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ARTICLE

The Impact of Energy Consumption on Agricultural Production in Pakistan

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ABSTRACT

Energy is the key element for economic development as it offers major services for continuing the economic activity, and thus, improves the human life. However, the empirical evidence regarding the influence of energy consumption on agricultural production in the context of developing economies is limited in the current empirical literature. Therefore, this research fulfill this gap by empirically investigating the impact of energy consumption on agriculture Production for Pakistan by collecting time series data based on annual observation from (1980–2020). For estimation purpose, this study employed the Auto Regressive Distributed Lag approach to analyze the existence of long-term connection between energy consumption and agriculture production. The study findings show that the long-term co-integration relationship exist between energy consumption of electricity, oil, and agricultural production. The energy consumption of electricity and oil has a significant and direct impact on agricultural production. The achievement of sustainable development is dependent on the proper energy consumption. Energy consumption is an important index that plays a pivotal role in policy making. Hence, based on empirical results, this study recommends policy makers and Pakistan government to design policies regarding the availability of cheaper elec-

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tricity to small farmers in the rural areas. For this purpose, advance techniques are needed. Therefore, government should allocate more funds for the innovations in the energy sector.

Keywords: Energy Consumption; Agricultural Production; Energy Consumption of Oil and Electricity; Autoregressive Distributed Lag Approach

1. Introduction

Energy consumption can be explained as all the energy that is used to perform an action or produce something. Effective energy use offers several advantages, such as better productivity, lower imports, and higher output levels that stimulate economic expansion. Energy at farm level may be classified into both direct and indirect energy. Direct energy is made up of petroleum-based fuels that are used to power automobiles, trucks, and machinery for field preparation, plantation, crop harvesting, chemical application, input conveyance, and market outputs. Indirect energy is used for the preparation of fertilizers, herbicides, and insecticides. Some energy resources are renewable, and others are non-renewable. Renewable resources are whose supply is replenishing naturally or can be sustained e.g., wind energy, solar energy. A non-renewable resource has a natural element that may not be replenished at a rate in which it is consumed e.g., coal, oil, natural gas etc.

Energy is considered as one of the important factors for achieving the sustainable goals for an economy. The requirement of energy utilization originates from the desire of humans to lead a better and comfortable life and to deal with the problem of scarce resources [1]. The aim was to achieve maximum benefits with limited resources e.g., Land, water, labor, raw materials, tools, time, money etc.

As these resources are limited, the goods produced from these limited resources are also limited. The constant growth in population is also a source of scarcity, thus maximizing the utilization of limited resources through energy is crucial. Energy is required for a variety of human activities, including transportation, manufacturing, building, and technology, but it is also an essential component of the agriculture sector.

Those countries experiencing an energy crisis also face a decrease in investors and economic activity since investors are hesitant to invest in these countries. Power outages are an issue in these economies such as Pakistan; when there is not enough supply of electricity, gas, and water. Hence, it is extremely difficult to operate the business in these countries.

Also, in this scenario the use of energy is not possible. There is a need to first solve the problem of power outages [1].

A good quality of life depends on the availability of fresh, renewable, and inexpensive energy [2–4]. Countries that depend mainly on the agriculture sector may significantly get benefit from sufficient energy at a fair price. Unfortunately, Pakistan is facing a problem of shortage of electricity supply as compared to its demand. This demand is further increasing due to increase in population and the development of the agriculture and industrial sector. Increasing energy prices hampering the pace of development in the country and create problems such as food insecurity and poverty [5].

The energy crisis, agriculture productivity, and poverty are closely related with each other, particularly in rural areas of developing economies. The energy crisis is in turn affecting the lives of farmers in three ways. First, when there is an energy crisis, it leads to disruptions in the energy supply. Second, farmers in developing countries have no options to substitute for these energy supply disruptions. Finally, these farmers are highly dependent on agriculture sector because it is the only source of income for them. The agriculture sector is highly affected by such small variations in inputs and these inputs are affected by energy supply [6]. It is also observed that farmers who have adequate access to energy and other facilities like better irrigated land, availability of credit etc., are low probability to keep fewer hectares of their land fallow.

High economic growth has always been one of the top priorities of policy makers, as it is considered as the yardstick for measuring the performance of politicians, economists and the public sector in general.

One measure of economic performance is the availability and effective utilization of scarce resources. In a country where agriculture plays a major role such as Pakistan's, the agricultural sector is vital, accounting for 19.3% of GDP and employing 35.89% of the workforce [7].

Since the COVID-19 pandemic, Pakistan economy has faced extraordinary challenges. It has also highlighted the importance of agricultural sector performance and alarmed the need to maintain/ensure sufficient food security and livelihoods. Among the contributory factors of agriculture production, energy consumption is an important factor of production.

Although the electricity supply situation in Pakistan has improved over the past decade. According to UNDP statistics, the percentage of peoples with access to electricity increased from 78% to 87% during the period of 2000–2016. Despite this fact, Pakistan still has a long way to go in order to achieve SDG-7 by 2030, which is to offer clean and inexpensive energy to its citizens by investing more in solar power, wind, and thermal energy projects to improve the infrastructure technology, productivity, and energy consumption, thereby, ensuring energy for all. None of the production activities is possible without adequate energy supply and consumption. The energy input per unit of output must be managed or reduced to improve the energy consumption which can be obtained with the desired variation of the energy inputs according to the input-output relationship.

From the review literature, it has been observed that there is still a gap regarding the association among agriculture production and energy consumption especially for developing economy, Pakistan. The agriculture sector of Pakistan has suffered a lot in terms of economic contribution and human resource contribution over the past decades due to energy crisis. As our economy is based on agriculture and has contributed significantly to GDP and labor absorption (of an overpopulated country with 6.65 million unemployed in 2020, or 5.1% by October 2020). Pakistan's imports of primary agricultural products had increased due to the above factor. There is a need for both direct energy consumption of fuel and electricity (to run different methods of agricultural production) and indirect consumption (production of agricultural inputs such as fertilizers or pesticides). Therefore, the main aim of the current study is to cover this gap by investigating the impact of energy consumption on agriculture production for Pakistan over the period from 1960–2019. The Autoregressive Distributed Lag Approach (ARDL) is employed to investigate the co-integration relationship between agricultural production and energy consumption for both the short term and long term.

This research will make an important contribution in the existing empirical literature by providing evidence among the relationship between energy consumption and agricultural economic growth for Pakistan. It will help policy makers to make a sustainable policy regarding the efficient utilization of energy consumption and its impacts on economic growth.

The remaining sections is structured as follows: Section 2 discusses the literature review. Section 3 describes the model, methodology, and data sources. Section 4 concludes the study results and suggest some policy recommendations.

Literature Review

Po-Chi et al. [8] examined productivity growth in all aspects of the agricultural sector in China from 1990–2003. The findings reveal that technological advancement, tax cuts, public investment in R&D, infrastructure projects, agricultural machinery, and regional diversity are the key factors of production.

Mohammadi [9] investigated the energy consumption of input and output usage in potato production. The findings reveal that the total usage of energy inputs was 81624.96 MJ ha^{-1}. The proportion of direct energy inputs used for potato production was 18% and the proportion of indirect energy inputs was 82%. Their findings revealed that the large usage of inputs in potato production was not followed by an expansion in final output. The cost analysis shows that the total cost of production for one hectare of potato output was $326.17. The benefit cost ratio was estimated as 1.88. Ahmed and Zeshan [10] examined the impact of energy consumption on agriculture sector of Pakistan. They also discussed energy intensity and structural changes in the country over the time. The study results concluded that all of the variables such as aggregate production and structural effect have a positive impact on energy consumption.

Akbar et al.[11] analyzed the long-term relationship among energy efficiency and economic growth for Pakistan. It also explores the relationship among the shares of different sectors of economy and energy efficiency. The results show that unidirectional causal relationship exist from GDP to energy intensity supporting the conservation hypothesis. Further, the results concluded that energy intensity is anticipated to increase with an increase in the shares of the services sector and industry in GDP. They investigated that economic growth leads to an increase in energy intensity. Energy intensity is increasing because of structural changes. As economies progresses, there is a shift from the agricultural sector to industrial sector. This movement in turn lead to energy consumption. As the industrial sector requires more energy consumption relative to agriculture sector.

Fei and Lin[12] examined the impact of usage of different types of technologies and energy inputs on agricultural output. The results revealed that agriculture output depends on many factors such as land, water availability, literacy rate of farmers, size of land etc. If energy inputs are used on fertile land, the results would be different as compared to same energy inputs used on infertile land. Similarly, more educated farmers would be able to use these energy inputs in a more appropriate manner relative to low educated farmers. Likewise, water availability, as water is one of the most important factors in increasing levels of agricultural outputs. Therefore, even when the same kind of energy inputs are used in different parts of the world, a number of factors cause variations in agricultural output.

Yang et al.[13] proposed that other than technology there are various factors that can help to attain energy efficiency. They discussed that if governments in developing countries take steps to combine scattered plots of land into one place, national land markets are created where farmers can have opportunities to perform transactions conveniently. This study found a direct association between farmers' income level and energy consumption. Based on results, the study suggests that policy makers should make a policy aimed at increasing income. For example, loans should be given to them with lenient rules. As when farmers would have more money, they would be able to apply advanced technologies, and therefore, increase their output levels. They also proposed that effective energy policies lead to energy efficiency improvement.

Abbasian and Souri[14] estimated the energy efficiency and productivity of the agricultural sector for New Zealand. They concluded that New Zealand's energy consumption was optimal as indicated by the energy efficiency index. Their findings exhibited a positive relationship between the added value of agriculture sector and energy consumption growth.

Ali and Imtiaz[6] analyzed the influence of the energy crisis on households working on farms. The study findings show that load shedding effects has a negative effect on farmers' income and production levels. The results suggested that a comprehensive policy for reduction in load shedding should be designed by the government. In addition, by announcing the proper duration and timings of load shedding can improve the farm management of farmers. Murshed[15] discussed the impact of energy consumption, its prices, and energy import dependence on gross and sectoral value-added for Sri Lanka. The results concluded that economic growth, both at aggregate and disaggregated level, depends on greater energy consumption. The services and industrial sector are normally more affected by oil prices shocks as compared to agriculture sector. Furthermore, they recommended that Sri Lanka's government should ensure energy security to attain the sustainable gross and sectoral growth. Imported energy dependency should be minimized and domestic investment is highly needed for Sri Lanka.

Rizvi et al.[16] focused on energy consumption for the agriculture sector of Potohar region in Pakistan. They analyzed the potential of renewable energy. This region of our country does not have a proper irrigation system and is irrigated by rainwater or pumping ground water where the pumps run on diesel or electricity. The Potohar region uses only 0.12% of solar energy, 0.01% of wind energy, and 0.22% of biogas. Only 0.2% of renewable energy biogas, solar pumping) is misused. The use of non-renewable energy in our country is at a very limited scale. In Pakistan, at this crucial stage, it is a necessary to implement a renewable energy friendly policy and rigorous adherence may not only save but can also improve the country's foreign exchange reserves.

Using data from the European economies from 2007 to 2016, Zafeiriou et al.[17] investigate the relationship between energy consumption from renewable energy sources and national economic growth. Additionally, the findings indicate that the consumption of renewable energy sources and economic growth are more correlated in nations with higher GDPs than in those with lower GDPs.

Using the nonlinear autoregressive distributed lag (NARDL) cointegration technique, Ntanos et al.[18] also investigated the relationship between agricultural carbon emissions and per capita income for the various EU economies. The results showed that greenhouse gas (GHG) emissions and agricultural revenue are strongly correlated.

Overall, the literature shows that the association between agriculture production and energy consumption is missing in the context of developing economies. This study covers this gap by analyzing the short and long run relationship between energy consumption and agriculture production for developing economy, Pakistan.

2. Materials and Methods

2.1. Theoretical Framework

Almas and Usman[19] proposed that energy is an output function with no strong and separable relationship to labor. This relationship is explained in the given below equation:

$$Q_t = F[g\left(K,E\right),L] \tag{1}$$

Bruno and Sachs[20] also described the connection between the level of production and energy consumption. They explained that the association between imported raw materials and the supply function of the whole economy within a model in which the effects of the rises in the oil price on the supply of the whole economy have been added. The equation of their proposed function is given below:

$$Q_t = F(L,K,R) \tag{2}$$

Where, *Q* represents the gross domestic production function, which is supposed to depend on the K, L, and imported raw material (R). The production returns to scale were rising and positive for every single factor.

Given that Cobb Douglas production function gives us a better estimate relative to the translog and transcendental function, as it permits the substitution among the factors during the production process, it has an appropriate function form, and significant variables and higher degrees of freedom, and since its production elasticities are more suitable for the agriculture sector.

To estimate the impact of labor, capital, and energy consumption on agricultural productivity, Cobb Douglas production function. Bernt and Wood[21, 22] has been used with agricultural output as dependent variable.

$$\begin{gathered}\text{log}Q_t = \beta_0 + \beta_1 \boldsymbol{log}AL_t + \beta_2 logAL_t{}^2 \\ +\beta_3 logAK_t + \beta_4 logAK_t{}^2 + \beta_5 \boldsymbol{log}ECE_t \\ +\beta_6 logECO_t + \beta_7 logLU_t \\ +\beta_8 logF_t + \beta_9 logIRR_t + \mu_t\end{gathered} \tag{3}$$

Table 1 explains the variables description. Where Q_t is the dependent variable as Added value of agriculture output, independent variables include AK_t is the share of fixed capital in agriculture sector, AL_t is the share of labor in agriculture sector, ECE_t is the total energy consumption of electricity in agriculture sector, ECO_t is the total energy consumption of oil in agriculture sector. Control variables include, LU_t land utilization in agriculture sector, F_t is the total amount of fertilizers used in agriculture sector. IRR_t = Irrigated area, μ_t is the error term, β_0 is the intercept. $\beta_1,\beta_2,\beta_3,\beta_4,\beta_5,\beta_6,,\beta_7$ are the slope parameters.

Table 1. Variables description.

Variables	Description	Units	Data Sources
Q_t	Agricultural output	Agriculture value added output	WDI
AK_t	share of capital in agriculture sector	Local Currency Units (LCU) millions.	FAO, Food and agriculture organization of United Nations
AL_t	Share of labor in agriculture sector	Percentage of total labor force employed in agriculture sector.	WDI
ECE_t	Total energy consumption of electricity in agriculture sector.	Tonne of oil equivalent (TOE)	Energy yearbook 2019. Ministry of Energy Hydrocarbon institute of Pakistan.
ECO_t	Total energy consumption of oil in agriculture sector	Tonne of Oil	Energy yearbook 2019. Ministry of Energy Hydrocarbon institute of Pakistan.
LU_t	Total land used in agriculture sector	Million hectares	Economic Survey of Pakistan
F_t	Total amount of fertilizers used in agriculture sector	Thousand Tonnes	Economic Survey of Pakistan
IRR_t	Irrigated area	Million hectares.	Indus River System Authority (IRSA)

Notes: Author's Own collections.

2.2. Data Sources

This study obtained time series data from 1980 to 2020 with annual observations in order to analyze the study's objectives. Numerous published secondary sources, including the World Development Indicator, the Economic Survey of Pakistan, and the Energy Yearbook 2019, were used to collect the data.

2.3. Estimation Techniques

To examine the relationship between energy consumption and agricultural production, the present study uses linear double-log model to investigates the short- and long-term relationship among candidate variables. We estimate this relationship by using Autoregressive Distributed Lag Approach (ARDL). Almas and Usman [19] suggested the ARDL bound test. ARDL is capable of working with both short and long term coefficients simultaneously, and it can be used to both I(0) and I(1) first-order stationary variables [21, 22].

3. Results and Discussion

In the initial phase, the unit root test was used to verify the stationarity of each candidate variable prior to utilizing the ARDL estimate technique. The unit root test results are displayed in **Table 2** below.

Table 2. Stationarity results.

Variables	ADF Test with Trend and Intercept	
	At Level	At 1st Difference
LQT	−2.2023 (0.2087)	−6.2743 *** (0.0000)
LAL	−2.2519 (0.1921)	−5.2375*** (0.0001)
LAK	0.4304 (0.8008)	−1.7961* (0.0693)
LAL2	−2.2798 (0.1832)	−7.0047*** (0.000)
LAK2	0.3243 (0.5623)	−8.7355*** (0.000)
LECE	0.8584 (0.8914)	−7.1782*** (0.0000)
LECO	−0.8673* (0.0659)	−6.0219*** (0.0000)
LF	3. 4025 (0.9997)	−1.6949* (0.0849)
LIRR	1.5185 (0.9660)	−7.9829*** (0.0000)
LLU	0.8546 (0.8909)	−9.1318* (0.0000)

Source: Author's own calculations.
Notes: ***, **, * indicates significance at 1%, 5%, and 10%.

Table 2 displays the ADF test results. ADF test results show that, with the exception of LECO, all series are integrated at order I (1).

The LECO variable is integrated at both level and order one and is stationary. Adopting the ARDL estimate technique for both short and long term dynamics requires that the variables employed in the current study be a combination of both variables integrated at I(0) and I(1).

ARDL Bound Test

Bound test result in given in below **Table 3**. According to the bound test results, the computed F-statistic value is greater than the upper bound at every significance level, indicating that the alternative hypothesis (long term association between variables) is accepted and the null hypothesis (no long-term connection between variables) is rejected. Overall, the findings of bound test reveal the presence of long-term relationship among all variables of the model. Stated differently, the findings indicate that there is a co-integration relationship between the candidate variables of the study.

ARDL Based Long-Term Results

We evaluated the short and long-term coefficients after examining the cointegration relationship among variables of the study. **Table 4** presents the long-term results of the ARDL-based model.

Table 3. Bound Cointegration.

Test -Stat	Value	Significance Level	I(0)	I(1)
F-Stat	9.7915	10%	1.70	2.83
		5%	1.97	3.18
		2.5%	2.22	3.49
		1%	2.54	3.91

Table 4. ARDL long run results.

Variables	Co-Efficient	Standard Error	T-Ratio	Probability
LAK	−6.7598	3.5562	−1.9008	0.0838 *
LAK^2	0.5506	0.1055	5.2187	0.0002 ***
LAL	−1.1524	0.4299	2.6804	0.0214 **
LAL^2	1.4216	0.2529	5.6219	0.0001 ***
LECE	0.1401	0.1845	0.7593	0.0462 **
LECO	0.1807	0.5401	6.8560	0.000***
LF	3.7027	0.5401	3.3744	0.0055 ***
LIRR	5.6851	2.8744	1.9778	0.0714***
LLU	−8.1021	2.1995	−3.6836	0.0031 ***

Note: ***, **, * indicates significance at 1%, 5%, and 10%.
Dependent Variable: Agricultural output.

The long run coefficients indicate that the partial effects of agricultural inputs on agriculture production. The coefficient of agricultural capital is negative and significant. However, the square term of agricultural physical capital is positive and significant stated that a one percent increase in physical capital tends to result in a 55.06 percent increase in agricultural output at 1% level, demonstrating the direct relationship between the agriculture capital and total output. This result is consistent with the economic literature.

An increase is physical capital stock in agriculture such as machinery, modern agricultural equipment like tractors, harvesters and farmers to harvest crops more quickly and efficiently, leading to increase output. This result is consistent with the previous studies [11, 23–25].

The variable labor is statistically significant and negative at 5% level. The square term of labor coefficient is positively significant. The co-efficient shows that there is a 1% increase in labor tends to increase the output level by 1.4216%. In many agricultural systems, especially in developing regions, farming relies heavily on manual labor for tasks e.g., sowing, weeding, irrigation, and harvesting. The more labor available, the greater the potential for increased output [26, 27].

The coefficient of LECE is positive and statistically significant at a 5% level, which indicate that as 1% increase in LECE tends to increase agricultural output in agriculture sector by 0.1401%. This result is consistent with the following studies [22–24].

The coefficient of LECO is positive and statistically significant at 5% significance level. The co-efficient of LECO shows that as 1% percent increase in LECO will lead to an increase the output by 0.1807%. This result is in line with [26, 28–30].

The variable land utilization is negatively significantly related to agricultural output. The co-efficient shows that the as one percent increase in land utilization will lead to a decrease in agricultural output by -8.1021%. This result is in line with [26, 30, 31].

The variable LF is negative and significant at 5% significance level. The variable fertilizer depicts that as one percent increase in fertilizer use will lead to increase the output level by 3.7027%. The variable irrigation has a direct and significant impact on agricultural output. The co-efficient shows that as 1% irrigation level increases will tend to an rise in agriculture output by 5.6851%. Our results are in line with [27, 28, 30].

ARDL Based Short-Term Results

The estimated short-term results are given in below **Table 5** with speed of adjustment coefficient.

Table 5. ARDL short-term results.

Dependent Variable: Agricultural Output				
Variables	**Co-Efficient**	**Standard Error**	**T-Ratio**	**Probability**
DLAK	−1.1524	0.2714	−4.2458	0.0014 ***
$DLAK^2$	0.0367	0.0482	0.7596	0.0462 **
DLAL	−6.7598	1.9397	−3.4848	0.0051 ***
$DLAL^2$	2.7767	0.0594	7.3974	0.000 ***
DLAECE	0.3538	0.0575	6.1446	0.0000 ***
DLAECO	1.3467	0.4671	5.2980	0.0000 ***
DLU	−1.1733	1.3671	−0.858	0.0470 **
DLF	2.0633	0.3081	6.6971	0.000***
DLIRR	1.4662	1.5788	0.9286	0.0370**
ECM (−1)	−0.2579	0.1130	−11.137	0.0000 ***

Notes: * Significant at one percent ** significant at five percent and *** significant at ten percent.

The results of **Table 5** report that in the short-term, the estimated value of lag coefficient of square of agricultural capital is positive and significant at 5% level. The variable capital findings are similar with long run. Similarly, the lag coefficient of square of agriculture labor is positive and significant at 1% significance level. The estimated lag coefficient of electricity consumption of energy and oil is also positive and significant in agriculture sector. This result is also similar with the long-term. Remaining variables lag coefficients of land utilization, fertilizers, and irrigation results are also similar with the long-term results.

The computed co-integration coefficients determine the adjustment speed. The convergence time is highlighted by the coefficient of error correction model (ECM) if there is fluctuation in wheat consumption. There is a long-term co-integration relationship between the variables, as indicated by the inverse and significant ECM coefficient, and the derived model exhibits convergence behavior. According to the calculated model's faster adjustment speed, the predicted coefficient of ECM (−1) is −0.2579 and significant at the 1% level [21]. The coefficient of adjustment speed is very high (0.2579) if there is any disequilibrium in agricultural output, according to the estimated coefficient of ECM (−1).

Diagnostic Testing

Table 6 displays the estimated outcomes of residual diagnostic testing.

Table 6. Residual diagnostic and stability analysis.

Diagnostic Test	Test Statistics	P-Value
Breusch-Pegan Goldfrey (BP) Heteroskedasticity Test	1.4126	0.4219
Jarque Bera Test (JB) (Normality Test)	1.1216	0.4756
Autocorrelation Test (LM Test)	0.9087	0.5432

Source: Authors Own Contributions.

The present study applies the Breusch Pegan (BP) test to detect heteroskedasticity. The test result demonstrates that the BP test's test statistics value is extremely low and negligible, supporting the claim that "no heteroskedasticity" exists in the calculated model. In a similar vein we use the Jarque Berra Test (JB) to determine whether or not our sample data series is normally distributed. The outcomes of the test show that the data is normally distributed and that the JB test's value is low and inconsequential. Similarly, LM test is used to check the problem of autocorrelation. Since there is no autocorrelation in the estimated data set, the test-statistic of the LM computed value is small and not significant, indicating that the null hypothesis is accepted and that the findings have some policy implications.

Furthermore, the projected results of the diagnostic tests (BP, JB, and LM) show that the model fits well and can make some useful policy recommendations.

4. Conclusion and Policy Suggestions

This study the main aim is to explain the influence of energy consumption on agricultural output of Pakistan. The current research used the independent variables such as, agriculture capital, agriculture labor, energy consumption of electricity and energy consumption of oil. We have also included few control variables such as land utilization, fertilizers, and irrigation. For estimation purpose, we applied the Auto regressive distributed lag (ARDL) approach.

The study findings show that co-integration relationship exists among candidate variables of the study. The finding conjecture that both in the short and long run, the energy consumption of oil and electricity has a major impact on agricultural productivity.

We can conclude from the results that agriculture production in Pakistan can be increased by appropriate energy consumption. By following the results of our study few policy suggestions are mentioned below:

- There should be an uninterrupted supply of energy not only in urban areas but also in rural areas. The government should subsidize energy inputs so that small farmers can also get benefit from their use.
- As labor is one of the most important and widely used input in the agriculture sector and it has a significant effect on the level of output. Thus, more skilled work labor should be employed in the agriculture sector.
- The availability of capital should be there for the farmers. The government should focus on providing advanced machinery and technology. Orientation programs for farmers should be initiated by the government to educate farmers on the use of agricultural inputs.

Author Contributions

Validation, S.R.; formal analysis, S.R.; data curation, S.R.; writing—original draft preparation, S.R. and S.S.; writing—review and editing, S.R. and MA; supervision, F.U.R., L.K.A. All authors have read and agreed to the published version of the manuscript.

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