

Sustainability Assessment of Livelihood Strategies in Agriculture Sector of Pakistan—A Systematic Review

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The agricultural dependent population that engage in self-sustaining livelihood strategies remain resilient to unpredictable events regardless of the type of livelihood strategies. This study aims to identify sustainable livelihood strategies adopted by agricultural dependent population in Pakistan. In this regard, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework is used to synthesise the literature from 2000 to 2023. The sustainability aspect of strategies is examined through three broadly accepted dimensions (environmental, social and economic). The study found out that the diversification dimension of sustainable agriculture is more resilient to any unpredictable events and has better livelihood outcomes. The maximum vulnerabilities were associated with weather shocks, limited climate-adaptation measures and policy negligence. This paper contributes to identifying the dominant and sustainable agricultural strategies and developing linkages among capitals and sustainable livelihood outcomes. It also highlights the research gap in agriculture literature given the changing scenarios according to the sectoral needs.

JEL Classification: Q1, O5, O21, O130

Keywords: Livelihood Strategies, Policy, Environment, Sustainability, Diversification, Livelihood Capitals.

1. INTRODUCTION

Livelihoods sustainability has emerged as a central issue in rural settings due to its exposure to multi-risks and complex socioeconomic linkages (Zhao & Su, 2026). The rural population derives their livelihoods from a diverse range of agricultural portfolios (Ayana, et al. 2022) which remain prone to environmental, economic, social and institutional risks (Habib, et al. 2023). Chambers & Conway (1992) elaborate that sustainable livelihoods must have the capacity to recover from stress and shocks and regain their strength to earlier position without damaging the natural resource base. The understanding about sustainability of livelihoods requires integrated approach in analysing rural households' resilience to shocks and building capacity for long term welfare and productivity (Scoones, 1998; Ellis, 2000; Barrett, et al. 2001). Agriculture, being the primary source of livelihoods in rural areas, can better assess their sustainability considering the resources and asset base of households. Alongside, the role of the government policies is also critical which supports agricultural systems for sustainable rural livelihoods (Gomiero, et al. 2011; Spedding 1988). Vulnerabilities in rural livelihoods are indicated by the prevalence of rural poverty, hunger, food crisis, malnutrition, water contamination, and environmental degradation (World Food Programme, 2025). These vulnerabilities imply that there is a gap between policy-making and desired outcomes for rural population across the world. For example, the food crisis

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in 2007 witnessed this policy neglect which affected the livelihoods of rural population. Environmental shocks are continuously deteriorating the means of earnings and livelihoods (Mobeen, et al. 2023). These significant events have resurfaced the attention of the international organisations and governments to the agriculture sector policies aiming to provide sustainable livelihoods to rural people (Altieri, 2008; Heltberg, 1998; Wiggins, et al. 2010). For that reason, the continuous occurrence of environmental events amid economic and institutional uncertainties, has created the need to assess the resilience of livelihood strategies adopted by the masses.

Sustainable livelihoods (to be read as SL onward) approach is an advanced version of Integrated Rural Development (IRD) which focuses on intersectoral development objectives whereas SL incorporates institutions, organisations, and participatory approach (Haug, 1999). The sustainability of strategies (such as farming, livestock, multi-cropping, on/off farm etc.) and their means of livelihoods (assets, capabilities etc.) strengthen each other with the support of policies. It consequently enhances higher productivity, better incomes, awareness and better living (DFID, 1999; Mutopo, 2014). However, environmental risks, limited institutional focus and economic shocks can be detrimental to rural livelihoods. Considering the multidimensional aspects of SL – resource base, assets, capabilities, institutions, social fabric, culture, risks, and nature of livelihood strategies (to be read as LS onward) – a diverse range of literature is available. Several studies have assessed the livelihoods resilience against environmental shocks including droughts, floods and glaciers melt (Usman, et al. 2024; Mobeen, et al. 2023; Nasrnia & Ashktorab 2021; Pandey, et al. 2017). Similarly, a strand of literature has discussed the impact of livelihood capitals on LS with particular focus on diversification (Habib, et al. 2023), farming (He & Ahmed 2022), sensitivity of capitals (Xu, et al. 2019), and assessment of coffee and cocoa producers (Salazar, et al. 2018). In the same way, a plenty of literature exists on the impact of agriculture LS on other outcomes such as poverty reduction, development, income, nutrition and related subjects (Dethier and Effenberger 2012; Webb & Kennedy 2014; Weißhuhn, et al. 2018; Viana, et al. 2022). In each study, a specific component of SL has been discussed either reflecting upon strategies, coping mechanisms or exposure to risks. SL carries a vast scope of research because of its multidimensionality, providing sufficient gap to conduct a comprehensive sustainability assessment of agriculture related strategies focusing on different outcomes of SL. With the transformation of agriculture from extensive to sustainable (Mason 2003), scoping reviews about impact of sustainable agriculture (SA) became noticeable. The scoping reviews discussed the connection of SA with environmental, economic, governance and social spheres (Van de Fliert & Braun 2002; Lichtfouse, et al. 2009; Brodt 2011; Yu & Wu 2018). On livelihood sustainability side, a recent review by Habib, et al. (2023) emphasised the impact of livelihood capitals on diversification only. It inferred that strong asset base strengthens the adaptive capacity of households against shocks. It also found out that ownership of natural, human and financial capitals makes the livelihoods sustainable. However, a comprehensive review connecting SA strategies with the outcomes of SL is yet to be conducted globally or at country level.

Pakistan is an agricultural country with 61 percent rural population (PBS, 2023) and 33.1 percent of total population derive their livelihoods from the agriculture sector (PBS, 2025). The LS of rural population are intertwined into several on-farm, off-farm activities, farming, livestock, dairy etc. which have been prone to climate shocks, economic and institutional changes. Usman, et al. (2024) mentions that there is a significant impact of climatic events on the rural livelihoods in Pakistan, however the adapters of mitigating strategies fare better. In economic context, inflation, farm-input

disruptions, high input costs, and water shortages reduce the agricultural productivity and farmers' incomes (Ahmad, et al. 2023). Similarly, limited institutional support makes it difficult for the farmers and agricultural dependent population to earn smooth incomes from their strategies. The World Food Programme (2025) also highlighted the vulnerabilities emerged due to the compounded effects of environmental and economic challenges in the country and called for emergency livelihood support from the institutions. In this regard, this study using the DFID (Department for International Development) livelihoods framework conducts sustainability assessment of the agriculture related LS disintegrating them into environmental, economic, and social dimensions of SA. Further, it also assesses the institutional support to maintain the resilience of the strategies through various government initiatives and policies. In this regard, this study identifies the policy loopholes and provides recommendations for better livelihoods as well as identifies research gaps.

Research Questions:

This study answers the following questions:

- Which livelihood strategies belonging to sustainable agriculture dimensions provide sustainable means of income, improved yield, and resilience to socio-economic, environmental or policy shocks?
- Do these livelihood strategies have any policy support?
- Which dimension of sustainable agriculture, in terms of economic, environmental and social dimensions, is more resilient to shock?

1.1. Important Concepts and Definitions

Before going into details, the concepts of sustainable livelihoods (SL), sustainable agriculture (SA), and livelihood strategies (LS) are elaborated below:

1.1.1. Sustainable Livelihoods (SL)

Livelihood is a complex concept which covers the means, activities, entitlements, and assets by which people make a living in a continuous pattern (UNDP, 2017; Hussein 2002). This study follows the definition of livelihood as below:

“A livelihood comprises the capabilities, assets and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base.” (Carney, 1998).

1.1.2. Sustainable Agriculture (SA)

Hayati, et al. (2011) argued that no consensus on the definition of SA is found thus, agriculture sustainability can be country specific, context specific or even farm specific. Nevertheless, the sustainability of agriculture is hard to measure due to different contributing factors of agriculture which are critical at one place but not of utmost importance in some other scenario (Velten, et al. 2015). This study is built on the following definition of SA:

“To be sustainable, agriculture must meet the needs of present and future generations, while ensuring profitability, environmental health, and social and economic equity. Sustainable food and agriculture contribute to all four pillars of food security – availability, access, utilisation and stability – and the dimensions of

sustainability (environmental, social and economic).” (Food and Agriculture Organisation).

1.1.3. Livelihood Strategies (LS)

A livelihood strategy is how people derive their incomes from a limited or diverse variety of opportunities (Ellis, 1998) whether based on assets, accessibility to paid work, exchange-work, self-employment etc. According to Ellis (1998), LS in rural areas are not limited to agricultural activities; rather many other sources of income have also been included in its ambit. People adopt a LS keeping in view the geography, asset base, substitution, availability of options opportunities and networking connections (Ellis 2000). In developing countries, with rapid globalisation and modernised policies, the rural livelihood/income strategies have started to evolve (Warren, 2002), however the majority still rely on primitive agriculture (Yang & Zhu 2013).

Within the existing literature, Habib, et al. (2023) in a systematic review, evaluated the role of livelihood capitals in determining the adoption of LS only in diversification dimension of SA. Mobeen, et al. (2023) in an empirical study focusing on Pakistan’s farmers, provided evidence about the significant role of capitals in climate adaptation process. However, Zulfikar and Thapa (2017) conducted agricultural sustainability at provincial level using selected indicators such as crop diversification & production, soil health, use of farm inputs, and rural employment. These studies provide limited evidence about broad assessment of LS derived from all dimensions of SA. This study contributes to literature in several ways. Firstly, it comprehensively applies DFID livelihood framework which is widely accepted approach to assess sustainability of LS. Secondly, it systematically evaluates empirical evidence from all sub-dimensions of SA and connects them to livelihood outcomes, diagnoses policies’ support, and identifies dominant strategies. Thirdly, it develops analytical linkages among types of capitals, LS, role of institutions/structures, and influencing factors that altogether shape SL and reveal resilience in each vulnerability context. In the end, it highlights policy and research gaps in literature focusing on the livelihoods of agricultural population in the country. It is claimed that no systematic review or bibliometric analysis assessing the sustainability of LS connecting with all dimensions of SA have been conducted, which is aimed in this paper. The paper is structured as follows; the conceptual framework is elaborated under the data and methodology in Section 2. Results and discussion parts reflecting upon regional and provincial comparisons are presented in Section 3, followed by conclusion in Section 4.

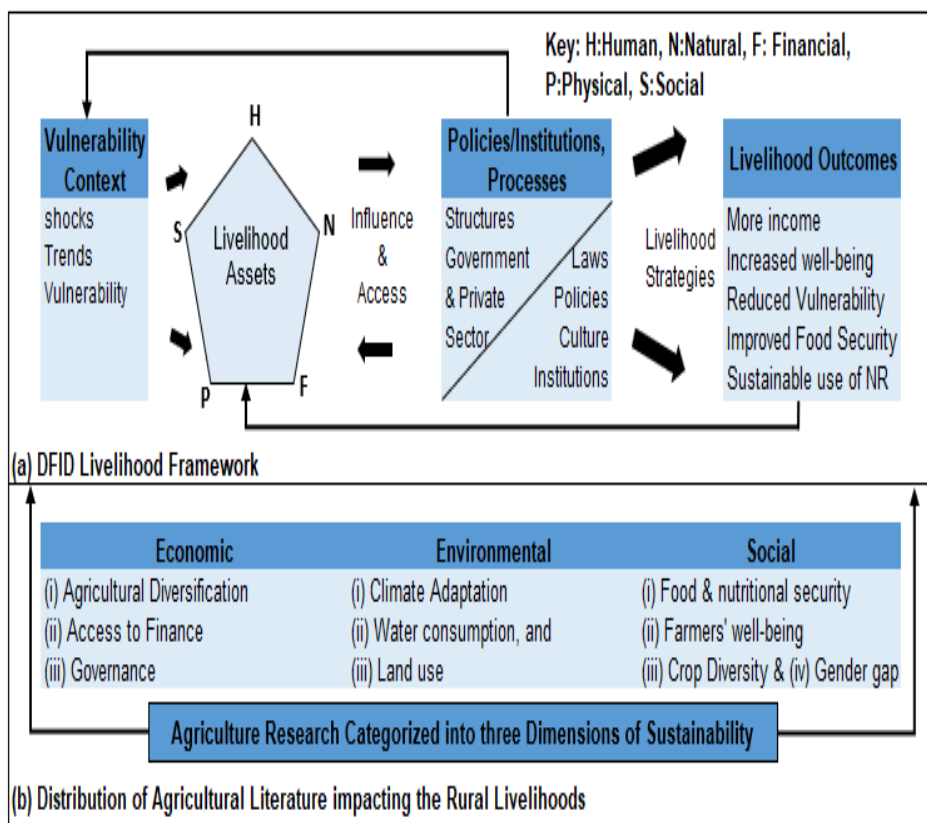
2. DATA AND METHODOLOGY

2.1. Conceptual Framework

This study conceptualises the idea of the sustainability assessment of LS derived from SA by using the framework introduced by the DFID in 1999 which was later renowned as DFID Framework 2000 (Solesbury, 2003) The framework (DFID, 1999) states that rural households perform in a vulnerability context emerging from various shocks (floods, conflict, health), trends (economic factors), and seasonal factors (prices, agricultural production). The consequences of those vulnerable factors are further influenced by the prevailing structures (government or private) and processes (rules, policies, laws, culture etc.). However, rural people have a certain kind of asset base laid

on capital (human, natural, financial, physical and social) which drives their livelihoods in the presence of the influencing factors. Keeping in view the vulnerability context and influencing factors, the rural people adopt a safe source of earning that could ensure a sustainable living. The outcomes of livelihoods as mentioned by the DFID framework are income, stronger voice, reduced vulnerability, improved food security and empowerment.

Fig. 1. DFID Framework in Connection with Agriculture Research

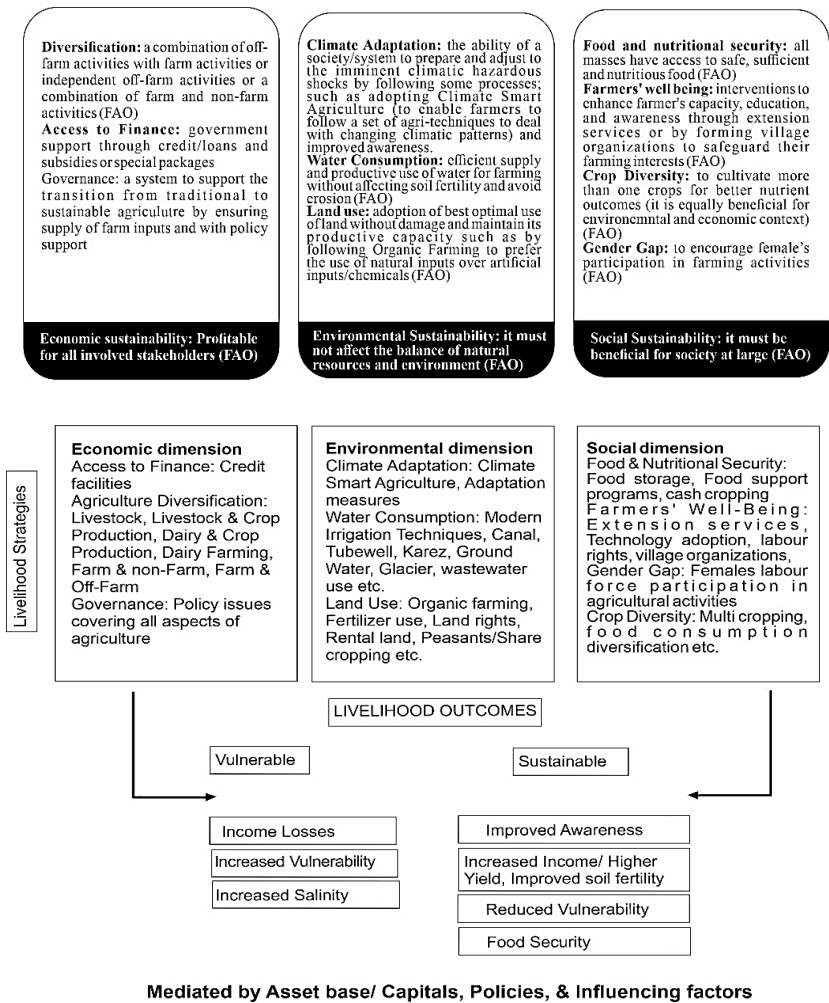


(Adapted from DFID Framework 2000) – Fig. 1(a) shows the influence of policies/ institutions and process on vulnerability context given the availability of livelihood assets. This nexus of livelihood assets, influence of policies/processes and vulnerability context is critical in gaining livelihood outcomes following a particular livelihood strategy. Fig. 1(b) shows the distribution of agricultural research distributed into three dimensions will observe the impact of each dimensions' strategies on the livelihood outcomes in the presence of policies, different influences and vulnerability contexts.

The LS derived from SA are segregated into three sustainability dimensions economic, environmental, and social following the SA matrix of Zhang, et al. (2021). The SA matrix empirically assessed the progress of SA in three dimensions of sustainability for all countries. The conceptual framework using the above theoretical base to analyse the literature for this study is reproduced in Figure 1.

The further distribution of sustainability dimensions of SA has been tailor-made into several themes as described in Zhang, et al. (2021) as well as following the inductive approach in Pakistan’s context. The definitions of each category along with their corresponding LS are given in Figure 2 and further elaboration is attached as appendix 1.

Fig. 2. Definitions of Different Themes of SA, Corresponding LS, and Livelihood Outcomes (Sustainable or Vulnerable).



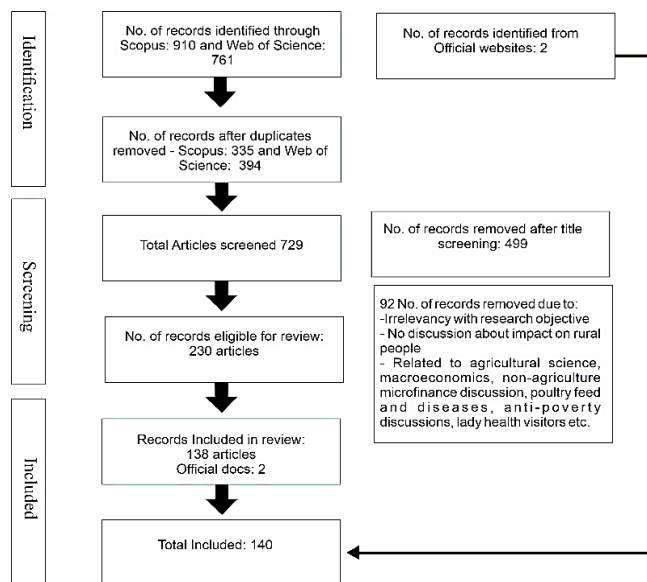
In view of the above, this study postulates that the sustainable agricultural strategies (e.g. diversification, access to finance, access to irrigation/water consumption, food security etc.) strengthen SL in terms of improved income, yields, awareness, and overall welfare if supported by livelihood assets and policies.

2.2. Methodology

The Preferred Reporting Items for Systematic Reviews and Meta Analysis (PRISMA) Framework (Hutton, et al. 2015; Tricco, et al. 2018) is used to extract literature

on SA and SL for Pakistan. The stepwise process of literature selection is elaborated in the flow chart, Figure 3.

Fig. 3. PRISMA Framework Flow Chart



2.2.1. Identification

The relevant literature was searched on two databases, Scopus and Web of Science (WOS). The Boolean operators included SA, SL, productivity enhancement, agriculture, climate, rural development, women, nutrition, irrigation, finance, land, agriculture governance, and food security (search string at Appendix 2). These keywords broadly reflect the outcomes mentioned in the DFID framework and dimensions of SA. The total number of articles identified for the review were 1671 as 910 obtained from Scopus and 761 from Web of Science. Two policy documents were acquired from the website of Ministry of National Food Security and Research for the year 2004 and 2018. The focus of the research was articles, review papers, chapters. The language was restricted to English, and discipline was limited to social sciences. The rationale to set the range of years from 2000 to 2023 for literature review is that the DFID livelihood framework was introduced in 1999.

2.2.2. Screening Criteria

After combining records acquired from WOS and Scopus, 942 were removed because of duplication using the conditional formatting with highlighting duplicates function in Excel and 729 Nos were selected for initial review. A further 499 Nos were excluded after title screening due to irrelevancy reasons. The excluded articles' titles reflected agricultural experiments, poultry feeds, agriculture historic origin in South Asia, production functions in education, role of enterprises etc. which do not meet the study objective. The criteria were limited to empirical research involving households connecting the SA practices with the outcomes of livelihood.

2.2.3. Eligibility

After preliminary screening 230 records were selected as eligible for the review meeting the objective of the study. The selected articles covered the research themes mentioned in Figure 2. After abstract reading and skimming the articles, another 92 Nos were excluded due to irrelevancy with the analytical framework and research objective. The reasons for exclusion were that; articles were belonging to agricultural sciences, macroeconomics, credit financing of non-agriculture activities, women role in non-farm fields etc. Further, we did not find any eligible articles for the years 2000, 2001, 2005 and 2006 in any theme .

2.2.4. Inclusion

In the end, 138 Nos of research articles and 2 policy/government documents were included. Out of the total 138 research articles, 114 Nos were empirical studies whereas 24 Nos were related to qualitative analysis or policy discussions. The 114 research articles with farm, household, and survey based empirical analysis were evaluated separately to deduce SL outcomes. The other 24 Nos were analysed separately along with policy documents and discussed with policy analysis in discussion section. On policy side, the articles discussing the role of government and governance inefficiencies were included.

2.3. Matrix Development to Categorise the Research Articles

2.3.1. Categorisation of SA

A deductive approach was adopted to divide the research studies into different themes of SA. By following the definitions of Figure 2, all articles were placed under ten themes of SA. On the other hand, an inductive approach in identifying the influencing factors was followed so that as many challenges as possible or supportive aspects could be detected. The allocation of each article to its specific theme was based on its title and abstract.

2.3.2. Categorisation of LS and SL Outcomes

On the same lines, an inductive approach was used to categorise each paper against its LS. The category of LS was identified through abstract reading whereas the SL outcome required thorough study of each article to identify influencing factors. The literature revealed several categories of LS which are mentioned above in Figure 2.

2.3.3. Matrix Formulation

After determining the themes of each research study with regards to SA, LS, and SL outcomes, a matrix was developed composed of 114 articles. The broad distribution occurred in three dimensions of sustainability followed by 10 outcomes of SL and 9 themes of SA (the 10th governance theme is discussed in qualitative context only). Though the SA practices were divided into three dimensions, their research and impact were cross cutting that involved more than one dimension at a time. For example, non-farm work is an economic dimension but if its outcome is influenced by culture and performed by women can make this paper belong to social dimension. We considered this aspect while allocating all research articles to its specific theme. In addition, other categorisations include; (i) influencing factors along with types of capital i.e. technology, mechanisation, social structure, farmers' organisation, landlessness etc. (ii) role of policies i.e. positive

if supporting the SL outcome, neglected if do not address the LS and SL outcome, less effective if policy exists but with weak implementation, (iii) policy indicator identifies the type of policy i.e. water policy, land reforms, women development policy, education and training of farmers, extension services, food security policy etc.

2.3.4. Determining the Status of SL

To determine the status of a sustainable agricultural strategy discussed in a paper, this study follows a multi-criteria evaluation approach derived from the components of DFID framework. Sustainability is identified based primarily on sustainable livelihood outcomes such as increased/stable income, improved yields, improved awareness, food secure households, empowerment, training of farmers etc. as reported in under-reviewed studies. The other criteria include the availability of asset base, coping strategies to shocks, influencing factors and role of policies. For example, if a study mentions increase in incomes due to off-farm and livestock activities even without the policy support. The study would be categorised as sustainable because of its resilience against market risks and better human and financial capital availability.

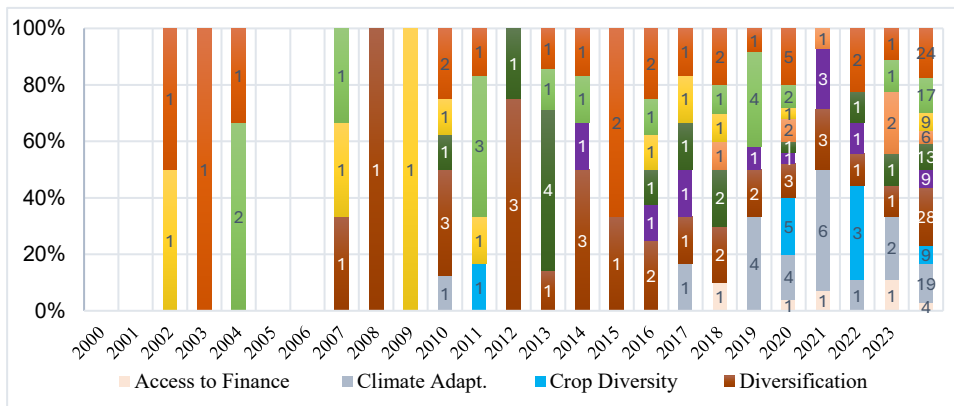
3. RESULTS AND DISCUSSION

3.1. Results

3.1.1. Persistence of Different Themes after Categorisation

The occurrence of each theme under SA kept on changing over the years. The persistence of the articles was calculated by taking percentage of the occurrence of the articles in from the total years. Diversification was the most persistently discussed topic with resilient sources of income among small farmers. Water consumption was the second most discussed topic in view of constrained resources and to sensitise solutions against inefficient ways of irrigation. The climate adaptation's frequency also remained higher which caught attention in 2010 with the devastating floods in Pakistan. It became an important area of research since 2017 when the climate-change started affecting life in the country. Figure 4 presents the persistence and frequency of topics as below:

Fig. 4. Depicts the Frequency of SA Research Themes During the Reviewed Period.



The bars of the graph show the number of studies in a year of different Theme. The last bar shows the total number of studies of each SA theme. During the years 2000, 2001, 2005 and 2006 no studies were found to match the objective of the study.

Table 1 presents the persistence of research categories and their relevance with the government policies as well as international events to reflect upon the need of research in a particular year.

Table 1
Persistence of SA Research Categories and Relevance with Policies

Category-Type (1)	Persistence (2)	Frequency (3)	Relevance with Policies and Major Events (4)
Mostly Discussed 50 percent - 100 percent	Diversification: 63 percent	20 percent	Inadequately found in policy priorities
	Water Consumption: 63 percent	17 percent	Aligned with national and international sensitisation and SDGs
Moderately Discussed 25 percent - 50 percent	Land use: 42 percent	12 percent	Limited to subsidies and fertilizers priorities
	Governance: 38 percent	7 percent	Inadequately found in policy priorities
	Food Security: 38 percent	9 percent	Emerged in literature after food crisis 2007-08
	Farmers' Well-being: 29 percent	7 percent	Inadequately found in policy priorities
Rarely/ Occasionally Discussed 1 percent - 25 percent	Climate Adaptation: 29 percent	14 percent	Mainstream debate since 2017
	Gender Gap: 17 percent	4 percent	Inadequately found in policy priorities
	Access to Finance: 17 percent	3 percent	Consistently found in policy priorities
	Crop Diversity: 13 percent	7 percent	Inadequately found in policy priorities

In Table 1, the column 1 categorises the literature into various types. The column 2 shows the persistence i.e. how much/repeatedly a SA theme was researched during the period of review. The frequency in column 3 represents the maximum number of studies of each theme found in literature out of the total number of studies. The column 4 represents the relevance of each researched topic with the policies reviewed in the literature as well as matched with the GoP's documents.

3.1.2. SA and Livelihood Interactions and Diagnosis Aligned with DFID Framework

Out of the total 114 empirical studies, 42 percent represented environmental dimension, 37 percent economic, and 21 percent social dimension as depicted in Table 2. Overall, 83 Nos of articles (73 percent) reported positive outcomes through sustainable strategies whereas 31 (27 percent) mentioned vulnerable strategies in different indications like income losses, weather damage, and food insecurity. More vulnerabilities were attached to environmental dimensions. On the other hand, agriculture diversification and modern water consumption techniques possessed resilience strategies. The literature

revealed different interconnections between LS and SA which are presented in Table 2. Similarly, the application of DFID framework to the reviewed literature aligned with its components is presented in Table 3. It emphasises LS in vulnerability context, institutional role, and outcome of LS followed by diagnosis of sustainability.

Table 2
Interaction between Sustainable Agriculture and Livelihood Strategies

Sustainability Dimension (1)	Sustainable Agriculture (2)	Livelihood Strategies (3)	Status of Strategy (4)
Economics (42)	Access to Finance 3 Diversification 21 Farmers' Well-being 1 Food Security 1 Land Use 5 Water Consumption 2	Agribusiness, Credit/Loan, Dairy and Crop Production, Dairy Farming, Farm and non-farm/Off-farm, Food Storage, Forest income, Livestock and crop production, Mechanised farming, Modern irrigation techniques, Multi crop, Single Crop, Surface Water	Sustainable (33)
	Access to Finance 1 Climate Adaptation 1 Crop Diversity 1 Diversification 4 Land Use 2	Dairy Farming, Livestock, Multi crop, Off-farm, Single Crop, Tenancy/ share cropping	Vulnerable (9)
Environmental (48)	Climate Adaptation 9 Crop Diversity 2 Farmers' Well-being 1 Food Security 1 Land Use 5 Water Consumption 15	Canal irrigation, multiple income sources, Ground water, Kitchen Gardening, Mechanised farming, Climate smart agriculture, Modern irrigation techniques, Multi crop, Single Crop, Technology adoption, Tubewell	Sustainable (33)
	Climate Adaptation 4 Crop Diversity 2 Land Use 2 Water Consumption 7	Canal, Glaciers, Ground water, Multi crop, Single Crop, Tenancy/share cropping, Wastewater usage	Vulnerable (15)
Social (24)	Diversification 2 Farmers' Well-being 7 Food Security 4 Gender Gap 4	Advisory/extension services, Cash Cropping, Dairy Farming, Farm and non-farm/Off-farm, Livestock, Multi crop, Single Crop	Sustainable (17)
	Crop Diversity 1 Food Security 1 Gender Gap 2 Land Use 3	Farm and Off-Farm, Land Rights, Livestock, Multi crop, Single Crop	Vulnerable (7)

In Table 2, the column 1 shows the distribution of reviewed studies under each dimension of sustainability. The column 2 further categorises the studies into different dimensions of SA. The column 3 reflects the type of livelihood strategies adopted by the rural households. The column 4 declares the status of livelihood strategy either sustainable or vulnerable according to the DFID framework elaboration

Table 3
Mapping of Variables Derived from Literature Aligned with DFID Components

Mapping of Variables Derived from Literature Aligned with DFID Components					
DFID Framework components (1)	DFID Framework Application Aligned with Reviewed Literature				
Livelihood Strategies (2)	Diagnostic Mechanism (3)	Institutional Role (4)	Observed Livelihood Outcomes (5)	Sustainability Diagnosis (6)	
Vulnerability Context	Weather shocks Climate smart strategies, modern irrigation, multi crop, diversification, Economic shocks migration, food storage, off-farm work, credit, livestock disease, diversification Social context Farmers org., extension services, gender role	Risk management, shock absorption, income stability, social participation and cohesion, (or vice versa)	Missing climate change policy, crop insurance initiatives, market stabilisation, efficient irrigation system, Inclusive water policies,	Households' own adaptive capacity, resilience, food secure, increased income, increased productivity	Conditional sustainability depending on policy support
Human Capital (H)	Technology adoption, Climate smart agriculture (CSA), motivation for mechanisation, women role	Knowledge diffusion, productivity enhancement	Extension services, training programmes	Higher yields, better income, awareness	Social and economic sustainability
Natural Capital (N)	Access to water resources i.e. canals, water management, land-use, crop diversity understanding	Resource efficiency, conservation, increased yield	Water governance, land rights,	Improved productivity, reduced degradation	Economic sustainability, environmentally sustainable if regulations exist
Physical Capital (P)	Precision farming, modern irrigation techniques, mechanisation	Cost effective, scale efficiency	Subsidies, infrastructure provision, (neglected smallholders in policies)	Higher productivity, profitability	Economic sustainability, exclusion of smallholders
Financial Capital (F)	Input investment, diversification, livestock expansion	Credit leverage, better liquidity	Credit policy, banking access	Increased output, but debt risks	Selective sustainability
Social Capital (S)	Female labour, cooperative participation, farmers organisations	Labor productivity, gender inclusion, women empowerment	Cultural norms, organisational support, missing policy role	Food security, income diversification	Potential sustainability constrained by norms
Structures & Processes	Strategy choice, adoption incentives	Institutional coordination, incentives mechanism	Policy support, inputs pricing, infrastructure, market role	Improved or partial outcomes	Central driver of sustainability or vulnerability
Livelihood Strategies (Overall)	Overall income and production enhancing activities	Productivity gains, and risk-oriented mechanisms	Market access, extension services, awareness	Income stability, resilience to shocks	Sustainable if institutionally supported
Livelihood Outcomes (Overall)	A few diversification activities are self-sustaining even w/o policy support and rest of them are sustainable due to human capital, financial capital and natural capital amid policy support.				

In Table 3, variables derived from the empirical literature (constitutes of 114 articles) are placed against DFID components to diagnose sustainability outcomes of the reviewed literature under each sustainable agriculture dimensions. The column 1 mentions the DFID framework components. Head row presents the mapping of deduced variables against DFID components. Column 2 presents the livelihood strategies in vulnerability context as well as based on capital, which drive the means of income. Column 3 mentions the diagnostic mechanism as which influencing factor affects the strategy positively or negatively. Column 4 mentions the institutional role. Column 5 states the sustainability outcomes whether income, productivity or production increased or decreased following the strategy in the presence of capitals. Column 6 infers the final outcome that declares a strategy sustainable or vulnerable following the DFID components path. To illustrate, if a household runs his livelihoods in a vulnerability context but follows the climate smart/adaptation measures, it will have better risk management understanding due to the institutional support in that area which would make his livelihood sustainable. If a strategy is based on a human capital/asset with required knowledge and expertise as well as positive policy support, the livelihood strategy will be delivering socio-economic benefits sustainably.

3.2. Discussion

3.2.1. Causal Linkages among DFID Components

The synthesised literature reveals that SL in Pakistan are formed with the interaction of regulated structures, policy support and strong asset base (human capital, financial capital and natural capital). The influencing factors belonging to human capital play a significant role in knowledge diffusion, training, and extension services, which lead to sustainable outcomes i.e. increased income, awareness and higher yields. They ensure economic sustainability among all LS. In this context, the results of our review are consistent with Zulfiqar and Thapa (2017) and indicate that the economic dimension of SA reflects the highest occurrence of sustainable LS followed by the environmental dimension. Under environmental dimension, the sustainability of LS depends on awareness and understanding about coping mechanisms which underlines the role of human capital. In this regard, our findings are aligned with Nasrnia & Ashktorab (2021) and Mobeen, et al. (2023) which emphasises the ability of people to perform against environmental shocks keeping the human capital at first, followed by physical and financial capital. Since, we divided the reviewed literature into ten different themes of SA dimensions, the thematic and analytical diagnosis of the literature is discussed below to draw causal linkages among DFID components:

i. *Agricultural Diversification*

Diversification in the empirical literature depicts the risk management approach of the rural population by connecting household assets to income stability for a SL. The literature provided adequate evidence that agriculture has been diversified into many off-farm, non-farm activities such as livestock, dairy farming, agribusinesses, forest incomes, which has reduced households' dependence on single-crop income and ensured smooth

consumption against climatic, price, and policy shocks (Sarwar, et al. 2012; Batool & Jamil, 2019, Rizwan, et al. 2020, Shahzad, et al. 2021, Rabbi, et al. 2010, Mehmood, et al. 2018). In the reviewed literature, diversification studies suggest that human capital, labor availability, market access, and technology adoption provide the core linkages which convert multiple activities into stable livelihood outcomes.

However, the literature also reveals that diversification becomes vulnerable while confronting challenges and shocks. When households switch to non-farm work due to low farm productivity, either livestock disease or the farming-based losses, make the income stability uncertain. Usually, livestock acts as a buffer asset when animal disease centers, technology, and feed markets exist, but becomes a liability if neglected due to lack of policy support. The gender role is very significant in livestock but is discounted due to cultural barriers and limited decision-making power (Arshad, et al. 2010, Aziz, et al. 2023).

Analytical Linkage

Human & financial capital → Diversification strategy → limited institutional but adequate market support → Income stability → Sustainability.

ii. Water Consumption

Water is the dominant natural and physical capital in the environmental dimension of SA which supports and generates sustainable strategies and outcomes. In physical term, modern irrigation techniques and in natural way, groundwater accessibility reduce production constraints and help generate stable income and yield gains (Ghumman, et al. 2011, Watto & Muger, 2014, Ashraf, et al. 2016). Specifically, climate smart irrigation techniques, drip irrigation, and perforated pipe irrigation increase water productivity and household welfare with the policy interventions and infrastructure support (Mongat, et al. 2015; Anwar, et al. 2020; Ishfaq, et al. 2020; Zafar, et al. 2020; Ahmad, et al. 2023).

In contrast, the literature also emphasises contradictory outcome of groundwater-based LS. Weak regulation allows the overextraction of the groundwater leading to declining aquifers, soil salinity and declining water reservoirs (Qureshi, 2020, Razzaq, et al. 2022, Watto & Muger, 2016). Thus, water-based LS generates sustainable economic benefits in the short-run but destabilises ecological balance in long-run. Hence, for long-term survival of technology-based irrigation strategies, sustainable practices and regulatory capacity must be enhanced.

Analytical Linkage

Natural capital (water) → Unchecked modern irrigation → Weak governance → Short-term economic sustainability → but long-term environmental vulnerability.

iii. Climate Adaptation Measures

Climate adaptation strategies in literature provide constantly a linkage amongst climate risk understanding, institutional role, and livelihood sustainability for the adopted strategies. Adoption of climate-smart agricultural strategies, heat resistant certified seeds, sowing timing, water management and schedules, crop insurance etc. reflect the better

understanding of climate among farmers which help them gain higher productivity and income stability (Imran, et al. 2018, Ali, et al. 2020, Sardar, et al. 2021, Shahzad, et al. 2021, Haq, et al. 2021). The extension services wherever available convert climate vulnerability into adaptive capacity with better information dissemination. On the other hand, the magnitude of devastation has always remained greater than the adaptation measures of households if institutional support is not available. The literature shows that climate shocks expose the LS to repeated losses, if not adapted to mitigation strategies. Hence, climate adaptation becomes sustainable by internalising accurate climate risk perception and with assets and institutional support which consequently lead to SL.

Analytical Linkage

Human capital (Climate awareness) → Climate smart agriculture (CSA) → Institutional support → Productivity & resilience → Sustainability.

iv. Food Security

The dominant LS to become food secure were food storage for future use, dependence on cash crops, and diversified means of incomes (Gazdar & Mallah, 2013; Amir, et al. 2013; Azeem, et al. 2016 and Sher, et al. 2018). Kitchen gardening and crop diversification ensure food security if households are equipped with required knowledge and investment. (Mohsin, et al. 2017). However, in the time of shocks such as floods, inflation or economic uncertainty, and pandemic, vulnerability emerges whether through income uncertainties or nutritional deficit. Smallholders who are dependent on single crops with meagre income resources found to be food insecure and malnourished (Ahmad & Farooq 2010; Bashir, et al. 2012; Ashraf, et al. 2013). Thus, the sustainability in food security is not solely dependent on production rather it also considers the people's capacity to store food and to cope with market challenges all times.

Analytical Linkage

Social and financial capital → Diversified production/storage → Different shocks → Nutritional security → Restrictive sustainability.

v. Land Use

Land use is at the core of agriculture and its dependent population. Most of the land related challenges as identified in the literature were landlessness, skewed land distribution and insecure tenancy rights which restrict farmers to invest in and gain economic benefits (Anwar, et al. 2004; Hussain & Hanjra, 2003; Haq, 2007; Ata, et al. 2019; Qasim, et al. 2020; Ayaz & Mughal, 2023). Compared with large, small farmers face higher production costs and limited access to credit, other resources and inputs, less attention in policies which convert their land asset into vulnerability instead of sustainable source of income (Saqib, et al. 2016; Saqib, et al. 2018). Moreover, organic farming though improves nutrition yet remains unprofitable to generate sustainable outcomes from land (Ali, et al. 2019, Akram, et al. 2020). Hence, land-based sustainable outcomes are only possible when property rights and financial incentives are ensured.

Analytical Linkage

Physical and natural capital → Tenure security → Investment → Productivity → SL.

vi. Farmers' Well-being

Human capital plays the utmost significant role in making the LS sustainable. The literature shows that extension services, training, and technology-adoption improve productivity and income. Farmers with access to mobile technology and apps, farming or extension networks adopt innovative methods faster which reduce production risks (Luqman, et al. 2016, Warriach, et al. 2019, Khan, et al. 2022, Salik, et al. 2021, Zia, et al. 2021).

On the other hand, the lack of information amongst the farmers regarding latest technology, input usage and their application keep the farmers in low-productivity circles equilibria (Murtaza & Thapa, 2017, Naveed & Hassan, 2021). Thus, farmers' well-being does not pertain to social aspect only but also connects to an economic mechanism which translates knowledge into resilience.

Analytical Linkage

Human and social capital → Information access → Technology adoption → Productivity → Sustainability.

vii. Gender Role

The literature reveals that women's participation in diversified activities improves food security, labour productivity and efficiency (Manzoor, et al. 2018; Mohiuddin, et al. 2020; Kavesh, et al. 2023; Rasheed, et al. 2020). However, women's unaccounted work by households discourages their participation and weakens sustainability at large. Cultural constraints and male supremacy limit women's right over her income and decision-making, restricts their participation into livelihood security (Aziz, et al. 2023; Manzoor, et al. 2018). Therefore, gender related LS are sustainable with acknowledgement of women participation.

Analytical Linkage

Human and social capital → Labour productivity → Limited decision power → Partial sustainability → Structural vulnerability.

viii. Access to Finance

Financial capital directly increases access to mechanised farming, technology adoption and productivity (Zulfiqar, et al. 2021; Chaiya, et al. 2023) make the LS sustainable. However, it increases vulnerability when credit becomes a debt burden for small farmers and is biased toward large landholders and forces vulnerable farmers to exit from agriculture (Saqib, et al. 2018; Ahmad, et al. 2020).

Analytical Linkage

Social (status) capital → Credit access → Investment and input adoption → Productivity → Sustainability (or debt-ridden vulnerability).

ix. *Crop Diversity*

Crop diversity contributes to nutritional and dietary needs and is a source of income diversification while coping with market uncertainties. Similarly, when cropping patterns are aligned with climate and market demand, it provides SL (Javed, et al. 2020). In contrast, when weather and price uncertainties increase, the multi-crop systems increase production cost and risk without proportional returns (Shah, et al. 2020; Hussain, et al. 2020; Waseem, et al. 2022). Hence, market incentives and agronomic benefits motivate the farmers to pursue multi-cropping and keep it a sustainable choice of better livelihood.

Analytical Linkage

Human capital (crop choice) → Market/climate interaction → Income stability → Conditional sustainability.

x. *Governance*

Governance is identified as a cross-cutting factor across all dimensions, converting the use of assets into different outcomes. The literature provides evidence that sustainable strategies constantly have policy and institutional support as well as enabling infrastructure, whereas policy neglect and weak regulation cause vulnerability of strategies. Thus, livelihood sustainability in Pakistan is primarily driven by institutional support. Assets and capital alone do not produce sustainable LS without coordinated policies, stable market mechanism, and regulation (Arshad, et al. 2017; Khan, et al. 2016).

Analytical Linkage

Capital/Assets/Processes → Institutions → Strategy effectiveness → Sustainability outcomes.

3.2.2. *Regional Comparison*

A broader South Asian comparison reveals important cross-country differences. Compared with Pakistan where on-farm LS are dominant, India has gradually transitioned toward livestock, dairy farming, and off-farm activities as a stable source of income (Kumar, et al. 2006; Patra, et al. 2012). Moreover, in several Indian regions many farmers exit from farming due to low profitability indicating uncertain income compared with relatively subsistence farming in Pakistan. This transformation from agricultural to non-agricultural activities has been noticed continued for long in India (Gogoi & Das, 2025). Bangladesh's LS and their sustainability are driven by climate adaptation and food security risks rather than sole income diversification. People at coastal areas tended to switch to more resilient agricultural practices to remain food secure, wherein the dominant influencing factors for diversification were education and adaptability-to-change (Wright, et al. 2012; Rasul & Gurung 2024). In contrast to Pakistan and India, where diversification appears to be a market-driven phenomenon, the LS and their sustainability in Bangladesh are more strongly influenced by environmental shocks and institutional preparedness (Ayeb-Karlsson, et al. 2016; Omi, et al. 2025).

Under environmental dimension, our review aligning with other studies discovers that there exist some common climate risks across South Asia such as rising temperatures, floods and drought which directly affect agricultural outcomes. However, their impact on livelihoods vary due to institutional capacity, policy response, preparedness, and adaptive measures (Albugami, et al. 2024; Syakirotin, et al. 2025). In Pakistan, the individual climate coping strategies and better water accessibility keep the agricultural LS sustainable. In India and Bangladesh, the policy interventions, adaptation awareness campaigns, climate/heat resistant inputs by the governments through a consolidated climate-coping frameworks build the resilience strongly (Das & Ansari, 2021; Hoque, et al. 2019). Conversely, in Pakistan the household level adaptation efforts make the LS sustainable rather than the policy response by government.

3.2.3. Provincial Differentiation of Livelihood Sustainability in Pakistan

The livelihood landscape of Pakistan is very diverse across all provinces due to variations in processes/structures, influencing factors, agroecological zones and weather diversity. The literature identifies that LS in Punjab are shaped by irrigation access, crop diversification, market mechanisms, financial capital, and technology adoption which lead to increase income and productivity. However, some instances of market volatility and rising input costs tend to cause economic vulnerabilities. In contrast, although Khyber Pakhtunkhwa is prone to weather uncertainties, yet irrigated agriculture offers SL (Safdar, et al. 2014). Better information dissemination due to extension services, mobile phone and internet technology in Khyber Pakhtunkhwa (Luqman, et al. 2016; Khan, et al. 2022), Punjab, and Sindh (Warriach, et al. 2019) helped increased agricultural productivity (Salik, et al. 2021, Zia, et al. 2021). Farmers of Khyber Pakhtunkhwa have better adaptive capacity to respond to weather shocks due to reliance on farm and off-farm LS. Agriculture in KP often yields modest productivity but subsistence farming keeps them food secure (Sher, et al. 2018). Land-use issues and its associated livelihoods prevail equally across the provinces with few land disparities in Sindh (Qureshi, et al. 2004). Many small holders preferred to leave agriculture in Sindh being unable to pay-off loan and finding less output per unit of land (Ahmad, et al. 2020). The crop diversification and water conservation practices improve sustainability in livelihoods, but weak institutional capacity is hard to combat environmental challenges in Sindh. Similarly, Balochistan presents vulnerability in several livelihood contexts in literature such as environmental constraints, restricted access to financial, physical and human assets and weak market linkages. Although weather shocks affect the agriculture in Balochistan, yet Karez irrigation still provides cost effective and sustainable means of irrigation (Mustafa & Qazi, 2007 and Ashraf, et al. 2016). Hence, the literature indicates diversity in LS based on available assets and resources, and so does sustainability due to variety of influencing factors across the provinces.

3.2.4. Role of Government and Agriculture Policy Analysis

During the review period, one agriculture policy-2004 and the other food security policy-2018 existed, highlighting a governance gap within the SA sub-dimension. The mission of the Ministry of Agriculture was transformed in 2009 due to administrative

reasons from agricultural sustainability to national food security (Uddin, 2010). It issued the first ever National Food Security Policy in 2018 which focuses mainly on zero hunger programmes and food security (NFS, 2018). Therefore, the policy negligence discussed in the empirical literature is associated with the absence of agriculture policy at federal level.

To discover the yearly policy direction about agricultural initiatives, the information has been acquired from the two documents of Ministry of Planning, Development & Special Initiatives i.e. Public Sector Development Programme (PSDP) (M/O PD&SI, 2023a) and the Annual Plans (M/O PD&SI, 2023b) for the last twenty-three years. According to the Annual Plans from 2000 to 2023, irrigation and watercourses development were found to be the top priority in terms of budget allocation followed by availability of agricultural inputs and easy credit for farmers. Further, other initiatives included agricultural research and technology development, agribusiness development, farm mechanisation, livestock development, and extension services. The Annual Plans highlighted excessive heat, unfavourable weather conditions, soil degradation, water logging, salinity and water scarcity as major challenges being faced by the agriculture sector of Pakistan (M/o PD&SI 2022-23b). In addition, undeveloped market linkages, farm mechanisation, and unstable commodity markets have been considered as hurdles in SA.

The policy analysis infers that the government interventions do not meet the demand of agriculture sector in terms of budget allocations and policy attention. As shown in Table 1, the policy support for diversified LS is inadequately found in literature, implying the self-sustaining capacity of those strategies due to human and financial capital. Similarly, there is limited attention to crop diversity by the government as barely any project has been found in the budget documents which is also indicated by Abro (2012). The consistent production of traditional crops and not diversifying into other cash crops indicates a policy neglect which keeps the farmers at same welfare level in the country (Waseem, et al. 2022). However, the government should promote cash crops and give training in this regard.

Literature notices that transformation of Pakistan's traditional agriculture into a modern one remains challenging without robust policy support. Several studies urge urgent governmental action on neglected administrative areas and environmental hazards (Sadiq, et al. 2019; Bhati, et al. 2019, Bakhsh & Kamran, 2019), such as water sustainability, irrigation improvement system (Ahmad 2007, Qureshi 2011), groundwater extraction, soil degradation, and less attention to small farmers in credit policies, obsolete extension services (Arshad, et al. 2017; Davies, et al. 2016; Iqbal, et al. 2018; Zulfiqar & Thapa, 2017). Hence, literature identified inconsistent policies as the biggest risk to agricultural growth and transformation.

In view of the policy perspectives and reviewed literature, Table 4 provides a consolidated picture highlighting the 'why and how mechanism' of these sustainability outcomes and government role, that have emerged within the Pakistan's specific economic, environmental and socio-economic contexts.

Table 4
Influencing Factors of Sustainability (or Vulnerability) Outcomes

Dimensions' Outcomes	Economic	Environmental	Social	Institutional (Role of Government)
Sustainability - Influencing factors	Loan access, better gender role, market linkages, policy reforms in water, resource use efficiency, technology adoption, investment, input efficiency/economy	Climate adaptation strategies, extension services, farmers organisation, organic farming, resource use efficiency, and technology adoption	Better leadership role, better gender role, private sector, technology adoption, extension services	Nascent and positive Role: <i>Education & training policy, Research & Technology, Water policy R&D (modern irrigation, competitive market</i>
Why and How Mechanism				
Vulnerability - Influencing factors	Landlessness, livestock diseases, farming shocks, weather shocks	Salinity, inefficient institutions, weather shocks, land rights/tenure issues,	Inefficient systems, landlessness, policy neglect in rural development, farming shocks	Less Effective: <i>Climate adaptation policy, food security policy, land reforms, R&D, women development policy</i>
Why and How (Mechanism)				Neglected Areas: female labour, water salinity, land degradation, mitigation support during weather shocks <i>Climate policy, water policy, rural development policy, women development</i>

Note: Table 4 presents the mechanism of adopted livelihood strategies which make them sustainable or vulnerable depending upon their influencing factors. Column 1 presents the outcome of SA dimensions broadly as sustainable or vulnerable. Columns 2, 3, and 4 explain the economic, environmental and social context of the sustainable (vulnerable) outcomes respectively whereas column 5 depicts the institutional role in determining the sustainability (vulnerability) outcome of the strategies.

3.2.5. Research Gap and Policy Implications

A succinct depiction of reviewed literature with research gaps in terms of sustainability of LS is given below:

1. A persistent problem of skewed land distribution, tenancy, and farm size was observed. The literature states that farm mechanisation and incentives to small farms do not generate benefits in accordance with the economies of scale principle which keep the small holders away from the government's benefits. Therefore, the Village Organisations (VOs) may be reinstated instead of

offering services at commercial banks level to provide loans and rental machinery to small farmers.

2. A few of the available studies discussed the marginal monetary benefits of organic farming as compared with conventional farming. Mass production without organic choices is to be prioritised to make food available and accessible to everyone.
3. A comparative analysis of conventional farming practices with those of sustainable must be conducted in all dimensions to observe improvement or deterioration in resources.
4. Several perception-based surveys were carried out to assess the awareness level of farmers about climate adaptation and extension services. The quantitative analysis on both issues is not adequate to examine the impact of both measures on agriculture production and livelihoods simultaneously.
5. A causal analysis of government credit offered to farmers must be conducted to assess its sustainability and impact on farming practices.
6. The role of technology adoption in enhancing agricultural productivity has not been discussed widely in the literature.

4. CONCLUSION

The concept of SL is not limited to only earning income, but it also encompasses well-being, technology adoption, stronger voices, sustainable use of resources, food security, and improved awareness following the DFID framework. In this regard, this study has explored the linkages between SA and outcomes of SL given their vulnerability context, capital, influencing factors and role of policies. It further determined the sustainability of the livelihood strategies discussed in the reviewed literature. The literature identified that livelihoods were influenced greatly by institutional role and the availability of different assets depending upon the nature of livelihood strategy. The findings revealed that the diversification dimension of SA is more resilient to any unpredictable events and has better livelihood outcomes. Moreover, LS associated with 'water consumption' improved or at least kept the rural people better off in their livelihoods. Climate adaptation measures and farmers' well-being categories did have positive impact with moderate linkages in raising awareness and preparedness to cope with farming or climatic hazards. Further, the risk of food insecurity depends upon economic accessibility, however literature revealed most of the households were food secure. Crop diversity was barely found in policy priorities as well as in literature too. Lastly, land use was identified as diversified source of LS. However, many vulnerabilities were identified in contrast to improvements in land use. If land rights and its distribution are revamped, many other avenues would be strengthened, particularly in the favor of small farmers. This study reveals that many farmers have a sustainable means of income, but their influencing factors like limited access to credit keep them poor due to their vulnerability context. It further includes diseases, economic shocks, floods, drought, land inequalities, culture, and farming shocks.

The study concludes that the sustainability of LS does not merely depend on strategies themselves, rather asset base plays a key mediating role which is consistent

with the livelihood framework. In Pakistan, human capital, financial capital and natural capital derive sustainable outcomes. In the context of institutions and structures, equitable policies' focus on sustainability dimensions will conserve resources and build stronger community linkages. The study identifies a few policy-neglect areas such as climate adaptation, women empowerment, farmers' well-being, crop diversity, and water conservation where vigorous policy attention is required as the fewer initiatives are inadequate to meet the substantial demand. Plenty of research in Pakistan is available on environmental and economic dimensions whereas the social dimension is underexplored.

4.1. Limitations of the Study

The objective of this systematic review was to conduct analytical synthesis of the studies following PRISMA guidelines. Its objective was to indicate which sustainable agricultural practices lead to sustainable LS and subsequent outcomes. The formal methodological analysis, appraisal checklist or quality scoring with econometric techniques' rigour was out of scope of this review. We acknowledge the absence of structured quality appraisal as a limitation of the study and suggest this scope for future systematic reviews incorporating metanalysis with methodological quality appraisal.

APPENDIX 1

*Description and Definitions of Different Aspects, Factors and Practices of SA and SL
(To Determine the Sustainability Status of each Paper)*

Sustainable Agriculture Practices w.r.t. Development Dimensions	Influencing Factors (Authors' description as per context)	Asset Base (Livelihood) (Authors' description as per context)	Livelihood Outcomes (Authors' Description as per context)
Economic Sustainability: Profitable for all Involved Stakeholders (FAO)	Interrupted resource supply: water supply, inputs supply, fertilizers use, market supplies, stoppage of resources due to natural processes	Physical capital: Crops' yield, livestock earning, water (when discussed in the context of infrastructure for water supply, for arid areas, for no rain, tubewell supply, water courses	Increased income: possible increase due to crop production
Productivity Enhancement: Efficient use of Agricultural Inputs to Attain Maximum output (OECD)	Input economy: optimal mix of inputs such as seeds, water etc.		Improved food & nutritional security
Diversification: A Combination of off-Farm Activities with Farm Activities or Independent off-farm Activities (FAO)	Dairy, livestock & crop production: different combination of agricultural activities with non-farm activities (specific)		Reduced vulnerability

Government Support/Subsidies: government incentives and special packages	Reforms/management: effective outcome of government's programme Inefficient system: where policy is implemented but unable to give desired output or somehow policy is available but interrupted, policy failures, policy disconnects, challenges, land grabbing	Social Capital: Community/ Village Organisations, culture role	Increased vulnerability
Female's role: females' participation in farming activities	Farm & off-farm: different combinations other than mentioned above	Human Capital: family/households' information, experience, decision making, awareness	Nutrition and food insecurity
Environmental Sustainability: it must not affect the balance of natural resources and environment (FAO)	Vulnerable (Temp & Rainfall variability): one of the consequences of climate resilience Sustainable: Adaptation practices		Improved awareness
Climate Resilience: the ability of a society/system to cope with climatic hazardous shocks	Shocks in farming: due to change in prices, diseases etc.	Financial Capital: availability of liquid assets/ cash, profit reinvested in crop, savings, cash availability due to bank credit	Asset deterioration
Climate Smart Agriculture: to enable farmers with agri-techniques to deal with changing climatic patterns	Resource use efficiency: efficient use of technology and other inputs (cost minimisation and profit maximisation)		Income losses
Organic Farming: to prefer the use of natural inputs over artificial inputs/chemicals (FAO)	Mixed manure: different combination of natural fertilizers and less use of chemicals	Natural capital: land, irrigation – canal, rains, surface irrigation water, mountains, biodiversity - “A configuration (over time and space) of natural resources and ecological processes that contributes through its existence and/or in some combination, to human welfare” (Dickie, et al. 2014)*.	Stronger voice
Irrigation: efficient supply of water for farming without affecting soil fertility and avoid erosion (FAO)	Resource use efficiency: efficient use of technology and other inputs (cost minimisation and profit maximisation)		Enhanced capacities
Land use: adoption of best optimal use of land without degradation and damage and maintain its productive capacity	Landlessness: affected people due to no ownership of land		

Social Sustainability: it must be beneficial for society at large (FAO)	Culture: cultural role to restrict societal development	Social Inclusion & equity
Food and nutritional security: all masses have access to safe, sufficient and nutritious food (FAO)	Vulnerable: poor or disadvantaged people	Food and nutritional security
Village/ Community Organisations: self-managed entities by the villagers to safeguard their farming interests	Public support programmes: such as PRSP	Stronger community and organisations, networking, support system
Farmers' well-being: interventions to enhance farmer's capacity, education, awareness	Extension services: farming guidance by a private NGO or government	Strong village and farmers organisations, support system
Research & technology: easy access to internet or technology by rural people	Technology: easy access to technology or internet	Skill building, motivation to adopt

All definitions are acquired from Food and Agriculture Organisation.

CSA: Climate Smart Agriculture [https://www.fao.org/climate-smart-agriculture/overview/en/#:~:text=Climate%2DSmart%20Agriculture%20\(CSA\),greenhouse%20gas%20emissions%20where%20possible.](https://www.fao.org/climate-smart-agriculture/overview/en/#:~:text=Climate%2DSmart%20Agriculture%20(CSA),greenhouse%20gas%20emissions%20where%20possible.)

Organic Farming:

<https://www.fao.org/3/ac784e/ac784e.htm#:~:text=The%20organic%20agriculture%20system%20relies,instead%20of%20using%20artificial%20inputs.>

Irrigation: <https://www.fao.org/3/t0231e/t0231e03.htm>

Land Use: <https://www.fao.org/economic/the-statistics-division-ess/other-statistics/socio-economic-agricultural-and-environmental-indicators/compendium-of-agricultural-environmental-indicators-1989-91-to-2000/annex-2-definitions/en/>

*https://ueaeprints.uea.ac.uk/id/eprint/55826/1/UKNEAFO_Synthesis.pdf

APPENDIX 2

Search String

(TITLE-ABS-KEY-AUTH ("sustainable agriculture" OR "Sustainable livelihood" OR "rural income" OR "Climate" OR "Crop diversity" OR "land" OR "Livestock" OR "water" OR "agricultural women" OR "agriculture policy" OR "economy" OR "rural development" OR "irrigation" OR "environment" OR "food security" OR "agriculture subsidies" OR " nutrition" OR "Governance" OR "village organisations" OR "diversification" OR "agribusiness" OR "small farmers") AND PUBYEAR > 1999 AND PUBYEAR < 2024) AND (sustainable AND agriculture) AND (livelihood) AND (LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "ECON") OR LIMIT-TO (SUBJAREA , "AGRI") OR LIMIT-TO (SUBJAREA , "ENVI") OR LIMIT-TO (SUBJAREA , "ARTS")) AND (LIMIT-TO (AFFILCOUNTRY , "Pakistan")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (PUBSTAGE , "final"))

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Declarations

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REFERENCES

- Abro, A. A. (2012). Determinants of crop diversification towards high value crops in Pakistan. *International Journal of Business, Management and Economic Research*, 3(3), 536–545.
- Ahmad, D., Kanwal, M., & Afzal, M. (2023). Climate change effects on riverbank erosion in Bait community flood-prone area of Punjab, Pakistan: An application of livelihood vulnerability index. *Environment, Development and Sustainability*, 25, 9387–9415.
- Ahmad, M. I., Oxley, L., & Ma, H. (2020). What Makes Farmers Exit Farming: A Case Study of Sindh Province, Pakistan. *Sustainability*, 12(8), 3160. <https://doi.org/10.3390/su12083160>.
- Ahmad, M. I., Oxley, L., Ma, H., & Liu, R. (2023). Does rural livelihood change? Household capital, climate shocks and farm entry–exit decisions in rural Pakistan. *Frontiers in Environmental Science*, 10, 857082.
- Ahmad, M., & Farooq, U. (2010). The state of food security in Pakistan: Future challenges and coping strategies. *The Pakistan Development Review*, 903–923.
- Ahmad, S. (2007). Land and water resources of Pakistan—A critical assessment. *The Pakistan Development Review*, 46(4)911–937.
- Akram, M. W., Akram, N., Wang, H., Andleeb, S., Ur Rehman, K., Kashif, U., & Hassan, S. F. (2020). Socioeconomics determinants to adopt agricultural machinery for sustainable organic farming in Pakistan: A multinomial probit model. *Sustainability*, 12(23), 9806. <https://doi.org/10.3390/su12239806>.
- Albugami, H. F., Ali, M. K., Hossain, S., Zaffar, H., & Ahmad, N. (2024). Climate change and sustainable livelihood in South Asia: A bibliometric analysis. *Environmental and Sustainability Indicators*, 24, 100524.
- Ali, M., Khan, I., Ali, M. A., Anjum, S. A., Ashraf, U., & Waqas, M. A. (2019). Integration of organic sources with inorganic phosphorus increases hybrid maize performance and grain quality. *Open Agriculture*, 4(1).
- Ali, U., Wang, J., Ullah, A., Tan, Y., Nurgazina, Z., & Khan, Z. A. (2020). Determinants of farmers' choice adaptation strategies to climate change: Evidence from Khyber Pakhtunkhwa Pakistan. *Pakistan Journal of Agricultural Sciences*, 57(3), 941–951.
- Altieri, M. A. (2008). Small farms as a planetary ecological asset: Five key reasons why we should support the revitalisation of small farms in the Global South. *Third World Network*.
- Amir, R. M., Shahbaz, B., Ali, T., & Zafar, M. I. (2013). Analysis of household food security concerns and coping strategies of small farmers in northwestern highlands of Pakistan. *Pakistan Journal of Agricultural Sciences*, 50(3), 505–510.
- Anwar, A. A., & Ahmad, W. (2020). Precision surface irrigation with conjunctive water use. *Sustainable Water Resources Management*, 6(5), 75.
- Anwar, T., Qureshi, S. K., Ali, H., & Ahmad, M. (2004). Landlessness and rural poverty in Pakistan. *The Pakistan Development Review*, 43(4), Part-II 855–874.

- Arshad, M., Kächele, H., Krupnik, T. J., Amjath-Babu, T. S., Aravindakshan, S., Abbas, A., & Müller, K. (2017). Climate variability, farmland value, and farmers' perceptions of climate change: implications for adaptation in rural Pakistan. *International Journal of Sustainable Development & World Ecology*, 24(6), 532–544.
- Arshad, S., Muhammad, S., Randhawa, M. A., Ashraf, I., & Chuadhry, K. M. (2010). Rural women's involvement in decision-making regarding livestock management. *Pakistan Journal of Agricultural Sciences*, 47(2), 1–4.
- Ashraf, M., Majeed, A., & Saeed, M. (2016). Impact evaluation of a karez irrigation scheme in Balochistan–Pakistan: Issues and Options. *Pakistan Journal of Agricultural Sciences*, 53(3), 661–671.
- Ashraf, S., Iftikhar, M., Shahbaz, B., Khan, G. A., & Luqman, M. (2013). Impacts of flood on livelihoods and food security of rural communities: a case study of southern Punjab, Pakistan. *Pakistan Journal of Agricultural Sciences*, 50(4).
- Ata, S., Shahbaz, B., Watto, M., & Siddiqui, M. (2019). Access and exclusion: case of transnational 'land grabbing' in Pakistan. *Journal of the Asia Pacific Economy*, 24(2), 1–16.
- Ayaz, M., & Mughal, M. (2023). Land inequality and landlessness in Pakistan: Measuring the diverse nature of land disparities. *Land Use Policy*, 131, 106720.
- Ayeb-Karlsson, S., Van der Geest, K., Ahmed, I., Huq, S., & Warner, K. (2016). A people-centred perspective on climate change, environmental stress, and livelihood resilience in Bangladesh. *Sustainability Science*, 11(4), 679–694.
- Azeem, M. M., Muger, A. W., & Schilizzi, S. (2016). Living on the edge: Household vulnerability to food-insecurity in the Punjab, Pakistan. *Food Policy*, 64, 1–13.
- Aziz, N., Khan, I., Nadahrajan, D., & He, J. (2023). A mixed-method (quantitative and qualitative) approach to measure women's empowerment in agriculture: evidence from Azad Jammu & Kashmir, Pakistan. *Community, Work & Family*, 26(1), 21–44.
- Aziz, N., Khan, I., Nadahrajan, D., & He, J. (2023). A mixed-method (quantitative and qualitative) approach to measure women's empowerment in agriculture: Evidence from Azad Jammu & Kashmir, Pakistan. *Community, Work & Family*, 26(1), 21–44.
- Bakhsh, K., & Kamran, M. (2019). Adaptation to Climate Change in Rain-Fed Farming System in Punjab, Pakistan. *International Journal of the Commons* 13(2), 833–847.
- Barrett, C. B., Reardon, T., & Webb, P. (2001). Nonfarm income diversification and household livelihood strategies in rural Africa: Concepts, dynamics, and policy implications. *Food Policy*, 26(4), 315–331.
- Bashir, M. K., Schilizzi, S., & Pandit, R. (2012). Are the determinants of food insecurity for landless households different from that of other rural households? *Pakistan Journal of Agricultural Sciences*, 49(3), 393–400.
- Batool, S., & Jamil, F. (2019). Rural employment and income diversification in Pakistan. *Pakistan Journal of Agricultural Research* 56(2), 503–510.
- Bhatti, M., Ahmad, W., Shah, M., & Khattak, M. (2019). Climate change evidence and community level autonomous adaptation measures in a canal irrigated agriculture system of Pakistan. *Climate and Development* 11(9), 109.
- Brod, S., Johan, S., Gail, F., Chuck, I., & David, C. (2011). Sustainable agriculture. The Nature Education Knowledge Project. <https://www.nature.com/scitable/knowledge/library/sustainable-agriculture-23562787/>
- Carney, D. (1998). Implementing the sustainable rural livelihoods approach. In *Sustainable rural livelihoods: What contribution can we make?* (pp. 3–27). Department for International Development.

- Chaiya, C., Sikandar, S., Pinthong, P., Saqib, S. E., & Ali, N. (2023). The Impact of Formal Agricultural Credit on Farm Productivity and Its Utilization in Khyber Pakhtunkhwa, Pakistan. *Sustainability* 15(2), 1217.
- Chambers, R., & Conway, G. R. (1992). Sustainable rural livelihoods: Practical concepts for the 21st century. Institute of Development Studies.
- Das, U., & Ansari, M. A. (2021). The nexus of climate change, sustainable agriculture and farm livelihood. *Climate Research*, 84, 23–40.
- Davies, S., Saeed, W., Moeen, M., Tanvee, r. T., & Irshad, A. (2016). Fiscal space for investment in agriculture—A Review of taxes and subsidies in agriculture in Pakistan. *The Pakistan Development Review*, 55(4), 873–887.
- Dethier, J. J., & Effenberger, A. (2012). Agriculture and development: A brief review of the literature. *Economic Systems*, 36, 175–205.
- DFID (1999). Sustainable livelihoods guidance sheets. *Department for International Development*, <https://www.livelihoodscentre.org/documents/114097690/114438878/Sustainable+livelihoods+guidance+sheets.pdf/594e5ea6-99a9-2a4e-f288-cbb4ac4bea8b?t=1569512091877>.
- Dickie, I., Cryle, P., & Maskell, L. (2014). *UK National Ecosystem Assessment follow-on: Work package report 1: Natural capital asset check*. UNEP-WCMC and LWEC.
- Ellis, F. (1998). Household strategies and rural livelihood diversification. *The Journal of Development Studies*, 35, 1–38.
- Ellis, F. (2000). Rural livelihoods and diversity in developing countries. *Oxford University Press*.
- Gazdar, H., & Mallah, H. B. (2013). Inflation and Food Security in Pakistan: Impact and Coping Strategies. *IDS Bulletin* 44(3).
- Ghumman, A., Khan, R., Hashmi, H., Kamal, M., & Khan, I. (2011). Performance assessment of canal irrigation in Pakistan. *African Journal of Agricultural Research* 6(12), 2692–2698.
- Gogoi, N., & Das, D. (2025). Livelihood strategies and their sustainability in rural areas of Assam, India: An assessment through mixed method approach. *Indian Journal of Agricultural Economics*, 80(3), 707–722.
- Gomiero, T., Pimentel, D., & Paoletti, M. G. (2011). Is there a need for a more sustainable agriculture? *Critical Reviews in Plant Sciences*, 30, 6–23.
- Habib, N., Ariyawardana, A., & Aziz, A. A. (2023). The influence and impact of livelihood capitals on livelihood diversification strategies in developing countries: A systematic literature review. *Environmental Science and Pollution Research*, 30(27), 69882–69898.
- Haq, R. (2007). Land inequality by mode of irrigation in Pakistan, 1990–2000. *The Pakistan Development Review*, 1011–1022.
- Haq, S. u., Boz, I., & Shahbaz, P. (2021). Adoption of climate-smart agriculture practices and differentiated nutritional outcome among rural households: a case of Punjab province, Pakistan. *Food Security*, 13, 913–931.
- Haug, R. (1999). From integrated rural development to sustainable livelihoods: What is the role of food and agriculture? *Forum for Development Studies*, 26, 181–201.
- Hayati, D., Ranjbar, Z., & Karami, E. (2011). Measuring agricultural sustainability. In E. Lichtfouse (Ed.), *Biodiversity, biofuels, agroforestry and conservation agriculture*, 5, 73–100). Springer.
- He, Y., & Ahmed, T. (2022). Farmers' livelihood capital and its impact on sustainable livelihood strategies: Evidence from the poverty-stricken areas of Southwest China. *Sustainability*, 14(9), 4955. <https://doi.org/10.3390/su14094955>
- Heltberg, R. (1998). Rural market imperfections and the farm size–productivity relationship: Evidence from Pakistan. *World Development*, 26(10), 1807–1826.

- Hoque, M. Z., Cui, S., Xu, L., Islam, I., Tang, J., & Ding, S. (2019). Assessing agricultural livelihood vulnerability to climate change in coastal Bangladesh. *International Journal of Environmental Research and Public Health*, 16(22), 4552.
- Hussain, A., Memon, J. A., & Hanif, S. (2020). Weather shocks, coping strategies and farmers' income: A case of rural areas of district Multan, Punjab. *Weather and Climate Extremes*, 30, 100288.
- Hussain, I., & Hanjra, M. A. (2003). Does irrigation water matter for rural poverty alleviation? Evidence from South and South-East Asia. *Water Policy* 5, 429-442.
- Hussein, K. (2002). Livelihoods approaches compared: A multi-agency review of current practices. Department for International Development.
- Hutton, B., Salanti, G., Caldwell, D. M., Chaimani, A., Schmid, C. H., Cameron, C., Ioannidis, J. P. A., Straus, S., Thorlund, K., Jansen, J. P., Mulrow, C., Catalá-López, F., Gøtzsche, P. C., Dickersin, K., Boutron, I., Altman, D. G., & Moher, D. (2015). The PRISMA extension statement for reporting of systematic reviews incorporating network meta-analyses of health care interventions: Checklist and explanations. *Annals of Internal Medicine*, 162, 777-784.
- Imran, M., Ali, A., Ashfaq, M., Hassan, S., Culas, R., & Ma, C. (2018). Impact of Climate Smart Agriculture (CSA) Practices on Cotton Production and Livelihood of Farmers in Punjab, Pakistan. *Sustainability*, 10(6), 2101.
- Iqbal, M. A., Ping, Q., Zafar, M. U., Abbas, A., Bashir, M. K., Ali, A., & Kousar, R. (2018). Farm risk sources and their mitigation: A case of cotton growers in Punjab. *Pakistan Journal of Agricultural Sciences*, 55(3), 677-684. <https://doi.org/10.21162/PAKJAS/18.7070>
- Ishfaq, M., Akbar, N., Anjum, S. A., & Anwar-Ijl-Haq, M. (2020). Growth, yield and water productivity of dry direct seeded rice and transplanted aromatic rice under different irrigation management regimes. *Journal of Integrative Agriculture*, 19(11), 2656-2673.
- Javed, S. A., Haider, A., & Nawaz, M. (2020). How agricultural practices managing market risk get attributed to climate change? Quasi-experiment evidence. *Journal of Rural Studies*, 73, 46-55.
- Kavesh, M. A., Lahiri-Dutt, K., & Adhikari, R. (2023). Women and plant entanglements: pulses commercialization and care relations in Punjab, Pakistan. *Oxford Development Studies*, 51(2), 84-96.
- Khan, A., Siddique, G., Rafiq-ur-Rehman, M., & Ahmed, S. (2016). Farm mechanization: Historical developments present status and future trends in Pakistan. *AMA, Agricultural Mechanization in Asia, Africa & Latin America* 47(2), 44-50.
- Khan, I. A., & Khan, M. S. (2018). Developing sustainable agriculture in Pakistan. CRC Press.
- Khan, M. Z., Abbas, H., & Khalid, A. (2022). Climate vulnerability of irrigation systems in the Upper Indus Basin: insights from three Karakoram villages in northern Pakistan. *Climate and Development*, 14(6), 499-511.
- Kumar, P., Singh, N. P., & Mathur, V. C. (2006). Sustainable agriculture and rural livelihoods: A synthesis. *Agricultural Economics Research Review*, 19, 1-22.
- Lichtfouse, E., Navarrete, M., Debaeke, P., Souchère, V., Alberola, C., & Ménéassieu, J. (2009). Agronomy for sustainable agriculture: A review. *Sustainable Agriculture*, 1-7.
- Luqman, M., Shahbaz, B., & Ali, T. (2016). Impact of agricultural services provided by non-state actors on rural livelihoods: A case of district Mansehra, Khyber Pukhtunkhwa, Pakistan. *Pakistan Journal of Agricultural Research* 53(3), 743-750.
- M/O PD&SI (2023a). Public sector development programme. Government of Pakistan. <https://www.pc.gov.pk/web/psdparchive>

- M/O PD&SI (2023b). Annual plan. Government of Pakistan. <https://pc.gov.pk/web/annualplan>.
- Manzoor, A., Khan, I. A., Ashfaq, H., Jabeen, N., & Maan, A. A. (2018). Women's involvement in livestock care and management: Implications for their social life in the Punjab, Pakistan. *Pakistan Journal of Agricultural Sciences*, 55(1), 239–242.
- Mason, J. (2003). Sustainable agriculture. Landlinks Press.
- Mehmood, Y., Rong, K., Bashir, M., & Arshad, M. (2018). Does partial quantity rationing of credit affect the technical efficiency of dairy farmers in Punjab, Pakistan? An application of stochastic frontier analysis. *British Food Journal* 120(2), 441–451.
- Mobeen, M., Kabir, K. H., Schneider, U. A., Ahmed, T., & Scheffran, J. (2023). Sustainable livelihood capital and climate change adaptation in Pakistan's agriculture: Structural equation modeling analysis in the VIABLE framework. *Heliyon*, 9(11), e22476.
- Mohiuddin, I., Kamran, M. A., Jalilov, S.-M., Ahmad, M.-u.-D., Adil, S. A., Ullah, R., & Khaliq, T. (2020). Scale and Drivers of Female Agricultural Labor: Evidence from Pakistan. *Sustainability*, 12(16), 6633. <https://doi.org/10.3390/su12166633>.
- Mohsin, M., Anwar, M., Jamal, F., Ajmal, F., & Breuste, J. (2017). Assessing the Role and Effectiveness of Kitchen Gardening toward Food Security in Punjab, Pakistan: A Case of District Bahawalpur. *International Journal of Urban Sustainable Development* 9(1), 64–78.
- Mongat, A. S., Arshad, M., Bakhsh, A., Shakoar, A., Anjum, L., Hameed, A., & Shamim, F. (2015). Design, installation and evaluation of solar drip irrigation system at mini dam command area. *Pakistan Journal of Agricultural Sciences*, 52(2).
- Murtaza, G., & Thapa, G. (2017). Factors affecting technical efficiency of small-scale apple farms in Balochistan Plateau, Pakistan. *Journal of Mountain Science*, 14, 782–794.
- Mustafa, D., & Qazi, M. U. (2007). Transition from karez to tubewell irrigation: Development, modernization, and social capital in Balochistan, Pakistan. *World Development*, 35(10), 1796–1813. <https://doi.org/10.1016/j.worlddev.2007.06.002>.
- Mutopo, P. (2014). Belonging and rural livelihoods: Women's access to land and non-permanent mobility at Merrivale Farm, Mwenezi District, Zimbabwe. *Erdkunde*, 68(3), 197–207.
- Nasrnia, F., & Ashktorab, N. (2021). Sustainable livelihood framework-based assessment of drought resilience patterns of rural households of Bakhtegan Basin, Iran. *Ecological Indicators*, 128, 107817.
- Naveed, M., & Hassan, A. (2021). Sustaining agriculture with information: An assessment of rural citrus farmers' information behaviour. *Information Development* 37(3), 496–51.
- NFS (2018). National food security policy. Ministry of National Food Security and Research. Government of Pakistan. <https://pbit.punjab.gov.pk/system/files/National%20Food%20Security%20Policy%202018.pdf>
- Omi, R. T., Raihan, F., Shaw, R., & Joarder, M. A. M. (2025). Coping with climate change: A livelihood vulnerability and adaptation analysis in Gaibandha, Rangpur, Bangladesh. *Journal of Flood Risk Management*, 18(1), e13036.
- Pandey, R., Jha, S. K., Alatalo, J. M., Archie, K. M., & Gupta, A. K. (2017). Sustainable livelihood framework-based indicators for assessing climate change vulnerability and adaptation for Himalayan communities. *Ecological Indicators*, 79, 338–346.
- Patra, P. S., Mula, G., Paramanik, B., Sarker, S. C., & Sarkar, A. (2012). Assessing the economic and social consequences of sustainability of rural livelihood in Eastern India. *African Journal of Agricultural Research*, 7(33), 4660–4668.
- PBS (2023). 7th population and housing census: Detailed results. Government of Pakistan. <https://www.pbs.gov.pk/digital-census/detailed-results>

- PBS (2025). Labour force survey 2024–25 annual report. Government of Pakistan. <https://www.pbs.gov.pk/wp-content/uploads/2020/07/LFS-2024-25-Annual-Report.pdf>
- Qasim, M., Pervaiz, Z., & Chaudhary, A. R. (2020). Do Poverty and Income Inequality Mediate the Association Between Agricultural Land Inequality and Human Development? *Social Indicators Research*, 151(1), 115–134.
- Qureshi, A. (2011). Water Management in the Indus Basin in Pakistan: Challenges and Opportunities. *Mountain Research and Development*, 31, 252–260.
- Qureshi, A. (2020). Groundwater Governance in Pakistan: From Colossal Development to Neglected Management. *Water* 12(11):3017.
- Qureshi, M. G., Qureshi, S. K., & Salam, A. (2004). Impact of changing profile of rural land market in Pakistan on resource allocation and equity [With comments]. *The Pakistan Development Review*, 43(4), 471–492.
- Rabbi, F., Bauer, S., & Idalinya, J. (2010). Contribution of forests to rural inequality reduction: present scope and future options for rural development and sustainable use of forests. *International Journal of Sustainable Development & World Ecology*, 17(1), 4–14.
- Rasheed, A., Mwalupaso, G., Abbas, Q., Tian, X., & Waseem, R. (2020). Women Participation: A Productivity Strategy in Rice Production. *Sustainability* 12(7):2870.
- Rasul, G., & Gurung, P. (2024). Unlocking the potentials of sustainable livelihoods in Chattogram Hill Tracts of Bangladesh. *Nature-Based Solutions*, 5, 100108.
- Razzaq, A., Xiao, M., Zhou, Y., Liu, H., Abbas, A., Liang, W., & Naseer, M. A. u. R. (2022). Impact of Participation in Groundwater Market on Farmland, Income, and Water Access: Evidence from Pakistan. *Water*, 14(12), 1832. <https://doi.org/10.3390/w14121832>.
- Rizwan, M., Qing, P., Saboor, A., Iqbal, M. A., & Nazir, A. (2020). Production Risk and Competency among Categorized Rice Peasants: Cross-Sectional Evidence from an Emerging Country. *Sustainability*, 12(9), 3770. <https://doi.org/10.3390/su12093770>.
- Sadiq, S., Saboor, A., Mohsin, A., Khalid, A., & Tanveer, F. (2019). Ricardian analysis of climate change–agriculture linkages in Pakistan. *Climate and Development*, 11(8), 679–686.
- Safdar, U., Shahbaz, B., Ali, T., Khan, I., Luqman, M., & Ali, S. (2014). Role of agricultural extension services in adaptation to climate change in highlands of Kaghan valley, Pakistan. *Pakistan Journal of Agricultural Research* 51(4).
- Salazar, O. V., Ramos-Martin, J., & Lomas, P. L. (2018). Livelihood sustainability assessment of coffee and cocoa producers in the Amazon region of Ecuador using household types. *Journal of Rural Studies*, 62, 1–9.
- Salik, M., Tanwir, F., Saboor, A., Akram, M., Anjum, F., Mehdi, M., et al. (2021). Role Of Radio Communication and Adoption of Modern Agricultural Technology: A Study Of Farmers In District Jhang, Punjab-Pakistan. *Pakistan Journal of Agricultural Sciences*, 58(2), 731.
- Saqib, S. E., Ahmad, M. M., & Panezai, S. (2016). Landholding size and farmers' access to credit and its utilisation in Pakistan. *Development in Practice*, 26(8), 1060–1071.
- Saqib, S. E., Kuwornu, J. K., Ahmad, M. M., & Panezai, S. (2018). Subsistence farmers' access to agricultural credit and its adequacy: Some empirical evidences from Pakistan. *International Journal of Social Economics*, 45(4), 644–660.
- Sardar, A., Kiani, A. K., & Kuslu, Y. (2021). Does adoption of climate-smart agriculture (CSA) practices improve farmers' crop income? Assessing the determinants and its impacts in Punjab province, Pakistan. *Environment, Development and Sustainability*, 23, 10119–10140.
- Sarwar, I., Ashfaq, M., Bari, A., & Hafeez, N. (2012). The contribution of various non-farm income sources in reducing income inequality across different farm sizes: A comparison

- of Barani Punjab and Cotton/Wheat Sindh. *Pakistan Journal of Agricultural Research* 49(3), 401–405.
- Scoones, I. (1998). Sustainable rural livelihoods: A framework for analysis (IDS Working Paper No. 72). Institute of Development Studies.
- Shah, H., Siderius, C., & Hellegers, P. (2020). Cost and effectiveness of in-season strategies for coping with weather variability in Pakistan's agriculture. *Agricultural Systems*, 178, 102746.
- Sher, G., Rabbi, F., & Hayat, U. (2018). Food insecurity and its determinants in rural Khyber Pakhtunkhwa, Pakistan. *Asian Journal of Agriculture and Biology*, 6, 308–315.
- Solesbury, W. (2003). Sustainable livelihoods: A case study of the evolution of DFID policy (Working Paper 217). Overseas Development Institute. <https://odi.org/en/publications/sustainable-livelihoods-a-case-study-of-the-evolution-of-dfid-policy/>.
- Spedding, C. R. W. (1988). An introduction to agricultural systems. Elsevier Applied Science Publishers.
- Syakirotin, M., Sulistyowati, L., Noor, T. I., & Tridakusumah, A. C. (2025). Sustainable livelihood strategy approach for farmer households in expansion areas: A bibliometric analysis. *Discover Sustainability*, 6(1), 983.
- Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., & Straus, S. E. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine*, 169(7), 467–473.
- Uddin, F. (2010). Analyzing 7th NFC award and its implications. *Policy Perspectives*, 7(2), 115–126.
- UNDP (2017). Guidance note: Application of the sustainable livelihoods framework in development projects. United Nations Development Programme.
- Usman, M., Ali, A., Ghafoor, A., Akram, R., Mohamed, R. A., Baig, I. A., & Wudil, A. H. (2024). Sustainable rural livelihoods in the face of climate-induced hazards in Pakistan: Nexus of coping mechanisms, determinants, and benefits. *International Journal of Disaster Risk Reduction*, 106, 104449.
- Van de Fliert, E., & Braun, A. R. (2002). Conceptualizing integrative, farmer participatory research for sustainable agriculture: From opportunities to impact. *Agriculture and Human Values*, 19(1), 25–38.
- Velten, S., Leventon, J., Jager, N., & Newig, J. (2015). What is sustainable agriculture? A systematic review. *Sustainability*, 7(6), 7833–7865.
- Viana, C. M., Freire, D., Abrantes, P., Rocha, J., & Pereira, P. (2022). Agricultural land systems importance for supporting food security and sustainable development goals: A systematic review. *Science of the Total Environment*, 806, 150718.
- Warren, P. (2002). Rural livelihoods and diversity. In *Livelihoods diversification and enterprise development*. Food and Agriculture Organization of the United Nations.
- Warriach, H., Wynn, P., Ishaq, M., Arif, S., Bhatti, A., Latif, S., et al. (2019). Impacts of improved extension services on awareness, knowledge, adoption rates and perceived benefits of smallholder dairy farmers in Pakistan. *Animal Production Science* 59(12).
- Waseem, M., Jaffry, A. H., Azam, M., Ahmad, I., Abbas, A., & Lee, J. E. (2022). Spatiotemporal analysis of drought and agriculture standardized residual yield series nexuses across Punjab, Pakistan. *Water*, 14(3), 496.
- Watto, M. A., & Mugera, A. W. (2014). Measuring Production and Irrigation Efficiencies of Rice Farms: Evidence from the Punjab Province, Pakistan. *Asian Economic Journal*, 28(3), 301–322.
- Watto, M., & Mugera, A. (2016). Irrigation water demand and implications for groundwater pricing in Pakistan. *Water Policy*, 18(3), 565–585.

- Webb, P., & Kennedy, E. (2014). Impacts of agriculture on nutrition: Nature of the evidence and research gaps. *Food and Nutrition Bulletin*, 35(1), 126–132.
- Weißhuhn, P., Helming, K., & Ferretti, J. (2018). Research impact assessment in agriculture—A review of approaches and impact areas. *Research Evaluation*, 27(1), 36–42.
- Wiggins, S., Kirsten, J., & Llambi, L. (2010). The future of small farms. *World Development*, 38(10), 1341–1348.
- World Food Programme (2025). Annual country report 2025: Pakistan (PK02). <https://www.wfp.org/publications/annual-country-reports-pakistan>.
- Wright, H., Kristjanson, P., & Bhatta, G. D. (2012). Understanding adaptive capacity: Sustainable livelihoods and food security in coastal Bangladesh (CCAFS Working Paper No. 32). CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). <https://cgspace.cgiar.org/items/6b9c2afc-8b5c-43fd-a7f9-c72fdc2a2a16>
- Xu, D., Deng, X., Guo, S., & Liu, S. (2019). Sensitivity of livelihood strategy to livelihood capital: An empirical investigation using nationally representative survey data from rural China. *Social Indicators Research*, 144, 113–131. <https://doi.org/10.1007/s11205-018-2037-6>
- Yang, D. T., & Zhu, X. (2013). Modernization of agriculture and long-term growth. *Journal of Monetary Economics*, 60(3), 367–382.
- Yu, J. & Wu, J. (2018). The sustainability of agricultural development in China: The agriculture–environment nexus. *Sustainability*, 10, 1776.
- Zafar, U., Arshad, M., Cheema, M., & Ahmad, R. (2020). Sensor Based Drip Irrigation To Enhance Crop Yield and Water Productivity in Semi-Arid Climatic Region of Pakistan. *Pakistan Journal of Agricultural Sciences*, 57(5), 1293-1301.
- Zhang, X., Yao, G., Vishwakarma, S., Dalin, C., Komarek, A. M., Kanter, D. R., Davis, K. F., Pfeifer, K., Zhao, J., Zou, T., D'Odorico, P., Folberth, C., Galeana Rodriguez, F., Fanzo, J., Rosa, L., Dennison, W., Musumba, M., Heyman, A., & Davidson, E. A. (2021). Quantitative assessment of agricultural sustainability reveals divergent priorities among nations. *One Earth*, 4(9), 1262–1277. <https://doi.org/10.1016/j.oneear.2021.08.015>
- Zhao, X., & Su, H. (2026). Paradigm shifts and frontier issues in contemporary sustainable livelihoods research: A geographical perspective. *Applied Geography*, 191, 104007.
- Zia, S. U. R., Ashraf, I., Hassan, G., Riaz, A., Tanwir, F., Nawaz, N., Asghar, S., & Salik, M. H. (2021). Pesticide usage and its application patterns among cotton growers of the southern Punjab, Pakistan. *Pakistan Journal of Agricultural Sciences*, 58(2), 739–742.
- Zulfiqar, F., & Thapa, G. B. (2017). Agricultural sustainability assessment at provincial level in Pakistan. *Land Use Policy*, 68, 492–502. <https://doi.org/10.1016/j.landusepol.2017.08.016>
- Zulfiqar, F., Shang, J., Zada, M., Alam, Q., & Rauf, T. (2021). Identifying the determinants of access to agricultural credit in Southern Punjab of Pakistan. *Geo Journal*, 86, 2767–2776.