pityrogramma calomelanos* shoot doubled with the addition of EDTA (Ethylene diamine tetraacetoc acid), a well known chelating agent[14]. The addition of another chelating agent, namely DMSA (Dima captasuccinic acid), resulted in aj 5-fold decrease in arsenic concentration in the *Pitytogramma calomelanos* shoot compared to control after 6 weeks of exposure to arsenic. The contrasting effect of these two chelating agents may be attributed to the strong bonding of arsenic ions by the thiol group present in DMSA. This study also indicated that the given fern uptakes and translocates arsenic in the form of arsenate and arsenite rather than DMSA-complex.

Such DETA or DSMA complex formation is central to chemically induced phytoextraction. It was also observed that *Pityrogramma calomelanos* gave the highest arsenic phytoextraction efficacy at 6 weeks exposure to arsenic in the EDTA treatment, with an efficacy of 77.8 mg As/kg based on whole plant biomass[14].

This apart, recently the first transgenic system for removing arsenic from the soil using genetically modified plants was also developed. These workers[15] were able to insert two genes from the common bacterium *Escherichia coli* into a member of the mustard family, called Arabidopsis, which enabled the latter to tolerate arsenic, at a level that is normally lethal to plants. Such genetically modified plant species could thus remove arsenic from the soil and transport it to the plant leaves in a form which is biologically much less available to the environment. Further, Meagher15 and his team reported that by inserting two unrelated genes from E. coli, called ars C and ECS into the model plant, namely Arabidopsis, the latter, when grown with exposure to arsenic, had accumulated 17 times greater fresh shoot weight and two to three times more arsenic per gram of tissue as compared to the common or 'wild type' plants. This team of UGA's Warnell School engineered the ars C gene to be turned on strongly by light, which falls naturally on leaves and stems (light-induced gene expression). The ars C reduces arsenate to a more toxic compound, namely arsenite, in leaves. Thus, this system enables the given plants to mop arsenic from soil, concentrate it, and then send it to the leaves in a more toxic form. This is where the second gene. ECS, creates more sulphur sinks to bind tightly to arsenite, making it biologically less available, thereby rendering the system the most effective one.

The success of remediation depends on establishing a selected plant community. Arsenic accumulation in several crop species has been worked out by the scientists at the Bidhan Chandra Krishi Viswavidyalaya, West Bengal

over the past five years in order to identify farmer-remunerative, but less arsenic accumulating cropping sequences. Some of these findings are cited in Table 3 which demonstrates the arsenic accumulation pattern of different non-hyperaccumulator crop plants, grown in different seasons, accumulating considerable amounts of arsenic. Though these crops may not offer much towards addressing the issue of arsenic contamination in soil-water system,

(iv) Phytovolatilization or Biotransformation : In this process, plants and microorganisms take up waste containing toxic contaminants and release the same into the air through volatilization. For this, arsenic culture solutions are utilized by certain bacterial strains and further methylation of arsenic takes place, thereby rendering the more toxic forms (inorganic ones) to less toxic methylated forms[16].

Table 3. ARSENIC ACCUMULATION IN CROP PLANTS GROWN IN DIFFERENT SEASONS IN THE SELECTED ARSENIC AFFECTED SOILS OF WEST BENGAL

Crops	Season	Arsenic concentration (mg/kg) at harvest			
		Root	Stem	Leaf	Economic produce
Boro Rice (IET-4786)	*Boro*	7.20	4.35	3.10	1.10
Sesame	*Pre-kharif*	35.3	8.58	7.89	0.028
Elephant Foot Yam	*Kharif*	3.52	3.46	3.10	1.10

nevertheless these crop species do reduce the arsenic loading in soil to some extent.

Table 3 tends to suggest that a large input of arsenic to boro rice throgh the contaminated groundawater irrigation source (during a period when groundwater rechanrge is at its minimum) facilitates build-up of the toxin in different plants of this crop as compared to, say, elephant foot yam which is primarily a rainfed *kharif* crop.

There pure bacterial cultures (*Aeromonas sp.) E. coli* and *Flavobacterium sp.),* grown in a chemically defined medium, were also capable of methylating arsenic compounds[16]. The cell extracts and shole cells of the *Methanobacterium* strain, namely M.o.H., reduced methylated arsenate other bacteria species (namely, *Proteus sp., Corynebacterium sp., Pseudomonas sp.)* are also capable of biotransformation[18]. Furthermore, *Achromobacter sp.* and *Enterobacter sp.* convert arsenate to monomethylarsine and dimethylarsine, whereas *Aeromonas sp.* and *Nocrdia sp.* convert the same to monomethylarsine, dimethylarsine, and trimethylarsine[19]. A broken-cell homogenate of the fungus *Candida humicala* converted arsenate to[74] arsenite, methylarsonate and dimethylarsenate which were further covnerted to 14 C-mono-di-and trimethyl arsenic comopunds, respectively[20, 21].

(v) Hydroponic system for treating waterstreams (Rhizofiltration) : Rhizofiltration is similar to the phyto-accumulation, but the

plants used for cleanup are raised in greenhouses with their roots in water. This system can be used for *ex situ* groundwater treatment. That is, groundwater is pumped to the surface to irrigate these plants. Typically hydroponic systems utilize an artificial soil medium, such as sand mixed with perlite or vermiculite. As the roots become saturated with contaminants, they are harvested and suitably disposed of.

(iv) Phytodegradation : In this process, plants[4] actually metabolize and destroy the contaminants within the plant tissues.

(vii) Hydraulic control : Generally, the use of phytoremediation is limited to the sites with lower contaminant concentrations and contamination in shallow soils, streams and groundwater. In this process, trees indirectly remediate by controlling groundwater movement. Trees act as natural pumps when their roots reach very close to the water table and establish a dense root mass that takes up large quantities of water. Using poplars and willows developed in the horticultural researchers conservation plant breeding programme at New Zealand[22], hybrids with a propensity for arsenic accumulation have been identified. A popular tree, for example, pulls out of the ground 30 gallons of water per day, while a cottonwood can absorb upto 350 gallons of water per day, thereby drawing a substantial amount of water along with the toxicant. Such water use characteristics for many of the populars and willows have also been evaluated allowing people to effectively seal sites, which are leaching mobile contaminats such as arsenic. The Soil Plant Atmosphere System Model (SPASMO), developed at the Horticultural Research Station in New Zealand[22], uniquely positions us to provide risk assessment for sites possessing the toxin.

TECHNICAL AND REGULATORY GUIDANCE ON PHYTOREMEDIATION

Phytoremediation has not been widely utilized till date, due, primarily to the limited knowledge on the technology. Therefore, the Interstate Technology and Regulatory Cooperation (ITRC), U.S.A., formed a phytoremediation work group in 1998, in order to indentify, provide guidance, and reduce technical and regulatory barriers for applying this technology[5]. Established in 1995, the ITRC is a state-led, national coalition of personnel drawn from the regulatory and the technology programmes of more than 25 states, three federal agencies, and tribal, public and stakeholders in the U.S.A. This presentation focuses on two guideance documents produced by the IRTC work gorup to explain phytoremediation to cunsultants, stakeholders, scientists, regulators, and the public. The first document, which is a decision-tree for soil, groundwater and sediments, provides a tool that can be used to determine the potential effectiveness of phytoremediation at a given site. The decision-tree document allows the user to take the basic information from a site and through a flow chart layout, decide if phytoremediation is feasible at the specific site. Background information and a glossary are provided to support each flow chart, one corresponding to each of the media. The ITRC phytoremediation work group is also working on a second, more comprehensive document, encompassing more of the technical and regulatory information and guidance for applying phytoremediation. This includes providing

suggestions and identifying lessons learnt from case studies in order to reduce future technical and regulatory barriers[5].

LIMITATONS

Notwithstanding the fact phytoremediation is a 'green technology', which could be cost-effective and ecofriendly *in situ* remediation technique, nevertheless it suffers from many limitations, yet to overcome, while contemplating the implementation of such phytoremediation options. Some of these are mentioned hereunderm :

(i) Lack of sustained, intensive research on phytoremediation of plants and microorganisms.

(ii) Some hyperaccumulator plant species may not lead to effective detoxification *per se,* but returns the load of the toxicant back to the environment in even more toxic forms once the phytoremediating plant complete its life cycle.

(iii) Such remediation processes are not generally stable on a long-term perspective.

(iv) Phytoremediation may even generate the secondary source of toxin while decomposition (of the native organic matrix of the phytoremediating plant biomass) takes place.

(v) The expertise and the knowledge-base available in the field do *not* seem to be adequate, while the cost-effectiveness of many such phytoremediation techniques is yet to be fully assessed.

Besides, phytoremediation also tends to suffer from the fact that it involves relatively low biomass production and is a rather slow remediation technolgy[23].

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DO YOU KNOW?

Q7. What percentage of water in the world is fresh water?

Q8. How often do snakes close their eyes?

MATHEMATICAL MODELLING IN SOCIAL PSYCHOLOGY —SOCIAL NETWORKS

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This article is an attempt to constructively articulate the use of graph theory in comprehending certain fundamental aspects of social psychology.

PREAMBLE

Mathematical modelling is used in the natural sciences as a technique for forming reasonable abstractions from confirmed observations in the real world, manipulating these abstractions using the available methodological means in the field of mathematics and then applying the results again to reality to encompass other unexplained observations, if any, or predict yet new possible phenomena reasonably relatable to the originally observed and established ones. In such an endeavour.

'It is necessary for the abstracting principle to be precisely specified and to be coordinated with essential features of the reality under consideration. The power of the technique depends on the flexibility with which the abstraction can be manipulated in concert with other relevant abstractions. It is sometimes supposed that mathematical models cannot usefully be constructed in the social sciences because human behaviour is too complex to be represented mathematically. This argument seriously underestimates the very high level of abstraction necessary to the construction of mathematical models. One never tries to represent the objects of study literally, only very limited aspects of them. Of course, the difficulty lies in the selection of essential aspects. There are two quite distinct reasons for the potential scientific superiority of *mathematical* over *purely verbal* descriptions : the greater *precision* of mathematical descriptions, and their greater *manipulability*. In applications to social sciences, however, precision is less important whenever present difficulties in *measurement* and in the *control* of extraneous variables render imprecise the empirical testing of models. But even if models are used only in the service of generating very approximate data fits, the greater manipulability of mathematical models is a very powerful advantage.[1]

However, 'the dilemma of uniqueness'[2] contains the deeper concerns about understanding of human psychology (which pervades social psychology) by invoking isolated and *ad hoc* methodological approaches of incisive inquiry such as *mathematical modeling* or carrying out

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even a seemingly cohesive web of *contextual psychological experiments* towards developing theories in social psychology.

We may ask ourselves about *the philosophic justification for the scientific study of human attitudes and behaviour.* At the very outset, an obvious justification is that *such a study is basic to gain a reasonable understanding of processes by which various human organizations, societies and civilizations come into, or go out of existence.* This is a primary goal of a study of (social) psychology and mathematical modelling has proven itself to be a powerful tool for advancement of knowledge in the field.

SOCIAL STRUCTURE AND PROCESS

Psychologists typically seek laws governing *behavioural characteristics* of individuals (belonging to any species as such), which may be valid either across a chosen species or for a class of individuals in the same species which sometimes may consist of even a single individual. Behavioural laws which apply in the case of the psychoanalysis of single individuals may be used to study *differences* among individuals' properties (e.g., *personality, genes, attitudes, habits*) and the associations between these differences and *differential behaviours.* While the latter "individualistic psychometric" approach to understanding behaviour has occupied much of psychology known today, questions like how the associations between an individual's behaviour and his or her currently measured properties were formed, how they are maintained, and how they change over long spans of time need more investigative study than simply identifying the associations themselves. 'An important part of the answers to how these individual *property-behavioru associations* are formed, maintained and change lies in the nature of that individual's prior and current *relatinioships* with others.'[2] This clearly indicates need for analyzing primarily the *structure* of interrelationships of an individual with others embedded in a larger *network* of interpersonal relations existing in the *social group* to which the individual belongs. In general, it is now well accepted that the so-called *social processes* are largely generated by *interpersonal interactions* between individuals in the society. Interpersonal interaction between two individuals involves often quite complex processes of *exchange* of their *individual dispositions* about attributes of their common concern. Thus, while '... dispositions are the raw material for the development of *personality*[2] ...' interpersonal interactions are fundamental to development of sociopsychological theories.

For instance, consider a *dyad,* viz., a pair of individuals A and B who somehow have come together; initially, let us suppose that they are *strangers*—such a dyad is denoted by writing $\{A, B\}$ for brevity. Each of these individuals has his own dispositions which define his *attitudes* on various attributes $a_1, a_2, a_3, \ldots, a_k$ of common concern between them and held intact by each during reasonably finite interval of time of their *interaction*. This interpersonal interaction is characterized by the processes of *disclosure* of their dispositions selectively as per the nature of a particular attribute a_i; disclosure of anyone disposition by any one individual in the dyad (say, A) *stimulates* in consideration of the disclosure by the other member of the dyad

(viz. *B*) who would then indentify a set of his own dispositions for disclosure in *response* to the former (*A*). The nature of response may be *positive* or *negative* according to where *B*'s response (which is a set) *matches* with *A*'s dispositions or not. This phenomenon is broadly termed as *attitude matching* in literature[3, 4] a reigning hypothesis is that *more the attitudes match, deeper is the positivity in the interaction.* One can sense a *structure* in this kind of interaction as conceived *system theoretically*[5]. Before we embark on expounding these advancements, the following 'dichotomy' must be kept in mind.

'A very important dichotomy can be drawn between *social structure* and *social process*, or *statics* versus *dynamics*. In the analysis of social structure, concern centers on the characterization of *communication* and *influence networks,* of social *cliques*, and *social cleavage,* of *centrality* and *status*. On the other hand, the *modeler* analyzing social dynamics attempts to account for *change over time* in opinions, attitudes, friendship, conformity, hostility, and other poperties within and between social groups or to *trace* the social diffusion of rumors, fads and innovations. Considerations of structure and process sometimes intermingle, as when structures are distinguished from one another according to their differing potentials under hypothesized dynamic situations, or when what is changing dynamically over time happens to be the social structure itself.[1]

It is fundamental importance to know the part of mathematics useful for modelling such situations, where 'structure' in a social group needs to be analysed; it is called *graph theory*. Therefore, we introduce some elementary notions and terminology of the subject of graph theory relevant to the study of *social systems* right through specific contexts.

By the term *graph*[6] we mean a *discrete* (or, 'combinatorial') *structure* consisting of a set of elements called *nodes* or *vertices* and certain number of pairs of these vertices, called *edges*. One may 'draw' to view such a structure on the Euclidean plane if the number of vertices and edges are reasonably small as follows : Represent each vertex as a *point* on the plane and represent each edge as a *line segment* connecting the two vertices contained in it. Some such 'small graphs' are shown in figure-1.

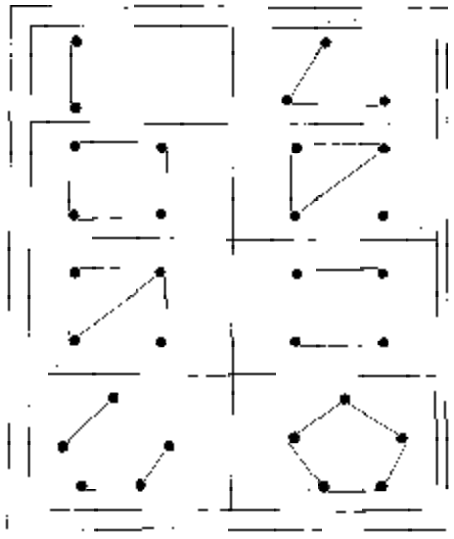

Figure-1 : Various 'graphs' on 2, 3, 4 and 5 vertices.

We now begin by giving a specific instance of this very 'graph theoretical' approach in social psychology where 'direction' of interpersonal interaction plays a major role. To treat such situations in the structure of a social group, by assigning a direction to each edge of the graph that represents the existing 'link' between two individuals in the structure of

ongoing interpersonal interactions in the group, the graph becomes a *directed graph* (or *digraph* for brevity) which would serve as a more appropriate model.

AMBISIDIGRAPHS

Interpersonal evaluative relationships are basically directed and dichotomic in nature. To deal with problems associated with such relations in a *social group*, especially toward deriving reasonable conclusions about the structural characteristics of the social group, the following *network model* has been suggested[7].

The members of the social group are represented as *nodes* (often called *vertices*) of the network in which any two nodes A and B are interconnected by at most all of the four *arcs* $(A, B)^+$, $(A, B)^-$, $(B, A)^+$ and $(B, A)^-$ where a *'plus'* ('+') or a *'minus'* ('–') sign in the super fix of an ordered pair represents the fact that the corresponding (oriented) relation is respectively *'positive'* or *'negative'* in character; such a network has been called an *ambient signed digraph* or *ambisidigraph* in short.

For instance, *figure-2* depicts an ambisidigraph 'state' of a 'small' social group consisting of five persons A, B, C, D and E; in this 'social network', $(A, C)^-$ is a negative arc, $(C, E)^+$ is a positive, $(B, A)^\pm$ is an *ambivalent arc* in the snese that B has positive as well as negative evaluations of A each represented by the corresponding type (positive or negative) or arc, so on. Its basic structure is a digraph in which every pair of vertices is *joined* by a most two arcs in each direction.

In fact, ambisidigraph model of a social group takes into account the state of *ambivalence*, viz., and simultaneous existence of "positivity" and "negativity" of evaluative opinions of an individual exhibited in respect of another, in the analyses of the social group. It also facilitates

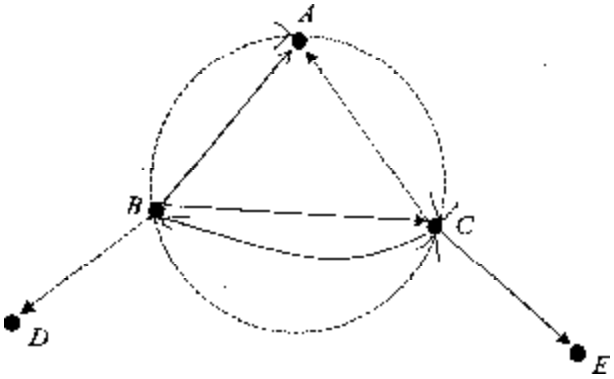

Figure-2 : An ambisidigraph state of a "small" social group.

treatment of the notion of "indifference" by which we mean a *"state of neutrality"* that may exist between two individuals in the social group who exert on each other some sort of *"balance of attitudes / feelings"* that represents a *"tacit agreement"* to maintain *"status quo"* in respect of ongoing processes of interaction between them.

One may further assign a positive real number to each arc to represent the *intensity* of the interpersonal relation measured on some reasonable scale. However, for simplicity to begin with, we initiate a study of these networks by disregarding such assignment of *weights* (equivalently, by treating all the weights to be unity to their arcs.

A concept of fundamental theoretical importance related to the structure of a network is that of *traversal* of its arcs, like we *walk* on a street. In fact, the term *walk* has been used in literature to mean a sequence $W_k = (v_0, a_1, v_1, a_2, v_2, a_3, \ldots, a_k, v_k)$ of vertices $v_0, v_1, v_2, v_3, \ldots, v_k$ and

arcs $a_1, a_2, a_3, \ldots, a_k$ of S such that $a_i = (v_{i-1}, v_i)$ for each i, $1 \leq i \leq k$; here, the positive integer k is called the length of the walk and the walk is said to joint the initial vertex v_0 to the *terminal* vertex v_k, or simply that W_k is a $v_0 - v_k$ *walk*.

For example, the the ambisidigraph of Figure-2, the 'alternating' sequence $(A, (A, C)^-, C, (C, B)^+, B, (B, C)^-, C, (C, B)^+, B, (B, C)^-, C, (C, E)^+, E$ is an $A - E$ walk of length six.

If, in a walk, all the acres are distinct then the walk is called a *trail* and if all the vertices are distinct (then observe that all the arcs must also be distinct) then the walk is called a *path*. A walk in which the initial and the terminal vertices are identical (i.e., one and the same) then the walk is said to be *closed*; it is said to be *open* otherwise.

For example, in the ambisidigraph of Figure-2, $(C, (C, B)^+, B, (B, C)^-, C, (C, B)^+, B, (B, C)^-, C)$ is a closed walk of length four. A closed walk in which all the vertices are distinct is called a cycle; for example, in Figure-2, $(C, (C, B)^+, B, (B, C)^-, C)$ is a cycle of length two and $(A, (A, C)^-, C, (C, B)^+, B, (B, A)^-, A)$ is a cycle of length three (such a cycle is often called a triangle).

Next, in the ambisidigraph S of Figure-2, consider the two triangles $T = (A, (A, C)^-, C, (C, B)^+, B, (B, A)^-, A)$ and $T' = (A, (A, C)^-, C, (C, B)^+, B, (B, A)^+, A)$. We wish to see if there is any interesting difference between these two triangles. In T, A has a negative opinion about C, C has a positive opinion about B and B has a negative opinion about A; or by a simpler interpretation, A dislikes C, C likes B and B dislikes A. In T', with similar interpretation, we have the situation in which A dislikes C, C likes B and B likes A; *what can one infer from this situation about C's disposition toward A?* At this stage it may be useful to stop and digest the thoughts provoked in this article in finding an answer to this question before embarking on a continuation of this discussion*.

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* Discussion on some of the issues raised in this paper will be continued in another paper later.

SHORT COMMUNICATION

ON THE ORIGINS OF INDIANS

D. Balasubramanian*

If you go by appearances, a Punjabi is different from a Bengali and a Bengali from a Tamilian. Indeed many Punjabis look like people from Pakistan or Iran, and several Indians from the northeast have an oriental touch about them, Yet, all we Indians are linked together by centuries of shared culture. One of the more fascinating questions in our minds is our origins–where do we come from, what is our stock and lineage, how many races are there in the world and how did mankind diverge into these types ?

Until recently these questions were largely addressed by archaeologists, anthropologists and geographers. They relied on tools such as fossil evidence, languages and shared cultures, physiognomy and body morphology. Decades of rigorous analysis, using these methods, has given us the indication that all mankind can be classified into five or six basic types. These are : the Negroid, the Caucasian, the Oriental and sub-branches thereof. People make further distinction such as Caucasoids, East Africans, the Arctic population, the American native (Red Indians), the Southeast Asians, the Pacific Islanders, the New Guineans and the Australian natives. Even the African groups are subclassified as the Bantu, the Zulu, the ! Kung, and so on.

AN ASIDE ON AFRICAN PHONETICS

For those who are surprised by the exclamatory mark in front of ! Kung above, here is the explanation. The Khoisan and the Hottentot languages of Southwestern Africa have, apart from alphabets, some characteristic click sounds and phonetic entities. These are symbolized with various diacritical marks. The symbol '/' refers to a dental click that sounds like 'c' in 'tch'. The symbol '!' is used for the palatal or cerebral click 'q' (sound of the letter 'q' in the word quest). The alveola click that sounds like "nu" (or Greek nu) is symbolized as '#' while the alteral click (sounding like the letter 'x') is | | and the labial click "" sounds much like the sound of a kiss. Some readers may be familiar with the click songs that the South African singer, Miriam Makeba, made famous in the sixties and seventies.

GENETIC LINEAGE

The origins and the branching of mankind into racial types can now be addressed, using the methods of genetics. Over a decade ago, it was realised by the late Allan Wilson, a New Zealander who worked at the University of California, that the DNA in the mitochondria of

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our cells can be used to trace our cells which pick up intermediary metabolites, react them with oxygen and produce energy. In order to do so, they work closely with the rest of the cell. They are autonomous because they carry their own DNA, separate from the DNA of the "host" cell, which is called the genome. Wilson and his graduate student Rebecca Cann utilized the advantage of the fact that mtDNA is strictly inherited from the mother. A child is born upon the fertilization of the mother's egg, discharges its DNA and nothing else. Thus, the father's contributions to his child is only his genomic DNA. The mother, on the other hand, not only gives the child her own DNA but also passes along the mitochondrial DNA that exists in her egg cell.

Mitochondrial DNA, or mtDNA as it is called, is a small and circular molecule that contains no more than 16600 units called nucleotides. It has several other interesting features in that it does not shuffle around internally like many other DNAs do and is, therefore, stable. However, it mutates much faster, in fact 20 times faster, than genomic DNA. On an average, there is a mutation of one nucleotide in every 10000 years. Even here, the D-loop portion of the mtDNA mutates even faster, about 10-fold faster. The analysis of the mtDNA of two individuals, a study of the mtDNA sequence and the diversity of nucleotides in it, lets us build the family tree. The rate of change or mutation also provides us with a clock that lets us trace the divergence of the family tree in time. In the now famous paper of Wilson and Cann of 1987 they showed that all of us humans can trace our ancestry back to a woman who lived in Africa 200 000 years ago–"Eve" as it were.

Closer to home, there have been questions asked about where we Indians come from. Physiognomy or even a cursory look at ourselves shows that we might be from different stocks. How does one address this question ? Earlier, archaeological and linguistic analysis had suggested that we might be largely made up of three basic populations–the Negroids, the Caucasians and the Orientals. These questions have now been brought into sharper focus by several Indian researchers, notably Prof Madhav Gadgil of the Centre for Ecological Sciences, Indian Institute of Science, Bangalore and by Dr. Shama Barnabas of the Division of Biochemical Sciences, National Chemical Laboratory, Pune.

THE PUNE STUDY

In a paper in Naturwissenschaften, Dr Barnabas along with her colleagues, R V Apte and C G Suresh, analyzed the mtDNA of 145 Indians belonging to 14 different language groups. The grouping by languages was natural because, of the various tongues spoken in India, four of them (Tamil, Telugu, Malyalam and Kannda) are Dravidian and fall into a class somewhat different from the others (Hindi, Sindhi, Gujarati, Urdu, Bihari, Punjabi, Bengali, Marwari, Konkaril and Marathi), which are Indo-European in origin. By and large, the people belonging to the Indo-European language group have remained as a unit somewhat separate from the Dravidian group due to sociocultural and linguistic barriers. Admittedly, with increasing mixing, awareness and opportunities, these barriers are breaking down, but that has

happened only in the last two or three generations. Thus, the Pune study is not unjustified.

Barnabas and her associates analyzed the mtDNA of 68 "North Indians "Central Indians" (largely those speaking Marathi) and 27 "South Indians" speaking Dravidian languages. They reacted the DNA with specific enzymes that cut the long DNA molecules at specific sites, separated the cut DNA on a gel using an electric field and compared the sizes and the patterns of the fragments so obtained. Such mapping let them build a family tree, or phylogeny, as it is called. A total of 29 types of mtDNA were found amongst Indians. The preponderance of the common mtDNA type in the Indian population shows that they share a common lineage with other world populations. Also, the results revealed that Indians share many mtDNA types with Caucasians, showing that all these 145 Indians that they studied have Caucasian genes in them. In some, there was also a mixture of the DNA type.

What is interesting from the study is that the North Indian and South Indian populations did not share common mtDNA types, other than two of the 29. Yet, the South Indian types have a strong Caucasian lineage. Clearly, one may argue that the sample size used here is rather small and thus one cannot draw very general conclusions. Quite so, but still the results are already very interesting and call for a more detailed study. I would have thought that at least some of the South Indian samples would have had some Negroid genes in them. Anthropology, physiognomy and bodily features have argued for some Negroid component in the South Indian population. Yet, the Barnabas study does not show these.

The other interesting result, based on mtDNA tree-building and dating, suggests that the South Indian population were earlier immigrants into India. Dr. Colin Renfrew of England had argued that the Dravidian languages of the South resemble the Elamite language which was spoken in the Zagros in the southern part of Iran and Iraq. This region was also the cradle of agriculture. It is thus likely that people moved from this region as early as 6000 BC, as part of the early Caucasian migration into India. The Pune data further suggest that the North Indian population came in as a second wave as part of the "kurgan" invasions of the nomadic farmers with the spread of the agricultural economy. This is also thought to be the way that the Indo-European languages spread.

In all this discussion, we have not addressed the question of who the *original* inhabitants of India might have been. Would that not be the tribals ? Is it not important, therefore, to analyze their DNA to check whether they came from an earlier stock ? Did they come out of Africa or did they originate right here ? The current consensus is in favour of the "Out of Africa" hypothesis for human origin. Thus, it will be increasingly important to study ancient and insulated tribes. Such a study is, indeed, on the cards as part of a global effort. Scientists at the CCMB, Hyderabad, have already started collecting DNA samples from some tribals of India.

THE BANGALORE STUDY

Prof Madhav Gadgil and his group have already analyzed seven samples from the kadar hunter-gatherer tribe of the mountains of kerala. In a paper in the April 1995 issue of *The American journal of Human Gentics*, in collaboration with Prof Luiga Luca Cavalli-Sforza and group at Stanford and Chris Ottolenghi at Paris. This group has examined the mtDNA of 48 individuals belonging to the Havik Brakmin Community of Uttara Kannada, 43 of the Mukri, a scheduled caste community of this region, in addition to the seven Karars of Kerala. Socioculturally, the Havik Brahmins did not mix with others. When their DNA was analyzed it was found that they expanded like a star from a central point of genetic tree. On the other hand, the Mukri individuals clustered, and were indeed well separated from the Havik lineage, but more like the bristles in a brush–many sequences attached to a few central branches. Unlike the Havik who seem to have undergone dramatic demographic changes, the demographic pattern of the Mukris suggests that they have maintained a fairly constant population size.

There are other interesting things about the Gadgil paper. One is that the study showed no clear separation, or identifiable caste-specific branches. Although the Havik Brahmins and Mukri Harijans are among the highest and lowest caste status, respectively, the DNA sequence from both the samples are found scattered throughout the tree. What this means is that there has been some level of gene flow between these two subpopulations. Indeed, this particular point was picked by another Indian geneticist, Dr D R Govindaraju at the Yale University School of Medicine, who responded to the Gadgil paper in a later issue of the same journal. He wondered about the tangled heritage and the demographic history of the Indian caste system and wondered whether this gene flow might have arisen due to factors including extramarital gene donation. In their reply, the Gadgil group concedes this possibility, but laid greater emphasis on ancestral polymorphism. Their argument is that the caste system crystallized fairly recently (a couple of thousand years, that is 100 generations, ago) and thus the gene flow could have happend prior to the separation of the population. The number of samples from the Kadar tribals being very small, it is too early to conclude anything about them. We need to wait for a more in-depth analysis of DNA from various indigeneous tribes.

KNOW THY INSTITUTIONS

ACHARYA N.G. RANGA AGRICULTURAL UNIVERSITY, HYDERABAD

Acharya N.G. Ranga Agricultural University is a State Agricultural University established, on the pattern of Land Grant System of education of USA, in the year 1964, to serve the people of state of Andhra Pradesh and the Country at large. At present, it has a network of:

(a) 20 Teaching institutes under three faculties viz., Agriculture, Veterinary and Home Science, (b) 67 Research stations comprising 57 Agriculture, 6 Livestock and 4 Fisheries stations, spread in seven agro-climatic zones, throughout the state, (c) 22 District Agricultural Advisory and Transfer of Technology Centres (DAATTCs), (d) 12 Krishi Vigyan Kendras (KVKs), (e) Extension Education Institute (EEI), (f) Agricultural Information and Communication Centre (AI&CC) and (g) Agricultural Technology Information Centre (ATIC).

MANDATE OF THE UNIVERSITY :

(i) Train manpower needed for agricultural development of the State, (ii) Constantly improve and generate technologies for increasing production in the agricultural sector and (iii) Disseminate the improved technologies to the farmers of the State, through the development departments of the Government.

The University serves its mandate through it's triple functions and integrated programmes of **teaching, research and extension** with the main emphasis being on overall development of agriculture and allied sectors of horticulture, animal husbandry, fisheries and home science in the state of Andhra Pradesh.

The University won the coveted BEST Institution award of the Indian Council of Agricultural Research (ICAR) for the year 1999, won twice the BEST PERFORMANCE AWARD for securing the highest and second highest number of seats in ICAR common Entrance Examination for admission to post-graduate courses in 2000 & 2004 respectively. The University is accredited both by the **University Grants Commission** (UGC) and the ICAR. In addition, the B.V.Sc. & A.H. degree is accredited by the **Veterinary Council of India.**

GOVERNANCE :

The University is governed by a 21-member Board of Management, which is the apex body, responsible for taking policy decisions. The academic administration of the Universiy is guided by the Academic Council and Faculty Boards. The research and extension activities of the University are guided by the Research and Extension Advisory Council. The Vice-Chancellor, heads the University administration and is supported by the Rigistrar, Director of Research, Director of Extension, Deans of Faculties, Comptroller, University Librarian and Estate Officer.

ACTIVITIES OF THE UNIVERSITY : Teaching

Academic Programmes

Agriculture	Veterinary	Home Science
Undergraduate		
B.Sc. (Agriculture), B.Sc. (Horticulture) B. Tech. (Ag. Engineering), B.Tech.Food Science, B.Sc. (CA&BM)*	B.V. Sc. & A.H. B. Tech. (Dairying.) B.F.Sc**	B.H.Sc.
Postgraduate		
M.Sc. (Ag.), M.Sc. (Horti.) M.Sc. (Environmental Science & Technology) M.Sc.(Ag. Biotech), M.A.B.M.	M.V.Sc. M. Tech. (Dairying) M.V.Sc. (Vety. Biotech)	M.Sc. (H.Sc.) M.Sc. (F.Sc.&Tech.)
Doctoral		
Ph.D.	Ph.D.	Ph.D.

* Bachelor of Commercial Agriculture & Business Management

** Bachelor of Fishery Science

In addition, two-year post-matriculate diploma courses in agriculture and animal husbandry and Certificate and short-term courses, in all the three faculties are offered.

SPECIAL TEACHNING CURRICULUM

l Adopted semester system of instruction, 10 point grading system, common semester final examinations for all campuses. The University was one of the first to introduce external examination component at the undergraduate

level, more than two decades ago. Adopted Annual examination pattern as per Veterinary Council of India (VCI) regulations for B.V.Sc. & A.H. Course from 1994-95.

- First University in the country to introduce "Rural Work Experience Programme" (RAWEP) in the year 1979-80 in which the students reside in villages for one full semester and get hands-on training on the problems faced by the farmers and exposure to rural environment.
- Introduced a novel scheme "Earn While You Learn", which help the B.V.Sc. students to gain work experience and improve their entrepreneurial skills.
- The three year programme of Home Science was relaced with the four year programme, with specialization in third and fourth years.
- One-semester-credit courses, each in Physical Education and NSS/NCC, were introduced during 1997, to make the students participate compulsory in various sports, games and NSS/ NCC activities, in order to make them physically fit and mentally alert.
- A central placement cell in he Administrative Office and regional placement cells, one each at 13 colleges, were established for students counselling and placement in different organisations and user agencies.

RESEARCH

The University's wide infrastructure covers seven agro-climatic zones of the state to fulfill the basic philosophy of research aimed at finding location-specific solutions to various problems affecting agriculture and allied fields and increasing productivity and profitability.

- Released 302 improved varieties in rice, sorghum, bajra, ragi, maize, korra, variga, horsegram, sunflower, soybean, blackmustard, mango, banana, amaranthus, dolichos beans, snapmelon, greengram; blackgram, redgam, groundnut, sesamum, sugarcane, cotton and castor.
- Research has been intensified on enhancing productivity, reducing cost of production, crop diversification, bio-fuel/diesel, stepping up farming systems research and on-farm research, food quality and safety, marketing support and market intelligence, biotechnology methods such as recombinant DNA technology, monoclonal antibodies, genetic engineering etc., food processing and value addition, aerobic rice, system of rice intensification (SRI), integrated crop management practices, dryland agriculture, dryland horticulture, pulses oilseeds, water management, crops and cropping systems under different ayacut areas, soil mapping, land use planning and conservation, maintenance and cataloguing of germplasms etc.
- The significant contributions of veterinary faculty are : Exploited Embryo Transfer Technology in livestock improvement and achieved successful transfer of Ongole cattle embryos; Isolated Blue Tongue virus serotype-2 which led to the development of an inactivated vaccine, Developed diagnostic kits for early detection of various animal diseases, standardized pelleting and expander-extruder technology for production of complete livestock feeds based on agricultural crop residues.

- Home science faculty has carried out extensive research in the areas of food science, threapeutic nutrition and community nutrition. Developed value added products from various foods, technology for extraction of natural dyes, low cost cnergy efficient equipment for household use, psycho-motor stimulation kits etc.

UNIVERSITY EXTENSION

Education of rural people in agriculture and allied areas in one of the main functions of the University, through first line extension work, with the motto "Reach the unreached". Transfer of Technoloty takes place through extension efforts such as :

- Organisation of training programmes for farmers, women, rural youth and grassroot level extension functionaries in on-farm and off-farm activities.
- Organisation of Karshaka vigyan vedikas in all 22 disticts convering thousands of farmers in each district.
- Organisation of Kisan Melas consisting of Rythu Sadassu, Exhibition and field demonstration, benefiting lakhs of farm families.
- Dissemination of technical information through bulletins, scripts, write-ups for news papers, magazines and journals, through media (AIR KTV) and publishing Vyavasaya Panchangam (Agricultural Almanac), a compendium of all technical information related to agriculture, animal husbandry and home science, ANGRAU Journal of Agriculture, ANGRAU News Letter periodically.

Farmers Call Centre, established by the University, is well supported by Expert Team, Crop Escorts and Disease Monitoring Cell for the campaign to enhance crop productivity and raise the farmers income.

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Conferences / Meetings / Symposia

Date	Topic	Contact
6-9 September 2005	Nanotechnology and the Health of the EU Citizen in 2020, Edinburgh	Carrie Smith Institute of Nanotechnology The Alpha Centre Stirling University, Innovation Park Stirling, FK9 4NF, UK E mail : carrie@nano.org.uk
19-23 September 2005	7th Global Conference on Environmental Education, Agra	Secretary Environmental Education, Indian Environmental Society, U-112 Vidhata House, Vikas Marg, Shakarpur, Delhi 110 092 Email : iesenor@vsnl.com
23-25 September 2005	National Conference on Tsunami Rehabilitation, Kurukshetra	Dr. V. P. Wani National Institute of Technology, Kurukshetra, Hariyana, 136119 Email : vpwani@nikkr.ac.in
21-24 October 2005	National Symposium on Recent trends in Environmental Biology & Biotechnological approach to Conserve Biodiversity, Gulbarga	Prof. K. Vijaykumar Department of Zoology Gulbarga University, Gulbarga-585106 E-mail : katepaga_vijaykumar@yahoo.com
7-10 November 2005	74th Annual Meeting of Society of Biological Chemistry (I), Lucknow	Secretary Society of Biological Chemists India, Indian Institute of Science, Banglore 560 012

Date	Topic	Contact
15-18 November 2005	9th **International Union Against Sexually Transmitted Infections** (IUSTI), World Congress on Medicine, Bangkok	**Dr. Chavalit Mangkalaviraj** Bangrak Hospital, VD Division 189 South Sathorn Road, Sathorn, Bangkok 10120, Thailand E-mail : chavalit@cotisa.org
29 November-2 December 2005	Third International Conference of **Plants & Environmental Pollution** Lucknow	**Dr. R. D. Tripathi** National Botanical Research Institute Lucknow-226001, India. E-mail : isebnbrilko@satyam.net.in
5-7 December 2005	9th **International Rubus** and **Ribes symposium,** Santiago	**Dr. Maria Pilar Banados** Universita Catoluade chile Casilla-306-22, Vicuna Makenna-4860, Santiago, Chile E-mail : pbanados@pue.c/
30 November-2 December 2005	National Symposium on **Instrumentation,** Cochin	**Prof. G. Mohan Rao** General Secretary, Instrument Society of India, Department of Instrumentation, Indian Institute of Science, Bangalore 560 012 Email : isoi@isu.iisc.ernet.in
3-7 January 2006	93rd Indian Science Congress on **Integrated Rural Development : Science and Technology,** Hyderabad	**General Secretary** Indian Science Congress Association 14, Dr. Biresh Guha Street, Kolkata 700 017. Email : iscacal@vsnl.net
10-13 January 2006	Second Internaltional Symposium on **Green Sustainable Chemistry,** Delhi	**Prof. M. Kidwai** Department of Chemistry, University of Delhi, Delhi 110007 Email : kidwai_chemistry@yahoo.co.uk

S & T ACROSS THE WORLD

YOUNG INNOVATORS REPRESENT INDIA

Innovation implies finding out new and better ways of a doing what has been done before, and who can look at things in a fresh, clear sighted light than the youth of today.

Keeping this in mind, the Confederation of Indian Industry, in collaboration with the Department of Science and Technology, Government of India, have launched an initiative called "Steer the Big Idea" to capture innovative ideas from young innovators for the benefit of industry and soceity. Last year, 10 young innovators were selected to represent India at the International Exhibition of Young Inventors in Tokyo.

This year the International Exhibition for Young Inventors was scheduled in May 2005 in Kuala Lumpur, Malaysia, for which 4 inventors were selected.

These include Miss Vindhya Revathi Vyjayanti for her project on "Correlation of the Raddii of In-circle and Circumcircle", Raghavendra G for his project on "Global Range Electronic Appliance Conroller" (GREAC); Kunal Gaurav for his project on "Extraction of Thread from Banana Trunk"; and Arpith Siromoney for an improved wheel chair. Good luck to all of them!

(CII Communique, Apr., 2005)

CLONING HUMAN EMBRYOS

Professor Ian Wilmot who created Dolly the first cloned sheep, and a team of scientists from Kings College, London, have obtained permission to clone early stage embryos to study motor neurone diseases (MND).

MND is caused by the death of cells called motor neurones that control movement in the brain and the spinal cord. It affects about 5000 persons in the UK, half whom die within 1 months of diagnosis. Weakness in the muscles that supply the face and throat, add to the problems of speech and cause difficulty in chewing and swallowing.

While critics belonging to such groups as the Pro-life Alliance, maintain that testing human embryos is wrong and immoral, and others question the benefits of such work, Prof. Wilmlot is tremendously excited about the venture. It is only the second time that the Human Fertilization and Embryology Authority has given such permission, and the Professor has made it clear that he does not plan to grow healthy replacement tissue. Instead he deliberately aims to clone embryos that have MND from patients who have the condition, so that the disease can be studied in unprecedented detail.

(BBC Health, Feb 2, 2005)

PASSING ON GENETIC TRAITS

Researchers in Berkeley University California, USA have identified a key mechanism for the passing on of genetic material from a parent cell to daughter cells which may help explain how a complex of proteins called kinetochores can recognize and stay attached to microtubules, hollow fibres in the walls of biological cells that are respobsible for the faithful segregation of chromosomes during cell division.

The researchers have found that the kinetochores proteins form rings around the microtubules and this ring formation promotes microtubule assembly, stabilizes against disassembly and promotes bundling. Where ring formation takes place *in vivo*, it could be the mechanism by which chromosomes are kept segregated during cell division or mitosis.

Mistakes in chromosome segregation during mitosis contribute to cancer and birth defects, but what actually causes such mistakes to occur has still to be probed fully.

(Research News, Feb 12, 2005)

DATA STORAGE IN COMING YEARS

The next generation of computers will be "instant on" which means that they will not need to be booted to move hard drive data into memory. They will require lesser space to store data, and will be able to access it faster, while consuming less power.

All this is becoming possible through the development of magnetic random access memory chips or MRAM which will store data through magnetization and the spin of electrons, as opposed to present day chips which utilize electron charges.

Certain complex metal oxides, including the material known as manganites are known to display a unique phenomenon, known as collosal magnetoresistance (CMR) and with CMR manganites, the application of a magnetic field can cause the material's electrical resistance to change by as much as 1000 percent. The CMR effect in manganites and other oxides is to form a type of polaron which is a type of electron that is bound to a local distortion of the atoms in the crystal.

This polaron is formed when the magnate is heated beyond its Curie temperature of about 350 degrees Kelvin and the distortion creates a sort of energy "well" that traps the electron. Indeed the spin polarization of CMR mangnites makes them excellent candidates for lightning-fast new logic devices such as transistors.

(Science@berkeley Lab, Apr. 18, 2005)

ANSWERS TO "DO YOU KNOW?"

A1. Sparrow.

A2. A swan has 25,000 and a duck has 12,000 feathers.

A3. About 50%.

A4. Sodium and Chlorine.

A5. The sex of the offspring depends on it. Above 87°C it is male and below female.

A6. 75-80% of taste is smell. The tongue can perceive only four tastes-sweet, salty, bitter and sour. The rest more complicated taste are actually smells. With nose closed, potato and apple taste the same.

A7. 3% approximately.

A8. Never.

LIBRARY SERVICE
The Indian Science Congress Association
14, Dr. Biresh Guha Street, Kolkata-700 017

The library of the Indian Science Congress Association subscribes the following Indian and Foreign journals. List of these journals are given below :

India

Current Science
Down to Earth
Food & Nutrition World
Indian Journal of Experimental Biology
Indian Journal of Biochemistry and Biophysics
Indian Journal of Marine Sciences
Pramana
PTI Science Service
Science Reporter

Foreign

Ambio
American Scientist
Endeavour
Interdisciplinary Science Reviews
International Studies in the Philosophy of Science
Journal of Environmental Planning and Management
Nature
Natural History
New Scientists
Policy Studies
Science
Science & Society
Social Choice and Welfare
Technology Analysis & Strategic Management
Tropical Science

In addition to those subscribed above, the following journals/newsletters are also received by the Library in exchange of the Association's journal "Everyman's Science" :

Chemecology
CSIR News
DRDO News
Environmental Awareness
Environmental Health Perspectives
Gana Darpan
Gyan Bigyan
IASSI Quarterly
INSA News
Indian Journal of Physics
JIMA
Natural History (Bombay)
Science & Culture
Spices India
University News
WMO Bulletin
WISTA

The Library is open to all category of members of the Association as well as school, college and university teachers on all weekdays (except Saturday, Sunday and holidays) from 10.00 a.m. to 5.30 p.m.

FORM IV

Rule 8

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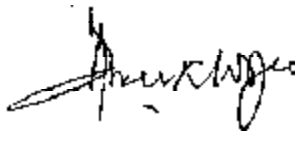
I, S.P. Mukherjee, hereby declare that the particulars given above are true to the best of my knowledge and belief.



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APPLICATION FORM FOR MEMBERSHIP

To
The General Secretary
The Indian Science Congress Association
14, Dr. Biresh Guha Street, Kolkata-700 017
Dear Sir,

I like to be enrolled as a Member/Life Member/Donor/Sessional Member/Student Member of the Indian Science Congress Association. I am sending herewith an amount of Rs..... in payment of my subscription by Bank Draft/Cheque/Money Order/Cash for/from the year 1st April 200..... to 31st March 200..... I would like to have reprint of proceedings of the following Sections (Please tick any one)

SECTIONS

1. Agriculture and Forestry Sciences
2. Animal, Veterinary and Fishery Sciences
3. Anthropological and Behavioural Sciences (including Archaeology and Psychology & Educational Sciences)
4. Chemical Sciences
5. Earth System Sciences
6. Engineering Sciences
7. Environmental Sciences
8. Information and Communication Science & Technology (including Computer Sciences)
9. Materials Science.
10. Mathematical Sciences (including Statistics)
11. Medical Sciences (including Physiology)
12. New Biology (including Biochemistry, Biophysics & Molecular Biology and Biotechnology)
13. Physical Sciences
14. Plant Sciences

Yours faithfully,

Date : (Signature)

Name (in block letters) :

Academic Qualifications :

Designation :

Address for Communication :
(including State, City/Town and Pin code)
Phone no. & e-mail

Note : (1) All Money Orders, Bank Drafts, Cheques, etc. should be drawn in favour of *Treasurer, The Indian Science Congress Association*. A Bank Charge of Rs. 70/- is to be added to the subscription amount, if paid by an outstation cheque.

Terms of Membership and Privileges of Members :

Membership of the Association is open to persons with *graduate or equivalent academic qualification* and interested in the advancement of science in India.

1. **Member** : A person willing to be enrolled as new Member has to pay an annual subscription of Rs. 200/- (for foreign * U.S. $ 50) only, along with an admission fee of Rs. 50/- (for foreign U.S. $20) only. The annual subscription of a Member shall become due to on the 1st April of each year. Any one who fails to pay the subscription *on or before the 15st July* in any year shall lose the right of voting and/or holding any office of the Association for that year. A Member failing to pay the annual subscription by the end of March of the following year shall cease to be a Member.

   Members may contribute papers for presentation at the Science Congress. They will receive, free of cost, reprint of the Proceedings of the Session of any one section of their interest and also the bimonthly journal of the Association "Everyman's Science".

2. **Sessional Member** : Sessional Members are those who join the Association for the Session only. They may contribute papers for presentation at the Science Congress and receive, free of cost, reprint of the Proceedings of the session of any one section of their interest. A Sessional Member has to pay subscription of Rs. 250/- (for foreign U.S. $ 60) only.

3. **Student Member** : A person studying at the undergraduate/postgraduate level may be enrolled as a Student Member, provided his/her application is duly certified by the Principal/Head of the Institution/Department. He/She may contribute papers for presentation at the Science Congress, provided such papers are communicated through members of the Association. The subscription for Student Membership is Rs. 100/- (for foreign U.S. $ 50) only.

4. **Life Member** : A Member may compound all future annual subscriptions by paying a single sum of Rs. 2000/- (for foreign U.S. $ 500) only. Any person who has been continuously a member for 10 years or more, shall be allowed a reduction in the compounding fee of Rs. 50/- for every year of such membership, provided that the compounding fee shall not be less than Rs. 1,200/- (for foreign U.S. $ 12.50 and U.S $ 300 respectively). A Life Member shall have all the privileges of a member during his/her lifetime.

5. **Institutional Member** : An Institution paying a subscription of Rs. 5,000/- (for foreign U.S. $ 2,500) only, can become an Institutional Member of the Association. It shall be eligible to nominate one person as its representative to attend Annual Session of the Science Congress. An Institutional Member shall be eligible to receive, free of cost, a copy of the Annual Science Congress Session as also a copy each of the Association's journal "Everyman's Science".

6. **Donor** : Any person paying a lump sum of Rs. 10,000/- (for foreign U.S. $ 5,000) only, can become a Donor of the Association. An *INDIVIDUAL DONOR* shall have all the rights and privileges of a Member during his/her lifetime. An Institution paying a lump sum of Rs. 50,000/- (for foreign U.S.$25,000) only, can become an *INSTITUTIONAL DONOR* of the Association, which shall have the right to nominate one person as its representative to attend Annual Session of the Science Congress. An Institutional/Individual Donor shall be eligible to receive, free of cost, a copy of the complete set of Proceedings of the Annual Science Congress Session and also the Association's journal "Everyman's Science".

(i) Members of all categories are entitled to Railway Concession of return ticket by the same route with such conditions as may be laid down by the Railway Board for travel to attend the Science Congress Session provided that their travelling expenses are not borne, even partly, by the Government (Central or State), Statutory Authority or a University or a City Corporation.

(ii) Members of all categories are entitled to reading facilities between 10.00 a.m. to 5.30 p.m. on all weekdays (except Saturdays & Sundays) in the Library of the Association.

*** A Foreign Member means one who is normally resident outside India**