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Analyzing the Impact of Fertilizer Crises on Wheat Production: A Case Study from South Punjab

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ABSTRACT

Replenishment and management of the food demand are the basic needs of the time to cope with the increasing demand for food due to the consistent rise in population. Wheat production in Pakistan showed much-fluctuated patterns from the time of wheat security to its server deficiency. Fertilizer is a basic need and an important input that results in high the cost of wheat production and also the farmers are facing many challenges regarding fertilizer prices in Pakistan. This study investigates the impact of the recent fertilizer crises on wheat production in South Punjab, Pakistan heavily reliant on agriculture. Fertilizer shortages and price volatility, exacerbated by global supply chain disruptions and domestic policy inconsistencies, have posed significant challenges for wheat farmers. Using a mixed-methods approach, including surveys, interviews, and primary data analysis, this research assesses changes in input usage, yield variations, and farmer coping mechanisms during the crisis period (2021–2024). A total of 105 respondents were selected and a multiple linear regression model was used to analyze the factor affecting fertilizer crisis of wheat. Overall significance of model was determined by F-test. The value of R2 is 51.3 percent which indicates that 51 percent of variations are explained by the model. It is suggested that there is a need for timely availability of farm inputs including credit to farmers, subsidy on fertilizer, direct asses to market, application of high yield wheat varieties, and contact of Agri. extension department will be small farmers.

Introduction

Agriculture plays a pivotal role in Pakistan's economy, not only as a source of food and employment but also in ensuring national food security and contributing to foreign exchange

earnings. Despite a visible shift toward the services sector, agriculture remains the backbone of Pakistan's economy, employing a large proportion of the labor force and supporting rural livelihoods (GOP, 2019). Wheat, being a staple food crop, holds critical significance in the country's food supply chain. However, multiple challenges, particularly input-related constraints such as fertilizer shortages and rising prices, have increasingly hindered its production.

In recent years, a growing fertilizer crisis characterized by supply shortages, price volatility, and black marketing has emerged as a serious threat to wheat productivity. Fertilizers are key agricultural inputs that directly influence crop yield, soil fertility, and plant growth. Their unavailability or unaffordability results in poor crop performance and poses risks to national food security. This introduction sets the context for analyzing the fertilizer crisis, its impact on wheat production in South Punjab, and the broader implications for Pakistan's agricultural sustainability.

Fertilizer Dependency and Its Role in Wheat Production

The productivity of Pakistan's agriculture sector largely depends on the application of critical inputs such as fertilizers, pesticides, and improved seed varieties. Wheat, in particular, is highly responsive to fertilizer application. For optimal growth, it requires nutrient supplementation, especially nitrogen (urea) and phosphorus (DAP). Experts recommend applying one bag of DAP during land preparation and at least three bags of urea during the crop's growth cycle (Ahmad, 2014).

Pakistan's soils are naturally deficient in key nutrients. More than 90 percent of soils lack phosphorus, while nitrogen and potassium deficiencies are also widespread (Rehman et al., 2019). As a result, balanced fertilizer use is indispensable. To produce 8 kg of grain, at least 1 kg of fertilizer nutrients is required. Fertilizer is not just a supplementary input and it is a cornerstone of crop productivity. However, farmers are now forced to reduce fertilizer usage due to its high market cost, especially when fertilizer is sold at inflated rates in the black market.

Fertilizer Crisis and its Socioeconomic Impact

The recent fertilizer crisis has deepened due to multiple factors: artificial shortages, market manipulation, weak regulatory enforcement, and global supply chain disruptions. In some regions, farmers report that DAP and urea were either unavailable or sold at prices well beyond government-mandated rates. For instance, urea that was supposed to sell for Rs. 1,800 per bag was being sold for Rs. 3,000 or more (Fazal et al., 2022). This has made it nearly impossible for small-scale farmers to afford sufficient quantities for their fields.

In South Punjab and other wheat-growing areas such as Peshawar and KPK, the shortage has already led to a decline in wheat production by 5–10 percent during the Rabi season (Naqshbandi, 2022). Farmers, especially those with limited resources, expressed their frustration and fears of long-term economic losses. As wheat yields decline, food prices increase, and access to basic nutrition becomes more difficult for low-income households.

Wheat production is not only vital for domestic consumption but also for stabilizing flour prices and avoiding food crises. When production targets are not met, the country is forced to import wheat at a high cost. In 2021, Pakistan spent over $1 billion on wheat imports due to domestic shortfalls caused in part by input constraints (Qureshi et al., 2021).

Environmental and Agronomic Constraints

Apart from economic factors, wheat production is also influenced by various agronomic and environmental constraints at three critical stages: pre-production, production, and post-production. In the pre-production phase, access to fertile and sufficient land is a major challenge. During the production phase, farmers face issues like water scarcity, extreme temperatures, weed infestations, and pest attacks. In the post-production phase, poor storage facilities and transportation losses further reduce effective yield (Cahill et al., 2014).

National Fertilizer Use Trends

Although fertilizer consumption in Pakistan has increased over the past few decades from under 1 million tons in the early 1980s to over 6 million tons in recent years, its use per acre remains low compared to global standards. In 2017, the consumption stood at 152.5 kg/ha, increasing slightly to 156 kg/ha in 2018 (Vos et al., 2015). This modest increase in usage is insufficient to meet the growing nutritional demands of high-yield wheat varieties. Fertilizer consumption remains unequally distributed among provinces, and much of the growth in consumption has come from Punjab and Sindh. In South Punjab, however, the recent fertilizer crisis has reversed these gains, reducing application rates by up to 20 percent in some areas (Naqshbandi & Jasimuddin, 2022). Reduced application has a direct negative impact on yield, which ultimately jeopardizes food security across the country.

Government Policies and Market Dynamics

Pakistan's fertilizer crisis is not merely a production issue it reflects structural weaknesses in the input distribution system. The government’s failure to regulate black market activity, control smuggling, and ensure equitable subsidy distribution has led to price distortions and artificial shortages. Despite domestic production accounting for 80 percent of total fertilizer needs, poor governance allows illegal profiteering and fertilizer smuggling, particularly of high-quality brands like Sona urea (Dawn, 2021).

The government has historically imposed GST and other taxes on fertilizers, further driving up costs. While subsidies were intended to offset these increases, the benefits have not trickled down effectively to smallholder farmers. Without serious intervention in market regulation and policy enforcement, the crisis is likely to continue.

Materials and Methods

This study adopts an empirical research approach to investigate the impact of the fertilizer crisis on wheat production in South Punjab. Empirical research is grounded in observable and verifiable evidence, and thus, this research is based on primary data collected directly from wheat farmers. The methodology encompasses the selection of the study area, sampling techniques, data collection tools, data analysis methods, and statistical models employed for interpretation.

Study Area and Sampling Design

The research was conducted in the wheat-growing districts of Layyah and Multan in South Punjab, Pakistan. These districts were selected due to their significance in production and accessibility within the constraints of time and resources. The study was carried out during the fall of 2022, coinciding with the wheat cultivation season.

A total of 13 villages as 8 from Layyah and 5 from Multan were randomly selected. From each village, a specific number of wheat farmers were selected to ensure representation. In total, 105 farmers participated in the study. The sample size was calculated using the standard sampling formula:

$N=Z2P(100-P)/x^2$---------- (1)

Where,

N= Sample size, Z = Confidence interval (95 percent), P = Estimated proportion of the population, x = Desired level of precision (10 percent)

Each farmer was randomly selected, and care was taken to include various socio-economic backgrounds. A complete list of farmers was compiled, and participants were drawn using a simple random sampling method.

Development and Testing of Research Instrument

The data collection tool was a structured questionnaire, designed to capture detailed information on demographic characteristics, farm operations, input usage, irrigation, labor, and challenges faced during the fertilizer crisis. Questions also explored farmer experiences, perceptions, and adjustments made in response to the crisis.

Before the full survey, the questionnaire was pre-tested with 8 respondents to identify any ambiguity or missing elements. Based on the pre-test feedback, modifications were made to improve clarity and relevance, particularly regarding the cost of inputs and yield estimates.

Data Collection and Processing

The finalized questionnaire was administered through face-to-face interviews with farmers in the selected villages. Respondents were assured of the confidentiality and academic purpose of the study to address concerns regarding data sharing. During the interviews, challenges such as distrust of the researcher's intent and recall inaccuracies were encountered. Some farmers had difficulty recalling exact figures for input costs and yields, which were instead collected as estimates.

Following data collection, all responses were checked for completeness and accuracy**,** coded appropriately, and entered into Microsoft Excel for statistical analysis.

Variables and Respondent Characteristics

To understand the variations in fertilizer use and its impact, several **socio-economic variables** were included in the analysis:

- Age, education, family size, and structure
- Farm size and farming experience
- Income sources, labor availability, and distance from road/market

In addition, farm-specific characteristics were considered:

- Soil testing, tractor ownership, irrigation sources (canal/tube well), and need for credit
- Access to agricultural extension services and use of recommendations

These variables were selected due to their direct influence on farmers' decision-making and input utilization.

Analytical Framework

Descriptive statistical tools were used to summarize the data. Measures such as mean, frequency, and percentage were employed to examine central tendencies and variation in the dataset. The formulas used include:

Mean: **AM=** $\bar{Y} = \sum \bar{Y}_i / N$

Frequency: **F = n/N**

Percentage: P **= (f/N)*100**

Where Y is an economic variable, N is the total number of observations, and f is the frequency of a given response.

Regression Analysis

To identify the determinants influencing variations in fertilizer usage, multiple regression analysis was employed. The model estimates the relationship between the dependent variable (fertilizer use difference) and multiple independent socio-economic and farm-related variables.

The regression equation is specified as: $Y=f\ (X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10})$

The specific form of the predicted function is as follows.

$$Y= \beta_o+ \beta_1X_1+ \beta_2X_2+ \beta_3X_3+ \beta_4X_4+ \beta_5X_5+ \beta_6X_6+ \beta_7X_7+ \beta_8X_8+ \beta_9X_9+ \beta_{10}X_{10}+\varepsilon$$

Whereas,

Y= A dependent variable representing difference between the fertilizer use, β_o= Constant term, β1, 2, 3…...10= Parameters to be estimated

Explanatory variables (X)

X_1= Age of sample respondents, X_2= Education of sample respondents, X_3=Farm size, X_4= Wheat farming experience, X_5= Family size, X_6= Farm income, X_7= Farm area in acre, X_8= Market price of wheat, X_9= Distance from the main road, X_{10}= Distance from the main market

This regression framework helps in isolating the influence of each variable on fertilizer use, thus providing a clear understanding of the underlying dynamics affecting wheat production during the fertilizer crisis.

Results and Discussion

Socio-Economic Characteristics of Wheat Growers

The socio-economic profile includes variables like age, education, experience, income, family structure, and access to resources. These characteristics provide insights into decision-making behaviors and adoption of agricultural practices.

Descriptive statistics were employed to understand the socio-economic characteristics of wheat growers and the constraints associated with fertilizer use. The analysis of respondent's socio-economic characteristics revealed that the majority of farmers, specifically 60 individuals, were above the age of 45 and 76.2 percent are below 50 years, suggesting they are relatively young and potentially receptive to innovation. Educational attainment remains low, with 66.7 percent having education below matriculation and an average schooling of 7.37 years. The data also indicated that the average off-farm income was Rs.265596.16, while the average farm income stood at Rs. 325,568.81. When combined, the total annual income from both sources averaged Rs. 452,275.23. Regarding market accessibility, the average distance from the farm to the main road was 6.27 kilometers, while the average distance to the main market was 7.63 kilometers. Most farmers had their own income-generating sources, with farming contributing significantly to their average earnings of Rs.325568.81 annually.

Farming Experience and Family Dynamics

Despite being young, farmers are experienced, with an average of 23.72 years in agriculture. Family structures were predominantly joint 41.9 percent and single 40 percent. The average family size was large (8.62 members), and most families 60 percent had 6–10 members. Yet, only 1.76 family members on average were actively involved in farming.

Farm Characteristics and Resource Ownership:

Farmers owned an average of 9.79 acres, rented in 3.29 acres, and rented out 0.42 acres. Most operational holdings were under 25 acres (88.5%). Only 21 percent of farmers had soil tested in the past 5 years, and average distances from main roads and markets were 6.61 km and 7.16 km, respectively.

Fertilizer Use Constraints and Institutional Support

Access to Credit and Extension Services

About 19 percent expressed a need for credit, and the ZTBL was the main credit source 15.2 percent. Extension services were found to be inadequate; 45.7 percent of farmers reported no visits during fertilizer crises, and 46.7 percent had no regular contact with agricultural representative. Only 29.5 percent found extension information useful.

Interaction with Fertilizer Companies

While 84.8% had at least two interactions with fertilizer companies, persistent problems remained, including late fertilizer application (16.2%) and reliance on broadcasting methods (83.8%) for sowing.

Seed and Fertilizer Quality Perception:

Most farmers reported good seed germination. Fertilizer quality and response were considered good by 73.3 percent and 84.4 percent of farmers, respectively. However, cost of wheat production compared to other crops was considered high by 42.9 percent.

Risks and Constraints

Production risk was moderate for most (58.1%), and disease risk was reported as low by 51.4 percent, Yield variability was high (32.4%), while price variability was moderate (56.2%).

Fertilizer shortages were largely attributed to smuggling (74.3 percent), hoarding (28.6%), and poor governance. Farmers also cited an ineffective extension department and weak cooperation among the farming community as contributing factors. Information regarding transferring from wheat farming to other crop. Majority of the farmer's response that do not want to shift from wheat to other cropping pattern i.e. 55.2 percent while 62.9 percent of the respondents have other plan other than farming.

Table 1: Fertilizer constrains by farmer

Response	Yes		No	
	F	%	f	%
Have you applied any alternative fertilizer to overcome this deficiency?	38	36.2	67	63.8
Have you any alternative plan to transform cropping pattern from wheat to another crop?	47	44.8	58	55.2
Do you or youth have other plans than agriculture?	66	62.9	39	37.1

Fertilizer prices are one of the major variables in dropping wheat yield. Survey results shows that majority of the farmers respond that fertilizer prices are not compatible with current prices

Table 2: Lesson learn from this crisis

Questions	Yes		No	
	F	%	F	%
I will purchase fertilizer even before sowing	44	41.9	61	58.1
Due to crisis, have you changed the fertilizer application method?	67	63.8	38	36.2
Do you think that the fertilizer prices are compatible with current wheat price?	17	16.2	88	83.8

Constraints faced by the respondents

The research study revealed several constraints faced by wheat farmers in the study area. A significant 63.8 percent of farmers did not use alternative fertilizers to address nutrient deficiencies, and 55.2 percent were unwilling to shift from wheat to other crops, although 62.9 percent had alternative plans outside farming. Fertilizer-related losses were notable 60.91 percent reported high losses due to poor fertilizer quality, while all respondents (100 percent) cited high fertilizer costs as a major cause of yield reduction. Similarly, all farmers reported heavy losses due to the rising cost of production, mainly driven by input prices such as fertilizers and irrigation. Campaign activities promoting timely sowing and input use had limited effect, with 72.4 percent showing low responsiveness. Moreover, 58.1 percent purchased fertilizer after sowing, often due to shortages, and 83.8 percent felt fertilizer prices were incompatible with wheat prices. Fertilizer purchasing also disrupted other farm operations 82.9 percent noted negative impacts, particularly on crop-related (61.9 percent), household (51.4 percent), and livestock (43.9 percent) activities.

Cost of fertilizer analysis

The analysis of fertilizer costs for the production years 2020–21 and 2021–22 shows a significant increase in input expenses. In 2020–21, the average per-acre cost for DAP, Urea, NP, NPK, and FYM was Rs. 4695.83, Rs. 1940.78, Rs. 2868.75, Rs. 2950, and Rs. 1800 respectively, with a total fertilizer cost of Rs. 13,838.69 per acre. In contrast, during 2021–22, the same fertilizers saw notable price hikes DAP rose to Rs. 8609.94 and FYM to Rs. 5808 resulting in a total cost of Rs.

24,625.39 per acre. This reflects a steep rise in fertilizer prices year-over-year, placing additional financial pressure on wheat farmers.

Table 3: Fertilizer costs analysis

Fertilizer Bags		**Urea**	**DAP**	**NP**	**AN**	**NPK**	**SSP**	**FYM**
Ave. unit/acre	**2020-21**	1.57	1.06	1.28	1.5	1	2.33	1.67
Average Cost/acre		1940.78	4695.83	2868.75	1600	2950	1133.33	1800
Minimum cost		1700	1000	2600	1600	1600	850	1700
Maximum cost		3600	8600	3500	1600	1600	1400	2500
Total cost		13838.69						
Ave. unit/acre	**2021-22**	1.53	1.00	1.17	1.5	1	2.5	2.4
Average/50 kg bag rate Rs.		1930	10,000	6300	1570	2950	2000	2420
Average Cost/acre		3766	8609.94	716.45	1600	2400	1725	5808
Minimum cost		1600	4000	2950	2100	2400	1050	2000
Maximum cost		32200	10,000	6800	2500	2400	2400	3000
Total cost		**24625.39**						

Multiple linear regression analysis

Multiple linear regression model

A multiple linear regression analysis was conducted to examine the impact of various factors on the difference in fertilizer use between 2020–21 and 2021–22. Independent variables included age, education, farming experience, farm income, farm area, market price, and distances from main road and market, along with two dummy variables: sowing time and credit need. The model was statistically significant (F = 18.17) with an R^2 of 51.3 percent, indicating that over half of the variation in fertilizer use difference was explained by these factors. Key findings show that farming experience, farm area, market price, family size, and distances from road and market significantly influenced fertilizer use. Overall, results highlight that logistical, financial, and demographic factors strongly affect fertilizer application patterns.

Table 4: Result of the multiple linear regression analysis

Variables	**B**	**t-values**
(Constant)	20.100	5.530
Age	-0.021	-0.963
Education	-0.111	-2.778
farming experience	0.018	3.782
farm income	-2.743	-1.009
farm size	0.023	2.318
market price of output	-0.003	-2.431
family size	0.048	1.940
distance from main road	0.018	2.432
distance from man market	0.044	1.785
sowing time	0.069	2.180
need for credit	-0.801	-1.055

Source: Author's own survey Results

R square = 0.51 percent **F- Ratio = 18.17**

Conclusions and Recommendations

Pakistan is considered an agrarian economy, where agriculture remains the dominant sector contributing significantly to GDP. Strengthening this sector is essential for poverty alleviation and improving living standards, as it holds the potential to meet domestic food needs and earn foreign exchange through exports. Wheat, the staple food crop of the country, accounts for nearly 60 percent of the average daily diet. However, wheat production is heavily dependent on timely and sufficient fertilizer use particularly DAP yet artificial shortages and rising urea prices have limited farmers from applying recommended doses.

This study was conducted in Multan and Layyah districts to analyze the socio-economic profile of wheat growers and investigate the causes behind the fertilizer crisis. Primary data was collected from 105 respondents. Descriptive statistics reveal that most farmers were below 50 years of age, with 80 percent having education up to or below matric level, and an average of seven years of schooling. The average family size was eight, commonly in joint family systems. Farming experience averaged 23 years, with 1.76 members working per farm. Around 46 percent hired permanent labor, and farm incomes ranged from Rs. 200,000 to 750,000 rupees.

Regression analysis showed that farming experience, farm size, distance from roads and markets, and sowing time had a significant positive impact on fertilizer use differences. In contrast, age, education, farm income, market price, and credit need had a negative or insignificant effect. Notably, education and age had minimal and statistically insignificant effects on fertilizer use gaps, indicating that structural and logistical factors play a more critical role than individual demographics.

According to the above findings following recommendations and suggestions were made:

1. High fertilizer prices were the chief hurdle to apply fertilizer at the recommended level. The fertilizer and pesticide shopkeepers and dealers, by creating artificial shortage, raise the prices of inputs. These should be checked. Selling sub-standard or adulterated inputs was also wide spread. The government should monitor the activities of market forces so that quality of fertilizer is available to the farmer at the officially fixed prices.
2. Credit is the key element in the modernization of agriculture due to complex loaning procedure, few farmers availed it. Small scale farmers were hard hit. Loaning procedure therefore should be simplified should also be sanctioned on the basis of personal security.
3. Farmer training programs should be launched to equip the farmers with better management skills, production technologies and resource utilization.
4. The result of this study indicates that the use of fertilizer is considerably in current as compared to previous year. It appears that there is a considerable potential for decreasing wheat output due to decrease in fertilizer use. Crop yield could be much higher if the use of fertilizer occupied.

Present study was concern with fertilizer use however in discussion with farmers during field survey; it was observed that farmers were much concerned about the loss of their crop caused by less fertilizer.

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Novelty Statement

This Study is new and adding to literature a scientific proof of overtime and dynamic effects of changing prices on use of fertilizer and its impact of yield.

REFERENCES

1. Abeledo, L.G., R. Savin and G.A. Slafer. 2008. Wheat productivity in the Mediterranean Ebro Valley: Analyzing the gap between attainable and potential yield with a simulation model. Eur. J. Agron. 28:541-550.
2. Ahmad, M., and U. Farooq. 2010. The state of food security in Pakistan: Future challenges and coping strategies. Pak. Dev. Rev. 49:903-923.
3. Ahmed, A.S., and M. Gautam. 2014. Increasing agricultural productivity. Pakistan Policy Note 6. Washington DC: World Bank.
4. Ashfaq, M., K.A. Parton, G.R. Griffith and R.R. Piggott 1999. A multilevel economic analysis of the wheat market in Pakistan. Conference paper. P. 410.
5. Bandyopadhyay, K., A. Misra, P. Ghosh, K. Hati, K. Mandal and M. Moahnty. 2010. Effect of irrigation and nitrogen application methods on input use efficiency of wheat under limited water supply in a Vertisol of central India. Irrig. Sci. 28:285-299.
6. Blackshaw, R., L. Molnar and F. Larney. 2005. Fertilizer, manure and compost effects on weed growth and competition with winter wheat in western Canada. J. Crop Prot. 24:971-980.
7. Brunelle, T., P. Dumas, F. Souty, B. Dorin and F. Nadaud. 2015. Evaluating the impact of rising fertilizer prices on crop yields. Agric Econ. 46:653-666.
8. Cahill, A.E., M.E. Aiello-Lammens, M. Caitlin Fisher-Reid, X. Hua, C.J. Karanewsky, H.Y. Ryu, G.C. Sbeglia, F. Spagnolo, J.B. Waldron and J.J. Wiens. 2014. Causes of warm-edge range limits: Systematic review, proximate factors and implications for climate change. J. Biogeogr. 41:429-442.
9. Croppenstedt, A., M. Demeke and M.M. Meschi. 2003. Technology adoption in the presence of constraints: the case of fertilizer demand in Ethiopia. Rev. Dev. Econ. 7:58-70.
10. DAWN, Lahore, Pakistan. Online available at www.dawn.com.
11. Doncic, D., V. Popovic, Z. Lakic, D. Popovic and Z. Petkovic. 2019. Economic analysis of wheat production and applied marketing management. Int. J. Agric. Fish. 65:91-100.
12. Duflo, E., M. Kremer and J. Robinson. 2008. How high are rates of return to fertilizer? Evidence from field experiments in Kenya. Am. Econ. Rev. 98:482-88.
13. Duressa, L.A., Ayana, N.G. 2020. Effects of Variety and fertilizer rate on yield of bread wheat (Triticum aestivum, L) varieties in East Wollega Zone, Western Ethiopia. Agric. Biol. Sci. J. 6:60-71.
14. FAS. 2020. Washington, D.C, United States of America. Online available at www.fas.usda.gov. 18/02/2022.
15. Fazal, A., A. Ismail, I. Naeem, C.A. Oliveira, S. Shaukat, M.U. Saleem, S. Saima, U. Nasir, A. Alam and Z. Aslam. 2022. Exposure assessment of selected pesticide residues using occurrence data in foods and serum samples in Pakistan. Int. J. Food Sci. 42.
16. GOP. 2019. Economic Survey of Pakistan 2018-19. Economic Adviser's Wing, Finance Division Govt. of Pakistan, Islamabad.
17. GOP. 2020. Economic Survey of Pakistan 2019-20. Economic Advisory Wing, Ministry of Finance, Islamabad.
18. Hanif, M.U., M. Zwawi, M. Algarni, A. Bahadar, H. Iqbal, S.C. Capareda, M.A. Hanif, A. Waqas, N. Hossain and M.T.H. Siddiqui. 2022. The effects of using pretreated cotton gin

Trash on the Production of Biogas from Anaerobic Co-Digestion with Cow Manure and sludge. Energies. 15:490.
19. Ilinova, A., D. Dmitrieva and A. Kraslawski. 2021. Influence of COVID-19 pandemic on fertilizer companies: The role of competitive advantages. Resources Policy. 71:10-19.
20. Ishfaq, M., M. Younas, M.Q. Waqar, U.I. Ahmed and M. Zia-ul-Hassan. 2017. Comparative analysis of wheat and brassica in terms of relative profitability: A case study of district Chakwal, Punjab, Pakistan. J. Environ. Agric. Sci. 10:71-77.
21. Kelly, V. 2006. Factors affecting demand for fertilizer in Sub-Saharan Africa, agriculture and rural development. World Bank Discuss paper. P. 23.
22. Khabarov, N. and M. Obersteiner. 2017. Global phosphorus fertilizer market and national policies: a case study revisiting the 2008 price peak. Front. Nutr. 4:22.
23. Khan, H.G.A., A. Ahmad and A. E Siraj. 2010. Impact of rising prices of fertilizers on crops production in Pakistan. Glob. J. Manag. Bus. Res. 10.54-61.
24. Komarek, A.M., S. Drogue, R. Chenoune, J. Hawkins, S. Msangi, H. Belhouchette and G. Flichman. 2017. Agricultural household effects of fertilizer price changes for smallholder farmers in central Malawi. Agric. Syst. 154:168-178.
25. Mishra, B., S.C. Tripathi. 2008. Agro-economic analysis of wheat based cropping system in India. Indian. J. Fert. 44:63-68.
26. Naqshbandi, M.M. and S.M. Jasimuddin. 2022. The linkage between open innovation, absorptive capacity and managerial ties: A cross-country perspective. J. Innov. Knowl. 7:100167.
27. Pandey, G.P., U. Khandkar, S. Tiwari and N. Kumawat. 2018. Productivity, profitability of wheat and soil fertility as influenced by different levels of nitrogen under SODIC vertisols. Int. J. Chem. Stud. 6:3292-3295.
28. PARC. 2013. National Coordinator Wheat Plant Sciences Division. Ministry of Food and Agriculture, Islamabad.
29. Quraishi, B.A. and M.J. Khan. 1970. Economics of fertilizer application to wheat crop: The results of a survey in Lyallpur district. Pak. Dev. Rev. 10:88-99.
30. Rahman, S. and M.K. Hasan. 2011. Environmental constraints and profitability relationships in agriculture: a case study of wheat farming in Bangladesh. J. Asian Pac. Econ. 16:630-643.
31. Rashid, S., M.W.A. Chattha, A. Fatima, M.F. Hyder and N. Tabasam. 2024. Economic analysis of fertilizer use and its price variability effects on wheat productivity in Punjab- a case study of Faisalabad. *Sarhad Journal of Agriculture*, 40(4): 1172-1180.