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Horticulture Research Amidst Current Challenges in Northeast India

Horticulture in Northeast India has always been the torch bearer to science enthusiasts, considering the region popularly acclaimed as a hot-spot for many crops. Researchers have been intensively experimenting to ensure path-defining breakthroughs from various angles, however, with limited success due to stalemate research blue-prints adopted over the years for this region. The paper discusses the current challenges in research of the horticulture sector and the way out for the Northeast India.

NORTHEAST region is endowed with enormous plant-soil-climate diversity and out of 800 species of wild edible crops in India about 300 are in Northeast India. The region can boast of as many 16 GI (Geographical indicators) tags in horticultural crops *viz*., Naga Mircha, Naga Tree Tomato, Arunachal Orange, Sikkim Large Cardamom, Mizo Chilli, Assam Karbi Anglong Ginger, Tripura Queen Pineapple, Tezpur Litchi, Khasi Mandarin, Kachai Lemon, Tamenlong Orange, Memong Narang, Kaji Nemu, Hathei Chilli, Naga Cucumber and Mizo Ginger, which is an indication of stewardship in horticulture research and development opportunities. Amidst these glittering accomplishments, horticulture research in Northeast India has to be relooked afresh keeping in mind the important priorities catering to pressing multi-pronged demands of horticulture towards societal changes.

Exploring diversity analysis using germplasm as an ecosystem: A plant genotype with an exotic trait growing in a natural habitat needs to be treated as a candid representation of the ecosystem with possible diversity assigned on account of variation in soil as growth habitat (microbial niches of phytobiome to investigate for beneficial microbes and microbial antagonists), phenotypic traits displaying tolerance against multiple stresses and yield/quality traits, though over-emphasized at times. While examining so, it is very likely to investigate a germplasm through all possible novel traits at various plant organizational setups. However, our current efforts do not address such wholesomeness.

A robust mechanism is the urgent call from researchers across disciplines to have a precise measure of crop-based germplasm diversity. Currently, duplicate accessions are mostly accountable, thereby, belittling our honest efforts to measure the germplasm diversity, unless barcoded germplasm (marker-assisted selection) is made mandatory in any germplasm exchange program. We are losing our precious germplasm materials if we continue to handle at this rate.

Paradigm shift from conventional yield/quality centric clonal selection program to nutraceutical profile/stress tolerance/microbial habitat-driven pursuit, coupled with sound clonal protection efforts need a fresh look. Shall we continue the same way using such tags, then whose fault is this, that we failed to popularize them and convert them as popular fruit or vegetable crops in the region where crop diversity is the tribal's way of life as custodian farmer? It is equally pertinent to look into so-called under-utilized or under-exploited fruit and vegetable diversity. Unless seed and planting materials for these crops are made available to growers, we may lose such precious diversity as a natural process of germplasm degeneration and climate catastrophe.

Encouraging horticulture-tourism and establishing nutritional gardens for the diversity in horticulture crops of the region would be quite handy for not only tribal farming but also ensuring in maintainance of those crops diversity, otherwise, it will remain ornamental.

Mother stock development: Massive efforts should advocated to look into the development of elite mother stocks of fruits, vegetables, and budded vegetables. It should be duly safeguarded by the provision of regionally duplicate identification and keep them pathogen free. Experts can develop tools for cleaning/filtering both current and newly emerging pathogens.

With this system, mother stocks can be used successfully and preserve future loss, unless we have a soilless containerized multiplication protocol for elite planting materials in order to reduce unwanted mortality in new field and arrest an untimely decline in productivity of crops, tropical or temperate; climacteric or non-climacteric in nature. There is hardly any right effort put into the analysis of developing crop specific trade routes and replacement rate of seed/planting material in the region.

Establishing crop grids: Modalities are direly needed to identify crop production epi-centres using agro-ecological zones *vis-à-vis* horticulture crops as a part of digitized horticulture, backed-up with soil-climate

Khasi Mandarin Orchards

Pineapple Orchard in Hills of Mizoram

Dragon Fruit in Farmer's Field of Mizoram

analogues embedded with all biologically defined quality attributes. This will enable to identify crop performance grids as a benchmark of success or failure of a given crop and develop a robust system of computing crop statistics through the application of geospatial tools. In the current scenario, there is no such effort for horticulture crops.

Soil health cards for horticulture crops: Our past depleted efforts in this direction strongly warrant developing crop-based soil health cards to realize its impact on the timely assessment of nutrient constraints in the field and check the current unprecedented menace of nutrient mining and curtailed crop soil capacity.

Retrofitting function-specific microbes in crop fertilization schedules could further lessen the undue reliance on the use of inorganic/synthetic fertilizers. Use of crop-customized nutrient composites (green nano-composites in organically grown crops) alongside irrigation (4R × 4W) would be a step forward guarantee towards more crop per drop, and more crop per gram nutrient use. Unfortunately, both of these riders are realistically missing from the current challenges of balanced fertilization of horticulture crops to achieve land degradation neutrality.

Protocols for organic horticulture and natural farming for climate neutrality: Renewed emphasis is needed for integrating agro-ecology with on-farm module of organic and natural farming coupled with *in-situ* water conservation (it is ironical, almost entire horticulture prospers under rainfed condition with an average annual rainfall of more than 2500 mm), and *in-situ* crop residue management, with an eye on developing good agricultural practices and sustainability in crop production (soil-crop-environment health indicators) on a long term basis. A sincere effort should also put forth to work upon the carbon and water-footprints of crops to test the pressure on the health of natural resources.

We comprehensively forget, perhaps a much greater onus of producing bio-inputs (biofertilizers, botanicals as biostimulants and microbial antagonists, preferably in bioformulation mode) with mass scale multiplication protocols or their label claims developed as a result of thoroughly laid out field experiments, so that bio-intensive management of horticulture crops becomes an immediate reality. The work of Assam Agricultural University (Jorhat, Assam), is worth mentioning in steering this program to good effect in Northeast India.

For organic and natural farming, horticulture-based integrated farming system can surmount by connecting farm productivity with pond productivity via soil-plant-water health continuum.

Crop Health: Addressing various diseases using environment friendly non-synthetics is another challenge to present day researchers amid vagaries in climate as minor pests/diseases of today could become major issues in future. Limited efforts so far in developing microbial consortium have provided some encouraging results in field, but ensuring crop health resilience is an upheaval task. The research works originated from the Department of Plant Pathology, Assam Agricultural University, have redeemed the growing confidence in the use of microbial bioformulations in this direction. Let's join our hands vigorously to see that microbes-mediated crop health management is no longer a hurdle for horticulture crops, with the lifting of stringent rules and regulations for label claims as a policy intervention. Some efforts to develop SymCom (synthetic microbes mimicking plant defence via involvement of secondary metabolites as signalling molecules in host-microbe interaction) must be initiated using horticulture crops in a collaborative mode.

Secondary horticulture: Post-harvest management with emphasis on proximal sensing of crop maturity, extending shelf life through pre-harvest practices *vis-à-vis* post-harvest upkeep of fruits, smart packaging, value-added products and waste utilization, all need renewed strategy depending upon prevailing harvesting window of different fruit crops round the year. Extending vase life and shelf life of dry flowers and the art of flower arrangements have seen a recent upsurge in floriculture, besides extraction of flower-based colours used in various cosmetic and food industries.

Horticulture crops and carbon trading: Climate change is the most threatening challenge to horticulture crops, otherwise known for producing exceptional biomass and preempt towards improved carbon sequestration by plants, translated well into important ecosystem service in the form of improved yield. This exceptional ability of horticulture crops offers an environmental carbon offset option and possible carbon trading opportunities in the horticulture sector. It is very likely that microbially tailored horticulture crops, introducing endophytes inside the plant body as a perennial ally in stress tolerance ability, would take this ability to a newer dimension.

Revolution in horticulture has already lessened the pressure on the use of cereal crops as an additional option for food and nutritional security. Introducing these stances on our current understanding relating various issues of horticulture crops would surely make us better prepared, negotiating with various challenges much better than ever before.

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