



# International Journal of Agriculture and Food Science

ISSN Print: 2664-844X  
 ISSN Online: 2664-8458  
 NAAS Rating (2026): 4.97  
 IJAFS 2026; 8(10): 323-326  
[www.agriculturaljournals.com](http://www.agriculturaljournals.com)  
 Received: 19-08-2026  
 Accepted: 28-09-2026  
 Published: 09-10-2026

## Smitha Hiremath

PG Scholar, Department of  
 Agricultural Statistics,  
 KSNUAHS, College of  
 Agriculture, School of Post  
 Graduation Studies, Main  
 Campus, Iruvakk, Shivamogga,  
 Karnataka, India

## Basavaraj I Halingali

Professor, Department of  
 Agricultural Statistics,  
 KSNUAHS, College of  
 Agriculture, School of Post  
 Graduation Studies, Main  
 Campus, Iruvakk, Shivamogga,  
 Karnataka, India

## Kiran Kumar R Patil

Assistant Professor, Department  
 of Agricultural Economics,  
 KSNUAHS, College of  
 Agriculture, School of Post  
 Graduation Studies, Main  
 Campus, Iruvakk, Shivamogga,  
 Karnataka, India

## Nagarajappa Adivappar

Professor, Department of Fruit  
 Science, KSNUAHS, College of  
 Agriculture, School of Post  
 Graduation Studies, Main  
 Campus, Iruvakk, Shivamogga,  
 Karnataka, India

## Nagaraja MS

Assistant Professor, Department  
 of Agricultural Statistics,  
 College of Agriculture, Hassan,  
 Karnataka, India

## Corresponding Author: Smitha Hiremath

PG Scholar, Department of  
 Agricultural Statistics,  
 KSNUAHS, College of  
 Agriculture, School of Post  
 Graduation Studies, Main  
 Campus, Iruvakk,  
 Shivamogga, Karnataka,  
 India

## Direction and market stability of black pepper exports under the Agriculture Export Policy regime

Smitha Hiremath<sup>1</sup>, Basavaraj I Halingali<sup>2</sup>, Kiran Kumar R Patil<sup>3</sup>, Nagarajappa Adivappar<sup>4</sup>, Nagaraja MS<sup>5</sup>

DOI: <https://www.doi.org/10.33545/2664844X.2026.v8.i10e.2034>

### ABSTRACT

India is an important producer and exporter of black pepper, and changes in international market conditions necessitate continuous assessment of export-market stability and diversification. The present study analysed the direction and stability of Indian black pepper export markets before and after the introduction of the Agriculture Export Policy (AEP), 2018. Secondary data on black pepper exports were collected from the Spices Board of India and official website Indiatat for the period 2011–12 to 2024–25 and divided into pre-AEP (2011–12 to 2017–18) and post-AEP (2018–19 to 2024–25) periods. Major export destinations were identified based on the triennium average export value during the latest three years of the post-AEP period. Markov Chain Analysis was employed to examine market retention and switching behaviour using transition probability matrices estimated through Linear Programming with LINGO software. The results indicated that the U.S.A. remained a stable market in both periods, whereas Germany was classified as a vulnerable market. The U.K. and Sweden were identified as emerging markets during the pre-AEP period, while Canada emerged as an additional emerging market in the post-AEP period. The transition probabilities also indicated changes in export-market retention and greater movement of export shares among destinations during the post-AEP period. The findings suggest that strengthening established markets while developing emerging destinations through improved market access, quality compliance, export infrastructure and market promotion could enhance the stability and diversification of Indian black pepper exports.

**Keywords:** Agriculture Export policy, Pepper, LINGO software, Markov Chain Analysis, Stable markets

### Introduction

India has emerged as an important participant in global agricultural trade, exporting a wide range of commodities, including spices. Among these, black pepper (*Piper nigrum* L.) occupies an important position due to its extensive use as a spice, flavouring agent and ingredient in food, pharmaceutical and other value-added products. India has a long history of pepper cultivation and trade, and black pepper continues to be an important commodity in the country's spice export basket. Its export performance is influenced by production conditions, international prices, exchange rate movements, global demand and changing market conditions (Thomas *et al.*, 2016) [1]. The changing nature of international trade has therefore increased the importance of understanding the performance and market orientation of Indian pepper exports.

The international trade of Indian pepper is influenced by several factors, including stringent quality and food-safety standards, sanitary and phytosanitary requirements, changing import regulations, international price fluctuations, competition from other pepper-producing countries and variations in global demand. These factors have made export-market diversification and the maintenance of stable international markets increasingly important. To address constraints affecting agricultural exports and to harness the export potential of Indian agriculture, the Government of India introduced the Agriculture Export Policy (AEP), 2018. The policy aimed to diversify the agricultural export basket and export destinations, promote high-value and value-added agricultural exports, improve market access, address sanitary and phytosanitary issues, strengthen export infrastructure and integrate Indian agriculture with global value chains (Government of India, 2018) [2]. The policy also emphasized the development of appropriate infrastructure, improvement of quality standards and facilitation of market access as important measures for strengthening India's agricultural exports.

The emphasis of AEP on export-market diversification and improved market access is particularly relevant to black pepper because of its exposure to changing international market conditions, quality requirements and competition in global markets. Examining the direction of trade of Indian black pepper in the context of the AEP provides an opportunity to understand changes in its export-market orientation and the stability of

major destinations. Although earlier studies have examined the direction of Indian pepper exports, limited evidence is available on the changes in destination patterns and market retention before and after the introduction of the Agriculture Export Policy, 2018 [2]. Hence, the present study was undertaken to analyse the direction of trade of Indian black pepper before and after the implementation of the Agriculture Export Policy, 2018 [2], with particular emphasis on the stability and retention of major export markets.

## Materials and Methods

### Study area

The study was conducted at the national level using secondary data on the export of Black pepper. Data were collected from the Spices Board of India and Indiatat website for the period from 2011–12 to 2024–25. The study period was classified into two phases namely, the pre-AEP period (2011–12 to 2017–18) and the post-AEP period (2018–19 to 2024–25), corresponding to the periods before and after the introduction of the Agriculture Export Policy (AEP), 2018.

The major export destinations for Indian ginger were identified based on the triennium average of export value during the latest three years of the post-AEP period. The selected destinations were subsequently used for analysing the direction of trade and stability of export markets during the pre-AEP and post-AEP periods.

### Analytical tools employed

Markov Chain Analysis was employed to estimate the direction of exports of Black pepper from India to destination countries during the pre-AEP and post-AEP periods. A transition probability matrix was constructed in which each element,  $P_{ij}$ , represented the probability that export share shifted from the  $i^{\text{th}}$  importing country to the  $j^{\text{th}}$  importing country during successive years. The diagonal elements represented the probability of retaining an existing market, whereas the off-diagonal elements represented the probability of switching export shares from one destination to another.

The Markov relationship may be expressed as:

$$E_t = \sum [E_{t-1}] P_{ij} + e_t \quad i = 1, \dots, n$$

Where,

$E_t$  = Export share of the selected spice to the  $j^{\text{th}}$  importing country in year (t)

$E_{t-1}$  = Export share of the selected spice to the  $i^{\text{th}}$  importing country in year ( $t-1$ )

$P_{ij}$  = probability of shift in export share from  $i^{\text{th}}$  importing country to  $j^{\text{th}}$  importing country

$e_t$  = error-term statistically independent of  $E_{t-1}$

$n$  = number of importing countries (5 countries)

The transition probabilities satisfy  $\sum P_{ij} = 1$  and  $0 \leq P_{ij} \leq 1$ . The transition probability matrix was estimated through Linear Programming using LINGO software by minimizing Mean Absolute Deviation (MAD). In the LP formulation, the vector of transition probabilities was constrained to be non-negative and each row of the probability matrix was constrained to sum to unity. The resulting diagonal probabilities were interpreted as measures of destination-market retention, while off-diagonal probabilities indicated the direction and magnitude of market switching. The approach follows the Markov Chain–Linear Programming framework used in studies of Indian agricultural export markets (Joshi *et al.*, 2015; Jhade *et al.*, 2021) [4, 3].

The stability, vulnerability and growth potential of the selected export markets were assessed by combining Markov chain transition probabilities with export growth and market-share indicators. The Markov chain approach was used to examine the persistence and movement of export markets across different export-value categories. The transition probability matrix provides the probability of a market moving from one category to another between two consecutive periods. The diagonal elements represent the probability of retaining the same category,

whereas the off-diagonal elements represent the probability of switching from one category to another.

A market with a high retention probability was considered relatively stable, whereas a low retention probability indicated greater instability in the export destination. The off-diagonal transition probabilities were also examined to assess the extent of switching or movement between export categories. Higher switching probabilities were interpreted as greater instability in the market position. This interpretation is consistent with the use of Markov transition probabilities for assessing the stability and switching behaviour of agricultural export destinations reported by Joshi *et al.* (2015) [4].

The export share of each destination was used to assess its relative importance in the export basket. A higher share indicated greater importance of the destination market, while a relatively smaller share indicated a comparatively lower contribution to total exports. Destination-wise export shares have been used to assess the relative importance of export markets in previous studies (Singh *et al.*, 2025) [5].

The compound annual growth rate (CAGR) of exports was estimated to assess the direction and rate of change in export performance over the study period. A positive CAGR indicated a growing export market, whereas a negative CAGR indicated a declining market. CAGR has been widely used as an indicator of export growth in agricultural export studies (Priyanka *et al.*, 2024) [6].

Based on the above indicators, the export markets were classified into different categories. A stable and important market was identified by a relatively high retention probability, particularly High-to-High persistence, together with a substantial export share. A vulnerable market was identified when a market had a relatively high export share but exhibited a declining export trend and/or a relatively high probability of downward movement from the High category to the Medium or Low category. An emerging market was identified when the market showed positive and relatively high export growth, particularly when accompanied by upward transitions towards the High category, despite having a relatively smaller export share. The combination of relatively high growth and a smaller existing market position has also been used to characterize emerging market potential. Markets having a relatively low export share, low or negative growth and a high probability of remaining in the Low category were considered weak or persistent low-performing markets.

Thus, the classification adopted in the present study was based on the joint interpretation of (i) Markov retention and switching probabilities, (ii) export share and (iii) CAGR. The use of Markov analysis in conjunction with growth measures is also consistent with approaches adopted in agricultural export-market studies, such as Yeledhalli *et al.* (2012) [7]. The criteria were combined in the present study to provide a more comprehensive assessment of the stability, vulnerability and emerging potential of the selected export destinations rather than relying on any single indicator.

## Results and Discussion

The transition probability matrix of pepper exports indicated a change in market stability and export orientation between the pre-AEP and post-AEP periods is presented in Table 1. During the pre-AEP period, U.S.A. and Canada recorded very high retention probabilities of 99.40 and 96.40 per cent, respectively, reflected strong and established trade relationships. This stability may be attributed to consistent demand, established distribution networks and India's established position in these markets. In contrast, Sweden recorded zero retention, with its exports shifting mainly to others (65.20%) and U.K. (20.90%), while 86.90 per cent of exports from U.K. shifted to Sweden, indicated considerable movement among European markets. During the post-AEP period, retention in U.S.A. and Canada declined to 87.20 and 59.70 per cent, respectively, whereas U.K. gained some stability, increasing from 0.00 to 25.80 per cent. Sweden and Germany recorded zero retention, suggesting a redistribution of export shares towards alternative markets. The major movements from Sweden to the U.S.A. (100.00%), Germany to Canada (64.70%) and Germany to U.K.

(35.30%) may be linked to differences in market demand, price competitiveness, competition and market accessibility. Sharma *et al.* (2024) [8], using Markov Chain Analysis, also found considerable variation in the stability of Indian pepper export destinations, highlighted the changing importance of individual markets. Similarly, Jain *et al.* (2025) [9] reported that macroeconomic conditions in importing countries influence India's black pepper exports, suggesting that changes in market conditions can affect export flows across destinations. The movement of 33.50 per cent of exports from other destina-

tions towards Germany, while 66.50 per cent remained within the other destinations category, further indicates that exporters continued to maintain a diversified market base. Overall, the post-AEP period showed some weakening of retention in the traditionally stable U.S.A. and Canadian markets, accompanied by greater movement towards alternative destinations, indicated a gradual adjustment in India's pepper export pattern in response to changing international market conditions.

**Table 1.** Transition in pepper exports during the pre and post AEP regime

|         | Pre-AEP  |        |       |        |         |        |
|---------|----------|--------|-------|--------|---------|--------|
|         | U.S.A    | Canada | U.K   | Sweden | Germany | Others |
| U.S.A   | 0.994    | 0.000  | 0.000 | 0.006  | 0.000   | 0.000  |
| Canada  | 0.012    | 0.964  | 0.024 | 0.000  | 0.000   | 0.000  |
| U.K     | 0.000    | 0.000  | 0.000 | 0.869  | 0.000   | 0.131  |
| Sweden  | 0.000    | 0.000  | 0.209 | 0.000  | 0.139   | 0.652  |
| Germany | 0.000    | 0.000  | 0.071 | 0.013  | 0.557   | 0.359  |
| Others  | 0.000    | 0.000  | 0.000 | 1.000  | 0.000   | 0.000  |
|         | Post-AEP |        |       |        |         |        |
|         | U.S.A    | Canada | U.K   | Sweden | Germany | Others |
| U.S.A   | 0.872    | 0.128  | 0.000 | 0.000  | 0.000   | 0.000  |
| Canada  | 0.000    | 0.597  | 0.061 | 0.217  | 0.088   | 0.037  |
| U.K     | 0.000    | 0.104  | 0.258 | 0.050  | 0.359   | 0.229  |
| Sweden  | 1.000    | 0.000  | 0.000 | 0.000  | 0.000   | 0.000  |
| Germany | 0.000    | 0.647  | 0.353 | 0.000  | 0.000   | 0.000  |
| Others  | 0.000    | 0.000  | 0.000 | 0.000  | 0.335   | 0.665  |

The market classification of Indian pepper exports showed changes in the stability and growth status of individual destinations between the pre-AEP and post-AEP periods (Table 13). During the pre-AEP period, the U.S.A. was identified as a stable market, which may be attributed to its sustained demand, established trade linkages and importance as a major destination for Indian pepper. Earlier studies have also identified the U.S.A. as an important and relatively stable market for Indian pepper exports (Sujatha *et al.*, 2008; Thomas *et al.*, 2016) [10, 1]. Germany was classified as a vulnerable market, possibly due to fluctuations in import demand, competition from other pepper-exporting countries and changing market conditions. The U.K. and Sweden were identified as emerging markets, indicating scope for expanding India's pepper exports to these destinations. During the post-AEP period, the U.S.A. retained its position as a stable market, suggesting continued demand and an established export relationship, while Germany remained vulnerable. The U.S.A. has also been identified as a relatively stable importer of Indian pepper in recent studies, with its market retention supported by sustained import demand. A notable change was observed in the emerging-market category, with Canada joining the U.K. and Sweden, possibly indicating growing market opportunities and scope for further export expansion. Recent evidence also identifies Canada and the U.S.A. as important and relatively stable destinations for Indian pepper, highlighting the potential of these markets for strengthening India's export presence. Overall, the post-AEP period indicated continued stability in the U.S.A., persistence of vulnerability in Germany and a broadening of emerging export opportunities through Canada, the U.K. and Sweden, suggesting scope for further market diversification.

**Table 2.** Classification of Export Market of Pepper Based on Market Stability and Growth During the Pre- and Post-AEP Regime

| Category           | Pre-AEP      | Post-AEP             |
|--------------------|--------------|----------------------|
| Stable markets     | U.S.A.       | U.S.A.               |
| Vulnerable markets | Germany      | Germany              |
| Emerging markets   | U.K., Sweden | Canada, U.K., Sweden |

## Conclusion

The study revealed that the direction and stability of Indian black pepper export markets changed between the pre-AEP and post-AEP periods. The U.S.A. remained a stable market in both periods, indicating the importance of sustained demand and established trade linkages, while Germany continued to be classified as a vulnerable market, suggesting the need for measures to improve market retention and competitiveness. The emergence of Canada as an additional emerging market, along with the continued presence of the U.K. and Sweden, indicates scope for further diversification of Indian pepper export destinations. The post-AEP period also showed greater movement of export shares among destinations, reflecting adjustments in India's export pattern in response to changing international market conditions. Overall, the findings suggest that strengthening established markets while developing emerging destinations through improved quality compliance, market promotion, infrastructure, competitiveness and market-specific strategies would help enhance the stability and diversification of Indian pepper exports. These measures are consistent with the objectives of the Agriculture Export Policy, 2018 [2], particularly its emphasis on export-market diversification and improved market access.

## References

1. Thomas FK, Arivarasan S, David Rajasekar D. An economic analysis of export performance of black pepper in India. *Int J Curr Adv Res.* 2016;5(7):1137-1138.

2. Government of India. Agriculture Export Policy, 2018. Ministry of Commerce and Industry, Department of Commerce, Government of India, New Delhi; 2018.
3. Jshade S, Singh A. Structural change analysis of groundnut export markets of India: Markov chain approach. *Indian J Econ Dev.* 2021;9:1-6.
4. Joshi D, Singh HP, Gurung B. Stability analysis of Indian spices export: A Markov chain approach. *Econ Aff.* 2015;60(2):257-262.
5. Singh P, Kumar S. Trade dynamics and performance of Indian horticulture sector: An empirical study. *Asian J Adv Agric Res.* 2025;25(8):23-36.
6. Priyanka T, Kerur NM, Naik BK, Yeledhalli RA, Venugopal CK. Export of fruits, vegetables and their products from India: A study on growth rate and instability index. *J Farm Sci.* 2024;37(1):59-63.
7. Yeledhalli RA, Patil PH, Patil C, Naik VR. Changing direction and magnitude of India's major fruit export to Middle East countries. *Int J Agric Stat Sci.* 2012;8(2):651-658.
8. Sharma M, Singh R, Bahadur A, Sharma MM. Performance and trade competitiveness of Indian spices: A Markov chain approach. *Indian J Econ Dev.* 2024;20(3):449-456.
9. Jain R, Elangovan G, Lakshminarayanan K. Do the macroeconomic determinants of export destinations matter? The case of Indian black pepper. *J Ind Compet Trade.* 2025;25(1):15.
10. Sujatha RV, Eswara Prasad Y. Direction of trade in Indian pepper exports: A Markov chain approach. *IUP J Agric Econ.* 2008.

**How to cite this article:** Hiremath S, Halingali BI, Patil KKR, Adivappar N, MS N. Direction and market stability of black pepper exports under the Agriculture Export Policy regime. *International Journal of Agriculture and Food Science.* 2026;8(10):323-326. doi: <https://www.doi.org/10.33545/2664844X.2026.v8.i10e.2034>