FIELD SURVEY PROTOCOL

Context, Approach, Methodology, Plan and SOPs

Mapping High-Potential Zones for Cold (Trout), Semi-Cold and Warm-water Aquaculture across Khyber Pakhtunkhwa Province and Developing a Cluster-based Commercialization Strategy

---

Prepared for:
Food and Agriculture Organization of the United Nations (FAO)

Prepared by:
Fisheries Development Board (FDB)

Dated: 8 October 2025

Project Details

Project Title:
Mapping High-Potential Zones for Cold (Trout), Semi-Cold and Warm-water Aquaculture across Khyber Pakhtunkhwa Province and Developing a Cluster-based Commercialization Strategy

Document Title:
Field Survey Protocol: Context, Approach, Methodology, Plan and SOPs

Prepared By:
Muhammad Junaid Wattoo, CEO, FDB
and the dedicated team of Fisheries Development Board (FDB)

Deliverable:
Output of activity No 1.3, under LOA for TCP/PAK/4005.

Project Sponsor:
Food and Agriculture Organization of the United Nations (FAO) on request of Fisheries Department, Government of Khaybar Pakhtunkhwa.

Project Manager:
Dr. Kanwar Muhammad Javed Iqbal, FAO

Lead Technical Officer
Tipparat Pongthanapanich, FAO Regional Office, Asia-Pacific, Bangkok

Implementing Agency:
Fisheries Development Board (FDB)

Submitted on:
8 October 2025

Acknowledgements
This report is a collaborative effort, and the authors extend their sincere gratitude to all individuals and organizations who contributed to its development. Special thanks are due to the Food and Agriculture Organization of the United Nations (FAO) for their sponsorship and unwavering support, and to the Fisheries Department Khyber Pakhtunkhwa for their invaluable insights and cooperation throughout this project and to the consultant team and staff of FDB.

Table of Contents

Field Survey Protocol

Survey protocol for conducting the aquaculture study in Khyber Pakhtunkhwa (KP) is designed to comprehensively identify high-potential zones (HPZs) for various aquaculture types and develop a cluster-based commercialization strategy. This plan employs a multi-stage, stratified purposive sampling approach, integrating desk-based research, extensive field surveys, and advanced GIS-based spatial analysis.

1. Introduction

1.1. Background and Context of Aquaculture in Pakistan and KP

Aquaculture, the controlled cultivation of aquatic organisms such as fish, crustaceans, mollusks, and aquatic plants, has become a vital component of global food production systems. It addresses the growing demand for animal protein, especially in regions where wild fish stocks are declining or insufficient to meet consumption needs. Pakistan, with its extensive river systems, lakes, and reservoirs, has witnessed a gradual rise in aquaculture activities, though the sector remains underdeveloped relative to its potential.

Khyber Pakhtunkhwa (KP), situated in the northwestern part of Pakistan, offers a unique environment for aquaculture development due to its diverse climatic zones and abundant water resources. The province's topography ranges from the high-altitude mountainous regions to fertile plains, creating varied ecological niches suitable for different aquaculture species. The province encompasses a wide altitudinal range, from the plains in the south to the high mountain valleys of the north, creating distinct ecological zones suitable for different aquaculture systems. The Northern Areas and upper regions of KP, with elevations exceeding 1,500 meters and water temperatures ranging from 10-18°C, are ideal for cold-water species such as rainbow trout and brown trout. The mid-elevation zones (800-1,500 meters) with moderate temperatures (18-25°C) can support semi-cold water species, while the lower plains with warmer temperatures (25-32°C) are suitable for traditional warm-water species such as carp, catfish, and tilapia.

Despite this natural advantage, aquaculture in KP is largely small-scale, fragmented, and lacks strategic planning, which limits its contribution to food security and economic development. Unplanned development can lead to conflicts over resource use, environmental degradation, and ultimately, the failure of aquaculture ventures. The need for a comprehensive, data-driven approach to identify high-potential zones (HPZs) and develop cluster-based commercialization strategies is critical. This study aims to fill this gap by integrating advanced GIS techniques, socio-economic analyses, and participatory fieldwork to provide actionable insights for sustainable aquaculture growth in KP.

1.2. Importance of Aquaculture for Economic Growth and Food Security

Aquaculture plays a pivotal role in enhancing food security by providing a consistent supply of nutritious protein-rich food. Globally, it contributes over half of the fish consumed by humans, and its importance is growing in developing countries. In Pakistan, aquaculture offers opportunities for rural employment, poverty alleviation, and diversification of income sources, particularly in areas where agriculture alone is insufficient.

In KP, aquaculture development aligns with national goals of improving nutrition, reducing rural poverty, and promoting sustainable resource use. By harnessing the province's natural resources and adopting cluster-based commercialization, aquaculture can stimulate local economies, create jobs, and reduce dependence on imported fish products. Moreover, sustainable aquaculture practices can mitigate environmental degradation and enhance resilience to climate change impacts. The expansion of aquaculture is a critical component of ensuring food security and providing economic opportunities in KP.

1.3. Purpose and Scope of this Protocol

This Field Survey Protocol serves as a comprehensive roadmap for the successful execution of field-based data collection activities. It provides a structured approach from inception to final reporting, offering clarity on methodologies, roles, and deliverables to ensure efficient coordination among all stakeholders. The protocol is specifically designed to address the following critical needs:

Operational Efficiency: Given the vast geographical area of KP and the diversity of aquaculture zones, the protocol employs a strategic, priority-based approach to optimize the 20-day fieldwork period. Rather than attempting superficial coverage of all potential sites, the protocol emphasizes thorough data collection from the most critical sites that serve both HPZ mapping and commercialization strategy objectives.

Scientific Rigor: The protocol integrates a GIS-based Multi-Criteria Analysis (MCA) framework adapted from FAO Technical Paper 705 for freshwater aquaculture spatial planning. This ensures that site identification and assessment are based on standardized, replicable criteria encompassing physical, chemical, biological, socioeconomic, and administrative parameters.

Dual-Objective Integration: The protocol is uniquely designed to support both HPZ mapping (Output 1) and commercialization strategy development (Output 2) through integrated site selection criteria and data collection instruments. This ensures that field efforts efficiently serve both objectives without duplication.

Adaptability and Contingency Planning: Recognizing the challenges of field operations in diverse and sometimes difficult terrain, the protocol incorporates adaptive sampling strategies and contingency planning to ensure that core objectives are achieved even when teams face unexpected challenges such as access difficulties, weather constraints, or respondent unavailability.

The scope of this protocol encompasses the deployment of three specialized field teams, each comprising three individuals, across the cold-water, semi-cold-water, and warm-water aquaculture zones of KP. The protocol provides detailed guidance on site selection priorities, data collection methodologies, quality assurance procedures, safety and ethical considerations, and post-fieldwork analysis procedures.

1.4. Methodological Framework Overview

This protocol employs a multi-stage, stratified purposive sampling approach that integrates three complementary methodological frameworks:

GIS-Based Spatial Planning Framework: Adapted from FAO's marine aquaculture site selection methodology for freshwater systems, this framework employs a five-phase process: (1) contextualization and scoping, (2) information and data collection, (3) pre-selection and site screening using exclusion criteria, (4) consultation and validation with stakeholders, and (5) detailed suitability analysis using weighted multi-criteria analysis. This framework ensures that HPZ identification is based on systematic integration of diverse spatial datasets including water resources, climate, topography, infrastructure, land use, and administrative boundaries.

Strategic Priority-Based Site Selection: Recognizing resource and time constraints, the protocol employs a three-tiered priority system that classifies potential survey sites as Priority 1 (P1: Must-Visit), Priority 2 (P2: Should-Visit), or Priority 3 (P3: Opportunistic). This system ensures that field teams focus their efforts on sites that are critically important for both HPZ mapping and commercialization strategy development, while maintaining flexibility to adapt to field realities. The priority system is supported by zone-specific site selection matrices that provide clear guidance for each field team.

Integrated Data Collection Approach: The protocol employs multiple data collection methods including structured enumerator surveys of aquaculture practitioners, key informant interviews (KIIs) with hatchery managers, government officials, traders, and other value chain actors, focus group discussions (FGDs) with farmer groups and communities, direct site observations and assessments, water quality testing, and GPS-based spatial data collection. This multi-method approach ensures comprehensive data collection that supports both biophysical site suitability analysis and socioeconomic commercialization strategy development.

1.5. Key Principles Guiding Field Operations

The implementation of this protocol is guided by several key principles that ensure the quality, efficiency, and ethical integrity of field operations:

The Golden Rule of Field Prioritization: "It is better to thoroughly cover all Priority 1 sites and a few Priority 2 sites than to rush and superficially cover all planned sites." This principle ensures that data quality takes precedence over quantity, and that the most critical sites receive adequate attention even when teams face time constraints.

Adaptive and Responsive Sampling: Field teams are empowered to make informed decisions in response to field realities, including adjusting schedules when sites are inaccessible, investigating unexpected discoveries of significant aquaculture activity, reducing sample sizes when data saturation is reached, and following value chain linkages to unplanned but important locations. All adaptations must be documented with clear rationale and communicated to project coordination.

Integration of Scientific and Local Knowledge: The protocol recognizes that credible HPZ identification requires integration of scientific criteria with local knowledge and stakeholder perspectives. Field teams are instructed to actively engage with local communities, aquaculture practitioners, and government officials to validate findings and incorporate contextual understanding.

Safety and Ethical Integrity: All field operations prioritize the safety of team members and respect for the rights and dignity of survey respondents. The protocol incorporates Free, Prior, and Informed Consent (FPIC) procedures, grievance redressal mechanisms, and clear safety protocols including immediate withdrawal from areas with security concerns.

Data Quality Assurance: The protocol incorporates multiple quality assurance mechanisms including daily data validation by team leaders, cross-verification of key information across multiple sources, regular communication with project coordination, and systematic documentation of data collection procedures and any deviations from planned protocols.

1.6. Expected Contributions and Outcomes

The successful implementation of this Field Survey Protocol will generate several critical contributions to the overall project objectives:

Comprehensive HPZ Database: Field surveys will generate a comprehensive database of potential aquaculture sites characterized by biophysical parameters (water quality, temperature, flow, altitude), socioeconomic factors (market access, infrastructure, land tenure), existing aquaculture activity (species, production systems, scale), and stakeholder information (farmers, hatcheries, traders, processors). This database will form the foundation for GIS-based spatial analysis and HPZ delineation.

Value Chain Understanding: Through KIIs and market surveys, the field work will generate detailed understanding of aquaculture value chains from seed production through grow-out,

processing, and marketing. This understanding is essential for developing practical and scalable commercialization strategies.

Stakeholder Mapping: Field activities will identify and characterize key stakeholders across the aquaculture sector including seed producers, input suppliers, farmers, traders, processors, tourism operators, government agencies, and financial institutions. This stakeholder mapping is critical for designing cluster-based commercialization interventions.

Validated Site Suitability Criteria: The field work will validate and refine the GIS-based site suitability criteria through ground-truthing, ensuring that the final HPZ maps reflect both scientific analysis and field realities.

Foundation for Commercialization Strategy: The integrated data collection approach ensures that field efforts generate the information required for both HPZ mapping and commercialization strategy development, including market dynamics, business models, value chain constraints and opportunities, and potential for public-private partnerships.

2. Project Context and Mandate

This Field Survey Protocol has been developed under the Letter of Agreement (LOA) between the Food and Agriculture Organization of the United Nations (FAO) and the Fisheries Development Board (FDB) for the implementation of project TCP/PAK/4005, titled "Promoting sustainable expansion of aquaculture in Khyber Pakhtunkhwa through mapping of high-potential zones and developing the commercialization strategy."

The LOA specifies a comprehensive work plan comprising multiple activities designed to achieve two primary outputs:

Output 1: High Potential Zones (HPZs) for cold (Trout), semi-cold and warm-water aquaculture mapped and introduced

This output encompasses activities including literature review, inception workshops, preparation and finalization of a survey plan, training of survey teams, field surveys of high potential zones and intended clustering, development of survey reports and lists of suitable sites, spatial analysis for GIS maps, consultation with experts for validation of results, GIS-based clustering and zoning of suitable sites, and drafting of the study report related to mapping work.

Output 2: Commercialization strategy for cluster-based farming in Khyber Pakhtunkhwa developed and introduced

This output includes activities such as needs assessment exercises, identification of potential aquaculture products and services, conduct of HPZ-specific market analysis and value chain assessment, examination of potential HPZs for public-private partnership, design of business

models and revenue streams, SWOT analysis of influencing factors, rationalization of findings, and drafting of the commercialization strategy as a comprehensive section of the overall consolidated study report.

This Field Survey Protocol specifically addresses Activity 1.3 (Preparation and finalization of a Survey Plan) and provides the operational framework for Activity 1.5 (Field surveys of high potential zones and intended clustering), while establishing the foundation for Activity 1.7 (Spatial analysis for GIS maps) and contributing to the data requirements for Output 2 activities.

3. Geographical Diversity and Coverage of Study Areas

KP's diverse topography and climate create distinct zones suitable for various aquaculture species:

a) Cold-Water Aquaculture (Trout)

Characteristics: These zones are typically high-altitude areas with cold, clean, fast-flowing water, and mountainous terrain. The ideal temperature range for trout is 10-14°C. Trout farming predominantly utilizes intensive culture systems in cemented raceways, requiring high-protein pellet feed.

Potential Zones:

1) **Swat District**: The Upper Swat Valley (e.g., Kalam, Ushu Valley, Madyan, Bahrain) is a well-established trout farming hub along the Swat River and its tributaries. Cold-water lakes such as Shago, Daral, Saidgai, Kondal, Batal, and Mahidand lakes are found here. The Madyan hatchery complex is a well-established public sector facility for trout breeding.

2) **Mansehra District (Kaghan Valley):** Areas along the Kunhar River (e.g., Naran, Kaghan, Shogran, Paras, Balakot) and Siran Vally, district Manshera, offer excellent conditions for trout farming and are popular with tourists. The Kunhar River is 166 km long, originating from Lolusar Lake. Shino Trout Hatchery in Kaghan also has a feed mill.

3) **Chitral District:** Identified for its high concentration of cold-water streams and existing trout farms (e.g., Garam Chashma, Bumburet, Chitral River tributaries, Ayun, Drosh, Lowari Pass area). Public sector trout hatcheries include Bomboret & Jaghoor.

4) **Upper Dir District**: Shows emerging potential for trout farming, with numerous cold-water streams such as River Panjkora, Barawal, Usherai, Lowari, Nihag, Doag, and Gawaldai streams. Kalkot in Upper Dir also has a public sector trout hatchery.

5) **Kohistan District**: Both Lower and Upper Kohistan, with its high-altitude streams and the Indus River (164 km long), present potential for riverine and remote cold-water aquaculture

(e.g., Bhasha Nala, Shutial Nala, Palyat Lake, Muheen Lake). Dubair nullah has been stocked with trout.

6) **Shangla District**: Mountainous streams and Indus River tributaries in Shangla have cold-water potential. Alpuri has a public sector trout hatchery.

7) **Newly Merged Districts (NMDs):** Major cold-water resources include River Kurram, ShalozanKhwar, PewarKhwar, ZeranKhwar, Kirman Khwar, Upper Bara River (Tirah), and Mastora River. Trout hatcheries exist in Malana and Shublan in District Kurrum.

Considerations for Cold-Water HPZs: Steep slopes and limited flat land can lead to higher construction costs for raceways, and flood risk in river valleys must be carefully assessed. A lack of a cool chain system is a significant constraint for transporting trout to markets outside these areas.

b) Semi-Cold-Water Aquaculture

Characteristics: These mid-altitude regions have moderate temperatures, typically between 15-20°C, and consistent water sources. They are suitable for species like Mahseer and some carp varieties.

Potential Zones:

1) **Lower Dir/Malakand Cluster**: This is a transitional zone with potential for Mahseer and other semi-cold water species. The Fisheries Department has a Mahseer hatchery at Thana village in Malakand for breeding and stocking.

2) **Mansehra/Abbottabad Cluster**: Areas around the Indus River and its tributaries, and the foothills of Abbottabad, provide suitable temperature regimes.

3) **Swabi, Nowshera, Haripur, Buner, Shangla, Kohistan**: These districts also exhibit mixed-zone potential, including semi-cold-water aquaculture. Examples include Indus River tributaries in Swabi, Kabul River in Nowshera, Tarbela Dam surroundings in Haripur, and the Barandu River in Buner.

Considerations for Semi-Cold Water HPZs: Maintaining water temperature stability year-round is crucial. Flood risk remains a concern in areas closer to river plains. The Mahseer population is in decline, but specific supporting data is limited.

c) Warm-Water Aquaculture (Carp, Tilapia)

Characteristics: These zones are characterized by lower altitudes, warmer temperatures (above 25°C), flatter terrain, and access to irrigation canals, rivers, or groundwater for pond filling.

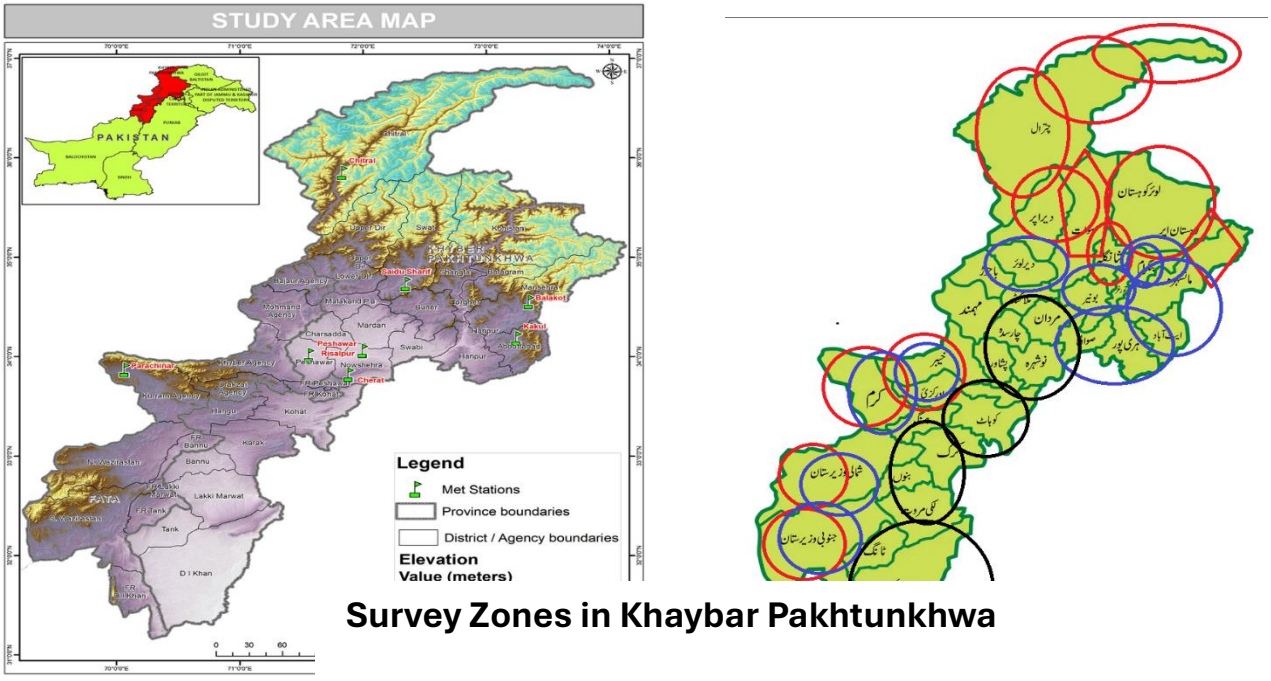
Farming typically involves extensive or semi-intensive polyculture systems of Indian major carps and exotic Chinese carps (Grass carp, Silver carp, Common carp).

Potential Zones:

1) **Peshawar Valley (Peshawar, Mardan, Charsadda, Nowshera Districts):** These plains offer extensive flat land suitable for pond construction with access to irrigation canals (e.g., Upper Swat Canal, Lower Swat Canal) and groundwater. This is a major hub for carp farming. Specific resources include River Kabul, River Naguman, River Shalam, and Azakhel Dam Khwar in Peshawar. Mardan has significant water resources like Kalpani Nullah, Bakhshalikhwar, and others, with over 700 private fish farms. Public sector carp hatcheries are located in Sherabad (Peshawar) and Charbanda (Mardan).

2) **Dera Ismail Khan (D.I. Khan) District:** Located in the southern part of KP, it has significant warm-water aquaculture potential, particularly along the Indus River, which flows for about 150 km along the district, and in waterlogged areas. The Rata Kulachi carp hatchery, though rebuilt, is currently in poor condition.

3) **Bannu/Kohat Cluster:** Developing areas benefiting from small dams and reservoirs. Bannu features the Kurram River (60 km long) and Baran Dam (2400 acres). Kohat Division has 90 km of the Indus River along with tributaries like Kohat Toi and 16 manmade dams. The Tanda Fish Hatchery in Kohat has cemented ponds and is well-maintained.



Survey Zones in Khaybar Pakhtunkhwa

4. Survey Approach and Methodology:

This section presents the comprehensive methodological framework for conducting field surveys to identify High Potential Zones (HPZs) for aquaculture development in Khyber Pakhtunkhwa and to gather data for developing a cluster-based commercialization strategy. The methodology integrates GIS-based spatial planning, strategic priority-based site selection, and multi-method data collection to ensure efficient and scientifically rigorous field operations.

4.1 Phase 1: Pre-Fieldwork (Desk-Based Analysis and HPZ Identification)

The pre-fieldwork phase establishes the foundation for efficient and targeted field operations through comprehensive desk-based research, GIS-based pre-selection of potential sites, and strategic planning of field team deployment.

4.1.1 Literature Review and Secondary Data Collection

The pre-fieldwork phase begins with systematic review of existing literature and collection of secondary data from multiple sources. This includes review of previous aquaculture studies in KP, government reports from the Fisheries Department and other relevant agencies, climate and hydrological data from meteorological and water resource agencies, land use and land cover data from Survey of Pakistan and satellite remote sensing sources, infrastructure data including road networks and market locations, administrative boundary data and protected area designations, and socioeconomic data from census and district development profiles.

This secondary data collection serves multiple purposes including providing baseline understanding of aquaculture potential and constraints across KP, enabling preliminary identification of potential HPZs through GIS analysis, informing the development of site selection criteria and priorities, and identifying key stakeholders and institutions to engage during field work.

4.1.2 GIS-Based Pre-Selection and Site Screening

The protocol employs a GIS-based Multi-Criteria Analysis (MCA) framework adapted from FAO Technical Paper 705 for freshwater aquaculture spatial planning. This framework enables systematic integration and analysis of diverse spatial datasets to identify areas with high potential for aquaculture development while excluding areas that are unsuitable due to legal, environmental, or practical constraints.

Exclusion Criteria and Zones

The first step in GIS-based pre-selection is the identification and mapping of exclusion zones where aquaculture development is strictly prohibited or practically infeasible. Areas meeting any of the following exclusion criteria are assigned a Suitability Index of -100 and removed from further consideration:

Protected Areas: National parks, wildlife sanctuaries, game reserves, and other legally designated protected areas are excluded to preserve biodiversity and ecosystem integrity. This includes both core protected areas and designated buffer zones where aquaculture is prohibited.

Urban and Built-up Areas: Cities, towns, and densely populated settlements are excluded due to land use conflicts, high land costs, and potential pollution concerns.

Primary Drinking Water Sources: Water bodies and river reaches that serve as primary sources of drinking water for communities are excluded to prevent contamination risks and ensure public health.

Severe Pollution Zones: Areas with documented high levels of industrial or agricultural pollution that would render water unsuitable for fish health and food safety are excluded based on available water quality data.

Insufficient Water Availability: Locations where water flow or availability is insufficient to support aquaculture operations throughout the year are excluded. This is particularly relevant for areas dependent on seasonal streams or areas with documented water scarcity.

Extreme Water Quality Conditions: Areas where pH, dissolved oxygen, or temperature consistently fall outside the tolerance range for all aquaculture species under consideration are excluded.

Site Suitability Parameters:
Following the exclusion of unsuitable areas, the remaining areas are evaluated based on a comprehensive set of site suitability parameters organized into five categories: physical, chemical, biological, socioeconomic, and administrative. Each parameter is assigned a Suitability Index (SI) value ranging from 1 (optimum conditions) to 0 (moderate conditions) to -1 (marginal conditions), and a Weighting Factor (K) from 1 to 10 reflecting its relative importance. The complete parameter specifications, ranges, and scoring criteria are provided in Annexure-6: GIS-Based Site Suitability Analysis Framework.

Physical Parameters relate to the physical characteristics of the site and its water source. Key physical parameters include altitude, which determines the temperature regime and thus suitability for cold-water, semi-cold-water, or warm-water species; water temperature, which directly influences fish metabolism, growth rates, and oxygen demand; and water availability and flow rate, which are essential for maintaining adequate dissolved oxygen levels and flushing away metabolic wastes.

Chemical Parameters pertain to the chemical composition of water, which directly affects fish health and growth. Critical chemical parameters include pH, which influences ammonia toxicity and nutrient availability; dissolved oxygen, which is essential for fish respiration; and salinity, which may be relevant in certain semi-cold-water environments or areas with brackish water intrusion.

Biological Parameters consider the biological aspects of the ecosystem. These include natural productivity indicated by plankton availability, which is particularly important for extensive warm-water pond culture systems, and assessment of potential impacts on biodiversity to ensure that aquaculture development does not threaten sensitive species or critical habitats.

Socioeconomic Parameters relate to the economic viability and social acceptability of aquaculture operations. Key socioeconomic parameters include access to markets, which is crucial for commercial success given the perishable nature of fresh fish; road proximity, which facilitates transport of inputs and outputs and reduces operational costs; and competing water uses, such as irrigation, domestic water supply, and hydropower, which must be assessed to avoid conflicts and ensure sustainability.

Administrative Parameters include legal and regulatory constraints. Critical administrative parameters include land and water tenure, as clear and secure tenure is essential for attracting investment and ensuring long-term viability, and protected area proximity, as aquaculture is typically not permitted within or near protected zones.

Degree of Compatibility Calculation

The Degree of Compatibility (DC) for each potential aquaculture site is calculated using a weighted linear combination formula that integrates the Suitability Index (SI) and Weighting Factor (K) for each parameter:

$DC = \Sigma (Ki \times SIi)$

where Ki is the weighting factor for parameter i, SIi is the suitability index for parameter i, and the summation is performed across all n parameters considered. Based on the calculated DC score, each location is classified into one of three categories:

- **Suitable (DC > 30):** Areas considered highly suitable for aquaculture that should be prioritized for field verification and development. These represent preliminary High Potential Aquaculture Zones.

- **Restricted (-30 ≤ DC ≤ 30):** Areas with some limitations that may be suitable for certain types of aquaculture or require specific management practices to mitigate risks.

- **Unsuitable (DC < -30):** Areas not suitable for aquaculture due to significant constraints.

The GIS-based pre-selection generates preliminary suitability maps for cold-water, semi-cold-water, and warm-water aquaculture systems. These maps identify broad areas with high potential that warrant field verification and detailed assessment.

4.1.3 Strategic Site Selection and Prioritization

The GIS-based pre-selection identifies a large number of potentially suitable areas across KP. However, given the time constraints (20-day fieldwork period) and resource limitations (three field teams of three persons each), it is not feasible to conduct detailed surveys at all potentially suitable locations. Therefore, the protocol employs a strategic site selection and prioritization framework to ensure that field efforts are concentrated on the most critical sites.

Dual-Objective Site Selection Criteria

Site selection must support both primary study outputs: HPZ Mapping (Output 1) and Commercialization Strategy Development (Output 2). Sites are evaluated based on their contribution to each objective:

For HPZ Mapping: Priority is given to sites with reliable year-round water sources with suitable quality, appropriate topography and available land, presence of existing aquaculture activity that demonstrates viability, and climate well-suited for target species that validates desktop climate models.

For Commercialization Strategy: Priority is given to sites with proximity to consumption centers, tourist hubs, or transport routes; availability of critical infrastructure including roads, electricity, telecommunications, and cold chain facilities; geographic concentration of farms indicating cluster development potential; and presence of key stakeholders including government offices, input suppliers, traders, and processors.

Three-Tiered Priority System

All potential survey sites are classified into one of three priority levels based on their importance for achieving study objectives:

Priority 1 (P1) - Must-Visit Sites: These are sites critically important for BOTH HPZ mapping and commercialization strategy development. P1 sites are non-negotiable and must be visited regardless of time constraints or logistical challenges. Field teams must allocate necessary time for thorough coverage of P1 sites. Examples include existing aquaculture clusters with multiple farms and established value chains, major hatcheries that serve as critical seed sources for entire regions, key market hubs where aquaculture products are traded, and areas with high biophysical potential combined with strong market linkage.

Priority 2 (P2) - Should-Visit Sites: These are sites that are strong in at least one core objective with potential relevance to the other. P2 sites should be visited as planned but can be shortened or skipped if necessary to protect the P1 schedule. Examples include areas with high biophysical potential but limited market access, secondary markets or input supply centers, sites with unique practices or emerging aquaculture systems, and government offices or research facilities with relevant expertise.

Priority 3 (P3) - Opportunistic Sites: These are sites offering supplementary data but not critical to core objectives. P3 sites should be visited only if time permits and they are conveniently located along planned routes. Examples include isolated individual farms in remote areas, sites with marginal potential that may provide comparative data, and communities with aquaculture interest but no current activity.

The Golden Rule of Field Prioritization

All field operations are guided by the principle: "It is better to thoroughly cover all Priority 1 sites and a few Priority-2 sites than to rush and superficially cover all planned sites." This ensures that data quality takes precedence over quantity and that the most critical sites receive adequate attention.

4.1.4 Development of Zone-Specific Site Selection Matrices

Based on the GIS-based pre-selection and the three-tiered priority system, detailed site selection matrices are developed for each of the three aquaculture zones (cold-water, semi-cold-water, warm-water). These matrices specify for each district or area the specific sites or locations to be visited, the priority level (P1, P2, or P3), the rationale for site selection, and the key activities to be conducted at each site. The complete zone-specific site selection matrices are presented in Section 4A.2.

4.1.5 Team-Specific Priority Schedules and Route Planning

For each of the three field teams, detailed priority schedules are developed that specify the sequence of site visits, the number of days allocated to each location, the priority level and strategic focus for each location, and the specific key activities to be conducted. These schedules are designed to optimize travel efficiency, ensure adequate time at P1 sites, and build in flexibility for adaptive sampling. The complete team-specific priority schedules are presented in Section 4A.3.

4.1.6 Preparation of Data Collection Instruments

The pre-fieldwork phase includes finalization of all data collection instruments including structured enumerator survey forms for aquaculture practitioners, key informant interview (KII) guides for hatchery managers, government officials, traders, and other stakeholders, focus group discussion (FGD) protocols for farmer groups and communities, site suitability assessment

checklists based on GIS parameters, water quality testing protocols, and GPS data collection protocols. All instruments are pilot-tested and refined based on feedback before field deployment.

4.1.7 Stakeholder Engagement and Coordination

Prior to field deployment, the project team engages with relevant stakeholders to facilitate field operations. This includes coordination with provincial and district fisheries departments to obtain necessary permissions and letters of introduction, engagement with hatchery managers and farmer associations to schedule interviews and site visits, coordination with local government officials to ensure smooth access to field sites, and communication with security agencies regarding planned field routes in sensitive areas.

4.2 Phase 2: During Fieldwork (Ground-Truthing and Data Collection)

The fieldwork phase involves deployment of three specialized field teams to conduct ground-truthing of GIS-identified potential HPZs, collect primary data through multiple methods, and gather information for commercialization strategy development. This phase is guided by the strategic priority framework and incorporates adaptive sampling strategies to respond to field realities.

4.2.1 Field Team Deployment and Coverage

Three field teams are deployed to cover the three major aquaculture zones of Khyber Pakhtunkhwa:

Team A - Cold-Water Zone: This team focuses on high-altitude areas suitable for trout farming, covering districts including Swat (Kalam, Ushu Valley, Madyan, Bahrain), Upper Dir (Kalkot, Panjkora River system), Chitral (Garam Chashma, Bumburet, Jaghoor), Mansehra (Kaghan Valley, Naran, Kunhar River), Kohistan (selected accessible areas), and Shangla (Alpuri area). The team's primary mission is to map the trout value chain from seed to market and identify promising expansion areas.

Team B - Semi-Cold-Water Zone: This team focuses on mid-altitude transitional areas suitable for Mahseer and certain carp varieties, covering districts including Lower Dir/Malakand (Timergara, Batkhela), Abbottabad/Haripur (Tarbela Dam, Khanpur Dam surroundings), Buner/Swabi (Barandu River, Pehur Canal), and Shangla/Nowshera (lower river reaches). The team's primary mission is to assess potential for new aquaculture systems, evaluate Mahseer habitats, and map market structure in transitional zones.

Team C - Warm-Water Zone: This team focuses on lower-altitude plains suitable for carp and tilapia farming, covering districts including Peshawar/Mardan (Sherabad and Charbanda

hatcheries, Peshawar fish market, Azakhel Dam area), Kohat (Tanda Dam and hatchery), Bannu (Baran Dam area), D.I. Khan (Rata Kulachi hatchery, Indus River areas), and accessible areas in newly merged districts. The team's primary mission is to map carp and tilapia value chains, focus on hatchery-to-market linkages, and assess saline aquaculture potential.
Each team operates for 20 days in the field, with daily schedules guided by the priority-based site selection framework.

4.2.2 Priority-Based Site Visitation Protocol

Field teams follow the priority-based site visitation protocol to ensure efficient use of time and thorough coverage of the most critical sites:

P1 Sites - Must-Visit Protocol: All P1 sites must be visited and receive thorough coverage. Teams allocate sufficient time for comprehensive data collection including multiple enumerator surveys, in-depth KIIs with key stakeholders, FGDs with farmer groups or communities where relevant, detailed site assessments including water quality testing and GPS mapping, market surveys where applicable, and photographic documentation. If a P1 site is inaccessible due to road blockage, adverse weather, or security concerns, teams must attempt alternative routes or reschedule the visit. If a P1 site remains inaccessible, teams immediately notify project coordination and reallocate time to other P1 sites or nearby P2 sites while planning to return to the inaccessible P1 site if conditions improve.

P2 Sites - Should-Visit Protocol: P2 sites are visited as planned in the schedule. However, if time constraints emerge due to delays at P1 sites or other factors, teams may shorten P2 site visits by reducing the number of enumerator surveys, conducting shorter KIIs, or skipping optional activities. If necessary to protect the P1 schedule, teams may skip P2 sites entirely, with the decision documented and communicated to project coordination.

P3 Sites - Opportunistic Protocol: P3 sites are visited only if time permits and they are conveniently located along planned routes. Teams conduct brief assessments at P3 sites, typically including one or two enumerator surveys, short informal interviews, basic site observations, and GPS waypoint recording.

4.2.3 Multi-Method Data Collection Approach

Field teams employ multiple complementary data collection methods to ensure comprehensive coverage of both biophysical and socioeconomic dimensions:

Structured Enumerator Surveys: Structured surveys are conducted with aquaculture practitioners (farmers, hatchery operators) using standardized survey forms. These surveys collect quantitative and qualitative data on farm characteristics, production systems, species cultured, input sources, production volumes, marketing channels, costs and revenues, constraints and

challenges, and training and support needs. Survey forms are provided in Annexure-1. Target sample sizes are determined based on the concentration of aquaculture activity at each site, with larger samples at P1 cluster sites and smaller samples at P2 and P3 sites.

Key Informant Interviews (KIIs): In-depth semi-structured interviews are conducted with key stakeholders across the aquaculture value chain. Key informants include hatchery managers (seed production, quality, distribution), government officials (policies, support programs, constraints), input suppliers (feed, equipment, availability, pricing), traders and wholesalers (market dynamics, prices, demand patterns), processors (value addition, quality requirements), tourism operators (demand for trout in tourist areas), and financial institutions (credit availability for aquaculture). KII guides are provided in Annexure-2.

Focus Group Discussions (FGDs): Group discussions are conducted with farmer groups, community members, and other stakeholder groups to gather collective perspectives on aquaculture potential, constraints, market opportunities, community perceptions, land and water access issues, and interest in cluster-based development. FGD protocols are provided in Section 7.

Direct Site Observations and Assessments: Field teams conduct systematic site assessments at each location using standardized site suitability assessment checklists based on the GIS parameters. Observations include physical characteristics (topography, land availability, water source type and flow), water quality (temperature, pH, dissolved oxygen using portable test kits), infrastructure (road access, electricity availability, distance to markets), land use and competing uses, and environmental conditions (vegetation, soil type, potential pollution sources). Site assessment checklists are provided in Section 7.5.

Water Quality Testing: Portable water quality test kits are used to measure key parameters including temperature, pH, and dissolved oxygen at all surveyed sites. Water samples may be collected for laboratory analysis where on-site testing indicates potential concerns. Water quality testing protocols and equipment specifications are provided in Annexure-5.

GPS-Based Spatial Data Collection: All surveyed sites, existing aquaculture facilities, water sources, and other relevant features are recorded using GPS devices. Waypoints include coordinates, altitude, site type, brief description, and photo references. GPS data collection protocols are provided in Annexure-4.

Market Surveys: At key market locations, teams conduct market surveys to assess fish prices, volumes traded, species availability, market infrastructure, trader networks, and linkages to production areas. Market surveys are particularly important at P1 market hub sites.

Photographic Documentation: Teams systematically document all sites, facilities, and activities through photographs. Photos are geotagged and linked to survey records.

4.2.4 Adaptive Sampling Strategies

Field teams are empowered to adapt their sampling strategies in response to field realities while maintaining focus on core objectives. Adaptive sampling strategies include:

Investigating Unexpected Discoveries: If teams discover significant aquaculture activity or potential sites that were not identified during pre-fieldwork planning, they may make judgment calls to investigate these discoveries. This may involve skipping a planned P2 site to thoroughly survey an unexpected P1-level discovery, dispatching a sub-team to verify and map a newly identified site while the main team continues with the planned schedule, or extending time at a site that proves to have greater importance than initially assessed.

Reaching Data Saturation: When teams have surveyed multiple similar sites and are obtaining highly repetitive data, they may reduce sample sizes for additional similar sites. For example, after surveying 12 similar trout farms in a cluster and finding consistent patterns, teams may conduct shorter assessments of additional farms in the same cluster.

Following the Value Chain: Teams may pursue important unplanned locations identified through data collection. For example, if a wholesaler mentions a significant unlisted landing site or production area, teams may dispatch a sub-team to verify and map the location, or if multiple farmers mention a new input supplier or service provider, teams may conduct an unplanned KII.

Responding to Respondent Availability: If a key respondent at a P1 site (such as a hatchery manager or market leader) is unavailable, teams may interview a deputy or knowledgeable alternative person, attempt to reschedule the interview for later in the fieldwork period, or compensate with additional enumerator surveys or a small FGD to gather the needed information. All adaptive sampling decisions must be documented in daily field reports with clear rationale and communicated to project coordination during daily check-ins.

4.2.5 Contingency Planning and Response Protocols

Field teams follow established contingency protocols to respond to challenges while protecting core objectives:

Time Delays: If a P1 visit takes longer than planned due to the richness of data or number of respondents, or if vehicle breakdown or other factors cause delays, teams identify the next P2 or P3 site on the schedule and shorten or skip that lower-priority visit to reclaim time. Teams never cut P1 visits short to stay on schedule.

Site Inaccessibility: If a P1 site is inaccessible, teams attempt alternative routes. If access remains impossible, teams use the time for a nearby P2 site and plan to reschedule the P1 visit. If a P2 or P3 site is inaccessible, teams cancel immediately and proceed to the next site or conduct more in-depth data collection at a nearby P1 site.

Key Respondent Unavailability: Teams follow the adaptive sampling strategy described above, noting the unavailability in field reports and flagging persistent P1 respondent unavailability to project coordination.

Security Concerns: Safety is the absolute priority. If teams receive official warnings or observe local unrest, they immediately withdraw to a safe location and regroup. Teams report security concerns immediately to project coordination without waiting for daily check-in. Teams use unexpected free time for data consolidation or planning.

Weather Constraints: If severe weather prevents travel or field work, teams use the time for data entry, quality checks, planning adjustments, and coordination with project management.

4.2.6 Daily Field Operations and Communication

Each field team follows a structured daily routine to ensure systematic data collection and quality control:

Morning Planning: Teams review the day's planned sites and activities, confirm priority levels and key objectives, check equipment and supplies, and coordinate logistics.

Field Data Collection: Teams conduct surveys, interviews, FGDs, and site assessments according to the priority-based protocol, with team leaders ensuring quality control and completeness.

Evening Data Review and Entry: Teams review all data collected during the day for completeness and consistency, enter data into mobile data collection applications or backup paper forms, conduct preliminary quality checks, and prepare data for transmission to central database.

Daily Check-In with Project Coordination: Team leaders conduct daily check-ins with project coordination to report progress against prioritized schedule, discuss any deviations and rationale, review next day's plan and confirm P1 and P2 targets, raise any challenges or support needs, and transmit collected data.

4.2.7 Data Quality Assurance During Fieldwork

Multiple quality assurance mechanisms are implemented during fieldwork:

Real-Time Data Validation: Mobile data collection applications include built-in validation rules to flag incomplete or inconsistent entries. Team leaders review all surveys and interview notes daily for completeness and clarity.

Cross-Verification: Key information is cross-verified across multiple sources. For example, production volumes reported by farmers are compared with trader estimates, and hatchery seed distribution is verified against farmer reports of seed sources.

Photographic Evidence: Systematic photographic documentation provides visual verification of site conditions, facilities, and activities.

GPS Verification: GPS coordinates are checked for accuracy and consistency, ensuring that recorded locations match the intended sites.

Supervisor Spot Checks: Project coordination may conduct spot checks by accompanying teams in the field or by calling back selected respondents to verify data collection procedures.

4.3 Phase 3: Post-Fieldwork (Extrapolation and Final Mapping)

The post-fieldwork phase involves systematic analysis of field data, integration with GIS layers, extrapolation of findings to the entire province, and finalization of HPZ maps and commercialization strategy recommendations.

4.3.1 Data Consolidation and Cleaning

All field data from the three teams are consolidated into a unified database. Data cleaning procedures include checking for completeness and resolving missing values, identifying and correcting inconsistencies, removing duplicate entries, standardizing coding and formatting, and verifying GPS coordinates and spatial data.

4.3.2 Descriptive Analysis of Field Data

Comprehensive descriptive analysis of field data is conducted to characterize aquaculture systems, production practices, value chains, and stakeholder networks across the three zones. Analysis includes summary statistics on farm characteristics, production systems, and economics; characterization of value chains from seed to market; identification of constraints and opportunities; and stakeholder mapping and network analysis.

4.3.3 Spatial Suitability Analysis and HPZ Delineation

Field data are integrated with GIS layers to conduct detailed spatial suitability analysis and delineate final High Potential Zones:

Ground-Truthing of GIS Parameters: Field observations and measurements are used to validate and refine the GIS-based parameter values. For example, field-measured water temperatures are compared with modeled temperature data, and field-observed market access times are used to refine distance-based market access estimates.

Refinement of Weighting Factors: Based on field insights and stakeholder consultations, the weighting factors (K values) for different parameters may be refined to better reflect local priorities and realities.

Recalculation of Degree of Compatibility: Using the ground-truthed parameter values and refined weighting factors, Degree of Compatibility (DC) scores are recalculated for all areas across KP using the weighted linear combination formula: $DC = \Sigma (Ki \times SIi)$.

Final HPZ Classification: Based on the recalculated DC scores, areas are classified into final suitability categories: Suitable ($DC > 30$) - designated as High Potential Zones (HPZs); Restricted ($-30 \leq DC \leq 30$) - areas with moderate potential requiring specific management; and Unsuitable ($DC < -30$) - areas not recommended for aquaculture development.

Cluster Identification: Within the HPZs, areas with geographic concentration of suitable sites and existing aquaculture activity are identified as priority clusters for commercialization strategy development.

HPZ Mapping: Final HPZ maps are produced for each aquaculture system (cold-water trout, semi-cold-water, warm-water carp/tilapia) showing suitable, restricted, and unsuitable areas; existing aquaculture facilities and activity; identified priority clusters; infrastructure and market locations; and protected areas and exclusion zones.

4.3.4 Extrapolation to Provincial Scale

Field survey data are extrapolated to the entire province using stratified extrapolation methods. Areas with similar biophysical and socioeconomic characteristics to surveyed sites are identified using GIS analysis. Findings from surveyed sites are extrapolated to similar unsurveyed areas with appropriate confidence levels and uncertainty estimates. Extrapolation is validated through comparison with secondary data sources and expert consultation.

4.3.5 Commercialization Strategy Development

Field data on value chains, market dynamics, stakeholder networks, and business models are analyzed to develop the cluster-based commercialization strategy. This includes identification of priority clusters for intervention, analysis of value chain constraints and opportunities, design of business models and revenue streams for individual, corporate, and public-private partnership interventions, SWOT analysis of factors influencing commercialization, and development of

specific recommendations for market access, value addition, quality improvement, and stakeholder coordination.

4.3.6 Stakeholder Consultation and Validation

Preliminary findings, HPZ maps, and commercialization strategy recommendations are presented to stakeholders for consultation and validation. This includes workshops with government officials, aquaculture practitioners, and private sector actors; expert consultations to validate technical findings; and community consultations in priority clusters to assess acceptability and refine recommendations.

4.3.7 Report Preparation and Finalization

The final consolidated study report is prepared integrating all findings, maps, and recommendations. The report includes comprehensive documentation of methodology, detailed presentation of HPZ maps with supporting analysis, cluster identification and characterization, commercialization strategy with specific recommendations, and lists of suitable sites with site-specific information. The report undergoes peer review before finalization and official launch.

4.4 Strategic Site Selection and Prioritization Framework

This section provides detailed operational guidance for field teams on site selection priorities, zone-specific site matrices, team-specific schedules, contingency planning, and communication protocols. The framework is designed to optimize the 20-day fieldwork period by ensuring that field efforts are concentrated on the most critical sites that serve both HPZ mapping and commercialization strategy objectives.

4.4.1 Site Selection Criteria and Priority System

4.4.1.1 Core Objectives

The site selection framework is designed to support two primary study outputs simultaneously:

HPZ Mapping (Output 1): Gather biophysical and socio-economic data to identify and map areas with highest potential for sustainable aquaculture development. This requires visiting sites that represent the diversity of aquaculture conditions across KP, including sites with optimal biophysical conditions, sites with existing successful aquaculture operations that demonstrate viability, sites with varying infrastructure and market access to understand these factors' influence, and sites representing different altitudinal and climatic zones.

Commercialization Strategy (Output 2): Collect market, value chain, and stakeholder information for cluster-based commercialization planning. This requires visiting sites where aquaculture value chains can be comprehensively mapped, major market hubs where fish are traded, hatcheries and input supply centers that serve as value chain anchors, areas with geographic

concentration of farms indicating cluster potential, and locations where key stakeholders (government, private sector, financial institutions) are present.
The most efficient approach is to prioritize sites that serve BOTH objectives, ensuring that limited field time generates maximum value for the overall study.

4.4.1.2 Site Selection Criteria

The following criteria are used to evaluate and prioritize potential survey sites:

Criteria Category	Specific Criteria	Rationale
HPZ Mapping	Water Availability & Quality	Reliable, year-round water sources with suitable quality are the most fundamental aquaculture requirement
	Land Suitability & Availability	Appropriate topography and available land; physical space is a key limiting factor
	Existing Aquaculture Activity	Presence of farms, hatcheries, or subsistence aquaculture provides baseline viability data
	Climatic Suitability	Climate well-suited for target species validates desktop climate models
Commercialization	Market Proximity & Access	Proximity to consumption centers, tourist hubs, transport routes is the primary driver of commercial viability
	Infrastructure Availability	Roads, electricity, telecommunications, cold chain are critical for entire value chain
	Cluster Potential	Geographic concentration of farms or cluster development potential is core component of commercialization strategy
	Stakeholder Presence	Location of government offices, input suppliers, traders, processors is essential for value chain understanding

4.4.1.3 Three-Tiered Priority System

All potential survey sites are classified into one of three priority levels:

Priority 1 (P1) - Must-Visit Sites
Definition: Sites critically important for BOTH HPZ mapping and commercialization strategy development.

Examples:

- Existing aquaculture clusters with multiple farms and established value chains
- Major hatcheries serving as critical seed sources for entire regions
- Key market hubs where aquaculture products are traded and value chains converge

- Areas with high biophysical potential combined with strong market linkage and infrastructure

Team Action:

- Non-negotiable visits - must be completed regardless of time constraints
- Allocate necessary time for thorough coverage including multiple surveys, in-depth KIIs, FGDs where relevant, comprehensive site assessments, and market analysis
- If a P1 site is inaccessible, teams must attempt alternative routes or reschedule
- Never cut P1 visits short to stay on schedule

Priority 2 (P2) - Should-Visit Sites
Definition: Sites strong in at least one core objective with potential relevance to the other.

Examples:

- Areas with high biophysical potential but limited current market access
- Secondary markets or input supply centers
- Sites with unique practices or emerging aquaculture systems
- Government offices or research facilities with relevant expertise
- Individual farms or small clusters that provide comparative data

Team Action:

- Visit as planned in the schedule
- Can be shortened if time constraints emerge (reduce number of surveys, conduct shorter KIIs, skip optional activities)
- Can be skipped entirely if necessary to protect P1 schedule
- Document and communicate any changes to project coordination

Priority 3 (P3) - Opportunistic Sites
Definition: Sites offering supplementary data but not critical to core objectives.

Examples:

- Isolated individual farms in remote areas
- Sites with marginal potential that may provide comparative data
- Communities with aquaculture interest but no current activity
- Areas identified opportunistically during field travel

Team Action:

- Visit only if time permits and conveniently located along planned routes
- Conduct brief assessments (1-2 surveys, short informal interviews, basic observations)
- Skip without hesitation if time is limited or access is difficult

- No need to communicate skipping of P3 sites unless they prove unexpectedly important

4.4.1.4 The Golden Rule of Field Prioritization

"It is better to thoroughly cover all Priority-1 sites and a few Priority-2 sites than to rush and superficially cover all planned sites."

This principle ensures that:

- Data quality takes precedence over quantity
- The most critical sites receive adequate attention
- Field teams make informed decisions when facing time constraints
- Core study objectives are protected even when full schedules cannot be completed

4.4.2 Zone-Specific Site Selection Matrices

The following matrices provide detailed site selection guidance for each of the three field teams. Each matrix specifies the district/area, specific sites/locations, priority level, rationale for selection, and key activities to be conducted.

4.4.2.1 Team A: Cold-Water Areas

Focus: Trout farming value chain, from hatchery to market, and identification of new high-potential areas

District/Area	Site/Location	Priority	Rationale	Key Activities
Swat	Kalam & Ushu Valley	**P1**	Epicenter of trout farming in KP, high tourism demand, clear cluster dynamics	Farm surveys (10-15 farms), water quality testing, KIIs with farmers & tourism operators, market surveys in tourist areas
	Madyan & Bahrain	**P1**	Location of Madyan Trout Hatchery (major seed source), numerous farms in area	KII with hatchery manager, farm surveys (8-10 farms), water quality testing, seed distribution assessment
	Daral, Saidgai, Kondal	**P2**	Areas with emerging trout farms, expansion potential	Farm surveys (4-6 farms), site suitability assessment, water quality testing
Upper Dir	Kalkot Hatchery & surrounding streams	**P1**	Important government hatchery, significant	KII with hatchery manager, stream assessments (Panjkora, Barawal, Usherai), water

			untapped potential in river system	quality testing, community FGDs
	Panjkora, Barawal, Usherai streams	**P2**	Key water bodies for potential expansion	Site suitability assessment, water quality testing, GPS mapping of potential sites
Chitral	Garam Chashma & Bumburet	**P1**	Established trout farming, unique high-altitude conditions, community-based models	Farm surveys (8-10 farms), KIIs with community leaders, water quality testing
	Jaghoor Hatchery	**P1**	Key public sector hatchery for Chitral region	KII with hatchery manager, seed distribution assessment, quality evaluation
	Ayun, Drosh	**P2**	Lower altitude areas, climatic boundary for trout	Site suitability assessment, water quality testing, temperature monitoring
Mansehra	Kaghan & Naran	**P1**	Major tourism hub with high trout demand, Kunhar River system	Market surveys (hotels/restaurants), KIIs with tourism businesses, farm surveys (8-10 farms), water quality testing
	Shino Trout Hatchery	**P1**	Critical public hatchery supplying Kaghan valley, includes feed mill	KII with hatchery manager, feed mill assessment, seed distribution analysis
Kohistan	Bhasha, Shutial, Dubair nullahs	**P3**	Remote, high-potential areas for opportunistic visits	Water quality testing, site suitability assessment, community interest assessment (only if accessible)
Shangla	Alpuri area	**P2**	Transitional zone between cold and semi-cold, Alpuri hatchery	KII with hatchery manager, water quality testing, community FGDs
NMDs (Kurram)	Malana/Shublan Hatcheries	**P2**	Assess viability in newly merged districts	KII with hatchery managers, assess river systems, KIIs with local officials

4.4.2.2 Team B: Semi-Cold-Water Areas

Focus: Mahseer conservation, potential for carp in transitional areas, and identifying sites for new aquaculture systems

District/Area	Site/Location	Priority	Rationale	Rationale	Key Activities
Lower Dir/Malakand	Timergara & Batkhela	**P1**	Key commercial and transit hubs, market dynamics and input supply chains	Market surveys, KIIs with traders and input suppliers, assess infrastructure	
	Swat River (lower reaches)	**P2**	Important for Mahseer populations and river-based aquaculture potential	Water quality testing, habitat assessment, KIIs with local fishermen	
Abbottabad/Haripur	Tarbela Dam surroundings	**P1**	Large water body with established fisheries, cage culture potential, proximity to markets	KIIs with dam authorities & fishermen, water quality testing, market surveys, assess cage culture sites	
	Khanpur Dam	**P2**	Significant water body with recreational and aquaculture potential	KIIs with authorities, water quality testing, site suitability for cage culture	
Buner/Swabi	Barandu River & Pehur High-Level Canal	**P2**	Important water sources, potential for integrated farming	Water quality testing, site suitability assessment, KIIs with irrigation department	
Shangla	Alpuri area	**P1**	Transitional zone between	Water quality testing,	

			cold and semi-cold for opportunistic surveys	community FGDs, assess mixed-zone potential	
Nowshera	Kabul River sections	**P2**	Mahseer habitat and warm-water transition	Habitat assessment, water quality testing, KIIs with fishermen	

4.4.2.3 Team C: Warm-Water Areas

Focus: Carp and Tilapia value chains, from hatchery to market, and assessing potential for saline aquaculture

District/Area	Site/Location	Priority	Rationale	Key Activities
Peshawar/Nowshera	Sherabad & Charbanda Carp Hatcheries	**P1**	Largest public carp hatcheries, critical for seed supply across warm-water zone	In-depth KIIs with hatchery managers, seed quality and distribution assessment, breeding protocols
	Peshawar Fish Market	**P1**	Main wholesale market for the province, essential for commercialization chain	Extensive market surveys, KIIs with wholesalers, traders, transporters, price analysis
	Azakhel Dam & surrounding farms	**P2**	Cluster of existing farms providing sample of current practices	Farm surveys (8-10 farms), water quality testing, FGDs with farmers
Kohat	Tanda Dam & Hatchery	**P1**	Important water body and hatchery serving southern districts	KII with hatchery manager, farm surveys around dam, water quality testing
Bannu	Baran Dam	**P1**	Significant water resource with potential for increased production	Site suitability assessment, water quality testing,

				KIIs with local officials
D.I. Khan	Rata Kulachi Fish Hatchery & surrounding farms	**P1**	Key hatchery and carp farm cluster, primary area for saline aquaculture assessment	KII with hatchery manager, farm surveys (10-12 farms), groundwater salinity testing
	Indus River (Paroa area)	**P2**	Potential for river-based aquaculture and capture fisheries interaction	KIIs with fishermen, water quality testing, habitat assessment
Waziristan (NMDs)	Community centers in Wana or Miranshah	**P3**	Opportunistic visits to assess community needs and aquaculture perceptions	KIIs with community leaders and government representatives (only if security permits)
Mardan	Farm clusters	**P2**	Major carp farming area with over 700 private farms	Farm surveys (sample of 10-12 farms), input supplier KIIs

4.5 Contingency Planning and Adaptive Sampling

4.5.1 Contingency Scenarios and Response Actions

Field teams will inevitably face challenges and unexpected situations. The following table provides guidance on how to respond to common contingency scenarios:

Scenario	**Recommended Action**	**Communication Protocol**
Time Delay (P1 visit takes longer than planned, vehicle breakdown, etc.)	1. Identify next P2 or P3 site on schedule 2. Shorten or skip lower-priority visit to reclaim time 3. Never cut P1 visit short to stay on schedule	Inform project coordinator during daily check-in, justify decision
Site Inaccessibility (road blocked, adverse weather)	**If P1 site:** Attempt alternative route; if impossible, use time for nearby P2 site and reschedule P1 **If P2/P3 site:** Cancel immediately, proceed to next site or conduct more in-depth P1 data collection	Immediately notify coordinator if P1 site inaccessible

Key Respondent Unavailable (hatchery manager, market leader)	1. Interview deputy or knowledgeable person 2. Try to reschedule 3. Compensate with more enumerator surveys or small FGD	Note unavailability in field report, flag persistent P1 unavailability
Security Concerns (local unrest, official warnings)	1. Safety is absolute priority - withdraw immediately 2. Move to safe location and regroup 3. Use time for data consolidation or planning	Report security concerns immediately, do not wait for daily check-in
Weather Constraints (severe weather prevents travel)	1. Use time for data entry and quality checks 2. Conduct planning adjustments 3. Coordinate with project management	Inform coordinator, discuss schedule adjustments
Unexpected Discovery (major unlisted farm cluster, significant site)	1. Make judgment call on importance 2. Consider skipping planned P2 site to investigate 3. Document discovery thoroughly	Report discovery during daily check-in, justify any schedule changes

4.5.2 Adaptive Sampling Strategies

Field teams are empowered to employ the following adaptive sampling strategies to optimize data collection:

- **Strategy 1: Investigating Unexpected Discoveries**
  When teams discover significant aquaculture activity or potential sites not identified during planning, they may make informed decisions to investigate. Example: Team discovers large unlisted farm cluster and decides to skip planned P2 site to survey new cluster thoroughly.

- **Strategy 2: Reaching Data Saturation**
  When sufficient repetitive data has been collected from similar sites, teams may reduce sample sizes for additional similar sites. Example: After surveying 12 similar trout farms and finding consistent patterns, team conducts shorter assessments of additional similar farms.

- **Strategy 3: Following the Value Chain**

Teams may pursue important unplanned locations identified through data collection. Example: Wholesaler mentions significant unlisted landing site; team dispatches sub-team to verify and map while main team continues with planned schedule.

- **Strategy 4: Flexible Time Allocation**
  Teams may reallocate time between activities based on data richness and respondent availability. Example: If hatchery manager provides exceptionally detailed information, team extends KII and reduces number of planned farm surveys at that location.
  All adaptive sampling decisions must be documented with clear rationale and communicated during daily check-ins.

4.6 Communication Protocols

4.6.1 Daily Check-In Requirements

Team leaders must conduct daily check-ins with project coordination (by phone or messaging app) to:

1. **Report Progress:** Sites visited during the day, priority levels of sites visited, number of surveys/KIIs/FGDs completed, any quality concerns or issues encountered

2. **Discuss Deviations:** Any deviations from planned schedule with rationale, adaptive sampling decisions made, contingency actions taken

3. **Review Next Day Plan:** Confirm next day's planned sites and priority levels (P1, P2, P3), discuss any anticipated challenges, confirm logistics and support needs

4. **Data Transmission:** Transmit collected data to central database, report on data quality checks conducted

4.6.2 Immediate Communication Triggers

The following situations require immediate communication with project coordination, without waiting for daily check-in:

- **Security concerns or threats** to team safety

- **Inaccessibility of P1 sites** that cannot be resolved through alternative routes

- **Equipment failure** that prevents data collection (GPS, water quality kits, mobile devices)

- **Major unexpected discoveries** that may significantly alter understanding of aquaculture potential

- **Serious data quality issues** that require guidance

4.6.3 Weekly Coordination Meetings

All three team leaders participate in weekly coordination meetings (by conference call if in field) to:

- Share experiences and lessons learned across teams
- Discuss common challenges and solutions
- Coordinate on cross-cutting issues (e.g., hatchery seed distribution networks)
- Review overall progress against study objectives
- Make any necessary adjustments to remaining schedules

4.6.4 Implementation Guidelines

4.6.4.1 For Team Leaders

Pre-Deployment:

- Review zone-specific site selection matrix thoroughly
- Ensure all team members understand the priority system and its rationale
- Prepare contingency plans for high-risk scenarios (weather, access, security)
- Familiarize team with all sites, especially P1 locations

Daily Planning:

- Start each day by confirming P1 targets and key objectives
- Identify potential time savings from P2/P3 sites if needed
- Brief team on priority levels and expected activities at each site
- Check equipment and supplies

Decision Making:

- Use The Golden Rule when facing time constraints or challenges
- Prioritize data quality over quantity
- Document all deviations with clear rationale
- Empower team members to contribute to adaptive decisions

Documentation:

- Record all deviations from planned schedule with rationale
- Document adaptive sampling decisions
- Maintain daily field notes on observations and insights
- Ensure all data are entered and backed up daily

4.6.4.2 For Project Coordination

Monitoring:

- Track daily progress against P1 targets across all teams
- Monitor data transmission and quality
- Identify teams facing challenges and provide support
- Maintain overall picture of study progress

Support:

- Provide guidance when teams face challenges accessing P1 sites
- Facilitate resolution of logistical issues
- Coordinate with government agencies when official support is needed
- Ensure teams have necessary resources and equipment

Flexibility:

- Allow teams to adapt schedules based on field realities
- Focus on protecting core objectives rather than rigid adherence to plans
- Support teams' adaptive sampling decisions when well-justified
- Be prepared to reallocate resources between teams if needed

Quality Assurance:

- Ensure thorough coverage of P1 sites takes precedence over comprehensive site coverage
- Conduct spot checks and validation of data quality
- Provide feedback to teams on data quality and completeness
- Ensure consistency in data collection across teams

5. The commercialization strategy protocol

This strategy development is intrinsically multidisciplinary, necessitating the seamless integration of detailed economic and financial analysis, spatial feasibility from GIS, and environmental sustainability assessments. The sequential protocol involves executing a comprehensive Needs Assessment to identify infrastructure gaps, followed by specifying potential aquaculture products and services, and conducting a detailed market analysis and value chain assessment. Utilizing financial projections, the next critical steps include designing scalable Business Models and defining revenue streams tailored for individual farmers, cooperatives, and Public-Private Partnership (PPP) interventions, which are simultaneously identified and examined for their potential. The culmination of the analysis is a comprehensive SWOT analysis of influencing factors for the commercial strategy, the rationalization of these findings, and the subsequent

drafting of the comprehensive commercialization strategy section for the consolidated study report. Ultimately, this protocol guides the prioritization of high-return investments and the design of policy recommendations that are spatially optimized, financially attractive, and environmentally sound.

6. Team Composition and Responsibilities

The overall study team is multidisciplinary, ensuring comprehensive expertise:

- **Team Leader: Aquaculture and Fisheries Expert**: Overall project management, methodology finalization, stakeholder engagement, quality assurance, team coordination, and report finalization.

- **GIS Specialist**: GIS protocol development, spatial data management, thematic map generation, GIS tool training, spatial analysis, and ground-truthing support.

- **Aquaculture Economist**: Economic feasibility assessment, market analysis, value chain assessment, business model development, financial projections, and economic SWOT analysis.

- **Market Research Specialist**: Market data collection, consumer behavior analysis, market access strategies, competitive analysis, value chain mapping, and commercialization strategy input.

- **Environmental Monitoring Specialist**: Environmental impact assessment, water quality monitoring, ecological suitability assessment, environmental data analysis, sustainable practices integration, and compliance.

- **Study Coordinator**: Logistical support, financial management, documentation management, communication facilitation, procurement, and reporting support.

- **Survey Enumerators (9 persons)**: Field data collection, adherence to protocols, accurate data recording, and interaction with local communities.

7. Data Collection Tools and Instruments

The study will utilize a comprehensive array of standardized tools and instruments to ensure the systematic and accurate collection of all necessary data for both the mapping of high-potential zones and the development of a cluster-based commercialization strategy. This approach is critical for maintaining data quality, consistency, and reliability across all field teams and phases of the study. Here is a list of the data collection tools and instruments:

a) **Survey Forms:** These are detailed, standardized forms designed to capture comprehensive information across various domains (Annexure-1). They are crucial for obtaining both quantitative and qualitative data. The specific forms include:

- **Site Identification and General Information:** Used to gather basic identification details for each surveyed site, including unique Site IDs, date of survey, team leader, accurate GPS coordinates (Latitude, Longitude, and Altitude), district, tehsil/sub-district, village/locality, water body type, current land use, and accessibility. It also includes sections for photographic evidence and general field notes.

- **Water Quality and Availability Assessment**: This form is vital for assessing the suitability of water sources for different aquaculture species. It captures on-site measurements of water temperature, pH level, dissolved oxygen (DO), conductivity, and turbidity. It also includes fields for Ammonia and Nitrate (if test kits are available), estimated water flow rates, seasonal water availability, dry months, water source reliability, and descriptions of potential water constraints like pollution or drought.

- **Infrastructure and Services Assessment**: Used to identify existing infrastructure and assess the availability of essential services in or near potential aquaculture sites. This includes road access, electricity availability, proximity to markets, feed suppliers, and hatcheries. It also assesses existing aquaculture activity, availability of extension services, technical capacity of local farmers, and the general security situation.

- **Socio-Economic and Community Insights**: This form gathers qualitative data from local communities and farmers to inform the commercialization strategy. It covers interviewee type, openness to aquaculture, perceived benefits and barriers, historical water use, preferred species for farming, interest in value addition and collective action/cooperatives, and specific notes on market and financial access challenges.

b) **Observation Forms:** These are specific forms designed for detailed on-site observations, complementing the quantitative data collected in other sections. The Observation Form for Water Flow, Seasonal Availability, and Potential Constraints is particularly important. It records observed water flow rates (High, Medium, Low, Stagnant), evidence of seasonal

fluctuation (e.g., dry riverbed marks), descriptions of water color and odor, presence of aquatic vegetation and life, and evidence/description of pollution. It also includes fields for documenting any other observed physical constraints and attaching photographs specific to water conditions.

c) **GIS Handsets / GPS Devices:** These are essential for spatial mapping and accurate GPS data collection, ensuring precise site identification by recording latitude, longitude, and altitude. They are used by field teams for ground-truthing and by the GIS Specialist for expert-level spatial data collection and verifying maps (Annexure-4).

d) **Chemical Kits / Water Quality Testing Kits**: For on-spot water quality testing of critical parameters such as temperature, pH, dissolved oxygen (DO), conductivity, hardness and turbidity. Enumerators are trained to use these calibrated kits meticulously, and the Environmental Monitoring Specialist oversees the testing. The plan acknowledges that ammonia and nitrate testing depends on kit availability, and laboratory analysis may be required where necessary (Annexure-5).

e) **Tablets/Cell Phones:** For digital data capture using pre-programmed survey forms with GPS integration and offline capabilities. These devices allow enumerators to record primary quantitative and qualitative data directly, minimizing entry errors through built-in validation rules and facilitating real-time data synchronization to a central server once connectivity is available.

f) **Cameras:** For photographic documentation of sites, water bodies, infrastructure, and aquaculture activities. It is recommended that photos be GPS-tagged to link them directly to the surveyed locations.

g) **Structured Interview Guides:** These detailed questions are designed for the Aquaculture Economist, Market Research Specialist, and Environmental Monitoring Specialist to gather specialized information from key informants.
    - The Aquaculture Economist uses KIIs to collect in-depth economic and market insights from large-scale farmers, hatchery owners, major traders, and financial institutions.
    - The Market Research Specialist conducts interviews with consumers, traders, wholesalers, and retailers to understand preferences, purchasing habits, supply chain dynamics, and market challenges.
    - The Environmental Monitoring Specialist conducts interviews with local communities, farmers, and authorities to gather insights on historical environmental changes, water use conflicts, and pollution concerns.

h) **Field Notebooks & Pens:** For manual note-taking and observations during fieldwork, and as a backup for digital data collection in areas where digital tools may not be feasible.

i) **Logistical Support (Vehicles):** Robust 4x4 vehicles with experienced local drivers are crucial for accessing remote sites, minimizing logistical failures, and ensuring the safety and mobility of field teams. Regular maintenance of these vehicles is a key mitigation strategy for operational risks.

j) **Field Attire:** Specific field attire, including a cap, vest, gloves and appropriate footwear for team identification and enhanced visibility during fieldwork including.

8. Data Collection and Management

Effective data management is deemed paramount for the success, integrity, security, and long-term accessibility of the study's data, covering the entire lifecycle from collection to archiving. The goal is to establish a data ecosystem that supports informed decision-making, transparency, and promotes further research and investment.

8.1 Data Types and Integration

The study collects diverse data types from multidisciplinary teams (Aquaculture Economist, GIS Specialist, Environmental Monitoring Specialist):

- **Quantitative Field Data:** Includes water quality parameters (temperature, pH, DO, conductivity, hardness and turbidity), GPS coordinates, altitude, distances, and numerical infrastructure assessments (Annexure-1).

- **Qualitative Field Data:** Comprises interview transcripts, field observations, focus group discussion notes, and anecdotal socio-economic information (Annexure-2).

- **Geospatial Data (GIS):** Consists of shapefiles, raster data (DEMs, satellite imagery), and thematic maps.

- **Photographic Evidence:** GPS-tagged images of sites, water bodies, and infrastructure.

The integration of these findings is critical for a holistic strategy. Geographic Information Systems (GIS) software (e.g., QGIS or ArcGIS) serves as the core platform for spatially integrating data, allowing for multi-criteria overlay and scoring based on spatial feasibility, economic viability, and environmental suitability.

8.2 Technology Stack and Workflow

The recommended technology stack is robust and prioritizes open-source tools:

Function	Primary Technology	Rationale and Components
Data Collection	**Survey123** (Mobile Data Collection Application - MDCA)	Open-source tool providing robust offline capability, excellent GPS integration, multimedia support (photos, audio), and flexible form design. Dedicated GPS devices are supplemental for critical control points requiring higher positional accuracy.
Data Processing/ Analysis	**QGIS**	QGIS, paired with PostgreSQL/PostGIS (for database management), handles spatial data processing, analysis, and suitability modeling.
Storage/Security	**PostgreSQL Database**	Centralized, structured database managed on a secure, password-protected server with regular automated cloud backups.
Dissemination	Interactive Web Maps / **Open Data Portals**	Findings are visualized via interactive maps and dashboards, and non-sensitive data is published on open data portals (e.g., CKAN/Dataverse) to promote transparency and reproducibility.

8.3 Storage, Security, and Archiving

Data security and preservation protocols are mandatory:

- **Access Control:** Access to active data is granted on a need-to-know basis, with different permission levels (e.g., read-only for enumerators).
- **Confidentiality:** Personal identifiable information (PII) must be anonymized or pseudonymized where appropriate, adhering strictly to ethical guidelines and privacy regulations.
- **Archiving:** Upon completion, all final datasets, reports, and documentation will be archived in stable, long-term repositories. Data must be archived in open, non-proprietary formats (e.g., CSV, GeoTIFF, PDF/A) and accompanied by comprehensive metadata to ensure future usability.

8.4 Data Quality Assurance (QA/QC)

A multi-layered approach to data quality assurance will be implemented to ensure the accuracy, consistency, and reliability of collected information, particularly for socio-economic and technical aquaculture data.

8.4.1 Advanced Data Validation and Cross-Verification

a) **Real-time Validation (MDCA):** The Mobile Data Collection Application (MDCA) will incorporate built-in validation rules, skip logic, and range checks to prevent erroneous entries at the point of collection. Enumerators will receive immediate feedback on inconsistencies.

b) **Daily Field-Level Review:** Team Leaders will conduct daily reviews of submitted data from their respective teams. This includes:
   - Completeness Check: Ensuring all mandatory fields are filled.
   - Consistency Check: Cross-referencing related data points within a single questionnaire (e.g., fish production figures against farm size, feed cost against feed type).
   - Plausibility Check: Identifying outliers or values that seem improbable based on local context and expert knowledge.
   - Spot Checks: Randomly re-interviewing a small percentage of respondents or re-measuring key parameters (e.g., pond dimensions, water quality) to verify enumerator accuracy.

c) **Central Office Data Cleaning and Verification:** A dedicated data management team at the central office will perform more rigorous checks, including:
   - Logical Consistency Checks: Running algorithms to identify complex inconsistencies across multiple variables or questionnaires.
   - Spatial Validation: Using GIS tools to verify the accuracy of GPS coordinates and ensure survey points fall within expected geographical boundaries.
   - Expert Review: Technical experts (e.g., aquaculture specialists, economists) will review a sample of data to identify any systematic biases or misinterpretations.

d) **Cross-Validation with Secondary Sources:** Where feasible, key socio-economic data (e.g., average household income, common crop yields) will be cross-referenced with available secondary data from government statistics or previous studies to ensure overall data coherence.

8.4.2 Qualitative Data Quality Assurance

For qualitative data collected through Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs), the following quality assurance measures will be applied:

a) **Detailed Transcription and Summarization:** All KIIs and FGDs will be accurately transcribed or thoroughly summarized immediately after the session.

b) **Facilitator Debriefing:** Team Leaders will conduct daily debriefing sessions with enumerators/facilitators to discuss key themes, clarify ambiguities, and ensure consistent interpretation of qualitative responses.

c) **Analyst Triangulation:** Multiple analysts will be involved in the coding and thematic analysis of qualitative data to enhance reliability and reduce individual bias. Discrepancies will be resolved through discussion and consensus.

d) Member Checking (Selective): Where appropriate and feasible, key findings or interpretations from qualitative data will be shared with a subset of interviewees or FGD participants to validate accuracy and ensure their perspectives are correctly represented.

9. Safety and Ethical Considerations

9.1 Safety Protocols

a) Ethical Data Collection and Privacy

The study emphasizes comprehensive training for enumerators on ethical guidelines and protocols:

- **Informed Consent and Voluntary Participation** Enumerators must obtain informed consent from all participants before starting an interview. This process includes assuring respondents that their participation is entirely voluntary and that they can withdraw at any time without penalty.

- **Confidentiality and Privacy** Strict confidentiality must be maintained. Respondents must be assured that all information provided will be kept confidential and used exclusively for the purposes of the study, with no personal identifying information (PII) shared without explicit consent. Interviews should be conducted in a private setting where respondents feel comfortable to speak freely.

- **Do No Harm Principle** Ethical guidelines mandate that the survey process must not cause any harm, discomfort, or risk to the respondents or the community.

- **Transparency and Respect** Interviewers must introduce themselves, explain the purpose of the study, and detail how the collected data will be used, including the potential benefits for the community. They must maintain a polite, neutral, and professional demeanor, respecting local customs and traditions.

- **Accountability** Organizations and individuals are held responsible for adhering to ethical data practices.

b) Field Safety and Personnel Security

Safety and security protocols are essential, especially given the remote nature of fieldwork in Khyber Pakhtunkhwa:

- **Risk Management** The project utilizes a Study-Level Risk Management Plan to address potential operational, logistical, and external security risks. Risks related to security concerns in field areas are mitigated through thorough security assessments, close liaison with local law enforcement, security briefings, and avoiding confirmed high-risk zones.

- **General Safety** All team members must prioritize personal safety, remain aware of their surroundings, and respect local customs.
- **Logistics and Communication** Field teams must adhere to a buddy system and maintain regular communication with the base office. Daily check-in and check-out procedures must be strictly followed.

- **Emergency Response** All team members must carry an Emergency Contact List. In the event of serious injury or illness, the team lead coordinates immediate **medical evacuation**.

- **Hostile Encounters** In the unlikely event of a hostile encounter, staff are instructed to remain calm, comply with instructions, and report the incident as soon as safe.

c) Chemical and Equipment Safety

Specific safety measures relate to the handling and maintenance of the water quality testing equipment:

- **Handling Chemicals** Enumerators are trained on learning basic safety precautions when handling chemicals or equipment. Personal Protective Equipment (PPE), such as gloves must be used when performing water quality tests.

- **Ventilation and Disposal** Testing must be carried out in well-ventilated areas to avoid inhaling fumes. Reagents must be stored properly and expired chemicals must be disposed of according to local hazardous waste regulations to prevent environmental contamination and safety hazards.

- **Equipment Care** Enumerators are trained on the basic maintenance and care for the water quality kit, including cleaning and proper storage of components and probes.

9.2 Community Engagement and Free, Prior, and Informed Consent (FPIC)

Effective and ethical community engagement is paramount for the success and legitimacy of the survey. This section details the protocols for engaging with communities and ensuring Free, Prior, and Informed Consent (FPIC) from all participants.

a) **Pre-Survey Community Entry and Sensitization:**
   - Local Authority Liaison: Before entering any community, the field teams will formally inform and seek permission from local authorities (e.g., Village Councils, local administration, community elders).
   - Community Meetings: Conduct initial community meetings to introduce the project, explain its objectives, scope, and potential benefits. Clearly communicate the purpose of the survey, the types of data to be collected, and how the data will be used.
   - Information Dissemination: Distribute project information materials (e.g., brochures, flyers in local languages) that clearly explain the survey and contact details for queries or grievances.

b) **Free, Prior, and Informed Consent (FPIC):**
   - Voluntary Participation: Emphasize that participation in the survey is entirely voluntary, and individuals have the right to refuse participation or withdraw at any point without any negative consequences.
   - Prior Information: Before commencing any interview or data collection, enumerators will clearly explain:
     - The purpose of the interview/data collection.
     - The estimated duration of the interview.
     - The types of questions to be asked.
     - How the collected data will be used and who will have access to it.
     - The anonymity and confidentiality of their responses.
     - Their right to refuse to answer any question or to terminate the interview at any time.
   - Informed Decision: Ensure that respondents fully understand the information provided before giving their consent. Use simple, clear language and allow ample opportunity for questions.
   - Consent Documentation: Obtain verbal consent from all participants, which will be recorded by the enumerator. For sensitive interviews or specific data collection, written consent may be sought where appropriate and culturally acceptable.

c) **Gender Sensitivity:** Ensure gender-sensitive approaches are applied throughout data collection, respecting cultural norms while promoting equitable participation and representation of all genders.

d) **Respect for Local Customs and Culture:** Enumerators will be trained to be culturally sensitive, respect local customs, traditions, and norms, and conduct themselves in a manner that builds trust and rapport with communities.

e) **Feedback to Communities:** Where possible and appropriate, share aggregated findings or relevant insights from the survey with the communities that participated, demonstrating the value of their contribution.

9.3 Grievance Redressal Mechanism (GRM)

To ensure accountability, transparency, and address any concerns or complaints arising during the field survey, a formal Grievance Redressal Mechanism (GRM) will be established. This mechanism will be accessible to all stakeholders, including survey respondents, community members, and enumerators.

a) **Principles:** The GRM will operate on principles of accessibility, fairness, transparency, impartiality, and timeliness.

b) **Channels for Lodging Grievances:**
   - **Direct to Team Leader:** Respondents or community members can verbally or in writing submit grievances to the field team leader.
   - **Dedicated Hotline/Email:** A dedicated phone number and email address will be established and communicated to communities for lodging complaints directly to the central project management unit.

c) **Process for Handling Grievances:**
   - **Receipt and Registration:** All grievances will be formally registered in a central log, noting the date, nature of the complaint, and complainant details (if provided).
   - **Acknowledgement:** Complainants will receive an acknowledgement of their grievance within 48 hours.
   - **Investigation:** The project management unit will investigate the grievance, gather necessary information and consult relevant parties.
   - **Resolution:** A resolution will be proposed within a specified timeframe (e.g., 7-14 working days), and communicated to the complainant.
   - **Appeal:** If the complainant is not satisfied with the resolution, an appeal can be made to a higher authority (e.g., FDB Senior Management for the FAO Country Office).

d) **Types of Grievances Covered:** The GRM will address grievances related to:
   - Enumerator conduct (e.g., disrespect, inappropriate behavior).
   - Data collection practices (e.g., privacy concerns, coercion).
   - Misinformation or misrepresentation by survey teams.
   - Any other concerns related to the survey activities.

e) **Confidentiality:** All grievances will be handled with utmost confidentiality, protecting the identity of complainants if requested.

f) **Reporting:** A summary of grievances received and their resolutions will be included in project progress reports.

10. Training

The training plan for this study is a comprehensive strategy designed to equip field enumerators with the necessary proficiency in specialized technology tools required for accurate and reliable data collection for the aquaculture study in Khyber Pakhtunkhwa (KP).

Overall Goal and Duration: The overall training goal is to ensure all field enumerators are proficient in using designated technology tools, thereby contributing to the high quality of the aquaculture study. The example schedule outlines a total duration of three days, which is adjustable based on the enumerator's prior experience.

10.1 Core Training Components (Technology Focus):

The training is structured around three main technological components and their associated data collection forms:

1. Mobile Data Collection Application (MDCA): Enumerators learn to navigate the MDCA interface and accurately fill out comprehensive digital survey forms, including those for:
   - Aquaculture Economic Data Collection (Farm Profile, Production Data, Cost Data, Revenue Data).
   - Environmental Monitoring (Site Identification, Water Quality On-Site, Ecological Observations).
   - GIS Component of Aquaculture Study (Spatial Data Collection, Infrastructure Mapping).
   - Training also covers utilizing multimedia features (photos, audio), managing data in offline mode, and synchronizing data.

2. Dedicated GPS Devices: Training ensures enumerators can operate the devices for accurate location data capture, mark waypoints, record tracks for survey sites and key features, and transfer GPS data for integration.

3. Water Quality Kits: Enumerators learn to properly calibrate and use the portable kits to measure key parameters (e.g., temperature, pH, dissolved oxygen), understand the significance of each parameter for aquaculture, and accurately record readings in the MDCA.

10.2 Methodology and Assessment:

The training employs a blended, interactive approach, placing emphasis on practical exercises and hands-on sessions to reinforce understanding and build confidence. Methods include demonstrations, group activities, role-playing (simulating interview scenarios), and a final integrated field simulation or pilot.

Assessment includes a practical proficiency test (hands-on evaluation of tool usage), data quality checks on collected practice data, and a knowledge quiz. Certification is awarded to enumerators who successfully pass all assessments, requiring, for example, a minimum of 80% accuracy on practical tests and a 70% passing score on the written quiz. The training also includes content on data quality and ethical considerations, such as informed consent, confidentiality, and identifying and resolving common data entry errors.

11. Field Survey Plan

11.1 Workplan and Timeline for Overall Survey Activities

The overall project timeline spans from September 2025 to April 2026. The overall timeline for the project execution is as under:

Outputs	**Output/activity**	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Output 1 – High Potential Zones (HPZs) for cold (Trout), semi-cold and warm-water aquaculture mapped and introduced	Literature review and work plan preparation	X							
	Preparation of Field Survey Protocol / Plan, including field teams' movement plan	X							
	Selection / hiring of field team	X							
	Training of a survey team on a plan and approach	X							
	Conduct Field Survey		X	X					
	Data entry and cleaning		X	X					
	Preparation and submission of Brief Field Activity Report, including annexes			X					

	of all sites' observation forms or datasheets								
	Preparation and submission of field survey report and list of suitable sites				X				
Commercialization strategy for cluster-based farming in Khyber Pakhtunkhwa developed and introduced	Needs Assessment exercise		X	X					
	Identify potential aquaculture products and services			X	X				
	Conduct HPZs specific market analysis and value chain assessment			X	X				
	Identify and examine potential HPZs for public private partnership (PPP)			X	X				
	Design Business Model			X	X				
	SWOT analysis of influencing factors for commercial strategy				X				

11.2 Tentative Survey Schedule

The tentative field visit schedule for three teams conducting the aquaculture zoning and commercialization study in Khyber Pakhtunkhwa is given below.

11.2.1 Operational Plan for Movement of Team A in Cold Water Areas

Tentative Schedule at Appendix-1

11.2.2 Operational Plan for Movement of Team B in Semi Cold / Cold Areas

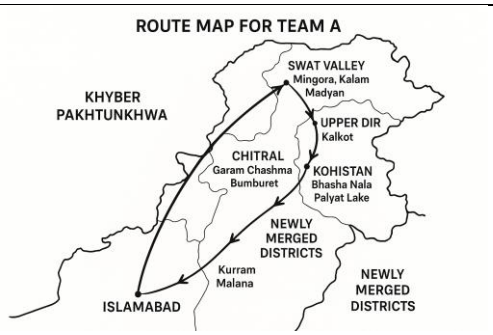
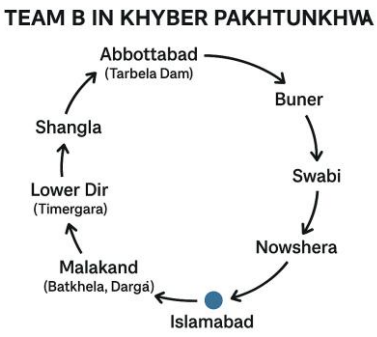
Tentative Schedule at Appendix-2

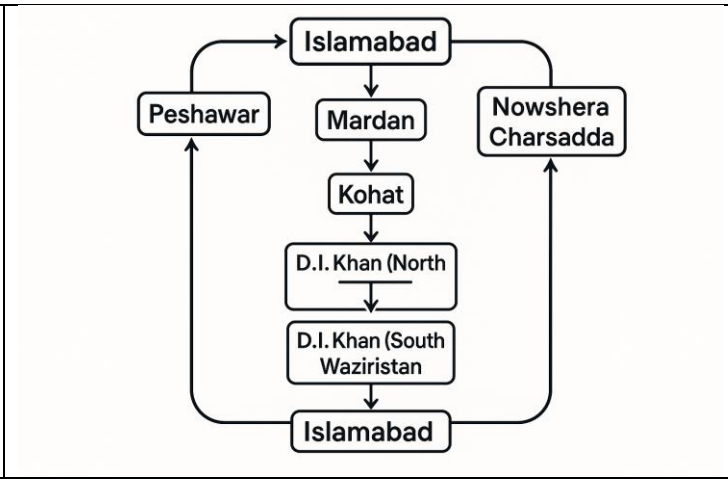
11.2.3 Operational Plan for Movement of Team C in Warm Water Areas

Tentative Schedule at Appendix-3

11.2.4 Survey Team Route Maps

The diagrammatic route maps below illustrate the travel plans for three teams, designed to ensure geographical proximity and maximize travel efficiency for each team.

Route Map for Team A:	
Route Map for Team B:	
Route Map for Team C:	


Islamabad
Peshawar
Mardan
Nowshera
Charsadda
Kohat
D.I. Khan (North
D.I. Khan (South
Waziristan
Islamabad

12. Enumerator Monitoring and Quality Control Plan

12.1 Introduction

Effective monitoring of field enumerators is paramount to ensuring the quality, accuracy, and integrity of data collected during the aquaculture survey. This section outlines a comprehensive plan for monitoring enumerator performance, adherence to protocols, and data quality, involving both FDB and FAO-Fisheries Department teams. The objective is to provide continuous oversight, timely feedback, and corrective measures to maintain high standards throughout the fieldwork phase.

12.2 Roles and Responsibilities for Monitoring

a) **Field Team Leader:** Responsible for daily supervision, direct observation, field-level data validation, and providing immediate feedback and technical support to enumerators.

b) **FDB Study Coordinator:** Responsible for overall coordination, remote data monitoring via the MDCA dashboard, central data cleaning, and managing the GRM.

c) **FDB-FAO-Fisheries Department Joint Monitoring Team**: Responsible for conducting periodic, independent oversight visits, data quality audits, and providing recommendations to FDB and FAO management.

12.3 Enumerator Monitoring Plan

a) **Daily Monitoring:**
   - Morning Briefings & Evening Debriefings: Conducted by Team Leaders to plan, review progress, and address issues.
   - Direct Observation & Spot Checks: Team Leaders will directly observe each enumerator weekly and conduct random re-interviews to verify data.

b) **Weekly Monitoring:**
   - Data Quality Reports: Generated by the FDB PMU to identify trends and issues.
   - Coordination Meetings: Virtual meetings between the FDB PMU and Team Leaders to discuss progress and challenges.

c) **Ad-Hoc Joint Monitoring Visits:**
   - The FDB-FAO-Fisheries Department team will conduct field visits to selected sites to perform independent audits and provide oversight.

12.4 Monitoring Tools

a) MDCA Dashboard

b) Enumerator Performance Log
c) Data Quality Checklists
d) Re-interview Forms
e) Monitoring Visit Report Template

12.5 Corrective Actions and Feedback Loop

A clear process for providing immediate feedback, targeted retraining, and performance reviews will be implemented. Findings from monitoring will inform adaptive management of the survey process.

13. Expected Outcomes of the Study

The study is structured around two main deliverables:

13.1 Output 1: High Potential Zones (HPZs) Mapped

This output focuses on defining the physical and environmental potential for aquaculture across the province. The key deliverables include:

- **HPZ Maps:** The production of **accurate and detailed GIS maps** delineating suitable zones for cold-water (Trout), semi-cold, and warm-water aquaculture across KP, leading to a consolidated map of identified sites.

- **HPZ Identification and Refinement:** Identification of HPZs that are optimized by integrating economic viability, spatial suitability, and environmental sustainability. This moves beyond simple site selection to a comprehensive spatial planning approach.

- **Survey Reports and Database:** A comprehensive Survey Report documenting field findings, water quality results, infrastructure assessments, and socio-economic insights. The final product will include a well-organized and validated GIS database tailored for aquaculture planning.

13.2 Output 2: Commercialization Strategy for Cluster-Based Farming

This output delivers the strategic and financial blueprint required to transform the identified HPZs into thriving aquaculture clusters. Key deliverables and analytical outputs include:

- **Integrated Commercial Strategy:** A holistic commercialization strategy document that promotes economic growth while safeguarding natural resources and ensuring social equity.

- **Business Models and Feasibility:** Detailed Economic and Financial Feasibility Assessments leading to the design of scalable and sustainable Business Model Blueprints. These models will be tailored for different scales of operation, including individual smallholders, cooperatives, and Public-Private Partnership (PPP) ventures.

- **Investment and Finance: Identified Investment Opportunities** accompanied by robust financial projections and a comprehensive Risk Assessment Report with mitigation strategies. The financial analysis, including Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period analysis, translates into strategies for investment prioritization and tailored financing solutions.

- **Market and Value Chain Analysis:** A comprehensive analysis of market opportunities, constraints, consumer preferences, purchasing habits, and value chain dynamics. This includes the creation of a Market Linkage Development Plan and a detailed Branding and Marketing Strategy for KP products.

- **Policy and Sustainability Recommendations:** Actionable policy recommendations for government and investors concerning economic incentives, financial mechanisms, and regulatory reforms. This includes recommendations for sustainable aquaculture practices, compliance reviews, and environmental risk mitigation.

13.3 Overarching Outcomes of Data Integration

The core success of the project relies on the successful integration of economic, GIS, and environmental data, which is expected to yield the following strategic results for Khyber Pakhtunkhwa:

- **De-risked Investments:** A clearer understanding of the combined economic, spatial, and environmental risks, leading to more informed investment decisions and effective mitigation strategies.

- **Efficient Resource Allocation:** Targeted allocation of public and private resources to the most suitable areas and aquaculture models.

- **Enhanced Policy Coherence:** Policy recommendations that are well-informed by the comprehensive understanding of interdependencies among economic, spatial, and environmental factors.

- **Improved Livelihoods:** Enhanced environmental sustainability, economic diversification, and better market access contribute directly to increased incomes and improved livelihoods for fish farmers.

Appendix

Appendix-1

Field Survey for Mapping of Aquaculture High Potential Zones in KPK

Movement Plan of Team-A – for Cold Water Zone

Led by Dr. Khalid Mahmood (Cell: 0300 2059137)

****

District	Date	Day	Activity	Stay
Swat	13-Oct	Monday	MINGORA AREA: Mingora and Beshband area	Mingora
	14-Oct	Tuesday	MINGORA TO MALAMJABA: Whole Malamjaba area	Mingora
	15-Oct	Wednesday	SWAT TO SOLATAN: Solathan and lalko area	Matta
	16-Oct	Thursday	MATTA TO MADYAN: Whole Madyan area	Madyan
	17-Oct	Friday	MINGORA TO MIANDAM & BAHRAIN: Miandam and Bahrain area	Miandam
	18-Oct	Saturday	MINGORA TO KALAM: Kalam area	Madyan
	19-Oct	Sunday	MADYAN TO UTRORH AND MAHODAND: Utrorh, Mankiyal, Mahodand area	Madyan
Shangla	20-Oct	Monday	SWAT TO SHANGLA: Alpuri, Lelonai and Shahpur area	Shangla
Buner	21-Oct	Tuesday	SHANGLA TO BUNER: Swarhi, Daggar, River Burandu	Malakand
Malakand	22-Oct	Wednesday	MALAKAND AREA: Thana and Batkhela	Timergara
Dir Lower	23-Oct	Thursday	DIR LOWER: Timergara area, Konahi stream	Timergara
Upper and Central Dir	24-Oct	Friday	DIR LOWER TO DIR UPPER: Usheeri Area (Gorkohi), Fish Farms constructed under 50:50 Scheme, other Potential sites and Usheeri stream	Dir City
	25-Oct	Saturday	DIR CITY TO KALKOT: Shiringal, Patrak area, Kalkot, Govt. Trout Hatchery Kalkot, Surrounding fish farms, Beyar Kohistan	Kalkot
	26-Oct	Sunday	KALKOT TO KUMRAT: Thall Kalan, Kumrat valley various fish farms, Kumrat stream, Malo area, Kumrat Kohistan,	Dir City
	27-Oct	Monday	DIR CITY TO KEERDARA, GWALDAI: Keerdara valley, Gwaldai valley, river Panjkora	Dir City

LOWER CHITRAL	28-Oct	Tuesday	DIR TO CHITRAL TOWN: Shishikoh area, Govt. Trout Hatchery Jaghoor, Private Fish Farms in the premises, Jaghoor stream	Chitral Town
	29-Oct	Wednesday	CHITRAL TO BOMBORAITE: Bomboraite area, Bomboraite Fish Farms, Bomboraite stream, Ayun fish Farm	Chitral Town
	30-Oct	Thursday	CHITRAL TO GARAMCHASHMA: Mogh area, Mizigram, Garamchashma area, Parabag, Private Fish Farms, Garamchashma River	Chitral Town
UPPER CHITRAL	31-Oct	Friday	CHITRAL TO LASPUR: Golein Valley, Golein Stream, Private Farms, Mustuj, Chinar, Toq	Laspur Valley
	1-Nov	Saturday	LASPUR TO BOONI: Sor Laspur, Phargram, Harchin, Sarghoz, Sonoghur	Booni
	2-Nov	Sunday	BOONI TO ISLAMABAD	

Optional visit or Exclusion on the basis on low potential:

Kolai Palas,	Kolai Palas is a newly formed district with limited infrastructure and economic development. Currently, there are no established fish farms, hatcheries, or dedicated fish markets in Kolai Palas.
Torghar district	while having limited existing aquaculture infrastructure, possesses significant potential for the development of cold-water trout farming.

Appendix-2

Field Survey for Mapping of Aquaculture High Potential Zones in KPK

Movement Plan of Team-B – for Semi-Cold-Water Zone

Led by Ms Kanwal un-Nisa (Cell: +92 333 8422258)

****

	DATE	DAY	ACTIVITY	Stay
DISTRICT HARIPUR	13-10	Mon	ISLAMABAD TO HARIPUR Shah Maqsood Fish Farms, Police Chawki Water, Morhi, Changi Bandi, Mohra Kalanwan (Cluster) the to Bagra via Lora Chawk, Bagra, (Ghamawan), Kanyala (Water Ways), River Haro and Back	Haripur
	14-10	Tue	HARIPUR TO KHANPUR REGION Najafpur, Garam Thoon, Khanpur Dam, Noordi (via Mang), Rehana, Jhatti Pind via Bypass, Beer (Take Measurements of Tarbela Dam on the way), River Siran and Back	Haripur
DISTRICT ABBOTTABAD	15-10	Wed	HARIPUR TO ABBOTTABAD Towards Lora Jabri via Lora Chawk, Rajoyia, Malkan and Havelian Regions (Sikanadar, Ehsan Khan, Shah Jahan)	Abbottabad
	16-10	Thu	ABBOTTABAD AREA Abbottabad to Sherwan, Mangal and Shaheedabad (Aquaculture Sites), Visit to Fish Market Near Sabzi Mandi and Mandian (Jadoon Plaza) (Muzamil, Umar Ehsan Qureshi)	Galiyat
	17-10	Fri	EXPLORING GALIYAT REGION Namli Maira Aquaculture Sites and Fish Market Visit Barahotar and Thandiani Naveed Trout Fish Farm (Nadeem, Daim Hammad, Hamza)	Kaghan
DISTRICT MANSEHRA	18-10	Sat	KAGHAN VALLEY Kaghan Fish Farm, Khanian (Qasim Shah Fish Farm), Lahar Banda Hatchery & Fish Farm (Shudheer), Israr Fish Farm, Jared Stream (10 Fish Farms Cluster), Shino Trout Hatchery	Kaghan
	19-10	Sun	KAGHAN VALLEY Rafaqat Fish Farm, Faridabad Boonja Stream (High Potential 50+ Fish Farms), Paras, Jandar Bela, Kiwai (7 Fish Farms), Shakirullah Fish Farm, DHPP, Gharhi Habibullah River Kunhar Parameters	Balakot

	20-10	Mon	<u>MANSEHRA AND SIRAN</u> Balakot to Mansehra Amjad Salar Carp Fish Farms Ghandian, Ichrian Carp Unit, Siran, Jabori Trout Fish Farms, Sachan Trout Hatchery and Fish Farms, Battal Road (Cluster of Fish Farms- Naeem Khan Owner), Domail, Himalay Trout Fish Farm, Nawazabad Thana, Mundi, Daloli (high Potential), Mandagucha Fish Farm & Zach Stream (Potential Site) and Back	Mansehra
	21-10	Tue	Buffer/Rest Data Consolidation and Planning	Battagram
DISTRICT BATTAG	22-10	Wed	<u>BATTAGRAM AND ALLAI</u> Shamlai Darra, Allai Via Thakot, Allai Trout Hatchery Bann, Rashang Stream & Fish Farm, Thakot and Back to Besham	Besham
DISTRICT KOHISTAN	23-10	Thu	<u>LOWER AND UPPER KOHISTAN</u> Behsam to Sholgara (Semi Cold) Stream, Dobair Stream *(Dobair to Monjgali is 24 km and is divided into 3 streams Henai, Medan, Chansar but Not Accessable. We will Take Measurements of Dobair Stream only)*, Pattan, Chawadarra Zia Fish Farm, Kayal Stream*(18 km above is Semu Darra have high potential)*, Mandraza, Zaidkharh Stream, Dasu Stream, Goshali Stream (coming from Sapat Valley) Seo Siglu Stream *(coming from Raziqa)* Back	Pattan
	24-10	Fri	Pattan to Palas Valley, Shared, Kundal Stream (High Potential Zone can be hub of Fisheries) and Back	Mansehra
	25-10	Sat	Travel Day Mansehra to Peshawar	Peshawar
DISTRICT PESHAWAR	26-10	Sun	Malak Zaman Farms (Village Dalazak) Dawood Fish Farm (Village Haryana) Liaquat Fish Farms (Village Sherabad) Govt. Carp Hatchery & Training Center (Sherabad) Mursaleen Fish Farm (Village Sherabad) Bilal Farm (Village Garha) Asad Fish Farm (Shahi Bala)	Peshawar
DISTRICT CHARSADDA	27-10	Mon	Irfan Fish Farm (Tehsil Charsadda) Bahramand Fish Farm (Behramand Kaly) Nisatta Private Fish Farm (Nisatta Village) Private Farms (Gulbella Area) Abdul Karim Fish Farm (Village Shabara) Arshad Khan Fish Farm (Village Shabara)	Peshawar
	28-10	Tue	Fawad Fish Farm (Tehsil Charsadda) Azam Khan Fish Farm (Akhunzada Village) Kamran Aqua-Tach Fish Farms (Village Sherpao, Teh Tangi) Shahab Khan Fish Farm (Tarnab, Teh Charsadda)	Peshawar

DISTRICT MARDAN	29-10	Wed	<u>TAKHT BHAI</u> Zahid Khan Farm (Hady Kallay) Dr Hamza Abbas (Mian Essa) Sajjad Khan Farm (Hosai Sareek Abad) Kashif (Lund Khwar) Jahan Zeb (Peer Sado) Shahid Hosain (Omair Abad) <u>KATLANG</u> Irfan Ali Farm (Katti Garhi) Muhammad Bilal Farm (Village Katlang) Wazeer Fish Farm (Village Katlang)	Peshawar
	30-10	Thu	<u>TEHSIL RUSTAM</u> Amir Zeb Farm (Village Behroch) Zahid Ali Farms (Village Kamargai) Aslam Fish Farms (Village Char Gulai) Jamal Ashraf Farms (Village Baigan) Fareed Fish Farm (Village Bari Kab) Anwar Khan Farm (Village Chana) Zubair Farms (Village Rustam)	Peshawar
	31-10	Fri	Zairullah Khan Farm (Mervais Mian Khan) Khalid Rehman Farm (Barichum) Zahir Shah Farm (Toro Qasim) Jan Alam Farm (Toru) Namdir Farm (Charbanda) Government Carp Fish Hatchery (Charbanda) Afzal Farm (Shankar) Fazal Qadar MD Mulyan (Niher Chowk Phar Hoti) Fazal Qadar MD Mulyan (Singe marmar Swabi Rd) Shakeel Farm (Fatma)	Peshawar
DISTRICT SWABI	01-11	Sat	Awaited	Peshawar
DISTRICT NOWSHERA	02-11	Sun	Anjum Sohail Farms (Qasim Ali Baig) Murad Khan Farms (Qasim Ali Baig) Gul Khan (Pashtun Garhi) Muneeb Farms (Aman Kot Pabbi) Rashid Khan Farms (Momin Garhi) Ghulam Razzaq Farm (Momin Garhi) Abid Farms (Momin Garhi)	Peshawar
	03-11	Mon	Back to Islamabad	

Appendix-3

Field Survey for Mapping of Aquaculture High Potential Zones in KPK

Movement Plan of Team-C – for Warm Water Zone

Led by Mr. Muneer Hussain (Cell: +92 336 9824755)

****

District	Date	Day	Potential sites for visit and survey activity
Bajuar	27 -28 Oct	Monday, Tuesday	Gabar china(Spring) Cold water) Salarzai stream Tali dam Fish market Pashat Bazar
Mohmand	29-Oct	Wednesday	River Kabul River Munda at Mohmand DAM Jay rain-fed small Dam Aqrab Dag rain-fed small Dam Michni rain -fed small Dam Mohmand Carp Hatchery and Training Center Fish market Yakaghund Shabqadar
Khyber	30-31 Oct.	Thursday, Friday	Main Khyber area Bara River Kabul River Khyber is a newly merged district where aquaculture is in its early stages of development. The district has potential for both warm water (carp) and cold water (trout) aquaculture. The Kabul River and its tributaries offer opportunities for cage culture and trout farming in the higher altitude areas
Kohat	01-02 Nov.	Saturday, Sunday	Tanda dam Darwazia dam Darmalak dam Gandyali dam Kandar dam Zameer Gul dam Auxiliary kandar dam Chanda Fatheh Khan dam River khushal Ghar Toi Banda river Dhoda area river Tanda Hatchery Kohat

			Fish market in the city near Old Lari Adah
Orakzai	03-04 Nov.	Monday, Tuesday	Sepai Stream Godar Stream Feroz Khel Stream Kalaya Stream Mishti mela Stream Sheikhan Stream Shaho Stream Saifal Dara Stream Feroz Khel Kalaya Utman Khel Siad Khalil Bazar Anjani And Khel
Hangu	5 Nov.	Wednesday	Naryab dam Kurram River Kohat Toi Jawzara Spring Khanki Toi Hangu Toi
Kuram	6 Nov.	Thursday	Saat China. Shah Kamal Hamza China River Kurram River Khurmana Shalozan Stream Pawar Stream Zeran Stream Malana Stream Karman Stream Kot Ragha Small Dam Govt Trout Fish Hatchery – Parachinar Rearing & Trout Demonstration Center – Parachinar
Karak	7-8 Nov	Friday, Saturday,	Shirki Dam Mardan Khel Dam Ghol Dam Latamber Dam Changhoz Dam Zebi Dam Karak Dam Karak Zeri Dam Local market karak Local market Mitha khel

Bannu	9- Nov	Sunday	**River Kurram** Bannu Fish Hatchery, (Govt:) Fish market Baran Dam Kachkot Canal
N. Waziristan	10-11 Nov.	Monday, Tuesday	Danday Darduni Dam Mersi Khel Dam Mir Kalam Dam River Tochi Chashma Stream Boya Stream Aaman Market Miransha
Lakki Marwat	12 Nov.	Wednesday	River Gambila Marwat Canal Shadi Khel Strean Tangi Spring Sream Fish Market Wana Private farms
D. I Khan	13-14 Nov.	Thursday, Friday	Unit No. 1 River Indus CRBC Canal Custom Lake Roshan Dhand Unit No.2 River Indus Rata Kulachi Fish Hatchery Muhammad Naeem Fish Farm 12.5 Acr Private farms
Tank	15 Nov.	Saturday	Main bazar and nearby areas, need assessment
S. Waziristan Lower	16 Nov.	Sunday	River Makeen GomalZam Dam Dargai Pal Dam Stream Wana StreemTani StreemNeliKach
S. Waziristan Upper	17 Nov.	Monday	Streem Chino khu Streem Samar Bagh Private farms and fish market
Return back	18 Nov.	Tuesday	

Annexures

Annexure-1

Enumerator Survey Form

Objective:

To collect comprehensive data for mapping high-potential aquaculture zones and informing a commercialization strategy. This form is to be used by enumerators for field data collection across cold-water, semi-cold water, and warm-water zones, including potential saline areas for shrimp farming.

Section A: General Information

Field	Type/Options	Description
Survey Date	Date	Date of survey.
Enumerator Name	Text	Name of the enumerator conducting the survey.
Team	Dropdown: Team A (Cold) / Team B (Semi-Cold) / Team C (Warm)	The survey team conducting the survey.
Respondent Name	Text	Name of the person being interviewed.
Respondent Contact	Numeric	Phone number of the respondent.
Respondent Profession	Dropdown: Farmer / Hatchery Operator / Feed Miller / Trader / Retailer / Other (specify)	Primary profession of the respondent.
Years in Aquaculture	Numeric	Number of years the respondent has been involved in aquaculture.
Training in Aquaculture	Dropdown: Yes / No	Whether the respondent has received any formal training in aquaculture.

Section B: Site Identification and Location

Field	Type/Options	Description
Site Code	Auto-generated/Text	Unique code for the survey site.
GPS Coordinates (Latitude)	Auto-capture	Automatically capture the latitude from the device.
GPS Coordinates (Longitude)	Auto-capture	Automatically capture the longitude from the device.
Altitude (meters)	Numeric	Altitude of the site in meters.
District	Text	District where the site is located.
Tehsil/Sub-District	Text	Tehsil or sub-district of the site.
Village/Locality	Text	Village or locality of the site.
Current Land Use	Dropdown: Agricultural / Residential / Commercial / Forest / Barren / Other (specify)	The current use of the land where the site is located.
Accessibility	Dropdown: Easily accessible (paved road) / Moderately accessible (dirt road) / Difficult (off-road/trekking)	Accessibility of the site.
Photographic Evidence	Attachment	Attach photos of the site, water body, and any existing infrastructure.
Field Notes	Long Text	General observations and remarks about the site.

Section C: Water Resource Assessment

Field	Type/Options	Description
Water Body Type	Dropdown: River / Stream / Spring / Borewell / Canal / Dam/Reservoir / Other (specify)	The type of water body available at the site.
Water Source Reliability	Dropdown: Perennial / Seasonal (specify dry months) / Intermittent	Reliability of the water source throughout the year.
Seasonal Water Availability	Text	Describe seasonal variations in water availability.
Water Flow (m^3/s)	Numeric	Estimated or measured water flow rate.
Potential Water Constraints	Long Text	Describe any observed or reported constraints related to water quality or availability (e.g., pollution, drought, upstream diversions).
Pollution Sources	Long Text	Describe any visible or reported sources of pollution (e.g., agricultural runoff, industrial discharge, domestic waste).

Water Quality Parameters

Parameter	Unit	Measurement
Temperature	°C	Water surface temperature.
pH	pH units	Acidity/alkalinity level.
Dissolved Oxygen (DO)	mg/L	Oxygen availability for fish.
Conductivity	µS/cm	Indicator of salinity/mineral content.
Turbidity	NTU	Water clarity.
Alkalinity	mg/L $CaCO_3$	Buffering capacity of the water.
Hardness	mg/L $CaCO_3$	Total hardness of the water.
Salinity (for saline areas)	ppt	Salinity level for potential shrimp farming.

Section D: Infrastructure and Market Access

Field	Type/Options	Description
Road Access	Dropdown: Paved road / Dirt road / Footpath only / No access	Type of road access to the site.
Electricity Availability	Dropdown: Grid connection / Solar / Hydro / Generator / None	Availability of electricity at the site.
Proximity to Market (km)	Numeric	Approximate distance to the nearest major market.
Proximity to Feed Suppliers (km)	Numeric	Approximate distance to the nearest aquaculture feed supplier.
Proximity to Hatchery (km)	Numeric	Approximate distance to the nearest fish hatchery.
Cold Chain Infrastructure	Dropdown: Available / Limited / None	Availability of cold storage and refrigerated transport.
Proximity to Processing Facilities (km)	Numeric	Approximate distance to the nearest fish processing facility.

Section E: Existing Aquaculture Practices (if applicable)

Field	Type/Options	Description
Existing Aquaculture Activity	Dropdown: Yes / No	Whether aquaculture is currently practiced at the site.
Farm Type	Dropdown: Smallholder / Cooperative / Commercial / PPP / Other (specify)	The type of farm operation.
Aquaculture System	Dropdown: Cold-water (Trout) / Semi-cold water (Carp) / Warm-water (Tilapia/Carp) / Shrimp (Saline) / Other (specify)	The type of aquaculture system based on species and environment.
Pond/Cage Type	Dropdown: Earthen Pond / Lined Pond / Cage / Raceway / Other (specify)	The type of pond or culture system used.
Total Farm Area (acres)	Numeric	Total area of the farm in acres.
Total Water Area (acres)	Numeric	Total water surface area used for aquaculture.

Number of Ponds/Cages	Numeric	Total number of ponds or cages.
Average Pond/Cage Size	Text	Average size of a single pond or cage (e.g., length x width x depth).
Species Cultured	Text	List all species currently being cultured.
Stocking Density	Numeric (fish/m^3)	Number of fish stocked per cubic meter.
Feed Type Used	Dropdown: Commercial Pellets / Farm-made Feed / Other (specify)	The primary type of feed used.
Feeding Frequency	Numeric (times/day)	How many times per day fish are fed.
Average Production (kg/year)	Numeric	Average annual production in kilograms.
Major Diseases/Problems	Long Text	Describe any major diseases or other problems encountered.
Extension Services	Dropdown: Readily available / Available with effort / Not available	Availability of government or private extension services.

Section F: Socio-Economic Profile

Field	Type/Options	Description
Household Size	Numeric	Total number of members in the respondent's household.
Primary Livelihood Source	Text	The main source of income for the household.
Contribution of Aquaculture to Household Income (%)	Numeric	The percentage of household income that comes from aquaculture.
Land Ownership	Dropdown: Owned / Leased / Other (specify)	Ownership status of the land used for aquaculture.
Access to Credit/Finance	Dropdown: Formal (Bank) / Informal (Moneylender) / None	Access to financial services for aquaculture activities.
Community Perception of Aquaculture	Dropdown: Very Positive / Positive / Neutral / Negative / Very Negative	The general perception of aquaculture in the local community.

Gender Roles in Aquaculture	Long Text	Describe the roles of men, women, and youth in aquaculture activities.

Section G: Commercialization and Market

Field	Type/Options	Description
Primary Market for Fish	Dropdown: Local Village Market / Nearby Town Market / Major City Market / Direct to Consumer / Other (specify)	The primary market where the respondent sells their fish.
Mode of Transport to Market	Text	How fish are transported to the market.
Post-Harvest Practices	Long Text	Describe how fish are handled, processed, and stored after harvesting.
Market Challenges	Long Text	Describe the main challenges faced in marketing and selling fish.
Interest in Value Addition	Dropdown: High / Medium / Low / None	The respondent's interest in value-added products (e.g., filleting, smoking).

End of Survey Form-1

Annexure-2

Consultant Survey Form:

Key Informant Interview (KII) & Focus Group Discussion (FGD) Guide

Objective: To gather in-depth qualitative data from key informants and focus groups to inform the development of a robust cluster-based commercialization strategy for aquaculture in Khyber Pakhtunkhwa. This guide is designed for the four consultants (Aquaculture Economist, Market Research Specialist, Environmental Monitoring Specialist, and GIS Consultant) during their 15-day field visits.

Instructions for Consultants:

- This guide provides a framework. Be flexible and adapt questions based on the flow of conversation and the expertise of the interviewee/group.
- Encourage open discussion and probe for detailed examples and explanations.
- Record responses accurately, noting direct quotes where appropriate.
- Pay attention to non-verbal cues and group dynamics during FGDs.
- Ensure ethical considerations (informed consent, confidentiality) are maintained throughout the interviews.

Section A: General Information

Field	Type/Options	Description
Date of Interview/FGD	Date	Date of the KII or FGD.
Consultant Name	Text	Name of the consultant conducting the interview/FGD.
Location (District, Tehsil, Village)	Text	Specific location of the interview/FGD.
Type of Session	Dropdown: KII / FGD	Indicate whether it's a Key Informant Interview or a Focus Group Discussion.
Key Informant/FGD Group Profile	Long Text	For KII: Role/Expertise of the informant (e.g., Fisheries Dept. Official, Large-scale Farmer, Trader, Input Supplier). For FGD: Description of group (e.g., Smallholder Farmers, Women in Aquaculture, Youth Group).
Number of Participants (for FGD)	Numeric	Total number of participants in the Focus Group Discussion.
Duration of Session	Numeric (minutes)	Approximate duration of the interview/FGD.

Section B: Input Supply Chain Analysis (Focus: Fingerlings, Feed, Equipment)

Objective:

To identify bottlenecks, cost drivers, and opportunities for local production or improved distribution of key aquaculture inputs.

Key Informant Interview Questions:

1. **Sources & Availability:**
    - What are the primary sources of fingerlings/seed, feed, and equipment for aquaculture farmers in this region? (Probe for government hatcheries, private suppliers, imports, local manufacturers).
    - Are these inputs consistently available throughout the year? What are the seasonal fluctuations or shortages?
    - What are the main challenges farmers face in accessing high-quality and affordable inputs?
2. **Quality & Pricing:**
    - How do you assess the quality of fingerlings (e.g., health, size, genetic purity)? Are there concerns about quality?
    - What are the typical prices for different types of fingerlings, feed, and equipment? How do prices vary by supplier, quantity, or season?
    - Are there any subsidies or support mechanisms for input costs? How effective are they?
3. **Transportation & Distribution:**
    - Describe the logistics of transporting inputs from suppliers to farms. What are the associated costs and challenges (e.g., road conditions, specialized vehicles, spoilage)?
    - What is the role of intermediaries in the input supply chain? Are there opportunities to streamline distribution?
4. **Local Production Potential:**
    - Is there potential for local production of fingerlings (new hatcheries), feed ingredients, or aquaculture equipment in this region? What are the feasibility and challenges?
    - What policies or investments would encourage local input production?

Focus Group Discussion Questions:

5. What are the biggest problems you face in getting good quality fingerlings/seed, feed, and equipment for your farm?
6. Where do you usually buy your inputs? Are you happy with the prices and quality?
7. What changes would help you get better and cheaper inputs?
8. Do you think we can produce more of these inputs locally? What would be needed to make that happen?

Section C: Post-Harvest Handling and Processing Protocols

Objective:

To assess current practices, identify gaps, and recommend improvements for handling, chilling, processing, and packaging fish to maintain quality and extend shelf life.

Key Informant Interview Questions:

9 **Harvesting Practices:**
- Describe common harvesting methods used in this region. Are there practices to minimize stress and injury to fish?
- What equipment is used for harvesting? Is it hygienic and appropriate?
- Are laborers involved in harvesting trained in proper fish handling?

10 **On-Farm Handling & Chilling:**
- How are fish handled immediately after harvest (e.g., stunning, bleeding, washing)?
- What chilling methods are employed (e.g., ice, chilled water)? Is ice readily available and of good quality?
- How are fish stored on the farm before transport? What is the typical storage duration?
- What are the estimated post-harvest losses (quantity and quality) at the farm level?

11 **Transportation to Markets/Processing Centers:**
- Describe the vehicles and containers used for transporting fish. Is ice used during transport? Is temperature maintained?
- What are the challenges during transport (e.g., long distances, poor roads, lack of refrigerated vehicles)?

12 **Processing Facilities (if any):**
- Are there any local or regional fish processing units? What is their capacity and product range?
- Assess the infrastructure, hygiene, and quality control measures in place at these facilities.
- Are processed products certified (e.g., food safety standards)?

Focus Group Discussion Questions:

13 What do you do with your fish immediately after harvesting? How do you keep them fresh?

14 What problems do you face in keeping your fish fresh after harvest and during transport to the market?

15 What kind of support or training would help you improve fish quality after harvest?

16 Are there any local facilities that process fish? What are your thoughts on their services?

Section D: Market Linkage Development Plan

Objective:

To establish and strengthen linkages between farmers/producers and various market segments, including roles of intermediaries, direct sales models, and e-commerce platforms.

Key Informant Interview Questions:

17 **Current Market Channels:**
- What are the primary market channels for aquaculture products from this region (e.g., local markets, regional wholesalers, direct sales, processors)?
- Describe the role of different intermediaries (e.g., agents, wholesalers, retailers) in the value chain.

18 **Market Access Challenges:**
- What are the main challenges farmers face in accessing profitable markets (e.g., price volatility, lack of market information, transportation issues, quality requirements)?
- Are there any existing farmer cooperatives or associations that facilitate market access?

19 **Opportunities for Improvement:**
- What opportunities exist for developing stronger market linkages (e.g., contract farming, direct sales to restaurants/supermarkets, e-commerce platforms)?
- How can market information be improved and disseminated to farmers?
- What role can government or private sector play in strengthening market linkages?

Focus Group Discussion Questions:

20 Where do you sell your fish? What are the prices you usually get?

21 What difficulties do you have in selling your fish and getting a good price?

22 Would you be interested in selling directly to buyers (e.g., restaurants, hotels) or through online platforms? What would help you do this?

23 Do you work with other farmers to sell your fish? How does that work?

Section E: Branding and Marketing Strategy

Objective:

To develop a detailed branding and marketing strategy that capitalizes on natural resources, improves operational efficiency, introduces modern marketing innovations, and promotes value addition and product diversification.

Key Informant Interview Questions:

24 **Current Marketing Efforts:**
- How are aquaculture products from this region currently marketed? Are there any existing brands or labels?
- What are the unique selling propositions (USPs) of aquaculture products from KP (e.g., quality, freshness, specific species)?

25 **Branding Potential:**
- Is there potential for developing a collective brand for KP aquaculture products? What would be the key elements of such a brand (e.g., logo, slogan, story)?
- How can product differentiation be achieved (e.g., organic, sustainably farmed, specific regional varieties)?

26 **Marketing Innovations:**
- What modern marketing innovations (e.g., social media, digital marketing, food festivals) could be leveraged to promote KP aquaculture?
- What role can packaging and labeling play in enhancing market appeal?

27 **Value Addition & Product Diversification:**
- What opportunities exist for value-added products (e.g., smoked fish, fish fillets, fish snacks)?
- How can product diversification (e.g., new species, different product forms) enhance market reach and profitability?

Focus Group Discussion Questions:

28 How do you tell people about your fish? Do you think a special name or logo for fish from KP would help sell more?

29 What makes fish from your area special or better than others?

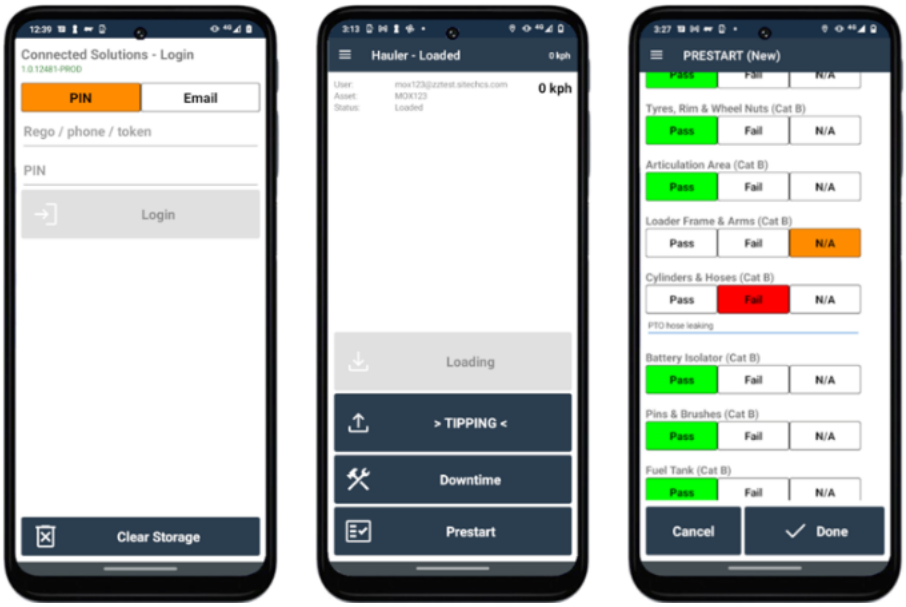
30 What new ways can we use to tell people about our fish (e.g., social media, local events)?

31 Would you be interested in making new products from fish (e.g., dried fish, fish pickles)? What kind of support would you need?

End of Survey Form-2

Mobile Data Collection Application (MDCA) Training Content

Mobile data collection (MDC) uses digital devices such as smartphones or tablets to collect survey and research data instead of paper-based forms. MDC has become popular in many sectors like health, humanitarian aid, education, agriculture, and development research.



GPS Device

GPS stands for Global Positioning System, a satellite-based navigation system. It provides location and time information anywhere on Earth where there is an unobstructed line of sight to GPS satellites. GPS is widely used in mobile data collection to capture accurate geographic coordinates (latitude, longitude, altitude) for survey points. The device calculates its position by triangulating signals from multiple satellites orbiting the Earth.

Water Quality and Survey Kits

Key water quality parameters critical for fish health are **Alkalinity, total dissolved solid, salinity, pH**, **dissolved oxygen (DO)**, and **temperature**.

Hands-on trainings will be provided for each test multiple times on water samples along with accuracy checks comparing results and immediate data entry into MDCA.

TDS, PH,

Conductivity Meter

Survey Kit