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Logistic Infrastructure, Informational Technology and Crop Production: Role of Food and Crop Production in Economic Miseries

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A B S T R A C T

This study examines the impacts of logistic facilities and infrastructure on crop and food production, inflation, and unemployment rates. It concludes that improvement in logistic facilities is an important significant and robust element of food and crop production growth. The logistic infrastructure improves employment in direct and indirect ways. Empirical evidence does not favor subsidies, tax exemptions, and credit to the private sector for crop production and food security enhancement. The study recognizes the importance of information technology for food and non-food crop production growth. Moreover, information technology improves the employment opportunities. These findings are based on 14 years data of 187 countries, while fixed and common effect models have been applied to estimate the parameters.

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1. Introduction

1.1. Importance of Logistic Facilities and Informational Efficiency in Agriculture

The production and supply of agriculture commodities is directly associated with their demand and marketing strategies. The transportation cost, inadequate market

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infrastructure, lack of market information, lack of processing units, storage facilities and price fluctuations are the major problems in marketing of agricultural products. Sarap & Nemade (2021) have defined the agriculture marketing as a series of activities involved in moving the goods from the point of production to the point of consumption. Sarap & Nemade (2021) have identified several problems of agricultural marketing in India. These problems are applicable in other developing countries particularly in South Asia and Sub-Saharan Africa. Lack of transportation facilities, lack of financial resources, lack of awareness, and lack of market intelligence are included in these problems. Several studies have identified the lack of financing and agricultural credit as main hindrance in the growth of agriculture sector. The financial illiteracy, lack of access to financial institutions, high rate of interest, insufficient mortgage, collateral security, lengthy procedures, complicated documentation, lack of interest of financial institutions for financing to agriculture sector and lack of awareness are the indicators of the hindrances in agriculture financing. FAO (2012) and Field to Market (2002) have emphasized the innovative financing for the growth of agriculture sector and food security. FAO (2012) has recommended that financial incentives should be directly related to the financial barriers in case-to-case basis.

The major issues related to growth in crop production and food insecurity can be categorized in two broad streams:

1. Insufficient and inappropriate logistic facilities, and

2. Lack of informational efficiency which is an outcome of the frictions in the flow of relevant information or lack of financial literacy and understanding.

The lack of informational efficiency may be related to the information about available financial resources, cost of financing, prices of the products, estimated demand for agriculture products, documentation and process of marketing, and most appropriate routes of transportation.

It is hypothesized in this study that above-mentioned issues can be resolved by provision of the appropriate logistic facilities and ability to use the internet. The study is divided in 4 sections. This section explains the role of logistic infrastructure and informational efficiency in the economic growth with special reference to agricultural products. Next section depicts the global picture of food insecurity, crop production and economic miseries. The research methodology to test the impacts of logistic infrastructure and information efficiency on crop and food production is explained in section 2, while section 3 discusses the empirical evidences and results of the study. Section: 4 summarizes the policy implications based on this study.

Though agriculture is a broader area which covers food and non-food crops, fisheries and livestock. However, this study is limited to food and non-food crops. The main objectives of this study are to identify the factors of growth in crop and foods production and the impacts of crop size on economic miseries of common peoples.

The role of logistic infrastructure in economic growth and business activities is largely recognized in economic literature. The impacts of logistic infrastructure on international trade, GDP growth and business activities have broadly been explained in the literature. The impact of logistic infrastructure development not only affects the living standard of households by direct use of these facilities, but also will create employment opportunities through peripheral business activities and their associated services.

Various studies in the context of developing countries have established the linkages between economic growth and infrastructure development. Hussain & Zhang (2018), OECD (2012), World Bank (2017) and Mehar (2017) have estimated the impact of logistic infrastructure on economic development. Though logistic infrastructure can directly generate several economic activities in supply chain, transportation and tourism sectors, its role is mor important to link the agriculture farms with the markets and points of consumption. The efficient logistic linkages between farms and markets accelerate economic growth. World Bank has concluded that infrastructure development significantly impacts the per capita income at Purchasing Power Parity (World Bank: 2017). The results of this study provide a useful insight that this mechanism is much more powerful than subsidies and transfer payments for alleviation of poverty. World Economic Forum (2012) and OECD (2012) have estimated the impact of various types of infrastructure on the growth of per capita income. Mehar (2018) has established a causal relation between deterioration in logistic infrastructure and the level of poverty. Lack of appropriate infrastructure, declining business competitiveness, lower rate of growth and economic miseries are the interconnected variables (Mehar 2017). The lower growth of the economy has resulted in falling tax revenue and a lack of resources to operate government institutions.

Similarly, the links between the use of information technology and economic growth have been assessed in various studies. Marlene et al. (2019), Gormez, (2019), Christian & Hornuf (2019) and Mehar (2021b) have estimated the impacts of information technology on economic growth. Stijn et al. (2018) mentioned that fintech credit deals a substitute funding source for businesses and consumers, and may expand access to credit for underserved fragments. It may improve the efficiency of financial intermediation. However, fintech credit sizes are greater in countries with less rigorous banking regulation. International Fund for Agricultural Development and the World Bank Group (2015) has pointed out that the importance of informational efficiency in economic development.

The modernization of logistic infrastructure is required to achieve competitiveness. It is obvious that reduction of transportation costs, smooth connectivity, and the shortening of delivery time stimulate the economic activities, employment opportunities and improve the quality and freshness of agriculture products. They induce many economic activities and networking which lead to increase

in business activities, employment and GDP growth. The enhancement in tax revenue is one of the outcomes of efficient logistic services. Another favorable externality of logistic facilities is the improvement in households' incomes and living standards through improvement in public transportation, banking, medical facilities and education (Mehar, 2019).

1.2. Food Security, Crop Production and Economic Miseries: Global Evidences

In this study, it is hypothesized that crop size and food production are the determinants of economic miseries of common peoples. It is noteworthy that inflation and unemployment are common indicators of economic miseries. The misery index created by Arthur Okun is commonly used to determine the economic conditions of common peoples in the economy. It assumes that a higher rate of unemployment and inflation create economic and social miseries for the peoples in a country. Tang & Lean (2009) has noted that misery index drives the crime rate. Based on data from 1960 to 2005, a significant correlation between the misery index and the crime rate has been found. (Tang & Lean, 2009).

Table 5 and 6 depict an important observation: the rate of inflation and unemployment is significantly higher in the countries with lower magnitude of logistic infrastructure development, while rate of unemployment and inflation is much lower in top 10 logistic developed countries. The countries with higher magnitude of logistic development have maintained their food and crop production indices despite lower cropland as percentage of their land area. These observations establish the nexus between development of logistic infrastructure, crop and food production and economic miseries. This study examines this relationship.

The statistical evidences highlight the global trends of economic miseries and crop production. Agriculture sector (including forestry and fishing) has contributed 4.3 percent share in global GDP in 2021; it was 3.6 in 2008. This share is around 17 percent in South Asian countries and 9 percent in middle income countries. However, share of food export was 8.6 percent in global merchandize exports, which was 7.1 percent in 2008. The share of food products in merchandizing exports was 12.5 percent for South Asian countries and 9.4 percent for middle income countries in 2021. While, the average growth of world agriculture production is 2 percent only (World Bank, 2023). These statistics indicate the food insecurity and growth in the demand of food products. The more important thing is the dependency of industrial and services sectors' growth on agriculture. The value addition of several industrial products depends on the agriculture products, while the role of agriculture sector in the growth of banking and finance, insurance, shipping and transport and supply chain services is extremely important. This is the main cause that agriculture remains as the main stray of the global economy.

It is envisaged by Table 1 that inflation is continuously much higher in low-income countries than high income countries. The rate of inflation is less than 5 percent in high income countries, European Union and the United States, while it is much higher in South Asia and low-income countries. The unemployment in middle income countries is higher than high- and low-income countries. There is a big variation in the magnitude of internet users. The ratio of internet users is much lower in low-income countries as compare to high income countries. Another notable difference between high- and low-income countries is the public sector spending on subsidies. More than 50 percent public expenditures of high-income countries including European Union and the United States are spent on subsidies and transfer payments. This ratio is less than 40 percent in low- and middle-income countries. The inefficiency of financial system in low-income countries (particularly in Sub-Saharan Africa) is reflected by interest rate spread.

Table 1: Economic Miseries: Regional Comparison

Region/ Group	Unemployment (% of total labor force): ILO estimate		Inflation (% change in consumer prices)	
	2008	2021	2008	2021
World	5.9	6.2	8.9	3.5
North America	5.8	5.6	3.1	4.0
European Union	7.2	7.0	4.2	2.6
South Asia	7.2	7.3	11.0	5.5
Sub-Saharan Africa	5.5	6.8	10.4	4.4
High income	5.9	5.6	4.5	2.5
Middle income	6.0	6.4	10.2	4.2
Low income	4.8	5.5	11.3	6.6

Source: World Bank (2023)

Table 2: Catalysts for Economic Development: Regional Comparison

Region/ Group	Individuals using the Internet (% of population)		Subsidies and other transfers (% of expense)		Interest rate spread (%)	
	2008	2021	2008	2021	2008	2021
World	23.0	63.1	40.2	47.2	6.2	
North America	74.3	91.9	60.8	71.0		
European Union	62.2	86.8	47.0	51.6		
South Asia	4.4	42.8	27.1	34.1	6.3	5.4
Sub-Saharan Africa	3.7	35.9		27.7*	6.7	8.1*
High income	68.1	90.1	49.4	56.7		
Middle income	14.6	61.2	36.8	41.1*	6.5	5.5
Low income	1.6	22.3			8.9	
*' 2020						

Source: World Bank (2023)

Table 3 and 4 unleash some interesting observations. The permanent cropland in South Asia is much higher than rest of world. Similarly, the ratio of permanent cropland as percentage of land area is significantly higher in middle income countries. More than 80 percent global population lives in in middle- and low-income countries, but share of middle- and low-income countries in global GDP is less than 40 percent. Their share in global GDP has increased significantly in 2021 as compare to 2008. This is mainly attributed to South Asia (mainly India).

Table 3: Economic Volume: Regional Comparison

Region/ Group	Share in Global Population (%)		Share in Global GDP (%)		Permanent cropland (% of land area)	
	2008 (World Population: 6.8 billion)	2021 (World Population: 7.9 billion)	2008 (World GDP: 64.1 trillion)	2021 (World GDP: 96.5 trillion)	2008	2021
World	100.0	100.0	100.0	100.0	1.2	1.3*
North America	5.0	4.7	25.5	26.2	0.2	0.2*
European Union	6.5	5.7	25.4	17.8	3.0	3.0*
South Asia	23.7	24.1	2.4	4.2	3.0	3.5*
Sub-Saharan Africa	12.2	15.0	2.0	2.0	1.1	1.3*
High income	17.1	15.7	72.7	62.0	0.5	0.5*
Middle income	75.1	74.8	26.0	37.1	1.6	1.9*
Low income	7.3	9.0	0.5	0.6	0.6	0.8*
*' 2020						

Source: World Bank (2023)

Table 4: Population and Economic Growth: Regional Comparison

Region/ Group	Population growth (annual %)		GDP growth (annual %)		GDP per capita (USD)	
	2008	2021	2005	2021	2008	2021
World	1.2	0.9	2.1	5.9	9428	12237
North America	1.0	0.2	0.2	5.8	48398	68370
European Union	0.3	-0.1	0.6	5.4	37050	38411
South Asia	1.5	1.0	3.3	8.0	947	2150
Sub-Saharan Africa	2.8	2.6	5.1	4.2	1531	1633
High income	0.8	0.0	0.5	5.2	40065	48225
Middle income	1.2	0.8	5.9	7.0	3264	6074
Low income	2.8	2.7	4.7	2.6	624	794

Source: World Bank (2023)

Table 5: Logistic Infrastructure and Economic Miseries- Top10 Countries

Rank	Country	Logistics performance Index: infrastructure (1=low to 5=high)	Unemployment (% of total labor force)	Inflation-consumer prices (%)	Crop production index (2014-2016 = 100)	Food production index (2014-2016 = 100)	Permanent crop land (% of total area)
1	Germany	4.37	3.4	1.7	81.4	91.6	0.57
2	Japan	4.25	2.4	1.0	96.5	99.5	0.76
3	Sweden	4.24	6.4	2.0	64.1	84.2	0.01
4	Netherlands	4.21	3.8	1.7	93.5	96.2	1.13
5	Austria	4.18	4.8	2.0	98.8	100.5	0.81
6	Singapore	4.06	3.6	0.4	105.9	113.2	0.14
7	United States	4.05	3.9	2.4	100.2	103.4	0.30
8	United Kingdom	4.03	4.0	2.3	91.3	99.6	0.19
9	United Arab Emirates	4.02	2.4	3.1	99.2	109.2	0.55
10	Switzerland	4.02	4.7	0.9	107.6	101.7	0.64

Source: Author's compilation based on World Bank (2023)

Table 6: Logistic Infrastructure and Economic Miseries- Bottom10 Countries

Rank	Country	Logistics performance Index: infrastructure (1=low to 5=high)	Unemployment (% of total labor force)	Inflation-consumer prices (%)	Crop production index (2014-2016 = 100)	Food production index (2014-2016 = 100)	Permanent crop land (% of total area)
147	Equatorial Guinea	1.88	8.6	1.3	101.5	101.5	1.75
148	Eritrea	1.86	5.9		100.3	102.4	0.02
159	Angola	1.86	7.4	19.6	106.1	106.2	0.25
150	Zimbabwe	1.83	4.8	10.6	136.1	115.0	0.26
151	Gambia, The	1.82	9.5	6.5	89.5	92.7	0.49
152	Sierra Leone	1.82	4.7	16.0	88.6	88.5	2.29
153	Somalia	1.81	18.9		103.7	97.8	0.04
154	Afghanistan	1.81	11.2	0.6	94.9	97.5	0.33
155	Guinea-Bissau	1.78	6.0	0.4	102.3	102.3	8.89
156	Guinea	1.56	5.0	9.8	115.6	115.4	2.85

Source: Author's compilation based on World Bank (2023)

2. Methodology: Determinants and Consequences of Food and Crop Size

In this study, we have tested that how crop and food productions, inflation and unemployment rates are affected by the logistic infrastructure and services. The rates of inflation and unemployment have been taken as indicators of economic miseries of common peoples in a country, while it is postulated that these indicators have been affected by the production of food and other crops. The effects of logistic infrastructure and services on production of food and other crops have been investigated. The relations and interaction of the explained and explanatory variables have been shown in Figure: 1. The impacts of explanatory factors on crop production (CRPINDX), food production (FOOD), rate of inflation (INFLCPI) and rate of unemployment (UNEMPL) can be explained in the following equation:

$$CRPINDX_{it} = \beta LGSTINF_{it} + \gamma INTRNT_{it} + \Omega SUBSD_{it} + \delta X_{it} + \mu_i + \tau_t + \epsilon_{it}$$
$$FOOD_{it} = \beta LGSTINF_{it} + \gamma INTRNT_{it} + \Omega SUBSD_{it} + \delta X_{it} + \mu_i + \tau_t + \epsilon_{it}$$
$$INFLCPI_{it} = \beta FOOD_{it} + \gamma INTRLND_{it} + \Omega SUBSD_{it} + \delta X_{it} + \mu_i + \tau_t + \epsilon_{it}$$
$$UNEMPL_{it} = \beta CRPINDX_{it} + \gamma INTRNT_{it} + \Omega GROW_{it} + \delta X_{it} + \mu_i + \tau_t + \epsilon_{it}$$

Where 'CRPINDXit' is crop production index (at base year 2014-16), of country 'i' in year 't'; 'FOODit' is food production index (at base year 2014-16) of country 'i' in year 't'; 'INFLCPIit', 'UNEMPLit' and 'LGSTINFit' are vectors of variables related to 'inflation rate for consumer prices', 'unemployment rate' and logistic infrastructure index. 'Xit' is a vector of exogenous control variables; 'μi' denotes unobserved time-invariant heterogeneity at the country level; 'τt' is a country-fixed effect; and 'εijt' is an independent disturbance term. The descriptions of variables have been shown in Table 7.

The above-mentioned equations have shown the direct effects of logistic infrastructure and services (LGSTINF) on the production of food (FOOD) and crops (CRPINDX). While, the indirect effects of logistic infrastructure and services (LGSTINF) on economic miseries' indicators - inflation (INFLCPI) and unemployment (UNEMPL) can be expressed as follows:

$$\frac{dINFLCPI}{dLGSTINF} = \frac{\partial INFLCPI}{\partial FOOD} \cdot \frac{\partial FOOD}{\partial LGSTINF}$$

$$\frac{dUNEMPL}{dLGSTINF} = \frac{\partial UNEMPL}{\partial CROP} \cdot \frac{\partial CROP}{\partial LGSTINF}$$

Several control variables to estimate the net effects of logistic infrastructure (LGSTINF) on crop production (CRPINDX), food production (FOOD), rate of inflation (INFLCPI) and unemployment rate (UNEMPL) have been included in the estimations. These relations can be expressed in the following 4 equations:

$$CRPINDX_{it} = \propto_i + \beta_1(LGSTINF_{it} * AFR_i) + \beta_2(LGSTINF_{it} * CAREC1_i) + \beta_3(LGSTINF_{it} * SAARC_i) + \beta_4 INTRNT_{it} + \beta_5 SUBSD_{it} + \beta_6 CRPLND_{it} + \beta_7 TXTGDP_{it} + \varepsilon_{it} \quad (1)$$

$$FOOD_{it} = \propto_i + \beta_1(LGSTINF_{it} * AFR_i) + \beta_2(LGSTINF_{it} * CAREC1_i) + \beta_3(LGSTINF_{it} * SAARC_i) + \beta_4 INTRNT_{it} + \beta_5 SUBSD_{it} + \beta_6 CRPLND_{it} + \beta_7 TXTGDP_{it} + \varepsilon_{it} \quad (2)$$

$$INFLCPI_{it} = \propto_i + \beta_1 FOOD_{it} + \beta_2 INTRLND_{it} + \beta_3 SUBSD_{it} + \beta_4 POPGRW_{it} + \beta_5 GROW_{it} + \beta_6 CRPINDX_{it} + \varepsilon_{it} \quad (3)$$

$$UNEMPL_{it} = \propto_i + \beta_1 CRPINDX_{it} + \beta_2 INTRNT_{it} + \beta_3 GROW_{it} + \beta_4 LGSTINF_{it} + \beta_5 DCPS_{it} + \varepsilon_{it} \quad (4)$$

First equation in the model identifies the determinants of volume of crop production in a country. It is postulated that crop production in a country is positively affected by more use of internet (INTRNT). The use of internet (INTRNT) improves informational efficiency which provides in time information about the weather conditions, trends of crop prices and demand of various crops by industrial consumers and common peoples. Similarly, crop production (CRPINDX) is affected by the logistic infrastructure and facilities in a country (LGSTINF)). The logistic infrastructure and services (LGSTINF) facilitate farmers in transportation of agricultural products to the markets. So, it may improve size of crop production (CRPINDX). It is also hypothesized that subsidies (SUBSD) play and important role in the improvement of crop size. The subsidies (SUBSD) can be transferred to the producers either through support price mechanism or direct subsidies to the buyers. In this equation, we have also tested the effects of the size of cropped area (CRPLND) and tax to GDP ratio (TXTGDP). The interaction of logistic infrastructure performance index (LGSTINF) with the special characteristics of CAREC and ECO member countries (except China and Turkey), Sub-Sahara African countries and South Asian countries are captured by slop dummy variables.

In second equation, it is hypothesized that logistic infrastructure (LGSTINFR), use of internet (INTRNT) and subsidies (SUBSD) will affect the magnitude of food production (FOOD) positively. The positive effect of crop area (CPLND) is also expected, while tax to GDP ratio may affect the crop size (negatively). The interaction of logistic infrastructure performance index (LGSTINF) with the special characteristics of CAREC and ECO member countries (CAREC1), Sub-Sahara African countries (AFR) and South Asian countries (SAARC) are captured by slop dummy variables.

The determinants of inflation rate (INFLCPI) have been tested in third equation. The magnitude of food production (FOOD), rate of interest for lending (INTRLND) and subsidies (SUBSD) have been taken as explanatory variables. The population growth (POGRW) is an indicator of demand-pull factors of inflation. So, this variable has also been included in the equation.

The effects of crop size (CRPINDX), use of internet by common peoples (INTRNT) and GDP growth (GROW) on unemployment rate (UNEMPL) have been tested through forth equation in this study.

Some other control variables have also been included in these equations. The descriptions of these variables and sources of data have been mentioned in Table 7. Figure: 2 explains the categories of variables. The interest rate on lending (INTRLND), subsidies and transfer payments (SUBSD), tax to GDP ratio (TXTGDP) and domestic credit to private sector (DCPS) have been classified as policy tools in this study while access and use of internet (INTRNT) has been defined as a catalyst in determination of crop size (CRPINDX), food production (FOOD) and unemployment (UNEMPL).

For estimation of the above-mentioned equations, we used the data of 187 countries for 14 years (2008 to 2021). This sample provides us an unbalanced panel data. The data of other countries could not be included in the model because unavailability of data on some indicators which are included in the analysis. Data for this analysis was extracted from the World Development Indicators' Data Bank (World Bank: 2023). The logistic infrastructure performance index (LGSTINF) is one of the main variables in this study. However, the data for logistic infrastructure index (LGSTINF) is available only for 5 years: 2010, 2012, 2014, 2016 and 2018. Unfortunately, the data of this variable is not available for other years. So, we could not measure the effects of COVID-19 and Russia-Ukraine war.

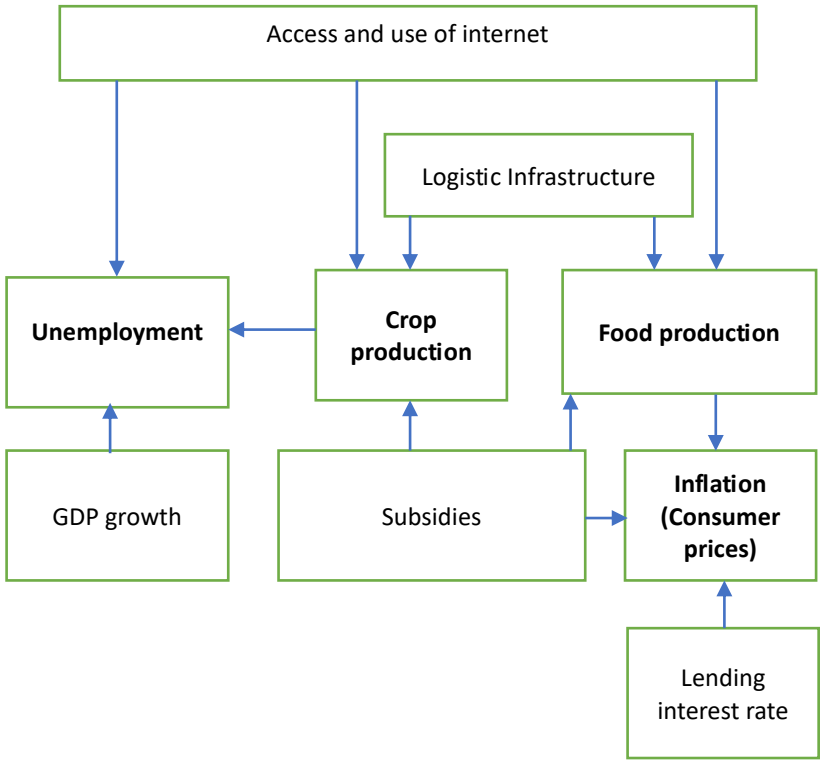
The Food and Agriculture Organization (FAO) is the primary source of data for crop and food production index (World Bank, 2023). Agricultural data are collected by the Food and Agriculture Organization of the United Nations (FAO) from official national sources through annual questionnaires and are supplemented with information from official secondary data sources. Crop production data refer to the actual harvested production from the field or orchard and gardens, excluding harvesting and threshing losses and that part of crop not harvested for any reason. Production therefore includes the quantities of the commodity sold in the market and the quantities consumed or used by the producers. Since the FAO indices are based on the concept of agriculture as a single enterprise, amounts of seed and feed are subtracted from the production data to avoid double counting. The "international commodity prices" are used in order to avoid the use of exchange rates and also to facilitate international comparative analysis of productivity at the national level. These international prices are expressed in

“international dollars," which have been derived by using Geary-Khamis formula for the agricultural sector. This method assigns a single price to each commodity regardless of the country where it was produced. The commodities covered in the computation of indices of agricultural production are all crops and livestock products originating in each country. The FAO indices show the relative level of the aggregate volume of agricultural production for each year in comparison with the base period 2014-2016. They are based on the sum of price-weighted quantities of different agricultural commodities produced after deductions of quantities used as seed and feed weighted in a similar manner. So, the resulting aggregate represents disposable production for any use except as seed and feed. All the indices at the country, regional and world levels are calculated by the Laspeyres formula. These indices may differ from those produced by the countries themselves because of differences in concepts of production, coverage, time periods, weights, time reference of data, methods of calculation, and use of international prices.

Crop production index shows agricultural production for each year relative to the base period 2014-2016. The commodities covered in the computation of indices of agricultural production are all crops and livestock products originating in each country. Practically all products are covered, with the main exception of fodder crops. The food production index includes commodities that are considered edible and that contain nutrients. Accordingly, coffee and tea are excluded along with inedible commodities because, although edible, they have practically no nutritive value.

To estimate the parameters through above-mentioned regressions, we applied panel least square (PLS) technique. We applied fixed effect models (FEM) to estimate the effects of explanatory variables on rates of inflation (INFLCPI) and unemployment (UNEMPL). However, for estimation of the production of crop (CRPINDX) and food (FOOD), the common effect models (CEM) have been applied. The selection of the common effect model (CEM) and fixed effect model (FEM) is based on the Chow Index and Hausman Test. The magnitude of Chow index and Hausman Test have been reported in Table 8 to 11. At first, stage, we conducted Chow Test. The estimated parameters of Chow tests have been reported in the respective tables. The Chow tests have suggested that common effect model is appropriate for estimation of crop size (CRPINDX) and food production (FOOD). However, acceptance of F-statistics and Wald Statistics indicate that common effect model (CEM) is not appropriate for estimation of inflation rate (INFLCPI) and unemployment rate (UNEMPL). Based on Hausman tests, we estimated the regression parameters in determination of inflation rate (INFLCPI) and unemployment (UNEMPL) through fixed effect models (FEM). For comparison and transparency purposes, all the tests have been reported in the respective tables.

Figure 1: Logistic Services, Crop Production and Economic Miseries (A Naive Picture of Connections)



Source: Author's depiction

Table 7: List of Variables and Sources of Data

Abbreviation	Definition	Source
AFR	Dummy variable equal to "1" if country belongs to Sub-Saharan Africa, and "0" otherwise	Author's depiction
CAREC	Dummy variable equal to '1' if a country is member of 'CAREC' or 'ECO' and '0' otherwise	Author's depiction
CAREC1	Dummy variable equal to '1' if a country is member of 'CAREC' or 'ECO' (excluding China and Turkey) and '0' otherwise	Author's depiction
CRPINDX	Crop production index (2014-2016 = 100)	Food and Agriculture Organization/ World Bank (2023)
CRPLND	Permanent crop land (% of total area)	Food and Agriculture Organization/ World Bank (2023)
DBUS	Business density (new businesses registrations per 1,000 people ages 15-64)	World Development Indicators; World Bank (2023)
DCPS	Domestic credit to private sector as % of GDP	International Financial Statistics, International Monetary Fund (2022)

FOOD	Food production index (2014-2016 = 100)	Food and Agriculture Organization/ World Bank (2023)
GDP	GDP (Billion USD)	World Development Indicators; World Bank (2023)
GROW	GDP growth (annual %)	World Development Indicators; World Bank (2023)
INFLCPI	Inflation- consumer prices (annual %)	World Development Indicators; World Bank (2023)
INTRLND	Average interest on lending (%)	World Development Indicators; World Bank (2023)
INTRNT	Individuals using the Internet (% of population)	World Development Indicators; World Bank (2023)
LGSTINF	Logistics performance (Quality of trade and transport-related infrastructure) index (1=low to 5=high)	World Development Indicators; World Bank (2023)
LGSTOVR	Logistics performance (Overall) index (1=low to 5=high)	World Development Indicators; World Bank (2023)
LGSTQLY	Logistics performance (Competence and quality of logistics services) index (1=low to 5=high)	World Development Indicators; World Bank (2023)
PCI	Per capita income in USD	World Development Indicators; World Bank (2023)
POP	Population (in Million)	World Development Indicators; World Bank (2023)
POPGRW	Population growth (annual %)	World Development Indicators; World Bank (2023)
SAARC	Dummy variable equal to "1" if country is member of SAARC, and "0" otherwise	Author's depiction
SUBSD	Subsidies and other transfers (% of government expenditures)	World Development Indicators; World Bank (2023)
TXTGDP	Tax revenue as % of GDP	World Development Indicators; World Bank (2023)
UNEMPL	Unemployment (% of total labor force)	World Development Indicators; World Bank (2023)

Source: Author's depiction

Figure 2: Classification of Variables

Target Variables
• Crop production • Food production • Inflation (Consumer prices) • Unemployment
Major Factors
• Logistic services and infrastructure • Crop area • GDP growth • Per capita income
Policy Variables
• Subsidies • Lending rate of interest • Tax to GDP ratio • Domestic credit to private sector

Instrumental Variables
• Food production • Crop production
Catalysts
• Use and access of internet
Exogenous Factors
• Population growth rate
Economic Grouping
• CAREC member countries • SAARC member countries • Sub-Saharan Africa

Source: Author's depiction

3. Results and Empirical Evidences

The results of regression analysis have been presented in Tables 8 to 11. The significance of parameters and overall goodness of fit in the equations have also been reported in the above-mentioned tables. The parameters associated with the betas show quantifications of the impacts of explanatory variables. The adjusted R-squares and F-statistics show goodness of fit in all estimated equations, which indicate that explanatory variables included in the models significantly cover the sufficient effects. The robustness in estimated parameters have also been checked by using the alternatives options.

It has been observed that use of internet by common peoples (INTRNT) is an important catalyst in improving the size of crop (CRPINDX) and food production (FOOD). It plays an important role in alleviation of unemployment (UNEMPL) also. The interaction variables (Slop dummies) indicate that logistic facilities and infrastructure (LGSTINF) play significant role in the improvement of food production (FOOD) in South Asian, Central Asian and Sub-Sahara African countries. The production of non-food crops is also improved by logistic facilities and infrastructure in Central Asian countries and Sub-Saharan Africa. These results are consistent in all alternative scenarios.

The empirical evidences show surprising role of subsidies and transfer payments (SUBSD). It is a common intuitive that subsidies can reduce the prices of consumers' goods. However, the results of this study show an opposite picture of this relation. The subsidies and transfer payments (SUBSD) are a contributing factor of inflation (INFLCPI). More subsidies (SUBSD) mean more inflation (INFLCPI). Even, the role of subsidies (SUBSD) is not positive in determination of crop size (CRPINDX) and food production (FOOD). The significant negative relation between GDP growth (GROW) and unemployment (UNEMPL) confirms the famous Philip's Curve theory in macroeconomics.

The growth in food production (FOOD) alleviates the inflation in consumer prices. Similarly, growth in production of non-food crops alleviates unemployment. It explains that growth in agriculture production generates economic activities to employ the people. The negative relation between unemployment and growth in agriculture

production is significant and robust in this study. No significant role of tax to GDP ratio has been noted in determination of food and crop production. The role of domestic credit to private sector (DCPS) in growth of agriculture production is not significant, which is consistent with previous findings (Mehar: 2022).

Table 8: Dependent Variable: Crop production index (CRPINDX) Method: Common Least Square Sample (adjusted): 2008-21 Periods included: 14; Cross-sections included: 187 Total panel (unbalanced) observations: 510

Independent Variable/ Option	Coefficients				
	I	II	III	IV	V
Constant	95.538*** (42.160)	95.485*** (41.458)	95.657*** (41.726)	95.739*** (41.486)	95.920*** (41.604)
LGSTINF*AFR: Logistics performance (infrastructure) index*Dummy variable equal to "1" if country belongs to Sub-Saharan Africa	2.695*** (3.653)			2.961*** (3.961)	2.974*** (3.983)
LGSTOVR*AFR: Logistics performance (Overall) index*Dummy variable equal to "1" if country belongs to Sub-Saharan Africa		2.451*** (3.538)			
LGSTQLY*AFR: Logistics performance (quality) index* Dummy variable equal to "1" if country belongs to Sub-Saharan Africa			2.458*** (3.476)		
LGSTINF*CAREC1: Logistics performance (infrastructure) index*Dummy variable equal to '1' if a country is member of 'CAREC' or 'ECO' (excluding China and Turkey)	1.434 (1.344)			3.352*** (2.725)	3.725*** (2.933)
LGSTOVR*CAREC1: Logistics performance (Overall) index*Dummy variable equal to '1' if a country is member of 'CAREC' or 'ECO' (excluding China and Turkey)		1.294 (1.292)			
LGSTQLY*CAREC1: Logistics performance (quality) index* Dummy variable equal to '1' if a country is member of 'CAREC' or 'ECO' (excluding China and Turkey)			1.267 (1.202)		
LGSTINF*SAARC: Logistics performance (infrastructure) index*Dummy variable equal to "1" if country is member of SAARC	1.693 (1.464)			1.480 (1.280)	-1.629 (-0.550)
LGSTOVR*SAARC: Logistics performance (Overall) index*Dummy variable equal to "1" if country is member of SAARC		1.474 (1.407)			
LGSTQLY*SAARC: Logistics performance (quality) index* Dummy variable equal to "1" if country is member of SAARC			1.451 (1.369)		

INTRNT: Individuals using the Internet (% of population)	0.086*** (3.099)	0.085*** (3.053)	0.084*** (3.001)	0.087*** (2.643)	0.093*** (3.093)
SUBSD: Subsidies and other transfers (% of government expenditures)	-0.088*** (-2.755)	-0.088*** (-2.745)	-0.088*** (-2.752)	-0.075** (-2.222)	-0.081** (-2.392)
CRPLND: Permanent crop land (% of total area)	0.221* (1.665)	0.221* (1.658)	0.216 (1.621)	0.209 (1.556)	0.217 (1.629)
TXTGDP: Tax revenue as % of GDP	-0.111 (-1.170)	-0.106 (-1.117)	-0.106 (-1.124)	-0.172 (-1.616)	-0.177* (-1.731)
DCPS: Domestic credit to private sector as % of GDP				0.003* (0.168)	
DCPS*SAARC: Domestic credit to private sector as % of GDP*Dummy variable equal to "1" if country is member of SAARC					0.167 (1.147)
Adjusted R-squared	0.037	0.035	0.035	0.044	0.046
F-statistic	3.812	3.675	3.599	3.712	3.883
S.E. of regression	12.034	12.045	12.051	11.866	11.850
Akaike Inf. Criterion	7.829	7.831	7.832	7.804	7.801
Schwarz Criterion	7.895	7.897	7.898	7.883	7.880
H-Q Criterion	7.855	7.857	7.858	7.835	7.832
Chow Breakpoint Test (Null Hypothesis: No breaks at 2010)					
F-statistic	0.711	0.691	0.708	0.783	0.726
Wald Statistic	5.687	5.527	5.661	7.050	6.530
Chow Breakpoint Test (Null Hypothesis: No breaks at 2018)					
F-statistic	0.548	0.532	0.546	0.720	0.671
Wald Statistic	4.383	4.256	4.371	6.481	6.042
#T-Statistics in parenthesis *p < 0.1; **p < 0.05; ***p < 0.01					

Source: Author's Estimations

Table 9: Dependent Variable: Food production index (FOOD) Method: Common Least Square Sample (adjusted): 2008-21 Periods included: 14; Cross-sections included: 187 Total panel (unbalanced) observations: 510

Independent Variable/ Option	Coefficients				
	I	II	III	IV	V
Constant	94.342*** (54.443)	94.256*** (53.512)	94.382*** (53.838)	94.333*** (53.568)	94.570*** (53.680)
LGSTINF*AFR: Logistics performance (infrastructure) index*Dummy variable equal to "1" if country belongs to Sub-Saharan Africa	2.441*** (4.327)			2.600*** (4.556)	2.619*** (4.591)
LGSTOVR*AFR: Logistics performance (Overall) index*Dummy variable equal to "1" if country belongs to Sub-Saharan Africa		2.236*** (4.220)			
LGSTQLY*AFR: Logistics performance (quality) index* Dummy variable equal to "1" if country belongs to Sub-Saharan Africa			2.259*** (4.177)		
LGSTINF*CAREC1: Logistics performance (infrastructure) index*Dummy variable equal to '1' if a	0.426 (0.523)			1.657* (1.764)	1.970** (2.030)

country is member of 'CAREC' or 'ECO' (excluding China and Turkey)					
LGSTOVR*CAREC1: Logistics performance (Overall) index*Dummy variable equal to '1' if a country is member of 'CAREC' or 'ECO' (excluding China and Turkey)		0.398 (0.520)			
LGSTQLY*CAREC1: Logistics performance (quality) index*Dummy variable equal to '1' if a country is member of 'CAREC' or 'ECO' (excluding China and Turkey)			0.390 (0.484)		
LGSTINF*SAARC: Logistics performance (infrastructure) index*Dummy variable equal to "1" if country is member of SAARC	2.258*** (2.552)			2.322*** (2.632)	0.379 (0.167)
LGSTOVR*SAARC: Logistics performance (Overall) index*Dummy variable equal to "1" if country is member of SAARC		2.005** (2.502)			
LGSTQLY*SAARC: Logistics performance (quality) index*Dummy variable equal to "1" if country is member of SAARC			1.976** (2.439)		
INTRNT: Individuals using the Internet (% of population)	0.112** (5.296)	0.112*** (5.242)	0.111*** (5.200)	0.135*** (5.347)	0.127*** (5.551)
SUBSD: Subsidies and other transfers (% of government expenditures)	-0.077*** (-3.133)	-0.076*** (-3.122)	-0.077*** (-3.130)	-0.076*** (-2.984)	-0.079*** (-3.052)
CRPLND: Permanent crop land (% of total area)	0.079 (0.776)	0.079 (0.781)	0.076 (0.749)	0.085 (0.829)	0.077 (0.757)
TXTGDP: Tax revenue as % of GDP	-0.063 (-0.870)	-0.058 (-0.807)	-0.059 (-0.819)	-0.096 (-1.183)	-0.122 (-1.566)
DCPS: Domestic credit to private sector as % of GDP				-0.011 (-0.877)	
DCPS*SAARC: Domestic credit to private sector as % of GDP* Dummy variable equal to "1" if country is member of SAARC					0.099 (0.887)
Adjusted R-squared	0.056	0.054	0.053	0.062	0.062
F-statistic	5.324	5.166	5.102	4.927	4.930
S.E. of regression	7.292	9.211	9.215	9.055	9.055
Akaike Inf. Criterion	7.359	7.294	7.295	7.263	7.263
Schwarz Criterion	7.318	7.361	7.362	7.342	7.342
H-Q Criterion		7.320	7.321	7.294	7.294
Chow Breakpoint Test (Null Hypothesis: No breaks at 2010)					
F-statistic	0.770	0.772	0.802	0.794	0.717
Wald Statistic	6.158	6.176	6.416	7.144	6.456
Chow Breakpoint Test (Null Hypothesis: No breaks at 2018)					
F-statistic	0.630	0.635	0.663	0.763	0.691
Wald Statistic	5.043	5.076	5.307	6.864	6.217
#T-Statistics in parenthesis *p < 0.1; **p < 0.05; ***p < 0.01					

Source: Author's Estimations

Table 10: Dependent Variable: Inflation- Consumer prices (INFLCPI) Method: Fixed Effect Model (Panel Least Square) Sample (adjusted): 2008-20 Periods included: 13; Cross-sections included: 100 Total panel (unbalanced) observations: 1026

Independent Variable/ Option	Coefficients				
	I	II	III	IV	V
Constant	7.293*** (4.027)	8.073*** (4.271)	7.628*** (4.114)	8.392*** (4.379)	7.490*** (4.013)
FOOD: Food production index	-0.053*** (-4.100)	-0.048*** (-3.637)	-0.055*** (-4.175)	-0.046*** (-3.433)	-0.066*** (-3.093)
INTRLND: Lending rate of interest (%)	0.464*** (8.765)	0.463*** (8.778)	0.461*** (8.644)	0.459*** (8.664)	0.463*** (8.661)
SUBSD: Subsidies and other transfers (% of government expenditures)	-0.068*** (-2.546)	-0.066** (-2.450)	-0.070*** (-2.575)	-0.062** (-2.297)	-0.069** (-2.531)
POPGRW: Population growth (annual %)	-0.104 (-0.548)		-0.094 (-0.492)		-0.101 (-0.327)
POP: Population (Million)		-0.033 (-1.503)		-0.033 (-1.493)	
GROW: GDP growth (%)			-0.037 (-1.044)		-0.037 (-1.061)
PCI: Per capita income in USD				-0.00001 (-1.006)	
CRPINDX: Crop production index					0.012 (0.662)
Adjusted R-squared	0.480	0.481	0.478	0.481	0.477
F-statistic	10.178	10.218	9.993	10.130	9.895
S.E. of regression	3.990	3.936	3.965	3.936	3.966
Akaike Inf. Criterion	5.463	5.674	5.689	5.675	5.691
Schwarz Criterion	5.676	6.174	6.198	6.179	6.201
H-Q Criterion	6.176	5.864	5.882	5.867	5.885
Hausman Test (Cross-section random Chi- Sqr)	31.535***	27.427***	37.302***	34.039***	38.120***
Chow Breakpoint Test (Null Hypothesis: No breaks at 2010)					
F-statistic	9.013	9.139	8.747	6.257	7.801
Wald Statistic	45.067	45.693	52.486	37.539	54.612
Chow Breakpoint Test (Null Hypothesis: No breaks at 2018)					
F-statistic	9.013	9.139	8.747	6.257	7.801
Wald Statistic	45.067	45.693	52.486	37.539	54.612
#T-Statistics in parenthesis *p < 0.1; **p < 0.05; ***p < 0.01					

Source: Author's Estimations

Table 11: Dependent Variable: Unemployment- % of total labor force (UNEMPL) Method: Fixed Effect Model (Panel Least Square) Sample (adjusted): 2010-18 Periods included: 5; Cross-sections included:163 Total panel (unbalanced) observations: 744

Independent Variable/ Option	Coefficients				
	I	II	III	IV	V
Constant	10.683*** (11.398)	8.513*** (8.434)	11.282*** (11.783)	11.189*** (10.592)	8.822*** (8.453)
CRPINDX: Crop production index	-0.020*** (-3.524)	-0.029*** (-4.702)	-0.020*** (-3.476)	-0.025*** (-3.751)	-0.028*** (-4.551)
INTRNT: Individuals using the Internet (% of population)	-0.020*** (-2.873)	-0.023*** (-3.309)	-0.021*** (-3.105)	-0.021*** (-2.808)	-0.025*** (-3.435)
GROW: GDP growth			-0.056*** (-3.611)	-0.054*** (-3.311)	-0.029* (-1.819)

LGSTINF: Logistics performance (infrastructure) index	0.002 (0.006)	0.059 (0.189)	-0.130 (-0.424)	0.021 (0.062)	-0.013 (-0.041)
DCPS: Domestic credit to private sector as % of GDP		0.056*** (8.491)			0.054*** (7.864)
DCPS*SAARC: Domestic credit to private sector as % of GDP*Dummy variable equal to "1" if country is member of SAARC				0.068 (1.348)	0.017 (0.349)
Adjusted R-squared	0.922	0.929	0.921	0.919	0.927
F-statistic	54.321	57.097	53.181	48.717	5(4.463
S.E. of regression	1.667	1.586	1.658	1.679	1.589
Akaike Inf. Criterion	4.053	3.963	4.045	4.079	3.969
Schwarz Criterion	5.082	5.032	5.083	5.159	5.056
H-Q Criterion	4.450	4.377	4.445	4.497	4.390
Hausman Test (Cross-section random Chi- Sqr)	16.425***	27.652***	17.052***	21.030***	30.933***
Chow Breakpoint Test (Null Hypothesis: No breaks at 2010)					
F-statistic	1.609	1.653	1.712	3.470**	2.614***
Wald Statistic	6.437	8.263	8.562	20.818***	18.301***
Chow Breakpoint Test (Null Hypothesis: No breaks at 2018)					
F-statistic	1.705	1.693	1.756	3.527***	2.671***
Wald Statistic	6.819	8.467	8.780	21.160***	18.693***
#T-Statistics in parenthesis *p < 0.1; **p < 0.05; ***p < 0.01					

Source: Author's Estimations

4. Policy Implications and Conclusion

This study supports the supply side policies for relief and alleviation of economic miseries of common peoples. The improvement in logistic facilities and infrastructure is an important significant and robust element of the growth in food and crop production, and improvement in employment opportunities. Empirical evidences do not favor the subsidies, tax exemptions and credit to private sector. The role of these fiscal and monetary measures is not significant in reducing the rate of inflation and improving the employment opportunities. The spending on infrastructure development and logistic improvement provides a sustainable way to enhance agriculture production and reducing economic miseries.

Another important aspect of the study is the improvement in informational efficiency by promoting the access and use of internet. The access and use of internet is a major factor of growth in crop and food production. Moreover, it directly improves employment opportunities. The significant negative effect of the use of internet on unemployment invites the attention of policy makers to focus on the frictionless access of common peoples to information technology. In fact, the internet connectivity improves the informational efficiency in the agriculture farms, crop areas and market places. The frictionless, immediate and cost-free access to relevant information

facilitates the producers in decision making. It establishes linkages between producers of agriculture products and market players. In this way, the information technology becomes an important catalyst in the growth of agriculture production.

It is noteworthy that access and use of internet has been recognized as a significant factor of growth in economic and business activities in various studies (Marlene, Huang, Morgan, and Shirai: 2019, Christian and Hornuf: 2019, Stijn, Frost, Turner and Zhu: 2018 and Mehar: 2021b), while this study recognizes the importance of information technology for growth of food and non-food crop production.

The importance of logistic facilities and infrastructure in the context of South Asia, Central Asia and Sub-Saharan Africa has been highlighted in this study. It is concluded that role of logistic facilities and infrastructure is more important in these countries. So far as financing the logistic facilities and infrastructure is concerned, the public private partnerships, financial guarantees, and utilizing spillover tax revenue may be the possible ways to finance the infrastructure in these countries. The investment banks and venture capital companies may provide the funds for long term large-scale infrastructure projects. However, the domestic credit through commercial banks and money market instruments which are considered good for working capital financing cannot be suitable for long-term financing of infrastructure related projects.

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Author Contributions:

Muhammad Ayub Mehar - Idea, Design, Data Collection, Interpretation of Data, Drafting, Critical Review, Final Approval and Responsibility, Literature Review, Supervising. Overall Contribution - 100%.

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