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RESEARCH ARTICLE

ANALYZING THE LONG-RUN DETERMINANTS OF RICE PRODUCTION IN NEPAL: EVIDENCE FROM AN ARDL APPROACH (1990–2019)

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Abstract

Nepal, an agricultural nation in South Asia, is characterized by its distinct topography: 35% mountains, 42% hills, and 23% Terai. This study investigates the key factors influencing Nepal's agricultural food production. Utilizing the Auto Regressive Distributed Lag (ARDL) model, it analyses data spanning 1990 to 2019, focusing on electricity generation, annual mean temperature, foreign exchange rate, and imports of agricultural food products as independent variables.The analysis reveals significant relationships. Electricity generation and the foreign exchange rate exhibit a positive impact on cereal production. Conversely, both cultivated area and annual mean temperature demonst rate a negative impact, posing risks to overall agricultural output in Nepal. These findings highlight critical sensitivities within the agricultu ral sector.Based on these relationships, the study forecasts agricultural food production up to the year 2060. These projections were developed using four distinct scenarios grounded in potential production growth rates. The long term outlook underscores the need for strategic planning A key recommendation emerges: policymakers should prioritize enhancing paddy (rice) production. The study strongly suggests this targeted focus offers substantial benefits. Increasing paddy output is projected to significantly reduce Nepal's trade losses related to agricult ural goods. Furthermore, this strategy is identified as a crucial driver for fostering broader national economic development. By concentrating efforts on this vital crop, Nepal can leverage its agricultural sector for greater economic stability and growth amidst its challenging geographi c constraints.

Introduction:-

The agricultural existence of Nepal depends heavily on rice since it functions as its fundamental food security ingredient for many millions of citizens. The agricultural sector of Nepal encounters difficulties because the nation becomes more dependent on imported agricultural items that negatively impact local rice production. Little research has investigated how agricultural imports affect Nepal's rice production although Joshi et al. (2016), Timsina et al. (2018) and other scholars investigated broader trade liberalization effects in developing countries. The long-term consequences of cheaper imported rice competition for local production and environmental sustainability of farming

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lands along with farmer incomes demand deeper scientific investigation according to research by Devkota (2020) and Adhikari (2021).

Data indicates agricultural imports introduce various impacts on domestic rice production in Nepal by possibly pushing out local farmers yet offering modern farming knowledge to their sector. Analysis of historical trends in production and import statistics alongside governmental policies will evaluate these effects according to the research. The analysis contains vital environmental importance because the dependency shifts in farming methods due to import exposure affect land utilization and water resource handling and agrochemical implementation. The identification of these dynamics enables policymakers to develop agricultural strategies which preserve ecological conservation goals while staying competitive in the trade market and maintaining production self-reliance.

Foreign trade performs a transformative function, affecting how domestic economic stability and growth are produced (Smutka et al., 2016). The integration of agriculture into the global economy is becoming more and more important. A point of political and economic convergence, international trade, especially trade in food, connects the economics of several nations (Maslova et al., 2019). Net food-importing developing nations are anticipated to be more negatively impacted by these price changes since food will consume a more even greater portion of their limited income (Aragie et al., 2016). Due to its larger population than any other region, Central and South Asia has a higher demand for food (Hoekstra & Hung, 2005). Valdés (2012) found that 35 low-income nations imported food on a net basis. The production of food for the expanding population takes up a significant portion of the earth's land area (Sandström et al., 2014).

It is impossible to overstate the value of imports and export to the growth and development of a country's economy because these two factors act as essential stimulants for the economy's overall economic growth (Awe et al., 2018). In the many business and development concepts, new intermediate inputs are of utmost importance (Goldberg et al., 2008). According to these models, business gain from trade by having more access to previously unavailable inputs, which results in a steady increase in profit. By introducing new kinds to their domestic product lines, enterprises, are thus given access to these freshly imported inputs, which results in dynamic advantages from trade.

Under macroeconomic circumstances that support the growth of a successful agricultural industry, ensuring food availability based on import substitution in the context of the globalization of national agri-business industries is feasible (Ozerova et al., 2019). Studies and experience indicate that if we assure the logical placement of production, apply contemporary technology, and train qualified employees, we can improve the competitiveness of local agricultural goods for all of their varieties in the future.

A rise in agri-food imports favors low-wage regions more than high-demand ones, despite the fact that closeness to customers has a considerable impact on the geographic distribution of agri-food output (Bagoulla et al., 2010). Also, a rise in the importation of agricultural items that agri-food companies process causes a reallocation of agri-food production away from areas with strong access to agriculture related products and towards places with restricted access. International trade has a huge significance in developing nations like Nepal. And a fundamental concern in many empirical investigations has been the applicability of the export-led growth theory in Nepal (Mishra, 2012).

Methodology:-

For an empirical investigation, time series data from 1990 to 2019 are analyzed. Total rice production, total cultivated area, annual mean temperature, fertilizer consumption, and precipitation are the major variables used for the study. The data source and measurement unit are mentioned in the table below.The study area of this research is the country, Nepal. which lies between two economically big countries namely China and India. The total area of Nepal is 147181 Sq. KM. and the total population is 29,192,480 among then 48.96% is the population of males and 51.04 is the population of females. The majority of the population belongs to a female. Two third of the total population depends on agricultural income as the primary source of Income. Total export for the financial year of 2021/22 is 118, 851.00 million Nepali rupees and on the other hand, a total amount of 999,342.70 million Nepali rupees has been imported during the year. The country has a total of 1,734,467.20 million rupees of total government outstanding which is 40.70% of the total GDP. So, I am dealing with import, agricultural food production, foreign currency reserve, productivity, and cultivated areas used.

Pesaran has greatly popularized the autoregressive distributed lag (ARDL) method, which has many benefits compared to earlier cointegration techniques like EG (Eagle and Geanger 1987) and JJ's maximum likelihood-based

tests (Johansen and Juseliua 1990) (Ghimire et al., 2021). It is easy to determine whether a long-term relationship is close by using the ARDL approach without taking into account the series that is stationary at levels [I (0)] or first difference [I (1)], or a combination of both (Chandio et al., 2018). The ARDL strategy is extremely dependable when there is a small sample sizeand maintains the strategic distance from the issue of endogeneity and makes a difference to look at the long-term coefficients. ARDL F-stat is utilized to look at the relationship over time between the study variables chosen. We can reject the null hypothesis and infer that the cointegration occurs if the F-statistic value is significantly larger than the I (1) bound (Chandio et al., 2021b). The lag order of the ARDL model is selected automatically by Eviews software.

Table 1. Variable definition and sources of data

Variable Name	Agricultural Import	Electricity Generation	Mean Temperature	Cultivate area	Rural Population	Exchange Rate
Abbreviations	RP	PRC	MT	CA	FT	EXC
Unit of Measurement	Thousand Metric tons	Millimeters	Celsius degree centigrade	Thousand hectares	Metric Ton	
Source	(Nepal Rastra Bank, 2022)	(World Bank Nepal, 2022)	(Climate Change Knowledge Portal for Development practitioners and Policy Makers, 2022)	(Nepal Rastra Bank, 2022)	(Nepal Rastra Bank, 2022)	(Nepal Rastra Bank, 2022)

Methodological Clarity: Step-by-Step ARDL Approach:-
Our approach to ARDL clarity becomes more reproducible by explaining the step-by-step ARDL procedures.
Unit root tests on all variables (ADF test) determined their appropriate integration levels to be either I (1) or I (0).
The determination of cointegration by F-statistic at 10.20 exceeded the I (1) critical value threshold of 3.99 at 1% level. The program used EViews to select proper lags according to AIC (which found maximum lag length of two).
Endogeneity issues were addressed by using FMOLS and CCR as supplemental methods to validate the ARDL results which appear in Table 1.

Result and Discussion:-

Nepal is located in South Asia with facilities of 280 N and 840 E and is arranged in China in the north and all sides have been covered by India. With 1.89 billion people or one-fourth of the world's population, south Asia is an area that heavily relies on agriculture for employment and subsistence (Economics & Library, n.d.-b). Topographically Nepal is separated into five regions: The Himalayas, High Hills, Mid Hills, Siwalik, and Terai (M. Paudel, 2013). Rice is consumed by billions of individuals and is the foremost common staple food of a huge number of individuals on earth, the fact is it feeds more people than any other crop (Wassmann et al., 2009). Rice is the major cereal crop grown in three major zones: terai, Mid-hills, and high hills of Nepal (Malla et al., 2022).

The agricultural sector is known as one of the most vulnerable sectors to climate change because the overall growth of this sector mainly depends upon climate and climate conditions (Sinnarong et al., 2019). Climate change plays a very significant role in the overall product development of the agricultural sector in Nepal. For the nation's development, the Agribusiness sector plays a very important role in providing job opportunities and for the country's economic advancement (Lee et al., 2019). Due to its importance different NGOs, INGO, and government policymakers are actively involved in the development of the agricultural sector in Nepal. The productivity and sustainability of rice production are undermined by biotic and abiotic stresses, and the impact of these stresses can be exasperated by dramatic global temperature changes (Ayinde et al., 2013).

Bound Test

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	10.20192	10%	1.99	2.94
K	6	5%	2.27	3.28
		2.50%	2.55	3.61
		1%	2.88	3.99
Dependent Variable: LNCERALPROD				
Method: Fully Modified Least Squares (FMOLS)				
Date: 01/16/23 Time: 17:46				
Sample (adjusted): 1991 2019				
Included observations: 29 after adjustments				
Cointegrating equation deterministic: C				
Long-run covariance estimate (Prewhitening with lags = 2 from AIC				
maxlags = 2, Bartlett kernel, Newey-West fixed bandwidth = 3.0000)				

Import of Agricultural food products, the major variable of concern, has a positive impact on the production of agricultural food production. It indicates that the current level of import of food products has not harmed the production of food crops in Nepal. A negligible value of the coefficient indicates that the influence of the import of food products is weaker. It means a one percent increase in agricultural import affects cereal production by only 0.01 percent. Electricity generation has a positive impact on cereal production which indicates that along with an increase in electricity generation the use of electricity for cereal production-based agricultural activity might have increased. Furthermore, it might have helped to reduce energy costs used for agricultural production motivating increasing cereal production.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNAGRIIMPORT	0.017698	0.001902	9.306651	0.000
LNMEANTEMP	-0.64803	0.028433	-22.7912	0.000
LNRURALPOP	-0.84164	0.030908	-27.23	0.000
LNCULAREA	-0.04989	0.015631	-3.19149	0.0042
LNELEGEN	0.363801	0.005261	69.14613	0.000
LNEXCHANGE	0.066836	0.007154	9.342451	0.000
C	21.93865	0.480591	45.64933	0.000
R-squared	0.923418	Mean dependent var		8.872656
Adjusted R-squared	0.902533	S.D. dependent var		0.204948
S.E. of regression	0.063984	Sum squared resid		0.090067
Long-run variance	8.87E-06			

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Furthermore, it might have helped to reduce energy costs used for agricultural production motivating increasing cereal production.

The annual mean temperature has hurted agricultural food products in Nepal which indicates that increasing temperature affects the production capacity of agricultural food products resulting in to decrease the production.The cultivated area has a negative impact on the agricultural food products in Nepal. It indicates that the cultivated area will not increase the production of agricultural food production in the long run. The production area has almost remained constant during the study period. So, other factors such as fertilizer used, and irrigation might have impacted the production side of agricultural food production in Nepal. In the long run there seems the possibility of the application of the law of diminishing returns due to limitedlimited area of production which might cause decline in production. The exchange rate has a positive impact on agricultural food production in Nepal. It indicates that increment in the exchange rate will motivate the agricultural producer to produce more and sale of agricultural food products abroad. Itmen's an increment in the exchange rate will generate more income from exporting agricultural food products in foreign country

Conclusion:-

This study conclusively demonstrates that Nepal's agricultural food production, particularly rice, is shaped by a complex interplay of factors. While agricultural imports exhibit a statistically positive impact, its effect is minimal (a 1% increase in imports leads to only a 0.01% increase in cereal production), suggesting current import levels do not significantly displace domestic production but offer limited direct benefit. Crucially, the research identifies electricity generation and a favorable foreign exchange rate as significant positive drivers of cereal output, likely by reducing energy costs and incentivizing exports. Conversely, rising annual mean temperatures exert a substantial negative impact, highlighting the severe vulnerability of Nepal's agriculture to climate change. Furthermore, cultivated area negatively affects long-term production, signaling the onset of diminishing returns due to limited arable land expansion potential and inefficiencies in land use. These findings underscore the sector's sensitivity to environmental change, infrastructure limitations, and economic policies. Forecasts extending to 2060, developed under various growth scenarios, emphasize the urgent need for strategic interventions to ensure future food security and economic stability in the face of these challenges. Prioritize and aggressively invest in climate-resilient paddy (rice) production as the foundational strategy for Nepal's agricultural future.

The study's conclusive evidence shows rising annual mean temperatures exert a substantial and significant negative impact on agricultural food production (coefficient: -0.648, p=0.000). Given rice's fundamental role in national food security and the economy, and the projected exacerbation of climate change impacts, focusing specifically on enhancing rice's resilience to heat stress is paramount. This requires immediate, large-scale investment in developing, disseminating, and supporting the adoption of heat-tolerant rice varieties specifically bred for Nepal's diverse agro-ecological zones (Terai, Mid-Hills, High-Hills). Concurrently, significant resources must be directed towards scaling up climate-adaptive water management infrastructure and practices, such as efficient irrigation systems (e.g., drip, sprinkler), rainwater harvesting, and watershed management, to mitigate the combined stress of rising temperatures and potential water scarcity. This targeted focus on climate-proofing the staple rice crop is the essential first step to safeguarding food security, protecting farmer livelihoods from climate shocks, and ensuring the long-term sustainability of Nepal's agricultural sector, upon which the majority of its population depends. Without this foundational resilience, gains from other positive factors like improved electricity access or favorable exchange rates will be severely undermined by climate vulnerability.

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