

## STUDY OF ADOPTION OF NEW TECHNOLOGIES FOR FURTHERING BIODIVERSITY CONSERVATION COMMERCE AND TRADE OF MEDICINAL AND AROMATIC PLANTS OF INDIA

D.R. RAMESH SINGH\*

### Introduction

Successful technologies in agriculture and horticulture can be transferred without loss of time for crop-improvement. Biotechnology has to be increasingly employed particularly for standardizing techniques for micro-propagation, somatic hybridization, evolving transgenic plants and resultant 'Genetically Modified' (GM) Medicinal and Aromatic Plants (MAPs).

### Conservation and agro-practices

MAPs are a bio-resource, generally grouped under Non-Timber Forest Produce (NTFP), basically obtained from natural forests. Open access collection mode has depleted MAPs to the extent that some regulation has become an urgent necessity. Collection has been further liberalized under Joint Forest Management (JFM) practice that provides for cent per cent share of all NTFPs to the JFM members in many states of India. In some of the MAPs, whole plant is utilized leading to irreversible damage e.g., orchids and other herbs. Depletion has accelerated and it is becoming difficult to maintain requirements of *in-situ* conservation of bio-resource, in the habitat on sustained-yield basis in 'viable populations'. The concept of 'viable population' used earlier for endangered fauna has to be extended

to threatened plants also. Basic optimal size that is required to conserve the 'core area' within range of natural distribution has to be ensured. Conservation of the entire habitat has to be done by judiciously managing 'edge effect' wherever required as many MAPs are naturally present in ecotones (Bhojvaid, 2003).

Specific characterization has become obligatory as synonyms are used that transgress specific limitations. For example, there are three species belonging to genus *Viola* ('Banaksa') in different altitudes of Himalaya. *Viola odorata* is the most effective expectorant and broncho-dilator that occurs in higher elevation of J&K and Himachal Pradesh. In commerce *Viola pilosa* is utilized routinely as of the three species this is the most abundant. 'Salam panja' the dried fleshy roots of terrestrial orchid *Dactylorhiza hatagirea* occurs along Indus river banks in Leh, Ladakh District of Jammu & Kashmir State and also similar locations of Uttaranchal and Himachal Pradesh states. Being an orchid germination of seeds is a problem and methods of germination *in-vitro* and also micro-propagation are required to be standardized.

'Ban kakri' *Podophyllum hexandrum* (Berberidaceae, a.p. podophyllin), shows wide spectrum of potential as medicine for

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\* CCF (Production), Haryana Forest Department, Panchkula (Haryana).

controlling tumours. It is extracted from resin that exudes from freshly cut ends of monopodial rhizome (Anon., 2003). A forest ground flora of *Cedrus deodara* that had serious problem of regeneration is being successfully cultivated by the Institute of Himalayan Bio-resource Technology of Council of Scientific and Industrial Research (IHBT, CSIR) at Palampur, Himachal Pradesh through 'embryo rescue' method. *Taxus baccata* ssp. *wallichiana* the source of natural taxol (a.p. texane) used in treatment of ovarian and breast cancer is being macro-propagated by rooting stem cuttings in many parts of Himachal Pradesh. It can be raised as a hedge and instead of stripping bark, taxol can be got by distilling leaves, thereby conserving the plant.

Ditto practice is being advocated for conserving 'guggal' *Commiphora wightii* that is a strong insect repellent and also has properties that reduces cholesterol in humans. By altering present method of one-time fatal oleoresin tapping between 6-8 years after planting to that of solvent extraction from branches as is being tried at CAZRI, Jodhpur (Anon., 2003). Other species of 'chittori guggal' *Commiphora agallocha* that has a faster rate of growth can be grafted on to the rootstock of *C. wightii* for increasing the production of oleoresin. It has been found that the seeds routinely sown give a germination per cent of up to 5%. However, heavy seeds that are gravity separated by floating in water are reported to give more than 65% germination as has been tried at Guggal Herbal Farm situated at Mangliawas in Ajmer district of Rajasthan. *C. wightii* has also been successfully micropropagated in Rajasthan.

'Kutki' (*Picrorhiza kurroa*) used in

many ailments of stomach and joints is being successfully micro-propagated and also being raised through seeds (Anon., 2003). Dysgenic and near total extraction of *Terminalia chebula*, Retz. and *Artocarpus lakoocha* Roxb. fruits are seriously impairing the regeneration in Siwalik belt. Genetic up-gradation of planting stock and standardization of agropractices is being done to ward off elimination of base population (Ramesh Singh *et al.*, 2003). *Nardostachys grandiflora* syn. *N. jatamansi* used as a mind stabilizer is also being micro-propagated but *in-situ* conservation has to be under taken urgently. *Saussurea costus* (anti rheumatic, anti-arthritis drug) was extensively cultivated in higher altitudes when demand was high from Peoples Republic of China. At present owing to demand contraction not much of interest is being shown in its cultivation.

Technology up-gradation has to occur for *in-situ* and *ex-situ* conservation particularly by standardizing agropractices for important MAPs by way of well documented package of practices similar to other already domesticated crops. Monitoring the quality of inputs and constancy of 'active principle' (a.p) acceptable to consumer, standardization of post harvest technology, improvement of productivity, packaging and preservation, market intelligence has to be made available. Traditional collectors and users over a period of time have evolved intermediate cost effective technologies for processing. That indigenous knowledge requires to be taken advantage of; dismantling that structure before establishing a better one is not advisable.

*Chlorophytum arundinaceum*, *C. tuberosam*, *C. breviscapum*, *C. attenuatum*, and *C. malabaricum* are different species of 'jungli, safed-muśli' naturally distributed from Siwalik hills in the north through Aravallis, Vindhya, Satpura to Eastern and Western Ghats of peninsular India. Excessive extraction of first two species from natural habitats and some limitations regarding uniformity of root tubers and presence of brown spots has made it second to *C. borivillianum* (species typica from Borivili national park of Maharashtra), that is being extensively cultivated. It has been recently domesticated in Udaipur and Sikar districts of Rajasthan and Jalgaon district of Maharashtra (Sarin, 2003). Tubers contain 27 alkaloids, a steroid named saponin (2-10%) polysaccharoids (40-45%), proteins (7-10%) and also minerals and vitamins. In ayurveda it is reputed to be a nerve-tonic and particularly useful for males. Speculators who are trading in sale of root tubers as 'seeds' are promising fabulous returns from cultivation of this herb. When promised returns are not realised prospective cultivators would become over cautious and stop raising other MAPs.

In agriculturally prosperous states of India that need diversification from wheat-paddy cultivation; raising MAPs is a possible model. It is having high demand in national and international markets. But the sale price of dry tubers has come down from Rs. 2000/kg to Rs. 300/kg in a matter of last three years for de-corticated, dried and blemishless tubers. The producers prefer to sell tubers for use as seeds to prospective cultivators instead of drying it because it gives them higher returns. It is a fact that large quantity of wild 'Safed-muśli' is getting extracted damaging

*in-situ* conservation to the extent of driving it to threatened status. Unless a central agency plays the role of benevolent regulator and educates farmers in quality and quantity to be produced in the country disillusionment would follow.

'Grit-kumari' gel obtained from *Aloe vera* and *Aloe barbadensis* both for medicinal use and as an ingredient in shampoos, shaving creams and other human surfactants has become important. Agropactices have been evolved for cultivation in marginal dry lands on opposite sides of a ridge using suckers. Though it is possible to macro-propagate these plants by suckers and rooting old and exposed stem axis it is being micro-propagated as the demand for seedlings is very high. The Energy Research Institute (TERI) situated at Gwal Pahari, in Faridabad district of Haryana is micro-propagating better gel-yielders. Commercial gel extraction is some-what capital intensive as it involves chilling the gel to -40°C and thus separating the hemi-cellulose. Crop improvement for superior gel in higher quantities may be required at this stage. As this plant can tolerate shade it can be usefully introduced in many forest types of India and agricultural land already diverted to this species can be redirected to cultivation of other species. Similarly 'sarpagandha' *Rauvolfia serpentina* can also be raised as a ground flora along edges in Sal (*Shorea robusta*) forests and can supply alkaloid 'reserpine' (a.p.) for controlling hypertension that can be used in the place of phenyle barbiturates. As this species is shade-tolerant it can be grown under both *Populus deltoides* and *Eucalyptus tereticornis* plantations raised on farmland particularly after first three years. During that period owing to greater shade of trees

raising agricultural crops would be economically not feasible and such land could be put under shade tolerant MAPs.

*Ex-situ* conservation should preferably be done within the natural area of distribution and the germplasm should be broad based incorporating all the varieties that exist within the range. Special emphasis should be given to elite germplasm as there is immediate threat to its existence. Areas that were previously occupied by the species are especially suited for re-introduction, with minor modifications of site through well thought out programmes by seeding and transplantations. Transplanting wild collections has to be done with care and not more than one-third of planting material that is suitably dispersed all over the site is to be used (Bhojvaid, 2002). At present greater emphasis is to be given for both *in-situ* conservation and evolving agropractices to following species *C. arundinaceum*, *C. tuberosum*, *Rauvolfia serpentina*, *Dactylorhiza hatagiera*, *Lycopodium clavatum*, *Vanda carulea*, (Blue vanda), *Picrorhiza kurroa*, *Nardostachys grandiflora*, *Taxus baccata*, ssp. *Wallichiana*, *Hypericum* spp. *Podophyllum hexandrum* and *Habenaria* spp; (Riddhi and Siddhi) *Valeriana officinalis*.

#### **Monitoring the quality of inputs and acceptable levels of nutraceuticals**

Popular herbal brand names of India have established domestic acceptability in a low cost economy among consumers whose quality consciousness was not very high. For catering to export market quality is a *sine qua non*. If quality up-gradation occurs for export market to conform to the

quality either dual pricing or upward shift in price-line would occur. Certification mechanism has to be evolved and strengthened for sustained export performance. Many players are involved from primary producer/collector, country druggist ('pansari')/reputed manufacturer/exporter, importer and retailers. Certification has to be done at every stage, multistage certification requires building an elaborate system of regulation. MAPs contain essential oils, hemi-celluloses, glycosides phyto-alkaloids and steroids that have the capacity to alter the anabolic and catabolic rates of users. Purified and synthesized 'active principles' often cause side effects as they do not have regulating molecules that operate within biological systems from where they were isolated. In MAPs variation exists and gets expressed at bio-molecular levels. Quite a few of the 'active principles' are stress-related chemicals produced by the plant growing in the 'edge location'. When agropractices are evolved initial selection of planting stock has to be from those areas that have established reputation to be very effective. During various phenological phases of the plant if stress is to be artificially induced instead of *ex-situ* cultivation *in-situ* cultivation should be preferred, as that would be cost effective. Within a species if a.p is identified and its quantity in oven dry anatomical portion of the MAP is related to the price it is possible to evolve a rational pricing mechanism.

Some not-so-scrupulous vaid/hakims/allopaths motivated by greed are known to resort to over use of chemicals that are likely to harm the user in the long run e.g., steroids. Some of the MAPs have similar if not identical effect on the user and many manufacturers resort to

substitution to increase their profits e.g., *Asparagus adscendens* root tubers available for Rs.70-150 /kg, green are used as a substitute for *C. borivilianum* root tubers sold for Rs. 300-800/kg (Anon., 2003). Even reputed manufacturers are known to use synthetic substitutes for costly phyto-products e.g., amla powder, rosewater (*Rosa damascena* and *R. bourboniana*) (Anon., 2003). Products obtained from members of Orchidaceae and other rare and endangered taxa are also similarly adulterated. Trade secrets are in fact Intellectual Property Rights (IPRs) of traders protected by patents if already obtained or by personal oath of secrecy.

Organic farming has almost been made a necessity for producing export-related MAPs. Despite the traces of persistent plant protection chemicals that have permeated into life support systems, particularly those that were banned by developed countries long time back (organo-mercury chemicals) but continue to be used in India even to date is going to pose serious problem of acceptability. Products grown in organic farming practices continue to suffer residual effects of plant protection chemicals between 4-6 years after change. Prescribed safe levels of acceptability for residues of universally used phyto-protection chemicals, is different in different countries; chiefly developed countries. Thus large-scale MAPs cultivation to cater to export market particularly those items that are likely to be consumed in larger quantities such as general purpose tonics and medicinal food supplements e.g. 'murabbas' to be under taken very carefully.

India being a tropical country large number of micro-flora viz., bacteria, fungi,

actinomycetes are in many of our systems and over long periods of exposure indigenous population has become resistant to them. Exposure to above micro-flora may harm new users, therefore, processing and packaging has to be of acceptable international standard.

### Post Harvest Technology (PHT)

Establishment of agro-practices and post harvest technology are two sides of the same coin. As the former is not yet fully expressed, the latter, is nowhere in sight. Sustained demand is the basis for development of both. Unlike produce from horticulture and agriculture where PHT is fully developed wild extractions made by lowly paid, seasonally employed, marginalized contractual wagers is not yet capable of achieving international standards, let alone national standards. Most of them have worked in isolation, on a small natural resource base, quite often very widely dispersed. The extractor is locally situated with reference to availability of bio-resource and the employer wants it in as much quantity as nature produces. Evolving agropractices including PHT for most of the MAPs in greater demand builds in higher cost for cultivation and PHT. In one of the trials first yield of *Ocimum sanctum* (Ram-tulsi) was taken in 100 days after seedling transplantation by clipping branches above 30 cm from the ground level. After five days shade dried leaves weighed 70 grams per kg of green branches harvested during first week of October. If this operation were to be delayed and done during later part of autumn the quantity of essential oils would be less. On the other hand during vegetative phase i.e., before flowering if a smaller yield is taken that

enhances vegetative growth and flower formation gets deferred. As there is more of essential oil in the leaves, harvesting schedule had to be altered to optimize essential produce output. In *C. borivilianum* it has been empirically established in sandy areas of Hisar supplement of Iron in the form of ferrous sulphate increases tuber yield (pers. comm., Behniwal, 2003). Instead of farm yard manure generally applied all over the field by broadcasting, point application of vermicompost as 'basal dose' in the rhizosphere gave better results. The resultant tubers were longer and healthier.

### Improvement of productivity

Woody perennials are a difficult material for breeding but quite a few MAPs are herbs belonging to monocotyledonous families. Cereal breeding has been successful to a greater extent because of possibility of taking two crops, one in the plains and the other in high hills (Malik, 2002). The same logic is applicable to many MAPs that can be bred for higher productivity, natural and induced variation can give very fertile base for genetic improvement. Evolution of pure lines, hybridization, and harnessing heterotic vigour as was done in wheat and rice has to be replicated in MAPs for higher productivity and disease resistance. When agropactices present large stretches of uniform crops out breaks of fungal and insect pests has to be expected. Integrated pest management (IPM) becomes a necessary component and requires to be developed as a package of practice. IPM may be easy to introduce as MAPs are to be raised through organic farming only. In case *C. borivilianum* clones, clone No. 412 and 414 were found

to have higher productivity of 45.57 and 45.42 g/plant compared to about 33 g produced by other clones (pers. comm., Beniwal, 2003). *Arnebia* spp. an ephemeral plant, the source of cicomine (a.p) used as anticarcinogenic can be repeatedly raised through micro-propagation whereas it can be grown for only one cycle in nature. Similarly for raising *Icenia foetida* that requires 2.5 lakh seedlings per hectare microtuberization should be a superior option for producing genetically superior seedlings.

MAPs produce perishable items whose shelf-life is limited. This fact is used by established traders to the disadvantage of collector/producer. Technology for deferring ripening and also decomposition has been successfully used-in 'genetically modified' (GM) horticultural crops. Also, many of the temperature sensitive MAPs that grow in higher altitude can tolerate low temperature. Where as same species in lower altitude continue to be sensitive to low temperature. Dormancy has been related to presence of higher concentration of 'hydrogen peroxide' as a free radical. A gene responsible for production of an enzyme titled as 'super oxide desmutase' (SOD) naturally present in *Potentilla alpina* and *P. fulgens* is known to counter build up of hydrogen peroxide. The gene has been cloned in bacteria and implanted in to the genome of *Camellia sinensis* (tea). There-by opening up possibility of extended vegetative phase (more production) in other crops by using biolistic-gun. That uses accelerated helium gas to fire activated gold particles coated with cloned gene that implants into nucleus. Once the gene is implanted further mass propagation is done through micro-propagation and organogenesis in to plantlets. This facility is available within

the country both in CSIR and ICAR labs and can be availed for at least those listed species by National Board for Medicinal Plants.

Notwithstanding the merits of sophisticated scientific techniques that are both skill and expenditure intensive 'common mans' traditional plant improvement techniques are more relevant and rewarding as they can overcome many pit falls related to hardening and high technology related uncertainty. The days of one-man basic research are not really over despite the establishment of large scientific laboratories.

### Market intelligence

Sustainable agropractices in MAPs can be under taken on the basis of market intelligence. A credible intelligence gathering mechanism has to be created and prices of planting material of different grades of produce should be made available on a web-site and through news papers and market bulletins. Total demand and present levels of supply within and outside the country are to be specially made available to prospective farmers and buyers. Quality control practices of products have to be insisted to reach international market.

### SUMMARY

MAPs provide a diversification and crop intensification option both to farmers and foresters. Organic farming or forest production can be introduced if returns on investment are remunerative. Biodiversity conservation can be enhanced by providing better access to these reinvented practices eg., organic farming. Traditional knowledge available regarding distribution, varieties, collection and processing has to be integrated with scientific and technological inputs. Breeding for higher quality and quantity in a short period is a distinct possibility both by traditional and modern practices. Central to the exercise of diversification and intensification option is sustained demand by domestic and international markets. Quality control has to be upgraded in all respects to lay claim to the rightful share in international market in consonance with the knowledge and techniques prescribed by Atharvaveda. Association of nutraceuticals with virility promoting herbal drugs currently in greater demand is likely to become unsustainable in the long run. This narrowly focused approach has to be combined with a stronger focus on preventive and curative aspects of medicinal plants to serve the larger public need of safe and efficacious herbal health care system. Market intelligence of total international demand and present levels of wild and domesticated supplies along with prices of planting stock and different grades of produce need to be made available to prospective farmers to prevent trade cycles. The search for the mythical 'sanjivini buti' is to be started in all sincerity as a national goal for serving 'vasudaivakutumb acam' of the community of nations.

भारत के औषध और सौरभिक पादपों की जैव विविधताएं तथा उनके वाणिज्य और व्यापार को आगे बढ़ाने को नई प्रौद्योगिकियां अपनाने का अध्ययन

डी०आर० रमेश सिंह

सारांश

औषध और सौरभिक पादप किसानों और वानिकों दोनों को विविधीकरण और फसल सघनीकरण के लिए विकल्प उपलब्ध कराते हैं। जैविक खेती अथवा वन्य उत्पादन को तभी शुरू कराया जा सकता है जब उसमें धननिवेश किए जाने से अच्छी प्रत्याय मिल पाती हो। जैवविविधता भी इन पुर्नविष्कृत प्रक्रियाओं उदा० जैविक खेती तक अधिक अच्छी पहुँच बनाकर ही बढ़ाई जा सकती है। एतदर्थ इनके वितरण, विभेदो, संग्रहकरण और विधायन करने विषयक मिलते पारम्परिक

ज्ञान को वैज्ञानिक और प्रौद्योगिकीय नए ज्ञान निवेश के साथ एकीकृत करना आवश्यक होगा। पारम्परिक और आधुनिक प्रक्रियाएँ दोनों को साथ मिलाकर अधिक अच्छी गुणवत्ता और मात्रा में कम समय के अन्दर ही इनका प्रजनन कर पाना एक स्पष्ट संभावना है। इस विविधीकरण और सघनीकरण विकल्प को व्यवहार में ला पाने की केन्द्रीय आवश्यकता है घरेलू और अन्तरराष्ट्रीय बाजारों में उनकी मांग निरन्तर बनी रहना। अन्तरराष्ट्रीय बाजारों में अपना अधिकारपूर्ण हिस्सा पाने का दावा करने के लिए हमें इसके सभी पक्षों के लिए गुणवत्ता नियन्त्रण को परिष्कृत बनाना होगा जो शक्तिवर्धन प्रेरित करने वाली जड़ीबूटियों वाली औषधियों के साथ क्लीवीकारक भेषजों के अथर्ववेद संघ द्वारा विहित ज्ञान और प्रविधियों से मेल खाता हो, जिनकी इस समय अधिक मांग है और जिसकी भविष्य में इतनी बढ़ने की संभावना है कि उसे शायद निरन्तर पूरा भी न किया जा सके। इस संकीर्णता-उन्मुख दृष्टि को हमें औषधियों के निरोधी और रोगोपचारी पक्षों पर अधिक जोर देने के साथ भी जोड़ना होगा ताकि वह जड़ी-बूटियों से बनाई औषधियों द्वारा अधिक जनता के लिए एक समर्थ और रोगदूर करने वाली निरापद स्वास्थ्य रक्षा प्रणाली बन सके। इसकी विभिन्न श्रेणियों की अपूर्ति के वर्तमान स्तर सम्बन्धी बाजार जानकारी उपलब्ध करानी होगी ताकि इसमें होने वाले व्यापारिक उतार-चढ़ावों से बचा जा सके। पौराणिक 'संजीवनी बूटी' की खोज में हमें उसे राष्ट्रीय लक्ष्य बनाकर सच्चे मन से लग जाना चाहिए ताकि संसार के सभी राष्ट्रों के लिए "वसुधैवकुटुम्बकम्" के आदर्श को पूरा किया जा सके।

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