

## International Journal of Agriculture Extension and Social Development

Volume 6; Issue 1; Jan-Jun 2023; Page No. 91-95

Received: 17-10-2022  
Accepted: 02-01-2023

Indexed Journal  
Peer Reviewed Journal

### Export performance and direction of trade of millets from India

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DOI: <https://doi.org/10.33545/26180723.2023.v6.i1b.180>

#### Abstract

Millets are a group of highly variable small seeded grains, widely grown around the world as cereal crops for nutritious human food and fodder for animals. Millets are important crops in the semi-arid tropics of Asia and Africa (especially in India and Nigeria), with 97 percent of millet production in developing countries. The current study intended to know the trends in export and direction of trade of selected millets in India from 2003-04 to 2021-22 and from 2012-13 to 2021-22 respectively. Among the millet crops, Sorghum, bajra and ragi were selected for the export dynamics study. Secondary data regarding export of millets and data on country wise exports was obtained from APEDA. Trend in exports is estimated using Compound Annual Growth Rate model. The exports millets were recorded higher CAGR of 23.93 percent during sexennial period I, where during sexennial period II and sexennial period III the CAGR was around -3 and -5 percent respectively. Which was reduced exports during the period. During the overall period was recorded -1.24 percent, which was varied during the latter years. The instability index in export of millets was estimated using Cuddy & Della Valle instability index. The CDVI during overall period recorded was 40.59 percent which was highly instable exports in the period. The dynamic nature of trade pattern of the millets was analyzed by employing first order Markov process. By TPM it was noticed that most loyal country which imports sorghum was UAE, UK for bajra and Nepal is major importer of ragi. Efforts should be taken to promote export of millets from India to explore and exploit potential of other markets and to avoid overdependency on few countries.

**Keywords:** Millets, Area, production, growth rate, instability index, exports, direction of trade, markov chain analysis

#### Introduction

Millets are a group of highly variable small seeded grains, widely grown around the world as cereal crops for nutritious food for human and fodder for animals. They do not form a taxonomic group, but rather a functional or agronomic one. Millets are important crops in the semi-arid tropics of Asia and Africa (especially in India and Nigeria), with 97 percent of millet production in developing countries. The crop is favoured due to its productivity and short growing season under dry, high-temperature conditions. Finger millet, Proso millet, and Foxtail millet are also important crop species. In the developed world, millets are less important, while millets are indigenous to many parts of the world, it is believed that they had an evolutionary origin in tropical Western Africa, as that is where the greatest number of both wild and cultivated forms exist. Millets have been important food staples in human history, particularly in Asia and Africa.

They have been in cultivation in East Asia for the last 10,000 years. Sorghum and millets have been important staples in the semi-arid tropics of Asia and Africa for centuries. These crops are still the principal sources of energy, protein, vitamins and minerals for millions of the poorest people in these regions.

Indian millets are a group of nutritiously rich, drought tolerant and mostly grown in the arid and semi-arid regions

of India. They are small-seeded grasses belonging to the botanical family Poaceae. They constitute an important source of food and fodder for millions of resource-poor farmers and play a vital role in ecological and economic security of India. These millets are also known as "coarse cereals" or "cereals of the poor". Indian Millets are nutritionally superior to wheat and rice as they are rich in protein, vitamins and minerals. They are also gluten-free and have a low glycemic index, making them ideal for people with celiac disease or diabetes. India is among the top 5 exporters of millets in world. World export of millet has increased from \$400 million in 2020 to \$470 million in 2021 (ITC trade map) India exported millets worth \$64.28 million in the year 2021-22, against \$59.75 million in 2020-21. Share of Millet based value added products is negligible. India is the largest producer as well as the largest exporter of cereal products in the world. India's export of cereals stood at Rs. 96,011.42 Crore / 12,872.64 USD Millions during the year 2021-22. Rice (including Basmati and Non-Basmati) occupy the major share in India's total cereals export with 75% (in value terms) during the same period. Whereas, other cereals including wheat represent only a 25% share of total cereals exported from India during this period.

The top importers of millets along with their share in world import are Indonesia (8%), Belgium (7.36%), Germany

(4.65), Mexico (4.1%), Italy (4.02%), United States of America (3.35%), United Kingdom (3.25%) Brazil (3.24%) and Netherlands (3.14%) in 2020. Top ten importers accounted for USD 221.7 million in 2020 out of the world import USD 466.3 million in same year.

With demand for nutria-cereals rising steadily globally, the Department of Commerce expects millets exports to increase exponentially in the coming years as Indian exporters find new markets abroad. Currently, India is the fifth largest exporter of millets in the world, according to 2020 data, with exports continuously increasing at around 3% CAGR in the last five years ending with 2020.

The top three importers of millets from India in 2020-21 were Nepal (USD 6.09 million), UAE (USD 4.84 million) and Saudi Arabia (USD 3.84 million). The other seven destinations in the top-ten list of India's millet export are Libya, Tunisia, Morocco, UK, Yemen, Oman and Algeria. Recognizing the importance of millets, Government of India observed 2018 as a Year of Millets to encourage and promote the production of millets. To create domestic and global demand and to provide nutritional food to the people, Government of India spearheaded the United Nations General Assembly (UNGA) resolution for declaring 2023 as International Year of Millets. The proposal of India was supported by 72 countries and UNGA declared 2023 as International Year of Millets in March, 2021.

## Methodology

### Source of data

The secondary data related to the details of information pertaining to total export of millets from India to other countries for the period 2003-04 to 2021-22 and secondary data on country – wise export of selected millets from India for the period 2012-13 to 2021-22 were obtained from agri exchange portal of APEDA.

The Data is divided in to three sexennial years for analysis purpose. Based on the quantity of export for export analysis Sorghum, Bajra, and Ragi are selected on the basis of high volume of exports.

### a. Growth model

To examine the compound growth rate of exports (Agricultural and processed food products to Nepal from India) in terms of volume for the period of twenty years from 1992 to 2022 and also for quinquennial period from India. Compound growth rates were estimated with the help of exponential function.

$$Y = a b^t \quad (1)$$

Where

Y = Dependent variable for which growth rate is estimated (export volume Mt.)

a= Constant

b = Regression coefficient

t = Time variable in year (1991 to 2022)

In the logarithmic form of the above equation estimated the compound growth rate

$$\log Y = \log a + t \log b$$

The value of antilog of 'b' was estimated by using LOGEST

function in MS-

Excel give below

Antilog of log b = LOGEST (Y<sub>1</sub>: Y<sub>n</sub>)

The per cent compound growth rate (r) was derived using relationship

$$'r' \text{ (per cent)} = [\text{antilog of log (b)} - 1] \times 100$$

The compound growth rate was tested for their significance by using the following formula:

$$t = \frac{r}{S.E.(r)}$$

### b. Cuddy-Della Valle index

Cuddy Della Valle Instability index (Cuddy and Della Valle 1978) is a modification of coefficient of variation to accommodate trend present in the data, which is commonly present in economic time series data. This method is superior over the scale dependent measures such as standard deviation. The Cuddy Della Valle index (CDVI) is calculated as follows:

$$CDVI = CV \sqrt{X}$$

Where, X = 1 - R<sup>2</sup>, CV is coefficient of variation, and R<sup>2</sup> is adjusted coefficient of determination. The ranges of CDVI (Rakesh Sihmar, 2014) [2] are given as follows:

Low instability = between 0 and 15

Medium instability = greater than 15 and lower than 30

High instability = greater than 30

### c. Markov Chain Analysis

Markov chain analysis was employed to analyze the structural change in any system whose progress through time can be measured in terms of single outcome variable. In the present study, the dynamic nature of trade patterns of sorghum, bajra and ragi from India studied using the Markov chain model.

Markov chain analysis involving developing a transitional probability matrix 'P', whose elements, P<sub>ij</sub> indicate the probability of exports switching from country 'i' to country 'j' over time. The diagonal element P<sub>ij</sub> where i=j, measure the probability of a country retaining its market share or in other words, the loyalty of an importing country to a particular country's exports.

In the context of current application, structural change was treated as a random process with eight importing countries for cereals. The assumption was that the average export of cereals from a country amongst importing countries in any period depends only on the export in the previous period and this dependence is same for all the periods. This was algebraically expressed as

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

Where

E<sub>jt</sub> = Exports from India to the j<sup>th</sup> country in the year t

E<sub>it-1</sub> = Exports of i<sup>th</sup> country during the year t-1

$P_{ij}$  = Probability that exports will shift from  $i^{\text{th}}$  country to  $j^{\text{th}}$  country  
 $e_{jt}$  = the error term which is statistically independent of  $E_{it-1}$

$n$  = the number of importing countries

The transitional probabilities  $P_{ij}$ , which can be arranged in a  $(c \times r)$  matrix, have the following properties.

$$0 < P_{ij} < 1 \text{ for all } i$$

Thus, the expected share of each importing country during period 't' is obtained by multiplying the exports of cereals to these countries in the previous period (t-1) with the transitional probability matrix. The probability matrices were estimated for the period from 2011-12 to 2021-22.

Thus, transitional probability matrix (T) was estimated using linear programming (LP) frame work by a method referred to as minimizing of Mean Absolute Deviation (MAD).

$$\text{Min, } O P^* + I e$$

$$\text{Subject to } X P^* + V = Y$$

$$G P^* = 1$$

$$P^* > 0$$

Where

$P^*$  is a vector of the probabilities  $P_{ij}$

$O$  is the vector of zeros

$i$  is an appropriately dimensional vectors of areas  $e$  is the vector of absolute errors

$Y$  is the proportion of exports to each country

$X$  is a block diagonal matrix of lagged values of  $Y$

$V$  is the vector of errors

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

The values in the transition probability matrix will have different interpretations. The value of diagonal elements indicates the probability of retention of the previous year's share, while values in the columns reveal probability of gain by a particular country from other countries, values in rows reveal probability that a country might lose to other countries in respect of a specific commodity exports.

### 3. Results and discussion

#### a) Trends in export of millets

The results of Table 1 reveal the trends and instability index in export of millets from India during the year 2004-05 to 2021-22. It could be observed from the table that the positive compound annual growth rate of around 24 percent had been observed during the sexennial period I. the probable reason might be the greater demand for Indian millets at international markets. During the same period the CDVI was 18.10 percent, which inferred that the exports were slightly stable. Which was due to regular export activity. During the sexennial period II and III the observed CAGR was around -3 and -5 percent. The negative growth rate might be because of lesser production of millets in India and awareness on importance of consuming millets among the Indians. The CDVI during the same period was 7.16 percent and 7.58 percent which was inferred that the exports were stable. Its may be due to the lesser export to other countries. The CAGR during the overall period was recorded -1.24 percent, which was varied during the latter years. The possible reason for this mainly due to lesser

exports from India and consumption of millets in Indian people raised in recent past. The CDVI during overall period recorded was 40.59 percent which was highly instable exports in the period. The main reason was during the recent years the exports were reduced and there was more instability on the export of millets.

The Cuddy & Della Valle instability index was used to compute the degree of variation around the trend. The Cuddy & Della Valle instability index was calculated for both area and production of selected millets for the period 2003-04 to 2021-22. With respect to Cuddy & Della Valle instability index the area of millets during the period I, bajra was more stable with 0.03 per cent, in period II sorghum was more stable with 0.02 percent of index value, during the period III, small millets were more stable with 0.05 percentage of instability index. In the overall period area of small millets was more stable with 0.05 per cent followed by overall millets (0.05%), sorghum (0.06%), and ragi (0.07%) during the study period. Similarly, Cuddy & Della Valle instability index of the production of millets during the period 1, small millets were more stable with 0.07 per cent, in period 2 sorghum were more stable with 0.05 percent of index value, during the period 3, small millets were more stable with 0.07 percentage of instability index. The total millets were more stable in production with index value of 0.11 per cent which was followed by sorghum (0.12), small millets (0.13%) ragi (0.15%) and bajra (0.17%) (0.11) during the same period.

The result of this index showed that the area as well as production of the millets was fluctuated variably. It's may be due to change in cropping pattern and low yielding capacity of these millets.

Dynamics of area under millets is calculated for triennium year 1990 to triennium year 2021 and presented in the Table 3 and 4 respectively. Results shows that both the area and production of mallets has been decreased in a remarkable rate. Area under small millets is reduced the most with -86.68 percent followed by sorghum (-69.64%), total millets (-56.49%), ragi (-55.29%) and bajra (-33.28%). similarly, bajra shown increase in production with 22.22 percent followed by ragi (-33.59%), total millets (-30.39%), sorghum (-62.42%) and small millets (-62.95%).

The area and production both had been changed negatively for all the millets, its due to mainly reduction of cropping area under millets because of replacement of millets by other crops. The production of all the millets was shown negative except bajra, here bajra have got good yielding varieties and its staple food for Northern parts of Karnataka.

#### b) To study the direction of export of selected millets from India

Change in direction of trade is studied with the help of Markov chain analysis for the period of 2012-13 to 2021-22, where Transitional Probability Matrix (TPM) is estimated for studying the direction of trade. As in transitional probability matrix diagonal elements provide information about an importing country's loyalty towards our export that is probability of retention of their trade with us. While the row elements show probability of loss of share of export of a country to their competing countries, elements in column shows the probability of gain of share of export of a particular country over their competing countries. By analyzing the TPM table we can analyze the direction in

which our export is moving or should move to undertake appropriate policy frame work in order to help exporters to help exporting their products with minimum uncertainty in export.

### Sorghum

The dynamics in the direction of sorghum export from India were computed using transitional probability matrix and presented in table 5. The major importing countries are UAE, Saudi Arabia, Bangladesh, Egypt, Taiwan, Kuwait, Qatar, Oman, Japan and the remaining importing countries are categorized as others. UAE retained 56.86 per cent of its original share followed by Others (89.27%), Bangladesh (48.26%) Saudi Arabia (11.90%), Taiwan (05.12%) and Qatar (00.85%). Japan and Oman lost 100 per cent of its share to others and Saudi Arabia respectively, Taiwan lost 94.88 per cent of its share to others. Qatar lost 88.96 per cent of its share to Taiwan. Kuwait lost 72.90 per cent of its share to Saudi Arabia. Egypt lost 42.00 per cent of its share to Kuwait, Bangladesh lost 40.30 per cent of its share to Saudi Arabia. Saudi Arabia lost 17.92 per cent of its share to Kuwait and Bangladesh lost its 11.44 per cent of its share to Qatar.

The results reveal that for export of sorghum from India the most reliable markets are UAE, Saudi Arabia, Bangladesh, Egypt, Taiwan, Kuwait, Qatar. The countries like UAE, Saudi Arabia Bangladesh are most loyal countries in importing sorghum from India and there is a huge scope for exploring many new markets other than these countries.

### Bajra

The dynamics in the direction of bajra export from India were computed using transitional probability matrix and presented in table 6. The major importing countries are UAE, Saudi Arabia, Libya, Oman, Tunisia, Yamen, Qatar, UK, Morocco and the remaining importing countries are categorized as others. Others retained 49.49 per cent of its original share followed by UK (46.84%), Tunisia (39.10%),

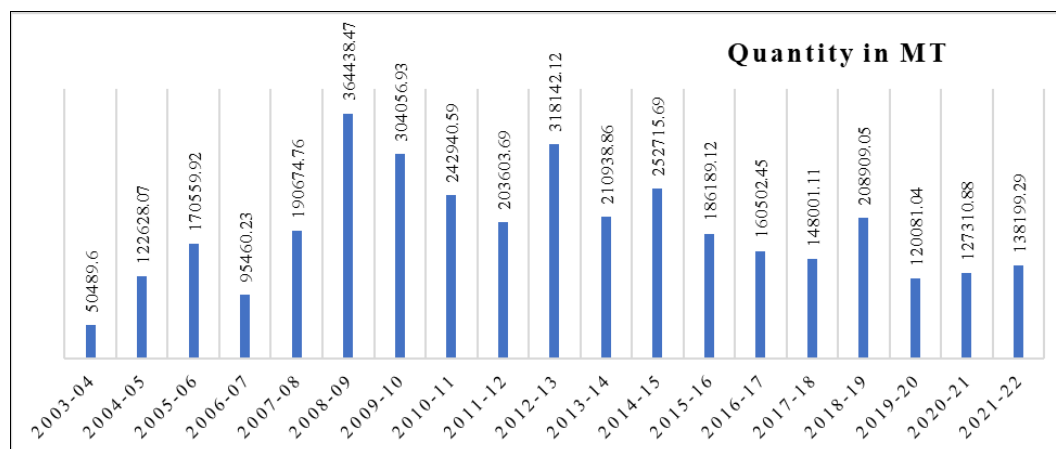
UAE (13.01%), Qatar (19.60%), Yamen (09.99%), Oman (01.59%) and Saudi Arabia (01.57%). Libya lost 100 per cent of its share to Saudi Arabia, Oman lost 97.43 per cent of its share to Saudi Arabia, Morocco lost 83.77 per cent of its share to UAE. Yamen lost 81.86 per cent of its share to others, Saudi Arabia lost 78.87 per cent of its share to UAE. Qatar lost 64.78 per cent of its share to Saudi Arabia and UK lost 53.16 per cent of its share to UAE.

From the results we can notice that for export of bajra from India the most reliable markets are UK, Tunisia, UAE, Qatar, Yamen, Oman Saudi Arabia. There are many other countries which are importing bajra from India but in the discontinues manner of trade which we may not rely on them to export trade in future.

### Ragi

The dynamics in the direction of ragi export from India were computed using transitional probability matrix and presented in table 7. The major importing countries are Nepal, UAE, Malaysia, UAS, Qatar, Maldives Canada, Kuwait, UK and the remaining importing countries are categorized as others. Nepal retained 73.48 per cent of its original share followed by Qatar (37.44%), Malaysia (31.53%), others (27.57%) UAE (14.10%) and Kuwait (09.23%). UAS and Maldives Oman lost 100 per cent of its share to Nepal, Kuwait lost 90.77 per cent of its share to UAE, others and Canada lost their 66.99 per cent and 64.57 per cent Nepal respectively, UK lost 46.62 per cent of its share to Canada. UAE lost 43.05 per cent of its share to others. Malaysia lost 34.45 per cent of its share toothers

The results reveal that for export of ragi from India the most reliable markets are Nepal, Qatar, Malaysia UAE, Saudi Arabia, Kuwait. These countries are importing ragi in a continues manner which India can depend for potential market in future. Effort can be made to for the countries which are importing ragi in a small quantity and limited intervals may be explored and can boost the export towards those countries.



**Graph 1:** Trends in export of Millets from India during 2003-04 to 2021-22

**Table 1:** Compound growth rates for volume of Export of millets from India to various countries during the period 2004-05 to 2021-22

Sl. No	Growth rates in different Sexennial periods	CAGR (%)	R <sup>2</sup>	CDVI (%)
1	Sexennial period-I (2004-05 to 2009-10)	23.93	0.61	18.01
2	Sexennial period-II (2010-11 to 2015-16)	-3.07	0.09	7.16
3	Sexennial period-III (2016-17 to 2021-22)	-4.89	0.22	7.58
4	Over all period (2004-05 to 2021-22)	-1.24	0.03	40.59



**Table 2:** Transitional probability matrix of Sorghum from India in terms of export quantity (2012-13 to 2021-22)

Loss Gain	U A E	Saudi Arabia	Bangladesh	Egypt	Taiwan	Kuwait	Qatar	Oman	Japan	others
U A E	0.5686	0.0031	0.1978	0.0000	0.0054	0.0410	0.0871	0.0760	0.0208	0.0000
Saudi Arabia	0.0870	0.1190	0.1711	0.0970	0.0000	0.1792	0.0000	0.0182	0.0887	0.2397
Bangladesh	0.0000	0.4030	0.4826	0.0000	0.0000	0.0000	0.1144	0.0000	0.0000	0.0000
Egypt	0.0000	0.0000	0.3399	0.0000	0.0000	0.4200	0.0000	0.0000	0.2401	0.0000
Taiwan	0.0000	0.0000	0.0000	0.0000	0.0512	0.0000	0.0000	0.0000	0.0000	0.9488
Kuwait	0.0000	0.7290	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2710
Qatar	0.0000	0.0000	0.0000	0.0000	0.8896	0.0000	0.0085	0.1019	0.0000	0.0000
Oman	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
Japan	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
others	0.0157	0.0291	0.0000	0.0093	0.0285	0.0122	0.0000	0.0019	0.0105	0.8927

Source: Author's calculation

**Table 3:** Transitional probability matrix of Bajra from India in terms of export quantity (2012-13 to 2021-22)

Loss Gain	U A E	Saudi Arabia	Libya	Oman	Tunisia	Yemen	Qatar	U K	Morocco	Others
U A E	0.1301	0.0000	0.1040	0.0000	0.2250	0.2954	0.0000	0.0000	0.0000	0.2455
Saudi Arabia	0.7887	0.0157	0.0000	0.1137	0.0000	0.0000	0.0819	0.0000	0.0000	0.0000
Libya	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Oman	0.0000	0.9743	0.0000	0.0159	0.0000	0.0000	0.0098	0.0000	0.0000	0.0000
Tunisia	0.0000	0.0001	0.1830	0.0000	0.3910	0.0000	0.0000	0.0524	0.3735	0.0000
Yemen	0.0815	0.0000	0.0000	0.0000	0.0000	0.0999	0.0000	0.0000	0.0000	0.8186
Qatar	0.0000	0.6478	0.0000	0.1562	0.0000	0.0000	0.1960	0.0000	0.0000	0.0000
U K	0.5316	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4684	0.0000	0.0000
Morocco	0.8377	0.0000	0.1386	0.0000	0.0000	0.0000	0.0237	0.0000	0.0000	0.0000
Others	0.0517	0.2892	0.0568	0.0000	0.0000	0.0551	0.0000	0.0152	0.0371	0.4949

Source: Author's calculation

**Table 4:** Transitional probability matrix of Ragi from India in terms of export quantity (2012-13 to 2021-22)

Loss Gain	Nepal	UAE	Malaysia	U S A	Qatar	Maldives	Canada	Kuwait	U K	Others
Nepal	0.7348	0.0118	0.0000	0.0000	0.0033	0.0011	0.0009	0.0000	0.0013	0.2468
UAE	0.0000	0.1410	0.2455	0.0506	0.0000	0.0000	0.0000	0.1324	0.0000	0.4305
Malaysia	0.0586	0.1239	0.3153	0.0000	0.0000	0.1209	0.0000	0.0068	0.0000	0.3745
U S A	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Qatar	0.0638	0.0000	0.0000	0.3812	0.3744	0.1806	0.0000	0.0000	0.0000	0.0000
Maldives	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Canada	0.6457	0.0000	0.2902	0.0000	0.0000	0.0641	0.0000	0.0000	0.0000	0.0000
Kuwait	0.0000	0.9077	0.0000	0.0000	0.0000	0.0000	0.0000	0.0923	0.0000	0.0000
U K	0.0000	0.2667	0.0000	0.1641	0.1030	0.0000	0.4662	0.0000	0.0000	0.0000
Others	0.6699	0.0049	0.0258	0.0042	0.0024	0.0028	0.0004	0.0043	0.0094	0.2757

Source: Author's calculation

## Conclusion

There was negative growth in area and production of selected millets in India. Hence, farmers need to be educated by imparting training for gain of knowledge on good agricultural practices in cultivation of millets. the value addition of millets is an important area to save the millets from depletion in area and production. The millets need to be popularized among the consumers regarding their nutrition values which creates demand in the market. Agricultural universities must develop and introduce high yielding varieties for these millets to get the attention of farmers. The as sorghum other millets must include under the minimum support price to secure the price loss by the farmers in the market. There is huge demand for millets along the globe. India being leading exporter of millets, UAE, Saudi Arabia, Bangladesh, Egypt, are the loyal importers for Sorghum, UK, Tunisia, UAE, Qatar are the loyal importers for bajra and Nepal, Qatar, Malaysia UAE are the loyal importers for Ragi. Efforts should be taken to promote export of selected products from India to explore and exploit potential of other markets and to avoid overdependency on few countries.

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