Does Human Capital Link to Agriculture Sector? Review Evidence from Bangladesh

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ABSTRACT

Bangladesh's economy depends heavily on agriculture, which therefore poses a formidable challenge to ending food insecurity. Education, workforce development, and technical field knowledge upgrades are required for this contest to increase the efficiency of the agricultural industry. The modern agriculture sector is prioritized in terms of sustainable economic growth. A key factor in Bangladesh's agriculture sector's growth has been human capital. This study's main goal was to evaluate the relationship between human capital and agricultural growth in Bangladesh from 1972 to 2021. To examine the relationship between the study variables with the analysis of the long-run and short-run, an autoregressive distributes lag (ARDL) bound testing technique to co-integration was used. The findings showed that every variable has a major impact on the agriculture industry. According to the findings, policy changes are required regarding investments in the education sector to strengthen human capital and an agricultural credit that contributed to increase Bangladesh's agricultural output.

Keywords: Human capital; agriculture sector; land; water, Bangladesh

INTRODUCTION

Production of crops and cattle, especially in developing nations, is essential to economic progress [1, 2]. Additionally, this industry guarantees the security of food and essential nutrients while also hiring pastoralists and supporting rural economies significantly [3]. The agricultural industry also contributes to emerging economies' export shares [4, 5]. Due to the food crisis and price increase, the agricultural sector changed the game for global politics and policymakers between 2008 and 2009 [6, 7]. In South Asian countries, agriculture is far more significant than other industries since one in three people are directly employed in it, it greatly boosts GDP, and it provides rural people with a means of subsistence [8, 9]. In Bangladesh, the agriculture industry contributed 15% of the total GDP [10]. Human capital biodata includes technique differences, sanitation, health, appropriate education, job training, immigration, and a connection with all population abilities for the development of the country [11]. Due to changes in human activity, individual turnover is now more lucrative, profitable, and beneficial for an economy [12]. Accordingly, Bangladesh's half-decade plan (2013–2018) set a target of 4.0–5.0% and effectively attained it in the agriculture sector by increasing total factor productivity (TFP) and incorporating new technologies [13]. In Bangladesh, over 51% of all jobs are in the agricultural sector [14]. While a literature review identified the role of education in inefficient farming and growth [15], it is generally accepted that well-trained, qualified

human capital makes an evaluation in crop farming activities directly related to total factor productivity (TFP) change [16]. Bangladesh is one of several developing nations whose economic development is largely dependent on how well its agriculture sector performs [17]. However, agriculture will undoubtedly have an impact on a nation's development [18]. Experience in the past shown that eras of strong and weak agricultural growth often coincided with those of strong and weak national economic performance [19]. More over half of the world's population is fed by agriculture, making it the most powerful industry in the world [20].

Thus, the paper main goal is to investigate the human capital effect on agricultural productivity increase and on the agricultural frontier expansion in Bangladesh. Such an objective is due to the importance of agricultural production in social and economic development, as it ensures the food and nutritional security in developing countries. In addition, agricultural production impacts the environmental, social and structural changes in the economy. In this sense, the concern arises to assess the possible implications of human capital on the agricultural sector in Bangladesh. Education and economic development are strongly correlated [21]. People with greater education pick up useful skills faster and can demonstrate them more naturally [22]. However, research was done, and the findings showed the new technology transformation and economic growth in the agriculture sector [23]. It also studied how the literal peoples readily accept modern technology as opposed to illiterate people [24].

CONCEPTUAL AND THEORETIC REVIEW

Human Capital a Conceptual Review

Schultz popularized the concept of human capital and the human capital model, which acknowledged human potential while enhancing productivity [25]. The power of competent human capital to increase sectoral and personal income has been documented [26]. The essential components of human capital include training, education, experience, and skill [27].

Human Capital a Theoretical Review

Rising agriculture sector expansion is accompanied by ongoing investments in human capital in developing nations [28]. The expansion of the agriculture industry can be influenced by human capital via a number of functional channels [29]. As surplus production is transported locally and internationally and human capital becomes more technologically savvy, the economy can advance [30]. Through the commercial marketing of crops and livestock products, the way farmers live their life is improved, which benefits numerous economic sectors. The agricultural sector must adopt contemporary methods, including new inputs, knowledge, and understanding of market demands [31]. The use of technology, management expertise, and the application of various growth strategies enable privatized enterprises to achieve their full potential [32].

According to the dual economy model, the economy can be split into the industrial and agricultural sectors, which make up the majority of this model [33]. The bulk of rural residents reside in rural areas, and agricultural goods constitute the mainstay of their income. It has been found that if some workers leave a labor group while the output remains constant, the marginal productivity of those workers is equal to zero [34]. The productivity and profits of the industrial sector improve with the involvement of labor, and farm sector salaries follow suit [35].

Prevailing Literature

Economic growth is influenced by human capital, which also helps to coordinate sectoral growth. There are over 184 million people living in Bangladesh, and the rural population is closely linked to the agricultural economy [28]. Approximately 15% of the nation's gross domestic product (GDP) is contributed by the agriculture sector, which employs more than 51% of the labor force [10]. Rice, cotton, sugarcane, wheat,

and maize are Bangladesh's major agricultural crops [36]. MIsra et al. research confirms that human capital has a positive impact on agricultural profitability [37]. Using skilled and specialized workers increased the rate of output growth. Rural profitability is increased as a result of human capital's contributions to the agricultural sector and the production growth blueprint [38].

Trade liberalization, modern technology, physical capital, and the total workforce have all had an impact on overall output, which has in turn influenced agricultural growth and lowered the unemployment rate [39]. Bangladesh's agriculture sector might grow faster with increased physical capital and skilled workers [40]. A rise in agricultural output directly contributes to the reduction of poverty since it creates jobs and money for households. A rise in technology, institutional change, asset endowments, and access to the market for progressive stockholders may lead to a decrease in poverty and an increase in agricultural productivity [33]. Agriculture and economic expansion had been strongly impacted by the labor educational system [41]. To achieve the desired industrial growth, it is essential to improve labor organization, planning, and management skills. Through technical training, advanced public education, and vocational education, productivity development in goods and services can be increased [30]. Economic growth is undoubtedly impacted by human resource development (HRD) and human resource management (HRM), while excellence in vocational training and public advanced training also increased the productivity of goods and services (Mehdi 2011). Total factor productivity (TFP) and GDP growth are found to be positively correlated. Productivity is significantly impacted by technological advancements, technical efficiency, and farmer education [36].

According to Kaboski's (2009) research, skilled labor (such as education, vocation, and industry experience) directly influences economic growth [42]. The ability of the labor force and productivity can be improved by increasing the availability of skilled and educated labor [43]. Cropped output is undoubtedly impacted by agricultural finance, whereas income in the sector is influenced by two mechanisms: wages per section of cropland and wages per developed area [44]. Impact of human capital on an economy's ability to grow economically.

MATERIALS AND METHODS

Sources of Data

Time series data was used from 1972-2021which was collected from the Economic Survey of Bangladesh (GOB) and World Development Indicators (WDI) asreported the variables description in (**Table 1**).

Table 1: Variables description and data sources

Variables	Descriptions	Data Sources
AVA	Agriculture Value Added	WDI
Lr	Employed Labor Force	WDI
La	Agricultural Land	WDI
Tr	Tractors	GOB
HC	Human Capital	WDI
W	Water Availability	WDI
Cr	Agricultural Credit	WDI

Model Specification

The following model uses the regression technique to examine the relationship between dependent and independent variables. The implicit forms of the multivariate regression model specification are followed.:

$$AVA = f(Lr_t, La_t, Tr_t, HC_t, W_t, Cr_t) \quad (1)$$

In Eq. (1) AVA indicates the agriculture value added, Lr indicates the labor force, La indicates the agricultural land, Tr show the tractors, HC indicates the human capital, W shows the water availability and Cr represents the agricultural credit. Equation 1 can also be written as;

$$\mathbf{AVA_t = \alpha_0 + \alpha_1 Lr_t + \alpha_2 La_t + \alpha_3 Tr_t + \alpha_4 HC_t + \alpha_5 W_t + \alpha_6 Cr_t + \mu t} \quad (\mathbf{2})$$

By employing natural logarithm to Eq. (2) it can be written as;

$$\mathbf{lnAVA_t = \alpha_0 + \alpha_1 lnLr_t + \alpha_2 lnLa_t + \alpha_3 lnTr_t + \alpha_4 lnHC_t + \alpha_5 lnW_t + \alpha_6 lnCr_t + \mu t} \quad (\mathbf{3})$$

Eq. (3) is the log-linear model, and is constant intercept, show the natural logarithm of agricultural value added, indicates the natural logarithm of labor force, shows the natural logarithm of agricultural land, indicates the natural logarithm of tractors, shows the natural logarithm of human capital, shows the natural logarithm of water availability, presents the natural logarithm of agricultural credit, and is error term.

Co-Integration with Autoregressive Distributed Lag (ARDL) Model

This study employs the Autoregressive Distributed Lag (ARDL) bounds testing method, which was created by Pesaran and Shin in 1998 and further extended by Pesaran et al. in 2001, to examine the relationship between the dependent and independent variables with the analysis of the long-run and short-run [45]. With the exception of the presence of I(2), the co-integration testing approach is applicable regardless of the sequence of integration with the relevant variables, I(0) and/or I(1). The ARDL representation of equation (3)'s unrestricted error correction model (UECM), shown in equation (4), was used to explore the long-run and short-run relations:

$$\begin{aligned}\mathbf{\Delta lnAVA_t} = \mathbf{\beta_0} &+ \sum_{i=1}^{p} \mathbf{\beta_{1i} \Delta lnAVA_{t-i}} + \sum_{i=1}^{q^1} \mathbf{\beta_{2i} \Delta lnLr_{t-i}} + \sum_{i=1}^{q^2} \mathbf{\beta_{3i} \Delta lnLa_{t-i}} + \sum_{i=1}^{q^3} \mathbf{\beta_{4i} \Delta lnTr_{t-i}} \\ &+ \sum_{i=1}^{q^4} \mathbf{\beta_{5i} \Delta lnHC_{t-i}} + \sum_{i=1}^{q^5} \mathbf{\beta_{6i} \Delta lnW_{t-i}} + \sum_{i=1}^{q^6} \mathbf{\beta_{7i} \Delta lnCr_{t-i}} + \mathbf{\alpha_1 lnAVA_{t-i}} + \mathbf{\alpha_2 lnLr_{t-i}} \\ &+ \mathbf{\alpha_3 lnLa_{t-i}} + \mathbf{\alpha_4 lnTr_{t-i}} + \mathbf{\alpha_5 lnHC_{t-i}} + \mathbf{\alpha_6 lnW_{t-i}} + \mathbf{\alpha_7 lnCr_{t-i}} + + \mathbf{\mu_t} \quad (\mathbf{4})\end{aligned}$$

Where, Δ indicates the difference operator, $\boldsymbol{\beta_0}$ is constant intercept, α indicates the coefficients of long-run, while β imprisonments the coefficients of short-run. The co- movement of the long-run analysis among the study variables of interest is ascertained on the basis of F-Statistics estimation.

EMPIRICAL RESULTS AND DISCUSSIONS

Unit Root Test Results

The results of the Phillips-Perron unit root test with intercept, followed by both intercept and trend, and the Augmented Dickey-Fuller unit root test are presented in Table 2.

Table 2. Results of augmented dickey–fuller and Phillips–Perron unit root test

Augmented Dickey–Fuller Unit Root Test			Phillips–Perron Unit Root Test	
Variables	At Level	First Difference	At Level	First Difference

LnLr	-1.18579	-14.6106*	-2.93931	-21.0787**
LnLa	-1.82795	-11.2113*	-2.79473	-17.8183*
LnTr	-0.91894	-6.06235*	-6.03922	-4.69567*
LnHC	-2.61705	-3.55872*	-0.85825	-4.40961**
LnW	-1.36485	-4.53943	-2.53872	-4.48891
LnAVA	-1.6508	-3.6607***	-1.85675	-22.1291*
LnCr	-1.46649	-5.76922	-1.46467	-3.7014

*, **, *** showed the rejection of null hypothesis at 1%, 5% and 10% level of significance

In order to determine the significance of the variables at 1%, 5%, and 10% and the fact that none of the variables had been integrated with the order of I(2), the results of the augmented Dickey-Fuller unit root test and Phillips-Perron unit root test were combined. The Autoregressive Distributed Lag (ARDL) model was then used. The ARDL bounds testing is suggested as being superior and preferable due to its many advantages, including not requiring that all of the system's variables be of an equal order of integration; being a very efficient estimator even with small samples; and even accepting some endogenous regressors. We choose to use the ARDL approach to cointegrate because it is very efficient even with small samples.

Bounds Testing Procedure

To determine whether there was a long-term link between the dependent and independent variables, a limits test was used. To determine the value of F or Wald statistics for the importance of the lagged variables, the OLS method is used. Table 3 provides an illustration of the significance of F or Wald statistics. The F-statistic has a value of 5.61889205, which is higher than the critical values at the upper bound at the (1% and 5%) significant level. These findings demonstrate that human capital and a measure of the performance of the agriculture industry are linked throughout time.

Table 3. ARDL bounds test for co-integration results

ARDL Bounds test for Co-integration results				
F-Statistic	**Significance Level**	**Lower Bound**	**Upper Bound**	**Decision**
5.61889205	10%	3.3681	4.5217	Co-integrated
	05%	2.7089	3.7286	
	01%	3.0076	3.2342	

The limits tests shown in table 3 summarize whether dependent and independent variables exhibit cointegration associations at the (1%, 5%, and 10%) significant levels. Additionally, we applied the Johansen and Juselius (1990) cointegration test, and Table 4's interpretation of the results using trace statistics and the greatest eigenvalues.

Table 4: Results of the Johansen cointegration test using trace statistic and maximum eigenvalues.

Trace Statistic				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.91117	399.29536	171.77320	0.00000
At most 1 *	0.90197	204.95980	126.59113	0.00000
At most 2 *	0.85854	297.57133	91.54734	0.00000

At most 4 *	0.74739	104.59748	72.28438	0.00010
At most 5 *	0.87087	78.49731	51.68442	0.01782
At most 5 *	0.57561	38.20794	26.54207	0.00000
At most 6 *	0.26874	9.48622	16.94443	0.32394
At most 7 *	0.00083	0.07200	4.24351	0.94739
Maximum Eigenvalue Statistic				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.9838	125.4783	48.3884	0.0000
At most 1 *	0.9671	93.2238	42.3445	0.0011
At most 2 *	0.9348	71.4430	36.2639	0.0020
At most 4 *	0.8080	41.9162	30.1352	0.0000
At most 5 *	0.7309	33.1816	23.9176	0.2391
At most 5 *	0.5572	20.4793	17.6193	0.9106
At most 6 *	0.2445	7.0218	11.1126	0.0176
At most 7 *	0.0006	0.0150	4.0886	0.0000

Denotes rejection of the hypothesis at the 0.05 level, ** p-values.

Table 5. Long-run analysis results ARDL Co-integrating and Long-Run Form

Co-integrating Form				
Variables	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(LnHC)	0.5993	0.2386	2.5618	0.0214
D(LnLr)	21.2043	8.3974	2.5756	0.0214
D(AVA)	-1.8654	2.0320	-0.9363	0.3859
D(LnLa)	0.7167	0.2052	3.5630	0.0020
D(LnTR)	0.1692	0.0551	3.1350	0.0061
D(LnW)	0.2358	0.0486	4.9545	0.0000
D(LnCr)	0.0841	0.0166	5.1612	0.0000
Coint. Equation(-1)	-0.5793	0.2404	-2.4578	0.0000
Long-Run Coefficients				
Variables	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
LnHC	1.7647	1.2602	3.4911	0.0337
LnLr	16.4887	9.3117	0.0260	0.0908
LnAVA	0.3859	3.3576	0.4060	0.7123
LnLa	1.0018	1.3487	4.0878	0.0092
LnTR	2.3340	3.1595	0.1668	0.0041
LnW	0.4063	1.9084	1.1113	0.0000
LnCr	0.6983	9.1596	7.2271	0.0908
C	-1.0821	26.2184	-7.7801	0.0000

Concentrating on the elasticity of variables in long-run analysis, the results naked that the human capital of Bangladesh has optimistic and significant impact, as the economic growth has coefficient of 1.7647 with p-value of 0.0337, Likewise (e.g., the coefficients of employed labor force, agriculture value-added growth,

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agriculture land area, agriculture machinery tractor, water ability and agriculture credits) had encouraging and significant impact upon each other and with economic growth. The coefficients of the employed labor force, agriculture value-added growth, agriculture land area, agriculture machinery, water availability, agriculture credit are 16.4887,0.3859, 1.0018, 2.3340, 0.4063 and 0.6983 with their p-values of 0.0908, 0.7123, 0.0092, 0.0041, 0.00, and 0.0908, respectively.

Short-Run Analysis

The outcomes of the short-run analysis were shown in Table 6. The co-integration existing among the set of variables necessitates an error correction model (ECM) to capture the dynamics of the short-run relationship with its co-efficient, which measures the speed of adjustment. The speed of adjustment towards the long-run equilibrium following a short-run shock is indicated by the error correction model. The major benefit of the (ECM) representation is that it avoids the issues of spurious correlation between dependent and explanatory factors, which must be bestowed to co-integrated variables. The short-run dynamic parameters were analyzed using the unrestricted error correction model (UECM). Engle and Granger developed the error correction model to compare the long-run stability of economic variables with their short-term performance.

The short-run relationship's dynamics have an R-squared value of 0.9938, which shows that there is about (99%) variation in economic growth as described by the model's independent variables. The independent variables' joint importance established the F-statistic at a (1%) level of significance. The Durbin-Watson (DW) statistic for the absence of any auto-correlation has a value of 3.4743, which did not match the usual DW value. However, this is sufficient to show whether the model contains any auto-correlation.

Table 6: Short-run analysis results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(AVA(-1))	2.2501	0.4134	5.4970	0.0000
D(AVA(-2))	1.4357	0.3022	4.7982	0.0002
D(AVA(-3))	0.4022	0.1575	2.5784	0.0202
D(Lr)	-134.4963	40.3832	-3.3638	0.0037
D(Lr(-1))	-82.7512	37.3045	-2.2404	0.0400
D(La)	-0.6582	0.5421	-1.2265	0.2427
D(Tr)	0.0482	0.0559	0.8724	0.4031
D(Tr(-1))	-0.2788	0.0742	-3.7945	0.0014
D(HC)	-7.3962	5.2017	-1.4361	0.1739
D(HC(-1))	-10.2491	5.4687	-1.8929	0.0780
D(W)	0.4601	0.1137	4.0861	0.0008
D(Cr)	0.0898	0.0244	3.7082	0.0017
D(Cr(-1))	-0.0647	0.0178	-3.6803	0.0019
C	-198.0215	25.9614	-7.7038	0.0000
CointEq(-1)	-0.5736	0.2380	-2.4337	0.0000
R-squared	0.99380	Mean dependent var.		7.4728
Adjusted R-squared	0.99434	S.D. dependent var.		0.3370
S.E. of regression	0.02780	Akaike info criterion.		-4.2706
Sum squared resid.	0.02080	Schwarz criterion		-3.7401
Log likelihood	62.85231	Hannan-Quinn criter		-4.0599
F-statistic	198.22760	Durbin-Watson stat		3.4743

Prob(F-statistic)	0.00000		

Table 7 shows the Breusch–Godfrey Serial Correlation Test, and heteroskedasti city test with p-values of 0.05572 and 0.10764 respectively.

Table 7. Diagnostic and stability tests outcomes

Diagnostic and Stability tests		
Test Statistics (LM Version)	Stability Tests	Prob.
Breusch–Godfrey Serial Correlation	3.33902	0.05572
Heteroscedasticity	0.80892	0.10764
CUSUM (Cumulative Sum)		Stable
CUSUMSQ (Cumulative Sum of Square)		Stable

Structural Stability Test

The long-run and short-run constraints are stabilized using stability tests that use the CUSUM and CUSUM square point. Figures 1 and 2 show the graphs for the CUSUM test and CUSUM square test, both of which show that all of the values fall inside the crucial ranges at a significance level of 5%. It demonstrates that the long-run and short-run parameters are stable.

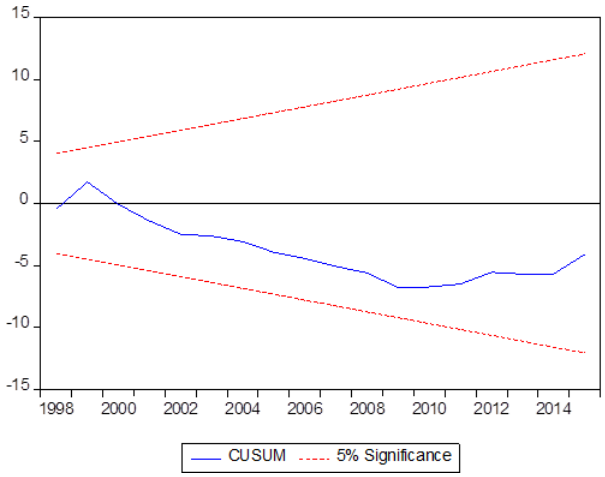

Figure 1. Plot of CUSUM

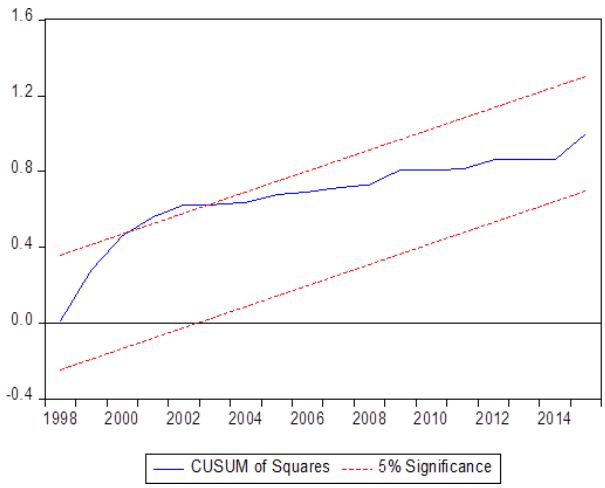

Figure 2. Plot of CUSUM of square

CONCLUSIONS

ARDL bound testing approach to co-integration was used to evaluate the link between the research variables with the analysis of both the long-run and short-run in order to determine the association between human capital and agricultural expansion. The preliminary findings suggested that factors such as agricultural financing, labor force, tractors, water accessibility, and human capital index have a major impact on Bangladesh's agricultural growth. In order to strengthen the agricultural sector, the government of Bangladesh should implement new policies involving human capital. In addition, the government must ensure that agricultural finance is timely and reasonably priced. It is also advised that the growth of agriculture be accelerated by both the quality and quantity of human capital.

Human capital has been identified as a significant aspect in the advancement and growth of the financial sector. This study has made an effort to analyze how human capital affects Bangladesh's actual GDP or development in the agricultural sector. The human capital is the information factor of generation, according to the neoclassical development theory, but people tend to think of it more like physical capital, which consistently loses value. Recent years have seen an increase in the relevance of human capital due to growing sectoral growth concerns. In the context of Bangladesh, this was the time when the government placed a strong emphasis on the increased use of human capital policies and sectoral growth-promoting initiatives. Policymakers, economists, and researchers can evaluate the performance of human capital and sectoral growth in Bangladesh and examine the status of human capital in this direction of sectoral growth using the review offered in this study. Less research, however, has been done on identifying additional human capital resources and factors that limit the expansion of the agriculture sector's contribution to overall economic growth. Future study may be conducted in this area.

REFERENCES

1. Adnan, K.M., et al., Catastrophic risk perceptions and the analysis of risk attitudes of Maize farming in Bangladesh. Journal of Agriculture and Food Research, 2023. **11**: p. 100471.
2. Herrero, M., et al., The roles of livestock in developing countries. animal, 2013. **7**(s1): p. 3-18.
3. Tama, R.A.Z., et al., Assessing farmers' intention towards conservation agriculture by using the Extended Theory of Planned Behavior. Journal of Environmental Management, 2021. **280**: p. 111654.
4. Md Reza, S., et al., Trade (exports) as an opportunity for Bangladesh: A VECM analysis. The International Trade Journal, 2019. **33**(1): p. 95-110.
5. Losilla, L.V., A. Engler, and V. Otter, Internationalization paths of fruit export companies from emerging economies: Are they regionally or globally oriented? International Journal of Emerging Markets, 2020. **15**(2): p. 320-343.
6. Saha, J., et al., Analysis of growth trends in area, production and yield of tea in Bangladesh. Journal of Agriculture and Food Research, 2021. **4**: p. 100136.
7. Clapp, J. and E. Helleiner, Troubled futures? The global food crisis and the politics of agricultural derivatives regulation. Review of International Political Economy, 2012. **19**(2): p. 181-207.
8. Sarker, S.A., et al., Renewable energy in Bangladesh: economic growth and policy perspectives. Journal of Science and Technology Policy Management, 2023. **14**(4): p. 780-797.
9. Byerlee, D., A. De Janvry, and E. Sadoulet, Agriculture for development: Toward a new paradigm. Annu. Rev. Resour. Econ., 2009. **1**(1): p. 15-31.
10. Statistics, O., Statistical Pocketbook Bangladesh, 2020. Bangladesh Bureau of Statistics (BBS), 2021.
11. Campbell, D. and I. Ahmed, The labour market in developing countries. Perspectives on Labour Economics for Development (ILO, 2013), 2012.
12. Sarker, S.A., et al., Economic viability and socio-environmental impacts of solar home systems for off-grid rural electrification in Bangladesh. Energies, 2020. **13**(3): p. 679.
13. Commission, B.P., Sustainable development goals: Bangladesh progress report 2020. Bangladesh Planning Commission: Dhaka, Bangladesh, 2020.

14. Organization, I.L., ILO Monitor: COVID-19 and the World of Work. 2020.
15. Adnan, K., et al., Simultaneous adoption of risk management strategies to manage the catastrophic risk of maize farmers in Bangladesh. GeoJournal, 2021. **86**(4): p. 1981-1998.
16. Adnan, K., et al., Simultaneous adoption of diversification and agricultural credit to manage catastrophic risk for maize production in Bangladesh. Environmental Science and Pollution Research, 2021. **28**(41): p. 58258-58270.
17. Adnan, K., et al., Adoption of Contract Farming and Precautionary Savings to Manage the Catastrophic Risk of Maize Farming: Evidence from Bangladesh. Sustainability, 2019. **11**(1): p. 29.
18. Adnan, K.M., M.M. Rahman, and S.A. Sarker, Marketing channels and post harvest practices of onion: a case of Bogra and Joypurhat District in Bangladesh. Universal Journal of Agricultural Research, 2014. **2**(2): p. 61-66.
19. Sarker, S.A., S. Wang, and K.M. Adnan, Energy consumption and economic growth nexus in Bangladesh. Journal of Systems Science and Information, 2019. **7**(6): p. 497-509.
20. Rahman, A., et al., How indebted farmers perceive and address financial risk in environmentally degraded areas in Bangladesh. Environmental Science and Pollution Research, 2020. **27**(7): p. 7439-7452.
21. Raza, M.H., et al., Environmental and Health Impacts of Crop Residue Burning: Scope of Sustainable Crop Residue Management Practices. International Journal of Environmental Research and Public Health, 2022. **19**(8): p. 4753.
22. Sarker, S.A., et al., Economic feasibility and determinants of biogas technology adoption: evidence from Bangladesh. Renewable and Sustainable Energy Reviews, 2020. **123**: p. 109766.
23. Adnan, K., et al., Risk management strategies to cope catastrophic risks in agriculture: the case of contract farming, diversification and precautionary savings. Agriculture, 2020. **10**(8): p. 351.
24. Huq, M., et al., Measuring vulnerability to environmental hazards: qualitative to quantitative, in Environment, climate, plant and vegetation growth. 2020, Springer. p. 421-452.
25. Schultz, T.W., Investment in human capital. The American economic review, 1961. **51**(1): p. 1-17.
26. Pasban, M. and S.H. Nojedeh, A Review of the Role of Human Capital in the Organization. Procedia-social and behavioral sciences, 2016. **230**: p. 249-253.
27. Vidotto, J.D.F., et al., A human capital measurement scale. Journal of Intellectual Capital, 2017. **18** (2): p. 316-329.
28. Khan, M.T.I., et al., Do natural disasters affect economic growth? The role of human capital, foreign direct investment, and infrastructure dynamics. Heliyon, 2023. **9**(1).
29. Barbier, E.B., The policy challenges of green rural transformation for Asia-Pacific emerging and developing economies in a post-COVID world. Economic Analysis and Policy, 2022. **75**: p. 689-704.
30. Goldin, C., The human-capital century and American leadership: Virtues of the past. The Journal of Economic History, 2001. **61**(2): p. 263-292.
31. Kremen, C., A. Iles, and C. Bacon, Diversified farming systems: an agroecological, systems-based alternative to modern industrial agriculture. Ecology and society, 2012. **17**(4).
32. Strayer, W., The returns to school quality: College choice and earnings. Journal of labor Economics, 2002. **20**(3): p. 475-503.
33. Jorgenson, D.W., The role of agriculture in economic development: Classical versus neoclassical models of growth, in Subsistence agriculture and economic development. 2017, Routledge. p. 320-347.
34. Azar, J., et al., Minimum wage employment effects and labor market concentration. 2019, National Bureau of Economic Research.
35. Charania, I. and X. Li, Smart farming: Agriculture's shift from a labor intensive to technology native industry. Internet of Things, 2020. **9**: p. 100142.
36. Adnan, K.M., et al., Profit efficiency and influencing factors for the inefficiency of maize production in Bangladesh. Journal of Agriculture and Food Research, 2021. **5**: p. 100161.
37. Mishra, L.N., M. Sen, and R.N. Mohapatra, On existence theorems for some generalized nonlinear functional-integral equations with applications. Filomat, 2017. **31**(7): p. 2081-2091.

38. Autor, D.H., D. Dorn, and G.H. Hanson, The China shock: Learning from labor-market adjustment to large changes in trade. Annual review of economics, 2016. **8**: p. 205-240.
39. Ali, S., et al., Impact of trade openness, human capital, and institutional performance on economic growth: Evidence from Organization of Islamic Cooperation countries. Journal of Public Affairs, 2022. **22**(4): p. e2654.
40. Pomi, S.S., S.M. Sarkar, and B.K. Dhar, Human or physical capital, which influences sustainable economic growth most? A study on Bangladesh. Canadian Journal of Business and Information Studies, 2021. **3**(5): p. 101-108.
41. Lechman, E. and H. Kaur, Economic growth and female labor force participation–verifying the U-feminization hypothesis. New evidence for 162 countries over the period 1990-2012. New evidence for, 2015. **162**: p. 1990-2012.
42. Kaboski, J.P., Education, sectoral composition, and growth. Review of Economic Dynamics, 2009. **12** (1): p. 168-182.
43. McGuinness, S., Overeducation in the labour market. Journal of economic surveys, 2006. **20**(3): p. 387-418.
44. Adnan, K.M., et al., An economic analysis of year round Pangus production and social impact in some selected areas of Mymensingh district in Bangladesh. Asian J. Agric. Extension, Econ. Sociol, 2016. **10**: p. 1-11.
45. Pesaran, M.H., Y. Shin, and R.J. Smith, Bounds testing approaches to the analysis of level relationships. Journal of applied econometrics, 2001. **16**(3): p. 289-326.