



## What Major Agricultural Cross-Border Trade Products in India Are Influenced by Payments?

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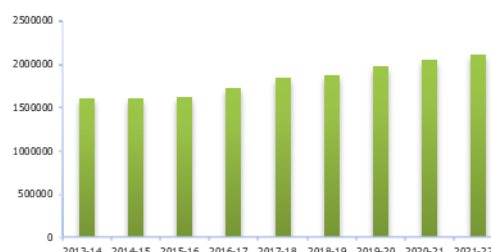
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Article History	Abstract
Received: 06 June 2023 Revised: 05 Sept 2023 Accepted: 16 Nov 2023	<p>This study explores the connection between overall Indian payment statistical indicators and the import-export patterns of around 40 major agricultural products regulated by the Agricultural and Processed Food Products Export Development Authority (APEDA) in India. Using separate regression analyses for import and export transactions from 2013 to 2022, our findings indicate that only a few of these products show a clear impact from payment indicators. In a time when digital payments are becoming increasingly important, the discovery that certain agricultural products are not affected by payment trends has significant implications for the financial landscape. As digital transactions continue to grow, understanding that some agricultural products remain independent of payment trends highlights the need for comprehensive intervention and further research. This study emphasizes the importance of thoroughly investigating these dynamics, providing insights to inform strategic decisions and policies that align with the changing financial ecosystem.</p>
CC License CC-BY-NC-SA 4.0	<p><b>Keywords:</b> Agriculture, Gross Value Added, Indian Economy, Payment Statistics, Trade</p>

### 1. Introduction

Agriculture is the backbone of the Indian economy, providing jobs for many people and contributing a large share of the country's GDP. India is a major producer of many crops, including food grains, fruits, vegetables, and spices. Despite recent progress, the Indian agricultural sector faces challenges such as small landholdings, rain-fed agriculture, post-harvest losses, and limited investment. The government is taking steps to address these challenges, such as investing in irrigation, encouraging crop diversification, improving cold storage infrastructure, and providing financial assistance to farmers. As the agricultural sector looks to the future, it is focusing on key areas such as horticulture, organic farming, and food processing. Horticulture is growing rapidly due to increased demand for fruits, vegetables, and spices. Organic farming is also gaining traction, supported by government initiatives.

Agriculture, Forestry and Fishing in Rupess (Crores)



**Fig. 1.** Gross value-added trends of Agriculture and allied (Constant Prices)

The food processing sector is expected to grow due to increasing demand for processed foods and beverages. At this juncture this work is emphasizing that payment systems are also playing an increasingly important role in the agricultural sector, helping to improve efficiency and transparency, and reduce costs. For example, the rapid adoption of digital payments in agriculture is helping farmers to sell their produce directly to buyers, eliminating intermediaries and improving their bargaining power.

The Indian government is promoting the adoption of digital payments in agriculture through initiatives such as the e-NAM platform, which enables farmers to sell their produce directly to buyers online. figure 1, is indicating the gross value-added trends of agriculture and allied as a whole for the period between 2013 and 2022, the period which has greater paradigm shift towards digital payments in India.

With rise in digital payments volume in the recent year's this empirical study aims to identify the relationship between payment statistics and the agriculture exports and imports, so as to consider efficient payments as a factor contributing to the growth of agriculture in India. In the following sections, we will explore the relationship between payments and agriculture using data from APEDA. We will first analyze the overall trends in payments and agriculture, and then identify the major products that are traded under the influence of payment efficiency. Finally, we will draw some conclusions about the impact of payment efficiency on agricultural trade of major products.

## 2. Literature Review

Žičkienė, Melnikienė, Morkūnas, Volkov (2022) conducted a thorough evaluation of the influence of direct payments (DPs) on agricultural resilience in the European Union. While their investigation unveiled a positive impact of DPs on economic resilience, it concurrently revealed adverse effects on farm efficiency and other factors. Recognizing the complexity of these outcomes, the researchers recommended policy adjustments to bolster overall economic resilience [1].

Coibion, Gorodnichenko, Weber (2020) brought attention to a crucial revelation amidst the pandemic, noting that U.S. households utilized only 40% of their stimulus payments due to limited spending opportunities. They expressed optimism for future effectiveness as the pandemic recedes, proposing a broader array of policies aimed at stimulating aggregate demand [2].

Carstens (2019) directed focus toward the challenges posed by central bank digital currencies (CBDCs), emphasizing their potential to fundamentally transform the monetary system. Notably, concerns were raised regarding the lack of clear societal demand for CBDCs and the significant implications for operational and financial system stability [3].

Zandi, Singh, Irving (2013) contributed insights into the economic significance of electronic payments, particularly card transactions, in catalyzing economic growth. Their research identified a positive correlation between the penetration and usage of card payments and overall economic growth, leading to recommendations for policies promoting electronic payment methods [4].

Noviana, Darma (2020) delved into digital marketing strategies in Indonesia, focusing on content marketing and social media promotion during the COVID-19 pandemic. Notably, they highlighted mobile banking as the preferred payment method in the "New Normal Era" [5].

Hasan, De Renzis, Schmiedel (2012) emphasized the pivotal role of electronic retail payments in fostering economic growth, specifically highlighting the positive impact of card payments. Their endorsement of policies promoting electronic retail payment instruments underscored the importance of these choices in propelling economic progress [6].

Moreno-Brid (1998) presented an insightful analytical model revealing constraints on Mexico's economic growth, primarily stemming from the nation's inability to generate sufficient foreign exchange. Within this context, strategies and challenges were discussed to promote economic growth and alleviate the balance-of-payments constraint [7].

Nakaso (2017) provided a historical perspective on the evolution of central bank payment and settlement systems, emphasizing their adaptability in the face of economic and technological shifts. This evolution included the transition from paper-based systems to efficient digital counterparts and the widespread adoption of real-time gross settlement (RTGS) systems [8].

Banerjee and Sinha (2023) investigated the impact of digital currencies on financial inclusion in India, focusing on Central Bank Digital Currencies (CBDCs). They proposed that digital currencies could

positively influence various economic and financial aspects, while acknowledging the need for further research to fully understand their potential [9].

Ali and Salameh (2023) explored the payment and settlement system in Saudi Arabia, uncovering a decline in traditional payment methods and a rise in online payment methods like Mada and E-payment. Critical issues related to security, traceability, and privacy within the system were highlighted, calling for substantial improvements [10].

Cipriani, Goldberg, La Spada (2023) examined the use of financial sanctions in international relations, with a focus on their impact on the international payment system and SWIFT. Notably, they emphasized the emergence of alternative systems in certain countries aiming to bypass Western-based infrastructures, highlighting the interplay between payments and global diplomacy [11].

Polasik, Huterska, Iftikhar, Mikula (2020) explored the PayTech sector in Europe, evaluating the impact of the Payment Services Directive 2 (PSD2). Their findings revealed significant growth driven by market potential, regulatory support, and evolving consumer payment habits [12].

The ECB Occasional Paper Series (2019) comprehensively examined the implications of crypto-assets for financial stability, monetary policy, and payment and market infrastructures. Importantly, they stressed that, at the time of their analysis, the risks posed by crypto-assets to the EU financial system were considered limited and manageable. Nevertheless, continuous monitoring and readiness for adverse scenarios were deemed crucial [13].

Hock-Han Tee and Hway-Boon Ong (2016) focused on the adoption of cashless payment methods, emphasizing the role of technology, including RFID and NFC, in driving the development of cashless payments. They highlighted the enduring impact of embracing cashless payment methods on economic growth [14].

Charles M. Kahn and William Roberds (2009) observed the complex economics of payments, emphasizing payment as a fundamental economic decision. They called for a comprehensive understanding of payment economics among policymakers and economists, asserting its importance for making informed decisions regarding payment systems and their far-reaching impact on economic activities [15].

### 3. Payments Vs Agricultural Trade

The efficient functioning of payment systems is indispensable for the success of cross-border agricultural trade, a pivotal driver of global economic development and food security. Amidst the complex web of international trade relationships, the effectiveness of payment systems assumes a central role in ensuring the timely and secure delivery of agricultural products to their intended destinations. This study delves into the correlation between payment efficiency and its profound impact on cross-border agricultural trade, scrutinizing the challenges and opportunities associated with payment systems, with a focus on the major products of exports and imports indicated in APEPDA INDIA.



Source: By author

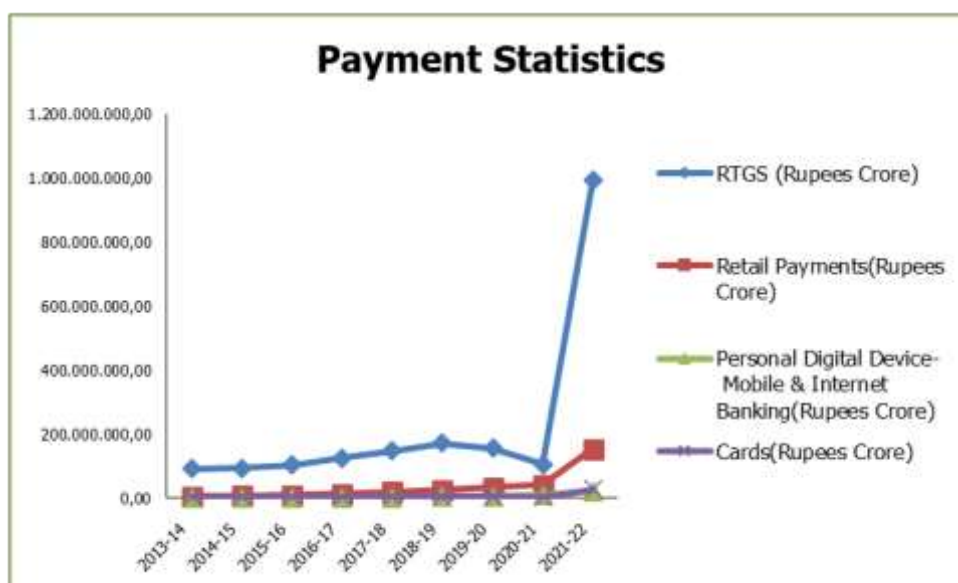
**Fig. 2.** Payment System Indicators Classification

Cross-border agricultural trade is inherently complex, involving the exchange of diverse agricultural products across geographical, cultural, and institutional divides. At the core of this complex process lies the imperative for efficient payment systems to facilitate the smooth flow of transactions. Timely and secure payments are not only essential for the economic growth of nations but also crucial for sustaining the livelihoods of farmers and advancing the global food security agenda.

A primary challenge in the domain of cross-border agricultural trade is the variability in payment systems across different nations. Divergent regulatory frameworks, currency fluctuations, and disparities in banking practices can introduce delays and uncertainties in transactions, creating a cascading effect that impacts farmers, exporters, and importers throughout the supply chain. Therefore, establishing a harmonized and efficient payment system is imperative to mitigate challenges and promote seamless cross-border agricultural trade.

The first challenge in achieving payment efficiency in cross-border agricultural trade lies in the realm of currency fluctuations and exchange rate risks. Agricultural trade often involves transactions in multiple currencies, exposing parties to the volatility of exchange rates. This inherent risk can lead to financial losses for farmers and exporters, who may find it challenging to predict the final value of their earnings. The uncertainty stemming from exchange rate fluctuations hampers the ability of stakeholders to plan and invest in the next agricultural cycle, creating a ripple effect that reverberates across the entire supply chain. Regulatory hurdles represent another significant challenge in the quest for efficient cross-border agricultural payments. Each country boasts its own set of regulations governing financial transactions, and navigating through this complex regulatory landscape can be a cumbersome process. Compliance with varying regulatory frameworks adds layers of complexity to cross-border transactions, increasing the time and cost associated with executing payments. Such regulatory challenges hinder the agility of agricultural trade participants, stifling the potential for growth and efficiency in the market.

Technology and financial infrastructure emerge as crucial elements in addressing the challenges of payment efficiency in cross-border agricultural trade. The advent of digital payment systems, blockchain technology, and innovative financial instruments presents opportunities to streamline transactions and enhance the security of cross-border payments. Digital payment solutions offer a faster and more transparent alternative to traditional banking channels, reducing the time and cost associated with cross-border transactions. Blockchain technology, with its decentralized and tamper-resistant ledger, holds the potential to revolutionize cross-border payments by providing transparency and traceability. Smart contracts, powered by blockchain, can automate payment processes based on predefined conditions, reducing the need for intermediaries and minimizing the risk of errors or fraud. Implementing these technological solutions requires collaboration between governments, financial institutions, and technology providers to establish standardized protocols and interoperable systems. Financial infrastructure plays a pivotal role in determining the efficiency of cross-border payment systems. The availability of robust banking networks, advanced payment gateways, and interoperable financial systems contributes to the seamless flow of transactions. Investment in modernizing financial infrastructure, both at the national and international levels, is essential to create an environment conducive to efficient cross-border agricultural payments. Figure 3 represents the trend of Payment statistics classified above earlier.



Source: Reserve Bank of India

**Fig. 3.** Payment Statistics of India

Despite the challenges, there are encouraging examples of initiatives aimed at improving payment efficiency in cross-border agricultural trade. International organizations, such as the World Trade Organization (WTO) and the International Chamber of Commerce (ICC), actively work towards

standardizing trade finance practices and advocating for reforms to enhance payment efficiency. Collaborative efforts between nations to harmonize regulatory frameworks and promote interoperability in payment systems contribute to creating an environment conducive to efficient cross-border transactions.

#### 4. Major Products Statistics

India's agricultural and processed food sector stands as a linchpin in the nation's economy, making substantial contributions to both domestic consumption and international trade. The Agricultural and Processed Food Products Export Development Authority (APEDA) plays a crucial role in promoting and regulating the export of a diverse array of agricultural and processed food products, making the identification of major products imperative for understanding economic dynamics and trade efficiency, particularly in terms of payment.

APEDA oversees the export of various products, and among these, albumin sourced from eggs and milk stands out. Rich in proteins, albumin finds valuable applications in food and pharmaceutical industries, showcasing India's prowess in dairy and poultry product processing on the global stage. Alcoholic beverages constitute another significant export category, reflecting India's thriving industry and diverse brewing practices.

**Table 1.** Total Year Wise Exports & Imports

Year	Total Exports Rs. Crore	Total Imports Rs. Crore
2013-14	1,36,921.21	23,977.42
2014-15	1,31,343.00	31,534.99
2015-16	1,07,482.86	41,763.43
2016-17	1,13,857.98	62,919.12
2017-18	1,25,858.09	47,625.37
2018-19	1,35,112.60	40,522.59
2019-20	1,19,400.67	41,856.97
2020-21	1,53,049.86	40,900.77
2021-22	1,84,769.24	54,191.26

Source: APEPDA INDIA

Animal casings, crucial in the food processing sector, underscore India's role in the global meat processing supply chain. Buffalo meat, known for its quality, is a major contributor to India's meat export, emphasizing the need for efficient trade practices in sustaining and expanding this sector. Cardanol, derived from cashew nut shell liquid, is a noteworthy industrial raw material, highlighting India's expertise in cashew processing and by-product utilization.

Casein, a milk protein, reflects India's key position in the global dairy industry, while cashew kernels and cashew nut shell liquid showcase the country's dominance in the global cashew market. Cereal preparations, including breakfast cereals and ready-to-eat meals, contribute significantly to India's export revenue, meeting diverse international consumer preferences. Cocoa products, sourced from cocoa beans, highlight India's involvement in global value chains related to the chocolate and confectionery sector. Preserved cucumber and gherkins underline India's proficiency in food preservation and processing techniques. Dairy products, floriculture, fresh grapes, and fresh mangoes demonstrate India's capabilities in providing high-quality agricultural and horticultural products to international markets. The export of fresh onions showcases India's reliability as a supplier in the global market, while the export of fruit and vegetable seeds is vital for sustaining agricultural productivity globally.

Groundnuts, guar gum, and jaggery exemplify India's contributions to global oilseed, natural gum, and confectionery markets, respectively. The export of maize positions India as a reliable supplier in the global market, and mango pulp showcases the country's ability to provide high-quality processed fruit products.

Milled products, millet, and miscellaneous preparations highlight the diverse food processing capabilities of India. The export of natural honey emphasizes the country's rich biodiversity and sustainable apiculture practices. Non-basmati rice and other cereals contribute to India's standing as a leading rice exporter, showcasing its agricultural abundance. Other fresh fruits, other fresh vegetables, and other meat products underline India's agricultural diversity and its role in the global meat market. Niche products like betel leaves and nuts showcase India's unique export offerings.

Poultry products, processed fruits, juices, and nuts, processed meat, and processed vegetables contribute significantly to India's export revenue, meeting the global demand for these processed food items. Pulses, sheep/goat meat, walnuts, and wheat showcase India's role in supplying protein sources, nuts, and staple cereals to international markets.

Table 1 presents the Major Products Import Statistics, providing a thorough overview of the essential goods brought into the country. This table offers valuable insights into the types and quantities of products that contribute to India's import scenario. Encompassing a wide range of items, from raw materials to finished goods, the data encapsulates the diverse nature of products shaping the nation's import landscape.

**Table 2.** Major Products Import Statistics

Product(MT)/ Year	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Albumin( Eggs & Milk )	1031.49	1562.1	2207.73	4332.74	4977.4	10848.33	10831.8	9056.36	18074.55
Alcoholic Beverages	101308.28	160664.94	283096.37	433798.28	563713.41	587958.73	576784.39	643688.41	559597.64
Animal Casings	0.22	0	0	0	0	0	0	14	1.54
Buffalo Meat	0	0	0	0	0	0.95	0	0	0
Cardanol	0	0	0	34.71	499.36	5.1	3.6	2.1	3.1
Casein	186.09	1134.46	823.66	434.19	305.53	559.29	2209.73	1856.76	2039.12
Cashew Kernels	0	0	0	774503.55	654019.76	839636.44	941416.21	834399.66	939198.52
Cashewnut Shell Liquid	0	0	0	1653.06	1593	6606.39	8661.92	2198.93	6523.32
Cereal Preparations	52374.22	63249.61	61392.61	67030.69	71097.54	90248.58	96278.08	113372.08	124806.96
Cocoa Products	51617.98	65309.57	56424.69	63613.17	71257.55	87593.24	85276.2	89060.1	111187.61
Cucumber and Gherkins( Prepd. & Presvd)	5.42	157.96	22.46	59.78	434.33	338.61	192.08	150.36	14.73
Dairy Products	9916.42	11901.61	16986.74	16305.78	22683.19	12513.08	17827.81	16183.26	11873.52
Floriculture	4308.8	4813.7	4768.81	5550.08	6241.1	6374.47	7313.92	3959.21	6235.88
Fresh Grapes	3955.17	2639.91	5217.36	4428.36	5626.96	7006.13	7583.78	6463.22	7980.74
Fresh Mangoes	7.52	0	0.95	5.04	12.14	30.54	138.6	17.97	56.03
Fresh Onions	17843.88	386.93	87323.61	86.83	6592.59	7080.71	141189.87	66264.43	28512.6
Fruits & Vegetables Seeds	8198.19	14115.24	14328.07	14073.87	16051.46	19609.09	17776.85	24925.8	19744.95
Groundnuts	114	21	106.43	325.05	1719.4	1086.89	1952.05	1036.15	748.25
Guargum	375.33	147.82	634.63	182.05	431.71	715.16	2150.09	366.07	176.36
Jaggery & Confectionery	40086.01	53608.34	72927.53	64086.73	82663.92	78982.56	80380.59	81626.56	85931.72
Maize	13866.58	6021.2	181763.94	83216.79	30696.54	86024.79	458510.71	24819.24	23725.96
Mango Pulp	33	30	19.22	0	0	160.2	500.13	47.6	68.8
Milled Products	3977.44	3466.12	4393.66	3555.95	3275.7	4184.83	4325.18	2532.74	3373.14
Millet	321.12	611.1	234	655.1	913.99	1032.34	733.08	428.45	517.48

Miscellaneous Preparations	180681.64	196700.86	186123.68	229557.04	131055.23	229465.71	275743.79	216530.05	336515.45
Natural Honey	319.42	792.62	423.01	161.7	404.92	570.83	387.69	494.28	661.28
Non Basmati Rice	1442.4	1903.4	1020.1	1141.3	2123.9	6870.9	5638.4	4763.0	10582.29
Other Cereals	8102.5	18340.09	24147.72	227497.4	233520.45	157265.62	213906.04	109670.31	87828.57
Other Fresh Fruits	562664.81	631227.95	629816.44	834811.68	753595.63	885216.87	716428.98	868379.49	120605.365
Other Fresh Vegetables	7106.7	15778.02	10181.7	8442.6	9014.5	7659.0	11139.46	14019.58	15929.57
Other Meat	312.76	418.54	499.89	593.46	783.73	876.44	948.26	499.56	909.14
Others (Betel Leaves & Nuts)	80881.48	110813.27	67849.14	30260.5	19185.59	20681.8	16885.81	25042.16	27349.33
Poultry Products	463.96	814.18	869.27	721.37	572.11	900.35	797.55	296.77	417.83
Processed Fruits, Juices & Nuts	42303.89	51906.88	53784.24	56147.63	73470.72	81424.7	79145.38	72648.93	89906.45
Processed Meat	388.5	248.35	72.1	132.47	94.74	119.38	120.55	135.86	174.08
Processed Vegetables	20896.28	12237.28	16844.84	14615.13	17152.55	20308.19	36329.49	20550.88	26234.34
Pulses	365516.332	463473.984	587839.752	666132.915	567627.829	259591.415	297536.681	250503.819	277157.434
Sheep/Goat Meat	59.26	83.57	57.35	122.92	216.29	119.38	160.25	12.3	53.58
Walnuts	141.32	1321.85	5490.73	12989.53	19573.76	13640.47	21305.23	35021.54	30087.75
Wheat	11271.39	27973.19	516166.56	574943.107	164972.488	2746.56	1884.51	2.66	54.06

Source: APEPDA INDIA

Table 2 unveils the Major Products Export Statistics, shedding light on the primary commodities driving India's export success. This table offers a detailed breakdown of export figures, showcasing the nation's strengths and contributions in the global marketplace. Spanning from agricultural and processed food products to industrial raw materials, the export statistics provide a nuanced understanding of India's economic role on the international stage.

**Table 3.** Major Products Export Statistics

Product(MT)/ Year	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Albumin( Eggs & Milk )	2025.32	2125.02	1934.12	1703.32	2081.99	2196.83	2483.48	2278.28	1464.97
Alcoholic Beverages	311564.19	264625.53	238672.05	230827.22	241235.47	231601.93	139364.43	247455.66	197868.31
Animal Casings	352.2	260.15	206.36	173.24	12424.66	14882.83	12816.18	13887.74	13826.91
Basmati Rice	375727.142	370226.07	404582.29	398519.56	405675.862	441458.416	445465.669	4630463.14	3948161.03
Buffalo Meat	145194.175	147630.978	131453.359	132357.611	135056.348	123663.84	115254.731	1085619.93	1175193.02
Cardanol	0	0	0	9009.5	5530.2	3579.1	3884.0	3306.09	3575.59
Casein	11461.71	8168.05	5897.99	6129.89	2670.47	5638.75	164.4	3401.65	8768.48

Cashew Kernels	0	0	0	91738. 82	90017. 42	78177. 32	84327. 61	70087.5 9	75422.6
Cashewnut Shell Liquid	0	0	0	2395.2	2794.9 5	1721.4 8	721.07	429.82	1368.06
Cereal Preparations	321468 .07	306328 .81	316533 .44	339923 .14	353237 .23	347752 .08	341736 .11	403267. 68	415544. 58
Cocoa Products	15962. 95	20877. 7	32652. 56	25649. 5	29582. 58	27603. 73	27410. 58	25768.0 4	27318.7 6
Cucumber and Gherkins( Prepd. & Presvd)	218749 .79	251183 .01	202954 .44	179660 .96	220939 .2	212819 .85	189342 .9	223515. 51	217521. 38
Dairy Products	159228 .51	66424. 37	33442. 52	39166. 98	48039. 4	113725 .73	51421. 83	54762.3 1	108711. 21
Floriculture	22485. 21	22947. 27	22691. 64	22020. 33	20703. 46	19726. 56	16949. 39	15695.2 9	23597.2 2
Fresh Grapes	160256 .26	94377. 41	132647 .6	198471 .3	188221 .18	246133 .77	193690 .51	246107. 37	263075. 62
Fresh Mangoes	41279. 97	42998. 33	36779. 26	52761	49180. 48	46510. 22	49658. 68	21033.5 6	27872.7 7
Fresh Onions	148249 8.58	123810 2.6	138295 9.54	241573 9.06	158898 5.72	218376 6.42	114989 6.84	1578016 .57	1537496 .85
Fruits & Vegetables Seeds	17816. 7	12499. 31	13104. 26	11288. 62	14463. 13	16151. 15	14796. 09	17177.1 8	11549.8 9
Groundnuts	509664 .84	708386 .26	542726 .41	725704 .34	504019 .2	489187 .11	664442 .92	638582. 92	514163. 87
Guargum	601945 .42	665177 .71	325250 .71	419948 .19	494101 .27	513211 .87	381880 .14	234871. 29	321394. 92
Jaggery & Confectione ry	266471 .96	258252 .73	292841 .25	297680 .57	252142 .85	313869 .81	341155 .34	631895. 81	551716. 73
Maize	395423 6.61	282561 0.6	697947 .17	566352 .23	705513 .84	105185 5.92	370066 .09	2879202 .93	3690469 .1
Mango Pulp	174860 .33	154820 .66	128866 .01	130886 .07	110923 .73	105873 .22	85725. 57	98369.7 5	123476. 71
Milled Products	418397 .99	415984 .45	431464 .5	255803 .65	270377 .3	307367 .5	283380 .99	392935. 4	695779. 69
Millet	216418 .78	257386 .98	188985 .05	166942 .3	156274 .02	219402 .5	129012 .88	146993. 61	158509. 98
Miscellaneo us Preparations	338972 .77	372998 .36	355786 .36	282577 .03	331670 .05	517179 .51	327513 .08	624257. 36	946537. 37
Natural Honey	28378. 4	29578. 56	38177. 04	45055. 45	51547. 31	61333. 9	59536. 76	59999.2 5	74413.0 6
Non Basmati Rice	713318 3.37	827404 6.02	646456 9.77	677080 4.28	864848 8.58	759967 4.1	504070 7.72	1309513 0.21	1726223 5.08
Other Cereals	441281 .76	430812 .94	80989. 41	1493.2 4	1344.0 2	5750.0 5	2403.6 2	2932.78	3049.58
Other Fresh Fruits	232109 .67	261211 .71	362954 .05	394315 .39	321157 .55	372213 .73	496577 .66	609612. 93	761031. 2
Other Fresh Vegetables	881598 .72	798600 .54	712562 .16	993117 .16	739055 .09	735743 .1	754007 .57	682085. 8	770233. 22
Other Meat	255.23	261.92	0	12.07	1044.4 3	852.36	1030.4 1	894.04	1946.95
Others (Betel Leaves & Nuts)	5685.0 8	9031.3 1	10716. 65	14389. 09	13185. 92	17364. 51	14003. 48	10151.6	14056.5 8
Poultry Products	437673 .53	556698 .81	659304 .15	448724 .73	453966 .53	544985 .05	350817 .81	255686. 92	320240. 46
Processed Fruits,	246131 .21	253346 .85	275584 .02	300006 .44	317353 .16	339606 .57	360488 .14	306990. 51	374260. 06



Juices & Nuts									
Processed Meat	488.78	406.11	279.42	140.9	269.66	405.63	439.61	774.11	462.58
Processed Vegetables	204662.62	180388.47	177332.52	210582.41	226483.9	248122.33	253276.97	403355.38	460621
Pulses	345276.73	222262.07	256051.91	136968.03	180193.85	289617.95	235699.03	296169.79	410375.86
Sheep/Goat Meat	20425.85	22827.77	21635.7	22008.58	21906.51	18424.97	14128.84	7050.55	8695.97
Walnuts	6724.48	2663.03	3289.52	2188.65	3595.69	1874.86	1648.22	1069.66	2482.55
Wheat	556237.474	292407.018	666668.95	265606.06	322790.14	226224.99	217354.23	2088487.66	7239366.78

Source: APEPDA INDIA

### 5. Methodology and Data Analysis

The methodology employed for analyzing the impact of payment data on the individual major products' export and import trends, utilizing data from APEDA (Agricultural and Processed Food Products Export Development Authority), follows a quantitative research design. This approach involves the systematic use of numerical data, statistical techniques, and a focus on measurable quantities. The study draws inspiration from the work of Hock-Han Tee and Hway-Boon Ong (2016), which classifies payments into four major groups: Large Value Payments (LVP), Retail Payments (RP), Mobile-based payments (CPDD), and Card-based payments (ATP) [14].

In this quantitative design, the independent variables are the four categories of payments—LVP, RP, CPDD, and ATP. These variables serve as indicators of different modes of transactions within the agricultural and processed food products export sector. The classification is crucial for understanding the diverse channels through which payments influence trade dynamics.

Table 4 provides a comprehensive overview of the descriptive statistics for the independent variables, representing payment statistics in the study. The variables include Real-Time Gross Settlement (RTGS)/Large Value Payments (LVP), Retail Payments, Personal Digital Device-Mobile & Internet Banking, and Cards, each measured in Rupees Crore.

**Table 4.** Descriptive Statistics of Independent variables (Payment Statistics)

	RTGS/LVP (Rupees Crore)	Retail Payments(RP) (Rupees Crore)	Personal Digital Device- Mobile & Internet Banking(CPDD) (Rupees Crore)	Cards(ATP) (Rupees Crore)
Mean	220255921.5	33843257.91	4723427.507	5823661.089
Standard Error	96834969.8	15363901.84	2303076.777	2560881.364
Median	125365207.6	19201797.73	1473854.49	3021400.196
Standard Deviation	290504909.4	46091705.52	6909230.33	7682644.091
Skewness	2.944233287	2.609691105	2.06923446	2.941925304
Sum	1982303294	304589321.2	42510847.56	52412949.8
Count	9	9	9	9

Source: Compiled by Author

The dependent variable in the study is the individual major products' export and import trends, specifically focusing on the quantity of products traded. This choice reflects the emphasis on the tangible volume of goods being exported or imported, providing a quantitative measure of the economic impact of payment efficiency on specific commodities. The regression equation for this study is as follows

$$MPROD_{wt} = B_0 + B_1LVP_{wt} + B_2RP_{wt} + B_3CPDD_{wt} + B_4ATP_{wt} \quad (1)$$

MPROD represents the individual major product quantity which might be exported or imported, B indicates the coefficients of regression, whereas the w represents the product under choice for analysis ranging from 1 to 40, t represents time where the series considers the 2013 as 1 and so on.

The data spans from 2013 to 2022, and the selection of major products aligns with APEDA's indications, ensuring a representative sample that mirrors the diversity of India's agri-food export basket.

The research design is quantitative, emphasizing the systematic use of statistical methods to analyze numerical data. Techniques such as correlation coefficients and regression analysis are applied to assess

the relationships between payment data and major product export and import trends. The correlation analysis provides insights into the strength and direction of the relationships, indicating whether and to what extent variations in payment methods coincide with changes in the quantity of major products traded. Regression analysis helps model the quantitative impact of payment data on major product export and import trends, identifying the specific payment methods that significantly affect trade quantities.

Table 5 presents the correlation coefficients between major product exports and payment statistics, providing insights into the relationships between these variables. The coefficients range from -1 to 1, where -1 indicates a perfect negative correlation, 0 indicates no correlation, and 1 indicates a perfect positive correlation. For instance, in the case of albumin (Eggs & Milk), there is a negative correlation with RTGS, Retail Payments, Personal Digital Device-Mobile & Internet Banking, and Cards, suggesting that as payment efficiency decreases, albumin exports tend to increase. On the other hand, for Animal Casings, there is a positive correlation with all payment methods, indicating that as payment efficiency increases, the export of animal casings also tends to increase.

**Table 5.** Correlation Coefficient between exports (Major Products) and payment statistics

Product	RTGS (Rupees Crore)	Retail Payments(Rupees Crore)	Personal Digital Device-Mobile & Internet Banking(Rupees Crore)	Cards(Rupees Crore)
Albumin( Eggs & Milk )	-0.308040975	-0.410159188	0.459415442	-0.302266812
Alcoholic Beverages	-0.114033632	-0.097283183	0.072863699	-0.119488426
Animal Casings	0.469007313	0.603706679	0.661027275	0.474450008
Basmati Rice	-0.077551151	0.026976971	0.103622531	-0.072186957
Buffalo Meat	-0.242375604	-0.411069865	0.532867085	-0.246555717
Cardanol	0.316918962	0.369480718	0.378045521	0.307529165
Casein	0.464733791	0.350984958	0.266406456	0.457449479
Cashew Kernels	0.15018935	0.211856818	0.219424997	0.143100343
Cashewnut Shell Liquid	0.458640429	0.436404641	0.360965588	0.449027249
Cereal Preparations	0.643701357	0.795357938	0.877949312	0.648248973
Cocoa Products	0.159428042	0.233982122	0.251173747	0.168259226
Cucumber and Gherkins( Prepd. & Presvd)	0.392603355	0.558639257	0.650538288	0.400354219
Dairy Products	0.481685902	0.447050919	0.407593373	0.475357881
Floriculture	0.908856758	0.957858087	0.95006219	0.908629948
Fresh Grapes	0.417770858	0.558509011	0.631117749	0.417856633
Fresh Mangoes	-0.055894112	-0.103569197	0.162401962	-0.063497873
Fresh Onions	0.419468772	0.355530844	0.263677866	0.409866217
Fruits & Vegetables Seeds	0.338045605	0.491445441	0.56655616	0.343762272
Groundnuts	0.124136005	0.238334137	0.352025389	0.127079108

Guargum	-0.2339679	-0.358382148	0.425900379	-0.239559079
Jaggery & Confectionery	0.681156951	0.827341502	0.913851959	0.684776508
Maize	0.616969579	0.621050361	0.621106611	0.615057232
Mango Pulp	0.519685378	0.40850092	0.318919266	0.513558542
Milled Products	0.887999529	0.944291156	0.956361449	0.892937427
Millet	0.125310598	0.100866115	0.0765617	0.12962574
Miscellaneous Preparations	0.771754633	0.896864644	0.95840796	0.77700059
Natural Honey	0.920779306	0.945989252	0.911245426	0.925482321
Non Basmati Rice	0.788745211	0.867781214	0.890650539	0.789805613
Other Cereals	-0.265513482	-0.367804882	0.407086267	-0.267725379
Other Fresh Fruits	0.749330149	0.862094094	0.912402162	0.754677882
Other Fresh Vegetables	0.021907187	0.002124129	0.009808832	0.010796983
Other Meat	0.880183027	0.942856272	0.940802573	0.883208367
Others (Betel Leaves & Nuts)	0.626415428	0.62234621	0.572554355	0.625809531
Poultry Products	-0.215183609	-0.346826789	0.455003056	-0.207717827
Processed Fruits, Juices & Nuts	0.661501705	0.792913521	0.853412744	0.666258281
Processed Meat	0.065864426	0.16674711	0.230546113	0.077382247
Processed Vegetables	0.684600452	0.834462667	0.922268809	0.689228214
Pulses	0.826178299	0.887823953	0.900531095	0.828947537
Sheep/Goat Meat	-0.467756396	-0.637171922	0.76826122	-0.47312548
Walnuts	-0.198429292	-0.32723961	0.402270191	-0.204898872
Wheat	0.779735273	0.740007948	0.696251198	0.777400892

Source: Compiled by author using Data Analysis tool in Microsoft Excel

Table 6 follows a similar structure, providing correlation coefficients, but this time for major product imports. Notable correlations include a strong positive correlation between imports of albumin (Eggs & Milk) and all payment methods, suggesting that increased payment efficiency is associated with higher imports of this product. Conversely, Guargum show a negative correlation with payment methods, indicating that as payment efficiency decreases, the imports of Guargum tend to increase.

**Table 6.** Correlation Coefficient between Imports (Major Products) and payment statistics

Product	RTGS (Rupees Crore)	Retail Payments(Rupees Crore)	Personal Digital Device-Mobile & Internet Banking(Rupees Crore)	Cards(Rupees Crore)
Albumin( Eggs & Milk )	0.916730926	0.968856139	0.963276127	0.919768683
Alcoholic Beverages	0.56183672	0.662510441	0.690960092	0.565206172

Animal Casings	0.286268236	0.474141044	0.61884050 4	0.290779832
Buffalo Meat	-0.06286967	-0.06482465	- 3	-0.064013649
Cardanol	0.3480518	0.420100672	0.41562087	0.349901475
Casein	0.549282425	0.685588722	0.78525899	0.561124969
Cashew Kernels	0.337437115	0.42689992	0.45236649 4	0.333229285
Cashewnut Shell Liquid	0.585050547	0.649408975	0.66403173 6	0.589365935
Cereal Preparations	0.734999938	0.864502684	0.92735667 8	0.741345016
Cocoa Products	0.824040455	0.912655732	0.93949862 5	0.829013463
Cucumber and Gherkins( Prepd. & Presvd)	-0.342077216	-0.304453079	-0.30124	-0.339891592
Dairy Products	-0.413651818	-0.453559192	- 5	-0.403265044
Floriculture	0.748753778	0.823237794	0.84627060 1	0.753447671
Fresh Grapes	0.362253092	0.427639886	0.44028980 7	0.367422089
Fresh Mangoes	0.710194175	0.768574298	0.78883704	0.716544754
Fresh Onions	-0.020170477	0.101726847	0.21622238 7	-0.007001899
Fruits & Vegetables Seeds	0.513123176	0.681373042	0.77491124 2	0.522005347
Groundnuts	0.327122522	0.437623104	0.47573240 9	0.331284195
Guargum	-0.226111233	-0.178604165	- 6	-0.218568437
Jaggery & Confectionery	0.729609567	0.862949628	0.92530063 9	0.734837473
Maize	-0.10877174	-0.054713085	0.00138145 5	-0.099692732
Mango Pulp	0.158802879	0.230530519	0.28662137 3	0.167560881
Milled Products	-0.211342265	-0.38003765	- 1	-0.212413385
Millet	0.263299318	0.37356507	0.41387827 3	0.265918344
Miscellaneous Preparations	0.788197549	0.844741729	0.85545642 2	0.7919177
Natural Honey	0.448333831	0.489386056	0.45864871 8	0.454382191
Non Basmati Rice	0.420572468	0.514252036	0.57295833 2	0.428851066
Other Cereals	0.20528915	0.302476728	0.34557919 8	0.202457886
Other Fresh Fruits	0.806597179	0.887284669	0.90040281 8	0.807174401
Other Fresh Vegetables	0.213536434	0.357179136	0.47313538 5	0.226207634
Other Meat	0.603186963	0.619991543	0.57733914 7	0.606991754
Others (Betel Leaves & Nuts)	-0.067131114	-0.176033509	- 1	-0.06196603
Poultry Products	0.445904576	0.439421288	0.40321308 6	0.451097357
Processed Fruits, Juices & Nuts	0.542283251	0.653913198	0.68691898 6	0.548505864

Processed Meat	0.009784786	-0.033882689	0.035289314	0.007059612
Processed Vegetables	0.529925053	0.627692287	0.689126209	0.535430336
Pulses	-0.020137253	-0.127248725	0.206104446	-0.025691756
Sheep/Goat Meat	-0.183266901	-0.250692232	0.325901456	-0.184920001
Walnuts	0.33864316	0.534048764	0.662838237	0.344017572
Wheat	-0.167475397	-0.225716746	0.263076409	-0.181669891

Source: Compiled by author using Data Analysis tool in Microsoft Excel

Table 7 presents regression analysis results, showcasing the relationship between major product exports and imports with payment statistics as independent variables. The multiple R, adjusted R square, and p-values provide insights into the overall fit and significance of the regression models. For instance, in the case of albumin exports, the multiple R value of 0.677 suggests a moderately strong positive relationship with payment statistics, and the p-value of 0.0004 indicates that the relationship is statistically significant. Similar analyses are conducted for each major product, offering a comprehensive understanding of how payment efficiency influences the trends in both exports and imports over the specified data range from 2013 to 2022.

**Table. 7.** Regression analysis between Major products Imports, Exports with Payment Statistics (Independent Variable)

Dependent Variables	EXPORTS			IMPORTS		
	Multiple R	Adjusted R Square	P Value	Multiple R	Adjusted R Square	P Value
Albumin( Eggs & Milk )	0.677	0.354	0.0004	0.96	0.92	0.0552
Alcoholic Beverages	0.117	-0.77	8E-05	0.75	0.51	0.00058
Animal Casings	0.842	0.683	0.0296	0.8	0.6	0.40795
Basmati Rice	0.231	-0.54	0.0001	-	-	-
Buffalo Meat	0.625	0.249	4E-06	0.3	-0.41	0.46607
Cardanol	0.651	0.301	0.0487	0.83	0.67	0.03553
Casein	0.629	0.257	0.0571	0.92	0.84	0.0077
Cashew Kernels	0.713	0.426	0.0231	0.73	0.47	0.02568
Cashewnut Shell Liquid	0.856	0.713	0.0313	0.49	-0.01	0.36328
Cereal Preparations	0.962	0.925	2E-06	0.96	0.93	0.00012
Cocoa Products	0.548	0.096	0.0004	0.92	0.84	6E-05
Cucumber and Gherkins( Prepd. & Presvd)	0.865	0.73	3E-05	0.62	0.24	0.0161
Dairy Products	0.342	-0.32	0.038	0.62	0.24	8E-05
Floriculture	0.955	0.91	3E-06	0.73	0.47	0.00147
Fresh Grapes	0.796	0.592	0.0002	0.39	-0.22	0.00085
Fresh Mangoes	0.309	-0.38	0.0003	0.67	0.33	0.71678
Fresh Onions	0.537	0.074	8E-05	0.58	0.15	0.15712
Fruits & Vegetables Seeds	0.873	0.745	7E-05	0.96	0.92	6.1E-06

Groundnuts	0.481	-0.04	0.0004	0.71	0.41	0.0526 3
Guargum	0.487	-0.03	0.0186	0.49	-0.02	0.0304 7
Jaggery & Confectionery	0.967	0.934	4E-05	0.99	0.98	5.2E- 07
Maize	0.568	0.136	0.117	0.23	-0.54	0.1623 3
Mango Pulp	0.593	0.186	7E-05	0.25	-0.5	0.4210 9
Milled Products	0.94	0.881	0.0002	0.86	0.72	3.9E- 05
Millet	0.094	-0.81	0.0002	0.68	0.36	0.0060 4
Miscellaneous Preparations	0.987	0.974	2E-05	0.74	0.48	0.0006 4
Natural Honey	0.962	0.923	3E-05	0.79	0.57	0.0009 2
Non Basmati Rice	0.827	0.654	0.0028	0.44	-0.12	0.1894 9
Other Cereals	0.552	0.104	0.1342	0.54	0.07	0.0273 6
Other Fresh Fruits	0.894	0.789	0.0003	0.93	0.86	5.5E- 05
Other Fresh Vegetables	0.432	-0.14	3E-05	0.65	0.29	0.0147 8
Other Meat	0.952	0.903	0.1359	0.62	0.24	0.0023 6
Others (Betel Leaves & Nuts)	0.489	-0.02	0.002	0.58	0.17	0.0065
Poultry Products	0.813	0.626	2E-05	0.29	-0.41	0.0012 9
Processed Fruits, Juices & Nuts	0.9	0.8	3E-05	0.86	0.71	0.0003 6
Processed Meat	0.404	-0.19	0.0042	0.35	-0.3	0.0074 3
Processed Vegetables	0.988	0.975	2E-06	0.53	0.07	0.0023 1
Pulses	0.813	0.626	0.0004	0.23	-0.55	0.01
Sheep/Goat Meat	0.9	0.8	3E-05	0.37	-0.26	0.0138 5
Walnuts	0.467	-0.07	0.0369	0.92	0.84	0.0033 6
Wheat	0.767	0.534	0.6055	0.49	-0.02	0.2396 9

Source: Compiled by author using Data Analysis tool in Microsoft Excel

## 6. Conclusions

The comprehensive analysis of payment statistics and their correlation with export-import dynamics for key agricultural products overseen by APEDA in India between 2013 and 2022 reveals nuanced relationships that merit detailed consideration. The distinct patterns observed in the correlations and regression results underscore the complex interplay between payment efficiency and the quantities of specific agricultural products involved in international trade.

The positive correlations identified in the export domain, particularly for products like Cereal Preparations, Floriculture, and Natural Honey, suggest a symbiotic relationship between enhanced payment efficiency and increased export quantities. These findings imply that as digital transactions and payment efficiency rise, certain agricultural products respond more positively, possibly due to improved transactional ease and accessibility in global markets.

Conversely, the negative correlations observed for products such as Sheep/Goat Meat and Poultry Products signal a more complex relationship. It suggests that increased payment efficiency may not uniformly benefit all products, and for certain commodities, other factors might override the positive impact of streamlined payments. This points to the need for a more granular understanding of the supply chain dynamics, market conditions, and inherent product characteristics influencing the observed correlations.

The import correlations further enrich our understanding, indicating that the positive impact of payment efficiency extends to products like Albumin (Eggs & Milk), Cereal Preparations, and Cocoa Products. These findings echo the export domain, emphasizing the cross-cutting influence of efficient payments on trade quantities. On the flip side, negative correlations for products such as Cucumber and Gherkins, Dairy Products, and Guar gum suggest that certain imports may not exhibit a linear increase with improved payment efficiency, reinforcing the product-specific nature of these relationships.

The regression results bring an additional layer of insight, highlighting the strength and direction of the relationships observed. In exports, products like Natural Honey, Miscellaneous Preparations, and Milled Products exhibit strong positive regression, emphasizing the significant contribution of enhanced payment efficiency to increased export quantities. Similarly, in imports, Albumin (Eggs & Milk) stands out with strong positive regression, reiterating the pivotal role of efficient payments in boosting import quantities.

These findings collectively underscore the need for targeted policy interventions that account for the diverse responses of different agricultural products to evolving payment landscapes. While some products demonstrate a robust positive correlation and regression with payment efficiency, others exhibit a more nuanced relationship, suggesting that a one-size-fits-all approach may not be effective. Policymakers should recognize the product-specific nature of these correlations and tailor interventions accordingly. And following factors are identified from the above results:

1. Payment Efficiency Impact
2. Product Nature Influence
3. Global Market Dynamics
4. Supply Chain Considerations

Furthermore, the study emphasizes the imperative for ongoing research to delve deeper into the factors influencing these complex relationships. Understanding why certain products are more responsive to improved payment efficiency than others is crucial for crafting effective and informed policies. It may involve examining supply chain intricacies, market dynamics, and the specific characteristics of each agricultural product.

In conclusion, the findings presented in this study offer valuable insights into the evolving dynamics of payment and trade in the agricultural sector. Recognizing the complex and product-specific nature of the relationships between payment efficiency and export-import quantities is paramount for informed decision-making. The study encourages policymakers and stakeholders to leverage these insights to navigate the changing financial ecosystem effectively, fostering sustainable growth and resilience in the agricultural export-import landscape.

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