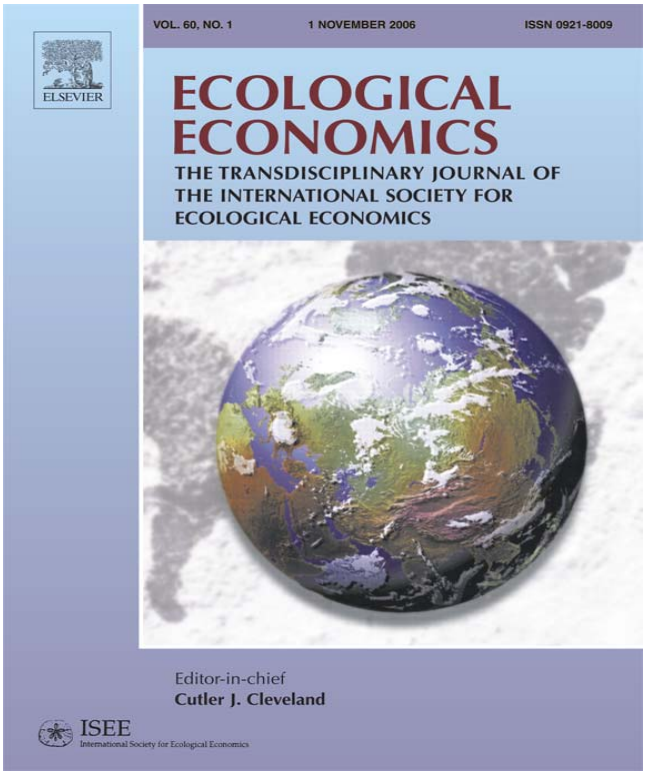

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SURVEY

Establishing a multi-stakeholder value index in medicinal plants—an economic study on selected plants in Kerala and Tamilnadu States of India

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ARTICLE INFO

Article history:
Received 9 September 2005
Received in revised form
23 January 2006
Accepted 2 February 2006
Available online 4 April 2006

Keywords:
Economic valuation
Medicinal plants
Benefit sharing
Multistakeholder priorities

ABSTRACT

In India, medicinal plants are valued for cultural reasons, non-monetary utilitarian purposes (food and medicine), industrial demand, and as a subset of the national biodiversity wealth. National policies to regulate the access and use in medicinal plants are to be framed in line with international regulations like Intellectual property rights and the Convention on Biodiversity. This requires prioritising between the numerous species using relevant indicators that may be market or non-market based.

In this study, an attempt is made to prioritise between 18 medicinal plants selected on the basis of economic importance and endemicity in the states of Kerala and Tamilnadu. The prioritisation is done through a Value Index. Data was collected (for the year 2001) through personal interviews using individual questionnaires for the different stakeholders identified as those who gain utilitarian value from medicinal plants (tribal communities, vaidyas (shamans/native healers), Ayurvedic pharmacies, non-governmental and government organizations, exporters). The value index was developed based on scores assigned for different factors influencing the value of medicinal plants related to the different stakeholders. The factors are categorized into domestic and international variables, like domestic and international market demand, non-monetary factors and impact of benefit sharing.

The contingency table of the scores for different species, analysed using Simple Correspondence Analysis provided positive (for international variables) and negative (for domestic variables) weights for different variables, indicating the contrasting variables that influence the value of a medicinal plant. In order to highlight the predominant utilities of the selected medicinal plants, the value index is decomposed into market and conservation index values. Results indicated that inclusion of perceptions of different stakeholders helps to prioritise investment decisions on medicinal plants, based on whether State desires to promote species in demand in the domestic market, international market or development of novel products based on use of medicinal plant species in indigenous communities. In addition, including benefit-sharing mechanisms into the frame of reference for the selected plants also highlights the utility of benefit sharing in sustaining indigenous traditions (by increasing value perception) through economic options.

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doi:10.1016/j.ecolecon.2006.02.010

1. Introduction

Medicinal plants have formed an integral part of the *Materia Medica* of various formal and informal systems of medicine. The contribution of floral biodiversity to health care has been well documented in different civilizations (Posey, 1999). In India, several medical systems have evolved, chiefly based on regional variations. Prominent among these systems are Ayurveda, Siddha and the Unani Systems of Medicine.[11] Of these, Ayurveda is the dominant medical stream in all parts of India, while Siddha is practised chiefly in Tamilnadu. Unani is also practised in all parts of India, although not to the extent of Ayurveda. Some of the important classical texts in these systems of medicine that exposit the use of medicinal plants, (along with other resources inter alia minerals, animal products) are *Caraka Samhita*, *Susruta Samhita*, *Ashtangahridaya* (in Ayurveda); Works by *Agastiyar*, *Bogar*, *Pulippani*, *Kongannar* (in Siddha). Apart from these documented sources, there is a wealth of information/knowledge on the use of plants for health care with informal sources inter alia households and native healers. This knowledge has developed (and continues to) through a process of experimentation and innovation and is now commonly referred to as indigenous knowledge, often used synonymously with the term traditional knowledge. Hence, an economic valuation exercise should ideally account for the utility that the resource imparts to the various stakeholders. In addition, it should also consider the impact that global conservation and ownership policies, as enunciated by the Convention on Biodiversity and Trade Related Aspects of Intellectual Property Rights, will have on the perceived utility of a species.

1.1. *Multiple stakeholder utility*

Different stakeholders use medicinal plants for various purposes. Each of these stakeholders attaches a value to the resource as it is of some utility to them. For instance, the Ayurvedic industry derives Use value from medicinal plants, which is used as a raw material; local communities derive Use Value from the resource in terms of food, medicine and the cultural or spiritual significance of medicinal plants; the Government values the medicinal plant resource as a national wealth with potential to derive economic rents. Hence, the value of a medicinal plant is not restricted to just pharmaceutical value but is indeed a composite value of utilities derived by various stakeholders. This study makes an attempt to capture this multiple stakeholder utility/value of medicinal plants.

1.2. *Overview of literature related to the study*

Several attempts are on to estimate the economic value of medicinal plants. Some of the significant studies are those by Principe (1990) where he estimates the economic value of a medicinal plant by using the final value of the pharmaceutical product as a proxy for the value of the plant; by Pearce and Moran (1994), where they attempt to capture the pharmaceutical value of an individual species of Biodiversity) through the probability of developing a successful drug, the extent to which the host country (from where the resource/knowledge is taken) is able to appropriate rents, the value of the drug developed, and the royalty commanded by the host nation; by Aylward (1998) who, assumes a royalty model to capture the pharmaceutical value of biodiversity in the Costa Rican; Principe (1996) differentiates 'economic value' from 'market value' of medicinal plants as the former includes societal benefits, accounting for both current values and potential value. He analyses the value of medicinal plant species using a similar methodology as followed by Pearce and Moran, where the value of prescriptions weighted by the percentage of plant based prescription drugs is used to estimate the value (total and present value) of species foregone due to extinction given the estimated rate of species loss. Other models of economic valuation such as those by Simpson and Sedjo (1996) and Cash (2002) obtain values assuming the probability of development of successful drug and value of final product.

Although these models, by trying to focus on the pharmaceutical value of biodiversity, provide a useful indicator of one of the options of the resources, the unsettled question then is, do these values sufficiently highlight the value of the resources from the perspective of other stakeholders, who may interact more immediately with the resources. Artuso (2002) provides an insightful analysis of the shortcomings of the earlier methods, whose assumptions were more suited for mathematical analysis purposes and ignored relevant heterogeneous issues. These include assumptions like perfect substitution between resources and very low estimates of probability of developing a successful product. Again, the utility of the resource to the different stakeholders/user groups would also vary, in turn affecting their perception of value of the resource.

Development of an index prioritising the qualitative and quantitative methods could be one comprehensible approach to emphasize the relative importance of a species. Cooper (2001) forwarded this argument while trying to estimate the value of plant germplasm used in plant breeding activities. The aim of the research was to identify the value of germplasm through its relative commercial benefits to different countries and thereby decide how much should individual nations contribute towards a global fund in order to ensure "benefit sharing" with source countries of germplasm. Here, different nations were considered as various stakeholders. Cooper concludes that data insufficiency hinders valuation procedure due to multiplicity of stakeholders. Development of a composite index through proxy observable macro variables was felt to be more indicative of the utility derived by different nations from germplasm collections. Kadekodi (2002) also argue on similar lines, while identifying the different valuation methodologies available to researchers to value biodiversity for developing a theme paper for the National Biodiversity Strategy and Action Plan. The group points out the need to identify appropriate indicators to conserve biodiversity based on the use pattern and concerns

[1] The Department of AYUSH (Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homoeopathy) consider the medical streams of Ayurveda, Siddha and Unani (Indian Systems of Medicine) and Homeopathy, and the therapies of Yoga and Naturopathy under its purview (http://indianmedicine.nic.in).

of different stakeholders. Posey (2002) raises the issue that valuation techniques account only for information and resources and ignore the social and environmental values assigned to biodiversity resources by indigenous or local communities.

Given this background, this study examines the economic value of medicinal plants, considering the utilitarian value that the resource imparts to various stakeholders. The stakeholders were identified based on a previous economic study on medicinal plants in Kerala (Suneetha, 1998), where the major marketing channels for medicinal plants and end-users of the plants were identified.

2. Methodology

2.1. Data collection

The study was conducted in the southern states of Kerala and Tamilnadu of India, where trading in medicinal plants is active (Suneetha, 2004). The cross section of stakeholders interviewed (using structured questionnaires) includes tribal members in Kerala, vaidyas (local healers) from Kerala and Tamilnadu, representatives of Ayurvedic pharmacies and research institutes involved in processing medicinal plants, representatives of organizations involved in the conservation of medicinal plants and concerns of local communities, including tribal members from Kerala and Tamilnadu, Forest department of Kerala and Exporter of medicinal plants in Tamilnadu [2] (Box 1). Consumers of medicinal plants as end-users were not included on the premise that the market demand (as evidenced by the resources of Ayurvedic pharmacies) is indicative (as derived from) of a large percentage of individual demand. This study also does not account for conservationists as a body of stakeholders, as the purview of the study is restricted to utilitarian value of the plant resources and does not include existence value.

Local healers were interviewed during Healer's Conventions (both random and purposive interviews were conducted with healers of higher standing); tribal members were interviewed randomly from the sample areas of Wyanad (when categorized, more interviewees were from the Kurichiar tribe) and Trivandrum (Kani tribal members). Selection of the sample areas was purposive as the Kani members collaborate with the Tropical Botanic Gardena and Research Institute (TBGRI) for development of herbal drugs and in ethnobotanical explorations, and vaidyas and tribal members from the Wyanad collaborate with the Kerala Institute for Research, Training and Development Studies on Scheduled Castes and Tribes (KIRTADS), Kozhikode. All other respondents were purposively chosen given their previous awareness, initiatives in benefit sharing and exposure to the issues related to the study that helped them to provide sensitised information.

Box 1
Respondents of the study

Type of Respondent	Name/ Number of Respondents	Region
Tribals	•Kurichiar Tribes of Wyanad (15) •Kurumbans of Wyanad (5) •Kani Tribe of Thiruvananthapuram (20)	Kerala
Vaidyas (Native healers)	•Siddha vaidyas (60) •Ayurvedic vaidyas (28)	Tamilnadu and Kerala
Organizations involved in the conservation of medicinal plants/ traditional knowledge	•Covenant Center for Development, Madurai. •Foundation for Revitalization of Local Health Traditions (FRLHT), Bangalore. •Wyanad Social Service Society (WSSS), Wyanad. •Kerala Institute for Research, Training and Development studies for scheduled castes and scheduled tribes (KIRTADS), Kozhikode. •Forest Department, Kerala.	Tamilnadu Kerala and Karnataka
Ayurvedic Pharmacies/ Research Institutes	•Arya Vaidya Sala, Kottakkal •Arya Vaidya Pharmacy, Coimbatore •Secretary, Kerala Ayurvedic Medicine Manufacturers' Association •Tropical Botanic Garden and Research Institute (TBGRI), Thiruvananthapuram •Gram Mooligai Company Ltd (GMCL), Madurai	Kerala and Tamilnadu
Exporters of Medicinal Plants	•PSS Krishnamurthy Exports Ltd, Tirunelveli	Tamilnadu

A conceptual framework for the valuation of medicinal plants incorporating different factors such as market values, non-market use values and spiritual or cultural values was identified. The different variables (Table 1) were identified based on literature reviews and direct interviews with the different stakeholders in the year 2001.

2.1.1. The model

The model assumes the economic value of medicinal plants to be a function of Investments, Market Value of medicinal plants, Non-market Use values, Benefit sharing measures, Cultural/Spiritual values attached to medicinal plants. Each of these variables is defined as follows:

- Investments could be from the Public, Parastatal (State organizations with autonomous power like KIRTADS), NGO sector or the Private sector. It indicates the value that is

[2] A limitation of the study is the non-inclusion of Allopathic or Western pharmacies as a stakeholder. To some extent, estimates of demand in the domestic and export markets do give an approximation of the demand from this sector, especially since the study intends to provide direction of demand than estimate the absolute magnitude of demand. However, the development of technology in fields of combinatorial chemistry and bioinformatics could lead to shifts in the demand for resources, that is beyond the scope of the study.

Table 1 – Scores of variables influencing medicinal plant species (2001)

Variable	Characteristic	Score
(1) Government programmes	Specific	3
	General	2
	None	1

This includes investments by the forest department on forest conservation activity. If this investment is specific to any of the 18 medicinal plants considered in this study, a score of '3' is assigned. If the investment is made in general for all medicinal plant species, then a score of '2' is assigned. If no investment is made, then a score of '1' is assigned, since the forest department invests on forest conservation as a whole and that would have had some indirect impact on medicinal plant species.

(2) Quasi government and NGO programmes	Specific	3
	General	2
	None	1

If there are specific programmes of quasi government institutions or NGOs like KIRTADS, FRLHT, CCD, then a score of '3' is assigned. This includes programs that promote the livelihoods of people using medicinal plant resources. For example, CCD organizes cultivation of *Withania* and collection of other species among traditional gatherer communities. Here, CCD gives information to the farmers/gatherers to cultivate the medicinal plants species, and link the gatherer communities with organizations like Gram Mooligai Company Ltd (GMCL) who market it.

These organizations promote the use of medicinal plants, in general in a region through demonstration gardens. This will get a score of '2'.

If there is no current program, a score of '1' will be assigned since in future there could be a initiative and at least there are no destructive or negative activities.

(3) Private initiatives	Specific	3
	General	2
	None	1

There are specific private initiatives for certain medicinal plants like Trichopus, where the company (Arya Vaidya Pharmacy) attempted to undertake contract farming with buy-back arrangement. In addition, the company also attempted to increase the number of seedlings for cultivation through tissue culture. Such initiatives are assigned a score of '3'. If the private initiatives were restricted to generally scouting for new sources of supply of a medicinal plant, a score of '2' is assigned; while if there is no current initiative, then a score of '1' is assigned.

(4) Government policies promoting medicinal plant cultivation	Specific	3
	General	2
	None	1

Specific regulations include government subsidies like input subsidy by provision of seedlings at low cost, promotion of specific medicinal plants by providing facilities like seedlings, loans for medicinal plants cultivation, buy-back arrangements, for which a score of '3' is assigned.

However, since all the 18 medicinal plants are being promoted by policies of the Kerala State Government (like through the Cultivation of Medicinal Plants scheme through the Dept. of Agriculture, which was initially started in 1995) and/or complemented by the policies of the Central Government such as through the recommendations of the Sub Group on Medicinal and Aromatic Plants, all the medicinal plants will get a score of '3'.

(5) Intellectual Property Rights (IPR) regulations	Specific	3
	General	2
	None	1

IPRs can be in terms of patents on products of medicinal plants, geographical indications, trade secrets, and copyrights. In such cases, a score of '3' is assigned.

Table 1 *(continued)*

Variable	Characteristic	Score

In the 'vaidya' tradition, medicines are prepared by the vaidya and administered on a case-by-case basis. Here, the knowledge is revered and hence secrecy is well recognized. In addition, the vaidyas transfer their knowledge through their children/relatives or disciples over a period of time where the student imbibes knowledge from the vaidya. The Government of India in the Patent Amendment Act, 1999, has amply recognized such knowledge. This type of protection is assigned a score of '2'. The methodology provides for cases where there may be no adequate protection mechanism in a country, in which case a score of '1' is assigned.

(6) Domestic market demand for medicinal plant (volume)	High	3
	Low	2
	None	1

If the market demand for a specific medicinal plant is high, then a score of '3' is assigned. Kerala has a tradition of using plant based medicines. The Ayurvedic pharmacies in Kerala have been studied and found to use at least 500 medicinal plants. Among them, it was found that 50 (list in Appendix A) plants were used in large quantities in medicinal formulations.

If any of the 18 medicinal plants chosen for the study figure in the list of fifty plants, a score of '3' is assigned. If any of the 18 plants do no figure in the list of 50, a score of '2' is assigned. If any of the 18 plants do not figure in the list of plants used by pharmacies, then a score of '1' is assigned.

(7) Domestic market price of medicinal plant	Above cost of production	3
	Below cost of production	2
	No price	1

For the 18 medicinal plants, if the market price of the medicinal plant species is higher than or equal to the cost of gathering or cost of production, whichever is higher, then a score of '3' is assigned. If the price is less than the cost of production or gathering, whichever is higher then a score of '2' is assigned. If any of the medicinal plants is not bought by the Ayurvedic pharmacies of Kerala, a value of '1' is assigned since they may be bought in small quantities. The cost of gathering/production was obtained from the cultivator/gatherer tribals and the prices were obtained from the Pharmacies.

(8) Change in real price of medicinal plant	Positive	3
	No change	2
	Negative	1

According to Barnett and Morse (1963), ceteris paribus increase in the real cost of extraction is an indicator of economic scarcity. Applying this principle here implies that if real price is on the rise, then the value of medicinal plant is increasing due to scarcity. In this study, the nominal price of medicinal plants is increasing in most of the selected 18 plants from 1996 to 2001. To capture this, the scoring is as follows:

If the real price rise is positive, a score of '3' is assigned; if there is no change, a score of '2' is assigned and if the real price change is negative, a score of '1' is assigned. Prices were obtained from the pharmacies.

(9) International trade in medicinal plant (volume)	High	3
	Low	2
	None	1

The data on quantity exported of each of the 18 medicinal plants was not available. Even the Director General of Foreign Trade (DGFT) records give data only for two species (*Cassia angustifolia* and *Plantago ovata*). As most other species are exported as 'Other Ayurvedic and Unani Drugs', their quantity was not available. However, since international trade in medicinal plants is catching up and hence is a one of the reflectors of quasi option value, one of the major exporters[a] from South India was approached for information related to direction of quantity traded for the selected

(continued on next page)

Table 1 (continued)

Variable	Characteristic	Score
species. If High, a score of '3' is assigned for the species; if low, a score of '2' is assigned, and if currently there is no trade, then a score of '1' is assigned as it could be traded in future.		
(10) Ratio of international price to market price	More than 1	3
	Equal to 1	2
	Less than 1 or unavailable	1
If the ratio is greater than 1, a score of '3' is assigned; if equal to 1, a score of '2' is assigned and if the ratio is less than '1' or if corresponding data for a species is unavailable from both domestic or international markets, a score of '1' is assigned, since the potential for exports exists given the available knowledge.		
(11) Consumptive use value of plant (food)	High frequent use	3
	Less frequent use	2
	Rarely used or non-use	1
Details on the variables 11, 12 and 13 were obtained from tribal communities.		
Non-consumptive use value for food includes using medicinal plants for culinary purposes. If any of the selected 18 species are used on a regular basis, a score of '3' is assigned; if less frequently used, a score of '2' is assigned and if rarely or not used, a score of '1' is assigned.		
(12) Consumptive use value of plant (medicine)	High frequent use	3
	Less frequent use	2
	Rarely used or non-use	1
If any of the selected 18 species are used on a regular basis by tribal communities for their home medicine, a score of '3' is assigned; if less frequently used, a score of '2' is assigned and if rarely or not used, a score of '1' is assigned.		
(13) Non-consumptive use value of plant (cultural/ spiritual reasons)	High frequent use	3
	Less frequent use	2
	Rarely used or non-use	1
Non-consumption use value includes using medicinal plants for purposes other than medicine or food purposes such as, religious, spiritual, aesthetic and cultural purposes. Strong dependence by tribal communities on a species (of the selected 18 species) gets a score of '3' for the plant, modest dependence—'2' and low or non-dependence—'1'.		
(14) Benefit sharing	Present	
	•Increase or stability in price	1
	•Acknowledgement and respect	1
	•Increase in information related to markets, price, end-use, etc.	1
	•Increase in employment	1
	•Increase in local use	1
	•Increase in conservation activities	1
	•Increased access to markets	1
	Absent	1
If benefit sharing arrangement is present, then it could lead to several consequences, seven of which have been identified for the study. A uniform score of '1' is given for each consequence.		
The impact of benefit sharing could have several effects at the community level such as higher price realization for an under or un-priced plant; a "feel good effect" due to increased acknowledgement of indigenous knowledge at "higher" levels of society; increase in access to markets to the industrial partner due to marketing of the product as a result of responsible research; higher employment opportunities at the local level due to increase in demand for resource; it could lead to a revisit of the knowledge system at the local level and hence an increase in the local use of the resource and knowledge systems; and foster a responsibility to conserve plant species for future use, all of which result in higher bringing forth the benefits. All these consequences may be found in a benefit sharing exercise, or only a few of these consequences may arise. A uniform score of '1' is given to each of these consequences. Hence, if benefit-sharing arrangements exist for a species, then the score could vary from 1 to 7. If no benefit sharing arrangement exists, a score of '1' is assigned as, in future, such arrangements are possible.		
Each factor influencing the valuation of a plant is given an equal marginal weight of '1'. Arguably, this will lead to a higher weight if all factors included under benefit sharing are true for a plant. This however provides an indicator of the increase in the perception of the value of a plant due to transfer payments from the market. As the marginal value is assumed at '1', each additional benefit (or potential value perception) is assigned a score of '1'.		

a PSS Krishnamurthy Exports Ltd, Tuticorin, Tamilnadu, whose group controls about 70% of exports of medicinal plants from the port of Tuticorin.

attached to the medicinal plant resource at the policy and organizational levels. It includes investment in various activities related to medicinal plants like conservation, cultivation, processing and so on.

- Private investment is determined by protection measures such as Patents or exclusive access to the resource. Exclusive access refers to sole rights given for a period of time to an individual or organization to access the resource from a given area or region.
- Market Value is determined both by the domestic and international markets. Market Value includes both the quantity of medicinal plant traded and the price of a species in the domestic market and the price of a species in export markets.
- The assurance of benefits for sharing knowledge on use of medicinal plants encourages communities or individuals to conserve medicinal plant resources they are associated with for their livelihoods as it increases the value perception associated with a plant species. It also encourages research partnerships between communities and research organizations. Research partnerships imply a sharing of knowledge and technology and benefits between the communities or individuals and the research body for the development of novel products. Hence, the effects of benefit sharing are considered as a variable determining the value of a medicinal plant.
- Conservation of medicinal plants from a utilitarian perspective can be defined as efforts taken to ensure sustained availability of a medicinal plant species. Conservation value does not imply existence value or potential threat for conservation. In this study, it indicates the non-market value that traditional communities place on a medicinal plant species that are primarily determined by domestic requirements from within the community viz., for local healthcare requirements, food or when the plants are required for cultural purposes, the rationale being to "conserve what is used". These consumptive and non-consumptive values attached to medicinal plants ensure their survival and sustainable use.

2.2. Scoring and indexing

The data were obtained for the year 2001 from the different stakeholders. As the data obtained were chiefly evocative in nature, the value of a medicinal plant can be expressed through an index, representing the perceptions of the stakeholders. An index helps to compare between different species over several (multiple) stakeholders and thereby do a composite prioritisation exercise between plant species. It helps to rank species by providing a relative weight, that can then be used to base decisions on investments on different species. Hence, although it may not provide a true magnitude of the value of a species, it does provide an indicator of the relative value of a species. Accordingly, a Value index was worked out for a medicinal plant. For this, scores were provided (Table 1) for the different variables identified as important by the various stakeholders and summing over the individual scores (please see Appendix A for rationale on assigning scores to the different contributing variables for the different species). To a great extent, this can be used as a method to prioritise investment on specific plants, although technology and evolution of substitutes and innovations in products, processes and use of medicinal plant resources could alter some priorities. The index serves as a checklist of benchmarks to prioritise between plants, and hence is sufficiently flexible to accommodate changes in the data on trade and conservation concerns related to medicinal plants. The index was worked out for a list of 18 plants, which were selected from a list prepared by the Sub-Group on Medicinal and Aromatic Plants for the Tenth Five Year Plan (Anonymous, 2000). Data were collected for the year 2001. The selected plants are *Adhatoda vasica*, *Aegle marmelos*, *Aloe vera*, *Andrographis paniculata*, *Asparagus racemosus*, *Cassia angustifolia*, *Emblica officinalis*, *Garcinia indica*, *Gloriosa superba*, *Gymnema sylvestre*, *Holostemma ada-kodien*, *Phyllanthes amarus*, *Piper longum*, *Plantago ovata*, *Sida rhombifolia*, *Tinospora cordifolia*, *Trichopus zeylanicus*, *Withania somnifera*. The plants were selected based on the criterion of endemicity and economic importance in the area of research study.

2.3. Simple correspondence analysis

The scores assigned were subjected to Simple Correspondence Analysis using the software MINITAB (version 11.12) to obtain the relative weights of each score. This methodology is defined as a 'nonlinear *multivariate descriptive statistical* method that graphically represents the rows and columns of a categorical data matrix in the same low-dimensional space" (Prasad, 1994). This method is used to analyse contingency tables such as two-way tables (Simple Correspondence Analysis) or multi-way tables (Multiple Correspondence Analysis), where the data matrix has non-negative values. It points out the impact of different variables on the variability in the data. It has been used widely in psychometric and environmental and land use pattern studies, where the impact of various factors on the behaviour of a person, species or productivity respectively have been analysed (Prasad, 1994).

For this analysis, the different scores for each variable for each species are organized into a contingency table and subjected to Simple Correspondence Analysis. The results of the Analysis give the relative contribution of the various factors to the variability in the data. This therefore helps to identify the distinguishing factors for each species. It further provides relative weights for the individual scores as co-ordinate values. As the scores for Government, Non-Government Programmes and Private initiatives and Government regulations were uniform for the selected species, these variables did not contribute to the variability of the data and hence have not been included in the index.

The different individual scores (I) for each variable are then weighed by the individual weights (a) or co-ordinates assigned by the analytical procedure for each factor or influencing variable for each species. Summing over these weighed scores for the different factors gives the total score for a species.

$$\text{Total Score for a } j\text{th species} = \text{Value Index} = \sum I_{ij}{}^{*}a$$

A comparison between the relative values of different species will help to identify species that are of interest to the different stakeholders. The analysis helps to classify the medicinal plant species based on market variables and on conservation variables.

Market index value of a species = Scores of {Intellectual Property Rights regulations + Domestic Market Demand + Change in real price + Domestic Market Price + Change in Real Price + Export Market Demand + Ratio of international price to domestic price}. This indicates the market utility derived from medicinal plants. Changes in real price indicate the value perception due to non-commensurate changes in availability of a plant species and its market price.

Conservation index value of species = Scores of {Non-monetary values (Food + Medicine + Cultural/Spiritual values) + Benefit sharing effects}.

This indicates the non-market utility derived from medicinal plants that imparts value to the species. Part of benefit sharing measures are transfer payments from the market, leading to increased value perception on all plants that are used by the communities. The selected species are then ranked based on the scores obtained in each case. In the case of Conservation index value of a species, the classification is done both excluding and including impact of benefit sharing arrangements in order to examine the degree to which benefit sharing arrangements strengthen the conservation value of medicinal plants.

3. Results and discussion

3.1. Relative value of selected medicinal plants

The 18 medicinal plant species considered in this study for valuation purpose are ranked according to the total scores obtained from Simple Correspondence Analysis. The total score is the sum of the components with positive and negative co-ordinates. Variables with negative co-ordinates are dominated by domestic factors inter alia Domestic market demand, Domestic market price, Change in real price, Food, Medicine, Cultural/Spiritual values. Variables with positive co-ordinates are dominated by international factors inter alia Intellectual property protection, Export

demand, Ratio of International to domestic prices and Benefit sharing arrangements.

The positive and negative co-ordinates can also be considered as Contrasting components (group of variables) influencing the value of medicinal plant species. The total score of a species subsumes the sum total of positive and negative co-ordinates with varying ranges of scores characterizing the economic and institutional factors influencing the value of the medicinal plant (Table 2). If total score is equal to zero, then negative (domestic) factors and positive (international) factors are equally crucial in determining the value of the medicinal plant. If the total score is more than zero, then international factors are the prime movers in determining the value of the medicinal plant. If the score is less than zero, the domestic factors are crucial in determining the value of medicinal plant.

The results indicate that in *Gloriosa*, *Cassia* and *Plantago*, the value is greatly influenced by international variables like Export demand in relation to other variables. For other medicinal plants, there is a dominance of either domestic (e.g., *Sida*, *Aegle*, *Tinospora*) or a combination of both (e.g., *Phyllanthus*, *Emblica*). Species with negative scores are influenced primarily by domestic variables (e.g., *Tinospora*, *Piper*, *Aegle*, *Asparagus*, *Withania*, *Sida*) while those with positive scores are influenced by international variables (e.g., *Garcinia*, *Gloriosa*, *Plantago*, *Cassia*). In the case of Phyllanthus, the score is closer to zero (0.06) indicating that it has high value both in domestic and international contexts (Table 3).

3.2. *Relative value of selected medicinal plants based on market and conservation variables*

Variables classified as Market variables are IPR, Domestic market demand, Domestic market price, Change in real price, Export demand and Ratio of international to domestic price. Variables classified as Conservation variables are Food, Medicine and Cultural and Spiritual Values and benefit sharing arrangements. Existence of Benefit sharing arrangements will strengthen the sense of belongingness of the species to the community and thereby increase the total value of the medicinal plant through both conservation and market values. Benefit sharing improves the value attached for the conservation of a plant species through transfer payments from market or pharmaceutical/industry to the indigenous communities. In order to explicitly capture the influence of Benefit sharing, value of the species is considered by including and excluding benefit sharing score. Species with high scores for conservation variables, excluding the benefit sharing arrangements, have the potential for new drug or product development.

3.3. *Market index value of medicinal plants*

Based on the scores obtained for the market variables, the different selected medicinal plant species are classified. This includes both domestic (negative co-ordinates) and international variables (positive co-ordinates).

The total score for domestic market are negative as the co-ordinates for the domestic variables obtained from the Simple Correspondence Analysis are negative. The scores are ranked in the ascending order of magnitude (how far they are away from zero), in order to highlight the medicinal plants that need to be focused for development considering the domestic market factors. The medicinal plants *Adhathoda*, *Aegle*, *A. vera*, *Emblica*, *Tinospora* (Table 4) are highly demanded in the domestic market by pharmaceuticals and *nati vaidyas*. In Kerala, *Sida* sp. is the most commonly used plant in most of the medicinal preparations/formulations. Among *Sida* species, the subspecies *S. rhombifolia* subsp. *retusa* is the most commonly demanded medicinal plant. However, due to

Table 2 – Weighted scores for the different selected variables influencing the selected medicinal plant species

Species	IPR	DMD	DMP	RP	ED	IP/DP	Food	Med	Cul	BS
Co-ordinate (weight)	0.002	−0.143	−0.025	−0.229	0.154	0.014	−0.019	−0.08	−0.053	0.576
Adhatoda vasica	0.006	−0.429	−0.075	−0.687	0.462	0.042	−0.038	−0.24	−0.159	1.728
Aegle marmelos	0.006	−0.429	−0.075	−0.687	0.308	0.014	−0.038	−0.24	−0.159	0.576
Aloe vera	0.006	−0.429	−0.075	−0.687	0.462	0.042	−0.038	−0.24	−0.106	1.728
Andrographis paniculata	0.004	−0.429	−0.075	−0.687	0.154	0.014	−0.038	−0.24	−0.159	1.152
Asparagus racemosus	0.004	−0.429	−0.075	−0.687	0.462	0.014	−0.038	−0.24	−0.159	0.576
Cassia angustifolia	0.004	−0.143	−0.075	−0.229	0.462	0.014	−0.019	−0.08	−0.053	0.576
Emblica officinalis	0.006	−0.429	−0.075	−0.687	0.462	0.042	−0.057	−0.24	−0.159	0.576
Garcinia indica	0.006	−0.286	−0.075	−0.229	0.462	0.042	−0.057	−0.16	−0.106	0.576
Gloriosa superba	0.004	−0.286	−0.05	−0.229	0.308	0.014	−0.019	−0.08	−0.053	0.576
Gymnema sylvestre	0.006	−0.286	−0.05	−0.687	0.462	0.014	−0.038	−0.24	−0.106	0.576
Holostemma ada-kodien	0.004	−0.429	−0.075	−0.229	0.154	0.014	−0.038	−0.16	−0.106	0.576
Phyllanthes amarus	0.006	−0.429	−0.05	−0.687	0.462	0.042	−0.038	−0.24	−0.159	1.152
Piper longum	0.004	−0.429	−0.075	−0.687	0.154	0.014	−0.038	−0.16	−0.106	0.576
Plantago ovata	0.004	−0.286	−0.075	−0.229	0.462	0.014	−0.019	−0.08	−0.053	0.576
Sida rhombifolia	0.004	−0.429	−0.075	−0.229	0.154	0.014	−0.057	−0.24	−0.159	0.576
Tinospora cordifolia	0.006	−0.429	−0.075	−0.687	0.154	0.014	−0.038	−0.24	−0.106	0.576
Trichopus zeylanicus	0.006	−0.286	−0.075	−0.229	0.462	0.014	−0.057	−0.24	−0.159	3.456
Withania somnifera	0.006	−0.429	−0.075	−0.687	0.462	0.042	−0.038	−0.24	−0.106	0.576

IPR—intellectual property protection, DMD—domestic market demand, DMP—domestic price, RP—change in real price, ED—export demand, IP/DP—ratio of international to domestic price, Food—non-monetary values (food), Med—non-monetary values (medicine), Cul—non-monetary values (cultural/spiritual), BS—benefit sharing arrangement.

Table 3 – Value index of the selected medicinal plants

Species	Sum of all negative co-ordinates for each medicinal plant species[a]	Sum of all positive co-ordinates excluding 'benefit sharing'[b]	Sum of positive co-ordinates, including 'benefit sharing'	Total score excluding 'benefit sharing'	Total score
Trichopus zeylanicus	−1.05	0.48	3.94	−0.56	2.89
Aloe vera	−1.58	0.51	2.24	−1.07	0.66
Adhatoda vasica	−1.63	0.51	2.24	−1.12	0.61
Cassia angustifolia	−0.60	0.48	1.06	−0.12	0.46
Plantago ovata	−0.74	0.48	1.06	−0.26	0.31
Gloriosa superba	−0.72	0.33	0.90	−0.39	0.19
Garcinia indica	−0.91	0.51	1.09	−0.40	0.17
Phyllanthus amarus	−1.60	0.51	1.66	−1.09	0.06
Holostemma ada-kodien	−1.04	0.17	0.75	−0.87	−0.29
Andrographis paniculata	−1.63	0.17	1.32	−1.46	−0.30
Gymnema sylvestre	−1.41	0.48	1.06	−0.93	−0.35
Sida rhombifolia	−1.19	0.17	0.75	−1.02	−0.44
Withania somnifera	−1.58	0.51	1.09	−1.07	−0.49
Emblica officinalis	−1.65	0.51	1.09	−1.14	−0.56
Asparagus racemosus	−1.63	0.48	1.06	−1.15	−0.57
Aegle marmelos	−1.63	0.33	0.90	−1.30	−0.72
Piper longum	−1.50	0.17	0.75	−1.32	−0.75
Tinospora cordifolia	−1.58	0.17	0.75	−1.40	−0.83

a Variables with negative co-ordinates are dominated by domestic factors inter alia domestic market demand, domestic market price, change in real price, food, medicine, cultural/spiritual values.
b Variables with positive co-ordinates are dominated by international factors inter alia intellectual property protection, export demand, ratio of international to domestic prices and benefit sharing arrangements.

physical scarcity, this plant is not available. This would have led to economic scarcity, but the gatherers are substituting this species with other subspecies of *Sida* and *S. rhombifolia*, which depress the scarcity value of the medicinal plant (Suneetha, 1998).

Cassia, *Plantago* and *Gloriosa* species are highly exported plant species. In addition to gathering from the wild, they are also primarily cultivated. Other species inter alia *Emblica*, *Adhatoda*, *Aloe* and *Phyllanthus* also have high export value due to export demand, patented products developed using these medicinal plants in importing countries and high ratio of international to domestic prices.

3.4. *Conservation index value excluding 'benefit sharing' arrangement*

As in the case of 'domestic market' variables, the 'conservation' value scores are also negative, as the results of the Simple Correspondence Analysis assign negative co-ordinates to these variables. This analysis considers the relative importance of medicinal plant species by focusing on scores secured by the plants for their utilities as food, medicine, and cultural or spiritual purposes. The scores are ranked in the ascending order of magnitude (how far they are away from zero), in order to highlight the medicinal plants that need to be focused for development considering the conservation variables.

Here, *Sida* and *Emblica* rank high due to their high use as food, medicine and for cultural purposes[3] (Table 5). *Gymnema* is highly used as medicine. These plants can be concentrated on for development of new products based on indigenous knowledge/information. *Cassia* and *Plantago* species have no/low demand by local communities. Since, *Trichopus* is primarily used for medicinal and for cultural purpose, it has a lower score in comparison with *Sida* and *Emblica*.

[3] The different medicinal plants are used for various non-consumptive purposes as symbolic in religious functions or special occasions like annual festivals, or to mark a milestone in a child's or person's life. Some species are considered sacred to a community like Trichopus in the case of Kani.

Table 4 – Prioritisation of medicinal plants based on market variables

Species	Domestic market	Export market	Total market score
Cassia angustifolia	−0.45	0.48	0.03
Garcinia indica	−0.59	0.51	−0.08
Plantago ovata	−0.59	0.48	−0.11
Trichopus zeylanicus	−0.59	0.48	−0.11
Gloriosa superba	−0.57	0.33	−0.24
Gymnema sylvestre	−1.02	0.48	−0.54
Holostemma ada-kodien	−0.73	0.17	−0.56
Sida rhombifolia	−0.73	0.17	−0.56
Phyllanthus amarus	−1.17	0.51	−0.66
Adhatoda vasica	−1.19	0.51	−0.68
Aloe vera	−1.19	0.51	−0.68
Emblica officinalis	−1.19	0.51	−0.68
Withania somnifera	−1.19	0.51	−0.68
Asparagus racemosus	−1.19	0.48	−0.71
Aegle marmelos	−1.19	0.33	−0.86
Andrographis paniculata	−1.19	0.17	−1.02
Piper longum	−1.19	0.17	−1.02
Tinospora cordifolia	−1.19	0.17	−1.02

3.5. *Conservation index value of medicinal plants including 'benefit sharing' arrangement*

Conservation index value of a species is augmented by 'benefit sharing' arrangement since it facilitates the conservation efforts of the communities and thereby strengthens the backward linkage of the pharmaceutical. Benefit sharing facilitates the transfer payments from market to conservation of the species through indigenous communities. Upon inclusion of 'benefit sharing', the ranking of medicinal plants alters, substantially with the negative 'conservation' scores offset by the positive scores of 'benefit sharing'. Thus, *Trichopus* (please see Appendix A for details on benefit sharing in the case of *Trichopus*), which has high conservation value, moves to first rank due to benefit sharing arrangement. Other species such as *Plantago*, with low conservation values, get higher values due to the offsetting of low conservation value by positive benefit sharing values.

Table 5 – Prioritisation of medicinal plant species based on conservation value

Species	Conservation score without benefit sharing	Conservation score with benefit sharing
Emblica officinalis	−0.46	0.12
Sida rhombifolia	−0.46	0.12
Adhatoda vasica	−0.44	1.29
Aegle marmelos	−0.44	0.14
Andrographis paniculata	−0.44	0.72
Asparagus racemosus	−0.44	0.14
Phyllanthus amarus	−0.44	0.72
Trichopus zeylanicus	−0.44	3.00
Aloe vera	−0.38	1.34
Gymnema sylvestre	−0.38	0.19
Tinospora cordifolia	−0.38	0.19
Garcinia indica	−0.32	0.25
Holostemma ada-kodien	−0.30	0.27
Piper longum	−0.30	0.27
Cassia angustifolia	−0.15	0.42
Gloriosa superba	−0.15	0.42
Plantago ovata	−0.15	0.42

Thus, inclusion of benefit sharing has two influences on the conservation score: (1) movement from negative score regime to positive regime, which implies movement from non-market to market regime in the initial stage, which may lead to widening of domestic and international demands; (2) substantial increase in the score, which leads to increase in the quasi option value of the medicinal plant, due to widening of utilitarian value of the medicinal plant.

A higher Market index value implies that transfer payments have to be made for the conservation of medicinal plants, Similarly, a higher Conservation index value has the following implications—(i) acknowledgement of the benefits of the medicinal plants hence transfer payments made from the market for the conservation of the resource and (ii) the medicinal plant resource is valued in indigenous communities and by *vaidyas*, and is yet to be recognized in the market place. This is a pointer to the potential value of medicinal plants to accrue returns and provides a lead for exploration of new products and markets.

The analysis also helps to cluster or categorize medicinal plant species distinguished by the influencing variables. For instance, *E. officinalis*, *A. vasica*, *P. amarus*, *W. somnifera* have high demand among indigenous communities, domestic pharmaceutical market and in export markets (Table 6, Fig. 1). These plants have high conservation and market values. However, market values are not transferred to indigenous communities for sustainable use or conservation, as in the case of *Trichopus*. If not done, owing to large-scale collection of the medicinal plant, higher market values lead to indiscriminate harvesting affecting sustainability of the resource. It is but obvious to anticipate an increase in the

Table 6 – Medicinal plant clusters distinguished by different market and non-market variables

Variables responsible for clustering the medicinal plant species	Species influenced by the variables
(1) Export demand (2) Ratio of international price to domestic price (IP/DP)	*Cassia*, *Plantago*
(1) Export demand (2) IP/DP (3) IPR	*Garcinia*, *Gloriosa*, *Emblica*, *Phyllanthus*, *Aloe*, *Adhatoda*, *Gymnema*, *Withania*
(1) IPR (2) Domestic price	*Emblica*, *Phyllanthus*, *Aloe*, *Adhatoda*, *Gymnema*, *Withania*
(1) Domestic demand (2) Real price change (3) Food/medicine, cultural/ spiritual values	*Garcinia*, *Emblica*, *Phyllanthus*, *Aloe*, *Asparagus*, *Holostemma*, *Piper*, *Tinospora*
(1) Domestic demand (2) Food/medicine, cultural/ spiritual values	*Sida*, *Andrographis*
(1) Benefit sharing mechanisms	*Trichopus*
(1) Export demand (2) IPR (3) Domestic price	*Aloe*, *Adhatoda*, *Phyllanthus*

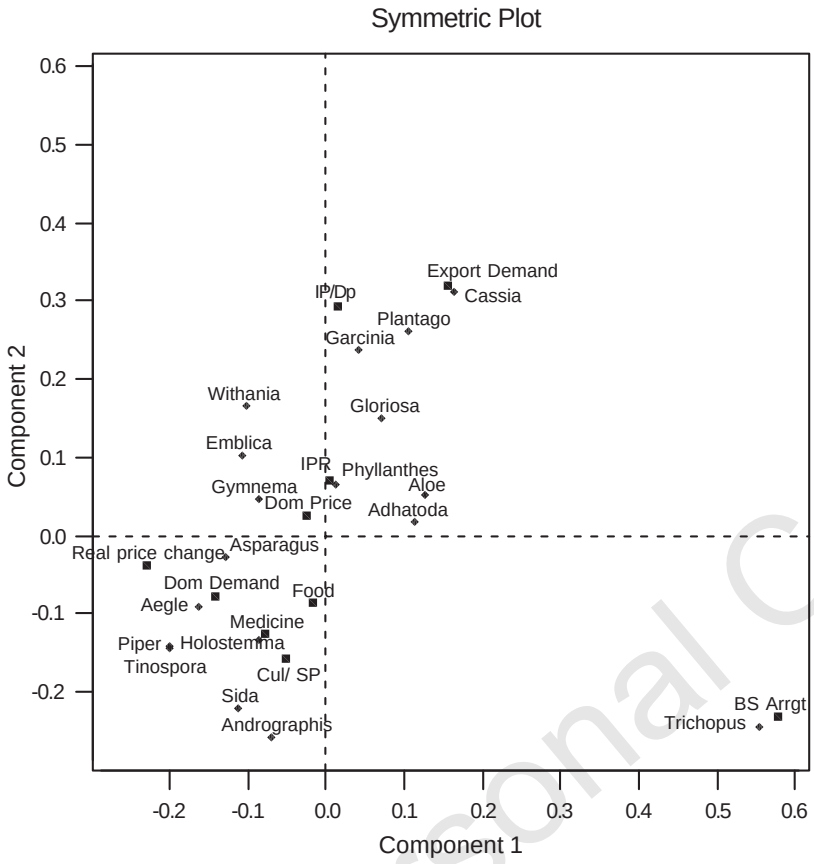

Fig. 1 – Graphical representation of the classification or clustering of selected medicinal plant species based on the influence of different variables.

cultivation of such medicinal plants with high demand. However, substitution of medicinal plants depresses the price of a species in demand (Suneetha, 1998) calling for appropriate regulations through incentives and infrastructure that facilitate cultivation and thereby conservation of medicinal plant species.

4. Implications and conclusions

The valuation exercise highlights that the inclusion of the perceptions of various stakeholders while valuing medicinal plants helps to prioritise species based on a broader framework of utility of the plants. This enables policy decisions to prioritise investment decisions on medicinal plants, based on whether State desires to promote species in demand in the domestic market, international market or development of novel products based on use of medicinal plant species in indigenous communities. The value index of the study helps in prioritising the medicinal plants based on market and conservation index values in domestic and international markets. This index serves as a checklist of benchmarks indicating the total value of medicinal plants to multiple stakeholders. These benchmarks can be classified into market factors, conservation factors and investment and policies, for the benefit of researchers to prioritise among species.

It is desirable for a country to have an equal emphasis on conservation and market appropriation of medicinal plants. The results of this study show that the conservation values of medicinal plants increase when benefits are shared with a community. Some of the measures to encourage benefit sharing are promotion of contractual agreements between indigenous communities (collectors/cultivators) and the pharmaceutical industry that will ensure an assured market for the indigenous community and assured quantum and quality of resource to the end user; designing and implementing in situ and appropriate ex situ conservation activities that promote development of endemic medicinal plants. This can be facilitated through State–Industry–NGO partnerships involving indigenous communities in the region (as is being promoted by NGOs such as FRLHT).

Acknowledgements

The first author was a recipient of the Jawaharlal Nehru Memorial Fund doctoral research fellowship (2001–2003) at University of Agricultural Sciences, Bangalore and the William J Fulbright Predoctoral Fellowship (2002–2003) at the Cornell University, USA. The authors are thankful to all the respondents of the study for their co-operation and support. The authors are particularly thankful to Prof. H. Sridhara (Department of Statistics, UAS, Bangalore) for his advice to use the

Simple Correspondence Analysis tool to classify medicinal plants based on their weighted relative values.

Appendix A. Rationale for assigning scores (variables 5 to 14, that are considered in the analysis)

V. Intellectual property protection

Medicinal plant species	IP protection	Score	Remarks[a]
Adhatoda vasica	High	3	Two Japanese patents
Aegle marmelos	High	3	Four US patents on products for pollution control and one Indian patent against diabetes
Aloe vera	High	3	Three US patents
Andrographis paniculata	Medium	2	As the IPR policy of the country will enable protection, if required
Asparagus racemosus	Medium	2	As above
Cassia angustifolia	Medium	2	As above
Emblica officinalis	High	3	Four US patents, four Japanese and five PCT[a] applications
Garcinia indica	High	3	At least two US patents, at least one PCT patent
Gloriosa superba	Medium	2	As the IPR policy of the country will enable protection, if required
Gymnema sylvestre	High	3	Six US patents
Holostemma ada-kodien	Medium	2	As the IPR policy of the country will enable protection, if required
Phyllanthes amarus	High	3	At least four US patents
Piper longum	Medium	2	As the IPR policy of the country will enable protection, if required
Plantago ovata	Medium	2	As above
Sida rhombifolia	Medium	2	As above
Tinospora cordifolia	High	3	One Indian patent
Trichopus zeylanicus	High	3	Four Indian patents
Withania somnifera	High	3	Five CSIR patents, seven US patents

a Information obtained from http://www.vshiva.net/archives/naturefacts/; http://www.ffnmag.com/ffn_backs/jul-aug_02/patents.cfm and http://www.Jeevani.com.
b PCT—Patent Co-operation Treaty.

VI. Domestic market demand

Medicinal plant species	Domestic market demand (2001)	Score
Adhatoda vasica	High	3
Aegle marmelos	High	3
Aloe vera	High	3
Andrographis paniculata	High	3
Asparagus racemosus	High	3
Cassia angustifolia	Insignificant	1
Emblica officinalis	High	3
Garcinia indica	Low	2
Gloriosa superba	Low	2
Gymnema sylvestre	Low	2
Holostemma ada-kodien	High	3
Phyllanthes amarus	High	3
Piper longum	High	3
Plantago ovata	Low	2
Sida rhombifolia	High	3
Tinospora cordifolia	High	3
Trichopus zeylanicus	Low	2
Withania somnifera	High	3

VII. Domestic price

Medicinal plant species	Domestic price (2001)	Score	Remarks
Adhatoda vasica	High	3	Based on remarks of cultivators/ collectors
Aegle marmelos	High	3	
Aloe vera	High	3	
Andrographis paniculata	High	3	
Asparagus racemosus	High	3	
Cassia angustifolia	High	3	
Emblica officinalis	High	3	
Garcinia indica	High	3	
Gloriosa superba	Low	2	
Gymnema sylvestre	Low	2	
Holostemma ada-kodien	High	3	
Phyllanthes amarus	Low	2	
Piper longum	High	3	
Plantago ovata	High	3	
Sida rhombifolia	High	3	
Tinospora cordifolia	High	3	
Trichopus zeylanicus	High	3	
Withania somnifera	High	3	

VIII. Change in real price

Medicinal plant species	Change in real price (1996–2001)	Score
Adhatoda vasica	+5.5	3
Aegle marmelos	+9.3	3
Aloe vera	+0.4	3
Andrographis paniculata	+9.7	3
Asparagus racemosus	+26.7	3
Cassia angustifolia	−5	1
Emblica officinalis	+2.3	3
Garcinia indica	−4.3	1
Gloriosa superba	−20	1
Gymnema sylvestre	+2.3	3
Holostemma ada-kodien	−104.6	1
Phyllanthes niruri	+1.7	3
Piper longum	+38.6	3
Plantago ovata	−3	1
Sida rhombifolia	−1.5	1
Tinospora cordifolia	+1.9	3
Trichopus zeylanicus	−18.4	1
Withania somnifera	+3.3	3

IX. Export demand

Medicinal plant species	Export demand (2001)	Score	Chiefly exported to
Adhatoda vasica	High	3	Europe
Aegle marmelos	Low	2	
Aloe vera	High	3	Most countries
Andrographis paniculata	None	1	
Asparagus racemosus	High	3	
Cassia angustifolia	High	3	Japan, China, Gulf countries, USA, Canada, Europe
Emblica officinalis	High	3	England, Finland, Germany, Belgium, Spain, Portugal, Netherlands
Garcinia indica	High	3	Europe, Japan, USA
Gloriosa superba	Low	2	France
Gymnema sylvestre	High	3	Japan, Malaysia, USA
Holostemma ada-kodien	None	1	
Phyllanthes amarus	High	3	Japan, Europe, USA
Piper longum	None	1	
Plantago ovata	High	3	Similar to Cassia buyers
Sida rhombifolia	None	1	
Tinospora cordifolia	None	1	
Trichopus zeylanicus	High	3	USA
Withania somnifera	High	3	Thailand, Indonesia, Philippines, Vietnam

X. Ratio of international to domestic price (IP/DP)

Medicinal plant species	Ratio of international to domestic prices (2001)	Score
Adhatoda vasica	1.67	3
Aegle marmelos	NA	1
Aloe vera	36	3
Andrographis paniculata	NA	1
Asparagus racemosus	NA	1
Cassia angustifolia	NA	1
Emblica officinalis	2.25	3
Garcinia indica	18.75	3
Gloriosa superba	NA	1
Gymnema sylvestre	NA	1
Holostemma ada-kodien	NA	1
Phyllanthes amarus	2.45	3
Piper longum	NA	1
Plantago ovata	NA	1
Sida rhombifolia	NA	1
Tinospora cordifolia	NA	1
Trichopus zeylanicus	NA	1
Withania somnifera	4.91	3

XI, XII, XIII. Non-monetary values (food, medicine, culture or spiritual values)

Medicinal plant species	Non-monetary values (scores)			Remarks
	Food	Medicine	Culture/ spiritual	
Adhatoda vasica	2	3	3	Based on remarks from tribal community members
Aegle marmelos	2	3	3	
Aloe vera	2	3	2	
Andrographis paniculata	2	3	3	
Asparagus racemosus	2	3	3	
Cassia angustifolia	1	1	1	
Emblica officinalis	3	3	3	
Garcinia indica	3	2	2	
Gloriosa superba	1	1	1	
Gymnema sylvestre	2	3	2	
Holostemma ada-kodien	2	2	2	
Phyllanthes amarus	2	3	2	
Piper longum	2	2	2	
Plantago ovata	1	1	1	
Sida rhombifolia	3	3	3	
Tinospora cordifolia	2	3	2	
Trichopus zeylanicus	3	3	3	
Withania somnifera	2	3	2	

XIV. Benefit sharing (BS) arrangement

Medicinal plant species	Benefit sharing arrangement	Score	Remarks
Adhatoda vasica	Present	3	Gram Mooligai Company Limited and communities with whom the company operates. It has led to increased access to markets, price stability, better information on prices, markets
Aegle marmelos	Absent	1	
Aloe vera	Present	3	Gram Mooligai Company Limited and communities with whom the company operates. It has led to increased access to markets, price stability, better information on

(continued on next page)

Appendix (*continued*)

Medicinal plant species	Benefit sharing arrangement	Score	Remarks
			prices, markets, etc.
Andrographis paniculata	Present	2	Gram Mooligai Company Limited and communities with whom the company operates. It has led to price stability, better information on prices, markets, etc.
Asparagus racemosus	Absent	1	
Cassia angustifolia	Absent	1	
Emblica officinalis	Absent	1	
Garcinia indica	Absent	1	
Gloriosa superba	Absent	1	
Gymnema sylvestre	Absent	1	
Holostemma ada-kodien	Absent	1	
Phyllanthes amarus	Present	2	Gram Mooligai Company Limited and communities with whom the company operates. It has led to price, stability, better information on prices, markets, etc.
Piper longum	Absent	1	
Plantago ovata	Absent	1	
Sida rhombifolia	Absent	1	
Tinospora cordifolia	Absent	1	
Trichopus czeylanicus	Present	6	Benefit sharing between Kanis and TBGRI in the development of product 'Jeevani' by TBGRI. It has led to price stability, better information on prices, access to markets, acknowledgement and respect, increase in employment and conservation activities
Withania somnifera	Absent	1	

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