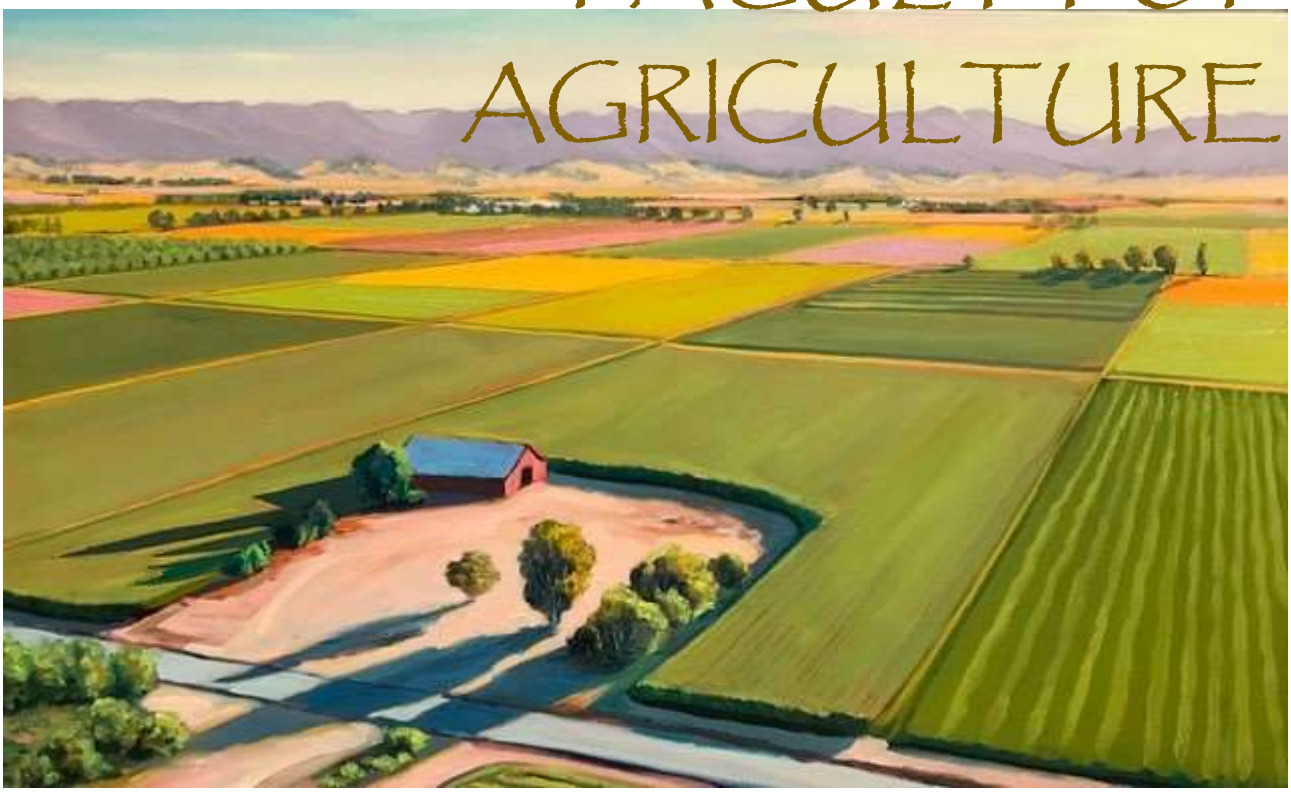
ANNUAL REPORT-NEWSLETTER
2018-2019

FACULTY OF AGRICULTURE



Volume 1 | Issue 2

Faculty of Agriculture

Sri Sri University, Bidyadarpur Arilo, Cuttack 754 006 Odisha

President's Message

I am pleased to learn that the Sri Sri University Faculty of Agriculture is publishing an in-house newsletter highlighting activities undertaken during the academic year 2018-2019. I am equally pleased that Faculty of Agriculture has set a benchmark in terms of building an effective platform for education and outreach program in Agricultural sciences. It has seen growing demand for student enrolment to various programs. It is a promising beginning to build a centre of excellence in agriculture at Sri Sri University.

In the background of India being predominantly agrarian economy, next generation of youth abandoning the agrarian profession is debated at various levels. The data indicates that this trend is nowhere close to changing. In view of this, modern agriculture has seen many challenges to sustain profitable economic growth at regional and national levels. Few of the current problems faced by the agriculture sector include; sub optimal productivity, loss of soil and water resources of agricultural landscapes, non-availability of cost effective and affordable technology, inefficient markets, poorly organized supply-demand market linkages. Evidently, the daunting task is how to achieve reverse migration of youth to practice agriculture so that we protect traditional farming that is linked to livelihood systems in order to build sustainable rural economy.

The program of Faculty of Agriculture has gained momentum to achieve excellence in education in agricultural sciences. We have focused approach to develop necessary infrastructure, human resources and support logistics to facilitate effective learning environment.

We are also planning to initiate newer programs and diploma courses to create skilled human resources at various levels. Likewise, we also propose to build platforms to enable research and doctoral degree programs in the Faculty of Agriculture. In addition, Faculty of Agriculture is also on course to plan and administer outreach programs to benefit the society at large.

I must congratulate Dr. Kumaraswamy, Dean, Faculty of Agriculture and his team working tirelessly to establish this faculty as a global centre of excellence.

I am confident that Faculty of Agriculture will grow to become an institution of eminence in education, training and outreach programs with significant contribution to agriculture sector at regional scale in our home state of Odisha and at the national level in India.

I wish that our Faculty of Agriculture consistently provides quality education to build the necessary competencies amongst the students and also provide focused experiential learning. I am glad that the teaching philosophy already adopted is helping in the overall personality development of our student community in a spiritually enabled learning environment.

I wish to see that Faculty of Agriculture grows to be world renowned centre of excellence.

My best wishes for all your future endeavours.

Mrs. Rajita Kulkarni

President
Sri Sri University

Vice Chancellor's Message

I am delighted to learn that Faculty of Agriculture is making progressive growth within a short period of its existence in the University. I place on record with great pleasure that the faculty is striving to achieve excellence in providing quality education with more focus on experiential learning. It is visible now with highest demand ratio for admission to the programmes offered by Faculty of Agriculture. Moreover, Faculty of Agriculture has already evolved as best-choice among the applicants planning to pursue studies at Sri Sri University. It has already positioned itself in attracting more number of applicants within 2 years of existence. We proudly celebrate the prospects it is bringing to us and support to promote in the future to achieve excellence.

Faculty of Agriculture has streamlined course curriculum as per ICAR guidelines with addition of innovative courses to provide exposure to students on inter-disciplinary courses. Likewise, necessary infrastructure- independent buildings with smart classrooms, laboratories and logistics to facilitate effective teaching and experiential learning are being added to facilitate effective teaching learning process. Besides, plans to develop farm to support education and research is in the stages of planning.

We are also adding faculty members with specific expertise at regular intervals. We are striving to build coherent meritorious faculty members in the Faculty of Agriculture and in 2019 we have added the maximum number of experienced Faculty members. Currently, faculty members have done commendable contribution in streamlining the teaching and learning process with plans of initiating funded research and outreach programmes.

Various departments will also be created to achieve excellence in each discipline with dedicated laboratory and adequate faculty members in various disciplines. We have established laboratories suitable for teaching the undergraduate students.

We also propose to initiate new programmes – B. Sc. (Hons.) Food Nutrition and Dietetics and Diploma **in** Agricultural Technologies and Entrepreneurship. Likewise, doctoral programmes will be initiated with an invite to prospective candidates to enroll from the academic year 2020.

We welcome and invite every young inquisitive mind interested to professional career in agriculture to join Faculty of Agriculture at Sri Sri University and also experience the spiritually enabled learning environment.

It is with immense pleasure, I look forward to welcoming you to the happiest divine campus of Sri Sri University and wish you a happy learning and meaningful future endeavours.

Prof. Ajay Kumar Singh

Vice Chancellor
Sri Sri University

Dean's Message

Dear student community,

It is with great honor and pleasure; I welcome you all as we progress to the academic year 2019-2020.

The SSU campus and community are eager to receive our returning and newly enrolled students from all over India. We have made sustained efforts to develop quality and value based education environment to strengthen your academic and experiential learning. Our goal is to engage you in the classroom in interactive learning and real-time examples in field and laboratory to provide pragmatic learning to prepare as skill ready professionals in your respective programs. The challenges faced in the rapidly evolving world, we have pledged to emphasize to deliver quality education that would enhance subject area knowledge, pragmatic skills and promote transformation and professional outlook of students. We are committed to enabling and stimulating learning environment and experiential education to combine creative thinking, innovation, entrepreneurship and overall personality development.

We are delighted to have a meritorious group of regular, adjunct and visiting faculty members with expertise in specific discipline that will engage all students in a dynamic and interactive classroom environment. Our teaching philosophy has been to engage students to actively take part in the learning process, while investing all efforts to be a critical learner and responsible student.

We have launched a series of exciting campus activities, leadership learning events, exposure field tours, community engagements, internship and rural initiatives. Students will make sincere effort to recognize and engage so that learning happens various levels from faculty members, peers and community.

It is also imperative that students must enjoy the campus life and classroom challenges while building friendships of a lifetime and nurturing a community feeling amongst themselves as they evolve to be an informed professional and a responsible citizen.

I am deeply grateful to all student community for inspiring me and colleagues with your presence and genuine interest to excel in your education at Faculty of Agriculture. I am looking to build an academic group with family values and ethical behaviour to facilitate holistic contribution to achieve excellence.

I look forward to working with you all. I welcome you to Faculty of Agriculture.

Prof. S. Kumaraswamy Ph.D.

Dean and Head, Faculty of Agriculture

We are growing

Faculty of Agriculture is expanding its disciplines with new programs. Currently, faculty has successfully integrated on-going programs- B.Sc. (Hons.) Agriculture and B.Sc. (Hons.) Horticulture. These programs are streamlined now with focused establishment of required infrastructure for education and field scale hands on experiential learning.

Besides, B.Sc. (Hons.) Agribusiness program is also initiated from the academic session 2019. The program has balanced course from technical topics of agricultural disciplines and business management. The program has unique-inter-disciplinary curriculum to attract and create human resources with informed technical knowledge on agriculture and management disciplines.

Faculty of Agriculture also planning to propose the program B.Sc. (Hons.) Food Nutrition and Dietetics from the academic calendar 2020. Likewise, 1 year-diploma course is also in the making to be offered from the

academic session 2020. The Faculty of Agriculture has plans to initiate Doctoral program in all the discipline with major focus on problem solving research and innovations.

Now, faculty members are being added with specific expertise to strengthen the academic and research program. Faculty of Agriculture has seen a promising growth with several academic and allied initiatives to promote quality education and experiential learning.

Newer courses are being designed and added to curriculum to integrate inter-disciplinary topics. Likewise, the student centric approach is incorporated into informal curricula with counseling sessions to understand the psychological issues relevant to learning process to help students to realize their academic potential. Students are also encouraged to participate in the extra-curricular activities, while they learn the leadership abilities and inter-personal skills to inculcate overall personality development.

Guest lectures/talks

A guest lecture by Dr. Vanadana Shiva was organized on August 12, 2018 on Natural Resource Scenarios of sustainable and industrial farming. The topics of the guest lecture provided insights on role of activism to protect the natural resources, genetic resources of various agro-ecosystems, involvement of youth agriculture. Besides, Dr. Vandana Shiva also briefed on her journey of becoming an activist to support the cause to protect the natural resources.

An insight on the 'First responder on medical emergency' was demonstrated by Mr. Vimal and colleague on October 5, 2018. The course content included how one can overcome several accidents that happen unannounced while working and type of precautionary measures should be exercised when working in the

field. Students were largely benefitted by way of accruing knowledge on techniques, methods and tools used in emergency scenarios.

Several students participated in inter-disciplinary seminar and also competitions.

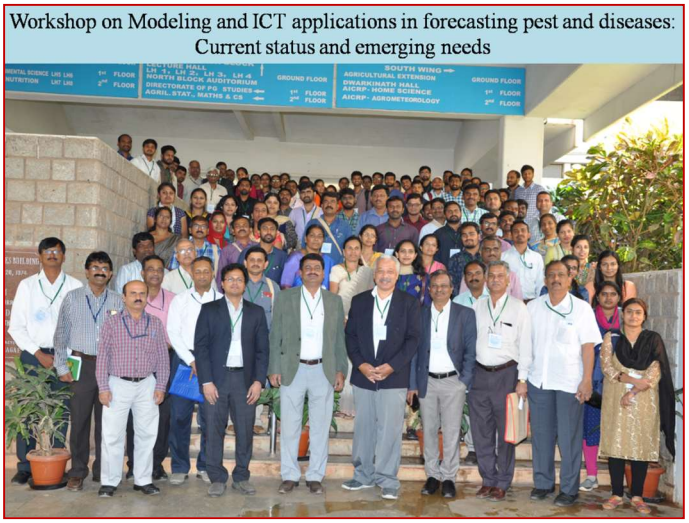
Participation in conference/workshop/FDP

1. Prof. S. Kumaraswamy participated in the International Conference on '**Emerging Scenarios in Agribusiness**', held at Indian Institute of Plantation Management, Bengaluru, March 21-22, 2019.

2. Mr. Snehashish Routry participated in the International Workshop on **'Modeling and ICT Applications in Forecasting Pest and Diseases: Current Status and Emerging Needs'** University of Agricultural Sciences, GKVK Campus, Bengaluru, February 12-13, 2019

3. Ms. Mandakini Kabi participated in '**Faculty Development Program for student Induction'** conducted by AICTE from, at ITER, SOA University, July 6-8, 2019

4. Ms. Suvalaxmi Palei participated as adjudicator in flower show held at Flower show at LR DAV Public School, Gandarpur, Cuttack, February 8, 2019



5. Mr. Prajjal Dey acted as organizing committee member of the National Conference on '**Challenges and Innovative Approaches in Agriculture and Allied Sciences Research, 2019.**

6. Mr. Prajjal Dey presented a research paper in National Conference on **'Challenges and Innovative Approaches in Agriculture and Allied Sciences Research**', Salem, Tamilnadu, July 26-27, 2019.

Recognitions/Awards

Mr. Snehashish Routry, Assistant Professor (Entomology) is a recipient of 'Young scientist' award by Madhumitha Fundation, Telengana

Mr. Vendant Dale, Year 3 student of B.Sc. (Hons.) Agriculture was adjudged as winner in Odisha Innovation campaign conducted in the Sri Sri University.

Publications

Anuj K.M, Sudhir N, Chinmayee M, and Ramesh C. 2018. Antioxidants elevates the resistance to Cercospora canescence in interspecific cross of Vigna radiate (Kopergaon) × Vigna mungo (Pant Urd 31)'. *Indian Phytpathology*

Anupama Singh, J.P. Jaiswal and Saurabh Badoni. 2018. Enhancing rust resistance in wheat through marker assisted backcross breeding. *Indian Journal of Genetics and Plant Breeding*, 78(1): 19-25.

Dey, P Diptanu Datta, Debanjana Saha, Selukash Parida and Darshan Panda. 2019. Plant-Endophyte Interaction and Its Application to Abiotic Stress Management of Crop Plants. *Int. J. Curr. Microbiol. App. Sci*: (doi.org/10.20546/ijcmas.2019.807)

Dey, P., Panda, D., Biswal, M., Behera, L., Baig, M.J., Nayak, L., Sharma, S., Samantaray, S., Ngangkham, U. and Kumar, A., 2019**.** Low Light Mediated Growth Responses in Rice: Implications for the role of photoreceptors and challenges *Journal of Pharmacognosy and Phytochemistry* **(*Accepted*)**

Dey, P., Panda, D., Dash, D., Kumar, A., Rout, G., and Baig, M.J., 2019 Understanding the mechanism of LL stress in rice-Current trends and future perspectives. *Plant Physiology and Biochemistry* (***Communicated***)

Kabi M, Baisakh B, Dash M and Tripathy S. K. 2019. Phenotyping of sesame (*Sesamum indicum* L.) genotypes for powdery mildew resistance. *Journal of Pharmacognosy and Phytochemistry* 8 (3): 1865-1867.

Kabi, M., Dash, M., Baisakh, B. 2018. 'Manipulation of Chromosome through wide hybridization for genetic enhancement of crop**'.** *In:* National Genetics Congress (NGC) 2018 on 'Genetics for Sustainable Food, Health and Nutrition Security'.

Kesawat, M.S., Shivaraj, S.M., and Kumar, M. 2019. Metalloid and their Role in the Biological System. *In:* Role of Metalloid in Plants. Wiley, USA (***Communicated***).

Kim, S.H., Vieira M., Kim, H.J., Kesawat, M.S., and Park, H.Y. 2019. MS2 Labeling of Endogenous Beta-Actin mRNA Does Not Result in Stabilization of Degradation Intermediates. *Molecules and Cells* 42: 189.

Kumar, A., Panda, D., Biswal, M., Dey, P., Behera, L., Baig, M.J., Nayak, L., Ngangkham, U. and Sharma, S. 2019. Low Light Stress Influences Resistant Starch Content and Glycemic Index of Rice (O. sativa L), *Starch-Stärke*,; p.1800216.

Palei S, Rout, G. R. and Dash D.K. 2019. Molecular and morphological assessment of Papaya (Carica papaya), *Research Journal of Biotechnology*,14 (1) 63-70.

Palei S, Dash, D.K., Rout, G.R., 2018. Biology and Biotechnology of Papaya, an important fruit crop of tropics: A Review, *Vegtos*, 31 (4) 1-15.

Palei S, Dash, D.K., Rout, G.R. 2019. Standardization of in vitro protocol for plant regeneration of Carica papaya cv. Co8 through indirect organogenesis, *Journal of Pharmacognosy and phytochemistry*, 8(3): 1954-1956.

Panda, D., Biswal, M., Behera, L., Baig, M.J., Dey, P., Nayak, L., Sharma, S., Samantaray, S., Ngangkham, U. and Kumar, A., 2019. Impact of low light stress on physiological, biochemical and agronomic attributes of rice. *Journal of Pharmacognosy and Phytochemistry*, *8* (1), pp.1814-1821.

Routray, S and Misra, H.P. 2019. Studies on Persistence toxicity of Thiamethoxam 25 WDG, Imidacloprid 17.8 SL and Dimethoate 30 EC against *Aphis craccivora* Koch. in Cowpea. *Journal of pharmacognosy and phytochemistry*.

Santosh, J.P. Jaiswal, Anupama Singh and Naveen Chandra Gahatyari. 2019. Assessment of genetic diversity for terminal heat tolerance in bread wheat (*Triticum aestivum* L. em. Thell.). *Journal of Pharmacognosy and phytochemistry*, 8(1): 2572-2579.

Santosh, J.P. Jaiswal, Anupama Singh and Naveen Chandra Gahatyari. 2019. Genetic diversity analysis in bread wheat (*Triticum aestivum* L. em. Thell.) for yield and physiological traits. *International Journal of current microbiology and applied sciences*, 8(2): xx-xx

Experiential learning and extracurricular events

Faculty of Agriculture organized several experiential learning and extra-curricular activities during the academic period 2018-2019. Our goal has been to implement experiential learning as part of the curricula to expose students to acquire practical skills. Likewise, extracurricular program were also conducted to encourage to constantly acquire inter-personal skills and promote individual talents.

Tree planting (August 5, 2018) – All students of B.Sc. (Hons.) Agriculture and B.Sc. (Hons.) Horticulture were initiated to the beginning of the semester by tree planting on the campus. All the students enthusiastically participated in tree planting and shared comraderies.

Students also visited Pir Jahania as part of educational and picnic activity on Jan. 5, 2019. Likewise, B.Sc. (Hons.) Horticulture students also visited the horticultural crops exhibition and flower show held in Bhubaneswar on January 12, 2019.







2018-8-1





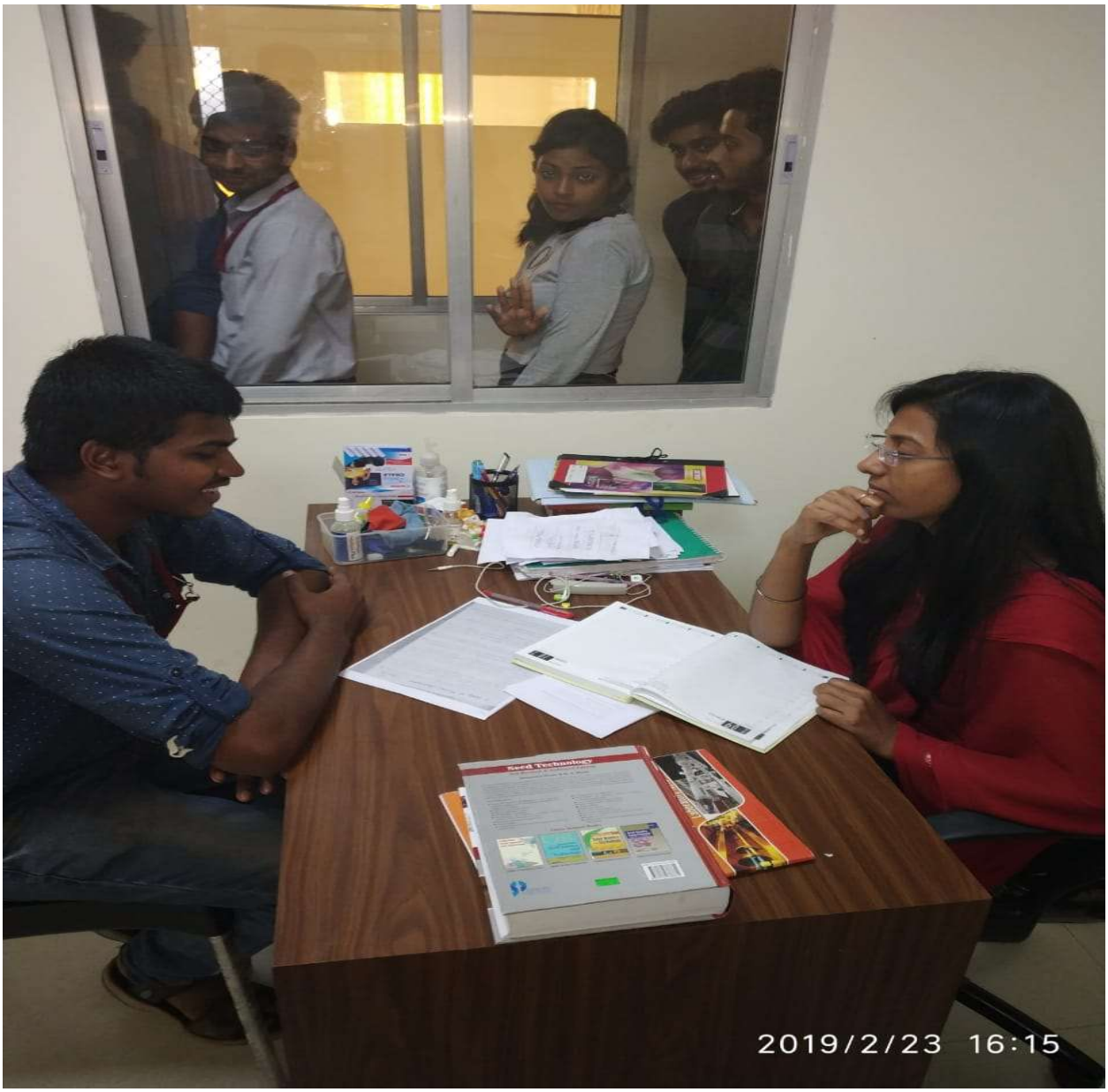

Students were exposed to several experiential learning during the academic session. Likewise, students also participated in extra-curricular activities like sports and cultural programs.








As part responsible education activities, faculty of Agriculture has been practicing Parent-Teacher-Student interactive session to understand the methods improve the learning process and effectively administer the student ready teaching activities. Likewise, we also pay attention individual students needs through streamlined student counselling program. Each faculty member interacts with each student to understand and address individual students learning needs.



Students also participated in sports, cultural and tree plantation activities as part of Farmer's Club, besides, outreach activities.

Faculty of Agriculture is striving to achieve excellence and also initiate new programs in academic year 2020.

Infrastructure and facilities

Faculty of Agriculture is making a strategic plan in developing infrastructure, laboratory, farm and logistics support the education and experiential learning. Few of the facilities, instruments and material

logistics, we have created include well-equipped laboratory with flame photometer, PCR, Gel documentation system, Laminar flow, Autoclave, BOD, Double distillation unit, Hot plate, Automated weather station, Universal pan evaporimeter, Refractrometer, pH and Eh meter, Hot air oven, Insect curation system, Hydrometer, Vortex mixer, Waterbath, Micro-Kjeldahl distillation unit, Microscopes, penetrometer, Stage micrometer, Digital colony counter, Chlorophyll meter, Centrifuge, Camera lucida, Desiccators, Electronic precision balances, Fridge, Munsell colour chart, glasswares and laboratory logistics. Microwave oven, orbital shaker, deep freezer, cryocan, corking and cap sealer, juice xtractor, dehydrator, germinator, lab soaker, micro centrifuge, muffle furnace, moisture meter, tensiometr, Kel Plus nitrogen analyzer.

Likewise, field cultivation tools viz., Mouldboard plough, Desi plough, Cono weeder, Seed drill, Knapsack sprayer etc. Besides, tools and minor equipment's required for field scale work.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B. O. D. INCUBATOR
ACCUMAX INDIA


RESET
DIGITAL COLONY COUNTER


LAB HEATING PLATE


Flame Photometer 128
FPM COMPRESSOR 126


LAMINAR AIR FLOW BENCH


FALCON
BUDDING
GRAFTING
KNIFE
FGK-50

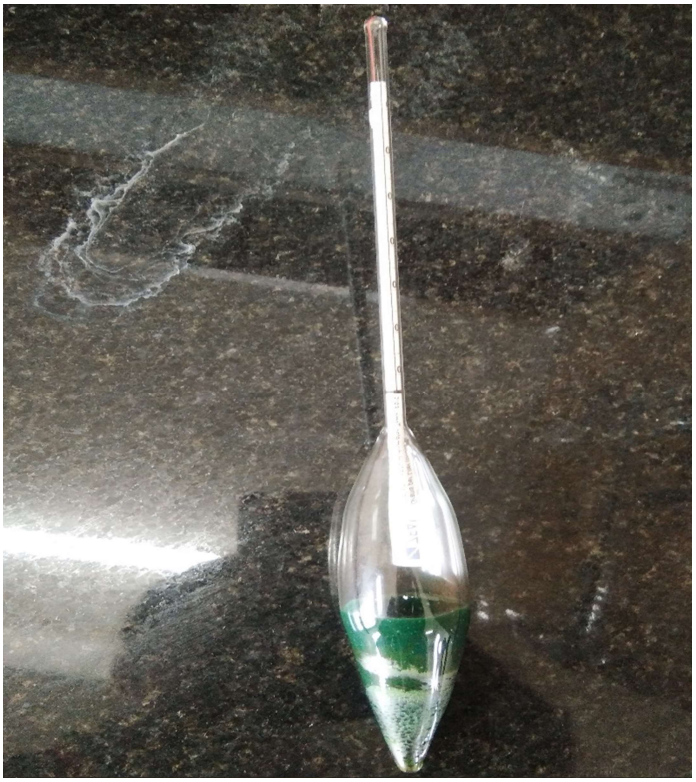

FALCON
Garden Tools
PRUNING
SECATEUR
SUPER


MUNSELL SOIL COLOR BOOK


VERTEX
VERTEX SCIENTIFIC & LAB INSTRUMENTS CO.


ATC


D.A.P.S.
CONTROLLER



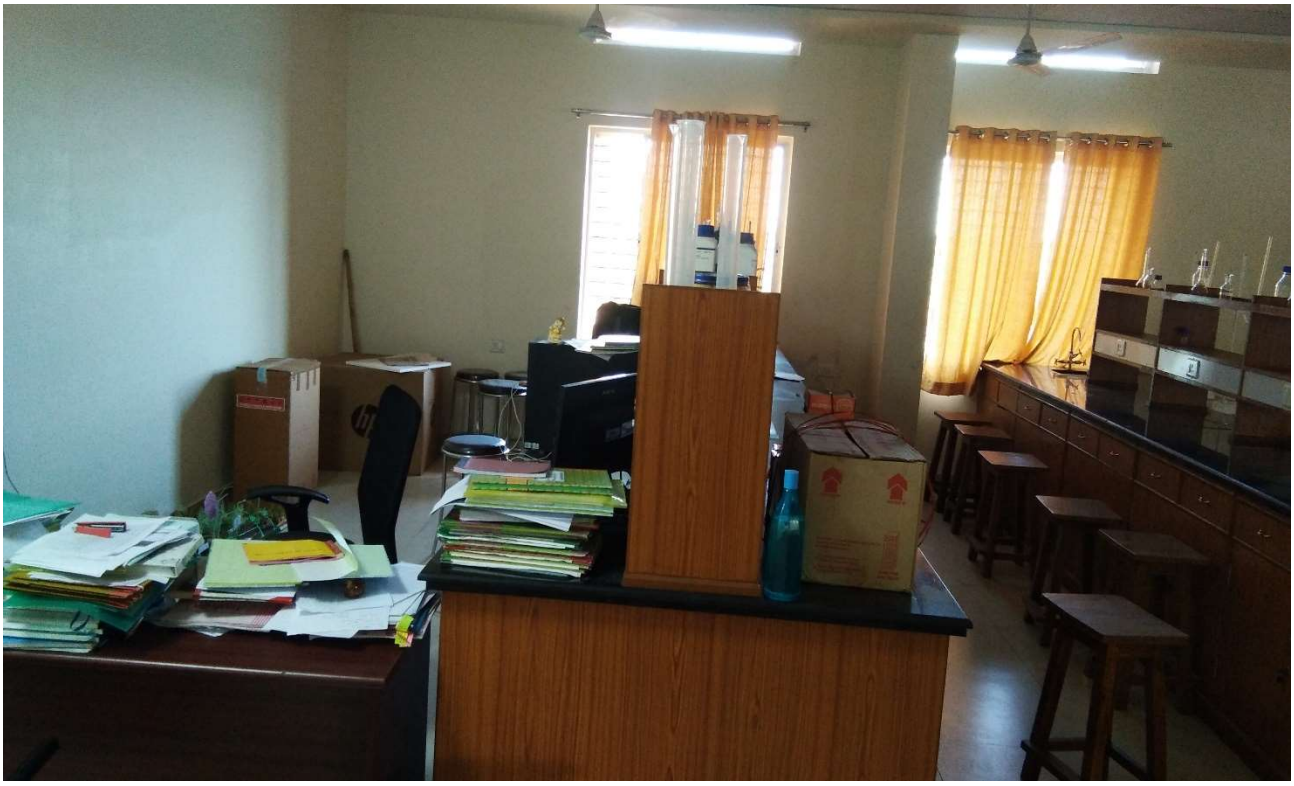

Digital pH Meter 335

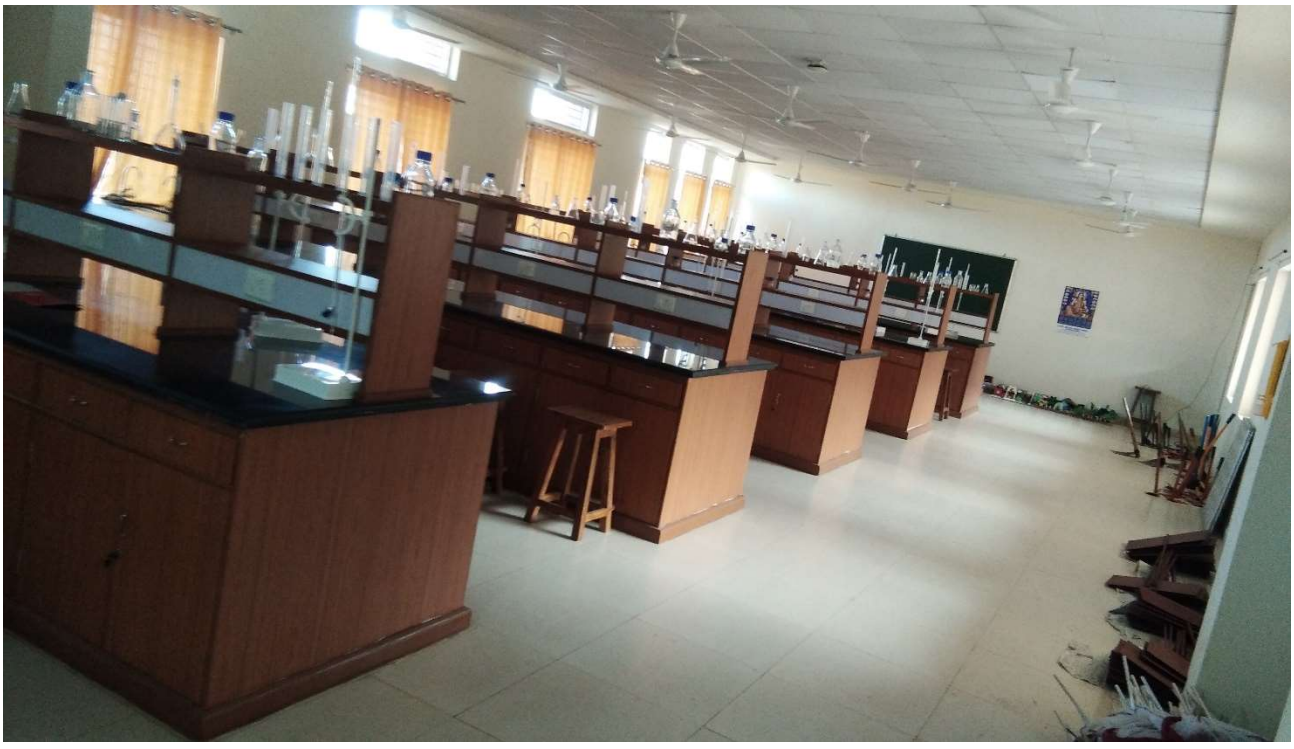

STAGE MICROMETER
2000-L17-1062
Qty.:1pcs
ESM11
CE
IMPROVED
ERMA INC.
Made in Japan


VMSP
RPM
TIME
Touch
OFF

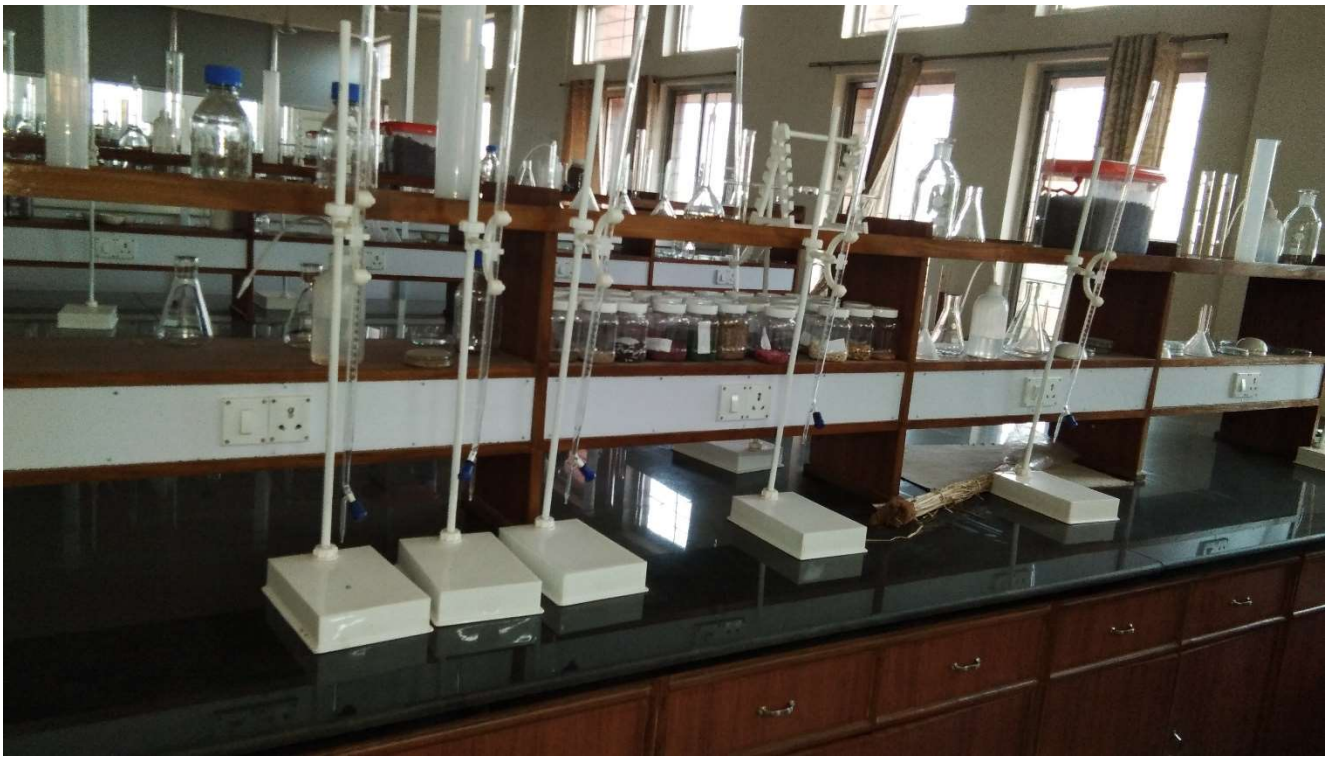

REMI 1ML


FRACTION V POWDER
98.0%
For Microbiology
Store at +2°C to +8°C
100 g : 02230
LOBA CHEMIE PVT. LTD.
Potato Dextrose Agar
Magnus






SRI GANESH



Conceptual popular articles

Regenerative Agriculture and Participatory Action Research

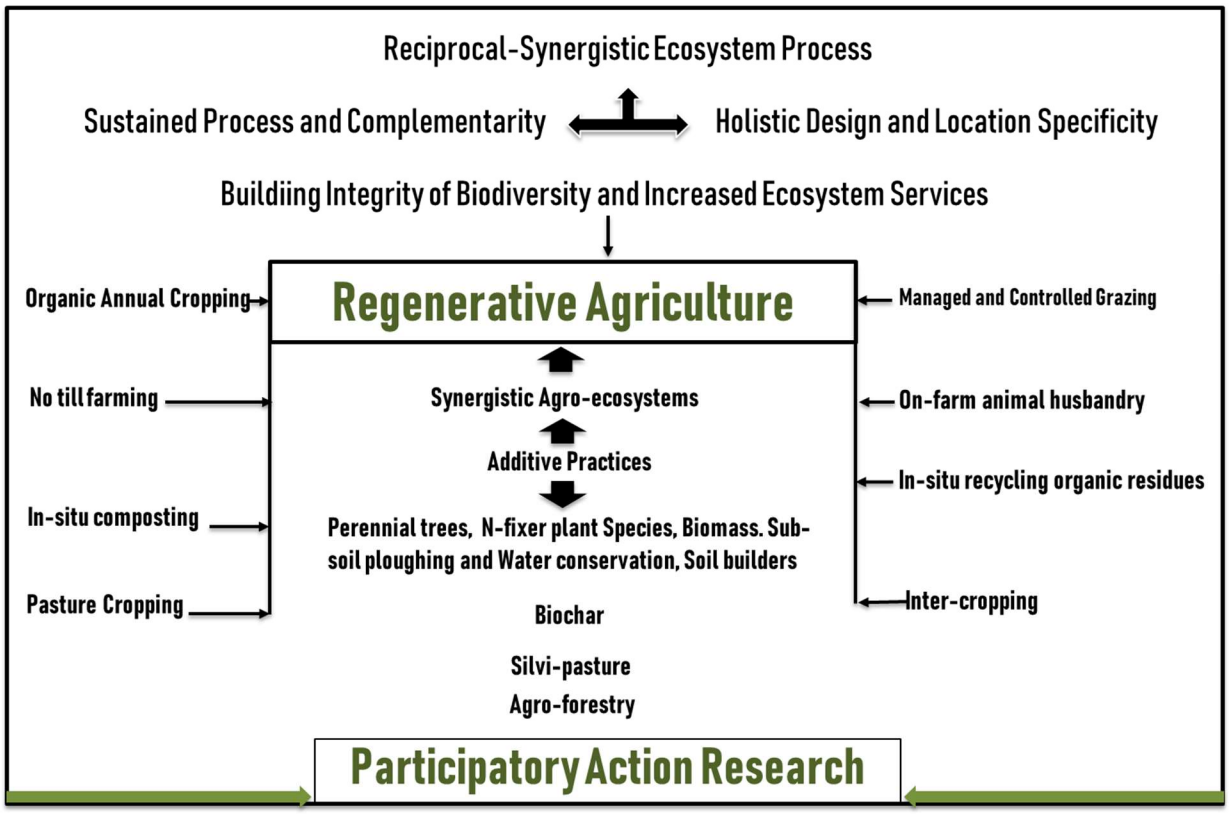
Prof. S. Kumaraswamy | Dean and HoD

World has increasing concern placed on the loss of inherent fertility of soils, depletion of native biodiversity of landscape with consequent loss of indigenous seeds, traditional knowledge, which threating agrarian economy and agriculture based livelihood systems. Prediction suggest that at current rates of soil destruction (accelerated depletion of belowground carbon, fertile soil erosion, deforestation leading to desertification, indiscriminate use of chemical followed pollution) aftermath of green revolution, humanity will suffer from poor health index due to a qualitatively degraded food characterized by diminished nutritive value. Moreover, humanity will no longer have fertile topsoil to sustain the productivity of agricultural landscapes. It becomes imperative to suggest that regenerating the soil and interactive synergistic process assume prime role in sustaining the agrarian economy and livelihood systems of the modern civilization.

The essential principle of the regenerative agriculture is to sustainably improve the natural integrity of ecosystem functions, integrates technologies that regenerate and revitalize the soil and the environment. Regenerative agriculture supports building healthy soil, produce high quality, nutritive food while the crop management practices improve the soil quality with consequently resulting in productive farms, healthy communities and sustenance of agrarian economy. It is a bio-dynamic and holistic integration of natural farming, inclusion of organic farming practices, conservation tillage, cover crops, crop rotation, recycling of organic residues, on-farm animal husbandry practices and pasture cropping to increase food production per unit area with sustained inherent soil functions and productive capacity, improved farmers' income and betterment of overall health index of agrarian landscape.

Paradigm shift to practice regenerative agriculture at scale can have larger impact at several levels;

- **Food Security at local to global scale:** Small-holder farmers contribute to larger extent to world food share, which are amenable for regenerative agricultural practices.
- **Mitigation of GHG emissions:** Regenerative agriculture with conservation principles and synergistic process modification has promise to minimize the GHG emission unlike the current industrial food production system, which is responsible for 44 to 57% of all global greenhouse gas emissions.
- **Climate change moderation:** Increased sequestration and storage carbon in the belowground and aboveground components through conservation practices in regenerative agriculture can moderately reduce human related climate change.
- **Sustained economic yields:** Regenerative agriculture is resilient smart farming system adapted to climate change scenarios with better yields than conventional and modern agriculture.
- **Soil buffering drought scenarios:** Sustenance of building soil carbon for long period will result net accumulation of carbon with consequent increase in water holding capacity of the soil. Regenerative organic agriculture builds soil organic matter.
- **Resilient local economy:** Low cost farming to produce quality produce has opportunity build specialized business models to improve rural economy.
- **Applications of traditional knowledge:** Regenerative farming uses traditional farming wisdom, which is critical to maintain the ecological integrity of agricultural systems.
- **Enrichment of biodiversity:** Regenerative agriculture enhances the biodiversity repositories of agricultural landscapes to maintain the production and environmental conservation.
- **Restoration of grazing lands:** Elements of regenerative farming considers recreation or restoration of the grasslands to support animal husbandry.
- **Nutritive value:** Diversified agro-ecosystems ensure quality and better nutrition value of the produce unlike conventional farming systems.



Linking agro-ecological development with participatory action research: Last decade has seen increasing need to address the agricultural developmental issues from the perspective that incorporates social and ecological dimensions. Participatory action research (PAR) holds the key and has relevance to raise the queries on the intuitive wisdom of stakeholders on sustainable agro-ecological practices. PAR is an adaptive social research through the integration of scientific basis to improve the overall management approach by the stakeholders. Unlike the extension activities, the close interactions in PAR promote broad participation in the research process and supports action leading to satisfying situation. Moreover, it reliably addresses the integral question of linking the ecological conservation initiatives as part of the socio-economic development at local scale. It raises queries on gains and losses in terms of maintenance of water quality, biodiversity, carbon storage, pest control, pollinators and predators, fisheries and ecotourism in agricultural landscapes. Thus future revolution in agricultural productivity must work on the principles of PAR that incorporates accumulated knowledge of ecological processes and feedbacks, disease dynamics, soil processes and beneficial microbial functions. A cyclical approach of PAR is promising in situation, which involves diversity of active stakeholders in research and as agents of positive change. The cyclic process of PAR includes observational, reflective thinking, experimental actions and co-evolution through network reciprocity. The duality of the PAR is important to create positive social and environmental change contributing essentially to scientific knowledge gain to stakeholders. It facilitates strategic and potential expansion of PAR linkages among the communities, organizations, researchers and development of network for mutual learning. However, long term sustenance of the PAR cycle is challenge by itself due to changing

priorities of the stakeholders and researchers. It is one of the drawbacks which may add skeptic view to PAR oriented approach to agro-ecological development initiatives. Many options may be created by asking questions in the initiation stage of the PAR process to make the PAR activity adaptable. The relevant questions may range from level of participation, powers of participants, gender issues, caste discriminations, social roles of participants within the communities, social skills of scientific researchers and interactive forces operating at spatial, geographic and political scales. In PAR approach, much importance need to be paid to benefit the adaptive management strategies (active and/or passive) in natural resource management. PAR provides an option to understand the degree of participation in research and change process. The typology and the degree of relationship has been suggested based on participation at the level of **i) Collegial**— trust based relationship where researchers work in close association with local stakeholders to strengthen their research, developmental capacities and practice advocacy; **ii) Collaborative**— a direct collaboration between researchers and stakeholder with realizable objective/s; **iii) Consultative**— researcher orients his approach to need based solving of problem of the stakeholder/s; and **iv) Contractual**—service oriented contract between the researcher and stakeholder. All these relationships can be operational at one time, however need empowerment of local communities of their social capital aiming at positive change as a long and negotiated process. The uneven power relationships, conflicts, rivalry, multiple cultures, caste based discrepancies operate while building PAR for agro-ecological sustainability.

Sustainability of agricultural landscapes can be addressed at several levels through farming community friendly policy instruments, which encourage diversity in farming systems, removal of subsidies on select degradative farm inputs (input-output levies), identify time tested agricultural models by critical analysis of socio-economic characteristics at landscape scale, which can be adapted with certain modification to suite the current farming systems, design self-operational and multiple level network systems for ingenuity sharing among the farming community and design landscape specific information and education program for farming community. Some of these points may be reviewed while debating on policy level reforms by the government and agencies alike to build resilient farming systems. The acceptability and conflict resolving issues of any policy reforms have been difficult to address. However, farm scale approach through PAR will yield positive changes in resolving conflict scenarios which is possibly achieved by the government agencies through designing an incentive based socially acceptable polices, However, policy reforms must consider landscape/region specific issues as it is impossible to design an ideal economic instrument rather define performance-based instruments. The policy reforms by the government agencies thus must consider designing strategies for participatory approaches and co-interest incentive schemes at farm scale to alleviate the sustainability issues of agricultural landscapes directed toward regenerative agricultural practices.

Ganoderma lucidum: A medicinal mushroom

Dr. Chinmayee Mohaptra | Assistant Professor, Plant Pathology

Among the large resources of fungi, higher Basidiomycetes, especially mushroom are unlimited sources of therapeutically useful biologically active agents. The significant pharmacological effects of mushrooms are bioregulation, maintenance of homeostasis, regulation of biorhythm, prevention and cure of various life threatening diseases such as cancer, cerebral stroke and heart diseases. Mushrooms are also known to have effective substances for anti-fungal, anti- inflammatory, anti-tumor, anti-viral, anti-bacterial, hepato-protective, anti-diabetic activities.

Medicinal mushrooms occurring in India namely *Ganoderma lucidum, Phellinus rimosus, Pleurotus florida* and *Pleurotus pulmonaris* possess profound antioxidants and anti-tumor activities.

Ganoderma lucidum (also called as '*Reishi*' mushroom in Japan and '*Ling Zhi*' in China meaning 'mushroom of immortality') is probably the first medicinal mushroom to gain importance in India. It is a medicinal fungus with a long history of use as a Chinese folk medicine for promotion of health and longevity. It is the annular mushroom which grows in a wide variety of dead or dying trees. It is a large, dark mushroom with glossy exterior and a woody texture. The latin word '*lucidus*' means shiny or brilliant and refers to varnished appearance of surface of mushrooms. Unlike other edible mushrooms, *Ganoderma lucidum* is bitter in taste. It thrives under hot and humid conditions.

Reishi Mushroom

Commercial products

A variety of commercial *Ganoderma lucidum* products are available in various forms, such as powders, dietary supplements and tea. They are produced from different parts of the mushroom including mycelia, spores and fruiting body. In manufacturing terms, the simplest types consist of intact fruiting bodies ground to powder and then processed to 'capsule' or 'tablet' form. Other 'non- extracted' products are prepared

from three sources: i) dried and powdered mycelia harvested from submerged liquid cultures grown in fermentation tanks; ii) dried and powdered combinations of substrate, mycelia, and mushroom primordia, following inoculation and incubation of a semi-solid medium with fungal mycelia; and iii) intact fungal spores or spores that have been broken by mechanical means.

Nutritional values

Artificial cultivation of *Ganoderma lucidum* has been achieved using substrates such as grain, saw dust, wood logs and cork residues. In a study of non- volatile components, it was found that the mushroom contains 1.8% ash, 26-28% carbohydrates, 3-5% crude fat, 59% crude fiber, and 7-8% crude protein. In addition to these, mushrooms contain a wide variety of bioactive molecules such as terpenoids, steroids, phenols, nucleotides and their derivatives, glucoproteins and polysaccharides. Mushroom proteins contain all the essential amino acids and are especially rich in lysine and leucine. The low total fat content and high proportion of polyunsaturated fatty acids relative to total fatty acids of mushrooms are considered significant contributors to health value of mushrooms.

Elemental analysis of *G. lucidum* revealed phosphorus, silica, Sulphur, potassium, calcium and magnesium to be their main mineral components. Iron, sodium, zinc, copper, manganese, and strontium were also detected in lower amounts. Potassium, calcium and magnesium (10.2%) are the major components. Germanium concentrations (489 µg/g) has been credited with immune potentiating, anti-tumor, antioxidant and anti-mutagenic activities.

Other components isolated from *G. lucidum* include enzymes such as metallo protease (delays clotting time), ergosterols (precursor of vitamin D_2), nucleosides and nucleotides (adenosine and guanosine).

Bio active components

Polysaccharides, peptidoglycans and triterpenes are the three major physiologically active constituents in *Ganoderma lucidum* (Mizuno, 1995 and Liu, 1999). *G. lucidum* polysaccharides are reported to exhibit a broad range of bioactivities, including anti – inflammatory hypoglycemic, anti- ulcer, anti- tumorogenic, and immune stimulating effects. The polysaccharides contain xylose, mannose, galactose and fucose in different conformations, including 1-3, 1-4 and 1-6 linked β- and α – D (or L) –substitutions. The mushroom also consists of a matrix of the polysaccharide chitin, which is largely indigestible by the human body and is partly responsible for the physical hardness of the mushroom.

Various bioactive peptidoglycans have been isolated from *G. lucidum* including *G. lucidum* proteoglycan (GLPG: with anti-viral activities), *G. lucidum* immuno-modulating substances (GLIS), and *G. lucidum* polysaccharide peptide (GLPP) and F_3 (a fructose containing glycoprotein fraction).

The first triterpenes isolated from *G. lucidum* are ganoderic acids A and B. Among triterpenes, more than 50 were found to be new and unique to this fungus. The vast majority are ganoderic and lucidenic acids, but other triterpenes such as ganoderals, ganoderiols and ganodermic acids have also been identified. Presence of these triterpenes gives the mushroom its bitter taste and has various health benefits, such as lipid lowering and anti-oxidant effects.

Therapeutic uses

- Traditionally, it has been widely used in treatment of hepatopathy, chronic hepatitis, hypertension, artritis, insomnia, bronchitis, asthma, and gastric ulcer.
- They reduce blood pressure, blood cholesterol, and blood sugar level as well as inhibition of platelet aggregation.
- It boosts the immune system by fighting with infections through increasing the number of white blood cells.
- It could also decrease anxiety and depression.

Living stones: Lithops

Ms. Suvalaxmi Palei | Assistant Professor, Horticulture

Lithops are small, interesting plants that are relatively easy to grow indoors. The first *Lithops* was discovered by William John Burchell in 1811 during a botanical expedition in southern Africa. During his travels in the Northern Cape Province, he found a strange looking brown stone with a fissure across the surface near the town of Prieska. On closer inspection, this strange-looking stone turned out to be a succulent plant. These plants, in the plant family Mesembryanthemaceae (Aizoaceae), were named for their stone-like appearance: *lithos* (=stone) and *opsis* (=like). Local Afrikaans names for these plants in areas where lithops are known include *beeskloutjie* (cattle hoof), *skaappootjie* (sheep hoof) or *perdeklou* (horse's hoof), for their resemblance to miniature hoofprints. In their native habitats in Namibia and South Africa, *Lithops* have evolved to blend in so well with their surroundings – looking just like the sand and stones they live among in shape, size and color – that they can be quite difficult to spot, even for those with a trained eye and years of experience.

Bionomics of Lithops

Lithops are able to survive in these dry areas because of their capacity to store water, with almost the entire plant devoted to this function. Each individual plant consists of two succulent leaves fused together in the shape of an inverted cone (although some species will produce multi-headed plants). The fissure at the top of the plant is the division between the two leaves. There is no stem; the taproot joins abruptly at the base of the leaves. The thick leaves can store enough water for the plants to survive for months without rain. In periods of drought (almost all the time) they shrivel and shrink below the soil level.

These small, nearly stemless succulents are partially subterranean. In habitat the plants only grow from ½-1″ high and from 1-3″ wide, and they grow flush with the ground. Staying small and keeping a low profile helps minimize the effect of the intense heat and sunlight where they live. But this also presents a problem of getting light to the photosynthetic apparatus of the leaf cells (chlorophyll) that are underground. To solve this dilemma, the wide leaf tips have windowed cells that allows light into the inner portion of the leaf, where it is diffused before reaching the chlorophyll, which is scattered along the interior leaf margins.

There are at least 37 species (new species continue to be discovered) and numerous varieties (145+) of *Lithops*; all look quite similar to each other, differing mainly in the shape, markings, color and texture of the body. They come in a variety of subtle colors of gray, brown, rust, green and pink. There is considerable variation in the patterns of dots, lines or patches on the upper surface that help them to mimic their surroundings. There may also be dimples or indentations where the markings appear. The markings may heavily cover the leaf surface, or the windows may cover most of the leaf surfaces.

Most *Lithops* flower during autumn and early winter, producing daisy-like yellow, pale orange or white flowers with many petals. The flowers open in the afternoon of sunny days and close again in late afternoon. The flowers emerge from the fissure between the leaves. Some flowers are scented. They range in size from roughly ½ to 1½″, depending on the species and conditions.

Lithops are self-sterile, so must be pollinated to produce seed. The seed is held inside a hydrochastic 4-8 chambered fruiting capsule, which only opens when moistened, exposing the tiny seeds. In nature, falling rain drops splash out the seeds to a distance of an inch to up to a few feet from the parent plant. Once the capsule dries, it closes again, protecting any seeds remaining until the next rain.

After the plant flowers, it goes into a period of dormancy during which at least one new body develops. In the spring the plants start to reabsorb the old leaves as the new ones develop. Eventually the new body

pushes out from the fissure between the old leaves. The fissure of the new leaves forms at about 90 degrees to the old fissure. Eventually, the old leaves wither away to a dry, papery sheath on the side of the new body. Many plants will also divide at this time, to produce more than one leaf pair so that a single body gradually becomes a small cluster.

Because they thrive in low humidity, need infrequent watering and care, and are relatively easy to grow, *Lithops* are popular novelty houseplants. With their small size and slow, compact growth these plants do not take up much room. *Lithops* are long lived – up to 40 or 50 years. It is quite possible to keep a plant in the same pot for 10 or 20 years. Lithops are non-toxic to humans or pets. (There are even some references to African children eating these plants as a means to quench their thirst.) Their health in cultivation depends on sufficient bright light, good soil drainage and proper watering.

Lithops can be grown successfully on a sunny windowsill (although a greenhouse is preferred) where they receive about 4 or 5 hours of direct sunlight during the early part of the day, and partial shade during the afternoon. Usually a southern window is the best location; an unobstructed eastern exposure is a good alternative. If a plant does not receive enough sunlight it will begin to grow slender and elongated, lean to one side to receive more light, lose coloration and turn greenish, and will eventually die if better conditions are not provided. But be cautious about moving a plant abruptly to brighter light – it could get sunburned and be fatally injured.

Lithops require well-drained soil, much the same as cactus. Add sharp sand, perlite, decomposed granite or other gritty material that will help improve drainage to regular houseplant potting mix, or use special cactus potting mix. These plants have an extensive root system, which means they need a larger pot than the plant size would indicate. Pots that are about 3 to 5 inches deep – with drain holes – are recommended to allow the roots adequate room to grow. Place the top of the plant just slightly above the surface of the soil, rather than at the soil surface as would occur in nature. Many growers top-dress with gravel or surround the plant with stones to give a more natural appearance.

Lithops have a yearly cycle of growth, and it is essential to water only during certain stages and to keep the soil dry at other stages of their growth. Over-watering is the chief cause of early demise. Too much water and they rot or produce new bodies at the wrong time of year. Too little water and they become stunted. How often you water depends on how quickly the potting medium dries out. In general, drench the plant and leave it to dry out completely (probably 1-2 weeks). Then wait a couple more days before watering

again. If in doubt…don't! It is best to water in the mornings so that the excess water evaporates and the upper layers of soil dry out fairly quickly. Some general guidelines for watering (but this may vary somewhat by species);

- Water from late spring into summer.
- When the plant goes dormant in the summer, stop watering. If the plant really shrivels, give just enough water to restore the firm appearance of the plant, but only water until about the top one-half inch of the soil is moistened.
- Resume watering in late summer-early fall, when the plants resume growth and bloom. The first sign of growth is when the fissure between the leaves begins to separate in preparation for flowering.
- Lithops should be left totally dry throughout winter and spring. Stop watering to allow the old leaf pair to dry out and the new pair develop. By early spring the new body should be visible. Watering can be resumed once the remains of the old body are completely shriveled and dry. If water is given too soon, the old "leaves" will try to continue to grow and the plant will not develop properly. Remember, the old leaves should totally dry up as the new leaves are growing.
- Fertilize *Lithops* sparingly and use a low nitrogen, high potassium type.
- *Lithops* can tolerate very high temperatures as long as there is plenty of fresh air. Never allow the plants to freeze.

Seed and plants of all species and many cultivars are today available from specialist succulent nurseries. They grow quickly from seed, and can be expected to flower in 3 to 4 years under optimal conditions. Sow the seeds during the summer in sandy medium, covering with a very thin layer of fine sand. Water the tiny seeds gently so you don't displace them. Place the container in a warm sunny spot, keeping them moist but not soggy. The first seeds should germinate in a few weeks (but germination may be spread out over a long period of time, with stragglers taking as long as a year). Once the seedlings are developing rapidly, reduce watering so that the top ¼" of medium dries out, but the lower medium stays moist. Don't water too much, as excessive watering during this period may cause damping off of the seedlings. When the plants are 2-3 months old, start letting them dry out completely for a few days between watering, and gradually increase the length of the drying time. The young plants can be transplanted when they are about a year old.

Lithops can also be propagated by dividing a multi-headed plant. Lift the plant, carefully cut through the roots and replant them immediately.

L. dorotheae *L. aucampiae* *L. optica* *L. verruculosa* *L. karasmontana* *L. otzeniana* *L. fulviceps var lactinea*

LIthops flower buds emerge from between the leaves (L and LC) and start to open (RC) the daisy-like flowers (R).

Marker assisted selection for crop improvement

Ms. Mandakini Kabi | Assistant Professor, Genetics and Plant Breeding

Plant breeding relies on the effectiveness of selection. It started with selection, flourished with selection and now appears to be striving in the process of selection. In conventional plant breeding, desirable plants are selected based on phenotypic assessment which is not the true reflection of genotype due to influence of environment on it. As a result, the outcome of the selection activity for development of a variety comes to fruitless. Plant breeding has a tradition of being benefited from parallel development in sister branches and technology out of which molecular biology has the potential role to play. Marker assisted selection (MAS) is an important area in molecular biology which brings about selection of trait based on marker instead of its underlying gene. As the marker is located near the DNA sequence of the desired gene and as it follows Mendelian inheritance; varietal breeding followed by MAS has been a reliable technology to expedite breeding process. However, MAS will probably never replace phenotypic selection, but complement to increase efficiency of phenotypic selection.

MAS for improvement of qualitative traits

In crop plants, many of the economically important traits are controlled by either major gene /QTL. Such characteristics include resistance to diseases or pests, male sterility, self-incompatibility and others related

to shape, color and architecture of whole plants and/or plant parts. These qualitative traits are not present in all varieties in a crop plant. So to transfer these qualitative traits to the variety under cultivation can lead to tremendous improvement in the variety. Marker loci flanking to the causative underlying gene helps in efficiency of selection than direct selection of the target gene. An example of MAS for qualitative trait is the selection of genotypes resistant to soybean cyst nematode (SCN) which is a very devastating pest in soybean. Identification of genotype resistance to this pest from the breeding population is very difficult. But, a tightly linked SSR marker 'Satt309' has been identified 1-2cM away from the resistance gene *rgh1*. Nematode resistant genotypes can be identified based on this marker with 99% accuracy through MAS.

MAS for improvement of quantitative traits

Most of the agronomic important traits are governed by polygene or by multiple QTL. Genetic improvement of such traits is very difficult task as these are controlled by a number of minor gene clusters(QTLs) distributed throughout the genome. Besides, expression of these traits is largely influenced by epistatic and QTL X environment interaction. Therefore, appropriate experimental design and approaches are needed to increase the efficiency of MAS. Attention should be given to replications both over time and space, consistency in experimental techniques, samplings and evaluations, robust data processing and statistical analysis. For example, composite interval mapping (CIM) allows the integration of data from different locations for joint analysis to estimate QTL-environment interaction so that stable QTLs across environments can be identified. Also a saturated linkage map enables accurate identification of both targeted QTLs as well as linked QTLs in coupling and repulsion linkage phases. Practically, only a few major QTLs are identified which contribute maximum phenotypic variation in the target population. In certain cases, where each QTL has minor-effect, a breeder would prefer to consider the strategy of gene pyramiding. ***Fusarium* head blight (FHB**) in wheat and barley caused by *Fusarium* species is a worldwide most devastating disease. Resistance to FHB is quantitatively inherited and many QTLs have been identified from different germplasm resources. In wheat a major QTL designated as *Fhb1* was consistently detected across multiple environments and populations, and explained 20-40% of phenotypic variation in most cases. Thus, wheat breeders would especially prefer to use this major QTL to develop new cultivars with FHB resistance.

MAS for gene pyramiding

Gene pyramiding is a new field of plant breeding. It entails stacking of multiple genes leading to their simultaneous expression in a variety to develop durable resistance expression. It is gaining considerable importance as it would improve the efficiency of plant breeding leading to the development of genetic stocks and precise development of broad spectrum resistance capabilities. The success of gene pyramiding

depends upon several critical factors, including the number of genes to be transferred, the distance between the target genes and flanking markers, the number of genotype selected in each breeding generation, the nature of germplasm etc. In rice, gene pyramiding has been successful to assemble four genes (Xa4, Xa5, Xa13 and Xa21) for bacterial blight resistance, three genes(Pi(2)t,Piz5,Pi(t)a) for blast resistance and two genes(Gm1 and Gm4) for Gall midge resistance. Similarly, durable resistance has been achieved in wheat by pyramiding three genes (Lr41, Lr42, Lr43) for leaf rust resistance and two genes (*Pm-1, Pm-2)* for powdery mildew resistance.

Construction of heterotic hybrid

Molecular marker based genetic analysis can be utilized to identify specific genomic region(s) containing QTLs for yield showing dominance or over dominance. Different lines/genotypes can be tested for number of QTLs involved and magnitude of their effect on the measured traits. The major QTLs identified, can be incorporated into the standard lines by marker based introgression using back cross breeding. The improved version of the existing inbreds would be amenable to develop hybrids for realizing higher heterosis than the existing ones. In maize, major QTL for yield was identified in inbred line-Tx303 and oh 43 which were then transferred through the use of molecular markers to inbred line B73 and Mo17 respectively. By crossing improved version of B73 and Mo17, 15% increase in yield improvement was achieved over check.

Maker Assisted Back Crossing

Marker assisted back crossing (MABC) is a form of marker assisted selection (MAS) which assist selection of desirable genotype in a back cross population through use of marker. MABC aims at transfer of one or few genes/QTLs of interest from a source genotype (serving as the donor parent) to an agronomically desirable cultivar or elite breeding line (serving as the recurrent parent) to improve the targeted trait. The procedure for MABC follow, regardless of dominance and recessive nature of inheritance of target gene. A molecular marker closely linked to the gene of interest will help to test the hybridity in F_1 as well as to trace the target gene in the back cross breeding population. Finally, finally, molecular profiles of the selfed progenies of advanced backcross generations (e.g. BC4F2) are used to detect the individuals carrying homozygous marker allele(s) of target trait for further evaluation and release.

The efficiency of MABC depends on the two selection approaches i.e. foreground selection and background selection. The former selection process is carried out based the marker genotyping for the target locus to **maintain the gene of interest in heterozygous state until** the final backcrossing is completed. Then the

selected plants are selfed and the progeny plants with homozygous donor allele(s) of selected markers are harvested for further evaluation and release. The effectiveness of foreground selection depends on the number of genes/loci involved in the selection, the marker-gene/QTL association or linkage distance and the undesirable linkage to the target gene/QTL. In case of background selection, the selection is made for the marker alleles covering most of the genomic regions of the recurrent parent for desirable traits except the target locus, or selection against the undesirable genome of donor parent. This quickens the recovery of recurrent parent(RP) genome and eliminate undesirable genes introduced from the donor parent. The time span for recovery of the RP genome depends on the number of markers used in background selection. A highly saturated linkage map will help to select the markers for recurrent parent. The more markers evenly distributed on all the chromosomes are selected for the RP alleles, the faster would be the recovery of the RP genome. However, a larger population size and robust genotyping technique are needed to address the linkage drag using DNA markers, although it is difficult to overcome in a traditional backcrossing program.

In vogue, background selection is carried out from BC3 and onwards. The individuals that have the desired marker alleles for target trait are selected first (foreground selection). Then the selected individuals are screened for other marker alleles again for the RP genome (background selection). This will pave the way for elimination of the individuals that do not have the allele of target gene and thus it is not necessary to genotype them for other traits. However, some workers exercised both foreground and background selection in the same backcross generation or even performed alternatively. The efficiency of MABC depends upon several factors, such as the population size for each generation of backcrossing, marker-gene association or the distance of markers from the target locus, number of markers used for target trait and RP background, and undesirable linkage drags.

Biotic elicitors inducing resistance in plants against insects

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Plants treated with elicitors generally develop resistance to a herbivore, because application of elicitors on plant surface activates multiple signalling pathways of intracellular defense. In a broad sense, 'elicitors', for a plant refer to chemicals from various sources that can trigger physiological and morphological responses against pests.

Elicitor needs to be recognized on plant by a receptor (protein), which activates the expression of defense genes. There are two groups of elicitors, the biotic and abiotic. Abiotic elicitors are fertilizers, synthetic pesticides, micronutrients (Zn, Fe, Mn, Cu, B, Si), antibiotics (ß-Oxytetracycline), major nutrient (K) etc. those induce resistance in plants against herbivores. Compared with biotic, abiotic elicitors induce defense reactions of plant when given in relatively high doses. In turn, the biotic elicitors are of biological origin and are active at very low doses. In this paper, biotic elicitors are being discussed.

Biotic elicitors

In plant–herbivore interactions, plants have evolved the ability to perceive herbivory associated molecular patterns (HAMPs) (Mithofer and Boland, 2008). To date, HAMPs can be of following types:

i) Chemical elicitors derived from herbivore oral secretions (OS).
ii) Chemical elicitors derived from herbivore ovipositional fluids (OF).
iii) Specific patterns of wounding.
iv) Volatiles from a nearby damaged plant.

Herbivore oral secretions (OS)

The effect of applying these elicitors to the specific host plants effectively mimics the effect produced by herbivory. ß-Glucosidase from the OS of the white cabbage butterfly larvae, *Pieris brassicae*, elicits the production of volatiles from cabbage plants. After cowpea (*Vigna unguiculata*) plants are attacked by fall armyworm (*Spodoptera frugiperda*), they emit ethylene and elevate the levels of jasmonic acid (JA) and salicylic acid (SA), thereby increasing their volatile emissions and the concentrations of defensive compounds. HPLC separation of OS revealed that a peptide named inceptin was the elicitor in fall armyworm's OS. Fatty acid–amino acid conjugates (FACs) are a second group of elicitors that allow plants to monitor the feeding activity of larvae.

FACs are composed of two moieties: a fatty acid moiety usually consisting of either linolenic acid or linoleic acid and their derivatives and an amino acid moiety, Gln or Glu. The fatty acids and amino acids are plant and insect derived, respectively, whereas the modification of fatty acid and conjugation of fatty acid and amino acid both happen in the caterpillar midgut.

Volicitin, a hydroxyl FAC (*N*-17-hydroxylinolenoyl- L-glutamine), was the first FAC identified in *Spodoptera exigua* (beet armyworm) OS, which induces volatile release in maize seedlings. Since then, different forms of FACs have been found in other insect species. The effects of applying FACs have been intensively studied

in *Nicotiana attenuata*. When synthetic FACs are applied to wounded *N. attenuata* leaves, they activate higher levels of MAPK activity and amplify and modify wound-induced changes in transcriptome, proteome and levels of defensive secondary metabolites.

A new class of elicitors known as caeliferins was recently isolated from the American bird grasshopper (*Schistocerca americana*). They are saturated and monounsaturated sulfated a-hydroxy fatty acids in which the ω-carbon is functionalized with either a sulphated hydroxyl or a carboxyl conjugated to glycine via an amide bond. Similar to applying FACs, applying caeliferins to maize seedlings elicits the release of volatile terpenes.

Herbivore ovipositional fluids (OF)

Many herbivorous insects lay eggs on plants and some plants respond to oviposition by forming neoplasm and necrotic tissue, producing ovicidal substances and emitting volatile signals that attract parasitoids. Oviposition fluid has been identified as containing the functional elicitors. Bruchins were isolated from the oviposition fluid of the pea weevil (*Bruchus pisorum* L.). They are long-chain α, ω-diols that are esterified at one or both oxygens with 3-hydroxypropanoic acid. Applying as little as 1 fmol (0.5 pg) results in neoplastic growth on the pods of particular genotypes of pea functioning as defence against oviposition. Recently benzyl cyanide (BC) isolated from *Pieris brassicae* oviposition fluid has been identified as the second elicitor in oviposition fluid. 1 ng of BC elicits defence responses in Brussels sprouts plants.

Specific patterns of wounding

In addition to chemical elicitors, the wounding resulting from the feeding activity of herbivores in some plant species can trigger herbivory-specific responses in plants. Different herbivores have distinct patterns of feeding involving variations in the way leaf tissue is removed, the frequency and the time period of feeding. It is possible that some plants perceive these herbivore-specific patterns of wounding and use this information to produce herbivory specific responses. Wounding lima bean leaves with a 'MecWorm', a device that mimics the timing but not the mechanical properties of the feeding damage resulting from *Spodoptera littoralis* larvae and the snail *Cepaea hortensis* feeding, elicits a volatile release similar to the natural feeding of these herbivores indicating that some plant species recognize the timing of wounding to tailor their defence responses. The generality of this recognition system needs further study.

Herbivores such as aphids and whiteflies (Hemiptera) suck on plants' phloem tissue with their stylets to obtain nutrition. Although the wounds elicited by this type of feeding are hard to observe with the naked eye, these insects still induce remarkable changes in both signalling and secondary metabolism. Unlike the insects that remove large quantities of tissue during their feeding, Hemiptera induce many responses in plants that are similar to those induced by pathogen attack.

As a general insects having chewing and biting type of mouth parts elicits Jasmonic acid whereas, insects having piercing and sucking type of mouthparts and pathogens elicit salicylic acid.

Volatiles from a damaged plant

Volatile organic compounds released from a nearby damaged plants can also elicit defence responses. Clipped *Artemesia tridentata* plants emit MeJA into the ambient air that can induce defence or sensitizing (priming) responses in neighbouring plants, perhaps by directly acting as JA after hydrolysis *in vivo*. Several studies have shown that other volatile compounds, such as terpenes and C6 volatiles induced by herbivory, also activate defence responses in adjacent plants. How these compounds mediate the transfer of information between plants are still under study.

Induced resistance is a host response with respect to the external stimulators. Its expression under field conditions is likely to be influenced by a number of factors, including the environment, genotype, crop nutrition and the extent to which plants are already induced. Research towards detecting and developing different biotic elicitors are scanty. Various biotechnological tools can improvise the response factor of plants. More findings in this direction can boost the eco-friendly management of crop pests.

Agronomic bio-fortification of Fe and Zn in rice and wheat

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Iron and zinc deficiencies in human nutrition are widespread in developing Asian and African countries where cereal grains are the staple food. Effects are therefore underway to develop cereal genotypes with grains denser in Fe and Zn by traditional plant breeding or using genetic engineering techniques. However, the products of genetic engineering are not well accepted in many countries. Also, there is a trade-off

between yield and grain biofortification. Agronomic biofortification offers to achieve this without sacrificing on yield and with no problem of product acceptance. From the view point of biofortification, foliar application has been reported to be better than the soil application of Fe and Zn, and for this purpose, chelated Fe and Zn fertilizers are better. Agronomic biofortification depends upon management practices, soil factors and plant factors.

Sources and method of application

Zn sulfate heptahydrate (ZNSHH) coated urea is superior to ZnO coated urea in increasing Zn concentration in unhusked rice. The superiority of ZNSHH was also recorded in succeeding crop when Zn was applied only to rice. Zn-EDTA is better than ZNSHH, but it is expensive. Split application of ZNSHH is better than a single application, but not in Zn-EDTA. Application of Zn as ZNSHH on Zn deficient soil significantly increases the grain yield as well as the the Zn concentration in rice grain. Foliar application of Zn both at jointing and heading stage gave 25% higher Zn concentration in wheat grain than soil application at 4.5 kg/ha. Zn concentration in wheat grain was 24% higher with soil + foliar application than foliar application alone and foliar application of Zn gave best result when it was done at grain filling stage.

Management practices affecting Fe and Zn Concentration

Tillage: Tillage practices like no tillage, zero tillage and conventional tillage affect the Zn uptake. In reduced tillage the soil compaction causes a serious problem in root proliferation which ultimately reduces the Zn uptake. Stipesevic *et al.* (2009) reported that Zn concentration in winter wheat was more in conventional tillage plot as compared to zero tillage plot.

Water management: Under prolonged submergence Fe could get precipitated as plaques of ferric hydroxide which are primarily goethite and have high capacity to bind metal ions like Zn^{+2} and Cu^{+2} resulting in their reduced uptake by rice roots. In calcareous soil, moderately anaerobic conditions have higher Zn availability than aerobic conditions, but Zn availability decreases when soil became very aerobic. Under aerobic conditions nitrate are dominant ion and rice roots release more OH^- ions resulting in the precipitation of Zn and reduced Zn uptake.

Both Fe and Zn interact positively with N and negatively with N and negatively with P. Zn concentration in winter wheat increase with increased N application rate, this is due to the improvement in root uptake and translocation of Zn due to N. Zn concentration in wheat grain decreases with increasing rate of P application.

Application of plant growth promoting rhizobacteria (PGPR) and mycorrhiza: PGPR stimulate the growth of the host plant due to increased mobility, uptake and enrichment of nutrients in plant.

Combination of *Bacillus* sp. and *Providencia* sp. significantly increases the Zn and Fe concentration of wheat grains. The colonization of arbuscular mycorrhizal fungi enhance nutrient uptake through roots of upland plants due to increased surface area for soil exploration. Inoculating rice seedlings in a wet or dry nursery with AFM increased Zn concentration in brown rice.

Soil factors affecting the availability of Fe and Zn to plants

As agronomic bio fortification is through soil-crop plant system, the factors affecting the availability of Fe and Zn in soil and their uptake by plants is need to be discussed.

Amounts present in soil: More is the amount present in the soil more is the availability to the plant, but most of the soils are deficient so the uptake is also less. Zn deficiency is widespread with 47% of Indian soils are deficient with Zn whereas 13% is deficient of Fe.

Soil solution pH: The availability of both Fe and Zn decreases with increase in soil solution pH. In pH range of 7.5-8.5 Fe availability is quite lower and at pH 8.0 soil solution Fe is in equilibrium with Fe contents mostly $Fe(OH_3)$ giving a soluble Fe concentration of $10^{-10.4}$ molar which is not adequate for plant growth. The solubility of Zn is also highly pH dependent and decreases 100 fold with each unit increasing pH. The Zn deficiency in plant is expected in alkaline soil, where Zn concentration in soil is between 10^{-8} to 10^{-10} M.
Mechanism of Zn fixation other than pH: The mechanisms other than pH that are responsible for the Zn fixation include complex formation with organic matter, occlusion in minerals through precipitation of other phases, diffusion into microspores and inter-particle spaces, solid phase diffusion and co precipitation with other minerals. Precipitation of Zn as insoluble franklinite ($Zn\ Fe_2O_4$) and ZnS in acidic soil and $Zn\ CO_3$ in calcareous soil.

Plant factors affecting Fe and Zn Concentration

Root characters: The cultivars that produce fine roots can explore large volume of soil and hence can uptake Fe and Zn more efficiently. So it is highly desirable to breed the species with a more efficient root system that is capable of mobilizing Fe and Zn in deficient soil.

Phytosiderophores: Phytosiderophores are the organic substances produced by the plants under Fe and Zn deficient condition. Zn PS (Zinc phytosiderophores) possess a greater ability to complex Zn and enhance its mobility in the rhizosphere and root apoplast. ZnPS has similar structural confirmation as FePS and similar regulatory mechanism. For the biosynthesis and/ or, release of PS under Zn and Fe deficiency.

Organic acids: Zn deficiency increases root exudation of organic acids such as oxalate, citrate, malate etc. greater the exudation of oxalates and citrate higher the tolerance of rice cultivars to Zn deficiency.

Zn utilization at the cellular level: The activity of carbonic anhydrase (CA) and superoxide dismutase (SOD) are decreases due to deficiency in Zn. When Zn was supplied to Zn-deficient plant, Zn inefficient genotypes of wheat lost the ability to increase CA activity, while Zn efficient wheat genotypes showed a high increase in CA activity.

Translocation in plants: Zn is highly mobile within the plant system and foliar applied Zn is translocated to leaves both above and below the treated leaf as well as to the root tips. The enhanced capacity of genotypes for Zn translocation from root to shoot and its utilization under reduced Zn supply has been shown to contribute to Zn efficiency in wheat genotypes.

Mechanism of Zn accumulation in Grain: In wheat, the xylem discontinues at the base of the grain so Zn has to enter only through the phloem, while there is no such discontinuation of xylem in rice and Zn can enter the grain directly through the xylem. Therefore, in wheat, a large proportion of Zn in grain comes through the remobilization of Zn from the leaves during the grain filling stage.

Agronomic biofortification is the easiest and fastest way for biofortification of cereal grains with Zn, Fe or other micronutrients in developing countries, where cereals are the staple food, which is the only way to reach to the poorest of the poor rural masses, who will never have money to buy mineral supplements nor can afford to improve the components of their diet by incorporating the animal proteins. Foliar application is better and require less amount of Fe and Zn fertilizers than their soil application. However, a better understanding of the various reactions that a micro mineral nutrients undergo in soil and the mechanisms involved in their absorption and translocation in plants, specially to grain, is necessary.

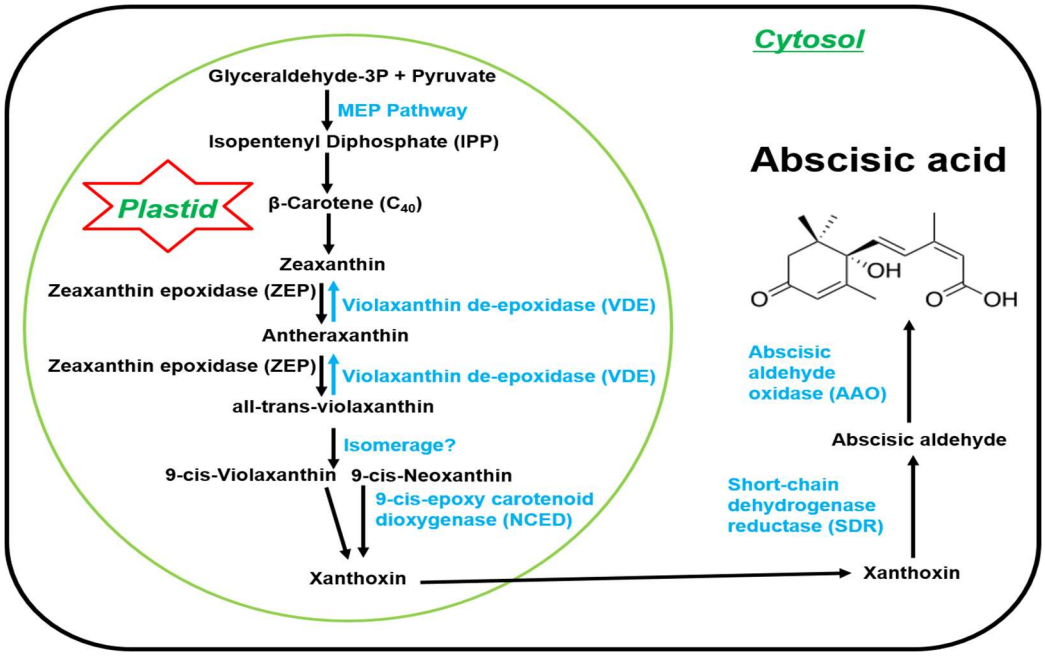
Abscisic acid and its role in higher plants

Dr. Mahipal Singh Kesawat | Assistant Professor, Genetics and Plant Breeding

Abscisic acid (ABA) is one of the class of phytohormone, which is regarded a stress hormone. It was first identified and characterized by Frederick T. Addicott and his associate at California in 1963 while he has been studying about a compound responsible for abscission of cotton fruits. Two compounds were isolated named as abscission I and abscission II. However, some other groups also discovered same compound at the same time and called dormin because they thought that it has an important role in bud dormancy in woody plants. Later all plant physiologists were agreed to call it ABA.

Biosynthesis of ABA

It is sesquiterpenoid (15-carbon) which is derived by mavalonic (MEP) and isopentenyl diphosphate (IPP) pathways in chloroplast, plastid and partially in the cytosol. ABA biosynthesis begin from the β-carotene through an oxidative cleavage reaction. The conversion of zeaxanthin, antheraxanthin and all trans-violaxanthin is catalyzed by zeaxanthin epoxidase (ZEP) while antheraxanthin is the intermediate product. All–trans-violaxanthin is converted to 9 -cis-neoxanthin or 9-cis-violaxanthin by the 9-cis-epoxy carotenoid dioxygenase (NCED), which yields a C15 intermediate product called xanthoxin and exported to the cytosol where xanthoxin is converted to ABA by two enzymatic reactions. Xanthoxin is converted to an ABA aldehyde by short-chain alcohol dehydrogenase/reductase (SDR). Finally, oxidation of the abscisic aldehyde to ABA is catalyzed by the abscisic aldehyde oxidase (AAO). The transport of ABA can occur through xylem, phloem and parenchyma cells.



Schematic representation of ABA biosynthesis in higher plants.

Role of ABA in higher plants

ABA has been implicated in diverse plant developmental processes including seed germination and maturation, seedling growth, bud dormancy, stomatal regulation, control the organ size, flowering, senescence and response to plant pathogen. ABA is especially crucial for plants in the response to abiotic stresses such as cold, freezing, drought, salinity, high temperature stress, heavy metal ions and UV radiation. ABA also inhibits shoot growth, however, promote the growth of roots. Further, ABA induces seeds to synthesize storage proteins and regulate the induction and maintenance of dormancy. Moreover, ABA induces gene expression of proteinase inhibitors in response to wounding which may explain its crucial role in pathogen defense. Transcriptional profiling studies in model species also demonstrated that 8 to 10% of plant genomes are either induced or suppressed by ABA at a single developmental stage. Tremendous progress has been made in past two decade to understand the intricate regulatory network of ABA signaling and biosynthesis. However, there are still large gaps in our understanding at the molecular level. Therefore, dissection of intricate regulatory network is necessary to understand the functions of essential regulatory genes and enzymes have been involved in the ABA signaling and biosynthesis. ABA signaling pathways are critical targets to enhance crop production under climate change scenarios.

Marker Assisted Breeding: A Boon for Conventional Breeding Approach

Dr. Anupama Singh | Assistant Professor, Genetics and Plant Breeding

In spite of optimism on conventional breeding for continued yield improvement, new technologies such as DNA markers serve as a new tool to detect the presence of allelic variation in the genes underlying the economic traits. DNA markers have enormous potential to improve the efficiency and precision of conventional plant breeding *via* marker-assisted selection (MAS) by reducing the reliance on laborious and fallible screening procedures. Marker assisted selection (MAS) is a powerful tool for the indirect selection of difficult traits at an early stage before production of the next generation, thus speeding up the process of conventional plant breeding and facilitating the improvement of traits that cannot be improved easily by conventional methods (Ribaut and Hoisington, 1998). MAS is most useful for traits where phenotypic evaluation is less cost effective or difficult, mostly the polygenic traits with low heritability and highly influenced by the environment and pyramiding different sources of disease resistance that have similar phenotypes, hence, MAS may also offer the opportunity to address the goals not possible through conventional breeding. In MAS, a phenotype is selected on the basis of genotype of the marker/trait. There

are different schemes of MAS which are assisting the various conventional breeding approaches. These are as follows;

i) Early generation marker assisted selection: Molecular markers can be employed at any stage of a plant breeding programme. Hence, MAS has great advantage in early generation selections by eliminating undesirable gene combinations especially those that lack essential disease resistance genes. MAS-based early generation selection not only selects suitable gene combinations but also ensure a high probability of retaining superior breeding lines.

ii) Marker-assisted backcross breeding (MABB): Backcrossing is used in plant breeding to transfer favourable traits from a donor plant/parent into an elite genotype (recurrent parent) which is agronomically superior variety of that zone/region lacking one or few traits of economic importance. In backcross method, the original cross is repeatedly backcrossed with recurrent parent to obtain maximum of genome from recurrent parent. There are three levels of selection in backcross breeding programme, where markers may be applied. The first and most important is foreground selection, which is selection of target gene/trait. Second is background selection; to accelerate the recovery of the recurrent parent genotype and the third is recombinant selection, to select backcross progeny having the target gene with tightly-linked flanking markers in order to minimize linkage drag.

iii) Marker-assisted recurrent selection (MARS): The improvement of complex traits via phenotypic recurrent selection is generally possible, but the long selection cycles impose restrictions on the practicability of this breeding method. With the use of markers, recurrent selection can be accelerated considerably and several selection-cycles are possible within one year, accumulating favourable QTL alleles in the breeding population.

iv) Marker assisted gene pyramiding: Pyramiding is the process of simultaneously combining multiple genes/QTLs together into a single genotype. This is possible through conventional breeding but extremely difficult or impossible at early generations. Using conventional phenotypic selection, individual plants must be phenotypically screened for all traits tested. DNA markers may facilitate selection because DNA marker assays are non-destructive and markers for multiple specific genes/QTLs can be tested using a single DNA sample without phenotyping. The most widespread application for pyramiding has been for combining multiple disease resistance genes.

v) Combined marker-assisted selection: The strategic combination of MAS with phenotypic screening is known as 'combined MAS'. It may have advantages over phenotypic screening or MAS alone in order to maximize genetic gain. This approach could be adopted when additional QTLs controlling a trait remain unidentified or when a large number of QTLs need to be manipulated. In some situations, a marker assay may not predict phenotype with 100% reliability. However, plant selection using such markers may still be useful for breeders in order to select a subset of plants using the markers to reduce the number of plants that need to be phenotypically evaluated. This may be particularly advantageous when the cost of marker genotyping is cheaper than phenotypic screening.

Advantages of MAS over conventional breeding methods;

i) **Time saving:** It will save the time by substituting the complex field trials for phenotypic selection with molecular marker test.
ii) **Stacking of genes for a single trait:** MAS allows breeders to identify the presence of multiple genes/alleles related to a single trait, when the alleles do not exert individually detectable effects on the expression of the trait.
iii) **Early detection:** MAS allows detection of alleles for desirable traits in the early growth period *i.e.* in the seedling stage itself well before the trait is expressed phenotypically.
iv) **Recessive genes:** In conventional breeding approaches, to detect the traits associated with recessive genes, an extra step of selfing is required. While, MAS allows breeders to identify heterozygous plants that carry a recessive allele of interest whose presence cannot be detected phenotypically
v) **No Seasonal barriers:** MAS offers potential savings compared with conventional selection when it is necessary to screen for traits whose expression depends on seasonal parameters. Using molecular markers, at any time of the year, breeders can screen for the presence of an allele (or alleles) associated with traits that are expressed only during certain growing seasons.
vi) **No Geographical boundaries:** MAS is essential to screen for traits whose expression depends on geographical considerations. Using molecular markers, breeders in one location can screen for the presence of an allele (or alleles) associated with traits expressed only in other locations.
vii) **Multiple genes, multiple traits:** MAS offers potential advantage when there is a need to select for multiple traits simultaneously. With conventional methods, it is often necessary to conduct separate trials to screen for individual traits.

Recent developments in DNA marker technology together with the concept of marker-assisted selection provide new solutions for selecting and maintaining desirable genotypes. Marker assisted selection can be

performed in early segregating populations and it is very important for pyramiding the multiple disease resistance genes together in a single plant, with the ultimate goal of producing varieties with durable or multiple disease resistance. Thus, with MAS it is now possible for the breeder to conduct many rounds of selection in a year. Now a day, it is necessary to integrate molecular marker technology into existing plant breeding programmes all over the world in order to allow researchers to access, select, transfer and combine genes at a faster rate and with a precision which was not possible earlier. However, potential limitations that might restrict the wide application of MAS in breeding were high costs and non-availability of suitable markers but, not as MAS is less efficient compared to phenotypic selection.

Bio-technology tools for crop improvement in vegetable crops

Ms. Meenakshi Badu | Assistant Professor, Horticulture

Over the past few decades, biotechnology bringing about a revolution in the field of biology. Biotechnology tools are useful for the improvement of characteristics of micro-organisms, animals, plants, food derived and preserving the environment. These tools have greatly contributed to the enhanced agriculture production, improved nutritional quality, abiotic and biotic resistance.

Tissue culture

Tissue culture is the *in vitro* multiplication of tissues or cells in aseptic and controlled artificial conditions. The term 'tissue culture' was coined by American pathologist Montrose Thoms Burrows. Tissue culture is an important tool for the study of the biology of cells, tissue, from multicellular organisms, speed-up the multiplication process for vegetatively propagated crops, production of double haploid, eradicate diseases transmitted by planting material, conserve endangered plant species, production of secondary metabolites and recombinant proteins, large scale production of artificial seeds through somatic embryogenesis and regeneration of transgenic plants with desirable traits. There are different kind of plant tissue culture techniques such as meristem culture, protoplast culture, embryo culture, anther culture, bud culture, callus culture and cell suspension culture.

Molecular marker

Molecular markers are heritable differences in nucleotide sequences of DNA at the corresponding position on homologous chromosome of two different individuals, which follow a simple Mendelian pattern of inheritance. There are different types of molecular markers listed in Table 1. DNA-based molecular markers are versatile tool in the field of taxonomy, physiology, embryology and genetic engineering. DNA markers

that can be routinely employed in various aspects of plant genome analysis such as characterization of genetic variability, genome fingerprinting, genome mapping, gene localization, analysis of genome evolution, population genetics, taxonomy, plant breeding, and diagnostics.

Table 1: Important characteristics of some molecular marker

	RFLP	**Mini Satellites**	**RAPD**	**Micro Satellites**	**ISSR**	**SSCP**	**CAPS**	**SCAR**	**AFLP**
Genomic abundance	High	Medium	High	High	Medium-High	Low	Low	Low	High
Level of polymorphism	Medium	High	Medium	High	Medium	Low	Low-Medium	Medium	Medium
Locus-specificity	Yes	No/Yes	No	Yes	No	Yes	Yes	Yes	No
Codominance of alleles	Yes	No/Yes	No	Yes	No	Yes	Yes	No/Yes	No/Yes
Reproducibility	High	High	Low	High	Medium-High	Medium	High	High	Medium -High
Labour-intensity	High	High	Low	Low	Low	Low-Medium	Low-Medium	Low	Medium
Technical demands	High	High	Low	Low-Medium	Low-Medium	Medium	Low	Low	Medium
Operational costs	High	High	Low	Low	Low-Medium	Low-Medium	Low	Low	Medium
Development costs	Medium-High	Medium-High	Low-Medium	High	Low	High	Medium	Medium	Low
Quantity of DNA Required	High	High	Low	Low	Low	Low	Low	Low	Medium
Amenability to automation	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes

Recombinant DNA technology

Recombinant DNA (rDNA) is piece of DNA formed by the combination from two DNA strand that are introduced into another organism to produce desirable traits that are of valuable to medical science, agriculture and industry. rDNA is employed for identification, mapping and gene sequencing, to elucidate their function, production of pharmaceutical proteins, improved nutrition quality, herbicide resistance crop, biotic and abiotic tolerant crops. There are three main things required to create rDNA: 1. Enzyme (restriction enzyme, DNA polymerase and DNA ligase). 2. vector and 3. Host organism. The restriction enzyme will help to cut the DNA molecule while polymerase will be need for DNA synthesis and ligase for binding. Vector is a vehicle that carry the desired gene into the host organism. The most commonly used vectors are plasmid. The host organism is the cell in which rDNA is mobilized for the amplification. rDNA technology has five steps: 1. Cutting the gene of interest by restriction enzyme. 2. Amplification of desired gene by PCR. 3. Inserting the genes into the vectors. 4. Transferring the vector into the host organism and 5. Obtaining the product of recombinant genes (Figure 1).

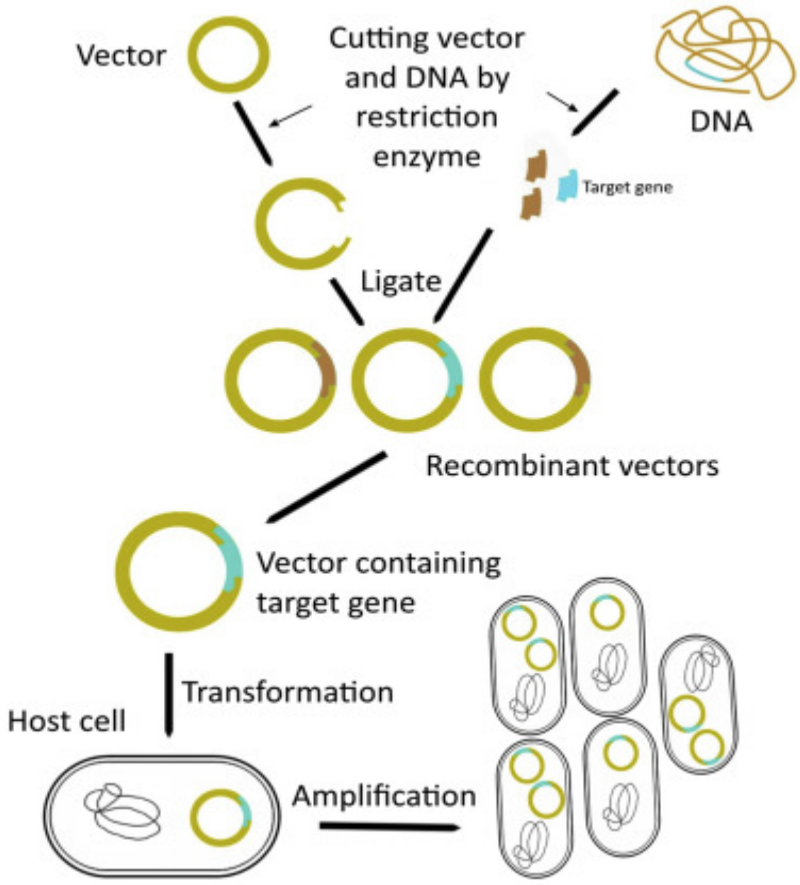


Figure 1: Schematic process to create rDNA.

How minerals defend the plant against diseases?

Mr. Prajjal Dey | Assistant Professor, Crop Physiology

Plant Pesticides are applied to the plant by foliar application to kill insects by insecticides, weeds by weedicides, fungus by fungicides and make the plants free from diseases. However, these plant pesticides not just kill harmful organisms, but also kill useful soil flora and fauna. Plant pesticides also deteriorate soil nutrients in the soil (Nitrogen, Phosphorous, Potassium, Calcium, Magnesium, Sulphur and micro nutrients such as Iron, Manganese, Zinc, Copper, Molybdenum, Boron, Chlorine). This is the reason why farmers need

to get rid of these toxic chemicals as soon as possible. Without the application of pesticides how the farmers can protect their plants from insect pest attack, fungus, bacteria's, rodents, mites etc.

What are plant nutrients and how it works?

Sixty (60) elements have been reported from plant ashes and out of these **thirty** (30) are present in all plants. Again out of these, **sixteen** (16) are essential nutrients that are necessary for a plant's growth and development-

Natural Nutrients (freely available in the atmosphere) – Carbon (C), Hydrogen (H), and Oxygen (O).

Primary Nutrients: Nitrogen (N), Phosphorous (P), and Potassium (K).

Secondary Nutrients: Magnesium (Mg), Calcium (Ca), and Sulphur (S).

Micro Nutrients: Iron (Fe), Manganese (Mn), Zinc (Zn), Copper (Cu), Molybdenum (Mo), Boron (B), Chlorine (Cl). Other micronutrients like nickel, chromium, Iodine, sodium, selenium, silicon, cobalt and tin are required by some specific plants.

All **sixteen** (16) essential plant nutrients play an important role independently in plant metabolism for growth and development. The function of one cannot replace the function of others. For that reason, a farmer has to ensure that he adopts the method of **Balanced Plant Nutrition** by applying all the necessary nutrients including both macro and micronutrients.

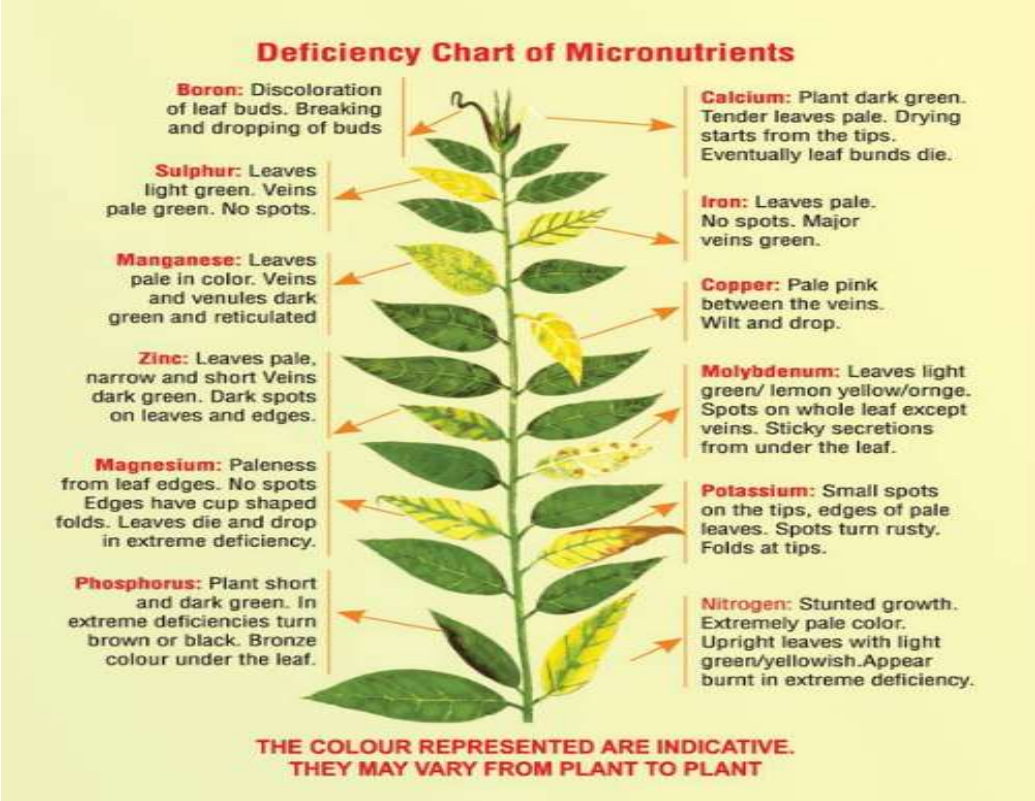


Fig 1: Deficiency symptoms of essential nutrients

There are many advantages by the application of beneficiary plant nutrients to the plants. Plant nutrients avoids antagonistic effect between the nutrients, minimize environmental pollution. It maintains the soil productivity, health, structure and texture of the soil for a longer period of time. Application of mineral nutrients also improves the qualitative and quantitative yield. Application of plant nutrition enhance resistance against diseases and pest attacks. Then what's the need of pesticides when the crop would be free from disease with zero tolerance towards pest and pathogens.

The standing stature of the crop reflects the healthy vegetative growth and seldom conveys nutrient deficiency symptoms. In addition, the Balanced Plant Nutrients exhibit resistance against diseases, pests and other abiotic stress in the environment.

How plant nutrients protect crop plants from disease and pests?

- **Selenium**: A beneficial nutrient protecting plants from insects, act as a repellent against spider mites, aphids and caterpillars feeding on plants. Selenium in small concentration is toxic to pests. Moreover, this beneficial nutrient ameliorates resistance to fungal disease in almost all the plants especially in Indian mustard.
- **Silicon:** Being a major component of cell wall rigidity, silicon reduces the severity of fungal attack particularly for foliar pathogens. It also forms physiological barrier for penetration of fungal hyphae

and their growth. Silicon also hinders virus growth and proliferation transmitted by fungi and sucking insects to the crop reducing virus infection.

- **Nickel**: Effective in paddy protection against Blast (*Pyricularia oryzae*) and Brown spot (*Cochliobolus miyabeanus*) nickel minimizes severity of rust, scab, little leaf, leaf curl and rosetting.
- **Potassium**: Potassium dosage in proper quantity increases resistance to several diseases in vegetable while deficiency in trivial amount might attract infections and insects. Fungal diseases, insects and mites, viruses, nematodes and harmful bacteria have been widely reported to be decreased by potassium application.
- **Magnesium**: Referred as overall plant health contributor in the plant. It acts as a defense against pathogens (soft rotting) as well as to a number of diseases like Bacterial Blight in Cotton, Wilt and fungal diseases in wheat, Soybean root rot, Potato Gangrene, Peanut Leaf spot etc.
- **Calcium:** One of the most essential elements of the cell wall, it develops stronger tissues and doesn't allow fungi and to penetrate across the surface cells. Thus serves as a barrier to fungus in addition it doesn't allow the bacteria to spread in the plant tissue.

Phalsa: A rich source of nutraceauticals

Ms. Tanushree Sahoo | Assistant Professor, Horticulture

Phalsa is an indigenous fruit crop that is also used as a folk medicine. The ripe phalsa fruit is consumed as fresh form and also processed into delicious, refreshing drinks, which is enjoyed during hot summer months in India. It is commercially cultivated in the states of Punjab, Haryana, Rajasthan, Uttar Pradesh, Madhya Pradesh and parts of Chattisgarh and on limited scale in the states Maharashtra, Gujarat, Andhra Pradesh, Bihar and West Bengal.

Scientific name: *Grewia subinaequalis;* **Family:** Tilliaceae; **Origin:** India

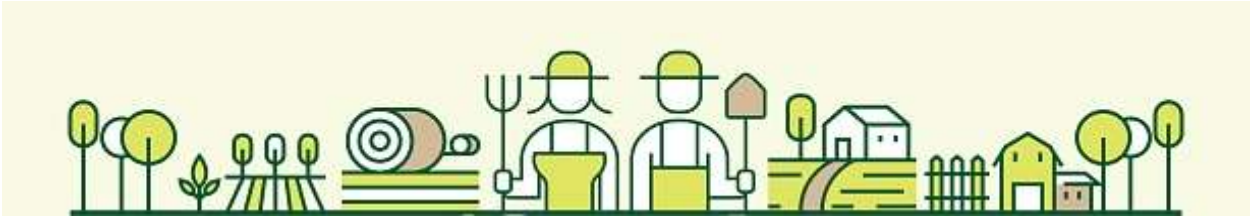
Phalsa is a large bushy plant, which can grow into a tree, if left unpruned. The fruit is botanically called drupe, small in size and red colour. The edible portion varies from 69-93 percent (Roy *et al*., 1995). Ripe fruits are sub-acidic and good source of vitamin A and C with fair source of phosphorus and iron. Fruits

contain 50-60 per cent juice; 10-11 per cent sugar and 2.0 -2.5 per cent acid (excellent for making juice and squash). The presence of glucose, fructose and maltose has been reported in ripe fruits by some workers. Among the organic acids, citric acid is predominant with traces of malic acid. The vitamin C content ranges between 27.39 and 39.5 mg/100 g. Phalsa seed contains 7.17 per cent crude fat. Seed coat and the kernel contain 2.0 and 23.7 % oil respectively which is rich in linoleic acid. Pigment responsible for the colour of phalsa fruit is anthocyanin, viz. delphinidin-3-glucoside and cyanidin-3-glucoside.

Nutritional and medicinal value;

- Phalsa fruit drink has cardio-tonic properties.
- Bio-fortified fruit juice has enhanced level of nutraceuticals.
- Phalsa juice has anti-diabetic due to its low glycemic index.
- Phalsa is source of essential amino acids such as threonine in pulp and methionine in seeds.
- Phalsa juice helps to in controlling obesity and prevents the cardio-vascular diseases.
- Fruit or fruit juice is helpful in anorexia, indigestion, thirst, stomatitis, cough, asthma, heart, throat, tuberculosis and sexual disability blood, spermatorrhoea, fever and diarrhea and liver disorders *etc*.
- Phalsa root bark is useful to cure urinary tract infections and rheumatism.
- Phalsa leaves are used to give relief from rashes, and various skin irritations and helps in healing wounds and cuts.

Phalsa fruits not only provide essential nutrients, but also possess high antioxidant activity. It can be used for waste land management purpose and highly suited for cultivation under arid and semi-arid regions. The shoots of the plants after pruning can be utilized either for making baskets or as a support to the vegetable crops. Therefore, there should be efforts to conserve the natural genetic resources and popularize its cultivation among the farmers' community of our country.



Students | Space

Indigenous knowledge about soil

Mr. Akshay Bankar | B.Sc. (Hons.) Agriculture

The farmers have accumulated some wisdom about agriculture practices and the agro eco-systems. The soil is one of the components of it. A study was conducted to know farmer's knowledge of soil and soil fertility in selected area *Gond*, *Baiga* and *Pradhan* tribal communities of Dindori district, Madhya Pradesh.

The soil of locality has been broadly classified by farmers into two categories based on their use which are agriculture and non-agriculture. The farmers have classified soil on the account of topography, texture, colour, stickiness, depth and cropping compatibility. They perceive soil fertility in terms of crop yield, both qualitative and quantitatively, which is obtained from particular field. More the crop yield from soil, more fertile it is. Based on their observations, farmers classified soil in following classes: i) Kalimitti is ranked first in terms of soil fertility among all soils. It has great potential, high productivity and high moisture retention

capacity, mainly cash crops are grown. ii) Sehra soil is second most fertile soil for production, well drained and moderately sloppy, to cultivate Kodo, pea, Red gram, linseed, Green gram and Black gram; iii) Bharra and Mooth bharra soils, basically light textures soil and slightly sloppy to grow mixed cropping of cereals and oilseeds to fulfil need; iv) Bharra and Kochai, due to low soil retention capacity and low response to fertilizer. This signifies the wisdom of farmer which they have accumulated from period of time and by years of practices.

Plants as aware and intelligent beings

Ms. Mrinali Mahanta | B.Sc. (Hons.) Agriculture

Plants are sessile organisms, they cannot run away from the undesirable conditions unlike animals and they have adapted to it or else die. They are exposed to various biotic stresses like animals, pathogens, pests etc. and abiotic stresses like extreme temperatures ranges, salinity, water scarcity, excess of water, sudden climatic changes etc. When exposed to such stresses they respond through specific ion channels and kinase pathway, reactive oxygen species (ROS) and phytohormones like ABA, salicylic acid, ethylene etc. It is also seen that plants release Gamma Amino Butyric Acid (GABA), which is surprisingly is a neurotransmitter seen in case of animals and is present in huge quantities in brain. This reduces the neural excitability hence used in the medication for depression, anxiety and sleeping disorders.

In various experiments conducted by various scientists it can be assumed that the plants have an analytical and analogous structure because they tend to remember the events of stress, the stimuli, process it, integrate it and respond to them accordingly. This can be reason, plants have great problem solving abilities, which can also be seen in case of phototropism and hydrotropism. Memory can be the reason that the wild varieties of the plants are more hardy and can perform under stress conditions.

Some experiments also prove that plants can hear sounds that mean they can pick up the vibrations due to the mechanical waves of sound. In one of the experiment plants reacted to the munching recording of the caterpillar by increasing the concentration of the various hormones and GABA, even if they were not affected by it. There are various instances where the plants grow better when they are talked to or when music is played around them. This is not any postulate or assumption. I myself have experienced it. One of neighbor is known to have a green thumb and a fabulous garden within a very small area and plants within her garden were healthier and grow nicely mine even if the plants had the same conditions. She used to talk to plants used like one did to their children, I used to wander why she used to do it until now. The

plants even tend to take energies around them and they grow better in happy environment just like we are more productive when the environment is positive.

The plants even communicate. They talk to the neighboring plants and microbes through various chemical signals. They are really good neighbor because they tend to make the plants nearby them about the upcoming unfavorable conditions. They even communicate to use through the various small signals like change in leaf colour, size and shape. Understanding their language will enable us to go more close towards and prevent a major problem.

All these points show that the plants are extremely aware and intelligent being even if they don't have a brain.

Turmeric: Traditional knowledge and patent issues

Ms. Athira Chandran | B.Sc. (Hons.) Agriculture

Traditional Knowledge is a living body of knowledge that is developed, sustained and passed on from generation to generation within a community, often forming part of its cultural or spiritual identity. As per that it is the knowledge that has ancient roots and is often informal and oral, is not protected by

conventional intellectual property protection systems. India has a limitless diversity in this traditional knowledge. But unfortunately, We, Indians are not giving importance to our traditional knowledge for much kind of things. We are busy with running behind the western culture.in this scenario; many multinational companies are take advantages over our traditional knowledge, Eg. Turmeric. Turmeric, as a tropical herb, it is widely grown in south-east India. Turmeric powder is widely used in India as a medicine, a food ingredient and a dye to name a few of its uses. For instance, it is used as a blood purifier, in treating the common cold, and as an anti-parasitic for many skin infections. It is also used as an essential ingredient in cooking many Indian dishes.

Turmeric lattes are gaining international popularity but they also symbolize the threat faced by traditional knowledge with commercial exploitation. once it is noticed that cafes and restaurants from across Sydney to San Francisco have introduced the drink - a combination of milk and ground halide to their menu. However, the use of turmeric in milk is not something new. More commonly known as *halide doodh* in India, it has been consumed for centuries in India to treat sore throat and cough. Turmeric; the active ingredient in turmeric milk has important medicinal properties like purification of blood, alleviates headaches and keep organs like the skin and lungs healthy.

Today, traditional knowledge associated with turmeric is vulnerable to commercial exploitation. In 1995, the United States awarded patent on turmeric to University of Mississippi medical centre for wound healing property. The claimed subject matter was the use of 'turmeric powder and its administration', both oral as well as topical, for wound healing. An exclusive right has been granted to sell and distribute. But after realizing the importance of protecting our wisdom and knowledge, The Indian Council for Scientific and Industrial Research (CSIR) had objected to the patent granted and provided documented evidences of the

prior art to USPTO (United State Patent and Trademark Office). Though it was a well-known fact that the use of turmeric was known in every household since ages in India, it was a herculean task to find published information on the use of turmeric powder through oral as well as topical route for wound healing. Due to extensive researches, 32 references were located in different languages namely Sanskrit, Urdu and Hindi. Therefore, the USPTO revoked the patent, stating that the claims made in the patent were obvious and anticipated, and agreeing that the use of turmeric was an old art of healing wounds. Therefore, the TK that belonged to India was safeguarded in Turmeric case.

But the battle is not ending here, it is still continuing for many other of our own traditional knowledge and our own products, Like Neem, Basmati Rice etc. And it will be continuing until and unless we are really get aware about our own wisdom and knowledge. The new generations "TECH WORMS" will be open their eyes someday and that will be make a new revolution for protecting our wisdom and knowledge, in fact that day is not so far. Let's hopefully wait for that day

Water: Elixir of life getting scare

Mr. R. Ananthakrishanan | B.Sc. (Hons.) Agriculture

Before we turn towards discussions about agriculture, its development or high funda planning about agriculture, we should know the upcoming risks on the availability of major input, water, in the forthcoming days. When a discussion is held on freshwater, it is often limited to humans and animals who drink it for sustaining their lives. But they never think that fresh water is a major component needed in agriculture too. Rather than listing every single reasons for water scarcity, it is more effective to generalize it as result of anthropogenic exploitation of resources.

Without heading towards digging out each reasons, let's talk how to tackle upcoming water scarcity. We should first classify the solutions broadly into two, based on its direction of action. First being a conservative approach and second being a remedial approach. Former is to save water using watershed management

practices which will conserve both water and land resources in a holistic manner. This is a successful practice in those areas where water is freshly available to be instantly utilized for agriculture. And the latter being a remedial approach is to manage different types of water as per the availability. These days there are specializations in saline agriculture as well as waste water management. Such specializations have a great impact which at least can accommodate numerous tolerant crops to pave a successful path towards a bright future of agriculture.

smart kind of solutions are achieved only when this conservatory and remedial approaches are collectively practiced. Conservation of these resources has been a need for developing sustainability and stability. Let's hope humans will sensibly behave and take actions appropriately to make this world a better place to live in.

Indian Agriculture: A crisis or an armoury of possibilities

Mr. Subham Ghose | B.Sc. (Hons.) Agriculture

Agriculture is the most important sector of Indian Economy. Indian agriculture sector accounts for 18 per cent of India's gross domestic product (GDP) and provides employment to 50% of the countries workforce.

India is the world's largest producer of pulses, rice, wheat, spices and spice products. India has many areas to choose for business such as dairy, meat, poultry, fisheries and food grains etc. India has emerged as the second largest producer of fruits and vegetables in the world.

India is an agriculture based country, where more than 50% of population is depend on agriculture. This structures the main source of income. The commitment of agribusiness in the national income in India is all the more, subsequently, it is said that agriculture in India is a backbone for Indian Economy. The contribution of agriculture in the initial two decades towards the total national output is between 48% and 60%. In the year 2001-2002, this contribution declined to just around 26%.

While agriculture's share in India's economy has progressively declined due to the high growth rates of the industrial and services sectors, the sector's importance in India's economic and social fabric goes well beyond this indicator. First, nearly three-quarters of India's families depend on rural incomes. Second, the majority of India's poor (some 770 million people or about 70 percent) are found in rural areas. And third, India's food security depends on producing cereal crops, as well as increasing its production of fruits, vegetables and milk to meet the demands of a growing population with rising incomes. To do so, a

productive, competitive, diversified and sustainable agricultural sector will need to emerge at an accelerated pace.

Economists said that the GDP deflator for agriculture is negative for the first time in many years. In other words, farmers are earning less than what they were before. Indeed, if the recent marches to New Delhi by thousands of farmers are any indication, the farm sector has already sent up emergency flares.

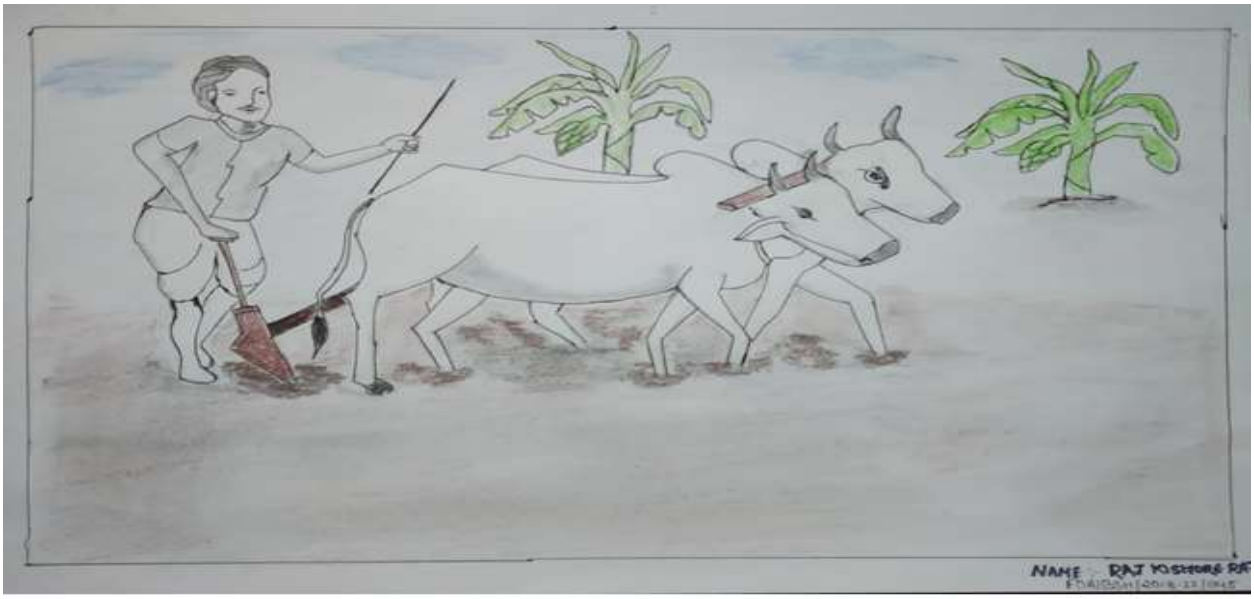
Major problems include raising agricultural productivity per unit of land, reducing rural poverty through a socially inclusive strategy that comprises both agriculture as well as non-farm employment, ensuring that agricultural growth responds to food security needs and the areas which need our attention are enhancing agricultural productivity, competitiveness, and rural growth, poverty alleviation and community actions, sustaining the environment and future agricultural productivity.

India is a global agricultural powerhouse. It is the world's largest producer of milk, pulses, and spices, and has the world's largest cattle herd (buffaloes), as well as the largest area under wheat, rice and cotton. It is the second largest producer of rice, wheat, cotton, sugarcane, farmed fish, sheep & goat meat, fruit, vegetables and tea. The country has some 195 m ha under cultivation of which some 63 percent are rainfed (roughly 125m ha) while 37 percent are irrigated (70m ha). In addition, forests cover some 65m ha of India's land.

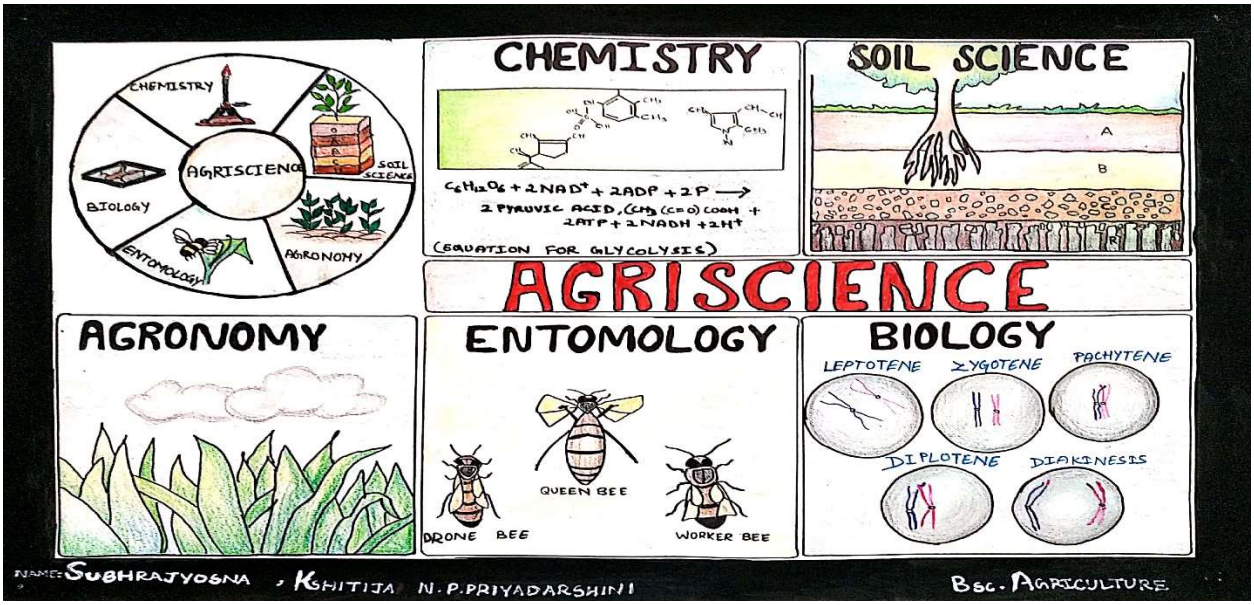
Most of the Indians are directly or indirectly depending on the agriculture. Some are directly attached with the farming and some other people are involved in doing business with these goods. India has the capacity to produce the food grains which can make vast difference in Indian Economy. To achieve targeted mark by the government it needs to provide support in case of land, bank loans and other machineries to the small farmers along with the big farmers with this we can expect some improvement in Indian economy.

So I urge everyone let's join hands together, actively take part in this transition phase of our nation, turn this agrarian crisis to the No.1 agricultural economy in the world.

Mr. Rajkishore | B.Sc. (Hons.) Horticulture



Mr. Sourav Ranjan Dash | B.Sc. (Hons.) Horticulture



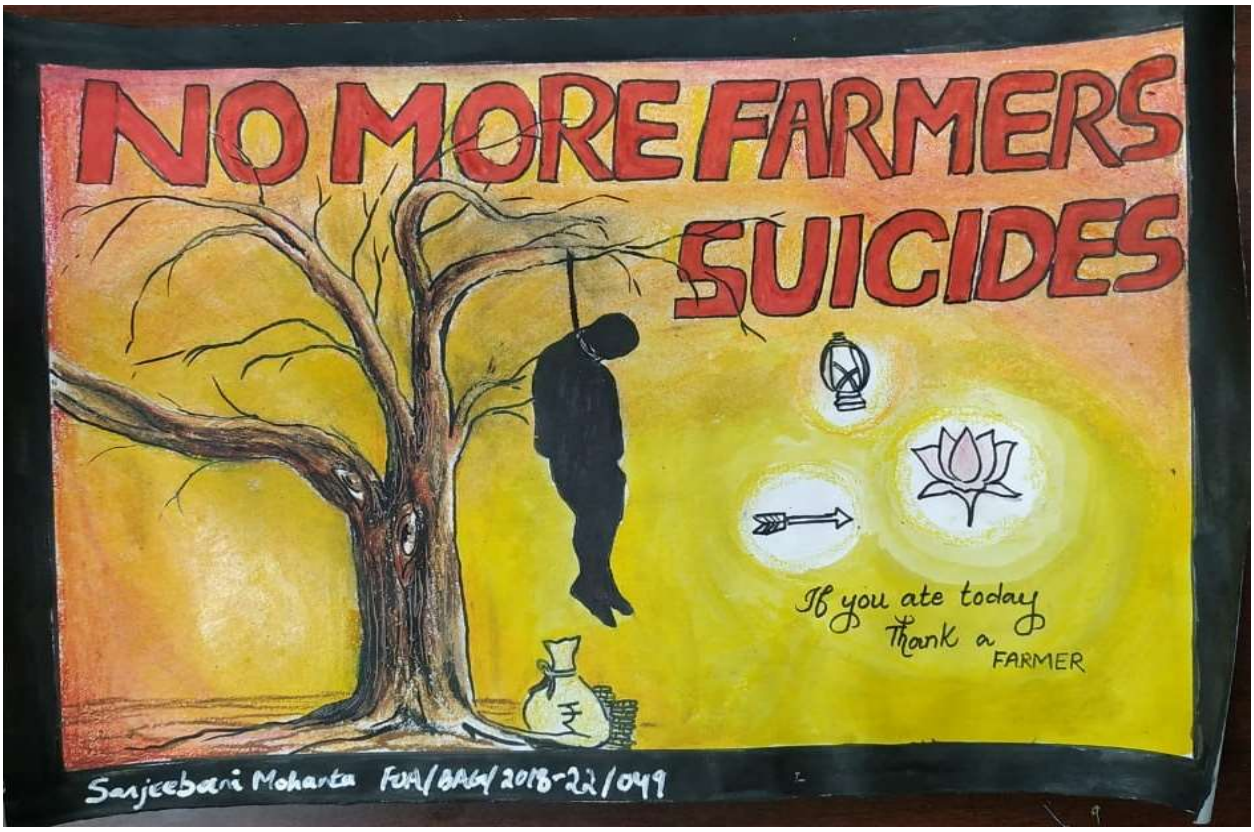
Do not let a tree lie

Do you know what trees think of you?
You are like their own child,
They provide you the purest oxygen,
And you give them pain in return!
You know what they hold for you?
Beautiful flowers, vegetables, fruits…
But you cut them down, scatter them around,
Harming your own mother, your own nature…
You leave them to die,
And you forget even to cry?
They bleed in pain, weep their heart out,
But as they cannot express,
Their feelings go in vain…
Today ask yourself, is that correct?
No, it isn't your heart will certainly reply.

Farmer: A person for you

Whole day works under the scorching sun,
But at night sleeps without fan,
He is a farmer, who struggles in pain…
He dies daily with a different death,
But want you to live with smiling face…
He is a man to provide you with food,
But barely serve himself a onetime meal…
He starves for you; He smiles for you…
He dies for you; He lives for you…
He is a person: with you; for you.
To value their sacrifices, understand their grief…
Help them to lead a life,
You are already living with.

Ms. Kshitija N.P. Priyadarshini | B.Sc. (Hons.) Agriculture



Ms. Sajeebani Mohanta | B.Sc. (Hons.) Agriculture

Ms. Smruti paik | B.Sc. (Hons.) Agriculture

Ms. Smruti paik | B.Sc. (Hons.) Agriculture

Fertile land

I can't let you grow in that piece of land
Where I find only sand and sand,
I will wait till spans until I get a fertile land;
Because I'm bonded with you
by an invisible band;

I don't want to use chemicals
rather I want you to grow naturally,
Not by the artificial means
but let the bond grow stronger anticipated,

I will plan and understand but can't disband,
to furnish you a suitable land
I'll wait till span, until I get a fertile land
Because I'm bonded with you
by an invisible band.

Ms. Smruti paik | B.Sc. (Hons.) Agriculture

I choose to honour you

Trees are pomes only God can write,
so serene, sublime & magnanimous,

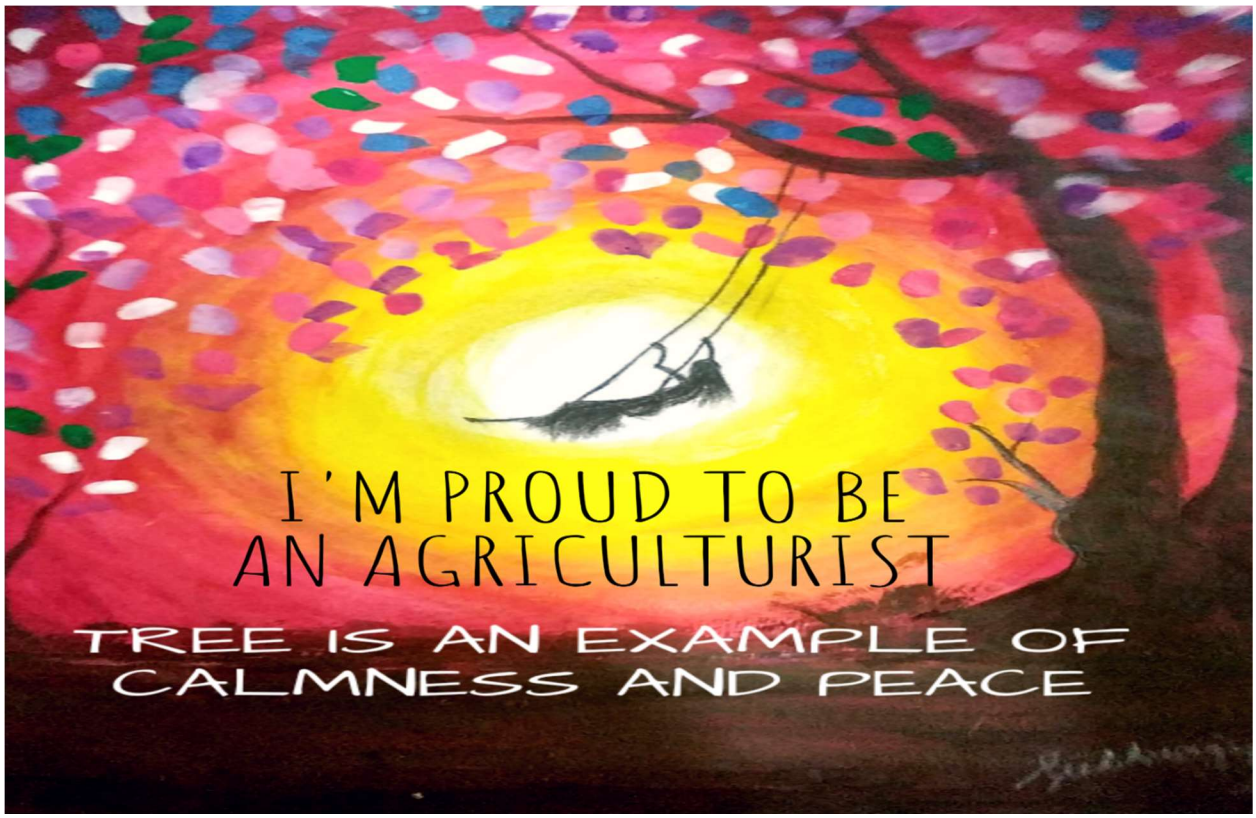
They are humble like mother,
strong and stout like father,
protect us like brother,
and care like sister.

Big or small does it matter?
They all provide us with food and shelter,

We can feel their love,
their act of kindness,
how they hurt themselves
to bring a smile on our face.

Tree itself is a poetry,
which only God can write.

Ms. Soumya Subhadarshinee | B.Sc. (Hons.) Agriculture



Ms. Subhrajyosna | B.Sc. (Hons.) Agriculture

Mr. Biswajeet Mishra | B.Sc. (Hons.) Agriculture

Students participated in YES+ course to help them realize their strengths and happy camaraderie while executing an activity.

Students also developed models to showcase a raja-yoga practices in agriculture. It provides them to apply the learning in the course Agricultural Heritage. Students are allowed to exercise freedom in expressing their thought process and concepts learnt in the classroom as visualize the concepts in the form of models.

Way forward

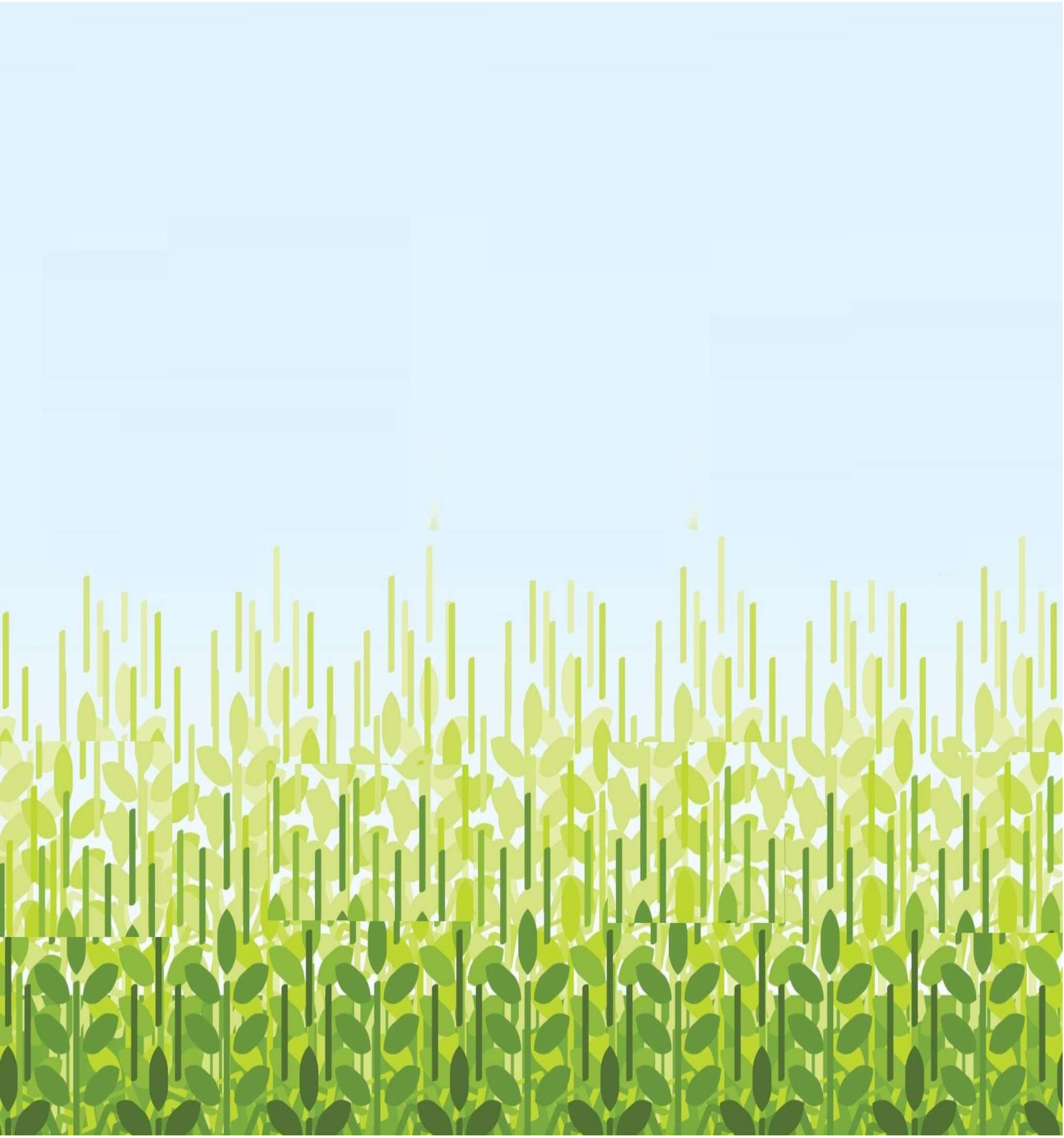
Faculty of Agriculture has seen a phenomenal growth in short time. However, sustaining the prospects of building it as centre of excellence calls for accruing several level of resources and logistics. In this direction, we have short-term plan to strategically taking initiative on action plans on **i) independent building with smart classrooms and necessary laboratories; ii) recruitment of faculty members with specific expertise; iii) development of farm; iv) creation of independent departments; v) accretion of logistics; vi) creation of central instrumental facility; and vii) initiation of research programs.**

We are proposing to start new programs **B.Sc. (Hons.) Food Nutrition and Dietetics**, **Diploma in Agricultural Technologies and Entrepreneurship.** We are take initiative to recruit students to pursue Ph.D. program.

Besides, we also have plan to conduct workshops, training program s and outreach activities. We positioning to initiate new programs and also strengthen the on-going program. Over a period, we would to like realize establishing the Faculty of Agriculture as Centre of Excellence in education and outreach activities in agricultural sciences.

the team

Faculty Members	Designation
Dr. S. Kumaraswamy	Professor
Dr. Chinmayee Mohapatra	Assistant Professor
Ms. Suvalaxmi Palei	Assistant Professor
Ms. Mandakini Kabi	Assistant Professor
Mr. Shehashish Routray	Assistant Professor
Mr. Subrata Kumar Mohanty	Assistant Professor
Dr. Anupama Singh	Assistant Professor
Dr. Mahipal Singh Kesawat	Assistant Professor
Ms. Meenakshi Badu	Assistant Professor
Mr. Prajjal Dey	Assistant Professor
Ms Tanushree Sahoo	Assistant Professor
Guest Faculty	
Mr. Biswajit Nayak	Assistant Professor
Dr. Anjala Devi	Assistant Professor
Mr. Prem Sukh	Assistant Professor
Visiting Faculty	
Dr. Damodara Parida	Professor, Emeritus
Mr. Debadatta Sethi	Visiting Faculty
Mr. D. P. Nayak	Visiting Faculty
Ms. Rituparna Mohaptra	Visiting Faculty
Ms. Prangya Paramita Sahoo	Visiting Faculty
Ms. Bijalaxmi Nayak	Visiting Faculty
Mr. Subrata Kumar Mohapatra	Visiting Faculty
Ms. Meenakshi Badu	Visiting Faculty
Staff Members	
Mrs. Lipsa Mohanty	Academic Assistant
Mrs. Sakshi Garg	Academic Assistant (Resigned)
Mr. Rasmi Ranjan Patra	Laboratory Assistant
Mr. Bijaya Kumar Mohanty	Helper



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