Agricultural Economics Research Review 2022, 35 (2), 151-158
DOI: 10.5958/0974-0279.2022.00037.4

Export and import of bamboo and bamboo products: Markov chain analysis

Jeemoni Gogoi[1], Ram Singh[1]*, S M Feroze[2], S Basanta Singh[2], and Hehlangki Tyngkan[1]

[1]School of Social Sciences, College of Post Graduate Studies in Agricultural Sciences, CAU(I), Umiam, Meghalaya 793103, India
[2]Department of Agricultural Economics, Central agricultural University, Imphal, Manipur 795001, India

*Corresponding author: ramsingh.cau@gmail.com

Abstract Bamboo trade has played a vital role in upliftment of socio-economic status of rural communities. This paper used trend analysis, instability index and markov chain analysis for logical inferences of the bamboo products export. The results reveal an incremental trend in area, production and productivity of bamboo, indicating ample scope for entrepreneurship development in bamboo sector. There is growth in export of bamboo products over the years however, India is still a net importer of bamboo products signifying huge scope to harness the global market.

Keywords Bamboo products, export, import, growth, Markov chain analysis

JEL codes Q17, Q23

Bamboo is the fastest growing plant. It belongs to the family *Poaceae* (Graminae) and found in the tropical, sub-tropical and mild temperate regions (FSI 2019). It is one of the most valuable non-wood forest products. Worldwide, more than two billion people depend on bamboos for their basic needs, as a renewable, productive, versatile, low cost or no cost, easily accessed, environment-enhancing resource especially in villages and countryside of the developing world (Sastry 2008). Value-added bamboo has the potential in environment and economy. Its trade has gained importance in upliftment of socio-economic status of rural communities (Sundriyal and Sundriyal 2011). The employment potential of bamboo is very high and the major work force constitutes of the rural poor, especially women and 432 million work days per annum are provided by the bamboo sector in India (Dhurga 2017). It was reported that, over 77 genera and 1,450 species (Hunter 2003) present in the world and most of which are confined to South-East Asia with largest number of species (ca 500) in China (Zhao-hua and Kobayashi 2004) followed by Japan (237) and India (138). In India, there are 125 indigenous and 11 exotic species of bamboos belonging to 23 genera. More than half of the species diversity has been recorded from North-East India with 58 species belonging to 10 genera (FSI 2011). The major bamboo producing countries in Asia are India and China, contributing 70 per cent bamboo of Asia .The largest bamboo producer and exporter in the world is China and there has been a rapid growth in its trade over the past few years. The export value of value-added bamboo products increased faster than the traditional ones (Junqi 2014). The National Bamboo Mission (NBM) is also playing a major role in development of bamboo sector in India. It have special subsidy schemes for the north eastern states to develop the sector right from propagation of quality planting material to establishment of processing industries to marketing of value added products(Government of India 2019). With increasing demand of bamboo products in the world our country has a wide scope to boost up its economy. This paper is an attempt to provide a comprehensive analysis of trends in its production and performance in global trade along with instability analysis of bamboo products.

Methodology

The analysis was based on the data for 10 years (2009 to 2018) of value of exports and imports of bamboo products. The secondary data on export and import of bamboo products was collected from the United Nations Comtrade Database (United Nations Comtrade Database 2020). Study period was guided by the availability of comparable data as India adopted the Harmonized Commodity Description and Coding System (HS) for bamboo products only in 2007. Prior to 2007 there were only ten 6-digit UN HS codes covering bamboo and rattan commodities, including bamboo and rattan vegetable materials, plaiting articles, furniture and seats, and bamboo shoots, of which only two were specified for bamboo and rattan. 14 new codes for bamboo and rattan have been put into effect since 2007, with the efforts of INBAR, the World Customs Organization and Chinese Customs, in which individual codes were given to bamboo and rattan wickerwork, furniture and seats, and bamboo charcoal, flooring, plywood, pulp, paper and preserved bamboo shoots. In 2018, there were 24 HS codes for bamboo and rattan (INBAR 2020). Total twelve bamboo products along with its HS codes are given in Table 1. The category of industrialized bamboo products has high demand in the global trade.

Analytical techniques

The Compound Annual Growth Rate (CAGR) and the instability index of the export and import were calculated. The product concentration was analyzed by estimating the share of values of products in export and import. Three potential bamboo products *viz.* seats prepared from bamboo, bamboo made mats and bamboo shoots, which can be prepared at household or community level of high export quality with less investment in machineries, among others were considered for markov chain analysis to observe their export performance. Major importing countries and other importing countries pooled together as other countries of the particular products from India were considered for the markov chain analysis.

Table 1 Description of bamboo products

Category	HS code	Item Details
Bamboo raw materials	140110	Bamboo used primarily for plaiting
Bamboo shoots	200591	Vegetable preparations; bamboo shoots, prepared or preserved otherwise than by vinegar or acetic acid, not frozen
Industrialized bamboo products	440210	Wood; charcoal of bamboo (including shell or nut charcoal), whether or not agglomerated
	441210	Plywood, veneered panels and similar laminated wood; of bamboo
	440921	Wood (including strips & friezes for parquet flooring, not assembled) continuously shaped (tongued, grooved, rebated, chamfered, V-jointed, beaded, moulded, rounded/ the like) along any of its edges, ends/faces, whether/not planed/sanded/end-jointed, non-con
	460121	Plaiting materials, plaits and similar products of plaiting materials; mats, matting and screens, of bamboo
	470630	Pulp; of bamboo
	482361	Paper and paperboard; trays, dishes, plates, cups and the like, of bamboo paper or paperboard
Bamboo woven products	460192	Plaits & similar products of plaiting materials, whether/not assembled into strips; plaiting materials, plaits & similar products of plaiting materials, bound together in parallel strands/woven, in sheet form, whether/not being finished articles, of bamboo
	460211	Basketwork, wickerwork and other articles; of bamboo, made directly to shape from plaiting materials or made up from goods of heading no. 4601
Bamboo furniture products	940152	Seats of bamboo
	940382	Furniture of bamboo

Source United Nations Comtrade Database, 2020

Markov Chain analysis

The average export of bamboo product to particular country was considered as a random variable following a first order Markov process (Kusuma and Basavaraja 2014), (Satishkumar et al. 2016).

$$E_{jt} = \sum_{i=1}^{n} (E_{it-1}) P_{ij} + e_{jt}$$

Where,

E_{jt} = Exports of bamboo product from India during the year t to j^{th} country

E_{it-1} = Exports of bamboo product to i^{th} country during the period t-1

P_{ij} = Probability that exports of bamboo product will shift from i^{th} country to j^{th} country

e_{jt} = The error term which is statistically independent of E_{it-1}, and

n = Number of importing countries of bamboo product

The transitional probability P_{ij}, which can be arranged in a (c x r) matrix, have the following properties.

$0 \leq P_{ij} \leq 1$

$\Sigma P_{ij} = 1$

The expected export share of bamboo product of a country during the period't' was obtained by multiplying the actual exports in the previous period (t-1) by the transitional probability matrix. The transitional probability matrix is estimated in the linear programming (LP) framework by a method referred to as minimization of mean absolute deviation (MAD).

The linear programming formulation is stated as,

Min $OP^* + I_e$

Subjected to

$XP^* + V = Y$

$GP^* = 1$

$P^* > 0$

Where, O is the vector of zeros

P^* is the vector in which probability P_{ij} are arranged

I is an apparently dimensioned vector of area, e is the vector of absolute errors

Y is the vector of export of bamboo product to each country.

X is the block diagonal matrix of lagged values of Y

V is the vector of errors

G is the grouping matrix to add the row elements of P arranged in P^* to unity.

Results and discussion

Status of bamboo in India

Bamboo has been traditionally harvested from forest lands in India and the homesteads which have a few clumps of one of the many species of bamboo for household use, but very less intervention in terms of commercial planting has been done in the past (Kumar and Tanya 2015). The total area under the bamboo in India has been increasing (Table 2.) It was observed that there was 12.78 per cent growth in area from 2011 to 2019 touching 16 million ha. India is producing 39.45 thousand million of bamboo culms (woody ringed stems of bamboo are called as culm) giving a total of 277587 thousand metric ton (MT) of bamboo in 2019. Number of estimated culms has increased by 40 per cent and green equivalent weight by 39 per cent between 2011 to 2019. The increasing trend in area and production over the past years shows a better scope for entrepreneurship development in bamboo sector which will generate large scale of employment. As per report of Forest Survey of India 2019, Madhya Pradesh has maximum bamboo bearing area (2.0 m ha) followed by Maharashtra (1.5 m ha), Arunachal Pradesh (1.49 m ha) and Odisha (1.18 m ha). The maximum number

Table 2 Area and production of bamboo in India

Particulars	2011	2017	2019	Change between 2011 and 2019 (%)
Area(million ha)	13.96	15.69	16.00	12.78
No of estimated culms (in million)	23297	28103	39454	40.96
Green equivalent weight ('000 MT)	169312	188759	277587	39.00

Source FSI, 2019

of green culms were found in Arunachal Pradesh (4869 million), followed by Assam (3082 million) and Madhya Pradesh (2406 million).

Bamboo production in north eastern region

Bamboo is one of the traditional economic crop for North-eastern region of India and also it has proven to have tremendous bio-genomic, resilience in combating the brunt of climate change (Basumatary et al. 2015). The north eastern region comprising of eight states along with West Bengal accounts for more than 50 per cent of the bamboo resources which is collectively considered as hotspot of biodiversity' (Upreti and Sundriyal 2001). In terms of bamboo bearing area Arunachal Pradesh stands at 3rd position followed by Assam and Manipur in 2019 (FSI 2019). Similarly, Arunachal Pradesh produces highest number of culms (14.62%), followed by Assam (9.70%), Nagaland (6.45%) and Manipur (3.86%). The weight of green culms was estimated maximum in Arunachal Pradesh (22.6 MT) followed by Nagaland (18.6 MT) and Assam (17.2 MT) as per the report of FSI, 2019. Hence, the statistics shows that there was dominance of north eastern states in terms of production of bamboo resources. It reveals that being the region unexplored has ample scope for intervention to earn more livelihood and income from these bamboo resources through developing entrepreneurship within the country to compete at globally. North Eastern Council (NEC) has also identified bamboo cultivation as a major source of economic gains to the North Eastern Region having potential to provide additional source of income to the small and marginal farmers, which has become priority of the Government (Government of India 2019) in boosting-up the economy of North Eastern Hill Region (NEHR).

Role of National Bamboo Mission in production of bamboo

The major operating scheme in the country for development of bamboo sector is National Bamboo Mission (NBM) which was launched as a centrally sponsored scheme in 2006-07 and was subsumed under Mission for Integrated Development of Horticulture (MIDH) in 2014-15. Maintenance of the bamboo plants were taken care under that and the significant growth of export were observed over the study period. After 2015, value addition along with other propagation activities were also carried out which in turn boosted the bamboo production along with the export of its products. NBM expects to cover more area ensuring adequate stocks of selected genetically superior quality planting material, promotion and diversification of bamboo products through establishment of MSME and development of value chain, setting up and strengthening of bamboo bazaars including promoting online trade and enhanced cooperation within the country related to research, technology, product development, machinery, trade information and knowledge sharing platform particularly for NE States to give a boost to the low key bamboo based industry in the country (Government of India 2019). With the successful achievements of the objectives of the mission will boost the bamboo sector of the country to next level.

Trade of bamboo and its products

The analysis of external trade of bamboo and its products showed a compound annual growth rate of 8.59 per cent (Table 3). On the other hand, the compound annual growth rate of import in its value terms was 15.00 per cent. The balance of trade was negative which signifies that India as a net importer of bamboo products despite of its second position in bamboo production in the world after China (Aniket 2013). It means that there are huge opportunities to harness the international market by increasing its production and ensuring establishment of a proper value chain ecosystem (Government of India 2019).

Table 3 External trade of bamboo products (in US million dollar)

Year	Export value	Import value	Balance of trade
2009	707254	8432635	-7725381
2010	594183	12537839	-11943656
2011	1514309	22791490	-21277181
2012	2114754	23804298	-21689544
2013	1348249	23502757	-22154508
2014	1585595	28895794	-27310199
2015	2599666	34659440	-32059774
2016	1061768	35004466	-33942698
2017	1290261	32962258	-31671997
2018	1959182	35076492	-33117310
CAGR(%)	8.59	15.00***	

*Significant at 10%, ** Significant at 5% and *** Significant at 1% probability level

Source United Nations Comtrade Database, 2020

Growth and instability in global trade of bamboo and its products

The relative shares to the total export value of bamboo products reveals that bamboo furniture products (22.67%) contributed more to total value and the lowest contribution was made by pulp of bamboo (0.44%). The compound annual growth rate was found to be highest in case of bamboo wood (75.09%) (Table 4). All the bamboo products shows a positive CAGR value but only five products shows significant growth in export value. Therefore, there is need to consider the quality of all the products to get a better price in the market. Although the products export value has been found to be increased over the years but there was high instability in the growth which may be due to unstable supply of the products as bamboo is mainly harvested from the reserved forests or community forests.

The import value of bamboo products was found to be much higher than the export. The CAGR of import value of bamboo poles were 60.69 per cent contributed highest among all the products to the total import share. Bamboo paper based products contributed lowest to total share with a value of 0.03 per cent. The instability index of the products in import value shows much less instability compared to export instability. Similar evidence has been reported by Anjum and Madhulika (2018). Therefore, policy makers need to focus on this aspect to reduce the instability in export of bamboo products so as to gain trust of the markets relying on India for its bamboo products.

Product concentration

Technically, lower product concentrations in external trade are indicative of wider product bases with considerable leverage to cushion the adverse effects of individual products. Conversely, higher product concentrations are vulnerable to fluctuations in prices of major product groups and consequently adverse effects on the performance of the sector (Joseph et al. 2006). The product concentrations in exports were covered by bamboo furniture (HS code 940382) with 22.67 per cent, charcoal of bamboo (HS code 440210) with 14.48 per cent, bamboo primarily used for plaiting material (HS code 140110) and bamboo paper based products (HS code 482361) with a total share of 60.92 per cent to the total export value (Table 5). All remaining 8 products contributes only 39.08 per cent to total export. Compared to exports, the product concentration was higher in import during the study period. HS code 140110 alone contributed 56.44 per cent share followed by bamboo charcoal, pulp of bamboo and bamboo wood. Therefore, it was evident that the value added products are more concentrated on the global market of bamboo just after the raw bamboo poles.

Table 4 Relative shares, compound annual growth rates and instability index of bamboo products exports and imports value (2009-2018)

HS code	Export			Import		
	Relative share (%)	CAGR (%)	Instability index (%)	Relative share (%)	CAGR (%)	Instability index (%)
140110	12.04	39.64	142.32	56.44	60.69***	29.52
200591	0.85	16.90*	139.54	0.31	46.98***	22.46
440210	14.48	56.58*	214.28	0.30	40.63	115.19
441210	5.75	44.79*	53.17	29.69	26.20*	41.18
440921	9.35	75.09***	38.24	2.32	40.60**	21.88
460121	8.41	34.40	69.41	2.17	35.60	25.47
460192	1.20	42.53	141.71	1.84	27.81**	51.70
460211	4.92	55.51**	88.80	2.06	44.00***	19.36
470630	0.44	62.08	76.58	2.56	43.97**	33.60
482361	11.73	24.17	137.54	0.03	39.51	99.19
940152	8.16	35.12	139.46	0.16	31.20	59.61
940382	22.67	31.84*	51.70	2.12	30.49*	40.15
Total	100			100		

*Significant at 10%, ** Significant at 5% and *** Significant at 1% probability level

Table 5 Product concentration in exports and import of bamboo products (2009-2018)

Export		Import	
HS code (%)	Share	HS code (%)	Share
940382	22.67	140110	56.44
440210	14.48	441210	29.69
140110	12.04	470630	2.56
482361	11.73	440921	2.32
Total	60.92	Total	91.01

Source United Nations Comtrade Database, 2020

Export analysis of bamboo and its products

In the north eastern region of India, there is lack of industrialization, therefore small scale industries or business are operating in the region. Bamboo products like seats prepared from bamboo, bamboo mats, bamboo shoots etc. are potential products which can be prepared at household or community level of high export quality with less investment in machineries. The major concern to be considered is mainly the market for the products and stability in export from which the stakeholders will not be discouraged. Therefore, export performance of these three potential bamboo based products, *viz.* bamboo shoots, bamboo mats and seats prepared from bamboo which can be prepared at household level in the north eastern region were carried out using markov chain analysis.

The major importers of bamboo made mats from India are Netherlands, Sri Lanka, Bahrain, Germany and Oman. The transitional probability matrix of bamboo made mats from India reveals that Netherlands was the most stable importer of bamboo made mats with highest retention capacity of 74 per cent (Table 6). Oman was the second stable importer from India with 50 per cent retention capacity by losing its share to Sri Lanka (28%) and Bahrain (21%). Other countries together have a retention capacity of 60 percent and likely to gain 100 percent of Bahrain market. The most unstable markets among the importing countries were Bahrain and Germany with the zero per cent retention. . The country like China is giving tough competition in the bamboo product market (INBAR 2019; Aniket 2013) which may be reason for zero retention capacity of Indian products in these markets. Bahrain having zero retention probability was likely to gain from Germany (92%) and Oman (21%). This indicates that India can continue exporting to Bahrain that has strong preference for the bamboo made mat.

The major importers of bamboo made seats from India were Australia, France, USA, Spain and Netherlands. The transitional probability matrix of bamboo made seats from India reveals that USA was the most stable importer of bamboo made seats with highest retention capacity of 63 per cent followed by Australia (45%) as second stable importer (Table 7). Other countries together retention capacity (71%) has shown that although they were importing in fewer amounts but were reliable importer from India. The study is in line with Satishkumar et al. (2016). Retention capacity of Spain was very low (9%) and was unstable importer of seats of bamboo by losing its share to Australia (33%) and other countries (50%). France and Netherland reported zero transitional probability implying that the markets were not stable for India's export. Although retention capacity of France was zero but it was likely to gain from Netherlands (69%) and USA (15%). Netherlands was likely to gain from Australia (32%) and Spain (6%). Similar studies were reported by Shilpa et al. (2017).

New Zealand was found to be the stable importer of bamboo shoot with 72 per cent retention probability

Table 6 Transitional probability matrix of bamboo mats export (2009 to 2018)

	Netherlands	Sri Lanka	Bahrain	Germany	Oman	Others
Netherlands	**0.769**	0.008	0.000	0.000	0.008	0.215
Sri Lanka	0.577	**0.220**	0.000	0.000	0.000	0.203
Bahrain	0.000	0.000	**0.000**	0.000	0.000	1.000
Germany	0.078	0.000	0.922	**0.000**	0.000	0.000
Oman	0.000	0.282	0.213	0.000	**0.505**	0.000
others	0.000	0.000	0.001	0.395	0.000	**0.603**

Table 7 Transitional probability matrix of bamboo made seats export (2009 to 2018)

Countries	Australia	France	USA	Spain	Netherlands	Others
Australia	**0.445**	0.000	0.131	0.000	0.332	0.092
France	0.000	**0.000**	0.000	0.000	0.000	1.000
USA	0.000	0.154	**0.634**	0.199	0.000	0.013
Spain	0.334	0.000	0.000	**0.096**	0.066	0.503
Netherlands	0.310	0.690	0.000	0.000	**0.000**	0.000
Others	0.002	0.003	0.246	0.030	0.000	**0.719**

Table 8 Transitional probability matrix of bamboo shoot export (2009 to 2018)

	United Arab Emirates	Australia	Germany	United Kingdom	New Zealand	Others
United Arab Emirates	**0.498**	0.502	0.000	0.000	0.000	0.000
Australia	0.012	**0.507**	0.000	0.165	0.107	0.210
Germany	0.154	0.000	**0.000**	0.761	0.000	0.084
United Kingdom	0.000	0.000	0.000	**0.000**	0.000	1.000
New Zealand	0.000	0.000	0.030	0.000	**0.728**	0.241
Others	0.000	0.000	0.017	0.056	0.000	**0.927**

losing its 24 per cent share to other countries (Table 8). Besides New Zealand, Australia and United Arab Emirates were the stable markets with retention capacity of 50 per cent and 49 per cent, respectively. The 'other countries' category which was the minor importers of bamboo shoot shows a retention probability of 92 per cent which suggests beneficial trade with these nations. Similar findings were given by Mahadevaiah et al. (2005) where other countries retained highest. Interestingly, the retention capacity of United Kingdom was found to be zero but it was likely to gain from the switch over from Germany and Australia. This shows that export of Indian bamboo shoot have strong preference of United Kingdom.

Conclusion

From the study we observed an increasing growth in bamboo sector in terms of area and production along with high growth in the export of bamboo products. Among all the products, value added bamboo products like furniture has shown more profit. The study also revealed that the bamboo products like bamboo shoots, bamboo made seats and bamboo made mat were having ample scope for its trade to abroad. The product bamboo shoots have scope for its export to New Zealand, USA market for bamboo made seats whereas the product bamboo made mat is preferred more in the market of Netherlands. India is also importing a large amount of bamboo products. Therefore, within our country there are ample scopes for its entrepreneurship development for huge number of unemployed youths. As so many programmes have been launched by state and central government like national bamboo mission (NBM) which need to realize among the society for further to make it more useful for every stakeholder.

Acknowledgement

The paper is a part of doctoral research study. The authors are grateful to the University Grant Commission(UGC), New Delhi for funding the research work.

References

Aniket, B. 2013. The Bamboo Industry in India: Supply Chain Structure, Challenges and Recommendations. http://dx.doi.org/10.2139/ssrn.2442953

Anjum, S. and Madhulika. 2018. Growth and instability analysis in Indian agriculture. *International Journal of Multidisciplinary Research and Development* 5(11):119-125. https://www.researchgate.net/publication/329208143_Growth_and_instability_analysis_in_Indian_agriculture

Basumatary, A, S K Middha, T Usha, B K Brahma and A K Goyal. 2015. Bamboo, as potential sources of food security, economic prosperity and ecological security in North-East India: an overview. *Research in Plant Biology* 5(2):17-23. https://www.researchgate.net/publication/274072343_Bamboo_as_Potential_Sources_of_Food_Security_Economic_Prosperity_and_Ecological_Security_in_North-East_India_An_Overview.

Dhurga, S. 2017. Problems and prospects of bamboo market in India. *Aayvagam an International Journal of Multidisciplinary Research* 5(2):86-90. http://aayvagam.journal.thamizhagam.net/issues/2017/Feb%202017%205/17%20Article%20Feb%202017%205.pdf

FSI (Forest Survey of India). 2011. India State of Forest Report, 2019. Ministry of Environment and Forests & Climate Change. Government of India. https://www.fsi.nic.in/forest-report-2011

FSI (Forest Survey of India). 2019. India State of Forest Report, 2019. Ministry of Environment and Forests & Climate Change. Government of India. https://fsi.nic.in/forest-report-2019

Government of India. 2019. Operational guidelines of National Bamboo Mission.2019. Government of India. https://nbm.nic.in/Documents/pdf/NBM_Guidelines_New.pdf

Hunter, I R. 2003. Bamboo resources, uses and trade: the future?. *Journal of Bamboo and Rattan* 2(4):319. DOI:10.1163/156915903322700368

INBAR. 2019. *Trade Overview 2018 Bamboo and Rattan Commodities in China*. https://resource.inbar.int/upload/file/1577946385.pdf

INBAR. 2020. International Bamboo and Rattan Organisation. Beijing 100102, P.R. China. https://www.inbar.int/programmes/sdg1-end-poverty/#1

Joseph, J, K T George and T Joseph. 2006. Trends in India's External Trade in Rubber and Rubber Products: An Inter Temporal Analysis. *Foreign Trade Review* 40(4):3-24. https://doi.org/10.1177/0015732515060401

Junqi, W. 2014. *International trade of bamboo and rattan 2012*. International Bamboo and Rattan Organisation, Beijing 100102, P.R. China. http://www.aha-kh.com/wp-content/uploads/2017/01/5-inbar-international-trade-of-bamboo-and-rattan-2012.pdf

Kumar , M and Tanya. 2015. Bamboo "Poor Men Timber": A review Study for its potential & market scenario in India. *Journal of Agriculture and Veterinary Science* 8(2):80-83. https://www.iosrjournals.org/iosr-javs/papers/vol8-issue2/Version-1/R08218083.pdf.

Kusuma, D K and H Basavaraja. 2014. Stability analysis of mango export markets of India: Markov Chain approach. *Karnataka Journal of Agricultural Sciences* 27(1):36-39. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.832.1579&rep=rep1&type=pdf

Mahadevaiah, G S, P C Ravi and P G Chengappa. 2005. Stability analysis of raw cotton export markets of India–Markov Chain approach. *Agricultural Economics Research Review* 18(347-2016-16683):253-259. https://core.ac.uk/download/pdf/6553439.pdf

Sastry, C B. 2008. A 2020 vision for bamboo in India: Opportunities and challenges. In: Proceedings of international conference "improvement of bamboo productivity and marketing for sustainable livelihood", New Delhi, 15–17th April, pp. 6–15.

Satishkumar, M, H V Harishkumar and R Rangegowda. 2016. Growth, export performance and competitiveness of basmati and non-basmati rice of India-an Markov chain approach. *International Journal of Agriculture, Environment and Biotechnology* 9(2): 305. DOI: 10.5958/2230-732X.2016.00040.1.

Shilpa, S J, S P A Serma, G K Chandrasekar, S Thangarasu and P Vinothini. 2017. Assessing the Trade Performance of Poultry Products in India-An Application of Markov Chain Analysis. *International Journal of Pure and Applied Biosci*ence 5(1):986-991.DOI: http://dx.doi.org/10.18782/2320-7051.2541.

Sundriyal, M and R C Sundriyal. 2011. Bamboo trade and future prospect in central Himalaya: a case study of traditional artisans of Uttarakhand, India. *Ethanobotany Research and Applications* 9: 445-454. DOI: 10.17348/era.9.0.445-454.

United Nations Comtrade Database. 2020. United Nations Commodity Trade Statistics Database. 2020. https://comtrade.un.org/data/.

Upreti, T C and R C Sundriyal. 2001. Bamboo and cane resources of Arunachal Pradesh: utilization pattern and implications for management. *Bamboo Science and Culture* 15(1):20-34. https://www.researchgate.net/profile/RC_Sundriyal/publication/236278273_Bamboo_and_cane_resources_of_Arunachal_Pradesh_Utilization_pattern_and_implications_for_management/links/55533d3108aeaaff3bf0387e/Bamboo-and-cane-resources-of-Arunachal-Pradesh-Utilization-pattern-and-implications-for-management.pdf

Zhao-hua, L I and M Kobayashi. 2004. Plantation future of bamboo in China. *Journal of Forestry Research* 15(3):233-242. https://doi.org/10.1007/BF02911032

Received 7 February 2021 Accepted 14 August 2021