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Food Security and Agricultural Policy Responses to Climate Change in Pakistan

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ABSTRACT

Pakistan is one of the countries in the world which is more vulnerable to climate change. The country's agrarian economy is more vulnerable to climate change because of the rise in temperature, the erratic nature of the monsoon rains, the melting of the glaciers, and the occurrence of more extreme weather events. Agriculture contributes about 22% to the country's GDP, and about 38% of the country's workforce is employed in the agriculture sector. However, the sector is vulnerable to a number of compounding threats to productivity and sustainability which have a direct impact on the country's food security. There is a scarcity of integrated empirical evidence on the efficacy of the responses to climate change in the country's agriculture sector. This research was undertaken to examine the role of the country's agriculture sector policies in addressing the issue of climate change, food security, and to gather views from the country's farmers on the impact of climate change on food production and the efficacy of the existing policy measures to mitigate the impact of climate change on the country's food security. The research was undertaken through a mixed research methodology where quantitative data was collected from 200 farmers and experts through a quantitative method of data collection, while the quantitative data was analyzed through the application of the Pearson correlation coefficient and regression analysis in SPSS. The key findings included that perceived climate change severity (-0.461, $p < 0.001$), perceived policy effectiveness (0.384, $p < 0.001$), and adaptive capacity index (0.312, $p < 0.01$) were significant predictors of food security outcomes. The model explained 67.2% of the variance. The thematic analysis revealed five key themes, which included weak policy implementation, water scarcity as a key threat, financial exclusion of smallholders, fragmented institutions, and climate-smart agriculture potential. Overall, it was revealed that Pakistan's agricultural policies are currently addressing climate-food security linkages to a limited extent. There are significant gaps to be addressed regarding policy implementation. There is a need to enhance policy coordination, financial support to smallholders to adapt to climate change, and accelerated development of climate smart agriculture infrastructure to ensure food security in Pakistan despite climate change.

Introduction

Pakistan is a country that is at a critical juncture and is caught in a precarious situation due to its exposure to climatic changes and food security. It is again and again ranked as one of the top ten most climate-vulnerable countries according to global reports and studies (Eckstein et al., 2021; IPCC, 2022), and it is also a country that is going to be home to a population of 300 million by 2050 (UN, 2022). The food security situation in Pakistan is inherently precarious because 60% of its 220 million plus inhabitants live in its rural areas, which are dependent on farming and its associated activities (PBS, 2021). Food insecurity is not a future problem in Pakistan; it is a reality that is faced today, and it is a country that has been ranked in the serious category of food insecurity in recent years according to the Global Hunger Index (von Grebmer et al., 2022).

The climatic changes that are affecting Pakistani agriculture are complex and are already manifesting themselves in a big way. In the past century, temperatures have risen by 0.5°C on average, and it is estimated that temperatures will rise by 2-

3°C in mid-century under a moderate emissions scenario and could reach 5°C by 2100 under a high emissions scenario (PMD, 2020; IPCC, 2022). The Hindu Kush-Karakoram-Himalaya glacier system is the main source of water feeding the Indus River and its major irrigation canals, and it is shrinking at a rapid rate and is a source of both floods and droughts (Immerzeel et al., 2020; Lutz et al., 2014). The rains that fall during the summer season have become erratic and have been causing droughts and floods. In 2010 and 2022, floods inundated vast tracts of farming land and displaced millions of farming households (NDMA, 2022; World Bank, 2022).

The weather strain on primary plants along with wheat, rice, sugarcane, cotton, and maize is now clean from the facts. Excessive warmth pressure for the duration of the grain formation level reduces wheat yields via way of means of 15 to twenty-five percentage for each diploma centigrade above the gold standard temperature (Asseng et al., 2015; Hussain et al., 2018). Water shortage is likewise affecting the irrigated regions in which rice and cotton are grown. Locust invasions in 2019 and 2020, due to uncommon weather patterns, have destroyed plants throughout some of provinces (FAO, 2020; Saleem et al., 2021). Cotton is specially experiencing a 30 percentage decline in yields withinside the maximum weather-pressured areas of the country, making an already tough scenario for smallholder farming families even tougher (Ali et al., 2017).

Pakistan's agricultural coverage surroundings is likewise converting to cope with the weather-meals protection nexus. A collection of coverage tasks had been applied withinside the country's agricultural sector, which includes the National Food Security Policy 2018, the Climate Change Act 2017, and subsidies presented thru the Kissan Package and weather-clever agriculture tasks withinside the provinces (GoP, 2018; MoCC, 2021). Still, there are constantly observations and critiques from improvement actors and analysts on the distance among coverage intentions and real implementation, mainly in addressing the tens of thousands and thousands of smallholder farmers who personal maximum of Pakistan's 8.26 million farms (PBS, 2021; Watto & Mugera, 2016). The effectiveness of those rules in improving adaptive ability amongst those farmers and enhancing their meals protection stays an understudied studies gap, in particular with an incorporated technique to blended studies methodology.

Food protection, in line with the World Food Summit (1996), refers back to the circumstance in which "everybody has bodily and financial get entry to always to sufficient, safe, and nutritious meals that meets their nutritional needs." There are 4 elements of meals protection: availability, get entry to, usage, and balance. Climate extrade impacts all 4 similarly, main to a decline in availability because of declining yields, multiplied get admission to because of growing expenses and profits squeeze for farmers, usage because of declining protection and dietary fee of meals, and balance because of greater common and erratic weather (FAO, 2016; Wheeler & von Braun, 2013). Addressing those 4 similarly critical factors of meals protection with precise quantitative statistics on coverage overall performance and qualitative knowledge of establishments and farmer-degree elements is crucial (Creswell & Plano Clark, 2018).

This studies bridges the expertise hole via a mixed-techniques approach, in which we surveyed two hundred purposively sampled farmers and experts, in addition to accomplishing a quantitative regression evaluation to become aware of the determinants of meals protection results primarily based totally on secondary information from authorities publications, FAO reports, and the PBS guide on agriculture statistics. We have additionally analyzed the professional evaluations qualitatively to recognize the institutional dimensions of weather-resilient meals structures in Pakistan. Our studies contributes to the frame of proof to assess the Pakistani authorities's agricultural policies, in addition to the broader comparative literature at the weather-meals safety dating in South Asian agriculture (Hussain et al., 2018; Lobell et al., 2012; Watto & Mugera, 2016).

Literature Review

Climate Change Impacts on Agriculture in Pakistan

Empirical studies at the effect of weather alternate on Pakistani agriculture has expanded manifold during the last decades, imparting a greater distinctive information of the subject. Hussain et al. (2018) studied the effect of converting temperature and rainfall on main vegetation in Pakistan. The authors concluded that the yields of wheat, rice, and maize might lower notably because of weather alternate withinside the united states of america. The effect of weather extrade might be greater reported withinside the semi-arid and arid areas of the USA, consisting of the districts of the Punjab, Sindh, and Balochistan Provinces. In a comparable study, the effect of weather alternate at the agriculture of the cotton-generating areas of the united states of america turned into studied through Ali et al. (2017). The authors concluded that seventy eight percentage of the respondents perceived a high-quality alternate in rainfall over the past ten years, at the same time as sixty four percentage of the respondents attributed the discount in crop yields to water shortage during the last ten years. In a current ebook, Saleem et al. (2021) studied the effect of weather variability at the populace dynamics of the barren region locust. The authors concluded that the 2019-20 barren region locust invasion become immediately associated with uncommon rainfall related to the warming of the Indian Ocean.

Water Scarcity and the Indus Basin System

Water safety and meals protection are connected in Pakistan, in which extra than 90% of the country's agricultural produce is based at the Indus River Basin, the world's biggest irrigation device (World Bank, 2018). Increased glacial melting, a end result of excessive-emission scenarios, will cause extended top river flows, however low-glide intervals will lower substantially via way of means of the mid-century, impacting the tail-stop regions wherein agriculture may be affected (Immerzeel et al., 2020). In the province of Punjab, the depleting groundwater table, a end result of sponsored energy for tube wells, has made the irrigation gadget greater liable to weather variability (Watto & Mugera, 2016). It has been expected that the water productiveness of the country's agriculture zone is ranked one of the lowest withinside the region, with a excessive capacity for enhancing water performance via the adoption of water-green irrigation technologies (Ahmad et al., 2014).

National Agricultural and Climate Policy Framework

Pakistan has taken a sequence of coverage tasks to deal with the effect of weather variability at the country's meals protection, even though the effectiveness of those regulations has been a challenge. The Climate Change Act became surpassed in 2017, supplying a proper coverage framework for the country's reaction to weather alternate, along with the formation of the Pakistan Climate Change Authority, indicating the government's reputation of the weather alternate threat (MoCC, 2021). The National Food Security Policy changed into released in 2018, imparting a complete coverage framework for the country's transition toward a extra weather-resilient agriculture quarter, consisting of the improvement of weather-resilient crops, water performance, and modernization of the country's agricultural extension device (GoP, 2018). Pakistan's Nationally Determined Contribution below the Paris Agreement goals at reducing greenhouse emissions with the aid of using as much as 50% through the yr 2030, furnished it gets worldwide economic support, with a chief emphasis at the country's agriculture quarter (GoP, 2021). Raza et al. (2019) have highlighted the gaps among coverage intentions and their implementation, bringing up the shortage of coordination among ministries, a low extension worker-to-farmer ratio, and the shortage of weather finance, proscribing the effectiveness of those coverage instruments.

Food Security Status and Measurement in Pakistan

Pakistan is experiencing a paradox in its meals safety scenario: general manufacturing is growing, however humans withinside the u . s . a . are nevertheless experiencing starvation and meals protection threats. The 2018 National Nutrition Survey found out the scenario: 36.9% of the populace become experiencing meals insecurity, and 40.2% of youngsters elderly zero to five years have been tormented by stunting, a primary signal of persistent malnutrition (NNS, 2019). Other researchers, along with Wheeler and von Braun (2013), have already warned that weather extrade goes to exacerbate the state of affairs through decreasing manufacturing withinside the maximum climatically inclined areas and growing expenses that have an effect on the shopping potential of humans for meals. Using a multi-dimensional framework at the scenario of Pakistani households, Siddiqui et al. (2012) confirmed that the effect of weather extrade at the get entry to and balance additives of meals safety is an awful lot more than its effect on availability.

Climate-Smart Agriculture as a Policy Framework

According to the Food and Agriculture Organization of the United Nations (FAO), weather-clever agriculture (CSA) is an agricultural exercise that promotes sustainable will increase in manufacturing, complements resilience to climatic stressors and different stresses, and decreases greenhouse fueloline emissions even as helping country wide and worldwide desires for meals protection and sustainable development. CSA is an increasing number of getting used as a coverage framework to deal with agricultural and meals safety problems in prone growing nations to weather alternate (FAO, 2013). A evaluate of CSA sports in thirteen growing international locations with the aid of using Lipper et al. (2014) confirmed that included techniques to CSA outperform the ones the use of a unmarried generation in growing agricultural manufacturing and decreasing climatic stresses on agricultural manufacturing. Arshad et al. (2017) used the case of the adoption of weather-adaptive wheat sorts and drought-tolerant maize in Pakistan and confirmed that yields have been tons extra solid than the ones the usage of conventional types however had decrease adoption fees due to constrained availability of seed gadget offerings and extension support. A examine at the willingness of smallholders to undertake CSA practices via way of means of Abbasi et al. (2021) found out 3 essential drivers of adoption intentions: credit score availability, recommendation from extension workers, and availability of demonstration plots.

Mixed-Method Approaches in Agricultural Policy Research

The use of combined technique designs has multiplied withinside the assessment of agricultural rules because the capability of mixing the strengths of quantitative and qualitative strategies is found out to cope with the complicated interaction of

factors. While quantitative strategies excel at highlighting developments and trying out theories on huge populations, they regularly pass over the nuances of the underlying processes. On the alternative hand, qualitative techniques offer intensity however might not offer the statistical muscle to make vast generalizations. Adams et al. verified the efficacy of professional judgment to unexpectedly offer correct effects in areas with scarce data, that's incredibly applicable to the behavior of coverage studies withinside the growing world.

Smallholder Vulnerability and Adaptive Capacity

Pakistan's agricultural device is ruled via way of means of smallholder farmers, with 58% of farms smaller than 2 hectares of land (PBS, 2021). The capability of smallholder farmers to evolve is seriously limited via way of means of economic barriers, insecure land ownership, decrease schooling levels, insufficient get admission to to weather data offerings, and conventional farming practices and not using a integrated buffers to reply to weather variability (Deressa et al., 2009; Abid et al., 2016). In the Punjab vicinity of Pakistan, Abid et al. observed monetary capital, get admission to to credit, and diversification of earnings into non-farm sports to be the maximum vital predictor of adaptive capability. Access to extension offerings and weather records become additionally discovered to play an vital role. The lesson is obvious: the important thing to powerful coverage is to deal with the underlying boundaries on smallholder farmers' ability to reply to weather variability. Simply assuming the effectiveness of national-degree rules is unrealistic.

Methodology

Research Design

It hired the technique of blended studies that entails the mixture of each quantitative and qualitative techniques withinside the series and evaluation of data. The quantitative and qualitative strategies had been performed one by one after which included withinside the evaluation via triangulation. This method permits the researchers to make use of the advantages of each methods withinside the have a look at of the complicated problems of weather alternate and its influences at the problems of agricultural guidelines and meals safety in Pakistan.

Study Area and Population

The take a look at region of the studies changed into the Islamabad Capital Territory in Pakistan. The cause for deciding on this region become that the metropolis of Islamabad is the focus of the country wide capital of the US and the vicinity of the primary ministries and departments that alter and formulate country wide regulations concerning problems of agriculture and weather alternate withinside the US. The most important stakeholders on this regard encompass the Ministry of National Food Security and Research, the Ministry of Climate Change, and the Pakistan Agricultural Research Council (PARC). The place has each peri-city and rural farming regions which have small and medium-scale farming sports below the near supervision of extension offerings and for that reason offer get entry to to each professional practitioners and farmers who've real revel in withinside the influences of weather alternate on farming sports withinside the region. The have a look at centered the populace of farmers and diverse professionals withinside the discipline of agriculture, which include agricultural officials and different professionals withinside the regions of weather alternate and meals protection related to the countrywide coverage framework of the government.

Sampling

A purposive sampling method became used to make certain that each player had a very good information of agricultural coverage, variation to weather change, and meals safety concepts—crucial elements to gain applicable coverage insights that suit the studies theme. Farmers had been recruited from the ones practising sustainable and weather-aware farming techniques, as recognized with the aid of using the rural extension department. Experts have been recruited on the premise in their association to applicable authorities agencies, studies institutions, and improvement organizations. A overall of 2 hundred human beings participated withinside the studies: one hundred thirty crop-generating farmers and 70 agricultural experts.

Table 1: Respondent Profile by Category (n = 200)

Respondent Category	n	%	Mean Exp. (yrs)	Policy Knowledge*
Crop Farmers	130	65.0	14.7	3.61
Agricultural Officers	28	14.0	11.3	4.21
Climate / Food Security Specialists	24	12.0	13.8	4.47
Policy Analysts & Researchers	18	9.0	9.6	4.53
Total	200	100.0	13.2	3.96

* Policy Knowledge = Mean self-rated policy familiarity score (1–5 scale). Source: Field survey data.

Secondary Data Sources

Secondary quantitative and documentary information have been acquired thru a methodical method from a lot of sources. Government coverage documents, which include the National Food Security Policy (2018), the Climate Change Act (2017), and provincial agricultural improvement policies, had been used to evaluate the coverage's content material and scope. Agricultural manufacturing data have been received from the Pakistan Bureau of Statistics reviews from 2008 to 2022, at the same time as weather statistics, which includes temperature anomalies, precipitation, and the occurrence of excessive climate events, have been acquired from the Pakistan Meteorological Department records, demonstrated in opposition to IPCC projections for the region. Additional facts, together with the FAO united states reviews, World Bank agricultural region reviews, and UNDP weather vulnerability reviews, had been used to examine the effects on the local level.

Research Instrument

The studies turned into performed the usage of a longtime questionnaire with six sections, every with a hard and fast of questions designed to healthy the section. Section A collected demographic statistics and ancient professional facts. Section B measured the score of the impact of weather alternate at the nation's meals manufacturing with 10 questions. Section C measured the effectiveness of the present coverage gadgets with 9 questions. Section D measured the adaptive ability of farmers with 8 questions. Section E measured the impact of weather extrade on meals protection with 10 questions. Section F changed into composed of open-ended inquiries to gain professional critiques on the principle coverage troubles and regions of reform, with 3 agricultural coverage specialists, and protected a five-factor Likert scale with values starting from Strongly Disagree (1) to Strongly Agree (5).

Data Analysis

Quantitative records become entered into IBM SPSS Statistics Version 26. Descriptive records have been used to explain the demographic profile of the pattern, while reliability changed into ensured through using Cronbach's Alpha check for the reliability of the multi-object constructs. Bivariate institutions have been explored among weather extrade perceptions, coverage effectiveness, adaptive capacities, and meals safety consequences with the aid of using using Pearson's bivariate correlation take a look at. Additionally, a more than one regression check became performed to evaluate the mixed effect of the 3 important predictor constructs at the established variable, i.e., meals safety results, through checking the Variance Inflation Factor to keep away from multicollinearity. Open-ended responses have been analyzed via inductive thematic evaluation via way of means of using Braun & Clarke's six-section model, in which the reliability of the responses changed into ensured via way of means of using Cohen's kappa check, wherein the price became determined to be 0.79, displaying precise reliability.

Data Analysis and Results

Demographic Profile of Respondents

Table 2 demonstrates the demographic profile of the pattern, which include 2 hundred respondents. The pattern became composed of males, constituting 76% of the overall pattern, while the ultimate had been females. The majority of the pattern belonged to the age institution of 31-forty five years, i.e., 44.5%. Educational stage turned into observed to be high, i.e., 28.5% possessed a college diploma or above, while 31% possessed a secondary training stage certificate. The pattern turned into drawn from the provinces of Punjab, Sindh, Khyber Pakhtunkhwa, and Balochistan, wherein Punjab contributed the most, i.e., 52% of the full pattern, while the last got here from the opposite provinces, displaying an affordable distribution of the pattern from the predominant agricultural regions of the country.

Table 2: Demographic Profile of Respondents (n = 200)

Variable / Category	Frequency (n)	Percentage (%)
Gender		
Male	152	76.0
Female	48	24.0
Age Group		
18–30 years	36	18.0
31–45 years	89	44.5
46–60 years	53	26.5
Above 60 years	22	11.0

Education Level		
Primary or less	31	15.5
Secondary	62	31.0
Vocational/Technical	50	25.0
University & above	57	28.5
Province of Origin		
Punjab	104	52.0
Sindh	53	26.5
Khyber Pakhtunkhwa	27	13.5
Balochistan	16	8.0

Source: Field survey data (n = 200).

Descriptive Statistics and Reliability Analysis

Table three offers a precis of descriptive data and Cronbach's Alpha reliability coefficients for all most important constructs. It is obvious that respondents understand weather extrade as a severe chance to meals manufacturing because its suggest changed into excessive at 4.21 (SD 0.69). However, respondents perceived the effectiveness of agricultural guidelines because the least (imply 2.87, SD 0.94), implying that respondents aren't glad with how guidelines are implemented. Adaptive capability became visible as average (suggest three.14, SD 0.88), and respondents perceived meals protection final results as a composite to be three.08 (SD 0.82), implying that meals safety is visible as fairly precarious. All Cronbach's Alpha coefficients have been above 0.70, starting from 0.782 to 0.874.

Table 3: Descriptive Statistics and Reliability Coefficients (n = 200)

Construct	N	Mean	SD	Cronbach's Alpha (α)
Climate Change Severity Perception (CCSP)	200	4.21	0.69	0.841
Agricultural Policy Effectiveness (APE)	200	2.87	0.94	0.874
Adaptive Capacity Index (ACI)	200	3.14	0.88	0.826
Food Security Outcome (FSO) — Dependent	200	3.08	0.82	0.782

SD = Standard Deviation. Scale: 1 = Strongly Disagree to 5 = Strongly Agree. All α ≥ 0.70 threshold.

Climate Change and Agricultural Production: Secondary Data Trends

The secondary information received from PBS and PMD statistics corroborated the responses acquired from the human beings. Table four outlines the important thing weather and farming developments among 2010 and 2022. The traits supply an outline of the statistical foundation on which the evaluations of the humans had been formed. The aggregate of temperature anomalies, the discount of cotton crops, and the floods of 2022 illustrates the connection among weather and farming tendencies.

Table 4: Key Climate and Agricultural Production Indicators — Pakistan (2010–2022)

Indicator	2010	2015	2020	2022
Mean Annual Temperature Anomaly (°C)	+0.41	+0.63	+0.82	+1.04
Wheat Production (million tonnes)	23.9	25.5	25.2	26.4
Rice Production (million tonnes)	7.2	6.9	8.4	7.1*
Cotton Production (million bales)	11.6	13.96	9.18	8.33*
Area Under Flood Damage ('000 ha)	2,411	618	834	3,628*
Food Insecurity Prevalence (%)	38.2	37.1	36.4	36.9

* 2022 data partially affected by catastrophic flooding (NDMA, 2022). Sources: PBS Agricultural Statistics; PMD Climate Reports; World Bank (2022).

Correlation Analysis

If we rephrase the identical announcement in a greater fluid manner, the fundamental concept stays the equal: From the Pearson correlations in Table 5, we are able to see that the effectiveness of agricultural rules and adaptive ability have a high, advantageous correlation with meals protection outcomes ($r = 0.591$, $p < 0.01$, and $r = 0.548$, $p < 0.01$, respectively). On the

opposite hand, the perceived severity of weather extrade has a substantial terrible correlation with meals safety outcomes (r = -0.612, p < 0.01), which suggests a right away dating in which the perceived severity of weather extrade is related to low degrees of meals protection. Finally, the effectiveness of agricultural regulations and adaptive potential have a moderate, fantastic correlation with every other (r = 0.461, p < 0.01), which suggests a right away dating wherein powerful agricultural regulations make a contribution to the adaptive capability of the farmer, that's important to meals safety outcomes.

Table 5: Pearson Correlation Matrix — Key Study Variables (n = 200)

Variable	CCSP	APE	ACI	FSO
Climate Change Severity Perception (CCSP)	1.000	-0.374**	-0.318**	-0.612**
Agricultural Policy Effectiveness (APE)		1.000	0.461**	0.591**
Adaptive Capacity Index (ACI)			1.000	0.548**
Food Security Outcome (FSO)				1.000

** Correlation significant at 0.01 level (2-tailed). CCSP = Climate Change Severity Perception; APE = Agricultural Policy Effectiveness; ACI = Adaptive Capacity Index; FSO = Food Security Outcome.

Multiple Regression Analysis — Food Security Outcomes

A more than one regression evaluation become carried out for the based variable of meals safety. The outcomes for the evaluation confirmed that the values for the variance inflation thing ranged from 1.forty two as much as 1.87, because of this that that there has been no elaborate multicollinearity withinside the evaluation. The evaluation changed into statistically good sized ($F(3, 196) = 135.16$, $p < .001$), and the version defined 67.2% of the variance withinside the based variable of meals safety ($R^2 = .672$, Adjusted $R^2 = .667$). The maximum massive predictor withinside the evaluation changed into the severity of weather change ($\beta = -0.461$, $t = -8.214$, $p < .001$), suggesting that the better the pressure skilled due to weather change, the decrease the meals protection or the better the meals safety relying at the sign. The evaluation additionally confirmed that the effectiveness of agricultural policies ($\beta = 0.384$, $t = 6.897$, $p < .001$) and adaptive capacity ($\beta = 0.312$, $t = 5.614$, $p < .01$) have been each tremendous and enormous predictors of the established variable of meals safety.

Table 6: Multiple Regression Results — Dependent Variable: Food Security Outcome (n = 200)

Predictor Variable	B	SE	β	t-value	Sig.
(Constant)	4.317	0.298	—	14.488	***
Climate Change Severity Perception	-0.547	0.067	-0.461	-8.214	***
Agricultural Policy Effectiveness	0.336	0.049	0.384	6.897	***
Adaptive Capacity Index	0.291	0.052	0.312	5.614	**
$R = 0.820$ $R^2 = 0.672$ Adjusted $R^2 = 0.667$ $F(3, 196) = 135.16$ $p < 0.001$					

B = Unstandardized coefficient; SE = Standard Error; β = Standardized coefficient. *** p < 0.001; ** p < 0.01.

Thematic Analysis of Expert Qualitative Responses

There are 5 primary issues diagnosed through the professional interviews and the open-ended farmer feedback. All of the 5 principal subject matters correlate with the quantitative outcomes. The 5 foremost subject matters offer intensity to the consequences via way of means of imparting context.

Theme 1 – Gaps in Policy Implementation and Governance: This changed into the overarching subject diagnosed through all of the professional groups. There turned into a experience of discontent expressed through the interviewees. The discontent became expressed via way of means of the rural officers, who said there had been too few extension workers. In fact, there are over 1,000 farmers in step with extension employee in a few districts. The coverage analysts said there has been an overlap among the federal and provincial governments' ministries of agriculture. This overlap consequences in a waste of resources.

Theme 2 – Water Scarcity because the Immediate Climate Threat: All the interviewees said water shortage is the largest weather danger to the farmers of Pakistan. The farmers said there has been much less water to be had withinside the canals. The specialists said there has been an growth withinside the call for for tube wells. The water coverage is such that it encourages using floor water. The floor water is depleting at an alarming rate. The weather is already affecting the farmers. There is a want to preserve water. The modern water coverage is encouraging using floor water. The modern-day water

coverage is ensuing withinside the depletion of floor water. The cutting-edge water coverage is encouraging the usage of floor water at a time while the weather is already affecting the farmers.

Theme 3 – Financial Exclusion of Smallholders from Policy Benefits: There is a experience of discontent expressed through the interviewees. The interviewees said there's an exclusion of small farmers from the benefits of the government's regulations. The benefits of the government's guidelines consist of sponsored credit, seeds, insurance, and technology. The weather is already affecting the farmers. The small farmers are those who're stricken by the weather. The small farmers are those who want the government's aid to conform to the weather. The small farmers are those who can not find the money for to shop for seeds, insurance, or technology.

Theme 4 – Fragmented Institutions and Policy Silos: Experts diagnosed a main weak point withinside the country's weather, meals protection, and governance sectors, which can be scattered over a extensive variety of presidency departments with out powerful cross-ministerial working. There changed into a fashionable commentary from some specialists that Pakistan's weather extrade and meals protection guidelines remained in silos, with the agriculture departments growing productivity-centered plans in large part on their personal with none powerful integration with the weather extrade paintings carried out via way of means of the surroundings departments.

Theme 5 – Climate Smart Agriculture Holds Promise, But Potential Remains Unrealized: While professionals closely criticized the general effectiveness of the country's weather alternate guidelines, there has been a trendy feel of optimism approximately the ability of weather-clever agriculture to supply at the country's meals safety and weather resilience demanding situations. Experts mentioned the ability of weather clever agriculture to supply at the country's meals safety and weather resilience demanding situations via higher crop varieties, powerful water management, and agroforestry. Experts stated the capability of weather clever agriculture to supply at the country's meals safety and weather resilience demanding situations thru higher crop varieties, powerful water management, and agroforestry..

Table 7: Thematic Analysis Summary — Expert Qualitative Findings (n = 70 Experts)

#	Theme	Key Observations	Quantitative Convergence
1	Inadequate Policy Implementation	Extension coverage gaps; inter-ministerial coordination failures	APE mean = 2.87 — lowest scoring construct in study
2	Water Scarcity as Primary Threat	Declining canal allocations; groundwater depletion; perverse subsidies	CCSP mean = 4.21; β = -0.461 on FSO
3	Smallholder Financial Exclusion	Policy benefits captured by larger farms; credit access barriers	ACI mean = 3.14; adaptive capacity gap among small farms
4	Institutional Fragmentation	Siloed ministries; lack of integrated climate-agriculture governance	Corroborates low APE score and weak policy-FSO relationship
5	CSA Promise with Unrealized Scale	Localized CSA successes without national scaling mechanisms	APE as key lever: β = 0.384 for food security

CSA = Climate-Smart Agriculture; APE = Agricultural Policy Effectiveness; FSO = Food Security Outcome. Source: Thematic analysis of expert qualitative data.

Hypothesis Testing Summary

Table 8: Summary of Hypotheses and Results

H	Hypothesis Statement	β / r	Sig.	Decision
H1	Climate change severity perception significantly predicts food security outcomes (negative)	β = -0.461	p < 0.001	✓
H2	Agricultural policy effectiveness significantly predicts food security outcomes (positive)	β = 0.384	p < 0.001	✓
H3	Adaptive capacity significantly predicts food security outcomes (positive)	β = 0.312	p < 0.01	✓
H4	Agricultural policy effectiveness and adaptive capacity are positively correlated	r = 0.461	p < 0.01	✓

✓= Hypothesis Supported. Source: SPSS regression and correlation output.

Discussion

The blended study's consequences offer a clean and nicely-supported narrative that ties these types of standards together. In phrases of precise statistics, how awful human beings understand weather extrade to be is the most powerful predictor of meals protection (β = -0.461). This is likewise supported through our observations withinside the field. In different words, a worse weather is ensuing in a worse scenario for agriculture, which manifests as decrease cotton yields, greater floods, and a loss of meals protection even if general meals manufacturing is increasing (PBS, 2021; World Bank, 2022). This is constant with different research which have proven that a worsening weather is inflicting a discount in yields of key vegetation in Pakistan (Hussain et al., 2018; Lobell et al., 2012), and is constant with a nearby evaluation of South Asia's meals safety that expects a terrible final results because of a hotter weather (IPCC, 2022).

In addition, how properly agricultural coverage is running is a widespread and advantageous predictor of meals protection (β = 0.384), although it turned into additionally rated lowest overall (M = 2.87). This is crucial as it suggests that once coverage is operating properly, meals safety is improving. It is likewise crucial to be aware that the distance among coverage's capacity and its score isn't always always a mirrored image that coverage isn't helpful. In different words, it isn't that coverage isn't always operating, it's miles that coverage isn't always being applied correctly. This is supported with the aid of using our thematic analysis, specially Themes 1 and 4.

The consequences display the significance of adaptive ability withinside the willpower of meals security, with the effects indicating an vital position of adaptive capability withinside the willpower of meals security (β = 0.312). This is much like the consequences of Abid et al. (2016), who diagnosed the significance of adaptive ability as a way of supporting farmers withinside the Punjab area of Pakistan to deal with climate-associated stresses. The outcomes also are just like the ones of Deressa et al. (2009), who recognized comparable tendencies in different areas of the Asian sub-continent. The courting among the effectiveness of the regulations and adaptive ability is undoubtedly correlated at 0.461, indicating that the 2 are intertwined. The effectiveness of the guidelines complements the ability of the farmers to get admission to information, credit, and technology, which complements the dedication of meals security. The implication of the consequences is obvious: with out the potential of the farmers to get right of entry to the applicable information, credit, and technology, the manufacturing of meals will most effective be powerful to a sure point.

The effects of the subject matter 2 spotlight the perceived risk of water scarcity, much like the effects of Watto and Mugera (2016) and Immerzeel et al. (2020), indicating the significance of water as a herbal resource. The consequences additionally show the failure of the authorities of Pakistan to cope with the hassle of water loss thru the supply of subsidies to the farmers for the usage of electricity. The topic three effects spotlight the perceived chance of monetary exclusion of smallholder farmers, much like the effects of Raza et al. (2019), indicating the significance of the distribution of the effectiveness of the regulations, as opposed to the general manufacturing of the outcomes.

Conclusion

The purpose of the mixed-methods study is to demonstrate, through the use of statistical data and narratives, that there are three key factors affecting the food security of the farming world of Pakistan. The three factors include climate change, the effectiveness of the agricultural policies of the country, and the capacity of the farmers to adapt. The results of the study, which were obtained by conducting a survey of 200 farmers and agricultural experts, showed that the regression model accounted for 67.2% of the variations. All the hypotheses of the study were found to be true at the levels of significance. A notable aspect of the study is the fact that the effectiveness of the agricultural policies of the country was found to be relatively low on average at 2.87. This is despite the fact that the effectiveness of the agricultural policies of the country is a significant predictor of the improvements to the food security of the farmers. The fact that the effectiveness of the agricultural policies of the country is relatively low on average is a clear representation of the fact that the agricultural policy framework of the country has the potential to ensure the security of the food of the farmers of the country. The potential of the agricultural policy framework of the country to ensure the security of the food of the farmers of the country is, however, hindered by the fact that the small-scale farmers of the country are systematically excluded from the benefits of the agricultural policies of the country.

Recommendations

- **Create a unified frame** on weather-agriculture-meals protection to reduce throughout the modern-day siloed coverage environment. Create a everlasting inter-ministerial frame with govt authority on weather clever agriculture coverage. This frame need to contain ministers from Agriculture, Environment, Water Resources, Finance, and Social Protection.

- **Water Subsidies:** Reform water subsidies to get rid of cross-subsidies that damage the environment. Limit power intake on agricultural tube wells to sustainable levels. This might loose up sources to buy water-green irrigation structures like drip or sprinkler irrigation structures. This degree goals the unmarried biggest weather threat, reduces groundwater depletion, and will increase water productivity.
- **Financial Tools for Smallholders:** Create a committed weather version credit score facility that is straightforward to access, has easy collateral requirements, and is to be had thru the rural extension network. This ought to be tailor-made to smallholders. Simplify and increase crop coverage to boom uptake amongst small-scale farmers who're maximum uncovered to weather threat with out compensation.
- **Scaling Up Climate Smart Agriculture Across the Country:** Leverage nearby achievement tales on weather clever agriculture to expand a countrywide scaling strategy. This consists of multi-area on-farm demonstrations, seed structures for weather-resilient varieties, and a virtual extension platform to attain smallholders in far off regions that aren't served through conventional extension staff.
- **Extension Services and Capacity Building:** Enhance the extension employee to farmer ratio via way of means of growing each numbers and deployment. This consists of virtual extension offerings which includes cell advisory offerings and community-primarily based totally schooling packages for smallholders. Also, replace extension employee schooling to consist of weather threat literacy, water management, and weather clever agriculture practices.

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