THE JOURNAL OF RESEARCH REVIEW

P-ISSN: 3006-2632 | E-ISSN: 3006-2640
Vol. 2. No. 02 (April-June) 2025 | Page 338-351

Determinants of Food Security in Developing Countries of Asia

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Abstract: *This research explores the Determinant of Food Security in Developing Countries of Asia. It reviews the impact of the factors include population density, carbon emission, cultivation area, trade openness and research & development on determinants of Food Security in developing countries of Asia which provides the basis for this study. Data for the analysis was gathered from the World Development Indicator and Food and Agriculture Organization for the years 2009 to 2022. The article compares two regression models to analyze the data, including the Fixed Effect Model, and Random Effect Models. The article compares the fixed Random Effect Model and The Hausman Test have been used to interpret the results in this article. The Hausman Test have been used to predict that Random Effect is better than the Fixed Effect. The dimension - food availability is negatively affected by Cultivation Area, Carbon Emissions and Trade Openness and positively affected by population density and Research & Development. And the dimension- food accessibility is negatively affected by Carbon Emissions and Trade Openness and positively affected by Cultivation Area, Population density and Research & development in developing countries of Asia.*

Keywords: Food security, south asia countries, RE and FE, Population density, Carbon emission and trade openness.

Introduction

Ending of hunger is an analytical part of the Sustainable Development Goals (SDGs. There are many parts of world facings same problem. And there is not a solution how to solve this problem. According to "FAO data" for 2017 and 2018, 821 million people or more than were undernourished in 2017. In 2017, the range of undernourished peoples in sub-Saharan Africa 23.2%, 2.5% points higher than in 2014. in hunger. As well as in 2018, 22 percent of children under five, or 149 million children, suffered from at least one form of asthma. (2018) noted that the 2019 Global Health Index (GHI). With more countries on the list, Asia exhibits a variety of situations. First off, ten nations are classified as serious, with Yemen remaining in the worst situation under the alarming category.

The prevailing model of agricultural expansion and intensification, which depends on using more capital inputs like pesticides and fertilizer, is being criticized for being insufficient (IAASTD, 2009). Two of the model's main issues are that it produces unacceptably high levels of environmental harm and has issues with economic viability (Tilman et al., 2002; IAASTD, 2009). As a result, alternative intensification models and especially the promise of sustainable land management technologies are

receiving more attention. By boosting soil fertility and structure, preserving soil and water, increasing the richness and activity of soil fauna, and fortifying the processes of elemental cycle, such methods can assist farmers on a private basis. According to the literature, these advantages may result in more stable and productive agricultural production systems (Lal, 1997a; World Bank, 2006; Woodfine, 2009; Pretty, 2008; 2011). As a result, they present a potentially significant way to raise food security and agricultural returns while also lessening the vulnerability of farming systems.

This region's nations have all had strong economic growth and improvements in human development indicators, which have significantly decreased levels of poverty and malnutrition. Still, it is home to almost half of the world's underprivileged and undernourished people (Bhiswajit et al., 2013).

With an estimated 1.7 billion people living there, South Asia has a significant demand on its comparatively meager supply of natural and agricultural resources. Given that only 14% of the world's land is arable, it must feed 25% of the world's people (Bay & Jamaica, 2013). Despite the fact that modern, cutting-edge technologies have helped humanity mostly avoid the realization of Malthus's prediction, increasing rates of hunger and malnutrition are still a stark reality, particularly in resource-poor nations like South Asia, which is home to 40% of the world's poor and roughly half of its malnourished population (Rangaswamy & Ramachandra, 2013). The majority of nations in the region have embarrassingly low government spending on agricultural R&D, while having an agri-based economy that accounts for approximately 22% of the GDP. Poor agricultural infrastructure, inefficient resource use, and insufficient funding for agricultural R&D exacerbate an already dire condition of hunger and food insecurity. The World Bank estimates that in order for South Asia to meet its development objectives, there is an enormous $2.5 trillion infrastructure gap. Even while South Asia currently has more scientific and technical R&D talent than ever before, the region still has a long way to go in terms of improving the prevalence of hunger and malnutrition.

Based on the most recent estimates, it is expected that, globally, between 720 million and 811 million people experienced hunger in 2020, and nearly 2.37 billion did not consume enough food. Taking into account the median value, this represents an increase of 161 million and 320 million people over 2019 and 2020, respectively (Food and Agriculture Organization of the United Nations, 2021). All of the world's regions will be impacted simultaneously. For instance, in Central Asia, where there were 2.6 million hungry people in 2020 18.18% increase from 2019 & have been one of the regions with the fastest growth rates (Food and Agriculture Organization of the United Nations, 2021). Five Central Asian nations: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan saw a series of changes from centrally planned to market-oriented economies following their independence from the Soviet Union (Babu, S.C.; Tashmatov, 1999).

The region's agriculture has been affected by the institutional and governance changes that Central Asian nations have undergone recently, but they have also made important progress in raising their own food production (Lioubimtseva, 2019; Babu, S.C.; Akramov, 2021). But a number of geopolitical, socioeconomic, and environmental issues continue to pose a threat to the region's food security, include a lack of institutional support for agricultural advancement, inadequate infrastructure and efficient transportation, a lack of research and farmer support, a lack of power for the development of evidence-based policies, small-scale land use farming, and land degradation increased by climate change (Winnen et al., 2017; Samad G et al., 2021; Burkitbayeva et al., 2021). Contributing to the low agricultural productivity that keeps domestic food demand from being fully met, particularly in Tajikistan and Kyrgyzstan, both of which rely heavily on the import of essential food items (World Food Programme, 2021).

The prices of food would be low if there was an adequate supply, and an excessive supply would result in an excessive outreach everywhere. Therefore, food security requires food availability, and increasing food production is advised to ensure food availability (Maxwell & Slater, 2003). Since supply and demand are inversely correlated, food would be produced in sufficient quantities to be available to

everyone for a reasonable price everywhere. Moreover, using high-quality ingredients helps ensure the food's safety and health. Thus, it can be said that one of the main reasons for food insecurity is low production. A major factor in the rise in wheat production can be credit. Because credit is readily available, farmers will buy high-quality inputs and cultivate wheat on schedule. As a consequence, production will rise, which will further reduce food insecurity. Therefore, food security can be guaranteed through the availability of agricultural credit.

The world's problems with environmental degradation are getting worse as a result of human activities like population expansion, industrialization, and other different farming methods (Charfeddine L, 2017). Pakistan is ranked eighth globally among countries affected by CO2 and second most in South Asia (Eckstein D. et al., 2017). The use of gas and oil-based energy, which makes up 80% of the nation's total energy output, is a major contributor to this major climate disruption. In addition, transportation, industry, and urbanization have all contributed to a recent sharp increase in energy demand (Alam M.M et al., 2016). In addition to the sources mentioned above, other factors are also accountable for the ecological issues like cultivation and the availability of food.

1.2 Statement of the problem:

As hunger is the major issue in developing Asian countries. Uncertain situation can affect the supply of food which is essential for meeting the nutritional demands of a population in low income Asian nations with regard to the influence on food security. Uneven states have an impact on the factors of surrounding the proper promotion of food supply to the most vulnerable communities.

1.3 Objectives of study:

- To check in low income Asian countries, the efficacy and efficiency of these repressors (Cultivation Area, Environmental Degradation CO2, Research & Development, Trade Openness and Population Density) affect a number of factors of food security.
- To Develop the general prosperity and healthful status of the populace.

1.4 Organization of study:

First we will discuss how the determinants affect the dimensions of food security in low income countries of Asia. After that we will take into account the literature review on food security. This is the way the rest of the paper is organized. The literature of earlier works is reviewed in the "Literature Review" part and the study methodology including model specification and estimating technique, is presented in the "Methodology" section. The "Result" part reports the empirical findings and the "Conclusion" section brings the study to a close.

2. Literature review:

Malthus (1798) is credited with pioneering work in this field, which links population growth and food security. According to the Malthusian theory, there are food shortages because there are more people than there is food available, which exacerbates long-term food insecurity (Malthus, 1798). Populations tend to grow much faster than human-produced goods like food and agricultural products.

Food self-sufficiency or food self-reliance are common indicators used to analyze food security (2013). Chikhuri (2013); Tanaka (2021) postulates that while, self-reliance necessitates a wider range of supply sources, including imports, self-sufficiency depends primarily on domestic production of food rather than imports. The system of global food supply has become increasingly dependent on international food trade in recent years (Zhang, C et al., 2021).

According to estimates, one in six people on the entire globe currently get almost all of their food from international trade; by 2050, that number could reach 50% (DG Okonju-Iweala, 2021). The World Bank and WTO continually promote the idea that access to international markets is essential for the development of their clients, particularly developing nations. They are also taking more and more

attention to the elimination of trade barriers that developed nations primarily impose on developing nations (Schillhorn van Veen, 2005).

Tariffs have not solely made it possible for consumers to benefit from prolonged periods of low prices, but they have also increased the spread of global price fluctuation and exposed them to brief price spikes that are likely to be short in contrast to prolonged periods of low prices (Food and Agriculture Organization of the United Nations). However, depending on a country's level of trade openness, involuntary gains & losses brought about by supply-side factors like varying agricultural productivity, violent conflict, and war, as well as natural disasters like drought and prohibitions, can increase or decrease and risk food security (Paarlberg, R. 2000).

Naqvi et al. (2016) found that due to the high margin of profit that comes from high production which is made possible by the use of high-quality inputs, credit encourages farmers to grow more. Expanded credit results are possible if the collateral's condition is eliminated since some farmers are hesitant to apply for loans from organizations or banks due to the state of their collateral (Chandio et al., 2017). It will improve food security in addition to raising food production (Iftikhar & Mahmood, 2017).

Asghar et al. (2015) conclude that one of the main obstacles poor farmers face is credit. Food security in the nation gets worse by low food production. The concept of food security places a strong emphasis on the accessibility and cost of food, which is achievable if credit restrictions are lowered. Therefore, if production increases, a sufficient amount of food will be available. It will also result in lower prices and give people more purchasing power. Therefore, both hunger and poverty are issues that can be resolved.

Alston et al. (2000) conducted a meta-analysis of 289 papers and found that the average returns on R&D in agriculture were 82% (mean) and 44% (median). Hurley et al. (2014) has conducted a reexamination of the rates of return in 372 distinct studies spanning the years 1958 to 2011, confirming the encouraging evidence of R&D spending despite the lower returns than previously recommended.

Similar to this, Mogues et al. (2012) provided updated data from developing-nation case studies. They draw the conclusion that there is substantial evidence from the literature on public investments to support the importance of research and extension. Following that, they highlight three findings: i) research and development (R&D) yields higher returns when it comes to shorter production cycles, such field crops. ii) Research and development (R&D) has been linked to higher returns than agricultural extension; iii) higher returns have been observed in R&D in Asia.

Coderoni and Esposti (2019) examine the long-term relationship between agriculture and CO2 emissions in Italy. The results showed that agriculture has a significant effect on CO2. In a similar vein, (Stolze, 2000) said that agriculture had a significant positive impact on the environment when the writers used organic structure. It is well known that environmental conditions like heat, humidity, and flooding have a significant effect on agriculture. Thus, through the direct and indirect use of fuel and energy, agriculture produces CO2, which has a significant negative impact on the environment (Reynolds, Waddington, 2015). The provision of natural life and increasing oxygen generation in the atmosphere through photosynthesis are examples of the beneficial effects of agriculture on the environment. On the other hand, the misuse of pesticides and chemical fertilizers is a cause of the bad consequences.

Between 1970 and 1990, Jenkins & Scanlan (2011) studied food security in developing nations. Six key difficulties with food security have been found by this research: urban bias, neo- Malthusian population pressure, economic dependency, modernization, ecological evolutionary processes, and militarism. Food security will be achieved and poverty, hunger, and undernourishment will be decreased via efficiency in development and economic growth, particularly in dry-land developing nations. Numerous studies have demonstrated that food security will benefit from efficient economic growth. Few studies have addressed the potential direct or indirect effects of food security on economic growth.

Trimmer (2000) states that food security has been assessed at the macro level in a few earlier studies, policy makers have established micro-level requirements for food security based on this research, including household access to food in local markets and domestic resources. Economic growth appears to be less affected by food security. However, in light of food security tactics, this study has concentrated primarily on Asia with respect to trade policy, the rate of income distribution, and food price volatility in the global rice market, all of which have an impact on food security and economic growth. The aforementioned authors used a lagged panel, also known as a conditional change model, which is thought to be the most effective way to capture structural trends that exhibit a significant degree of stability across time.

Chikhuri (2013) states that traditionally, food security has been examined in terms of self- sufficiency or self-reliance. While self-reliance necessitates a wider range of supply sources, including imports, self-sufficiency requires domestic food consumption to primarily rely on domestic production rather than imports. The global food supply has become increasingly dependent on international food trade in recent years, and an increasing number of nations have realized how important trade openness is to maintaining a sufficient level of food security as a result of population expansion, climate change, and other reasons, trade is becoming more and more important in ensuring food security.

Fusco et al.(2020) states that trade openness has decreased food self-sufficiency and increased reliance on imports which is expected to make the food supply less secure, especially in light of the fact that agriculture's intrinsic function in maintaining ecological and natural resources makes free trade incompatible with agriculture resources at the national and international levels, as well as the unfair playing field brought about by the disparate ways that agriculture has been seen, protected, and taxed in various nations.

3.Model and Methodology

3.1 Introduction

Our study's primary focus is on the Determinants of Food Security in Developing Countries of Asia. Thus, the foundation of this model is a framework designed to examine the relationship between factors influencing food security. The results of our analysis will also be empirically analyzed using a few economic variables. The data from the Asian Developing Countries will be estimated over a range of time periods and used in this model.

3.2 Theoretical Framework and Model Specification

This model's framework entails determining the linear relationship between the system's or model's endogenous variables and their dependence on exogenous factors that are external to it. A number of factors affect agricultural productivity are: arable land, Co2, R&D, trade openness, population density. There are advantages and disadvantages to these factors for agricultural productivity. Its detrimental effects on agricultural output are mostly known from underdeveloped nations. Through intense land use and soil nutrient loss, biological, physical, and socioeconomic factors indirectly impact crop yield and food security. Furthermore, as 75% of global agricultural output is rain-fed, a decrease in rainfall has a direct impact on crop yield and food security (M.M. Islam & Al Mamun, 2020; Lin et al., 2017).

Mathematical form of our model is:

FS = f (CA, CO2, R&D, TO, PD)

Where FS (Food Security) is our endogenous variable and CA (Cultivation Area), CO2 (Carbon Dioxide), R&D (Research & Development), TO (Trade Openness), PD (Population Density) are our exogenous variables.

Econometric model:

$FSavit = \alpha + \beta 1CAit + \beta 2CO2it + \beta 3R\&Dit + \beta 4TOit + \beta 5PDit + Ɛit$ $FSacit = \alpha + \beta 1CAit + \beta 2CO2it + \beta 3R\&Dit + \beta 4TOit + \beta 5PDit + Ɛit$

Here, FS→ Food Security, av→ Food Availability, ac→ Food Accessibility which are our dependent variables. α and β are coefficients, CA→ Cultivation Area, CO2→ Carbon Dioxide, R&D→ Research & Development, TO→ Trade Openness, PD→ Population Density which are our independent variables.

The model uses legal data, where t is the time series mean and i is the number of cross-sections.

The residual, often known as the error term, is denoted by ε and represents the sum of all unknown factors influencing the connection between the independent and dependent variables.

Regression coefficients α0, β1, β2, β3, β4, β5, β6 indicate the amount that a change in the independent variable will impact the dependent variable (Zahid, F et al.,2022).

3.3 Variables Description and Data Sources:

For the empirical analysis, we will use the yearly secondary penal statistics of 15 Developing countries of Asia from 2009 to 2022.Accessibility (Fac) are taken as the dependent variables and Cultivation Area (CA), Carbon Dioxide (CO2), Research & Development (R&D), Trade Openness (TO), Population Density (PD) which are our independent variables.

Table below shows the variables, descriptive definition and data source of the dependent and independent variables, which will be used in this study. Here Food Availability (Fav), Food

Sr No.	Variables and symbols	Description	Data Source
1.	Food Availability(FAV)	Food production indices, relative level of aggregate volume of agricultural production	FAO
2.	Food Accessibility(FAC)	Consumer price indices, change between the current and references periods of average g/s basket	FAO
3.	Cultivation Area(CA)	Percentage of land area	WDI
4.	Carbon Emission(CE)	CO2 emission from gaseous fuel consumption(% of total)	WDI
5.	Research & Development(R&D)	Patent applications, non-residence + patent applications, residential	WDI
6.	Trade Openness(TO)	Ratio of exports plus imports over GDP	WDI
7.	Population Density(PD)	Person per sq.km	WDI

Note: (WDI), (FAO)

3.4 Econometric Methodology:

With regard to the index's measurement, this study builds it by averaging the FAO's two parts of food security: the indexes of food exist, easily get. We make use of a panel covering 15 developing nations between 2009 and 2022. The datasets on dependent and independent variables are obtained for the current investigation from a variety of data sources (Marti et al., 2014; World Bank;2018).

The World Bank's WDI and the FAO's FAOSTAT provided the majority of the data for this study. FAO reports in Rome and Italy in 2006 and 2003, Dithmer and Abdulai (2017) and Fusco et al. (2020) state that the following two categories of food security determinants were taken into consideration: the trade openness measure, as the first category, is the core independent variable.

The employment in agriculture, or the percentage of people of working age employed in farms sector overall, is a important indicator of the importance of agriculture. This information is derived from the WDI. Arable land per person is the primary component of the national resource endowment for agricultural production, and the WDI provides data on this. The ability to produce biomass is the most important aspect of agricultural land usage in order to maintain food production and adapt to cultural norms that support sustainable agricultural land management (Blum, W.E.H, 2013).

Cereal yield is measured using data from the WDI and is used as a stand-in for agricultural productivity. Food security in many developing nations still primarily depends on domestic agricultural production despite increased internationalization (Funk and Brown, 2009). Increasing agricultural productivity is one of the key strategies to increase domestic food availability and lower prices (Baldos and Hertel, 2014) and (Ayodeji et al., 2018). GDP growth data is derived from the WDI and is used to reflect cyclical swings in total output.

The WDI provides data on population increase, which is used to characterize population pressures on food security. Population pressures, as indicated by the fast pace of population expansion, invariably lead to rising global food needs and falling per capita food supply (Dithmer and Abdulai, 2017).

Natural disasters can have far-reaching negative effects on the agriculture sector beyond just physical harm. For example, they can reduce productivity and output, decrease agricultural commodity exports and increase food imports, upsetting the balance of payments and trade in the affected countries, and halt the growth and sustainable development of the agriculture sector FAO in Rome and Italy in 2015.

This panel data regression analysis will be performed using the Fixed effect model. When examining the effects of variables over time, we employ the fixed effect model (FE). FE's

functional form is

FS = f (CA, CO2, R&D, TO, PD)

The Housman test will be used to determine if the random effect or fixed effect model is more suited for our model. Under the Hausman Test, a model with random effects is the null hypothesis, and a fixed effect is the alternative hypothesis.

$FSavit = \alpha + \beta 1CAit + \beta 2CO2it + \beta 3PDit + \beta 4R\&Dit + \beta 5TOit + Єit$ $FSacit = \alpha + \beta 1CAit + \beta 2CO2it + \beta 3R\&Dit + \beta 4TOit + \beta 5PDit + Єit$

4. Analysis:

Analysis for Food Availability FE

To estimate the coefficients of the variables, we use STATA. Prior to applying the FE to the variables, we first ensure that the data is tightly balanced afterwards check it.

Regression results

fa	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
ca	2.092	1.678	1.25	.214	-1.218	5.402	
ce	-.605	.304	-1.99	.048	-1.204	-.005	**
pd	.279	.061	4.56	0	.159	.4	***
rd	0	0	2.26	.025	0	0	**
to	-.062	.086	-0.73	.469	-.231		.107
Constant	-3.02	31.818	-0.09	.924	-65.782	59.742	

Mean dependent var	99.932	SD dependent var	14.654
R-squared	0.268	Number of obs	210
F-test	13.888	Prob > F	0.000
Akaike crit. (AIC)	1653.501	Bayesian crit. (BIC)	1673.584

*** p<.01, ** p<.05, * p<.1

This regression results shows that our three coefficient variables (ca, ce and to) are insignificant and two coefficient variables (pd and rd) are significant in nature. Given that the Prob>F is likewise significant and less than 0.5, there is a strong likelihood that the model is a fixed effect model.

We will now estimate the Hausman hypothesis using the RE model. According to the Housman Test, a model with random effects is the null hypothesis, while a fixed effect is the alternative (Houseman, 1978).

RE

Random-effects GLS regression Number of obs = 210

Group variables: id Number of groups = 15

R-sq: within = 0.1784 Obs per group: min = 14 between = 0.0740 avg = 14.0

overall = 0.0265 max = 14

Wald chi2 (5) = 6.46

corr (u_i, x) = 0 (assumed) prob > chi2 = 0.2643

fa	**Coef.**	**Std. Err.**	**z**	**p> |z|**	**[95% Conf.**	**Interval]**
ca	.0963188	.1295791	0.74	0.457	-.1576516	.3502891
ce	-.153417	.0873146	-1.76	0.079	-.3245504	.0177163
pd	.0094068	.0084942	1.11	0.268	-.0072416	.0260552
rd	4.03e-06	4.51e-06	0.90	0.371	-4.80e-o6	.0000129

to	-.0001625	.0358943	-0.00	0.996	-.070514	.0701891
_cons	97.45165	4.180552	23.31	0.000	89.25792	105.6454
sigma_u	2.977645					
sigma_e	12.672569					
rho	.05232119					

cause the Z statistics is likewise highly insignificant, this illustrates the extremely irrelevant results. The model's RE status is shown by the prob>chi2=0.2643 value

Hausman:

Now use the Hausman test to decide between the FE and RE models that should be used.

The Hausman test's value is determined using the Chi-Square test. Based on the Chi-Square statistics, likelihood, and degree of freedom, it selects the FE or RE.

Following the storage of FE and RE, the STATA Hausman Test is run, with the following outcomes:

Mean dependent var	100.609	SD dependent var	23.541
Overall r-squared	0.015	Number of obs	210
Chi-square	3.047	Prob > chi2	0.693
R-squared within	0.271	R-squared between	0.000

*** p<.01, ** p<.05, * p<.1

Because the Z statistics is likewise highly insignificant, this illustrates the extremely irrelevant results. The model's RE status is shown by the prob>chi2=0.693 value

Hausman test

Now use the Hausman test to decide between the FE and RE models that should be used.

The Hausman test's value is determined using the Chi-Square test. Based on the Chi-Square statistics, likelihood, and degree of freedom, it selects the FE or RE.

Following the storage of FE and RE, the STATA Hausman Test is run, with the following outcomes:

Coefficients	b fe	B re	(b-B) Difference	sqrt (diag(V_b-V_B)) S.E.
ca ce rd to	5.298936 -1.060873 .0000319 -.3125406	-.0971065 -.1450718 2.29e-06 -.0057619	5.396042 -.9158008 -.0000296 -.3067787	2.475873 .4352763 .0000101 .1180608
pd	.5575368	.0140132	.5435236	.0899513

b = consistent under Ho and Ha; obtained from xtreg B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic chi2(4) = (b-B)'[(V_b-V_B) ^ (-1)] (b-B)

= 123.49

Prob>chi2 = 0.0000

The results of the Hausman test show that the Chi-square is extremely significant for FEM if the value is less than 0.05, or Prob>chi2 = 0.0000. Thus, the alternative hypothesis on the Hausman effect will be accepted and the null hypothesis will be rejected. This shows that the FE model is better than the random effect model.

Regression results:

fac	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Ca	5.299	2.481	2.14	.034	.405	10.193	**
Ce	-1.061	.449	-2.36	.019	-1.947	-.175	**
Rd	0	0	2.72	.007	0	0	***
To	-.313	.127	-2.47	.015	-.563	-.063	**
Pd	.558	.091	6.16	0	.379	.736	***
Constant	-116.058	47.039	-2.47	.015	-208.845	-23.272	**

Mean dependent var	100.609	SD dependent var	23.541
R-squared	0.411	Number of obs	210
F-test	26.551	Prob > F	0.000
Akaike crit. (AIC)	1817.699	Bayesian crit. (BIC)	1837.782

*** p<.01, ** p<.05, * p<.1

Interpretation:

In second model our first coefficient ca (cultivation area) has positive relation with dep var fa (food accessibility) and has significant t value. Next coefficient ce (carbon emission) has negative relation with dep var fa (food accessibility) but has insignificant t value. Now comes to third coefficient rd (research & development) has positive relation and also has significant t value. Next coefficient which is to (trade openness) has a negative relation and insignificant t value. Lastly, coefficient pd (population density) has a positive relation with dep var fa (food accessibility) and significant t value. Insignificant t value means there is no relationship between dependent & independent variables and significant t value means there is a strong relationship between dependent and independent variables.

5. Conclusion:

To be conclude, this paper investigates how Cultivation area, Trade Openness, Carbon emissions, Research & Development, and Population density effects the four dimensions of Food security in developing countries of Asia, Using Panel data from the year 2009 to 2022 by using estimation procedures the results from regression analysis shows that:

The dimension - food availability is negatively affected by Cultivation Area, Carbon Emissions and Trade Openness and positively affected by population density and Research & Development.

And the dimension- food accessibility is negatively affected by Carbon Emissions and Trade Openness and positively affected by Cultivation Area, Population density and Research & development in

developing countries of Asia.

6. Policy Recommendation:

A broad plan is required when variables like trade openness, carbon emissions, and cultivation area have a detrimental impact on food availability.

Set in place policies to control agricultural commodity trade, such as tariffs, quotas, and quality requirements, in order to protect regional food production and advance sustainable practices around the world.

Encouragement of efficient irrigation systems and the use of renewable energy sources can also help reduce emissions.

Promote biodiversity preservation and redevelopment of degraded areas, as these are crucial for preserving robust food systems and flourishing ecosystems.

When population density and research and development have a favorable impact on food availability, policymakers should take these aspects into consideration.

To provide farmers with the knowledge and abilities necessary to implement sustainable practices and adjust to shifting environmental conditions, offer education and training programs.

Encourage the implementation of cutting-edge technologies to increase food production efficiency while reducing environmental damage, such as biotechnology, sustainable aquaculture, and precision farming.

A planned approach is necessary when trade openness and carbon emissions have a negative impact on food accessibility.

Communities can decrease their reliance on long-distance food transportation, so cutting carbon emissions and improving food accessibility, by encouraging local food production and distribution networks.

Invest more in domestic agriculture to improve food self-sufficiency and lessen reliance on imported foods. This might entail giving farmer's financial support, technical help,

and subsidies in order to increase output, upgrade infrastructure, and encourage sustainable agricultural methods that ensure food security and accessibility.

When population density and cultivation area research and development have a favorable impact on food accessibility, policymakers should take these factors into consideration.

Policymakers can reduce the environmental impact of food production while improving food accessibility in densely populated areas by encouraging the implementation of these cutting-edge farming techniques.

The long-term availability of land for food agriculture and the promotion of food accessibility can be ensured by policymakers by shielding arable land from urban sprawl and development pressure.

Encourage farmers to invest in energy-efficient practices, renewable energy technologies, and environmentally friendly transportation networks by offering them incentives and support.

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