

## Prescriptive Analysis of Endogenous Production of *Asafoetida* (Hing) in India

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*Asafoetida* (Hing), a crucial spice in Indian cuisine, is predominantly sourced through imports from other countries, such as Afghanistan and Iran, despite India being the global leader in its consumption (40%). Motivated by India's heavy reliance on *Asafoetida* imports and the transformative potential of endogenous cultivation, this study examines the policy shift towards endogenous production of *Asafoetida* in India, with the aim of import substitution. Using import and export data of *Asafoetida* from the Ministry of Commerce and Industry, Government of India, the Compound Annual Growth Rate (CAGR), Coefficient of Variation (CV), and the Cuddy-Della Valle-Instability index (CVD) in *Asafoetida* trade were calculated. The implications of this policy on trade dynamics and its ripple effects on various economic variables are thoroughly analyzed. This study reveals that the average annual import value surpasses exports, highlighting the need for endogenous production. Moderate instability in *Asafoetida* trade was found and the necessity of advanced production techniques and robust supply chains was highlighted. The estimation of total land and seeds required for *Asafoetida* production in India is also done to cut imports and achieve self-sufficiency. This study highlights the capability of economic uplifting of hilly states of India. The policy recommendations advocate for strengthened supply chains, incentivized cultivation, and supportive frameworks.

**Keywords:** *Asafoetida* policy, Export, Import substitution, Production estimation, Spice

### Introduction

*Asafoetida*, popularly known as Hing in the Indian subcontinent, is a highly demanded condiment in the Indian market. Persians introduced *Asafoetida* to India from the northwestern border, specifically during the rule of Persian king Darius the Great in 518 BCE.<sup>1</sup> Currently, India accounts for the consumption of 40% of the total world production of Hing.<sup>2,3</sup> Despite this, India relies on foreign countries, such as Afghanistan and Iran, for raw Hing. This dependence arises due to the lack of plantation materials for *Ferula Asafoetida* plants in India. Moreover, the unavailability of appropriate agriculture technologies and post-harvest crop management has also served as the central bottlenecks for the indigenous production of *Asafoetida* in India till now. The *Asafoetida* plant grows to 2–3 m in height, 30–40 cm in circular mass, and takes 5 years to flower.<sup>1,4</sup> The plant thrives in dry soil with temperatures between 35–40°C and maximum annual rainfall of 200 mm, a condition seldom found in tropical plateaus, plains, and the humid coasts.<sup>2,5,6</sup>

According to the Council of Scientific and

Industrial Research (CSIR), a premier scientific organization in India, “~1200 tonnes of raw Hing, worth ~100 million USD, is imported annually from Iran, Afghanistan, and Uzbekistan.”<sup>7</sup> The major imports for *Asafoetida* by India were from Afghanistan (~98.2%), followed by Uzbekistan (~0.83%), and Iran (0.14%) in Financial Year (FY) 2019–2020 (Fig. 1). The demand for *Asafoetida* in India remained constant even during the COVID-19 national lockdown period (FY 2020–21). The imports of *Asafoetida* during pandemic times were worth of 106.79 million USD, which was significantly above the average value of imports over the last 20 years, i.e., 64.9355 million USD, according to the data from the Ministry of Commerce and Industry, Government of India.<sup>8</sup>

Between the FY 2014–15 and 2019–20, total imports in India grew at a Compound Annual Growth Rate (CAGR) of 15.34%, according to Technavio research report.<sup>9</sup> The purchased raw Hing is converted into a compounded form and then exported. India exports processed Hing to United Arab Emirates (UAE), USA, Saudi Arabia, Singapore and Malaysia. According to the Ministry of Commerce and Industry data, India exported 8.63 million USD worth of Hing

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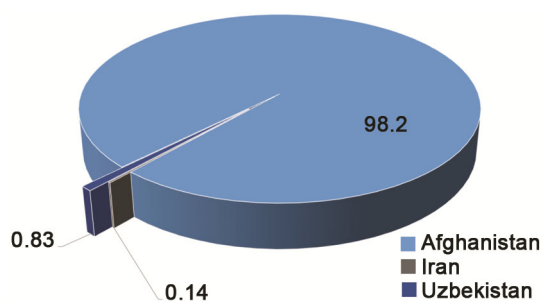


Fig. 1 — The pie chart shows the percent share of *Asafoetida* imports by India from other countries in FY 2019–2020; The figure shows that major imports are from Afghanistan ( $\approx 98.2\%$ ); The pie chart in the figure is plotted from the *Asafoetida* import data by the Ministry of Commerce and Industry<sup>8</sup>

in FY 2019–2020, which shows a 7.8% decline in exports compared to FY 2018–2019.<sup>(8)</sup>

However, in recent years, a paradigm shift has occurred in Indian “Hing Economics”. On 6 March 2020, the Chief Minister of Himachal Pradesh announced the state government’s resolution to start the cultivation of Hing in his budget speech. Subsequently, a MoU between the state government and CSIR-Institute of Himalayan Bioresource Technology (CSIR-IHBT), Palampur, was signed for this mission.<sup>10</sup> This revolutionary move from the state government is the first step in the last 29 years for the country’s indigenous cultivation of *Asafoetida*. In 2020, six accessions of seeds were introduced through ICAR-National Bureau of Plant Genetic Resources (ICAR-NBPGR).<sup>10</sup> In addition, CSIR-IHBT Palampur identified several places in India that can provide optimal environmental conditions for cultivating *Asafoetida*. It includes parts of Lahaul-Spiti, Mandi, Kinnour districts, where training programs were organized on *Asafoetida* cultivation.<sup>7,10</sup>

The economic gravity of this policy is evident since the global market of *Asafoetida* grew at a CAGR of 6% from 2019 to 2023. The global market’s incremental growth was worth of 743.19 million USD between 2019 and 2024.<sup>(9)</sup> In addition, the research report determines that Middle Eastern and African (MEA) countries are likely to be the largest market in the near future. India has been actively building economic ties with MEA countries by taking initiatives like the India-UAE Comprehensive Economic Partnership Agreement (CEPA).<sup>11–13</sup> Therefore, if this policy achieves the goal of import substitution, it would likely to be another factor that can solidify economic ties with MEA countries. The exports will be essential in “Hing Economics”

because 60.3% of the global market growth in *Asafoetida* trade has been due to offshore exports.<sup>9</sup>

Existing literature extensively details the historical significance of *Asafoetida*, emphasizing its culinary and medicinal usage, but does not address India’s transition to endogenous Hing production. The absence of a comprehensive analysis of the recent policy shift towards cultivating *Asafoetida* domestically leaves a significant knowledge void. Moreover, the dynamics of import substitution and the economic implications of transitioning to indigenous Hing production in India remained under-explored till now. Motivated by the knowledge gap in the literature, this paper presents the prescriptive analysis of endogenous Hing cultivation policy as a means of Import substitution and India as a prospective exporter of indigenous Hing. Furthermore, the production estimation was carried out to calculate the amount of land in hectares (ha), with the number of seeds needed to cut out imports and reach self-sufficiency. This study investigated the instability in trade and ties them with the trends of imports, exports, and economic variables such as commodity cost, disposable income, and foreign exchange reserves. In the end this study gauged the challenges and proposed recommendations regarding the import substitution policy of *Asafoetida*.

The novelty of the study lies in its focus on the recent policy shift towards cultivating *Asafoetida* domestically and its potential economic ramifications. By providing a prescriptive analysis, the study offers insights into the transformative possibilities of making India self-sufficient in *Asafoetida* production.

### Data Source and Methodology

This study analyzed the data of *Asafoetida* exports and imports by India during the FY 2003–2004 to 2022–2023 (Table 1). The data is taken from the website of the Ministry of Commerce and Industry.<sup>8</sup> The value of *Asafoetida* imports and exports are taken in million USD. Using this data, instability in *Asafoetida* trade was calculated and interpreted the trend of exports and imports in India.

Furthermore, the value of Compound Annual Growth Rate of *Asafoetida* import and export by India was calculated to comprehend the global market. The value of CAGR is calculated as follows:

$$\text{CAGR} = \left( \frac{V_f}{V_b} \right)^{1/t} - 1 \quad \dots (1)$$

where,  $V_f$  is the final value of an economic variable,  $V_b$  corresponds to the beginning value of the variable,

and  $t$  is the time in years. The coefficient of variation ( $CV$ ) was calculated from the mean and standard deviation as follows:

$$CV = \left(\frac{\sigma}{\mu}\right) \times 100 \quad \dots (2)$$

where,  $\mu$  is the mean value of variable  $X = x_1, x_2, \dots, x_n$  i.e.,  $\mu = (\sum_{i=1}^n x_i) / N$  and  $\sigma$  is the standard deviation from mean given as

$$\sigma = \sqrt{\left(\sum_{i=1}^n x_i - \mu\right)^2 / N} \quad \dots (3)$$

To analyse the variability and instability in the trade, the Cuddy-Della Valle-Instability index ( $CVD$ ) was calculated using the following formula:

$$CVD = \left(\frac{\sigma}{\mu}\right) \times 100 \times (1 - r^2) \quad \dots (4)$$

where,  $r^2$  is the adjusted coefficient of determination.

The  $CV$  value overestimates the instability of time series data. However, the value of  $CVD$  detrends the time-series data and shows the accurate flux value in export or import trends. The  $CVD$  value between 0 and 15 shows low instability, and the value between 15 and 30 showcases moderate instability. Finally, high flux is represented by  $CVD$  values greater than 30.

Table 1 — Exports and imports of *Asafoetida* by India for the past 20 years

Year	Imports (million USD)	Exports (million USD)
2003–04	8.01	1.88
2004–05	12.62	3.36
2005–06	7.97	2.01
2006–07	16.52	2.03
2007–08	27.49	2.83
2008–09	23.50	2.98
2009–10	27.65	3.66
2010–11	45.13	4.31
2011–12	48.28	4.22
2012–13	40.81	5.39
2013–14	57.36	5.69
2014–15	65.08	6.72
2015–16	80.16	7.06
2016–17	87.01	8.55
2017–18	108.56	8.22
2018–19	111.14	9.36
2019–20	132.90	8.63
2020–21	106.79	12.52
2021–22	103.85	9.62
2022–23	187.88	9.82

Source: Ministry of Commerce and Industry

## Results and Further Discussion

### Imports and Export of *Asafoetida* by India

The import of *Asafoetida* in India has risen since 2003 (Table 1) In FY 2022–2023, *Asafoetida* imports were 187.88 million USD. The annual average value over the last 20 years (from 2003–2023) is 64.9355 million USD (Table 2), and the import of *Asafoetida* by India grew at a  $CAGR$  of 17% between 2003 and 2023. Analysis shows a continuous increase in *Asafoetida* imports from 2003 to 2022, suggesting a constant drain of foreign reserves to carry out this trade. Thus, with endogenous production of *Asafoetida*, India can cut out this massive surge of imports.

In India, Hing is also used in the treatment of several diseases such as asthma, bronchitis, intestinal parasites, ulcers, stomach aches, weak digestion and influenza etc.<sup>14–18</sup> Apart from export-oriented cultivation, the Ministry of AYUSH, Government of India with CSIR-IHBT can use the indigenous grown *Asafoetida* to build and promote traditional medicine practices. This step may benefit the pharmaceutical sector economically with a push toward India’s traditional medicine system.

Moreover, *Asafoetida*’s price is way above the marginal cost of production. It is because imports from Afghanistan carry their own cost of travel through Pakistan, crossing the India-Pakistan border, which requires the approval of the government of Pakistan. Traders try to avoid this due to tense bilateral relations between India and Pakistan and finally tend to resort to the more expensive way of transportation, i.e., aerial.<sup>19–22</sup> The political turmoil in Afghanistan led this trade to be filled with uncertainty. Although the demand for Hing seems price inelastic, its cost in the Indian market can be reduced significantly with endogenous production.

The exports India has carried out annually from FY 2003–2004 to 2022–2023 have risen from 1.88 million USD to 9.82 million USD (Table 1). The average annual value of these exports is 5.943 million USD (Table 2), and the export of *Asafoetida* grew at a  $CAGR$  of 8.61% between 2003–2023. The analysis shows an increase in exports of *Asafoetida* by India from the year 2003 to 2022. However, it is important to note that the average value of imports is significantly larger than that of exports, indicating a net loss of foreign reserves.

Table 2 — The value of mean, standard deviation,  $CV$  and  $CVD$  for *Asafoetida* imports and exports by India during FY 2003–2023

	$\mu$ (million USD)	$\sigma$ (million USD)	$CV$	$CVD$
Imports	64.935	48.743	75.06	26.19
Exports	5.943	3.147	52.95	16.18

Table 3 — The regression statistics of *Asafoetida* exports and imports by India; The linear regression model is fitted on the data tabulated in Table 1

Regression stat for Exports		Regression stat for Imports	
Multiple R	0.95	Multiple R	0.94
R Square	0.91	R Square	0.88
Adjusted R Square	0.90	Adjusted R Square	0.87
Standard Error	0.96	Standard Error	17.0
Observations	20	Observations	20

The regression statistics of *Asafoetida* import and export by India are shown in Table 3 by using Microsoft Excel. It is observed that the linear regression model fits the data very well with very high  $r^2$  value, i.e., 0.91 and 0.88, for exports and imports, respectively corresponding to 20 year’s data from FY 2003–2024.

**Analysis of Instability in *Asafoetida* Trade**

Regarding the instability in *Asafoetida* trade, as evident from Table 2, the variation from the mean value for exports and imports is ~52% and ~75%, respectively, indicating a significant trade variation from the mean. The CV D values of exports and imports are 16.18 and 26.19, suggesting moderate instability in these trades. It is speculated that these instabilities resulted from erratic political conditions in Afghanistan.<sup>23,24</sup> For example, similar geopolitical conditions in contemporary times have led to blockages in the current wheat supply chains due to the violation of the “Black Sea Grain Deal.”<sup>25, 26</sup> resulting in wheat prices spiraling upwards and harsh transportation ways.

To substitute imports and increase the endogenous production of *Asafoetida*, India will need advanced production techniques and robust supply chains so that the value of *CVD* does not increase further, which in turn indicates a higher instability in trade of *Asafoetida*. Moreover, the endogenous production of this commodity may have significant implications on the Indian economy as its demand, price and supply chains remained inelastic in the Indian market despite the pandemic-induced lockdown.

**Production Estimation of *Asafoetida* in India and its Comparison with Afghanistan**

This section first highlight *Asafoetida*’s cultivation and trade impact in Afghanistan’s economy and then estimate the area and plants India needs to cultivate to attain self-sufficiency. It further emphasized the benefits India will attain by the introduction of this policy.

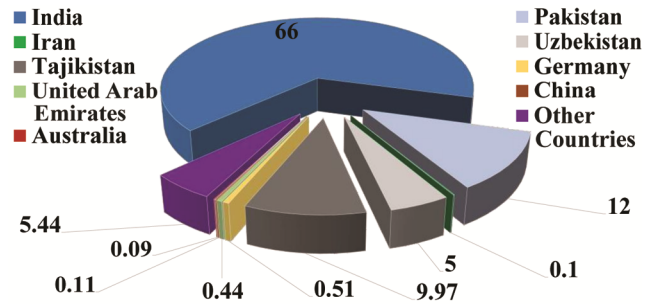


Fig. 2 — The share of exports from Afghanistan to the rest of the world; Data source: Guledagudda *et al.*<sup>27</sup>

***Asafoetida* Production in Afghanistan and its Impact on the Afghan Economy**

The climatic conditions in Afghanistan make it the best possible area for *Asafoetida* cultivation. As mentioned above, the expanded global market of *Asafoetida* has resulted in this being a major commodity of the Afghan economy. In particular, Samangan province has a share of 68 and 73 percent of the total production of *Asafoetida* in Afghanistan. The river plains in this region have fertile land, which makes it the best place for the *Asafoetida* cultivation. Furthermore, agriculture-perennial horticulture, livestock and SMEs (Agriculture and non-agriculture small-scale value addition) summarizes Samangan’s economic growth and prosperity in *Asafoetida* trade.<sup>27,28</sup> From Table 1 it is observed that India is the major importer of *Asafoetida* (~66%), showcasing its dependence on Afghanistan, followed by Pakistan and Tajikistan. Furthermore, Afghanistan’s *Asafoetida* exports increased at the rate of 19.15 and 28.17 percent in terms of quantity and value, respectively.<sup>27</sup> The *Asafoetida*’s market capture by Afghanistan was possible because of the increase in endogenous production, area of cultivation, and exports. In 2010–11, the area under *Asafoetida* cultivation in Afghanistan was 8052 ha. However, to meet the global demand, the area of cultivation increased to 1, 08, 956 ha by 2019–20, with an average productivity of 5200 Kgs/ha.<sup>27</sup> This resulted in 7.39 percent growth of *Asafoetida* production, consistent with the global demand.

**Estimation of *Asafoetida* Production in India and its Impact on Indian Economy**

India is importing ~1200 tonnes of raw *Asafoetida* from other countries. According to recent reports<sup>28</sup>, one *Asafoetida* plant, planted in Himachal Pradesh, is estimated to yield ~25 – 30 grams of Hing and the plants are proposed to be planted at a distance of 1 meter apart, which in turn results in ~ 8000 plants

per hectare. Thus, each hectare produces about 240000 grams i.e. 240 kg of Hing. It is important to note that the *Asafoetida* plants cultivated in Himachal Pradesh are new to the Indian environment. It will take some time for them to acclimate to the Indian atmosphere. Thus, the yield per hectare will likely to grow significantly in the coming years.

Now, to cut down the massive surge of imports (i.e., ~1200 tonnes of *Asafoetida*) and to attain self-sufficiency, India would need ~5000 ha of land and ~40 million *Asafoetida* plants. The estimated land area is significantly lower than Afghanistan's area under *Asafoetida* cultivation and can be achieved in India. However, the main challenge in the production is the gestation period of 5–6 years. The plant cannot endure water logging, so the soil should be well-drained. The land should be shoveled and levelled before planting the seeds. All this should have to be tackled in a comprehensive manner using state-of-the-art technologies to attain self-sufficiency in *Asafoetida* cultivation and production.

In addition to import substitution, the endogenous *Asafoetida* cultivation will improve the economy of hilly and northeastern states of India, which are severely affected by the migration of people from hilly areas to metropolitan cities. Hing cultivation will help diversify farmers' choice of cultivation. Moreover, it will help increase the disposable income (income left for final consumption after the investment into agriculture) of these farmers, as the net returns from cultivation outweigh the net investment, as mentioned below. The Director of CSIR-IHBT, Palampur, commented on the financial benefits of *Asafoetida* cultivation to the farmers, by saying.<sup>29</sup>

*“It will cost farmers nearly Rs. 3 lakhs per hectare over the next five years and give them a net return of a minimum of Rs. 10 lakhs from the fifth year onwards. In collaboration with state governments, we will support farmers with finance and technical know-how. It will be a game changer for farmers in the cold desert region of the country.”*

Furthermore, this policy is not only benefitting Indian farmers through monetary gains but also has ecological impacts. This is because large sections of land will be brought under cultivation as this policy expands. The barren land of cold, dry soil will be turned into productive cultivating land, making the expansion of cultivation beneficial for the farmers and the environment.

### **Problems and Policy Recommendations**

In India, the policy related to endogenous cultivation of *Asafoetida* is in its infancy, and India will likely face many problems in the future as this policy expands. This section highlights some of the possible problems for this policy's implementation and recommends ways to tackle them.

#### ***Distress Exports***

India has been at the forefront of export markets for agricultural products. It ranks as one of the top countries in exporting products such as milk, fruits, vegetables, tea, and sugar. However, a large Indian population poses a daunting problem when distributing these agricultural goods, resulting in a very low average per capita availability. To finance this huge domestic demand, commodities are imported from foreign nations. Thus, this “distress export” makes these commodities unavailable to low-income groups, as the cost of agricultural goods increases because of imports. For instance, in February 2022, the Indian government decided to ban wheat exports, fearing domestic inflation, and rising global import demand. The same story is being painted with the ban on rice export in 2023, resulting in an increase in rice prices globally. The social costs of these “distress exports” exceed the social gains. Thus, it is critical to tackle this problem, and India needs efficient production technology and cost-cutting strategies to meet the growing domestic and export demands.

#### ***Disruption of Supply Chains***

Export trade is crucial in providing livelihood to farmers and workers employed in these global supply chains. Resilient supply chains must be guaranteed through uninterrupted production, especially in this volatile international geopolitical arena. For this, diversification of production areas is necessary. Certain places in Southern India tend to have favorable climatic characteristics for *Asafoetida* cultivation, like the colder region in certain hill stations in South India. *Asafoetida* also can be grown in drained-out areas like deserts. Western botanists tend to grow this crop in sandy regions. This helps boost domestic production with on-shore or near-shore output, making it convenient for supply chains to function and reducing transportation pressure. Hence, this export-oriented approach should initially be guided by conservative economic policies.

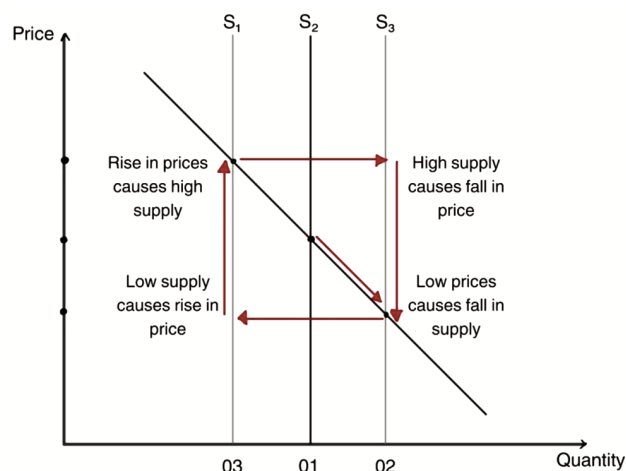


Fig. 3 — Cobb-Web phenomena- showcasing expectations effect prices

#### **Cobb-Web Phenomena**

Appropriate policy measures need to be implemented by the state or central government to tackle the Cobb-Web phenomenon, which states that price fluctuations lead to fluctuations in supply, resulting in frantic prices. The Cobb-Web phenomenon is shown in Fig. 3. Thus, price regulation is vital. Good market intelligence is also needed, as it helps with transparent and robust information dissemination. The farmers should have a finer idea of the prices in the last cycle to have more rational expectations of prices in the current production cycle and escape a volatile Cobb-Webb phenomenon.

One recommendation would be to include the endogenous cultivation of *Asafoetida* under the purview of the Spice Board, Ministry of Commerce, Government of India. The Spice Board may formulate Standard Operational Procedures (SOP) for the *Asafoetida* cultivation and its marketing to support the farmers and relevant stakeholders. *Asafoetida* is a capital-intensive crop, and it will be difficult for small farmers to arrange lump sum money for the initial cultivation. Thus, the Spice Board may provide financial assistance to the farmers for the initial plantation of *Asafoetida* plants, supply of fertilizers, and conduct training programs to spread awareness among farmers about the best practices for *Hing* cultivation. The Spice Board may also incentivize the best *Asafoetida* farmers with cash prizes to encourage them to cultivate *Hing*. Similar initiatives by the Spice Board for Cardamom production have led to an increase in the area of cultivation of Cardamom in the northeast regions of India.<sup>30</sup> To promote research and development on *Asafoetida*, a research wing may be

established in collaboration with CSIR-IHBT, Palampur, as the Indian Cardamom Research Institute (ICRI) was set up to promote research and development on Cardamom. The Spice Board may also launch an E-Auction facility for the *Asafoetida* trade, which has been proven successful in the case of spices like cardamom. The Farmer Producer Organizations (FPOs) can also be formed for the farmers directly involved in *Asafoetida* cultivation and marketing. In this direction, the Small Farmers Agribusiness Consortium (SFAC), directed by the Department of Agriculture and Cooperation, Ministry of Agriculture, may help and support the State Governments in forming these FPOs. The FPO's primary operations will not only help in supplying seeds, fertilizers, and machinery to the farmers but also provide training, financial, and technical advice for *Asafoetida* cultivation and marketing. During the COVID-19 pandemic, the spice sector proved to be resilient. The private sector and rapid policy changes helped prevent trade disruptions.

#### **Conclusions**

The instability in *Asafoetida* trade, with a coefficient of variation of ~52% and ~75% for exports and imports, respectively, accentuates vulnerability in trade due to the geopolitical conditions, notably in Afghanistan. To address this, India must adopt advanced production techniques to establish stable supply chains. The estimation of total land for *Asafoetida* production reveals that achieving self-sufficiency necessitates ~5000 hectares land and ~40 million plants, promising economic uplifting of hilly regions. Despite challenges such as a 5–6-year gestation period, the financial benefits for farmers and positive ecological impacts make endogenous cultivation transformative. Policy recommendations of this study include strengthening supply chains, incentivizing endogenous cultivation, and formulating supportive frameworks. The ripple effects of this policy will not only help cut down the prices of *Hing* commodities in India but also help preserve foreign exchange reserves, increasing farmers' disposable income. While acknowledging geopolitical complexities in *Asafoetida* trade, this study highlights the transformative potential of endogenous cultivation for economic growth and environmental benefits.

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### Conflict of Interest

The authors declare no conflict of interest.

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