

A retrospective analysis in the conservation of selected sites with *Salacia* species in the Southern Province of Sri Lanka

S. M. Amarathunge¹ and L. H. P. Gunarathne²

¹Post Graduate Institute of Agriculture, University of Peradeniya, Sri Lanka

²Department of Agricultural Economics & Business Management, Faculty of Agriculture, University of Peradeniya, Sri Lanka

ABSTRACT

The genus Salacia has high importance as it contains a medicinal value. Cultivation of Salacia species has become an attractive, profitable industry over the past few years mainly due to an increase in its demand and market value. Due to overexploitation, the majority of these bears threatened will become extinct in the future. Hence, the conservation plan for Salacia species was presented to conserve Salacia species. Data were collected from relevant respondents from the Ayurvedic Department, Ayurvedic industries, and Department of Agriculture and stakeholders of the value chain using focus group interviews and discussions from May to July in 2019. Five options for recovery of Salacia species in the selected site were decided. Manage Salacia species on forest patches (option 2), protect plants of Salacia species at selected sites to correspond to the full range of remaining genetic diversity (option 3), and maintain Salacia species in cultivation (option 5) were chosen as the best options for the recovery of Salacia species in the selected sites. To manage these species on forest patches, protect plants at sites chosen to correspond to the full range of remaining genetic diversity, and maintain these species in cultivation, plans including their outcomes were decided. These suggestions, if suitably implicated, will go a long way forward conserving this invaluable herbal wealth.

Keywords: *cultivation, medicinal value, overexploitation, recovery options*

INTRODUCTION

Sri Lanka is blessed with a rich diversity of medicinal plants. They are one of the significant natural resources of the country occurring on diverse ecosystems, which play an important role in the Sri Lankan Ayurvedic medical system. According to National Red List (2012), *Salacia oblonga* Wall. Ex Wight & Arn. (Gal Himbutu), *Salacia diandra* Thw., *Salacia acuminatissima* Kosterm., spec. Nov. (celastr) and *Salacia reticulata* Wight. (Kothala Himbutu/Himbutu Wel) are currently endangered plant species. *Salacia chinensis* L. [*Salacia prinoides* (Wild.) DC.] (Heen Himbutu Wel) is near threatened according to a classification applied to a species believed likely to move

into the endangered category soon if causal factors continue (MOE, 2012).

Geographical distribution of *Salacia* species

According to Arunakumara and Subasinghe (2010), *Salacia* species are widely distributed in Sri Lanka, India, China, Vietnam, Malaysia, Indonesia, and other Asian countries. They are morphologically and chemically distinct species that are distributed in Southern India and Western Ghats (Yoganarasimham, 1996). They are found mainly in dry zone as in the districts of Hambanthota, Anuradapuraya, Pollonnaruwa, Monaragala, Kurunegala, and Puttalam of Sri Lanka. But documentary evidence is very much

lacking in exact locations in which the species are abundantly distributed (Ryanghyok *et al.*, 2008; Arunakumara and Subasinghe, 2010).

Past distribution and abundance

Old herbarium specimens of *Salacia* species can be seen in Department of National Botanic Gardens, Royal Botanic Gardens, Peradeniya, Sri Lanka, and published records of *Salacia* species are very few.

Present distribution and status

They occur in very few areas in the wet zone and they grow in or near forest patches. Most sites of *Salacia* species are available on land controlled by the Department of Forest, but these plants are still being collected. This justifies upgrading the current listing from "Endangered" (MOE, 2012) to "Extinct". *Salacia* species grow as climbing shrubs on trees.

Reasons for the decline

Most of the medicinal plants are in danger due to over-harvesting, over use of plant materials due to poverty, discrimination of land consumption, in-equilibrium in dividing capital and profit, the gap between knowledge and skills, complex socio-economic problems, the introduction of

exotic or invasive species and destruction of habitat. Reasons for overexploitation of these natural resources are population growth, urbanization, and the limitless collection of medicinal plants from the wild (Sharmal *et al.*, 2010).

Overexploitation of *Salacia* species and threaten condition of *Salacia* species

According to Keeragalaarachchi *et al.* (2016), Kothala Himbutu has high national and international markets demand. Hence, people uproot them from the wild on a large scale. In most cases, the extraction is done before maturing of the medicinal plants, which leads to the elimination of the species from nature. Therefore, the conservation of this valuable plant is very important.

The objective of the study was to make a conservation plan to conserve this valuable plant in selected sites with *Salacia* species in the Southern Province of Sri Lanka. The key management goal of this plan is to ensure the continuation of these *Salacia* species in the wild and the maintenance.

METHODOLOGY

Three sites with a fewer number of *Salacia* species in each district of the Southern Province (Figure 1) of Sri Lanka were identified to make a conservation plan.

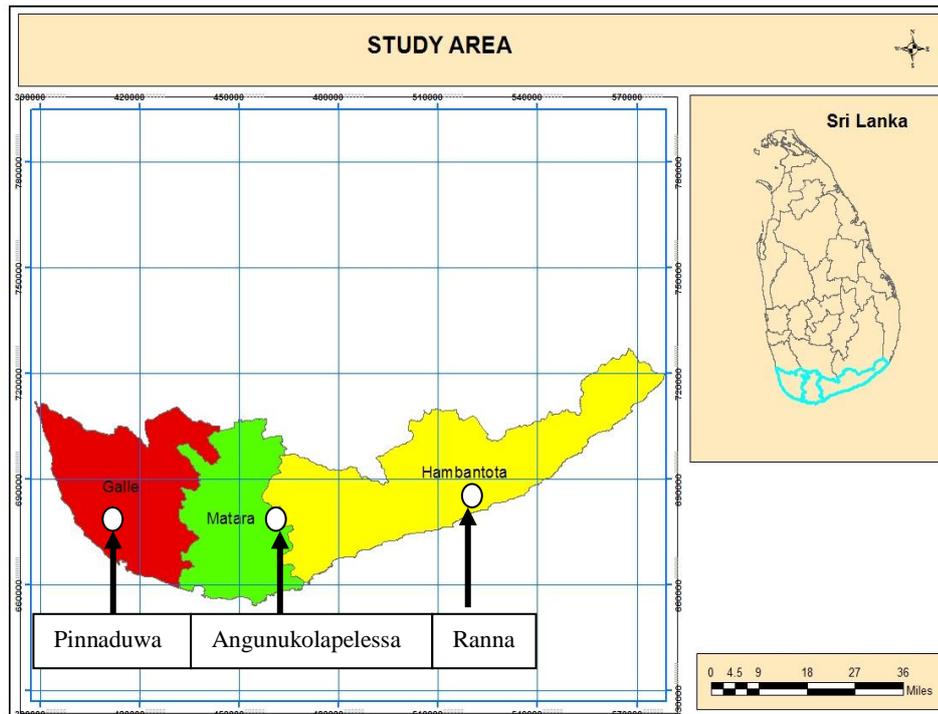


Figure 1: Map showing the study area in the Southern Province of Sri Lanka

Then Field observations, face to face interviews, focus group interviews and discussions were carried out with stakeholders in the Ayurvedic Department, Ayurvedic industries, and Department of Agriculture and selected value chain representatives such as farmers, wild collectors of herbal raw materials, traders, whole-sellers in three districts of the Southern Province, Sri Lanka from May to July in 2019 to determine the nature of the problem, reasons for it, basis for reasoning and their role in that situation.

The combined target randomly chosen sample population was a hundred which included officers in the Ayurvedic Department (Fifteen), officers in the Department of Agriculture (Fifteen), cultivators/farmers (Fifteen), collectors (Twenty), traders (Ten), processors (Fifteen) and whole-sellers (Ten). Five main options for the recovery of *Salacia* species in the selected sites were decided. From those options for recovery, the best three options were selected. A plan for each best option with their outcomes was decided.

RESULTS AND DISCUSSION

A medicinal plant resource is a sustainable option for natural resource management and livelihood enhancement from the perspective of biodiversity conservation (Maikhuri *et al.*, 2005; Negi *et al.*, 2010). A recovery strategy is provided for *Salacia* species which is threatened with extinction. The survivals of these species are threatened principally by herbal collectors digging up the plants to obtain the stem or root for trade.

This plan includes an outline of management options and a work plan. The options for recovery range from a do-nothing to protect *Salacia* species (option 1), Manage *Salacia* species on forest patches (option 2), Protect plants of *Salacia* species at selected sites to correspond to the full range of remaining genetic diversity (option 3), to the best, Fully protect plants of *Salacia* species from herbal trade collectors and other destructive animals at all sites (option 4), which is almost certainly not reachable and Maintain *Salacia* species in cultivation (option 5).

Option 1: Do nothing to protect *Salacia* species

This is not an acceptable option, as *Salacia* species can be expected to decline drastically over the next few years with much more local extinction unless there is effective management. Within the next 10-30 years, it will be extinct or very close to it.

Option 2: Manage *Salacia* species on forest patches

Plants of *Salacia* species could be transferred to suitable habitats. Seed of *Salacia* species probably takes at least 5 to 7 months to germinate and grow into a plant and it may take that long to determine whether the species has been successfully established.

Option 3: Protect plants of *Salacia* species at selected sites to correspond to the full range of remaining genetic diversity

The difficulty with this option is that we do not know which sites to be selected to cover the full range of remaining genetic diversity. The research could be carried out to determine it and sites selected consequently and sites could be selected geographically.

Option 4: Fully protect plants of *Salacia* species from herbal trade collectors and other destructive animals at all sites

One problem with using enclosures at some sites is the possibility of drawing attention to these plants and having them dug up by herbal raw material collectors. There are ways to decrease the threat of the plants being found. Sites are on private and public land and in various stages of decline.

Option 5: Maintain *Salacia* species in cultivation

Salacia species can be maintained in garden.

The following recommendations are based on options 2, 3 and 5.

Recommendation 1.

As a minimum, to protect plants of *Salacia* species from herbal raw material collectors and other recognized threats at all known sites on land administered by the Department of Forestry

Recommendation 2.

Promote public interest and involvements in the recovery of *Salacia* species and encourage its protection on private land

Recommendation 3.

Advocate for the listing of *Salacia* species to prohibit the export of stem and root

Recommendation 4.

Obtain better information on the distribution, condition, and trends of *Salacia* species

Recommendation 5.

Carry out or promote research on the propagation, genetics, ecology, and protection of *Salacia* species

Recommendation 6.

Establish plants of *Salacia* species in cultivation for transfer purposes, research and public education and establish a seed bank.

To meet each recommendation and fulfill the management goal, the following actions are required:

Recommendation 1: As a minimum, to protect plants of *Salacia* species from herbal raw material collectors and other recognized threats at all known sites on land administered by the Department of Forestry

According to Morikawa *et al.* (2015) *Salacia* species play a momentous role in diabetic control all over the world for

thousands of years *Salacia* species play a momentous role in diabetic control worldwide for thousands of years. It has now become a subject of broad studies for diabetes control and management too. Roots and stems are used as medicinal decoction or powder.

Deforestation and the illegal logging of trees are reported in the southern province of Sri Lanka. Preservation of representative samples of rain forests in different regions is strongly recommended to provide *in situ* conservation (Gunatilleke and Gunatilleke, 1991). As a result of an unrestricted collection of medicinal plants from the wild, the status of several high-value medicinal plant species is under threat. Results of this activity have been widely recognized and threatened wild medicinal plant species are brought under cultivation (Schippmann *et al.*, 2002).

Plan

Plants of *Salacia* species should be protected using enclosures, whichever is practical.

1) Contact landowners and encourage conservation - All landowners should be informed of the presence of *Salacia* populations on their property. Private landowners should be informed of the options for legal protection.

2) Seek legal dedication - Such dedications can usually be made by private or public landowners, and thus they do not require a transfer of property rights. If established, such landowners should provide management for the habitats and plant communities associated with the *Salacia* species and allow monitoring access. The government should regulate the collection of *Salacia* species from the wild, and the government should prohibit the collection from the wild of threatened *Salacia* species except for propagation purposes. Ministries of Agriculture, Health and Trade, should develop and co-ordinate a program to

improve the techniques for harvesting and storing *Salacia* species and preparing their products.

3) Conduct management assessment of public and private lands - Survey all extant *Salacia* populations for ecological conditions, maintain *Salacia* species and assess and identify management needs. Additional sites also may be evaluated to determine their recovery potential. Specific management problems should be identified and resolved, and determinations should be made as to the recovery potential of each site. Design new Medicinal Plant Conservation Areas (MPCAs) for *Salacia* species were, provided the area itself is not under threat and subject to the dynamics of the system and the extent of human pressure. Development of action plans for harvesting, processing, and sustainably producing *Salacia* species at the village level (Village Action Plans) also could be practiced.

Outcome

This protection should ensure the survival of the *Salacia* species at several sites until research results enable sites to be more carefully selected.

Recommendation 2: Promote public interest and involvement in the recovery of *Salacia* species, encourage its protection on private land

The general public's assistance is essential if we are to prevent widespread loss of *Salacia* species plants to herbal collectors.

Plan

1) To form a group of people, preferably a self-motivated friends group, willing to support with locating and protecting plants and to use public relations in the form of talks, displays, media releases, posters, leaflets or other handouts to inform the general public of the importance of conserving *Salacia* species, to look for their support with its protection from herbal

collectors and to achieve funding for this work. Publicity should be targeted at landowners with *Salacia* species on their property, herbal raw material collectors and others most likely to find plants of *Salacia* species, conservationists and rural communities in areas of *Salacia* species. Visits should be made to all retail outlets which sell or have been known to sell stems and roots to discourage retailers from accepting stem and roots for sale. Public relations programs should be developed to promote understanding of the values and management needs of *Salacia* populations in lowland wet zone.

2) Produce a fact sheet and make it available on the Service website - A fact sheet should be developed for *Salacia* species. This fact sheet should describe the life history, current, and historic geographic range, educational values, and proper management techniques of *Salacia* species.

3) Hold workshops on managing sites of *Salacia* species - Workshops should be held for biologists to discuss monitoring, management and re-establishment techniques to ensure that proper and consistent techniques are used across the *Salacia* species range.

4) Promote news reports and press releases - Information on *Salacia* species should be made available to the public through news reports and press releases. Development of forest plantations, home gardens and other agroforestry systems with *Salacia* species to meet the social needs, which can reduce the threats to natural forests, produce a database containing information on location, quantities threats and remedial actions covering about *Salacia* species by a survey, establish programs of *Salacia* species partnership with local agencies, conservation organizations, the business community, landowners and other concerned citizens, awareness programs of the importance of conserving *Salacia* species, increased skills in conservation and

researching sustainable extraction of *Salacia* species, existing sources of traditional knowledge on *Salacia* species compiled and preserved in-country, opportunities for increased choices of livelihood, and better incomes for those involved in home gardening and commercial cultivation of *Salacia* species, motivation for innovation and development of new processes and medicinal products from *Salacia* species, lectures, formal courses and educational campaigns on *Salacia* species for particular target groups.

Outcome

Public responsiveness and support for the recovery goal and wider positive reception of conservation issues.

Reduce collection of stem and roots and protection of *Salacia* plants on some private land.

Recommendation 3: Advocate for the listing of *Salacia* species to prohibit the export of stem and root

Collectors dig up *Salacia* species plants for interest and supply stem and roots for tourists and local markets. The commercial exploitation of *Salacia* species for export purposes has increased exponentially in recent years. This has occurred because of the need for growing world demand and interest in natural remedies and a rapidly expanding global bio-prospecting industry. In turn, a rising number of *Salacia* species are being harvested for external export from Sri Lanka, and various international and multinational companies have made significant inroads into the country. Despite the high value of *Salacia* species in trade and the exporters and end-users of these products, very little value typically accrues to the harvester.

Local communities are entering into contracts with pharmaceutical companies, but there exist weak mechanisms to regulate, monitor or control either such arrangements or the harvesting and trade in *Salacia* species more generally.

Plan

1) At future meetings, work towards the inclusion of *Salacia* species. Provision of information services and institutional support focused on developing and promoting an adequate legal and regulatory framework covering access to and management of indigenous medicinal plant knowledge and related information (intellectual property rights) on *Salacia* species.

2) Creation of a project management unit to manage these activities and to provide coordination and technical support of the required services, establish legal protection of intellectual property rights associated with *Salacia* species through the development and enactment of guidelines and regulations governing access to and the use of ethno-botanical surveys, establish National Policies on the *Salacia* species to provide an opportunity in the advancement of medicinal plants sector on the conservation and utilization of medicinal plants in protected areas, publish a handbook on strategic planning for *Salacia* species conservation to guide on when and how to prepare and promote *Salacia* species conservation strategies (SCSs), creation of a regiment of field staff well trained in aspects of social mobilization, data collection, and analysis, documentation of field data of *Salacia* species, etc.

Outcome

No export of *Salacia* plants from Sri Lanka.

Recommendation 4: To obtain better information on the distribution, condition, and trends of *Salacia* species

Salacia species have been recorded in the past from many sites where they may still be present. The main concern should be given to relocating old sites in ecological districts where it is presently not known to occur and to sites near or beyond the current limits of distribution.

According to national and/or regional regulations, suitable documentation to certify that no such medicinal plant materials collected from the wild are included when medicinal plant materials from threatened, endangered, or protected medicinal plant species are obtained through cultivation (WHO, 2003).

Plan

1) Prepare a report for publication in the ecological management bulletin on survey methodology, collection of data at sites of *Salacia* species.

A rare plant survey form should be completed and sufficient details recorded to ensure the site can be relocated for each location where *Salacia* species is found, historical data will be distributed to relevant conservancies to follow up, but inquiries should also be made to people familiar with *Salacia* species sites.

The state and trends of all protected populations should be monitored. Establish baseline information and inventories of *Salacia* species by activities covering socio-economic and ethno-botanical data collection, design of the national medicinal plant database built on ethno-botanical surveys and information compiled from other studies and sources can be established for *Salacia* species, produce teacher manuals of *Salacia* species that can be allowed schools and students to obtain.

Outcome

This information will help fill the gaps in our knowledge of the distribution of *Salacia* species.

Any sites with *Salacia* species found will be necessary for genetic diversity research and potential sites for long-term protection.

Monitoring will signify trends and provide data showing whether additional action is required for the population to survive.

Recommendation 5: To carry out or promote research on the propagation, genetics, ecology, and protection of *Salacia* species

Although seedlings of *Salacia* species have been established in cultivation, their growth rate has been prolonged, and only a very small per-cent of the seed sown has germinated and established.

Plan

- 1) Get funds/support for research on the propagation and genetic diversity of *Salacia* species ecology.
- 2) Conduct research on restoration management and introductions techniques - To develop proper management guidelines for *Salacia* species, the effects of different management regimes on species reproduction, survivorship, and population growth should be determined.
- 3) Conduct studies on seedling ecology and establishment - This research would suggest that managers can control some restoration parameters while other factors cannot. Continued and additional restoration projects should coincide with replicating this research and identifying other possible factors influencing recovery. Research should focus on actions that land managers and conservation organizations can take to identify appropriate habitats, successfully introduce new populations, and restore population viability.
- 4) Determine *Salacia* species pollinators and their management needs - Research should be conducted to determine if there are primary and secondary pollinators of *Salacia* species. Research is also needed to determine if important pollinators have been lost from habitats of *Salacia* species, and if they have been lost, methods to restore pollinators should be developed. Research on different habitat management techniques should assess impacts on pollinators.
- 5) Identify external factors affecting life-history stages - Future research should focus on identifying and determining how to manage critical external factors, such as insect herbivores or pathogens, that can significantly reduce the reproductive effort in *Salacia* species.
- 6) Select sites for introduction and restoration - When population restoration is needed to meet recovery criteria for a particular physiographic region, the service coordinate the selection of sites for restoration actions among appropriate agencies. As with extant populations, these sites should meet the recovery criteria of having legal protection and minimum size, and management needs to achieve at least moderate viability.
- 7) Introduce or restore new populations in historic sites and newly identified habitat - With recovery of existing populations that are not reproducing, introduced populations should contain high numbers of genotypes and should be large enough to buffer against stochastic environmental or demographic events that might destroy smaller populations.
- 8) Establish new populations using seeds or plants - Because juveniles reach sexual maturity much faster than planted seeds, they are the optimal introduction technique. Juvenile plants should be introduced from nurseries on appropriate habitats on protected land and managed by a conservation organization. Growth and yield studies (sustainability studies) of *Salacia* species, education in and extension of Ayurvedic medicine practices of *Salacia* species, ensure availability of material of target populations that are exploited and/or cultivated by local people ensure access to populations for research and plant breeding of *Salacia* species, propagation research and field plantation techniques of *Salacia* species for further extension to end users, delineate and map the MPCAs, village's distribution, among other items needed to formulate sustainable use plans for *Salacia*

species, develop projects on *Salacia* species can be done with the assistance of the Department of Ayurveda and Bandaranaike Memorial Ayurvedic Research Institute (BMARI) on better harvesting and processing techniques, investigate various pathological agents infecting medicinal plants, establish new and rehabilitate existing nurseries for the collection and conservation of germplasm and plant materials, which succeeded in collecting and protecting about *Salacia* species, develop tissue culture protocols on the *Salacia* species, carefully monitor these *Salacia* species materials by network institutions which conduct horticultural research, establish a Sri Lankan biodiversity strategy funding package for the Department of Conservation's work on *Salacia* species recovery programs, initiate funding collection from Institutions such as National Medicinal Plants Board, Department of Science and Technology, Department of Biotechnology, molecular biology, biochemistry.

Outcome

Superior cultivation techniques, faster seedling growth rates, and improved methods. Increased understanding of the genetic diversity of *Salacia* species and information to assist the careful selection of sites to be managed over the long term, to maintain the genetic diversity and thereby the resilience of the population.

Recommendation 6: Establish plants of *Salacia* species in cultivation for transfer purposes, research and public education, and establish a seed bank

Plants should be grown in cultivation and a seed bank established to supply *Salacia* species for establishment on lowland wet zone in Sri Lanka and provide material for scientific study. Hence farmers need to be encouraged to grow species with economic potential and protect sustainability in their natural habitat (Phondani *et al.*, 2013).

Plan

- 1) To launch a seed bank and cultivate plants in suitable plant collections, but not to establish a commercial trade in this species. Before a seed bank can be established, research is needed to devise suitable germination tests to find the best ways to store the seeds of *Salacia* species.
- 2) Collect and store seeds - Representative seeds should be collected from different populations and placed in long-term storage through the center for plant conservation.
- 3) Researches on seed germination will allow long-term maintenance of seed collections and will facilitate propagation.
- 4) Grow and maintain plants - A genetically diverse propagule source can be established at arboretum. Plants from different areas are grown, and artificial crosses from different areas have produced a genetically diverse conservation population. This collection can serve as a propagule source for the recovery and restoration of populations. Develop germination requirements and cultural methods for establishing the species by the Department of Agriculture, Natural Resource Conservation Service. Once techniques are developed, local botanic gardens should grow plants representing different geographic areas.
- 5) Improve national nurseries for *Salacia* species, grow *Salacia* species and return to natural habitats, carefully maintain live plant materials of *Salacia* species collected from nature under controlled conditions as seeds, rooted cuttings or mature plants, ensures material is available for restoration and recovery efforts for *Salacia* species, an improved supply of planting materials of *Salacia* species, select the developmental areas, apart from the protection of the existing bio-resources, the medicinal plant species of the neighboring areas will also be introduced and cultivated at large scale, the remaining areas in the Forest Division remain open for sustainable harvesting of the *Salacia* species, guidelines for such re-

introductions are being prepared by Botanic Gardens Conservation International and IUCN's Species Survival Commission.

Outcome

Plants established in cultivation would be used for transfers to Southern Province, research and the seed bank, help ensure that some of the genetic diversity of the *Salacia* species survives.

Review and track recovery progress

Progress towards meeting recovery plan goals should be reviewed periodically by holding meetings of the recovery team interested scientists and others contributing towards the recovery of this species.

Reassess the viability of each population

Updated information should be provided to the appropriate State agencies.

Developing a post-delisting monitoring plan

According to the Endangered Species Act, the status of species that have been recovered to the point of no longer needing protection by the Act will be monitored for at least five years. Upon the completion of a species status review, indicating that the recovery criteria have been satisfied, a post-delisting monitoring plan will be developed.

Due to that, most tropical countries have imposed rules and regulations to protect the intellectual property rights of traditional medicines and medicinal plants. It is very important to examine how these plant species can be managed for multiple uses which are socially acceptable, ecologically sustainable, and economically viable.

CONCLUSIONS

Manage *Salacia* species on forest patches, protect plants of *Salacia* species at selected sites to correspond to the full range of remaining genetic diversity and maintain

Salacia species in cultivation are the best three options for recovery of *Salacia* species. Recommendations to be achieved for the above mentioned recovery options are, protect plants of *Salacia* species from herbal raw material collectors and other recognized threats at all known sites on land administered by the Department of Forestry, promote public interest and involvements in the recovery of *Salacia* species encourage its protection on private land, advocate for the listing of *Salacia* species to prohibit the export of stem and root, obtain better information on the distribution, condition, and trends of *Salacia* species, carry out or promote research on the propagation, genetics, ecology, and protection of *Salacia* species, and establish plants of *Salacia* species in cultivation for transfer purposes, research and public education and establish a seed bank. To conserve *Salacia* species in the selected areas, we could start with the mentioned plans with different outcomes. It also provides a functional example of economic opportunities and research into medicinal plant species that can allow national and international policy planners to connection livelihoods and socio-economic development with the conservation of natural resources.

REFERENCES

- Arunakumara, K.K.I.U. and Subasinghe, S. (2010). *Salacia reticulata* wight. a review of botany, phytochemistry and pharmacology. *Tropical Agricultural Research and Extension*, 13(2): pp 41-47.
- Gunatilleke, I.A.U.N. and Gunatilleke, C.V.S. (1991). Threatened woody endemics of the wet lowlands of Sri Lanka and their conservation. *Conservation Biology*, 55: pp 17-36.
- Keeragalaarachchi, K.A.G.P., Dharmadasa, R.M., Wijesekara, R.G.S. and Kudavidanage, E.P. (2016). Natural antidiabetic potential of *Salacia chinensis*

- L. (Celastraceae) based on morphological, phytochemical, physico-chemical and bioactivity: A promising alternative for *Salacia reticulata* Thw. *World Journal of Agricultural Research*, 4(2), pp 49-55.
- Maikhuri, R.K., Rao, K.S. and Kandari, L.S., (2005). Does the outreach program make an impact - A case study of medicinal and aromatic plant cultivation in Uttaranchal. *Current Science*, 88: pp 1480-1486.
- MOE. (2012). *The National Red List 2012 of Sri Lanka. Conservation status of the Fauna and Flora*. Ministry of Environment, Colombo, Sri Lanka. pp 236.
- Morikawa, T., Akaki, J., Ninomiya, K., Kinouchi, E., Tanabe, G., Pongpiriyadacha, Y. and Muraoka, O. (2015). Salacinol and Related Analogs: New Leads for Type 2 Diabetes Therapeutic Candidates from the Thai Traditional Natural Medicine *Salacia chinensis*. *Nutrients*, 7(3): pp 1480-1493.
- Negi, V.S., Maikhuri, R.K. and Phondani, P.C. (2010). An inventory of indigenous knowledge and cultivation practices of medicinal plants in Govind Pashu Vihar Wildlife Sanctuary, Central Himalaya, India. *International Journal of Biodiversity Science Ecosystem Services and Management*, 6: pp 96-105.
- Phondani, P.C., Maikhuri, R.K. and Bisht, N.S. (2013). Endorsement of ethnomedicinal knowledge towards conservation in the context of changing socio-economic and cultural values of traditional communities around Binsar Wildlife Sanctuary in Uttarakhand, India. *Journal of Agricultural and Environmental Ethics*, 26: pp 573-600.
- Ryanghyok, I.M., Mano, H., Nakatani, S., Shimizu, J. and Wada, M., (2008). Safety evaluation of the aqueous extract Kothala himbutu (*Salacia reticulata*) stem in the Hepatic gene expression profile of normal mice using DNA microarrays. *Biotechnology Biochemistry*, 72(12): pp 3075-3083.
- Ryanghyok, I.M., Mano, H., Nakatani, S., Shimizu, J. and Wada, M., (2008). Aqueous extract of Kothala himbutu (*Salacia reticulata*) stem promotes oxygen consumption and suppresses body fat accumulation in mice. *Journal of Health Science*, 54(6): pp 645-653.
- Schippmann, U., Leaman, D.J. and Cunningham, A.B. (2002). *Impact of Cultivation and Gathering of Medicinal Plants on Biodiversity: Global Trends and Issues*. In Biodiversity and Ecosystem Approach in Agriculture, Forestry and Fisheries, Satellite event on the occasion of the ninth regular session of the Commission on Genetic Resources for Food and Agriculture, Rome.
- Sharmal, S., Rathi, N., Kamal, B., Pundir, D., Kaur, B. and Arya, S. (2010). Conservation of biodiversity of highly important medicinal plants of India through tissue culture technology- a review. *Agriculture and Biology Journal of North America*, 1(5): pp 827-833.
- WHO. (2003). World Health Organization guidelines on good agricultural and collection practices (GACP) for medicinal plants. Geneva. pp 12.
- Yoganarasimham, S.N. (1996). *Medicinal Plants of India*. Volume 1: Interline Publishing Private Limited, India.