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Agroecological Evaluation of Ten Farms in District Malir, Karachi Using the FAO TAPE Framework

Research Proposal

Submitted by:

Submitted to:

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Introduction

Agriculture plays a major role in economic and social aspect of the Pakistani society particularly in rural regions. The majority of households rely on agriculture as their main source of income and food security. According to recent debates on sustainable food systems, the farming communities in such countries as Pakistan are experiencing pressure due to the effects of environmental degradation, climate change, and the rising input costs (Geck et al., 2023). These issues are especially serious in semi-arid areas like Sindh where the lack of water, the deterioration of soil nutrients, and unreliable weather conditions have a direct influence on the production of crops (Mobeen et al., 2025). With the increasing intensity of these pressures, it is a fact that researchers and development agencies have emphasized the need to have more resilient and sustainable models of agriculture (Zulfiqar & Thapa, 2017). Agroecology is one of the methods that are gaining increasing popularity at the international level, combining ecological knowledge, experience of farmers, and social values to redesign the agricultural systems to ensure their long-term sustainability (Bicksler et al., 2020).

Agroecology has been developing throughout almost one hundred years. It was initially a scientific idea in the early twentieth century, focusing mainly on the exploitation of the ecological principle in crop production. With time, the notion was extended to social, cultural and economic aspects of agriculture. This expanded concept focuses on improving the environment, social justice, and community health (FAO, 2019a). Agroecology is nowadays seen as a holistic framework around the world to improve biodiversity, empower local knowledge, responsible government, and solidarity-based economy. They are reflected in the Ten Elements of Agroecology outlined in the Food and Agriculture Organization (FAO), which are the principles of evaluating agroecological transitions in various areas (FAO, 2018). Asian, Latin American, African countries have started relying on these aspects to examine how farms are changing traditional systems to the more sustainable ones.

Although agroecology has offered a solid theoretical framework, one of the biggest gaps in the research has been that there exists no standardized approach to the measurement of agroecological performance. Numerous previous researches were small-scale, were based on uneven indicators, or relied on qualitative observations (Geck et al., 2023). The FAO has addressed

this methodological gap by developing the Tool of Agroecology Performance Evaluation (TAPE), and provides a structure, globally applicable and participative approach to evaluating agroecology on a farm, community, and territorial level (FAO, 2019a). TAPE has a stage by stage approach, starting with the contextualisation (Step 0), then evaluating the state of agroecological transition with the 10 Elements (Step 1), and finally appraising the performance in the context of environmental, economic, social, and governance (FAO, 2019b). The last phase also summarises the results by engaging in participative sessions with farmers and other local stakeholders (Bicksler et al., 2020). This framework enables the investigators to gather similar data and comply with local circumstances.

These issues are especially relevant to Pakistan when agriculture is highly vulnerable to climatic change, water scarcity and land degradation. Research indicates that the farmers in Sindh and Punjab are becoming more aware of the risks associated with climate factors yet they are usually unavailable with powerful methods to adapt to the risks (Mobeen et al., 2025). Meanwhile, the domination of high-input production based on the use of synthetic fertilizers, pesticides, and unceasing extraction of groundwater has generated environmental issues that are long-term, including a decrease in soil fertility, salinity, and biodiversity (Zulfiqar and Thapa, 2017). A study by Sindh suggests that farmers place value on sustainable production methods like crop rotation and organic amendments but adoption is inconsistency and on a small scale basis (Kumbhar et al., 2012). The shift towards sustainability will remain slow without a defined framework of evaluating progress or determining limitations.

The diversity of the agro-ecological zones is a major factor in the farming in Pakistan. This determines how people grow crops, availability of water and risks associated with the climate. Pakistan Agricultural research council has divided the country into specific agro-ecological regions, which provide the necessary background on the differences in farming systems (Baig et al., 2021). District Malir in Karachi is located in the arid coastal environment of semi-arid that relies on tube wells and seasonal river or canal flows. The district supplies vegetables, fruits, and fodder to the urban Karachi household, however, the district has limited academic attention in terms of sustainability measurements or agroecological evaluation. This gap makes Malir an appropriate study that can be used to apply evaluative tools like TAPE.

Globally, the trend of agroecology is supported by policy debates, scientific evidence, and legal perspectives. The recent reviews demonstrate that agroecology is most consistent with the Sustainable Development Goals, especially the goals concerning food security, responsible production, and climate action (PakistanLawyer.com, 2024). Agroecology could improve food systems in Pakistan where they are challenged by ecological and governance issues through ensuring the soil is healthy, the local economies are strengthened, and better access to resources including land and water are available to all. With the help of TAPE, one can reveal the advantages, limitations, and possibilities to enhance the agricultural resilience (Khan et al., 2025).

The application of TAPE in District Malir can help to gain a clear insight into agroecological transition. The Ten Performance Indicators that make up sustainability in the tool which include productivity, income, soil health, biodiversity, dietary diversity, pesticide exposure, gender equity, youth involvement, land tenure, and value addition provide a holistic picture of sustainability (FAO, 2019b). These indicators transcend the assessments based on yields and display the impacts of farming on livelihoods, community welfare, and ecological resilience. They are also useful in determining the limitations, including limited market access, gender inequalities, and lack of institutional support challenges that are usually witnessed in Pakistani agriculture.

The participatory aspect of TAPE contributes to the additional power of its implementation in Malir. The framework recommends the creation of results interpretation and jointly developed recommendations, which is promoted in Step 3 by a conversation between farmers, researchers, and community leaders (Bicksler et al., 2020). This methodology enhances the learning process, knowledge sharing, and trust that is critical in improving decision-making in changing and resource-constrained situations. In such areas as Malir, where urban growth and informal agriculture practices determine the local agriculture, the methods of such participation can be useful to design interventions that are feasible and culturally relevant.

The recent geographical analysis also points to the evident decrease in the water resources of Malir. Spatiotemporal NDWI analysis of the Malir River revealed the linear decrease in surface water between 2000 and 2020, with an increase in salinity and reduction in seasonal flows (Nadeem et al., 2021). Because agriculture in Malir relies on shallow groundwater and on recharge which the river basin provides, this ongoing depletion puts further strain on already weak agricultural regimes. The data is limited and outdated and no roper Tape framework is applied. This intensifies the need to comprehend whether addressing local farms practices can enhance their soil health, reduce water usage, and build resilience. These aspects can be measured using the FAO TAPE framework. Through administering TAPE to ten farms in District Malir, this study will produce evidence-based information concerning their achieving transition levels, performance levels, and opportunities on how to fortify sustainable agriculture in the area.

2. Problem Statement

Agriculture in District Malir, Karachi is facing major challenges that directly affected sustainability and stability of farming families. The area is located in a semi -arid coastal region and farmers have been relying on tube wells, irregular canal supply and unreliable weather conditions. Farmers have not been able to sustain a consistent production over the years due to emergency issues like the fall in the ground water levels, soil erosion, the rise in the cost of inputs, and the advent of climatic pressures. Most of the farms in Malir cultivate vegetables, fodder and fruit crops to satisfy increasing population in Karachi, however these production systems are being strained with the shortage of natural resources and changing environmental conditions.

Even though some farmers in Malir have started adopting practices that are similar to those of agroecology like crop diversification, reducing chemical application, or enhancing soil through organic matter, they are mostly unplanned and inconsistent. There is no structured way to know to what extent these farms are shifting towards agro ecological principles or whether these methods are leading to any improvement of the environment and socio-economic conditions. Consequently, it is not clear how far the district is going with regard to sustainable farming. The farmers continues to face several problems that include high dependency, low market value, poor soil health, and exposure to environmental risks, yet there is no appropriate framework that could be adopted locally to assess these in a holistic way.

The lack of formal assessment is a major gap, particularly since Malir happens to be one of the most significant peri-urban areas in agriculture in Karachi. Without clear knowledge on existing practices makes it challenging to researchers, extension workers, or policymakers to develop specific intervention that helps farmers to convert their systems to more resilient and sustainable ones. Social aspects of farming in Malir such as gender roles, participation of youth, food variety, or land tenure status are also not well known.

Therefore, the main problem this study addresses is the absence of a standard, evidence-based method for evaluating agroecological transitions and farm performance in District Malir. By applying the complete TAPE framework, this study aims to fill this gap by generating a clear picture of the current situation, identifying constraints, and highlighting opportunities for improving sustainable agriculture in the region.

3. Objectives

To apply the FAO TAPE framework to evaluate the agroecological transition and performance of selected farms in District Malir, Karachi.

3.1 Specific Objectives

1. To assess the level of agroecological transition of selected farms using FAO's TAPE framework, particularly through the Characterisation of Agroecological Transition (CAET).
2. To evaluate the performance of farms across environmental, economic, and social dimensions based on TAPE's multidimensional performance indicators.
3. To identify constraints and opportunities for improving and strengthening agroecological practices in the study area.

4. Literature

4.1 Concept of Agroecology

Agroecology has gained a lot of attention all over the world given that numerous farmers and governments are seeking alternative to conventional, chemical-intensive farming. Recent literature demonstrates that agroecology is not only an ecological practice. It bridges the gap between food production and the health of the ecosystem and the wellbeing of farmers and social values (Faure et al., 2024). The research of different countries prove that agroecology enhances biodiversity, food security, and climate resilience through the limitation of reliance on synthetic inputs and natural ecological processes promotion.

The social aspect of agroecology is brought out through evidence in Cameroon. Molua (2011) found that female farmers in Cameroon face lower access to productive resources than male farmers, which constrains their ability to adopt climate-adaptation options. This indicates that agroecology deals with ecological as well as social circumstances such as access to resources and gender roles.

According to scientific work, the concepts of agroecology are founded on the principles of diversification, nutrient recycling, soil regeneration, and resilience. According to Wezel et al. (2020), agroecology is a multidimensional strategy that unites ecological, economic, cultural, and governance views. These principles assist farmers to minimise the use of chemicals, ensure that th soil remains fertile and enhance their capacity to withstand climate stresses.

The Latin American research indicates obvious advantages. Agroecology has been scientifically demonstrated to have the capacity to grow the agro-crop and animal production, and therefore overall farm output, enhance the resiliency of farms to climatic changes, improve diets and farm income, preserve biodiversity and the natural resource base, and lower dependency of farmers on external inputs (Altieri and Nicholls, 2020). Likewise, Pimentel et al. (2005) found that in their long-term trial in Pennsylvania, the organic (legume-based) system incurred fertilizer and lime costs of approximately US $18 per hectare compared to US $79 per hectare in the conventional system**. T**hese works reveal that agroecology offers a viable and sustainable solution to enhancing the environmental and livelihood performance.

This demonstrates that agroecology is a clear path to the reconstruction of the farming systems in such a way that they are both ecologically sound, socially equitable and economically sustainable which are all of great concern to District Malir where farmers are struggling against climate change, lack of water, and increased production expenses.

4.2 FAO's Ten Elements of Agroecology

The Ten Elements of Agroecology allow the FAO to give the world a recognised framework on how to transition to sustainable agriculture. These factors combine ecological concepts with social, cultural, and economic ones, and are applicable to analyze as well as evaluate agroecological practices (FAO, 2019a). Research indicates that the Ten Elements are becoming more popular in the countries to design agricultural reforms and assess sustainability (Faure et al., 2024).

Wezel et al. (2020) describes the interaction of the Ten Elements. Factors like diversity, efficiency, recycling, and resilience are ecological factors that assist farms to keep the soil healthy, have a reduced reliance on external inputs, and be better adapted to climate risks. Co-creation of knowledge, human values, food traditions, and responsible governance, are some social and cultural factors that make sure that communities actively participate in developing their food system. These elements do not work individually; e.g. diversification contributes to resilience and through co-creation of knowledge can help farmers to enhance practices through mutual learning.

The Ten Elements were first published by FAO in 2018, and they rapidly gained traction as the basis of discussion of agroecology globally (FAO, 2018). These aspects were later on incorporated into agroecology measuring tools such as the Tool for Agroecology Performance Evaluation (TAPE) (FAO, 2019b). Such association renders the Ten Elements vital in comprehending the relevance of evaluating agroecology in other nations and the roles that levels of transition play in the analyses of farms in District Malir.

4.3 Agroecology Performance Evaluation

According to recent research, there is a strong emphasis on the necessity to measure agroecology in terms of indicators that reflect both environmental and social and economic performance. A review of case studies carried out showed that 51 out of 100 socio-economic indicators associated with agroecology were positive, 30 negative, 10 neutral, and 9 inconclusive (Mouratiadou et al., 2024). These findings indicate that agroecology has numerous advantages, and its effectiveness may differ depending on context, farm type, and empowering conditions.

Research that uses the TAPE framework establishes that agroecology cannot be quantified using yield. The assessments should cover the health of the soil, biodiversity, dietary diversity, income stability, pesticide exposure, and gender inclusion (Lucantoni et al., 2024). Examples include that, the more agroecological the farms, the more climate-resilient they are and the more diverse their diet and female and youth involvement.

The importance of structured evaluation is also reflected by the Measuring Agroecology and its Performance (MAP) initiative of FAO. Agroecology cannot be compared at different places without standardised tools (Geck, M, 2024). TAPE can solve this by providing a stepwise approach of evaluating both levels of transition (Step 1) and multidimensional performance results (Step 2). The indicators addressed in the framework include productivity, income, soil health, empowerment, and added value (FAO, 2019a; FAO, 2019b).

This fact demonstrates why such a systematic assessment instrument as TAPE should be used to examine farm operations in District Malir where the environmental pressure, water shortage, and inadequate market access determine the performance of farms.

4.4 Application of TAPE in Global and Local Contexts

TAPE has been extensively used in various places and agricultural systems. Research indicates that the framework assists researchers and the governments to interpret agroecological transitions and establish the factors that promote or restrain adoption. One example of TAPE application by FAO is its ROLL project that evaluated levels of transition and performance using

TAPE in multiple regions, revealing that governance, market access, and land tenure determine the sustainability results (FAO, 2024).

TAPE has been implemented in Benin, Ethiopia, Kenya and Madagascar in Africa. Such studies have shown that the low-transition and high-transition farms show strong variations, particularly the diversity of diets, pesticide exposure, gender involvement, and biodiversity (DeSIRA-LIFT, 2025). The findings motivated governments of countries to incorporate agroecology in agricultural policies and extension packages.

Recent applications of TAPE in Latin America show clear farm typologies based on land size and production systems. A research employing TAPE in the Colombian Andean-Amazon transition zone revealed four farm typologies and that Mixed Family Farms (MFF) performed best based on agroecological metrics (Crop Diversity Index of approximately 64), Soil Health Index of 4.24 and the family empowerment (approximately 85%). Such farms also were characterized by rather productive autonomy (VA/GVP 0.69) which means that they were more independent and did not rely on external inputs so much (Vazquez-Alvarez et al., 2025). These results demonstrate that TAPE is able to distinguish the farm structures and provide specific interventions. Community-based research (as in the case of women-led farms in the United States) emphasizes that TAPE is used to measure social outcomes such as decision-making, labour roles and empowerment (Gomori-Ruben & Reid, 2023).

TAPE is a highly acceptable method across the world, but in Pakistan; its implementation is very minimal. None of the major published studies investigated the extent of transition in agroecology or the performance of the farms in terms of TAPE. This disjunction renders the current study in the District Malir significant, as it will help give context-specific information on Pakistan and to inform policy and development efforts in sustainable farming in the future.

5. Materials and Methods

5.1 Description of Study Area

This research will be conducted in District Malir, which is found at the eastern side of Karachi, in the Sindh province in Pakistan. The district is located in the semi-arid coastal climate

with the low and very fluctuating levels of precipitation and the broad differences in temperature. The average rainfall is also approximately 150-200 mm annually with the temperatures being about 12 o C during the winter season and over 40°C during the summer. Agriculture in Malir is supported mainly by tube wells**,** supplemented by occasional canal flows and seasonal runoff from the Malir River basin. The district has a variety of farming systems, which include vegetables (e.g., tomato, chilli, okra), fruit orchards (banana, papaya, guava), and fodder. These conditions make Malir an important location for assessing agroecological transition due to increasing pressure on water availability, soil fertility, and climate resilience.

5.2 Selection and Characteristics of Farms

Purposive sampling will be done to ensure that it captures the major cropping systems and various sizes of farms in the District Malir since there are 10 agricultural farms in total targeted. The farms will contain small, medium and large farms which are between about 10 to 100 acres. All sampled farms will be sampled according to the same territorial unit as per TAPE manual in order to have a common territorial inference space to ensure that the farms are subjected to similar agroecological, environmental, and socio-economic conditions. This improves the level of comparability of CAET scores and performance indicators. The permission to take part will be issued by farmers, and access to the field will be made easy by the already existing community networks.

5.3 Data Collection Tools

Structured questionnaires on the basis of FAO TAPE framework will be used to gather primary data. Such questionnaires will be conducted face to face interviews with farmers. Further observations in the field will involve the recording of patterns of cropping, soil and water management, biodiversity characteristics and the use of inputs. Two focus group discussions (FGDs) will be arranged to record the views of the community about the problems of farming, climate risks, gender roles, and sustainability views. The Sindh Agriculture Department, local extension offices and the relevant institutional reports will be used to collect secondary data. These tools will collectively give needed to analyze a farm level as well as territory level analysis with TAPE.

5.4 Steps of the FAO TAPE Framework

Step 0: Contextualization and Farm Characterization

Step 0 will record the larger territorial setting of the District Malir, such as environmental factors, primary agricultural institutions, water sources, land tenure, market accessibility and institutional facilitation. At the farm level, the baseline data will be obtained through the household size, crop and livestock structure, labour structure, and resource limitation. This measure gives rise to the contextual background of analysing agroecological transition and performance.

Step 1: Description of Agroecological Transition (CAET)

Step 1 will determine the extent to which individual farms adhere to the principles of agroecological with Characterisation of Agroecological Transition (CAET). The CAET tool analyses the farms by comparing them with the Ten Elements of Agroecology, such as rhythm, synergies, recycling, soil and water management, decreased dependence on external inputs, biodiversity conservation, co-creation of knowledge, social values, accountable governance, and circular economy practices. Each farm will receive a transition score, which will allow grouping it in low-, medium-, or high-transition levels.

Step 2: Multidimensional Performance Assessment

The second step will assess the environmental, economic, and social performance based on the performance indicators of TAPE. Primary indicators are included like soil health practices, water efficiency, input dependency, income diversification, dietary diversity, pesticide exposure, and risk exposure and gender participation and youth participation. Even though the data will be gathered on the farm/household level, the findings can be summed up to the territorial level to learn more about the general trends of sustainability in Malir as it is suggested in the TAPE manual.

Step 3: Synthesis, Aggregation, and Interpretation

The synthesis of the results will be performed to compare the farms, determine the patterns and relationships between the agroecological transition levels (Step 1) and performance outcomes

(Step 2). This step will involve participatory interpretation in terms of feedbacks and FGDs where farmers will be able to validate the findings and help in the identification of constraints and opportunities. The synthesis will bring out the enabling and limiting factors affecting agroecology in District Malir.

5.5 Statistical Analysis

Microsoft Excel will be used to enter all the data and analyse it. CAET scores, performance indicators and farm characteristics will be summarised with the use of descriptive statistics. Images will be used to present the transition levels and performance differences across farms in the form of radar charts, bar graphs and comparative tables. Pattern grouping or simple cluster analysis will be employed where applicable to determine similarities on the basis of the farm size, cropping system or management practices. The whole analysis will be performed according to the recommendations of TAPE in order to produce farm-level and territory-level interpretations.

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