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EFFECT OF AGRICULTURAL TRADE LIBERALIZATION ON FARM INCOME IN INDIA: AN EMPIRICAL ANALYSIS USING ARDL APPROACH

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Abstract
This study examines cointigration between farm income and agricultural export using ARDL approach during trade liberalization era (1991-2021) in India. ARDL is one of the most dynamic unrestricted model in economic literature. We have used ARDL approach to account for the non stationary of the data. Several measures and indicators are used to assess farmers' income in the country. Agricultural GDP can provide an approximate proxy for farm income to some extent, but it has limitations. Agricultural GDP represents the total monetary value of all goods and services produced within the agricultural sector. Farmers' income, on the other hand, is the actual earnings that farmers receive from their agricultural activities. This paper considers only Agriculture component of Gross Domestic Product at constant prices as a proxy for farm income. The ARDL Bound test revealed the existence of a long run relationship among selected variables. The coefficient of error correction term indicates that short run shocks could be adjusted towards their long run equilibrium at a rate of 107 percent per annum. The results of the study show that in the long run, agricultural output is positively influenced by exports, fertilizer use, and yield. Imports do not have a significant long-run impact. In the short run lagged differences of imports and fertilizer use have significant affect on farm income. CUSUM test demonstrates stability in the model and diagnostic tests shows that there is no serial correlation as well. While this study has limitations, it provides valuable insights into the relationships between agricultural exports and farm income in India.

Keywords: Liberalisation, Agricultural trade, Farm income, Bounds test, CUSUM, ARDL

1. Introduction

Several countries have carried out economic reform and followed trade liberalisation over last several decades. The impact of trade liberalisation on farmers' income is a significant and complex topic. Trade liberalisation policies include tariff reductions, removal of non tariff barriers, or participation in trade agreements. Trade liberalisation encourages countries to specialise in goods and services in which they have a comparative advantage, which can potentially increase the income. Changes in the factor endowments, such as land, labour and capital may affect farmers' income. Trade liberalisation typically leads to increased market access for agricultural products; this can increase demand and competition, influencing prices

and income. Open markets may lead to greater price fluctuations, affecting farmers' income stability.

Farmers' income refers to the earnings or revenue generated by individuals or households engaged in agricultural activities. This income is primarily derived from the sale of crops, livestock, and other agricultural products, as well as related activities such as agribusiness, agro-processing, and value addition. Measuring farmers' income in India is a difficult task due to the diversity of agricultural practices, landholding sizes, crops grown, and other factors. Several measures and indicators are used to assess farmers' income in the country: Gross income, Net Income, crop income etc. Agricultural GDP can provide an approximate proxy for farmers' income to some extent, but it has limitations. Agricultural GDP is the value of all goods and services produced within the agricultural sector. Farmers' income, on the other hand, is the actual earnings that farmers receive from their agricultural activities.

Agricultural Gross Domestic Product (GDP) stands as a pivotal indicator of the economic health of a nation's agricultural sector, serving as a proxy for the income generated by farmers. In our study we have consider only Agriculture component of GDP, the determination of agricultural GDP is a complex interplay of various factors, each exerting its influence on the overall productivity and economic output of the agricultural sector. This paper examines the factors affecting agricultural GDP and also looks into the cointegration between variables in the long run, employing Autoregressive Distributed Lag (ARDL) approach. The independent variables in this study include Agricultural Export, Import, Yield, and Fertilizer consumption, each contributing uniquely to the agricultural production and income.

Agriculture plays an important role in the process of economic development of countries. The importance of understanding and analyzing the determinants of agricultural GDP lies in its direct correlation with the income of farmers. As the world grapples with evolving global dynamics, such as climate change, trade liberalization, and technological advancements, it becomes imperative to dissect the contributing factors that influence the economic outcomes of those engaged in agriculture.

One of the important variables in this study is Agricultural Export. The volume and value of agricultural exports not only reflect the competitiveness of a nation's agriculture sector but also influence the income generated by farmers. Changes in global demand, trade policies, and market access can significantly impact the export potential of agricultural products, thereby affecting the overall agricultural GDP. Another key variable in our study is Yield which explains the quantity of agricultural output per unit of land. The cost of inputs on seeds, fertilizers, machinery and labor constitutes a significant component of the production process. Fluctuations in input costs can have a direct impact on the on farmers' income.

This study examines the cointigration between the farm income and agricultural export using ARDL approach during trade liberalization era (1991-2021) in India, and also investigates the long run cointegration among the variables. The section two of the study discusses some of the important studies carried out on the topic; section three discusses data sources and methodology which have been used in this paper/research. Results of the study have been

reported and discussed in section four and finally conclusion of the study and its limitations have been presented in section five.

2. Literature Review

International trade has become one of the most important drivers of economic growth of a nation. The overall effect of free trade or regional cooperation may be positive, negative or indifferent, depending on the volume of trade creation and trade diversion Clausing (2001).

Anwor et al (2013) finds in their study that trade liberalization has an impact on the agriculture sector's and its export sub-sector's performance in Nigeria. Yusida et al. (2021) findings indicate that an increase in food crop imports alone could lead to a decrease in farmer income. However, if this rise in food crop imports is accompanied by increased exports and production in non-agricultural products, it could result in an increase in farmer income. Anderson et al. (2006) found that transitioning to free merchandise trade would lead to several positive outcomes in developing countries, like increase in agricultural output and exports.

Khan et al. (2021) discovered that trade liberalization in Pakistan doesn't result in reducing income inequality in the short term. They observed that trade agreements favoring agriculture, while improving income equality, is due to decrease in urban and non-farm household income [21]. The key finding of Dhar (2023) is that India's agriculture sector faces challenges due to WTO agreements, including constraints on domestic support measures like minimum support prices and restrictions on export subsidies, impacting the implementation of national food security initiatives. Faridi (2012) conducted research on the impact of agricultural exports on Pakistan's economy, analyzing data from 1972 to 2008. Contrary to expectations, the study found that increasing agricultural exports hindered economic growth, while non-agricultural exports were found to stimulate economic development. As a result, the study suggested promoting non-agricultural and textile products to foster economic growth in Pakistan.

The agriculture sector's performance is contingent on multiple things. Several researches have been carried out on the factors influencing the agriculture sector. Some of the references include Mehdi (2011) , Udah and Nwachukwu (2014) , Ahmad and Heng (2012) , Raza and Siddiqui (2014) , Kannan (2011) , Tripathi and Prasad (2009) , Solanki (2017) , Kamat et al. (2007) , Aynalem et al. (2019) . Existing research have not reached a clear consensus on the extent and impact of different factors on agricultural production. This section reviews and presents literature from different countries worldwide followed by Indian studies.

Mehdi (2011) analyzes the factors influencing agricultural growth in Iran from 1970 to 2007 using annual time series data and the ARDL model. The study discovered that human capital and investments in the agriculture sector had a favorable and considerable impact on agricultural value addition. Shita et al. (2019) found that in Ethiopia, agricultural technology adoption, arable land area, and real GDP had a positive effect on agricultural productivity (cereal output per hectare). The study utilized the ARDL technique to analyze data from 1990 to 2016. Udah and Nwachukwu (2014) examined factors influencing agricultural growth in Nigeria using time series data from 1960 to 2010. Using OLS approach, researchers discovered that factor productivity and infrastructural development, had a major impact on the expansion

of the farming industry. A study conducted by Ahmad and Heng (2012) utilized the ARDL model to analyze the factors influencing the increase of Agricultural Productivity in Pakistan. The primary influencing elements in agricultural productivity development were identified as fertilizer, human capital, and agricultural credit.

Raza and Siddiqui (2014) used the Johansen Co-integration Approach to examine the factors influencing agricultural output in Pakistan based on data from 1972 to 2012. The findings indicated that the quantity of tractors, enhanced seeds, tube-wells, water supply, and agricultural workforce have a significant and favorable impact on agricultural production.

Kannan (2011) analyzed the factors influencing agricultural growth in India using annual data from 1967/68 to 2007/08 and the Ordinary Least Squares (OLS) method. The projected findings indicate that irrigation, capital formation, rainfall, and fertilizer usage have a considerable favorable impact on agricultural growth.

Tripathi and Prasad (2009) used the OLS regression model with annual data from 1950-51 to 2005/06 to explore factors influencing agricultural productivity in India. Land, labor, and capital were identified as the primary sources of agricultural output.

Solanki (2017) examined factors influencing farm GDP in India from 1990/91 to 2011/12 using a VAR model. The study indicated that public investment, terms of trade, and minimum support price had a positive impact on agriculture GDP, whereas fertilizer subsidy has a negative effect.

Kamat et al. (2007) utilized the Cobb Douglas Production Function with the OLS method to study the factors influencing agricultural GDP in India from 1970/71 to 2002/03. The institutional credit and support price of wheat have a beneficial impact on agricultural productivity, whereas the net irrigated area has a negative effect. A distinct regression model was used specifically for the post-economic reform period. All factors were deemed negligible.

Chand et al. (2015) in his study found that agricultural income earned after adjusting for input costs and wages has been different in the last three decades. Farm income per cultivator increased by 2.74% a year from 1983–84 to 1993–94 and dropped to below 2% in the next decade. From 2004–05 to 2011–12, per cultivator farm income increased by 7.3% a year. Das et al. (2017) discovered a U-shaped relationship between farm size and farm income, suggesting that there is an optimal farm size for maximizing income, and an inverted U-shaped relationship is found between farm income and farm and off farm diversification indicating that there is an optimal level of diversification beyond which income may decline.

Dev (2020) discussed in his paper that in India while the farm laws offer farmers more choices and potential for better prices, uncertainties persist. Addressing imperfections, developing marketing infrastructure and shifting focus from cereal-centric policies to diversified agriculture are crucial for success, aiming to achieve higher agricultural growth and increased farmers' income.

Singh (2020) in his findings suggest that neoliberal reforms and open economic policies have not translated into improved agricultural development or enhanced food security in India, but rather have exacerbated existing challenges and inequalities.

Kumar et al (2021) investigates the major factors affecting the performance of agriculture sector in India by using ARDL approach. There study concludes that certified seeds, fertilizers'consumption, net irrigated area and pesticide have positive effect on agricultural GDP in the long run

3. Data and Methodology

The research work is based on the secondary data obtained from different sources like, Ministry of Agriculture, the Directorate of Economics and statistics, and Reserve Bank of India, Mumbai. For the research work the annual time series data on Agriculture component of GDP at constant prices, export, import, fertilizer consumption and yield have been taken for the time period from 1991 to 2001.

For any meaningful regression model, variable should be stationary because the regression analysis based on non stationary variables may give spurious results. Order of the integration of variables helps to select the appropriate model in the time series. Therefore, we have conducted the stationarity test to establish the order of integration. The study uses Phillips-Perron and KPSS along with Augmented Dickey Fuller (ADF) test to measure unit root. Although ADF test is most widely used unit root test, PP test is considered more robust for the presence of autocorrelation and heteroscedasticity.

If all the variables are stationary at level 1 that is I(I), it implies that they have unit root and are non stationary. In this case, it is generally recommended to use a cointegration analysis or error correction model (ECM) to account for non stationarity of the variables. Cointegration analysis helps identify long term relationship among variables and the ECM allows modeling short term dynamics and adjusting for any deviation from the long term equilibrium.

The most commonly used model for such cases are Engle-Granger two step cointegration test, the Johnsen cointegration test and ARDL Bound test. These test help to determine if there is stable long-term relationship among I(I) variables, and if so an ECM can be constructed to study their short term dynamics. This study uses ARDL model to examine the relationship between farmers income and export, import, fertilizer consumption and yield .The ARDL approach is flexible and widely used method for modeling relationship among nonstationary time series data.

For examining the relationship among the agricultural output and various inputs the following regression model has been specified and estimated.

$$lnAGDP = \alpha_0 + \beta_1 lnEX + \beta_2 lnIM + \beta_3 lnFTZ + \beta_4 lnYLD + \varepsilon_t \quad (1)$$

In the above equation, the dependent variable (AGDP) represents Agriculture component of GDP.EX stands for the agricultural export and IM is agricultural import.FTZ indicates total fertilizer consumption and YLD is yield.

Further, we estimate the equation (2) for ARDL bounds test Proposed by Pesaaran, Shin and Smith (2001). The study assesses the long run relationship between Agricultural GDP, Export, Import, Fertilizer and Yield. As in our study our dependent variable is I(l), we have estimated the equation two for bounds test cointegration.

$$\Delta lnAGDP = \alpha_0 + \sum_{i=1}^{n_1} \alpha_{1i}\, \Delta lnEX + \sum_{i=1}^{n_2} \alpha_{2i}\, \Delta lnIM + \sum_{I=1}^{n_3} \alpha_{3i}\, \Delta lnFTZ + \sum_{i=1}^{n_4} \alpha_{4i}\, \Delta lnYLD + \beta_1 lnEX + \beta_2 lnIM + \beta_3 lnFTZ + \beta_4 lnYLD + \mu_t \quad (2)$$

F statistic obtained from the regressing above equation is compared with critical value obtain from Pesaran et al (2001) if the value of F statistic is greater than the upper Bound we reject the null hypothesis of no cointegration, and the value of F statistic is smaller than the critical value of the lower bound I(0), there is no cointegration. After confirming the existence of cointegration among the variables based on the bounds test we regress ARDL restricted error correction model as given in equation (3) below.

$$\Delta lnAGDP = \alpha_0 + \sum_{i=1}^{n_1} \alpha_{1i}\, \Delta lnEX + \sum_{i=1}^{n_2} \alpha_{2i}\, \Delta lnIM + \sum_{I=1}^{n_3} \alpha_{3i}\, \Delta lnFTZ + \sum_{i=1}^{n_4} \alpha_{4i}\, \Delta lnYLD + \theta ECT_{t-1} + \mu_t \quad (3)$$

The coefficient of error correction term θ shows the speed of adjustment towards the long run equilibrium and remaining coefficient provides short run dynamics.

4. Results and Discussions

4.1.Descriptive Analysis

Figure1. Shows the trend of AGDP, over the past three decades, the Agricultural Gross Domestic Product (GDP) in India has shown both positive and negative trend. In the early

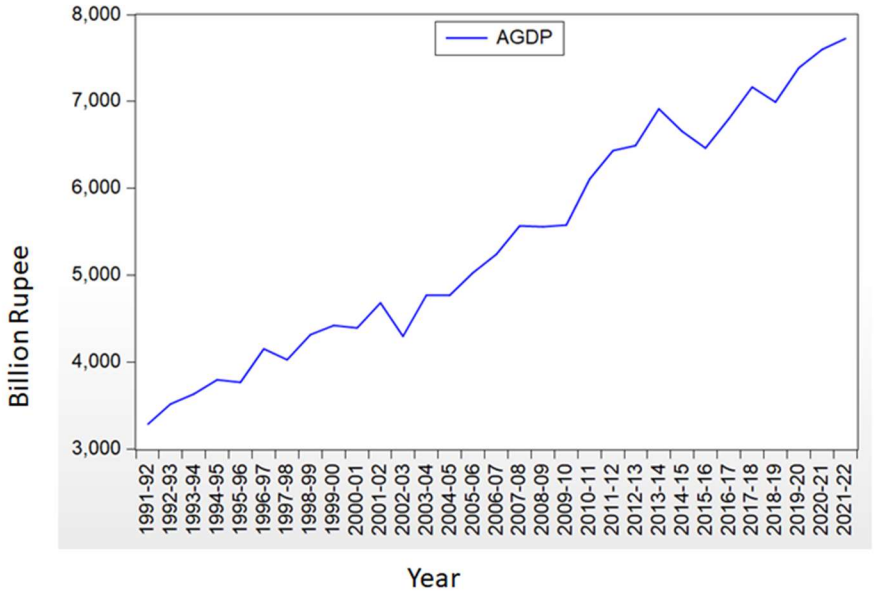

Figure 1. Trend of AGDP

1990s, India faced significant economic reforms aimed at liberalizing various sectors including agriculture. This period witnessed moderate growth in agricultural GDP as the sector started to adapt to new policies and technologies. During 2000 – 2010 the agricultural sector in India saw mixed growth. Factors such as fluctuations in monsoon rains, increased use of technology in farming practices, and government initiatives like the National Agriculture Policy

influenced agricultural GDP growth. Overall, the growth rate was relatively stable but not very high.

The agricultural GDP growth during 2010 – 2020 was somewhat volatile. There were periods of good growth driven by favorable monsoon rains, increased government spending on agricultural infrastructure, and the introduction of schemes like the Pradhan Mantri Kisan Samman Nidhi (PM-KISAN). However, challenges such as agrarian distress, water scarcity, and price fluctuations persisted, impacting overall growth.

The agricultural sector faced significant challenges and transformations during the early years of 2020s, including the COVID-19 pandemic. Despite disruptions caused by the pandemic, the agricultural sector demonstrated resilience, with the government implementing various measures to support farmers and ensure food security.

India embarked on economic reforms in 1991 that liberalized its economy, including the agricultural sector. This period witnessed a gradual increase in agricultural exports as the country started to engage more actively in international trade. Key agricultural commodities exported during this time included rice, wheat, spices, tea, and cotton.

Figure2. shows the trend of Agricultural Export, after 2010 India's agricultural exports saw significant growth in commodities included rice, buffalo meat, spices, fruits, vegetables, and processed food products. The government introduced schemes like the Agricultural Export Policy 2018 to further boost agricultural exports. The COVID-19 pandemic disrupted global trade patterns and supply chains, leading to fluctuations in export volumes and prices. However, India's agricultural exports showed resilience, with certain commodities witnessing increased demand in international markets. The government implemented measures to support agricultural exporters and mitigate the impact of the pandemic on trade.

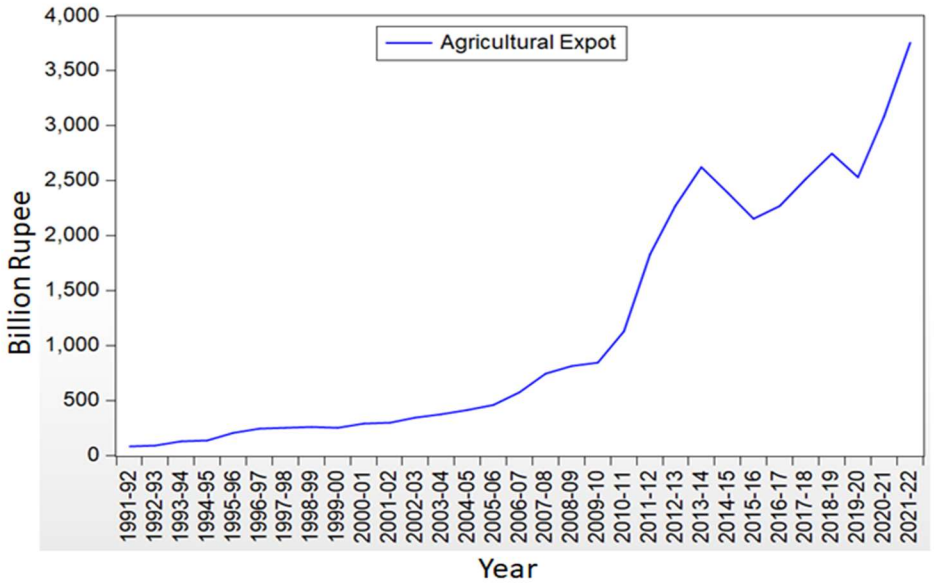

Figure 2. Trend of Agricultural Export

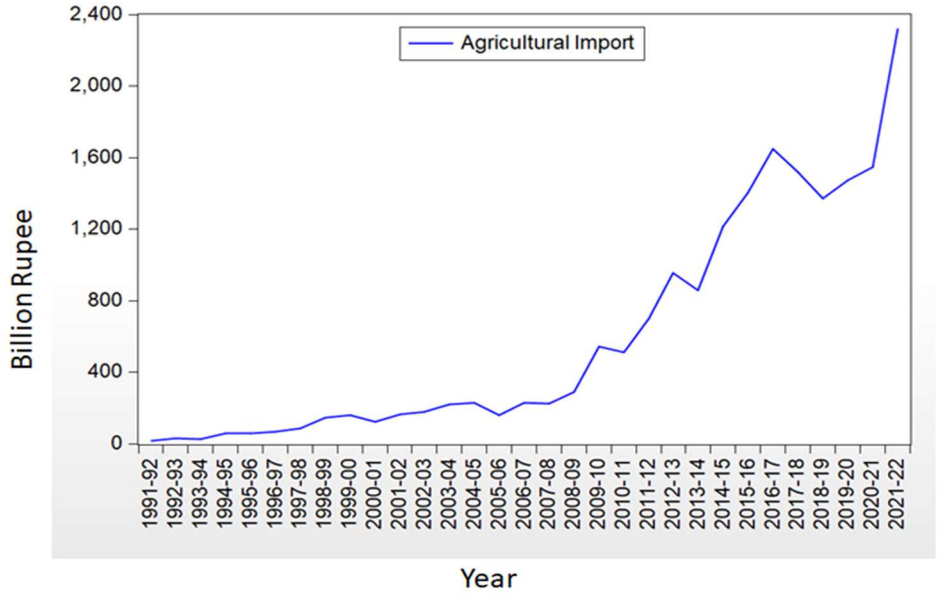

Figure 3. Trend of Agricultural Imports

In the early 1990s, the pattern of agricultural imports underwent significant changes, influenced by shifts in policies, consumer preferences, production capabilities, and global trade dynamics. The general trend over the last 30 years has been one of increasing agricultural imports in India as shown in figure 3.

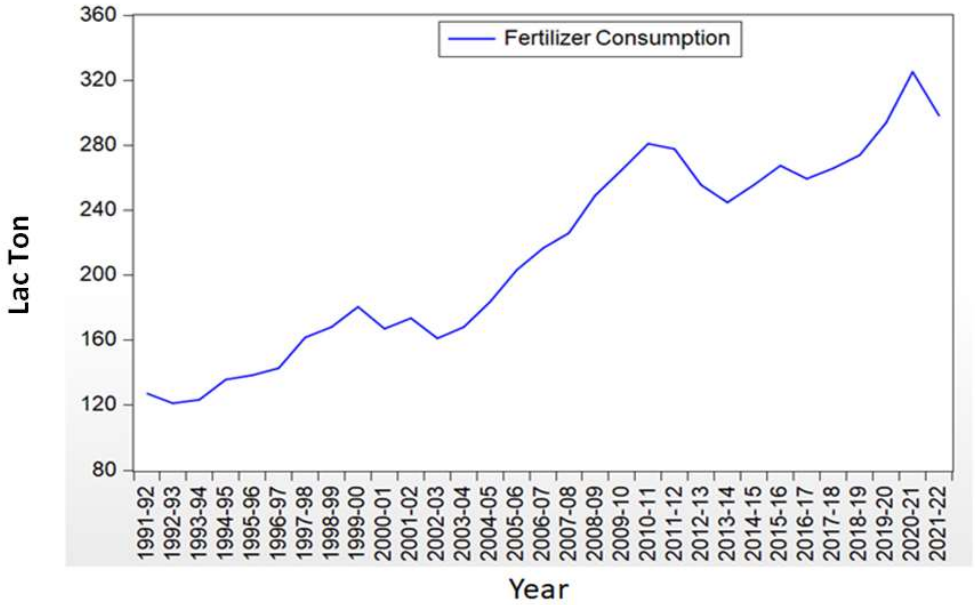

Figure 4. Trend of Fertilizer Consumption

Fertilizer consumption in India has witnessed significant growth due to various factors such as increasing population, expanding agricultural practices, government subsidies, and the adoption of modern farming techniques. Over the past thirty years fertilizer consumption in India has generally trended upwards as shown in figure 4.

Major cereal crops such as rice, wheat, and maize are crucial components of India's food security and agricultural economy. The trend of Yield has shown in figure 5, during 1990s, cereal yields in India experienced moderate growth. The Green Revolution, which began in the 1960s and 1970s, continued to have a significant impact on cereal production during the 1990s. The adoption of high-yielding crop varieties, along with the use of fertilizers, irrigation, and other modern agricultural practices, contributed to yield increases.

India saw a further increase in cereal yields during the 2000s. Government initiatives, such as subsidies for fertilizers, improved access to credit for farmers, and investments in agricultural infrastructure, helped sustain yield growth. Additionally, advancements in

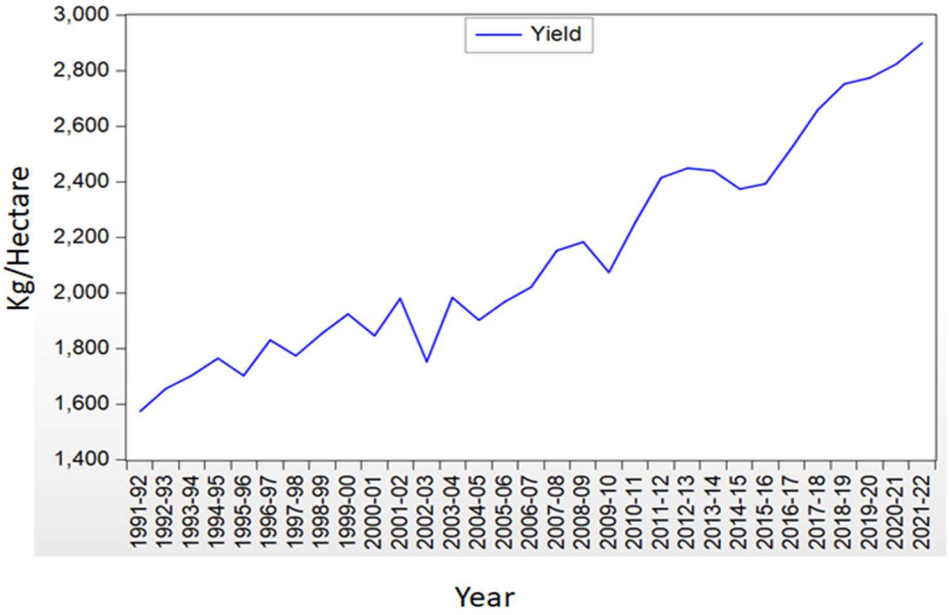

Figure 5. Trend of Yield

agricultural technology and research played a role in boosting productivity. The growth in cereal yields continued during 2010-2020 at a slower pace compared to previous decades. Factors such as climate change, land degradation, and water scarcity posed challenges to agricultural productivity. However, efforts to promote sustainable agricultural practices, including the adoption of precision farming techniques and the use of drought-resistant crop varieties, helped mitigate some of these challenges.

4.2.Econometric Results

4.2.1. Unit Root Test

The Augmented Dicky Fuller Test (ADF) and Phillips Perron (PP) test were used to check the stationarity of the time series data. We have used the ADF and PP tests to check the stationarity of our time series data, examining both levels and first differences. Eviews software has been utilized for this task. The results of the test are reported in the table 1.Based on the results, it is evident that all variables used in the study are stationary at the first difference I(I) and non-stationary at level I(0), according to both the ADF and PP tests. With this information, we have used ARDL to investigate relationships among different variables in the study.

4.2.2. Bounds Test for Cointegration

The ARDL Bound Test, is employed to determine the presence of long-run relationships between two or more variables. This step is necessary to confirm the existence of long-run relationships. The selection of ARDL (2,0,2,2,0) was done using the Akaike Information Criteria (AIC), which is a measure for lag length selection. This selection is done automatically and helps in choosing the most suitable lag lengths based on likelihood considerations. Calculation reveals that the F statistic value is 23.70200 , which exceeds the upper bound critical value at all significance levels. This implies that there is a long-run relationship between the variables in the model.

Table 1: Different Unit Root Test Results

Variable	ADF		PP	
	level	First Difference	level	First Difference
AGDP	-0.91415	-9.206681	-1.2600	-9.432532
	(0.7691)	(0.0000)***	(0.6346)	(0.0000)***
EX	-1.0308	-3.9482	-1.114958	-3.833078
	(0.7285)	(0.0052)***	(0.6966)	(0.0069)***
IM	-0.701163	-1.942669	-1.837684	-7.960116
	(0.8281)	(0.0515)**	(0.3559)	(0.0000)***
FTZ	-0.995100	-4.493620	-0.997600	-4.436147
	(0.7420)	(0.0013)***	(0.7412)	(0.0015)***
YLD	1.029053	-9.704511	0.047622	-19.84993
	(0.9956)	(0.00000)***	(0.9558)	(0.0001)***

Notes: P value is denoted in parenthesis

** and *** denotes rejection of null at 5 percent and 1 percent significance level respectively

Table 2: ARDL Bound Test Cointegration Results

Test Statistic	Value	Signif.	Lower Bound	Upper Bound
F-statistic	23.70200	10%	2.525	3.09
k	4	5%	3.058	3.49

1%	4.28	5.84

4.2.3. Long Run Coefficient

After confirming the cointegration among the variables through the Bound Test, we will now analyze the long-run determinants of Agricultural GDP. The results indicate that in the long run, agricultural output is positively influenced by exports, fertilizer use, and yield. Imports do not have a significant long-run impact.

Table 3: Long Run Relationship among Variables (ARDL Bound)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.642191	1.716785	5.033939	0.0001
LN_AGDP(-1)	-1.076991	0.154996	-6.948508	0.0000
LN_EXPORT	0.095001	0.028731	3.306525	0.0039
LN_IMPORT(-1)	0.010687	0.018094	0.590624	0.5621
LN_FERTILIZER(-1)	0.267970	0.058688	4.566006	0.0002
LN_YIELD	0.387987	0.086453	4.487863	0.0003

4.2.4. Short Run Coefficient

The short-run dynamic model, represented by equation 3, has been estimated, and its results are reported in the in the table 4. The ECM results indicate significant short-term relationships between agricultural output and the lagged differences of imports and fertilizer use. The error correction term is highly significant, suggesting that any deviation from the long-term equilibrium is corrected quickly in the next period.

4.2.5. Diagnostic Tests for ARDL Model

In conclusion, diagnostic examinations for the ARDL model, including autocorrelation, normality, and stability tests, were conducted, and the results suggested that the estimated model is appropriate. Table 5 illustrates that there is no indication of serial autocorrelation or heteroscedasticity. The Jarque-Bera test verified that the error terms conform to a normal distribution, and Ramsey's RESET test supported the correct specification of the functional form.

Table 4: Short Run Relationship among Variables (ARDL-ECM)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_AGRI(-1))	-0.128120	0.067632	-1.894365	0.0744
D(LN_IMPORT)	-0.020021	0.011921	-1.679448	0.1103
D(LN_IMPORT(-1))	-0.032523	0.011881	-2.737291	0.0135
D(LN_FERTILIZER)	0.225583	0.052246	4.317742	0.0004
D(LN_FERTILIZER(-1))	-0.137095	0.056989	-2.405653	0.0271

CointEq(-1)*	-1.076991	0.079894	-13.48018	0.0000

Table 5: Residual Robustness

Diagnostic tests	Null Hypothesis	Statistics	Probability	Decision
SerialCorrelation (Breusch-Godfrey Test)	No serial correlation	0.6420	0.43	Accept Null Hypothesis
Heteroskedasticity (White Test)	Homoscedastic	0.9922	0.52	Accept Null Hypothesis
Normalitiy (Jarque-Bera Test)	Normally distributed	0.1640	0.92	Accept Null Hypothesis
Model Specification (Ramsey Reset Test)	Functional form is correctly specified	1.4941	0.17	Accept Null Hypothesis

The stability of the model is validate with the help of CUSUM test, as shown in figures 6 and 7.

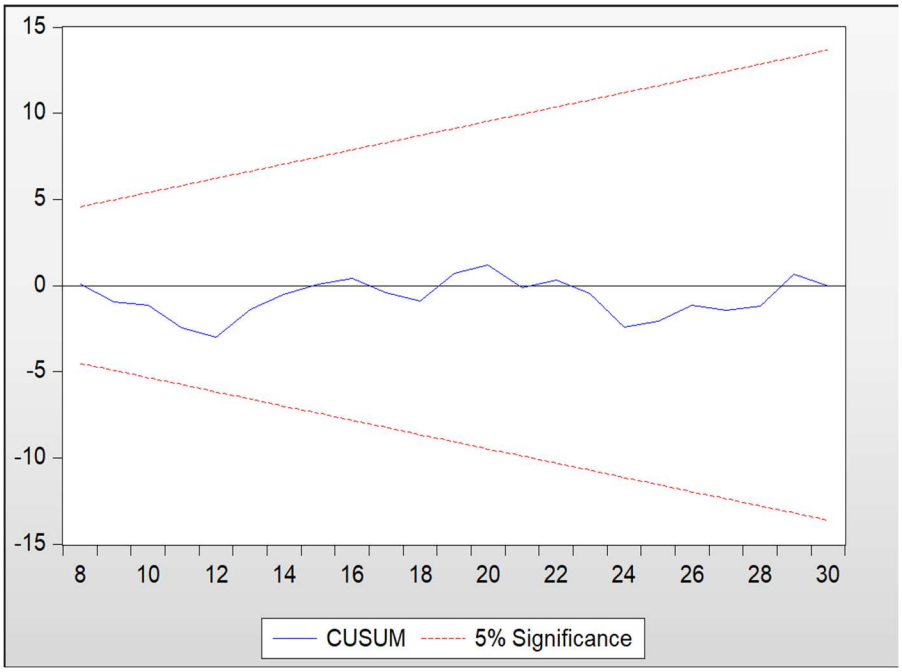

Figure 6. CUSUM Test for Stability

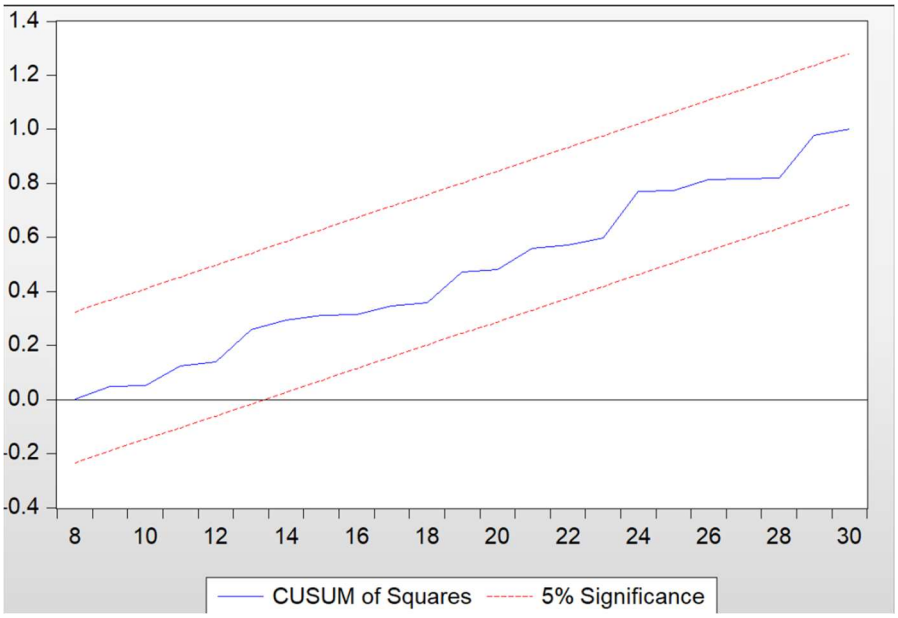

Figure 7. CUSUM Square for Stability

5. Conclusion

In order to understand the impact of trade liberalization on farm's income, this study examined the relationship between farm income and agricultural exports in India during the period of trade liberalization (1991-2021) using the ARDL approach. The ARDL Bound test confirmed the presence of a long-run relationship between farm income and agricultural exports in India. This suggests that changes in agricultural exports have a sustained impact on farm income over time. In the short run, the study identified that lagged differences of Imports and fertilizer use significantly affect farm income.

The results indicate that agricultural exports have a positive and significant effect on farm income in the long run. This underscores the importance of international trade in contributing to the economic well-being of farmers in India. Diagnostic tests, including the CUSUM test, demonstrated the stability of the model. This indicates that the relationships identified in the study are robust and reliable for analyzing the dynamics between agricultural exports and farm income. The study utilized the agriculture component of Gross Domestic Product (GDP) at constant prices as a proxy for farm income. While this approach has limitations, it provides valuable insights into the trends and relationships between agricultural output and farmers' earnings. While this approach has limitations, it provides valuable insights into the relationships between agricultural exports and farm income

DATA AVAILABILITY STATEMENT

The data set used in the manuscript has been obtained from the websites listed below.

1. https://desagri.gov.in/document-report-category/agriculture-statistics-at-a-glance/
2. https://www.worldbank.org/

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