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COMMUNICATION

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IS CULTIVATION OF *SAUSSUREA COSTUS* (ASTERALES: ASTERACEAE) SUSTAINING ITS CONSERVATION?

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Abstract: *Saussurea costus* (Falc.) Lipsch., (Asteraceae) known in English as Costus, is a threatened Himalayan medicinal plant listed on CITES (2014) Appendix I, Schedule VI of the Wildlife Protection Act (India) 1972, and Critically Endangered on the IUCN Red List. Wild collection of Costus is banned in India and permission is required for its cultivation and marketing. In the past 100 years of cultivation, various policy and management issues have impacted commercialization of the species. In 2015, we conducted surveys in the village of Kanol, Chamoli District, Uttarakhand, India to determine the status of Costus cultivation, problems associated with its marketing and the potential for expanded propagation to enhance local livelihoods. Forty-nine farmers in the study area were cultivating costus and interest in its cultivation had increased in the recent past due to the availability of governmental support. Annually, 1,250–2,950 kg roots (dried) and 20–57 kg seeds from this plant were produced by farmers within the study area. The area under Costus cultivation per farm was fairly constant (0.5 or 0.6 ha.) from 2012 to 2014, and the production of roots per farm ranged from 128 to 156 kg per year. Market prices for dried roots per kg had decreased over time. We found that regional and national marketing of the plant was not a problem for farmers, but export of cultivated products was a major challenge due to existing laws. In addition, local understanding related to post-harvest value addition, and self-reliance in Costus cultivation, was generally poor. Better national policies that increase the prospects for export, and more outreach to local villagers, are needed to improve the conservation and sustainable uses of Costus.

Keywords: Asteraceae, Costus, export, Himalaya, India, medicinal plant, wild collection.

Abbreviations: CITES—The Convention on International Trade in Endangered Species of Wild fauna and Flora | IUCN—International Union for Conservation of Nature and Natural Resources | TRAFFIC—Trade Records Analysis of Flora and Fauna in Commerce | WWF— World Wide Fund | WCCB—Wildlife Crime Control Bureau.

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Author contribution: CPK conducted field surveys, JTH contributed in manuscript preparation and editing, BSN supervised the work and JCK helped in manuscript preparation.

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INTRODUCTION

Saussurea costus (Falc.) Lipsch. [*Aucklandia costus* Falc.] syn. *S. lappa* (Decne.) Sch.Bip. (English and trade name: Costus; Hindi: Kuth, Koot, Kut; Sanskrit: Kushtha), a member of the family Compositae/Asteraceae is a threatened medicinal plant native to the Indian Himalaya (Madhuri et al. 2011; Zahara et al. 2014; USDA 2018). IUCN and the Red Data Book (RDB) of Indian Plants list the species as Critically Endangered and Endangered, respectively, due to its restricted distribution and heavy harvesting pressures (Hajra 1988; Walter & Gillet 1998; Saha et al. 2015). In the state of Jammu & Kashmir, costus grows as a wild perennial along the Indo-Pakistan border (Kuniyal et al. 2015). Rapid propagation techniques have been developed (Johnson et al. 1997), and the plant is cultivated in selected portions of the states of Uttarakhand and Himachal Pradesh for both medicinal and germplasm purposes. Its roots are used to produce aromatic oils and both leaves and roots are used in traditional and modern medicines for many purposes (e.g., Akhtar & Riffat 1991; Kala 2005; Parekh & Karathia 2006; Pandey et al. 2007). Cultivation began in 1920 in Himachal Pradesh and in 1929 in Uttarakhand (Kuniyal et al. 2005, 2015).

In 1950, the area under *Costus* cultivation in Himachal Pradesh was nearly 600ha, and this was the major source of the plant for both in-country trade and export to China (Kuniyal et al. 2015), which is the major market importing wild plant and animal products from neighbouring countries and from many other parts of the world (e.g., Heinen et al. 1995, 2001). During that period, the estimated annual production of *Costus* in Himachal Pradesh was 300 to 400 metric tons (MT; 1.0MT = 1,000.00kg; TRAFFIC 2011). In 1962, Indo-Chinese trans-border trade was stopped due to political conflicts between the two countries and the export of *Costus* was greatly affected. Cultivation, however, persisted and from 1988 to 2001 an estimated 304MT of *Costus*, at INR20.40 (USD0.30) to INR56.00 (USD0.84) per kg (INR66.64 = USD1.00, as on 08 March 2017), from Himachal Pradesh was marketed within India. By 2002, the per-farm area under *Costus* cultivation was quite small, ranging from 0.002 to 0.014 ha (Kuniyal et al. 2005).

In 1929, introductory cultivation of costus began at the Department of Forest's Bhuna Farm, located at about 3,150m in Chamoli District, Uttarakhand, India. Cultivated *Costus* from this region was presumably all exported to China at that time, but information regarding annual production is not available. From 2007

to 2010, 11.04MT of *Costus* (at INR53.00 to INR120.00 per kg; USD0.80 to USD1.80), was traded in national markets from Uttarakhand (Kuniyal et al. 2013). Despite market volatility, support from local communities and institutions for the cultivation of *Costus* remains due to consistent demand within India.

In 1975, *Costus* was listed to CITES Appendix II, however, India was not the party to CITES at that time. In 1978, the state government of Jammu & Kashmir, India, enacted the Kuth (*Costus*) Act for the conservation, preservation, protection and storage of the species. In 1980, with the consent of the Government of India, *Costus* was relisted on Appendix I of CITES (TRAFFIC 2011). To foster international compliance, the Government of India amended the Wildlife Protection Act (1972) (WPA) in 1991 and inserted Schedule VI for the protection of six rare medicinal plant species including *Costus* (WPA 1972; TRAFFIC 2011). Due to its inclusion on Schedule VI of the WPA, cultivation, possession, storage and trade of the species or its parts became illegal without permission from the chief wildlife warden.

At the time of inclusion in CITES and WPA, only the status of wild populations of *Costus* was considered, while the fact that it was and remains under cultivation in other Indian states was overlooked. Conflicts have, therefore, arisen about the validity of cultivated produce, and cultivators must abide by laws meant for the conservation of wild plants. This is a common issue for endangered plants otherwise under cultivation worldwide (e.g., Heinen & Chagain 2002; Shrestha-Acharya & Heinen 2006; Liu et al. 2014). Due to such provisions, herbal formulations or products containing costus can be seized at national and international destinations (TRAFFIC 2013). Therefore, validation of cultivated plant species listed in CITES and/or national conservation legislation requires much more consideration.

Here we made household surveys to explore the current status of *Costus* cultivation in the village of Kanol, Chamoli District, Uttarakhand, India, in an effort to assess marketing patterns of cultivated produce and prospects for expansion of cultivation to promote rural livelihoods. We also considered the possibility of local self-reliance in costus cultivation and provide suggestions for how laws can be amended to better facilitate domestic cultivation and marketing.

MATERIALS AND METHODS

Study area

The village of Kanol, Chamoli District, Uttarakhand, India was selected for the field survey. Kanol is located about 8.0km from the department of forest's Bhuna Experimental Farm ($\sim 3,150\text{m}$; 30.154°N , 79.395°E), where cultivation of *costus* was initiated in 1929. The village includes about 300 families in three settlements: Sarma-Badguna, Pranmati and Kanol. As is common throughout rural areas of India (e.g., Shrivastava & Heinen 2005), cultivation of staples such as potato (*Solanum tuberosum* L.), wheat (*Triticum aestivum* L.), barley (*Hordeum vulgare* L.), amaranth (*Amaranthus caudatus* L.), and beans (*Phaseolus vulgaris* L.) is done in self-owned or leased agricultural lands and cultivation of optional cash crops such as *costus* frequently takes place in small home garden plots. In addition, rearing livestock such as water buffalo (*Bubalus bubalis* L.), cattle/cows (*Bos taurus* L.), humped cattle/bullock (*Bos indicus* L.), sheep (*Ovis aries* L.) and goats (*Capra aegragus hircus* L.) is also common. The collection of *Ophiocordyceps sinensis* (Berk.) G.H. Sung, J.M.Sung, Hywel-Jones & Spatafora syn. *Cordyceps sinensis* (Berk.) Sacc. (Vern. - Kida Jadi, Eng. Winter Worm-Summer Grass, Tibetan - Yartsa Gumba) during May and June has also emerged as a significant economic activity in recent years (Kuniyal & Sundriyal 2013). In response to government programs, the cultivation of *Saussurea costus*, as well as other

medicinal herbs such as *Picrorhiza kurroa* Royle ex Benth. (Kutki) and *Aconitum heterophyllum* Wall. (Atis) has also received recent attention. Majority of the villagers of Kanol are well-accustomed to the cultivation of *costus* but, at present, only 49 families in the area cultivate *costus* from domestic germplasm.

For the past one and a half decades, programs have been initiated by the Government of Uttarakhand for promoting the cultivation of medicinal and aromatic plants (MAPs). As per rules, MAPs growers in Uttarakhand are registered with the Herbal Research and Development Institute (HRDI). On the basis of registration, transit passes (permission for transport and sale of cultivated MAPs products to anyone and anywhere in India) are granted to growers. The Chief Wildlife Warden, Government of Uttarakhand, has delegated power to the Herbal Research and Development Institute for granting permission to cultivate *Costus* and Indian Medicines and Pharmaceuticals Limited (IMPCL), a government-operated company based in Uttarakhand, has agreed to purchase cultivated *Costus* from local farmers at INR150.00/kg (Choudhary et al. 2013). The price for sale or purchase of *costus* seed is set at INR1,000.00/kg by the government.

Surveys

Field surveys were conducted in the Sarma-Badguna ($\sim 2,400\text{m}$, 30.250°N , 79.583°E), Pranmati ($\sim 2,500\text{m}$, 30.257°N , 79.566°E), and Kanol ($\sim 2,600\text{m}$, 30.245°N ,



Figure 1. Study area showing different settlements (Sarma-Badguna, Pranmati and Kanol) (not to scale).

79.205°E) settlements of Kanol village during October 2015 (Figure 1). *Costus* is a perennial and harvestable produce is obtained after approximately two and a half years of growth. Therefore, the area under cultivation in respective years was considered, only, where from produce was harvested in that year. A semi-structured questionnaire, asking information regarding, i) area under *Costus* cultivation, ii) production of roots and seeds in the past three years, iii) prices received from the sale of roots and seeds at the village level, iv) marketing patterns at the village level, and v) key problems in marketing, was used for field surveys.

Data were analysed for total production and prices per kilogram during field surveys. General discussion with villagers as key informants (e.g., Shrestha-Acharya & Heinen 2006) was also held regarding cultivators' intentions for, or interest in, self-reliance in *Costus* cultivation, problems they face exporting *costus*, and whether fluctuations in the prices of raw material was a hindrance to production. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Wildlife Crime Control Bureau (www.wccb.org) websites were also considered for understanding national and international compliances and regulations about trade of threatened, CITES listed MAPs.

RESULTS

During the years 2012–13, 2013–14, and 2014–15, the area under *Costus* cultivation in the study area was 0.97ha. (18 farmers), 0.50ha. (8 farmers), and 1.18ha. (23 farmers), respectively. On an individual basis, the average area under *Costus* cultivation was 0.05–0.06 ha. A total of 2,425kg of *Costus* was produced in 2012–13, while much less (1,250kg) was produced in 2013–14 and more (2,950kg) was produced in 2014–15. On an average per annum basis, individual farmers produced about 135kg, 156kg, and 128kg of *Costus* in 2012–13, 2013–14, and 2014–15, respectively (Table 1). The average prices for the sale of *costus* at the village level were INR118.33 (USD1.77) in 2012–13, INR110.10 (USD1.65) in 2013–14, and INR74.35 (USD1.11) in 2014–15. The estimated average income per farmer per year from the sale of roots was INR15,941.41 (USD239.22), INR17,187.00 (USD257.92), and INR9,536.10 (USD143.01) in 2012–13, 2013–14, and 2014–15, respectively (Table 1).

A total 119.50kg of *Costus* seeds was produced in the study area during 2012–13 to 2014–15. On an individual basis, cultivators were able to produce

averages of 3.17kg of seed in 2012–13, 2.50kg in 2013–14 and 1.85kg in 2014–15, respectively. Accordingly, on the basis of officially-fixed price (Rs. 1,000.00/kg; US \$ 15,00, for seeds), individual farmers earned, on average, Rs. 3,170.00 (US \$ 47.56), Rs. 2,500.00 (US \$ 37.51) and Rs. 1,850.00 (US \$ 27.76) in 2012–13, 2013–14 and 2014–15 respectively (Table 1). Only four farmers in the study area (who, in fact, were not registered traders) were engaged in collection, pooling, traditional drying and sale of *Costus* from the village to nearby towns. Produce, at the town-level, was then sold to any independently-registered trader with the forest department or its corporation, or to anyone authorized by the District Herbal Produce Purchasing and Selling Cooperative Association. In some instances, *Costus* produce may also be purchased by any unregistered trader, in which case, unreported trade is illegal under national and state law.

Cultivators informed that, in general, local, regional, and national trade of *Costus* is not a problem due to recent facilitation from the Uttarakhand State Government. Ever-fluctuating or generally decreasing prices were the main worry reported but, in any case, farmers were still able to sell their produce. Export-oriented marketing, however, poses many hurdles such as problems in obtaining legal procurement certificate (LPC), which is required for issuing valid export permits from the Wildlife Crime Control Bureau (WCCB). Maintaining quality standards required for export purposes was also reportedly difficult for local growers, a common problem in the region (e.g., Shrestha-Acharya & Heinen 2006). Cultivation of *Costus* along with Amaranth in mountain villages is innovative (Image 1a), however, misidentification of species in cultivation was another problem for the villagers (also see Heinen & Shrestha-Acharya 2011).

For example, the native weed *Arcitum lappa* L. (Asteraceae) also grows throughout the region and it is difficult to differentiate it from *Costus* in its vegetative stages (Image 1b,c). They are easy to differentiate only during flowering or fruiting, but that generally takes more than two years. Subsistence agro-pastoralism or other competing economic interests may be making *Costus* cultivation less important to villagers because the plant grows rather slowly and thus has a delayed effect on livelihoods. Even seed collection does not get the attention it deserves despite guaranteed prices and markets, so seeds sometimes go unharvested and germinate at their inflorescences due to their viviparous nature (Chauhan et al. 2018; Image 1d).

Table 1. Cultivation and production of *Saussurea costus* in Kanol, a remote village of Uttarakhand (the western Himalaya), India.

Year	No. of farmers (Total 49; involved in village level marketing 04)	Area under cultivation, hectare*		Production in kg (MT)		Average Price (INR/kg)	Income at village level (in INR)		Seed production in the third year (in kg)		Income from seeds production (in INR) @ INR1000.00/kg (in USD)	
		Total area	Average area per farmer	Total production	Average production per farmer		Total income (in USD)	Average income per farmer (in USD)	Total production	Average production per farmer	Total income @ Rs. 1000.00/kg (in USD)	Average income per farmer (in USD)
2012–13	18	0.97	0.05	2,425.00 (2.43)	134.72 (0.13)	118.33 ± 26.40 (1.78 ± 0.40)	2,86,950.00 (4305.97)	15,941.41 (239.22)	57.00	3.17	57,000.00 (855.34)	3,170.00 (47.56)
2013–14	08	0.50	0.06	1,250.00 (1.25)	156.25 (0.16)	110.00 ± 26.73 (1.65 ± 0.40)	1,37,500.00 (2063.33)	17,187.50 (257.92)	20.00	2.50	20,000.00 (300.12)	2,500.00 (37.51)
2014–15	23	1.18	0.05	2,950.00 (2.95)	128.26 (0.13)	74.35 ± 6.62 (1.12 ± 0.10)	2,19,332.00 (3291.30)	9,536.10 (143.10)	42.50	1.85	42,500.00 (637.75)	1,850.00 (27.76)

*Cost of cultivation/ha., (soil and land development, seeds cost, weeding and hoeing, maintenance up to 3 years, uprooting or harvesting, and drying and packaging is approximately Rs. 150,000.00 (US \$ 2250.90, @ Rs. 66.64 = US\$ 1.00), and total profit after 3 years may be Rs. 3,34,566.00 (US \$ 5770.80). USD1 = INR66.64 as on 08 March 2017).



Figure 2. a—cultivation of *Saussurea costus* along with *Amaranth* (red inflorescences) | b—flower head of *S. costus* | c—inflorescence of *Arcitum lappa* | d—germinating seeds of *S. costus* on the infructescence. © C.P. Kuniyal.

DISCUSSION

The fact that there is some continued production via traditional cultivation of *Saussurea costus* in this remote Himalayan village is encouraging for the conservation of this endangered plant. On an average annual basis, we found that individual farmers had 0.05ha under cultivation, from which about 100kg of roots and 2.50kg of seeds could be produced once the plants reached maturity (i.e., after two to three years). Therefore, the average economic benefit from *Costus* cultivation estimated from this study is INR16,700.00 (USD250.00). Calculated on per hectare basis, the total (gross) profit would be approximately INR334,566.00 (USD5,020.50). On the other hand, on a per hectare basis, the income from traditional cultivation of potato is around INR175,700.00 (USD2,636.55; Kuniyal & Sundriyal 2013). In order to promote *Costus* as an economically-attractive crop, and to make it competitive with food crops, the prices for its sale at the village level would have to increase one-and-a-half to two times more than at current prices.

A total of 49 farmers in three settlements (Sarma-Badguna, Pranmati, and Kanol) of the village of Kanol were cultivating *Costus* during the years under study. Almost all of them have revived this practice since 2009 from locally available seeds. A few growers also procured some seeds from the adjacent state of Himachal Pradesh; however, the productivity of both materials was virtually identical indicating that domestically-propagated plants showed no loss in fitness. This can be a concern with regard to some other medicinal plants proposed for cultivation (e.g., Liu et al. 2014). Despite the fact that this plant is established as a fully-domesticated agricultural crop, the economic potential of *Costus* is high and export oriented cultivation could possibly be achieved via support from government sources to maintain the gene pool in this area.

The domestication and mass cultivation of *Costus* in the Indian Himalaya was previously aimed at producing large quantities for export to China. Today, small-scale cultivation persists to fill local and within-country demand only. Therefore, programmes supporting entrepreneurship development should be local to regional, and involve some value addition and legal support (Kuniyal & Negi 2016, 2018). As currently practiced, *Costus* cultivation is more an opportunistic activity in some areas for small-income generation. The trend in marketing has also indicated that, as the availability of produce increased, prices decreased and this is of great concern for cultivators.

During the field surveys, it was noted that cultivation of *Costus* is as traditional as it was decades ago and farmers are not aware of, or trained about, proper cleaning, drying and storage of harvested *Costus* for value addition. Therefore, developing a better understanding of cultivators and training them in post-harvest management techniques are equally or more important than knowing traditional practices. Value addition and possibilities for development of *Costus*-based small scale industries is a possibility, but there is a long way to go. *Costus* cultivators and collectors at the village level, as well as local traders, tend to work independently. There is a need to bring them together in the form of a grower's and/or trader's cooperative organization to promote price sharing and training for more effective marketing.

A majority of growers in the study area still look to government for help in the cultivation and marketing of MAPs. More self-reliance would promote more innovation at all stages of production. From the part of facilitating agencies, adopting strategies for reconciling traditional farming, conservation and identification of social, legal and political actions may help in bringing about positive changes in conservation-oriented farming (Harvey et al. 2008). As compared to conventional approaches, developing socio-entrepreneurial approaches can be effective in enhancing conservation efficacy and benefit sharing (Buschke 2015). Determining management goals for threatened species, and specific policies for integrated development of the MAPs sector, are also essential (Heinen & Shrestha-Acharya 2011). Collecting baseline information allows for the evaluation of conservation practices and can be used to set interventions for future (Bull et al. 2014). Domestication and mass cultivation of MAPs takes high energy inputs, so developing supply mechanisms with lower energy input may be advantageous to growers (Smith-Hall et al. 2012).

Policy and legal efforts of parties to CITES and the Convention on Biological Diversity appear to be currently insufficient (Lambooy & Levashova 2011). Generally, developing countries are more focussed on rapid economic development despite costs, rather than on more sustainable economic ventures (Okereke & Ehresman 2015). As a result, MAPs are still a neglected commodity in local, regional and national development plans of many poor countries (Larsen & Olsen 2007). It is well accepted that policy and legal support from governments may improve multiple perspectives of any indigenous practice (Ens et al. 2015). Legal amendments would be required in conservation acts for promoting

costus or any other CITES-listed species, as an export-oriented medicinal crop (Kuniyal et al. 2015).

Cultivation of *Costus* is a century-old practice, therefore, accepting it as an indigenous practice is inevitable. Cultivation of any CITES listed MAPs in remote, inaccessible and developing regions presents options for both conservation and socio-economic development. While preparing conservation plans for *Costus*, the fact that it has been under cultivation for almost a century was largely overlooked. Conservation criteria, and rules and regulations for protection, were devised only based on information about its status in the wild. As a result, farmers cultivating costus have to abide by these rules. In order to meet international compliance, while an application is filed with the office of WCCB for obtaining a legal procurement certificate for any CITES-listed species, the applicant has to provide information regarding (i) source of procurement (collected from wild/bred in captivity/artificially propagated), (ii) license number, and (iii) country in which the specimen was taken from wild/bred in captivity/artificially propagated.

Thus the procedure is complicated and the onus is on the cultivator, which creates confusion and discourages value-added, export-oriented cultivation. The cultivation and export of MAPs should be attractive to growers in remote villages given the poverty inherent to these regions, and it would be an excellent example of special conservation sites (Baral et al. 2014), involving conservation through participatory approaches and income generation. Therefore, attempts to maintain costus cultivation in this area and modifying rules and regulations as per real-world conditions are highly recommended. Capacity building of farmers for improved agricultural practices, value addition and self-reliance are good options for the conservation and sustainable uses of threatened MAPs.

CONCLUSIONS

Rejuvenation of the cultivation of *Costus* in remote mountain villages, and obtaining additional income from the sale of its roots and seeds, is encouraging in that it promotes the conservation of a threatened species. Villagers have conserved this species, outside of its native range, as a cash crop for about a century with rather little reward in return. Cultivation of *Costus* has secured its place in traditional agriculture in the study area and capacity building of farmers for better agricultural practices, as well as developing and teaching techniques for value addition, would produce

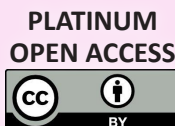
better economic returns. Self-reliance of costus production, in the economic sense, could possibly be achieved through the creation of growers' cooperatives and the expansion of production into semi-processed products. Some intervention by governmental or non-governmental entities could facilitate this and thus make cultivation more attractive to local farmers. Considering 'cultivation' and 'collection from the wild' as two very separate cases, and simplifying rules and regulations for cultivated produce, will encourage farmers and promote wider cultivation (Kuniyal et al. 2015). This should be a goal for both conservation of any marketable species, and local economic development to improve rural livelihoods.

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