

Strengthening the Efforts on “Nano-Bio-Information Technology for the Development of North-Western Himalayan States of India” A Brainstorming Session Report

Anil Kumar*

Department of Molecular Biology & Genetic Engineering, College of Basic Sciences & Humanities, G. B. Pant University of Agriculture & Technology, Pantnagar-263145, Uttarakhand, India.

*Corresponding author: Dr. Anil Kumar, Coordinator Pantnagar Biotechnology Programme, Professor & Head, Department of Molecular Biology & Genetic Engineering; e-mail: anilkumar.mbge@gmail.com

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ABSTRACT

North-Western Himalayan states are treasure trove of Biological diversity which is an important source of various compounds, genes and proteins of industrial and pharmaceutical importance. Thus biodiversity generates economic revenue through bio-prospecting which links biodiversity with industries. However conservation and sustainable use of biological diversity is critically important not only to ensure the continuous supply of food, fibre, fodder but also to maintain ecological balance and promote industrial growth in Himalayan states. Advances in Nanotechnology, Biotechnology and Bioinformatics are of immense importance in preservation and bio-prospecting of important molecules by harnessing biodiversity so as to promote industrial and agricultural growth of these states. During the brainstorming session, participants deliberated on the applications of nanotechnology, biotechnology and information technology to manage the challenges of food and nutritional security in these states and to promote the growth on front of agriculture, biomedical and industrial sector. This report summarizes the nanotechnology, biotechnology and bioinformatics as integrated discipline of frontier science and technologies “Nano-Bio-Information Technology” for the holistic development of hill states of India with very useful recommendations.

Keywords: Biotechnology, Bioinformatics, Nanotechnology.

INTRODUCTION

Similar to other emerging fields, Nano-Bio-Information Technology at times seems to be a collection of unrelated lines of research and very specialized applications. Is nano-bio-information technology a discipline of its own or is it merely an interdisciplinary concept? By sharing our ideas and suggestions we can each contribute to our mutual understanding so that this area develops a greater cohesiveness. As this happens, fundamental insights about nano-bio-information technology will emerge. Hopefully more generous funding and facilities for nanotechnology will follow as a better case is made for the importance of

nanotechnology in science and in its practical applications. No doubt this brain storming session has contributed to this challenging process. It is important that we all try to educate other scientists and the general public about science and nano-bio-information technology. Doing research and writing technical papers is not enough. Many young people are avoiding science in our colleges and universities because of the hard work involved. They do not get far enough to realize how rewarding it is to test one's own idea with an experiment. We need to reach out and inform the public about science by speaking and writing for the general public. We need to emphasize the opportunities

in science, especially for women. We need funding for more basic research in nano-bio-information technology, especially work oriented to applied research of benefit to society. One scientist cannot adequately train young researchers because a single scientist is only doing part, not the whole. Agriculture or health will not be changed by a single person, but only by a group working effectively and productively together. Due to constraints in the availability of skilled workers in the field of newly emerging nano-bio-information technologies, cooperative tie ups with universities should be made so that for each and every organisation a minimum of five students should be well trained in established laboratory with the requisite financial support being provided. Scientists should be given the opportunity to deliver lectures worldwide so that they can learn by feedback from their peers and other experts. At the same time, resource persons should be invited from different countries to give lectures at symposia so that up-to-date information flows freely. Extension and awareness activities should reinforce awareness that nano-bio-information technology should be more on sustainable natural resource management. Creating broader public awareness of the use of such technologies in solving many problems of society through the information media is necessary.

Pantnagar Biotechnology programme organised a two day brain storming sessions on the topic **“Prioritizing research areas on nano-bio-information technology for development of North-Western Himalayan states and strengthening efforts in frontier sciences and practicing hi-tech research”** on 12-13 July 2013 to address major and common issues and challenges related to the development of North-Western Himalayan states through interventions of nanotechnology, biotechnology and bioinformatics of the hill states such as Uttarakhand, Himachal Pradesh and Jammu and Kashmir. Invitations for participation for scientists, academicians, research scholars in this brain storming session were circulated throughout the country and due to the highly relevant and most challenging thematic areas, received overwhelming response. Over 150 scientists and academicians not only from the hill states but also from other parts of our country actively participated and presented their views to solve the most challenging issues of these hill states using modern tools and techniques of frontier sciences and technology. The brain-storming session **was solely planned for formulating and devising strategies to strengthen the efforts towards the applications of nanotechnology through innovation in nano-systems, design and use of biotechnology, bioinformatics and system biology in an integrated fashion for the development of hill states.** Indeed, this meeting really helped in the sensitization through provoking the thoughts for addressing many demand driven issues, ensuring regional food security through minimizing emerging issues and challenges in agriculture by adopting successful and innovative technologies and also formulation of programs for

addressing emerging challenges to use available huge bio-resources for the development of agri-food-nutrition and pharma sectors in the north-western Himalayan states. We further look forward for continuous guidance and support of scientific community and policy-makers in establishment and implementation of the regional need based programs in future.

Agri-horti-forestry is the life blood of Himalayan state's economy and food and nutritional security is one of the important agenda for regional co-operation amongst north-western Himalayan states. These states are facing new challenges for small holder's dominated agriculture, land degradation, climate change impact, unpredictable weather conditions, low productivity and quality, post-harvest losses, poor and uncertain marketing system, low export quality etc. NWHs (North-Western Himalayan States) have enough potentialities for regional collaboration in Agro-horti-forestry and has been facing number of challenges which can be resolved by effective networking with the stakeholders/players working in these areas by adopting newer tools on biotechnology, nanotechnology and information technology. The brain storming session guided us in formulating programs for establishment of regional centres for practicing Hi-Tech research to ensure food security as well as nutritional security to reduce poverty and hunger in these states. Since, the problem was highly diversified and has to address within only two days, the brain storming sessions were divided into 6 over all sessions including Coordinator's meeting and round-up session for making recommendations. Each session was attended by a galaxy of eminent scientists and also speakers who first gave informative presentations which consisted of raising questions and challenges in the core areas followed by concluding session with suggestions and recommendations. The thematic areas of brain storming session are as follows:

- ❖ SWOT analysis (strengths, weaknesses, opportunities and threats analysis) of current status of bio-resources and its potential in agro-climatic conditions in north western Himalayan states
- ❖ Use of newer technologies for development of Himalayan states
- ❖ Multi-disciplinary approaches in biotech research for agri-food, nutritional and health security.
- ❖ Nanotechnology for enhancing the precision and efficiency of biological system
- ❖ Bioinformatics for documentation of Himalayan bio-resources and discovery of novel molecules.

This was first ever attempt, this brain storming session was organized in the country for holistic integration of all innovative technologies and harnessing potential of frontier sciences for effective utilization of huge bio-resources of NWH regions for the regional development. It is an index of the importance attached to frontier

sciences by our scientific community for their clear policy and scientific direction for the promotion of symbiotic interaction between modern sciences and regional development.

The brain storming session was inaugurated in the benign presence of eminent scientist and dignitaries of our country. Dr. J P Pandey, the honourable Vice chancellor (Acting) and Registrar of GBPUA&T, Pantnagar was the Chairman while Dr. H.P. Singh, Ex. Deputy Director General (Horticulture) and Chairman CHAI was the Chief Guest and Dr. P.S. Ahuja, Director, CSIR-IHBT, Palampur, was the Guest of honour. The inauguration started with the lightening of lamp by the dignitaries on the dais followed by presentation of bouquet to the dignitaries. Welcome address was given by Dr. Uma Melkania, Dean CBSH. Dr. Anil Kumar, Coordinator of the Pantnagar Biotechnology Programme then presented the overview of theme of the two days brain storming session. Four books namely 1. 'Nanotechnology in Agriculture' by Dr. Anil Kumar, Dr. V A Parthasarathy, Dr. Babita Singh and Dr. H P Singh, 2. 'Crop Diagnostics' by Dr. Anand Raj, Dr. I D Bhat and Dr. H P Singh 3. Concept Paper on Prioritizing the research areas on 'Nano-Bio-Information Technology for the development of North-Western Himalayan States' by Dr. Anil Kumar 4. Proceedings of Brain Storming session by Dr. Anil Kumar and Dr. Dinesh Pandey were released during the inaugural session by the dignitaries on dais. The inaugural key note address entitled "*Augmentation of Nano-bioinformation technology in agriculture for the development of Himalayan states*" was delivered by the Chief Guest Dr. H.P. Singh, Ex. Deputy Director General (Horticulture) and chairman CHAI. Dr. Singh in his speech described various strategies to achieve the goal of Himalayan development. He said that, it is not enough to wait patiently while scientists and engineers do their traditional work. Rather, special efforts are required to break down barriers between fields and to develop the new intellectual and physical resources that are needed.

The theme of the Plenary inaugural session was: Technological interventions of Frontier Sciences: Biotechnology, Nanotechnology and Bioinformatics. The plenary inaugural lecture was delivered by the Dr. P.S. Ahuja, Director, IHBT, Palampur on the topic "*Some Advances in Bio-Information-Nano Technology for Western Himalayan Bioresources*". Dr. G.K. Garg and Dr. Nazir A Ganai were the chairman and rapporteurs of this session. Dr. Ahuja in his lecture pointed that nanotechnology is important to improve the value of our products and services per unit of natural resources employed to meet the challenges of future. He emphasized on networking of institutions in north western Himalayan states for conservation of Himalayan biodiversity. He further added that building libraries of sRNAs with important role in epigenetic regulation, screening plants for plant derived molecules (PDM) against diseases like diabetes, malaria and asthma and bioprospecting for genes with unique

function can add value to our resources and their conservation e.g. genes like beta 1,3 glucanase (cellulose degradation), SOD for industrial application. He also informed that the IHBT has developed many viral/fungal diagnostic kits for e.g., apple scab and viral diseases.

Three lectures were delivered by distinguished in the session SWOT analysis of current status of bio-resources and its potential in agro-climatic conditions in north western Himalayan states. Dr. Uma Melkania and Dr. D. P. Uniyal were the convenor and co-convenor while Dr. L.M.S. Palni and Dr. B.D. Lakchaura were the chairman and co-chairman of the session. Dr. J.P. Jaiswal and Dr. N.K. Singh were the rapporteurs. The first presentation was delivered by Dr. R.S. Chauhan, Dean (Biotechnology) and Professor & Head, Department of Biotechnology and Bioinformatics, JUIT on the topic "*Agro-biodiversity in the western Himalayan Region with special reference to Himachal Pradesh*". He informed that out of total 45,000 to 47,000 floral species found in the country, as many as 3,295 species (7.32%) are in HP. Himachal has 3,120 species of flowering plants, 38 species of orchids, 13 species of conifers and 124 species of pteridophytes (including ferns). He pointed out that besides being so rich, the most distressing situation is that many of these valuable genetic resources are eroding at very high rate due to various reasons and therefore the entire range of genetic diversity has been evaluated for different traits which may contribute in breeding new crop varieties and other production enhancement research programs. The genetic resources are safely conserved as base collections in the National Gene Bank at NBPGR headquarter, Pusa, New Delhi and as active collections in Medium term storage at Shimla in HP and Bhowali in Uttarakhand.

The next presentation was delivered by Dr. L.M.S. Palni, former Director, G. B. Pant Institute of Himalayan Environment and Development, Kosi- Katarmal, Almora. He described that the Uttarakhand state has three distinct geoclimatic zones and harbors about 175 rare species of aromatic and medicinal plants. He further added that Uttarakhand would benefit greatly from the direct intervention of biotechnological research for sustainable development of the State and its economic uplift in tandem with the preservation of its fragile but unique ecosystems, environment and the rich biodiversity. He informed that the Govt. of Uttarakhand had set up State Biotechnology Programmes in 2003 (website: www.ua.nic.in/biotech) for the overall development of biotechnology in the state, including setting up of biotech industrial park(s) in the state, State Biotechnology Programme (SBP) at Biotech Bhavan, Haldi, near Pantnagar. The State Biotechnology Policy was released on Jan. 2004. Dr. Palni enumerated the potential of biotechnology in setting up biotechnology based industries. He further discussed that the Government of Uttarakhand needs to accord priority to nano-bio-information technology sector to shape future socio-economic growth. Setting

up of proposed Biotech Park needs to be accelerated to address the biotech industry's requirements for specialized infrastructure and thereby encourage new biotech enterprises, drive life sciences research, accelerate commercialization of new technologies, enable biotech organizations, to forge alliances and enhance competitiveness of biotech companies located in the state. He concluded that the state should continue to place strong emphasis on quality education and training for the youth in this sector, as well as imparting vocational skills to farm based population.

The third lecture was delivered by Dr. Manjoor Shah, Department of Botany, University of Kashmir Srinagar, Jammu and Kashmir. Dr. Manjoor described that the State of Jammu and Kashmir has been divided into three biogeographic zones, viz., Trans-Himalayan region (Ladakh), northwest Himalayas (Kashmir valley, mountain ranges of Kashmir and mountain ranges of Jammu) and Jammu plains. Being beset with considerable topographic, altitudinal and climatic variation, the region offers diverse ecological niches and supports high degree of endemism, in recognition of which in concert with other parts, the Himalayas have been declared recently as a Biodiversity Hotspot. Though some components of Himalayan biodiversity are well known, many other constituents are neither yet properly documented nor scientifically described. Besides, the resource potential of unique and rich biodiversity of the region has, unfortunately, is very far from having been fully realized, despite being popularly known as a "biomass state" *sensu* Khosho (1997). Though the nature-centered traditions and indigenous biodiversity concept still survives in Kashmir Himalayan region with considerable relevance to innovation of bio-resources and their sustainable use, the convergent use of modern technologies, such as bioinformatics, biotechnology and nanotechnology can significantly improve harnessing the bioresource potential of the hilly states, in general, and Jammu and Kashmir, in particular. He further added that information technology offers potentially great use in documentation, digitization and dissemination of information on biodiversity; biotechnology can be used to explore novel bioactives of potentially enormous therapeutic and industrial importance. The nanotechnology can be used for finer value addition to most of the biodiversity based products to enhance their quality and marketability. Bio-resource availability and economic potential can be computed on the basis of basic data on species diversity, use and non-use values of various species, the area and productivity of agriculture and horticulture crops, forests and plantations. Fundamental to such efforts is, however, the basic stocktaking of our biodiversity and assessment its real resource potential. Jammu and Kashmir, in comparison to other hilly states of northern India, is not exceptionally the largest in terms of area, but also most diverse in terms of floristic, faunal and microbial diversity. He said that for bio-prospecting, special attention should be given to endemics. Given

the richness of diversity, chemical profile of indexed medicinal plants of Kashmir Valley is still not available and hence should to be undertaken on priority. Moreover, ethnic knowledge needs to be documented and folklore claims need to scientifically be validated before any phytochemical investigation of such plants is undertaken. The convergent use of modern technologies, such as bioinformatics, biotechnology and nanotechnology can significantly improve harnessing the bio-resource potential of the hilly states, in general, and Jammu and Kashmir, in particular.

There were three lectures in this session, Use of newer technologies for development of Himalayan states. Dr. G.K. Singh and J.P.S. Gautam were the convenor and the co-convenor respectively along with Dr. G.K. Garg and Dr. S.K. Nandi as chairman and co-chairman respectively. Dr Sanjay Mohan Gupta, scientist at DRDO, Haldwani and Dr. Sameer Srivastava were the rapporteurs. The first lecture was delivered by Dr. G.K. Garg, Director, Krishidhan Research Foundation Pvt. Ltd on the topic entitled "*Harnessing the molecular knowledge from biodiversity of Uttarakhand and using biotechnology for eco-friendly economic development*". Dr. Garg in his lecture explained the biodiversity versus bioresources and gave a detailed description about the Medicinal plants of Himalayan region and informed that presence of about 1748 medicinal plants (32.2% of India) that could be used for drug discovery. He also pointed that a total of 97 agriculture and 17 horticulture crops are grown in Uttarakhand while total 67 wild fruits and 27 vegetable are edible. He also highlighted the importance of *Eleusine coracana* (maida) which is an excellent model crop for- infant children, diabetics, women and contract farmers and *Fagopyrum esculentum* (kuttu) which is a good antioxidant, high lysine content, good for type 2 diabetes. He also informed about the benefits of Gahat which is good for kidney stone.

The second lecture of this session was delivered by Dr. Sumar Singh, Ramalingamswamy Fellow, New Delhi on the topic "*Western Himalayan States as ideal destination for developing biotech products/recombinant vaccines: Building biotech clusters on a public-private partnership model-Taking Anthrax vaccine: From clone to clinical trial as case study*". Dr. Singh in his presentation stressed on the public-private relationship for drug discovery. He further discussed about the potential of biowarfare agents and genes useful for vaccine development. He also informed that Mice are not good animal model for study of Anthrax while Guinea pig is more suitable.

The third lecture in this session was delivered by Dr. Absar Ahmad, Scientist, NCL, Pune on the title "*Biological Synthesis of Inorganic Nanomaterials and their Applications in Imaging, Diagnosis, Therapeutics, Agriculture and related sectors*". Dr. Ahmad informed that the Nano particles have been isolated from different fungi along with many other important molecules current research is now being focused for

increasing production in crop plants using nanotechnology approaches; development of smart treatment/delivery systems. He further informed that the biosynthesized nanoparticles of Bismuth could be synthesized at room temperature as against chemically synthesized particles.

In the second day of program, the details of the three core brain storming sessions which covered the areas of biotechnology, bioinformatics and nanotechnology are as follows:

Multi-disciplinary approaches in biotech research for agri-food, nutritional and health security

The biotechnology session "Multi-disciplinary, Approaches in Biotech Research for Food, Nutritional and Health security" was convened by Dr. J. Kumar, Dean, (Agriculture) and co-convened by Dr. H.S. Chawla, Head, Genetics and Plant Breeding along with Dr. N.K. Singh of NRCPB, New Delhi and Dr. Sanjay Kumar of IHBT, Palampur as Chairman and Co-chairman respectively. Dr. Sandeep Arora and Dr. Dinesh Pandey of MBGE, GBPUA&T, Pantnagar were the rapporteurs of this session. There were over all 6 presentations in his session and the glimpses of each of the presentations are described as follows.

The first presentation of this session was given by Dr. N.K. Singh on the topic "*Potential of Genomics for utilization of Himalayan Bio resources*". Dr. Singh enumerated the various advances in Genomics that have resulted in development of various high throughput molecular markers such as SNP's, or indels which should be used to characterize genetic diversity of hill states. He further emphasized that Next generation sequencing should be used for genotyping and transcript profiling of important medicinal and aromatic plants of North- Western Himalayan states. This would help in characterizing and cloning of important genes which can move across the species through genetic transformation for successful deployment into crop species.

The next presentation was delivered by Dr. Sanjay Kumar of IHBT, Palampur, Himachal Pradesh, entitled "*Harnessing niche specific plant biology in western Himalaya for value addition*". He informed that plants experience and get adapted to harsh environment at high altitude, and hence the genes in those plant species are expected to impart higher tolerance to stress. Such genes can be transferred to the crop plants to engineer stress resistance. The effect of climate change such as elevated CO₂, temperatures etc. should be studied at the level of genes and secondary metabolites production in the plants. Biotechnological approaches should be used to investigate the molecular mechanism of secondary metabolite biosynthesis and the relevant genes could be transferred in to crop plants for their molecular pharming.

Dr Partha Roy of IIT, Roorkee in his presentation entitled "*Plant based medicines: their prospects and*

future towards the development of pharmaceuticals and nutraceuticals for ailment of various diseases: a case study of cancer" described the use of phytochemicals which lowers the risk of cancer development in humans via for example, radical scavenging, anti-oxidation, anti-inflammatory and anti-proliferative mechanisms. Biodiversity can be exploited for development of phytochemicals whose efficacy for therapeutic purposes can be assessed by using *in vitro* and *in vivo* approaches. After discovery, phytochemicals can synergize with cytotoxic drugs, to develop novel chemo-preventive compounds which increase efficacy of drugs and lower the toxic side effects on normal cells and development of drug resistance.

Dr. Owais from AMU, Aligarh in his presentation entitled "*Himalyan Hearbs: Harnessing their potential for development of Bio-pharmaceuticals*" informed about the various uses of medicinal plants. He described about a plant origin compound - Picroliv, isolated from the root and the rhizome of *Picrorhiza kurroa* or kutki, contains iridoid glycosides which have immunomodulator properties. It stimulates T cell proliferation, antibody production and strengthens killing mechanisms of macrophages. It can be used along with antimalarial chloroquine to control drug resistant *Plasmodium yoelii* infection. He suggested *Withania somnifera*, *Tridax procumbens*, *Tinospora cordifolia*, *Taxus wallichiana*, *Randia dumetorum*, *Piper longum*, *Epilobium angustifolium*, *Emblica officinalis*, *Eclipta alba*, *Curcuma longa*, *Curculigo orchioides*, *Chlorophytum borivilianum*, *Chlorella vulgaris*, *Centella asiatica*, *Caesalpinia bonducella*, *Boerhaavia diffusa*, *Baliospermum montanum* can also be utilized for extraction of immuno-modulatory compounds.

Dr Prabodh Trivedi from National Botanical Research Institute, Lucknow delivered the presentation entitled "*Secondary plant product pathway elucidation and engineering to improve crop productivity and human health*" in which he stressed the use of Genomics and genetic engineering based strategies to scale up biosynthesis of secondary metabolites in medicinally important plants of Himalayan states or develop strategies for the synthesis of these molecules in heterologous systems through metabolic engineering. He further stressed that Transcriptome analysis or analysis or generation of EST databases from different chemotypes of medicinal plants will help in pinpointing key candidate genes or enzymes involved in biosynthesis of secondary metabolites. These genes can be up-regulated or down regulated in medicinal plants by genetic engineering methods for pathway engineering leading to enhanced synthesis of secondary metabolites. Alternatively the metabolic pathway can be engineered in other heterologous transgenic plants to produce value added products.

Dr. Anil Kumar Coordinator Pantnagar Biotechnology Programme has emphasized that finger millet has

certain very important properties such as abiotic stress tolerance, rich source of non-available carbohydrates with low glycemic index hence beneficial for prevention of diabetes and cardio vascular diseases, exceptionally high levels of minerals like Calcium, chromium, zinc, copper and magnesium, high content of good quality protein and delay ageing by reducing glycosylation of body proteins. Association mapping can be carried out to identify molecular markers linked with important quality traits of ethnic crops. It will help in identification of QTL regulating these traits which can subsequently be transferred in normal cultivated crops. Use of various functional genomics techniques along with bioinformatics tools and softwares, can be used in isolation and characterization of nutritionally rich genes and proteins which will help in prevention and therapy of complex nutrition-related disorders by the knowledge-based discovery or design of functional foods. The transcriptome of finger millet developing spike has been sequenced through Illumina pair end sequencing. This will accelerate high throughput data mining of gene and regulatory sequences and will lead to better understanding of the mineral accumulation pathways and thereby use of such gene(s) and protein(s) in transgenics approaches. Finger millet also contains high protein, with prolamins being the major seed storage proteins. Identification and isolation of a seed specific prolamins gene promoter has been done through 'genome walker' technique. He further elaborated that there is absolute need of genomic research on agriculturally important plants and under utilized crops which can be harnessed for nutraceuticals, pharmaceuticals and cosmaceuticals purposes and it can be achieved through Hi-Through put next generation genome sequencing platforms.

Dr. Nazir Ganai of SKUAST-Kashmir Shuhama, Srinagar described about the Bioeconomy which refers to the set of economic activities relating to the invention, development, production and use of biological products and processes. These benefits are expected to improve health outcomes, boost the productivity of agriculture and industrial processes, and enhance environmental sustainability. DBT should form a team, with partners in government, industry and academia, to assess how pervasive biotechnological applications are likely to improve the economy of Himalayan states. The team shall formulate a project to design a bio-economy policy agenda for the country vis-a-vis the Himalayan states in particular, and shall examine the potential impact on economies and societies, and most importantly, the policies needed to promote and exploit this new wave of innovations to promote high-level social and economic goals. The project shall also evaluate the potential impact of biotechnologies and biosciences on the economy and identify those areas where public policy can be effective in removing barriers, encouraging innovation, and improving understanding and co-operation among the various stakeholders. Biotech schools, Biotech hubs, Biotech parks should be established in the hill states to disseminate the knowledge about Nano, Bio and

informatics to address the problems / challenges under temperate and cold desert conditions.

Bioinformatics for documentation of Himalayan bio-resources and discovery of novel molecules.

The bioinformatics session was entitled as "Prioritizing Research Areas on Bioinformatics for Documentation of Himalayan Bioresources and Discovery of Novel Molecules". In this session, R.S. Chauhan, of Jaypee University of Information Technology, Waknaghat, Solan and Dr. Mukesh Jain, NIPGR, New Delhi were the Chairman and Co-chairman of this session along with Dr. S.D. Samantray and Dr. Gohar Taj as Convenor and Co-Convenor respectively and Dr. Monendra Grover, NBPGR, New Delhi and Dr. Vikram Singh Gaur of MBGE, GBPUAT, Pantnagar were the rapporteurs of this session. There were over all 4 presentations in this session and the crucial points of each of the presentations are described as follows.

Dr Kushwaha in his presentation has emphasized that Indian sub-continent is known for its diverse bioclimatic regions and harbours rich flora and fauna. The continent is a confluence point of three major terrestrial bio-geographical realms (*viz.*, the Indo-Malayan, the Eurasian, and the Afro-tropic and is ranked as one of the 12 mega-biodiversity countries in the world with 49,219 plant and 89,451 animal species. According to an estimate, about 30% plant species are endemic to India. In order to inventory, analyze, prospect and conserve the vast Indian bio-resources, a large number of organizations are generating enormous datasets. It was realized that these datasets from diverse geographic areas need to be networked in such a manner that the large variety of databases can be made seamlessly accessible. The developments in the information and communication technology have made it possible to bring such information systems in one portal. Thus, Indian Bio-resource Information Network (IBIN) was developed as single portal on Indian bio-resources, where all the databases and information systems bio-resources and biodiversity elements are brought together in an easily compatible and accessible format, initially in English but eventually in all major Indian languages

The first presentation of this session was given by Dr. A. R. Rao, IARI, New Delhi on the topic "Centre for Agricultural Bioinformatics (CABin) and its role in Agricultural Bioinformatics Research in India". He described in his presentation about high performance computing (HPC) Facility at CABin, New Delhi. He further emphasized the aim, objective and major thrust area of national facility of his centre for agricultural bioinformatics. He discussed various statistical and computational methods which are applied for several biological analyses. He further pointed out the statistical issues related with genome prediction, SNP association with disease and risk prediction, encoding algorithms and whole genome association or genome wide association analysis.

The next presentation was delivered by Dr. Mukesh Jain, NBPGR, New Delhi on “*Next Generation Genomics Approaches for the Prioritization of Indian Bio-resources*”. He described in detail about the history of DNA Sequencing and also comparison of different sequencing platforms. He informed about the applications of next generation sequencing technologies and its importance in crop improvement. He further emphasized that through next generation genomics of Himalayan bio-resources we can achieve the understanding of evolutionary relationship among plant species, identify the genes and genetic variations important for agronomically important traits and produce the secondary metabolites like vitamins, oils etc.

Dr Monendra Grover from NIPGR, New Delhi in his presentation entitled “*The new facet of nano-bioinformatics in agriculture: Quantum Computational modeling*” informed about the basis of quantum computational modeling. He described about Quantum computers, algorithms for quantum computers, digital vs quantum and principle of simulation. In their studies, he has taken the example of cold stress response. He also informed as a first step towards quantum computational modeling of the cold stress response they calculated the maximum speed of computation of the proteins involved in cold stress.

The last presentation of this session was given by Dr. Durgesh Pant of Uttarakhand Open University, Dehradun on “*IT-Initiatives for difficult geographies: Mountain IT-Initiatives*”. He described about the difficult geography of north-western himalayan states and its challenges. He discussed about the need of strengthening of societies working in inclusive IT/Bioresources, mountain IT policy and public – government gaps. He suggested that life of inhabitants of difficult geographies can be significantly improved by Mountain IT-Initiatives like Telemedicine, Health informatics, E-learning, E-education and Exploring business potential, Entrepreneurship development etc. It provides bottom-up approach as a replacement to the traditional top down approach.

Nanotechnology for enhancing the precision and efficiency of biological system

The convenor and Co-Convenor of this session were Dr. K. P. Singh and Dr. Deepa Bhagat along with Dr. K.S.Subramanian and Dr. Siddhartha S. Mukhopadhyay which were seated as Chairman and Co-Chairman respectively. Dr Rajeew Shukla and Dr MGH Zaidi, GBPUA&T, Pantnagar were the rapporteurs of this session. There were over all 5 lectures in this session and the highlights of each of the presentation are given as follows.

The first presentation of this session was given by Dr. K. S. Subramanian; Tamil Nadu Agricultural University entitled “*Nano Agriculture in North Western Himalayan States*”. Dr. Subramanian has discussed about the High Altitude Agriculture for self-reliance, early detection of

pests and diseases, nano-food systems, forestry management and medicinal nanotechnology.

The second lecture entitled “*Clay, Nanotechnology and The Himalayan Agriculture: Scaling New Highs*” was delivered by Dr. Siddhartha S. Mukhopadhyay, Punjab Agricultural University. He informed about the overview of Himalayan region, climate, organic matter content and biodiversity. Further, he emphasized that Himalayan region having good capability to provide a diversity of clay minerals for the formulation of nano particles/nano materials and this clay nano materials can be utilized for carbon sequestration, re-vegetation, slow nutrient release, water absorption etc.

Dr. Vinod Saharan, Sr. Scientist, Department of Biotechnology, MPUAT, Udaipur has presented views on “*Biopolymer based nano-materials for plant protection: an eco-friendly approach*”. He re-defined the definition of bio-nano particles up to 1000 nm instead of 100 nm in common. Further it was said that bio-nano materials have good capability to retain/load the chemicals like fungicides, nutrients, plant growth regulators for control release in the system. Use of bio-molecules is important for crop protection especially against fungal diseases and in his lecture it was concluded that Cu-chitosan nanoformulation found very promising as antifungal agent.

The next lecture was delivered by Dr. Parveen Singh, Principal Scientist, IVRI, Izzatnagar, entitled “*Nanodiagnosics: Gold nano particle based lateral flow assay test for real-time diagnosis of PPR disease of goat and sheep in Himalayan region*”. He has shared his experience on gold based biosensor for early detection of disease in animals. Nanodiagnosics are a good tool to detect diseases, monoclonal antibodies conjugates with gold nano particles. He discussed that Lateral flow assay test is a rapid sensitive specific test for detecting viruses in goat and sheep in Himalayan regions.

The last talk was delivered by Ramesh Raliya, Central Arid Zone Research Institute, Jodhpur, Rajasthan entitled “*Biosynthesis of Nanoparticles and its Application in Agriculture*”. They have collaboration with Washington State University USA for biosynthesis of nanoparticles. Furthermore, opportunities are explored by them to synthesise nano particles from bacteria, fungi and plants.

Since Nanotechnology is an interdisciplinary concept, all organizations of the Government of India such as CSIR, ICAR, DBT, DST, ICMR, and many more, should have a policy to work together, with consortia meeting twice yearly and free and open collaboration above MOUs. Since Nanotechnology is a new emerging field, it is not in the mandate of the many scattered organizations. We need funding for more basic research in Nanotechnology, especially work oriented to applied research of benefit to society.

Pantnagar Declarations on Strengthening the Efforts on Nano-Bio-Information Technology for the Development of North-Western Himalayan States

North-Western Himalayan States (NWHS) namely, Uttarakhand, Himachal Pradesh and Jammu and Kashmir, occupy 331,393 square Km of area, harbour ~25% of Biodiversity that is critical to the socio-economic development of ~30.0 million people residing in these states. Recognizing that there are many challenges and issues that are common to these states and application of modern science and technologies can accelerate the eco-friendly harnessing of the rich bio-resources with these states, a two day brain storming session on the topic “Strengthening the Efforts on Nano-Bio-Information Technology for the Development of North-Western Himalayan States” was organised by Department of Molecular Biology and Genetic Engineering, College of Basic Sciences, G.B. University of Agriculture and Technology, Pantnagar, with active support from Department of Biotechnology, Govt of India, Uttarakhand Council of Science and Technology, Ministry of Environment and Forest Govt of India. Sixty two eminent experts from various National organizations and Industry Participated and deliberated intensely to converge on following recommendations which are being documented and released as:

1. First and foremost, in order to ascertain that the rich Himalayan bio-resources are utilized to usher optimized and sustained economic development of people of the Himalayan states, there is need to fully catalogue and characterize the existing biodiversity with complete descriptor data for genotypes and chemotypes in digital database.

It is therefore recommended that a network project involving natural scientists, IT scientists, bioinformaticians and molecular biologists is created that would facilitate current ground truth of bio-resources and promote bioinformatics interventions for bioresource organization in a usable and sharing format. It will have following mandate.

- *Identify and make a consortium of scientists for north-western Himalayan states (NWHS) and be provided with necessary financial and infrastructural support to evolve and develop a pattern of inventorization approaches based on functional attributes of species of plants, animals and microbes in NWHS as well as define the rules for their judicious exploitation.*
- *A coordinated project should be created with scientists from diverse field and expertise to forge defined sub projects so that a catalogue of all the bio-resources, genotype, chemotype and ecotype to be compiled with required validation on ground. Initial catalogue could be compiled from the information available in literature and with Botanical Survey of India.*

2. It is apparent that sophisticated Bioinformatics based interventions need to be developed and used for recording, digitization of huge bioresource information and for compiling genomic information for identification of novel genes and ensure user friendly access and need based reporting.

Hence, it is recommended that a bioinformatics grid be developed for NWHS to have facilitated access to this holistic information for collaborating scientists, scientific institutions in their quest to harness the huge bioresources through nanobioinformation technologies for the development of agri-food-nutrition and pharma sectors in these states.

3. It is not enough that only information is compiled but also that there is scientific and sustainable exploitation of these resources. To harness the huge potential of these bioresources application of modern sciences such as nanotechnology, biotechnology and bioinformatics can make things amenable to get accelerated. It is recognized that appropriately trained scientists/faculty are lacking in these states,

Therefore it is recommended that to fill this gap in quality and skilled human resources few centres of excellence should be recognized for training existing man power with special incentive schemes for faculty and student exchange and fellowship be created for new entrants so that the good infrastructure and facilities that are to be created in the network project are fully utilized to achieve the envisaged objectives in this project.

4. The wealth of state that can be used for rapid development of Agriculture, biomedicine and industry is not restricted to biodiversity per se but also in the genes and metabolites that are unique to some of these bioresources based on ecology of these plants. It is imperative that these genes are mined properly and would again need appropriate technological interventions. Therefore it is strongly recommended that development of various functional genomics techniques along with bioinformatics tools and softwares which are prerequisite for isolation and characterization of nutritionally important genes and proteins which would help in prevention and therapy of complex nutrition-related disorders by the knowledge-based discoveries and designing functional foods be taken on priority.

Therefore, it is recommended that whole genome sequencing of priority species of these states have to be done in order to get huge genomic information for making sense and heritage rights accordingly. Genomics and genetic engineering based approaches will help in cloning and characterization of agronomical important genes which can enhance agricultural productivity. Biotechnological methods should be complemented with

nanotechnology and bioinformatics to enhance the output.

5. A policy prioritization to strengthen the frontier sciences will enable the states to achieve inclusive growth. Applications of frontier sciences and technologies will not only be helpful in managing the challenges of food and nutritional security in these states but will promote the growth of agriculture, biomedical and industrial sectors in these regions.

It is recommended that development of network projects in NWHS zone in order to address issues of food, nutritional and ecological security will greatly accelerate the progress in this direction.

6. Nanobiotechnology is an emerging field which would find increasing applications in the development of nanopesticides and nanoherbicides, nanofertilizers, nanosensors, nanofeed additives, smart drug- delivery system, nanocoatings, zeolites for water retention, enhanced barriers to microbial contamination or spoilage, detection of food-borne pathogens or spoilage organisms, nano based veterinary treatments, removal or detoxification of harmful pollutants. An emphasis on purposeful development of nanotechnologies will go long way in making states healthy, pollution free and advanced in food and nutritional security through better food processing.

It is recommended that each state may identify the principal area in which nanobiotechnology is more crucial for its socioeconomic development. An Advanced Institute for Research and Education in Nanobiotechnology be set up in each state and mandated with different area and thereafter networked for integrated development of NWHS

7. Nano-bio-information technology can be utilized to strengthen basic research regarding the impact of climate change on horticultural crops using controlled environmental facilities, simulation models, analysis of past weather data and its integration with productivity changes (including extreme events). The need and knowledge driven nano-bio-information technology programme with

finest state-of-art equipments and facilities will significantly contribute in enhancing the agricultural productivity and expedite to solve need based research problems as well as industrial development in the hill States.

It is recommended that an empowered task force be created with defined budget and objectives to promote applications of nano-bio-information technologies through grant of objective specific peer reviewed projects.

8. Finally, it was felt that with time many technologies would develop which would be of interest for entrepreneurship and development.

Therefore it is recommended that a common website be created with participation of all collaborating institutions and centres and it should provide all the information and opportunities in this field as well as a dynamic list of all the potential technologies that are available throughout the region. Initially this site can be used to compile and display the existing information and status.

Details about the organization of 'Brainstorming session' can be found at the URL

http://cs.gbpuat-tech.ac.in/conference_management/node/67 and detailed report along with photographs of 'Brainstorming session' is available on URL <http://www.gbpuat-cbsh.ac.in/>

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