

OliveCulture Pakistan: Building a Sustainable, Climate-Smart and Competitive Value Chain

Edited by:

Marco Marchetti, Costantino Parma, Zeinab Hamouche



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Contents

Foreword	15
Introduction	17
Chapter I: State-of-the-Art of olive sector in Pakistan: A review report – <i>Aslam M., Marchetti M., Parma C.</i>	19
I – Overview of the olive sector in Pakistan	19
II – National and international initiatives	20
III – Assessment of the agronomic studies done with the PSDP project from 2014	27
IV – Synthesis of agronomic research on olive cultivation in Pakistan	31
1. Adaptability and cultivar evaluation	31
2. Yield, oil quality, and biochemical traits	32
3. Propagation, grafting, and plant establishment	32
4. Phenology, pollination, and fruit set	32
5. Environmental and nutritional influences	33
6. Local germplasm and future prospects	33
V – Identification of the major olive varietal trials established in Pakistan	33
1. Varietal tests and performance	33
2. Olive varieties genetic characterization studies	34
A. Genetic diversity and differentiation between wild and cultivated olives	34
B. SSR and RAPD marker-based genetic analysis	35
C. Implications for breeding and germplasm management	35
VI – Strategic considerations and policy gaps in the development of the olive sector in Pakistan	36
Chapter II: Assessment of the olive value chain in Pakistan – <i>Aslam M.,</i> <i>Marchetti M., Parma C.</i>	41
I – Introduction	41
II – SWOT analysis of the proposed olive value chain	43
1. Strengths	44
2. Weaknesses	45
3. Opportunities	46
4. Threats	46

III – Analysis of the available data on olive consumption and production	50
1. Fresh olive supply/value chain	50
2. Imported olive oil supply/value chain.....	51
3. Locally processed olive oil supply/value chain	51
IV – Public sector (federal and provincial) services and facilities to develop olive value chain	54
V – Mapping provincial government initiatives for services and facilities to develop olive value chain	57
1. Balochistan	57
A. Development of olive production and processing in Balochistan	57
B. Promotion of olive cultivation for economic development and poverty alleviation (PIDSA-funded).....	58
C. AFNEPAK Project.....	58
D. Promotion of olive cultivation on a commercial scale in Pakistan	58
E. Growth for rural advancement and sustainable progress (GRASP)	58
F. Additional initiatives and support measures.....	59
2. Punjab.....	59
A. Key achievements and current status.....	60
B. Key constraints and gaps	60
C. Government response and future strategy	61
3. Khyber Pakhtunkhwa	62
A. Promotion of the production and marketing of olive oil in Pakistan (2008)	62
B. Distribution of olive saplings	62
C. Provision of oil extraction facilities	63
D. Expansion of olive cultivation.....	63
E. Promotion of olive cultivation on a commercial scale in Pakistan (POCCSP – Provincial Component).....	63
F. Ten billion tree Tsunami program (Phase I: 2019-2023).....	63
G. Provincial olive development initiative	64
H. Phased expansion strategy	64
4. Azad Jammu and Kashmir	64
A. Key achievements	64
B. Key constraints	65
5. Gilgit-Baltistan	65
A. Key achievements	65
B. Key constraints	65

VI – Assessment and sampling of wild olives with agronomic potential in suitable provinces.....	66
VII – Mapping of existing services and facilities	68
1. Mapping of registered olive plant nurseries and registered olive varieties.....	68
2. Mapping of olive oil extraction units.....	69
3. Mapping of olive processing/table olive value addition units	69
4. Mapping of research and development institutes involved in olive promotion	70
VIII –Considerations and recommendations.....	71
Chapter III: Action plan and policy recommendations for a holistic development of the Pakistani olive value chain – Awan A.A., Cardone G., Parma C., Amna H., Marchetti M., Babar S., Rasool S.	75
I – Introduction	76
II – Context and sustainability dimensions of the olive value chain	77
1. Environmental dimension	77
2. Economic dimension	78
3. Social dimension	80
III – Production and processing.....	81
1. Cultivation.....	81
2. Processing.....	83
A. Olive oil	83
B. Table olives	86
IV – Marketing	87
1. Marketing channels of olive	87
2. Domestic demand for olive oil	89
3. Import of olive oil	89
4. Constraints in market development	90
V – Legislation, certification and policies	91
VI – Research, education, training and extension	92
VII – SWOT analysis	93
VIII –Needs and policy gaps.....	97
1. Production and processing	97
2. Marketing.....	98
3. Legislation, certification, and policies	98

4. Research, education, training, and extension services	98
IX – Strategic objectives	99
1. Production and processing	99
2. Marketing	99
3. Legislation, certification, and policies	99
4. Research, education, training, and extension services	100
X – Action points	100
XI – Conclusions	101
Chapter IV: Selection of olive cultivars and their potential by province – <i>Awan A.A., Laghezza L., Parma C., Marchetti M., Awan M.A.</i>	113
I – Introduction	114
II – Methodological considerations and limitations	115
III – Cross-pollination	115
IV – Pakistan ATLAS of climate suitable varietal map per province	116
V – Selection of best-yielding olive varieties divided by provinces	117
VI – Conclusions and future perspectives	125
Chapter V: Olive orchard management for sustainable production – Parma C. <i>and Marchetti M.</i>	129
I – Introduction	129
II – Olive cultivation: Main agronomic aspects	130
1. Peco-climatic inclination	130
2. Olive groves, orchard systems and varieties	132
A. Olive groves	132
B. Orchard systems (Form of farming)	132
C. Variety selection	133
D. Pruning	133
3. Nutritional requirements of the olive tree	134
A. Soil analysis and foliar diagnostics	134
B. Fertilization plan	136
4. Parasitic diseases and pests	137
5. Water requirements, irrigation methods, and water management	139
A. Irrigation methods	139

B. Critical water demand periods.....	139
C. Irrigation volumes and scheduling.....	139
6. Methods of harvesting and storing olives	140
A. Structure and maturation of the olive	140
B. Early and late harvesting.....	141
C. Main harvesting methods	141
7. Regulation on Good Agricultural Practices	142
A. Management of soil fertility	142
B. Phytosanitary protection.....	145
III – Conclusions	146
 Chapter VI: Policy framework for promoting olive production as a climate change mitigation strategy in Pakistan – Ali A., Awan M.A., Marchetti M., Parma C. .	
I – Introduction	150
II – Methodology.....	151
1. Assessment of carbon sequestration.....	151
A. Determination of above-ground biomass	152
B. Determination of below-ground biomass.....	152
C. Conversion to carbon stock and CO ₂ equivalent.....	153
D. Carbon sequestration rate.....	153
2. Assessment of carbon footprint	153
A. Land preparation	153
B. Fertilizers and pesticides application	153
C. Irrigation	153
D. Oil extraction	153
3. Policy context and government priorities	154
III – Field survey findings	154
1. Olive farming practices	154
2. Attributes of sampled farms	154
3. Biomass and carbon stocks.....	156
4. Carbon sequestration	157
5. Carbon footprint.....	158
A. GHG emissions from land preparation	158
B. GHG emissions from fertilizers and pesticides applications	158
C. GHG emissions from oil extraction.....	158
6. Net Carbon balance.....	159
IV – Evaluation of olive cultivation for carbon credit trading in Pakistan	160

1. Eligibility criteria under the VCM	161
V – Recommendations for developing a policy framework to valorize olive production as a climate change mitigation strategy	163
1. Promoting sustainable farming practices for carbon sequestration in olive groves 163	
2. Integration of olive-based carbon projects into carbon trading policy	163
3. Awareness raising.....	164
4. Capacity building.....	164
5. Formation of olive grower cooperatives and clusters	164
6. Private sector engagement	164
7. Strengthening institutional linkages.....	165
8. Establishment of a Measurement, Reporting and Verification (MRV) system	165
Chapter VII: Toward responsible olive tourism in Pakistan: Potential assessment and participatory planning – Rana A.U.R., Marchetti M., Parma C.	171
I – Introduction	172
II – Methodology and approach	173
1. Desk review and preliminary assessment.....	173
2. Field surveys and site assessments.....	173
3. Stakeholder consultations	173
III – Development of the Responsible Participatory Tourism Framework	174
IV – Selection of high-potential areas for olive tourism	174
V – Assessment of potential sites for olive tourism	175
VI – SWOT analysis	192
VII – Key findings of the SWOT analysis.....	193
VIII –Responsible Participatory Olive Tourism Plan	193
1. Strategic framework for the development of responsible olive tourism	195
A. Protection of natural and cultural heritage	195
B. Community awareness and stakeholder sensitization	195
C. Institutional arrangements	196
D. Development of olive tourism infrastructure and services.....	197
E. Marketing and promotion	201
F. Signposting and tourist information	201
G. Printed and digital information materials.....	201
H. Digital marketing and social media	201

I. Networking with tour operators	201
J. International farm trips for olive tourism services providers	201
K. Olive-based souvenirs and local products.....	202
L. Production of documentary films.....	202
M. Visitor safety and security	202
N. Capacity building of tourism service providers	203
O. Olive tourism education and codes of conduct.....	203
P. Monitoring and evaluation	203
2. Action Plan and estimated budget for implementing a Responsible Participatory Tourism Plan	203
A. Pilot areas and Action plan	203
Conclusions	211
Memories	213

Project context

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The project aims to support the sustainable development of the olive sector in Pakistan through a holistic approach encompassing olive cultivation, nursery production, orchard management, processing, quality improvement, capacity building, and value chain enhancement. By promoting technical knowledge transfer, institutional collaboration, and sustainable agricultural practices, the initiative contributes to strengthening the competitiveness, resilience, and long-term sustainability of the Pakistani olive sector.

The content presented in this monograph covers the activities, achievements, and outcomes developed between January 2022 and June 2024.

Acknowledgments

This monograph is the result of a collective effort involving researchers, institutions, technical experts, development partners, and stakeholders committed to the sustainable development of the olive sector in Pakistan. The authors would like to express their sincere gratitude to all those who contributed, directly or indirectly, to the preparation and realization of this work.

We gratefully acknowledge the Ministry of National Food Security & Research, Government of Pakistan, and the Pakistan Oilseeds Department for their strategic guidance, institutional support, and facilitation throughout the implementation of project activities.

We extend our appreciation to the Italian Agency for Development Cooperation (AICS), Office for Pakistan and Afghanistan, for its continuous support in implementing project activities. We also acknowledge the technical backstopping and knowledge exchange facilitated through international collaboration, particularly in adapting best practices to local agroecological conditions.

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Disclaimer: The views and opinions expressed in this document are those of the authors and do not necessarily reflect the official policies or positions of the supporting organizations and institutions.

Foreword

Biagio Di Terlizzi – Director

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For more than sixty years, the International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM) has been guided by a simple but demanding conviction: that the Mediterranean is not only a sea, but a method — a way of sharing scientific knowledge, building human capacity, and translating agronomic research into tangible development that crosses borders. At CIHEAM Bari, the operational seat of the Organization in Italy, this belief has taken the concrete form of postgraduate training, applied research, and international cooperation projects, designed hand in hand with our partner countries.

Among all the crops that express the Mediterranean identity, the olive tree occupies a place of its own. It is at once an agronomic resource and a cultural emblem — a symbol of resilience, of patience, of continuity between generations, and of the peaceful encounter between peoples. It is therefore deeply meaningful that this monograph should extend the olive's long Mediterranean story to Pakistan, a country whose soils have hosted wild olive for millennia and where the “zaitun” is held in profound cultural and spiritual esteem.

The work presented in these pages is the fruit of a sustained cooperation between Italy and Pakistan, in which CIHEAM Bari has been honored to take part. It reflects what cooperation should be at its best: not the transfer of a finished model, but the patient co-construction of knowledge adapted to local conditions — from the high valleys of Khyber Pakhtunkhwa to the hills of Punjab and the arid lands of Balochistan. Behind every chapter lie field trials, institutional dialogue, and the daily commitment of Pakistani and Italian researchers, technicians, and farmers who have chosen to invest in a shared vision.

That vision is both strategic and timely. By reducing dependence on imported edible oils, valorizing marginal and underused lands, generating rural employment, and contributing to climate change mitigation through carbon sequestration, the olive sector responds simultaneously to food security, economic, social, and environmental priorities. This monograph has the considerable merit of treating these dimensions not in isolation but as a single, coherent value chain — linking varietal selection, sustainable agronomic management, governance, quality standards, market development, and even the emerging promise of responsible olive tourism.

I hope that this volume will serve policymakers, researchers, extension services, investors, farmers, and students alike, and that it will stand as a durable reference for all those who believe, as we do at CIHEAM Bari, that olive cultivation can become one of the pillars of a sustainable, climate-smart, and competitive agriculture in Pakistan. I extend my sincere gratitude to the authors, to the Pakistani institutions that have accompanied this journey, and to all the partners whose dedication has made this work possible. The Mediterranean olive has found in Pakistan a generous new land; may this monograph help it flourish there for generations to come.

Introduction

Marco Marchetti and Costantino Parma

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Agriculture is a multidisciplinary science devoted to the wise use of natural resources; yet, for us, promoting olive cultivation in Pakistan has carried a value that goes well beyond agronomy. We have always “interpreted” the Mediterranean olive as a descendant of the wild olive that has long covered Pakistani soils, and the revered “zaitun” — celebrated for its spiritual significance and its renowned health virtues — as a treasure waiting to be valorized on a far larger scale.

Cultivating olive orchards across the provinces — from the mountains to the valleys, from the hilly tracts to the edge of the desert — has given us the rare privilege of watching a Mediterranean crop take root in a new homeland, and of accompanying the farmers, technicians, and institutions who have made that possible. We had the further privilege of developing our work in a country of fascination, history, heritage, and tradition: a true crossroads of cultures, where the olive does not arrive as a stranger, but returns to a land that has always known it.

This monograph sets out a reality: Pakistan now possesses, besides the agro-climatic conditions, the institutional momentum and the accumulated technical knowledge to transform a promising but fragmented olive sector into a sustainable, climate-smart, and competitive value chain. We contend that olive cultivation is no longer a marginal experiment, but a strategic pathway for agricultural diversification, edible-oil import substitution, rural development, and climate-resilient land use — and that the time to consolidate it is now.

The significance of this achievement is both national and regional. Pakistan has long depended on imported edible oils, with domestic production unable to meet consumption; reducing this gap is a recognized national priority with direct implications for trade balances and food security. At the same time, olive groves can bring productive life to marginal lands, create employment for rural communities — including women and youth — and act as carbon sinks that contribute to the country’s climate commitments. The stakeholders are correspondingly broad: farmer communities as pillars; policymakers and provincial authorities shaping the enabling environment; researchers and extension agents bringing and disseminating the technologies; investors and processors building the market; and the students and young professionals who will carry the sector forward.

Olive science is, of course, mature in its Mediterranean cradle, and Pakistan itself has accumulated decades of varietal trials, government programs, and a remarkable endowment of wild *Olea* resources. Yet this knowledge has too often remained dispersed — scattered across institutions, provinces, and disciplines, and rarely assembled into a coherent, value-chain perspective. Herein lies the gap this monograph seeks to fill: rather than treating cultivars, agronomy, governance, quality, markets, environment, and tourism as separate topics, we read them as interdependent links in a single chain and ask what is needed to make that chain both competitive and resilient.

To do so, the volume draws together complementary methods and materials: a critical review of the state of the art and of the policy framework; SWOT and value-chain analysis supported by available production and consumption data; institutional and resource mapping at federal and provincial levels; agro-climatic and varietal zoning across the principal olive-growing regions of Balochistan, Khyber Pakhtunkhwa, and Punjab; field-based assessment of carbon stocks and greenhouse-gas balances in selected areas; and comparative lessons drawn from Mediterranean experience, including participatory planning for rural tourism. The scope is deliberately focused on Pakistan's main olive provinces and on the sector as an integrated system; it is not intended as an exhaustive technical manual, but as a strategic synthesis that connects evidence to action.

The chapters are designed to build upon one another. Chapter I depicts the state-of-the-art of the olive sector in Pakistan, tracing its historical development and the role of international cooperation, notably between Italy and Pakistan. Chapter II assesses the olive value chain itself through a SWOT framework, mapping institutional services, public facilities, and wild-olive resources with agronomic potential. Chapter III translates this diagnosis into an action plan and policy recommendations for the holistic development of the chain, from production and processing to governance and market integration. Chapter IV turns to the agronomic foundation of the sector, examining the selection of olive cultivars and their potential province by province. Chapter V addresses olive-orchard management for sustainable production, integrating good agricultural practices, soil fertility, irrigation, pruning, and integrated pest and disease management. Chapter VI broadens the horizon to the environment, presenting a policy framework that positions olive production as a significant asset for climate-change mitigation through carbon sequestration and access to carbon markets. Finally, Chapter VII looks toward responsible olive tourism, exploring how agriculture, culture, and landscape can be woven into a common territorial strategy for long-term rural development through community participation.

Taken together, these chapters move from where the olive sector stands, to where it could go, and to how it might get there — from diagnosis to strategy to practice. We hope that the reader will close this volume convinced, as we are, that the olive tree has a lasting and multidimensional future in Pakistan, and that nurturing it is an endeavor worthy of the country's history, its land, and its people.

State-of-the-Art of olive sector in Pakistan

A review report

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Abstract. Pakistan has remained heavily dependent on imported edible oils due to the persistent gap between domestic production and consumption, making the development of alternative oilseed crops a national priority. In this context, olive cultivation has emerged as a promising sector owing to the country's favorable agro-climatic conditions and the increasing support provided through public sector and international cooperation initiatives. The study provides a comprehensive overview of the olive sector in Pakistan, examining its historical development, current status, and future potential. It further examines the role of government interventions, international collaborations, and the strengthening of the olive value chain. The role of projects implemented with international partners, especially within the framework of Italy-Pakistan cooperation, is also highlighted. Moreover, the study discusses the major challenges limiting the sector's expansion, including technical, institutional, and market-related constraints, while emphasizing opportunities for sustainable growth, rural development, and import substitution. Overall, the present work presents olive cultivation as a strategic sector capable of contributing to economic development, agricultural diversification, and long-term sustainability in Pakistan.

Keywords. Olive sector – Value chain – Sustainable agriculture – Rural development.

État des lieux du secteur oléicole au Pakistan : Rapport de synthèse

Résumé. Le Pakistan demeure fortement dépendant des importations d'huiles alimentaires en raison du déséquilibre persistant entre la production nationale et la consommation, faisant du développement des cultures oléagineuses alternatives une priorité nationale. Dans ce contexte, l'oléiculture s'est imposée comme un secteur prometteur grâce aux conditions agroclimatiques favorables du pays et au soutien croissant apporté par les soutiens publics et les initiatives de coopération internationale. L'étude offre une vue d'ensemble du secteur oléicole au Pakistan en analysant son évolution historique, sa situation actuelle et son potentiel futur. Elle examine également le rôle des interventions gouvernementales, des collaborations internationales, ainsi que du renforcement de la chaîne de valeur oléicole. Le rôle des projets mis en œuvre avec des partenaires internationaux, notamment dans le cadre de la coopération italo-pakistanaise, est également mis en évidence. Par ailleurs, l'étude aborde les principaux défis limitant l'expansion du secteur, notamment les contraintes techniques, institutionnelles et commerciales, tout en soulignant les opportunités de croissance durable, de développement rural et de substitution aux importations. Dans l'ensemble, ce travail présente l'oléiculture comme un secteur stratégique capable de contribuer au développement économique, à la diversification agricole et à la durabilité à long terme au Pakistan.

Mots-clés. Secteur oléicole – Chaîne de valeur – Agriculture durable – Développement rural.

I – Overview of the olive sector in Pakistan

Pakistan has remained a major importer of edible oil since the early 1970s due to a persistent imbalance between domestic production and consumption. Currently, approximately two-thirds of the national demand is met through imports, placing a significant burden on the country's foreign exchange reserves. Despite numerous policy initiatives aimed at boosting oilseed production, the

sector has largely failed to achieve self-sufficiency. Domestic production contributes only 13-15% of total consumption, while 85-87% is fulfilled through imports. Meanwhile, per capita edible oil consumption has increased substantially from 5.31 kg in 1973-1974 to around 20 kg in 2018 and is projected to reach 22 kg by 2028. This growth is expected to raise total demand to approximately 6.5 million tons, compared to the current local production of less than 0.5 million tons, thereby further widening the demand-supply gap and increasing the import bill (Business Recorder, 2022).

In this context, exploring alternative and sustainable sources of edible oil has become a national priority. The olive tree (*Olea europaea* L.), an evergreen species native to the Mediterranean basin, including southeastern Europe, West Asia, and North Africa, represents a promising option. According to the Food and Agriculture Organization (FAO, 2018), the global area under olive cultivation reached 10.5 million hectares in 2018, reflecting a 26% increase since 2000, while total production rose by 35% to over 21 million tons. These trends highlight the growing economic importance and adaptability of olive cultivation worldwide.

Pakistan possesses considerable agro-climatic potential for olive cultivation, particularly in regions such as Balochistan, Khyber Pakhtunkhwa, and Punjab. Recognizing this potential, the government has initiated several efforts to promote the olive sector as part of a broader strategy to reduce dependence on imported edible oils. At the federal level, the Pakistan Oilseed Department POD (formerly Pakistan Oilseed Development Board) plays a central role in policy formulation, coordination, and research promotion for oilseed crops, including olives. However, there remains a critical need to revitalize the sector through integrated and transformative approaches that incorporate both conventional and non-conventional oilseed crops.

International collaboration has significantly contributed to the development of the olive sector in Pakistan. In particular, the OliveCulture Project, implemented by CIHEAM Bari in partnership with national institutions such as POD, represents a key initiative aimed at strengthening the olive value chain. Since the 1980s, the Italian Government has supported olive promotion in Pakistan, and current efforts focus on a holistic, multidisciplinary approach encompassing nursery development, orchard management, harvesting and post-harvest practices, capacity building (including youth and women engagement), marketing, branding, and compliance with international standards.

To ensure the effective implementation of these initiatives, it is essential to conduct a comprehensive assessment of the existing olive sector in Pakistan. Such an analysis should consider the outcomes of previous national and international efforts, including the introduction and adaptability testing of exotic cultivars, as well as advancements in cultivation and processing techniques. Reviewing the historical development of the sector alongside current practices will provide valuable insights for stakeholders, enabling better integration of ongoing activities and more informed strategic planning for future growth.

II – National and international initiatives

The Government of Pakistan, in collaboration with several international development partners, has played a pivotal role in promoting olive cultivation and processing in the country. Public sector institutions, working in close coordination with international agencies, have provided substantial

financial support, technical assistance, and capacity-building initiatives targeting researchers, academic institutions, farmers, and industry stakeholders across the olive value chain. These efforts have facilitated the introduction of high-yielding olive cultivars, the transfer of advanced production technologies, and the provision of modern tools and olive oil extraction machinery, contributing significantly to the sector's development.

Over the past two and a half decades, numerous projects have been implemented to support the expansion of olive cultivation and the strengthening of its value chain in Pakistan. A detailed overview of these initiatives is presented below, while a chronological summary of the major projects, primarily funded at the federal level, is provided in Table 1.

- a) Keeping in view the large presence of wild olives in different ecological zones of Pakistan with various morphological and ecological types, the Ministry of Food, Agriculture and Livestock (MinFAL), through the Pakistan Oilseed Development Board (PODB) launched in 1986 a project to graft about 5.5 million wild plants, but less than 1% plants went into production. Notwithstanding the limited success of the grafting efforts, the favorable performance of some olive plants, occasionally introduced from Mediterranean countries by researchers, officials, and travelers, demonstrated the species' adaptability and indicated the potential for its successful cultivation in Pakistan.
- b) The pioneer structured initiative was taken in 1986 with the assistance and funding from the Italian Government of the *"Fruit, Vegetable and Olive Project."* (1986-1989), implemented by AGROTEC with the Pakistan Agricultural Research Council (PARC). Some experimental trials with the exotic olive germplasm were established in the provinces and at the National Agriculture Research Center (NARC). It is worth mentioning that olive was not a main component of the project, nevertheless the basis was laid down for introducing cultivation by exploring the suitability of country's agro-ecology zones. The scientific and technical response was positive, but the real outcomes would have been ensured by a regular follow-up post-project.
- c) PODB during 2005 launched the project captioned as *"New plantation of Olive in Khyber Pakhtunkhwa, Potohar and Balochistan, and maintenance of olive orchards established by POD"* at the cost of Rs. 39.185 million. PODB also developed 150 acres of model olive farm at Sangbhatti, Mardan and planted about 20,000 olive plants. It also established germplasm unit on 10 acres comprising of 1,000 olive plants of different varieties imported from Italy and other countries, incurring a cost of Rs. 38.0 million.
- d) The Italian Government resumed the dedicated support for the development of olive on modern way, in consideration of the relevant failures of the grafting, and financed the project *"Promotion of the production and marketing of olive oil in Pakistan"*, implemented by the Istituto Agronomico per l'Oltremare & PODB from 2007 to 2008. The Project identified suitable areas for olive growing and published the *"Atlas of suitable areas for olive growing in 14 Districts in Khyber Pakhtunkhwa (KP) (formerly North-West Frontier Province, NWFP) and Balochistan"*, and a market study to understand oil consumption and market dynamics.
- e) The Pakistan Italian Debt Swap Agreement (PIDSA) awarded in 2012 to the Ministry of National Food Security and Research the project captioned as *"Promotion of Olive Cultivation for Economic Development and Poverty Alleviation"*. The project, with the cost of PKR 382 million, was executed through PARC coordination system in KP, Baluchistan, Federally

Administered Tribal Areas (FATA) and Punjab provinces. The project represents the first significant investment in the country for the development of the olive sector, aiming to increase the local production of edible oils by cultivating olive specially to utilize culturable waste lands and expand the cultivation of olives in selected/identified areas through new plantations in these provinces. The project achieved several important outcomes that significantly contributed to the initial development of the olive sector in Pakistan. Large-scale olive plantation activities were carried out at farmers' fields across Balochistan, KP, Punjab, FATA, and the Islamabad Federal area, resulting in the establishment of olive orchards over a considerable cultivated area. In parallel, extensive efforts were made in plant propagation and nursery management through the distribution of a high number of olive cuttings to support future plantation activities and strengthen local nursery production systems. Capacity-building activities were also implemented through training sessions and field days aimed at improving farmers' and technicians' knowledge of olive cultivation practices. The project further supported the maintenance of mother orchards, rehabilitation of previously established olive orchards, and development of related infrastructure. Moreover, adaptability and varietal trials were conducted at numerous locations across different provinces to evaluate the performance of olive varieties under diverse agro-climatic conditions. Awareness and promotional campaigns were continuously conducted through print and electronic media to enhance public understanding of olive cultivation and its economic potential. Overall, these interventions played a fundamental role in introducing and promoting olive cultivation in Pakistan and established the basis for future expansion and investment in the sector.

- f) The Italian Government, extending the support for the development of olive sector in a consequential and consistent manner, financed the regional project "*Technical assistance and support to line ministries in the agricultural sector with emphasis on olive production/AFNEPAK*" (in Pakistan, Afghanistan and Nepal) implemented by the Istituto Agronomico per l'Oltremare (IAO) & PARC, from 2012 to 2016. The project was approved with the overarching objective of strengthening the agricultural sector, with particular emphasis on the development of olive cultivation and olive oil production, while contributing to the improvement of rural livelihoods. The project aimed to comprehensively develop Pakistan's olive sector by identifying regions with natural suitability for cultivation, creating opportunity cost models, establishing a national olive registry, and collecting meteorological data to support informed decision-making and market analysis. It sought to strengthen human resources through training of technicians and farmers, provide technical support for farm-level production systems including cultivar adaptability and cultivation practices, and promote the formation and capacity-building of farmers' associations and related organizations. Additionally, the project focused on enhancing olive oil quality and value addition through best practices and laboratory training, while promoting olive production and consumption via targeted outreach, technical assistance, and engagement with government, NGOs, communities, and private investors. The project achieved its objectives only partially, as activities were suspended by the counterpart, and the project remains administratively open. Many of the planned interventions were designed to complement and support the PIDSA Olive Project. Despite these constraints, several important outputs were delivered. In addition to extensive training-of-trainers programs and technical assistance activities, key achievements included the development of a comprehensive market study, "*Market Analysis for Value Chain and Olive Oil Consumption in Pakistan*," conducted by the Punjab Economic Research Institute, as well as the mapping of olive plantation areas.

- g) Under the PIDSA-funded project “*Early Recovery of Agriculture and Livelihood Program for Conflicted Areas (Malakand)*,” implemented by the Provincial Disaster Management Authority/Provincial Reconstruction and Rehabilitation Authority (PDMA/PaRRA) of Khyber Pakhtunkhwa between March 2010 and July 2012, with a total budget of Rs 713 million, olive cultivation initiatives were introduced in the Swat region with the technical support of PODB. As part of the project, approximately 24,000 imported olive plants were established over 71 hectares of rangeland under barani (rainfed) conditions. In addition, training sessions and follow-up support were provided to stakeholders. Grafting activities were also carried out on 247,878 wild olive plants. However, subsequent evaluations indicated a relatively low survival and growth rate of the plantations, mainly due to various constraints, which were later taken into consideration by PODB for future interventions.
- h) Building on the positive outcomes and nationwide response to the PIDSA-funded olive initiatives, the Public Sector Development Programme (PSDP) launched a flagship mega-project titled “*Promotion of Olive Cultivation on Commercial Scale in Pakistan*” (POCCSP), with a total allocation of PKR 2,444.545 million, implemented by PARC. The project was designed on the premise that large tracts of Pakistan’s virgin land are suitable for olive cultivation, supported by research findings from adaptability trials of exotic cultivars and the widespread presence of wild olive populations across the country.

The primary objective of the project was to realize the full potential of olive cultivation across major regions, including Balochistan, Khyber Pakhtunkhwa (KP), Punjab, Azad Jammu and Kashmir (AJK), Gilgit-Baltistan (GB), and Southern Punjab. The first phase (2014–2021) has been completed, while Phase II, with an expanded budget of PKR 6,410.229 million, was initiated in 2021-2022 under the implementation of the Pakistan Oilseed Department (POD) of the Ministry of National Food Security and Research (MNFSR) and was scheduled for completion in 2024.

Over its implementation period, the project aims to establish olive plantations on approximately 75,000 acres by supplying both imported and locally produced olive plants. It also focuses on strengthening public and private sector capacity for large-scale production of certified, disease-free nursery plants, including the development of mother orchards for quality budwood. Drip irrigation systems are being installed over 16,000 hectares, supporting approximately 3.6 million olive trees. At present, 25 olive oil extraction units of varying capacities are operational across the country in both public and private sectors. The project also emphasizes capacity building, particularly targeting youth and women, and includes the provision of oil extraction units and value-addition equipment to enhance processing capabilities. Overall, the project comprises nine components implemented at federal and provincial levels, including Punjab, Balochistan, KP, GB, and AJK. A detailed assessment of its agronomic outcomes is presented in Section III.

The Barani Agriculture Research Institute (BARI) at Chakwal has been engaged in olive research since 1991, during which more than 50 olive varieties have been evaluated for adaptability. In 2012, with the support of the Punjab Agriculture and Meat Company (PAMCO), a project was initiated involving the import of 13,100 saplings for the establishment of mother blocks. Subsequently, PIDSA-funded initiatives significantly accelerated olive development in the region, contributing to the transformation of the Potohar plateau into what is now referred to as the “Olive Valley” of Pakistan. In parallel, BARI conducted an adaptation study (2010-2014), funded by the Punjab Agricultural Research Board (PARB), focusing on the evaluation

of new olive cultivars and the standardization of propagation techniques and value-addition processes under rainfed conditions in Punjab.

- i) Complementing the federal POCCSP initiative, the Government of Punjab launched a provincial olive development project (2015-2020) with a budget of PKR 2,629.786 million. The project aimed to expand olive cultivation by over 15,100 acres through the distribution of approximately 2.04 million certified nursery plants. Key components included strengthening the private sector's capacity for plant acclimatization, providing technical support for orchard establishment and management, improving water resource development, and promoting efficient drip irrigation systems. The project received support from USAID, which played a significant role in strengthening institutional capacity, particularly in establishing BARI as a Centre of Excellence for olive research and development. As part of these efforts, the Centre of Excellence for Olive Research and Training (CEFORT) was established at BARI Chakwal with a total cost of PKR 283.121 million. CEFORT is tasked with advancing research and capacity building in olive cultivation, orchard management, post-harvest processing, and value addition. It also serves as a hub for technology development and dissemination, genetic resource conservation, and socio-economic research related to the olive sector.
- j) The "*Programme for Poverty Reduction*" (PPR), funded by the Italian Government and implemented by the Pakistan Poverty Alleviation Fund (PPAF), introduced olive cultivation as a livelihood diversification strategy for rural communities. Between 2016 and 2020, a total of 53,608 olive saplings were planted across approximately 560 acres, benefiting 692 households. In addition to plantation activities, the program facilitated the establishment of three olive oil extraction units, one in KP and two in Balochistan, managed by community-based associations in collaboration with PPAF and partner organizations. The facility in Lower Dir also includes a unit dedicated to table olive processing, contributing to local value addition and income generation.
- k) The European Union is currently funding the project "*Growth for Rural Advancement and Sustainable Progress (GRASP)*", implemented by the International Trade Centre (ITC) from 2019 to 2024 in selected districts of Balochistan and Sindh. The project aims to reduce poverty and promote sustainable and inclusive economic growth by supporting rural Small and Medium-sized Enterprises (SMEs). In Balochistan, olive cultivation has been identified as a priority crop, offering opportunities for synergy with ongoing national and provincial initiatives. Field-level implementation is supported by FAO (for agricultural development) and PPAF (for Small and Medium-sized Enterprises (SME) development). This initiative builds upon earlier European Union-funded programs, such as the *Programme for Economic Advancement and Community Empowerment (PEACE)*, implemented in Swat from 2012 to 2018, which supported olive oil production and community-based enterprise development. The GRASP project is expected to further strengthen these foundations, including the promotion of producer groups managing shared olive processing facilities.
- l) Keeping in view the olive cultivation success story, but also the complexity for reaching a viable value chain, the Government of Pakistan through Economic Affairs Division requested to Italian Agency for Development Cooperation (AICS) to further support the process of olive development. Positively, the Italian Government has financed the Project "*OliveCulture - Holistic and multi-professional Mechanism for a Pakistani Olive Value Chain*" which has been designed to strengthen the Pakistani olive oil value chain on several levels in a holistic,

participatory, and multifunctional way, involving institutions, businesses, farmers, youth, women and consumers, to improve productive, economic, and qualitative performances. The Project is funded by the Italian Ministry of Foreign Affairs and AICS and jointly implemented by CIHEAM – Bari and the Ministry of National Food Security and Research, through POD. The POD and its national project “Promotion of Olive cultivation on commercial scale in Pakistan - Phase II” are the main partners, encouraging herewith a holistic and multi-professional mechanism for strengthening the Pakistani quality olive value chain. The Project started on the 17th of January 2022 and ended in March 2024.

Table 1 provides a chronological overview of the major national and international projects implemented for the development of the olive sector in Pakistan.

Table 1. National and international projects executed for the promotion of olive cultivation and development of its value chain.

N°	Title of the project	Project time span	Executing organization/Sponsor	Project domain	Project cost PKR (Million)
1	Grafting wild olives into bearing species	1986	Pakistan Oilseed Development Board PODB	Pakistan Oilseed Development Board	-
2	Fruit, Vegetable and Olive Project	1986 to 1989	AGROTEC & Pakistan Agriculture Research Council (PARC)/Italian Government	Punjab, KPK, Baluchistan, FATA	-
3	Accelerated promotion of olive cultivation	2000 to 2004	Pakistan Oilseed Development Board (PODB)	KPK and Potohar	24.055
4	Rapid conversion of wild olive into oil bearing species	2004 to 2008	Pakistan Oilseed Development Board (PODB)	Punjab, KPK, Baluchistan	186.379
5	Development of olive model farms for R&D activities	NA	Pakistan Oilseed Development Board (PODB)	NA	-
6	Development of olive production and processing in Baluchistan	NA	PODB - M/o Food and Agriculture and Livestock (MINFAL)	Baluchistan	190.00
7	Promotion of the production and marketing of olive oil in Pakistan.	2007 to 2008	Istituto Agronomico per l'Oltremare (IAO) & Pakistan Oilseed Development Board (PODB)/ Italian Government	KPK, Baluchistan	0.8 M. Euro
8	Adaptation study of new cultivars of olive and standardization of its propagation and value addition techniques	2010 to 2014	PARB, Punjab and Barani Agriculture Research Institute (BARI), Chakwal	Barani Areas of Punjab	21.97
9	Technical assistance and support to line ministries in the agricultural sector with emphasis on olive production (AFNEPAK)	2012-2016	Istituto Agronomico per l'Oltremare (IAO) & Pakistan Agriculture Research Council (PARC)/Italian Government	Afghanistan, Nepal and Pakistan	2.4 M € (0.8 M for Pakistan)
10	Promotion of olive cultivation for economic development and poverty alleviation	2012 to 2015	Pakistan Italian Debt Swap Agreement (PIDSA) and PARC /Italian Government	Punjab, KPK, Baluchistan, FATA	382.15
11	Developing Potohar into an olive valley	2015 to 2020	Punjab Agriculture Development Program, BARI Chakwal	Punjab Barani regions	2629.79

12	Plantation of Five million of olive saplings in KPK and maintenance of model farm at Sangbhatti	2013 to 2019	Agriculture Program. Research Peshawar	Development Agriculture Institute,	KPK and FATA	1154.17
13	Development of olive production and processing in Baluchistan	2016 to 2019	Baluchistan Development Agriculture Institute, Quetta	Agriculture Program. Research	Baluchistan	190.00
14	Promotion of Olive Cultivation on commercial scale in Pakistan. Phase-1 (POCCSP)	2014 to 2022	M/o National Food Security and Research (MNFSR) - PARC		Punjab, KPK, Baluchistan, FATA and AJK	2320.27
15	Promotion of Olive cultivation on commercial scale in Pakistan. Phase-2 (POCCSP)	2021 to 2024	PSDP MFSR Pakistan Oilseed Department (POD)		Punjab, KPK, Baluchistan, AJK, GB, and Southern Punjab	6.41 billion
16	Project OliveCulture "Holistic and multi-professional mechanism for a Pakistani Olive Value Chain"	2022 to 2024	CIHEAM Bari & Pakistan Oilseed Department (POD)/ Italian Government		Baluchistan, Khyber Pakhtunkhwa, Punjab, Sindh, Gilgit-Baltistan and Islamabad Capital Territory	€ 1,500,000

III – Assessment of the agronomic studies done with the PSDP project from 2014

To effectively evaluate agronomic activities and olive crop production under the national project “*Promotion of Olive Cultivation on Commercial Scale in Pakistan (POCCSP, 2021)*,” it is essential to first provide a clear overview of the initiative. The project, briefly introduced in the previous section, was approved in 2014 with a total allocation of Rs. 2,320.27 million, aiming to harness the country's potential for olive cultivation. The Ministry of National Food Security & Research entrusted to PARC its implementation. The initiative was structured in two phases and covered multiple regions, including Baluchistan, KP, Punjab, AJK, and GB. Phase I was successfully completed in 2019.

Subsequently, the second phase, titled “*Promotion of Olive Cultivation on Commercial Scale in Pakistan (Phase II): National Program on Olive Deepening*”, was approved during the Executive Committee of the National Economic Council (ECNEC) meeting held on 1st of June 2021 by the Ministry of Planning Development & Special Initiatives. The MNFSR assigned its implementation to POD. Phase II targets the expansion of olive cultivation to 75,000 acres, alongside the grafting of 5 million wild olive plants across public and private lands, including forest areas. In addition, the program includes support for the establishment of six olive oil extraction units, ten table olive processing units, and ten nursery tunnels, all provided to the private sector on a 50% matching

grant basis. This phase was initiated during 2021-2022 and is scheduled for completion by 2024 (POCCSP, 2022).

Overall, the PSDP-funded project (Phases I and II combined) is designed to strengthen the olive value chain across diverse agro-ecological zones by providing essential services, infrastructure, equipment, and inputs. The key objectives defined for Phase I include:

- Establishment of olive plantations over 50,000 acres;
- Development of infrastructure and capacity in both public and private sectors for large-scale production of true-to-type, disease-free nursery plants;
- Provision of both exotic and locally produced olive plants to farmers;
- Human resource development through training programs, with emphasis on youth and gender inclusion;
- Installation of oil extraction units and value-addition equipment to support processing;
- Development of mother orchards for the supply of high-quality budwood.

These interventions were designed to incorporate state-of-the-art technological support, aiming to enhance the capabilities of stakeholders across the entire olive value chain, from production to processing. The project interventions and their follow-up progress and achievements for the period 2014-2021 (POCCSP, 2022) are summarized in Table 2.

In addition to the progress mentioned in Table 2, it may be mentioned: (i) 20% - 30% of the olive fruits are used in preparing value-added products, pickles, jams, sweets, and syrups which have increased demand, (ii) joint research, development, and training of olive value chain stakeholders have been conducted through specialized dedicated institutions such as CEFORT established by the Government of Punjab at BARI Chakwal with technical and financial support of USAID Pakistan, and (iii) the intellectual property rights for marketing olive oil and value-added products, a trade mark and logo as "*Pak Olive*" has been approved by the intellectual property organization, Government of Pakistan.

The project assigned an "Impact Assessment Study", released in April 2022 and conducted by Khaity.Pk. The study was based on a structured, questionnaire-based survey of approximately 670 olive growers representing the project's operational regions across the country. It provided a comprehensive evaluation of the project's interventions and their outcomes. Overall, the findings indicate that the implemented activities have generated tangible results and positive impacts, highlighting Pakistan's strong potential to further develop a sustainable olive value chain. It is important to note that the assessment covers the period from 2014 to 2021, during which only about 20% of the plantations had begun fruiting.

Table 2. Summary of key interventions and progress under POCCSP.

Intervention	Description	Progress
Provision of certified, true-to-type olive plants	Distribution of imported certified olive saplings	13,354 acres planted (1.719 million saplings): Baluchistan 56%, KP 24%, Punjab 15%, AJK 3%, GB 2%; ~3,884 farmers benefited; >17% plantations fruiting
Installation of drip irrigation systems	Deployment of High-Efficiency Irrigation Systems (HEIS) at farm level	Installed on 1,686 acres for 124 farmers (75% of target): Baluchistan 35%, KP 45%, Punjab 20%
Specialized nurseries	Establishment of double-shaded nurseries for propagation	12 nurseries established: 6 in Baluchistan, 3 in KP, 2 in Punjab, 1 in ICT; equipped with irrigation, heating, cooling, and temperature control systems
Olive oil extraction units	Installation of olive processing mills	9 mills installed: MORI TEM Oliomio Gold (100 kg/hr) at multiple sites; PIERALISI (600 kg/hr) at BARI Attock, ARI Loralai, BARDC Quetta
Adaptability support	Support to provinces for testing exotic olive varieties	25 trials completed; data collection ongoing for variety registration and certification
Establishment of olive mother blocks (GPUs)	Development of germplasm units in public institutions	GPUs established across all project regions, including GB and AJK
Local propagation	Production of olive plants through cuttings	1.856 million cuttings planted across project components
Training of stakeholders	Capacity building across the olive value chain	63 training sessions conducted (out of 91); >4,370 farmers trained in best practices, processing, and marketing
Installation of weather stations	Deployment of agro-meteorological monitoring systems	5 stations installed: BARI Attock, NTHRI Shinkiyari, ARI Quetta, UET Khuzdar, Loralai
Upgradation of value-addition labs	Enhancement of research and processing laboratories	Labs upgraded at BARI Chakwal, ARI Tarnab, ARI Quetta; improved infrastructure, equipment, and standardization capacity

As olive trees typically reach full productivity after nearly 10 years, the long-term outcomes are expected to be significantly greater. The key findings of the study are summarized below:

- Approximately 45% of irrigated land and 35% of rainfed land have been allocated to olive cultivation.
- The average survival rate of olive plantations on farmers' fields ranges between 80-90%, although mortality rates of up to 50% were reported in some cases, mainly due to drought and water scarcity.
- About 73% of farmers reported receiving guidance from the project on cultivar selection, with Arbequina and Arbosana being the most widely planted varieties.
- Around 37% of farmers reported the presence of wild olive trees on their land, typically covering areas between 1 to 10 acres.

- Approximately 59% of farmers use pesticides once or twice a year to manage pests and diseases, with costs ranging from Rs. 1,000 to 10,000 per acre.
- About 86% of farmers apply fertilizers, mostly once per season, at an average cost of Rs. 10,000 per acre. Among them, 90% rely on organic fertilizers, particularly animal manure (81%) and poultry waste (6%). Meanwhile, 13% of farmers reported not using any fertilizers.
- Of the 670 farms surveyed, only 19% had started production, and about 7% had reached 50% production capacity.
- Harvesting is predominantly manual, practiced by 99% of farmers, while only 1% use mechanical tools. The lack of appropriate harvesting machinery remains a major constraint. Harvesting costs are typically around Rs. 10,000 per acre.
- Drip irrigation systems were installed on 1,686 acres under the project, whereas other farmers continue to rely on conventional irrigation methods.
- A large majority (91%) of farmers believe that olive cultivation has a positive impact on soil quality.
- Livestock manure is widely used as fertilizer, accounting for 77% of usage across provinces.
- In most cases, farms are located more than 5 km from markets, which increases transportation challenges.
- Around 35% of farmers produce value-added olive products at the farm level. Among these, producers are distributed as follows: Baluchistan (53%), KP (14%), Punjab (28%), and ICT/Federal (5%).
- Access to processing and storage infrastructure remains limited: 63% of farmers lack access to olive extraction units, 78% do not have access to government storage facilities, and 69% do not own storage facilities. Notably, 90% expressed interest in establishing such facilities with government support (80-100% subsidy).
- Regarding government-established value-addition laboratories, 48% of farmers reported no access, 35% did not respond, and 9% were unaware of their existence.
- Concerning weather stations, 74% of farmers reported no nearby access or awareness, while only 11% had access to such facilities.
- Farm maintenance costs were estimated at approximately Rs. 5,000 per acre by 21% of farmers, while 76% did not provide a response.
- Transportation costs vary depending on distance to market: 46% of farmers reported costs below Rs. 20,000, 9% between Rs. 20,000-50,000, and 43% between Rs. 50,000-100,000.
- Training programs were attended by 54% of farmers, while 11% were unaware of such opportunities. Participants generally reported positive impacts on their skills and knowledge, with strong demand for future training, particularly in agronomic practices and cost reduction.
- Overall, 58% of farmers stated that training improved their knowledge of olive cultivation, while 37% did not respond and 4% reported no noticeable benefit.
- 84% of farmers believe that olive cultivation has a positive impact on surrounding vegetation and wildlife.

IV – Synthesis of agronomic research on olive cultivation in Pakistan

Olive tree vegetative and reproductive growth are strongly influenced by environmental factors such as light availability, canopy architecture, and varietal characteristics (Schneider *et al.*, 2012; Cherbiy-Hoffmann *et al.*, 2013; Rousseaux *et al.*, 2020). Differences among cultivars in leaf area distribution, anatomical traits, and canopy structure play a crucial role in determining productivity. Under Mediterranean conditions, cultivars such as Arbequina, Coratina, and Frantoio have been identified as highly suitable due to their favorable agronomic and physiological traits (Tous, 2010; Neri *et al.*, 2020).

1. Adaptability and cultivar evaluation

To assess suitability under local conditions, extensive adaptability trials have been conducted across Pakistan. Trials at 93 locations across the country have assessed cultivar suitability for different ecological zones (Awan *et al.*, 2014; Pulido-Fernández *et al.*, 2019). According to the POCCSP project report (2014-2021), more than 100 olive cultivars were introduced and tested, particularly by BARI Chakwal and ARI Peshawar. These studies demonstrated that a large proportion of the tested cultivars are suitable for oil extraction, while some show better performance as table olives.

Despite this extensive work, a major limitation remains the absence of a centralized and structured database linking cultivar performance to specific environmental conditions. This gap makes it difficult for farmers to select appropriate varieties based on yield potential, oil quality, and adaptability. Historically, the availability of certified, true-to-type, disease-free planting material was also a constraint, although recent initiatives under POCCSP have improved access through nursery development and plant distribution.

Given that Pakistan's climate differs from the Mediterranean, often characterized by higher temperature extremes, lower and erratic rainfall, and variable soil conditions, cultivar performance varies widely across regions. For example, oil content analysis of different cultivars collected from Quetta, Loralai, and Zhob showed significant variation, with oil content ranging from 17.5% in Dolce Agogia to 65% in Gemlik (Khaliq *et al.*, 2020). Gemlik was identified as a superior cultivar in terms of oil recovery, while Arbequina and Frantoio also showed consistently high oil content.

Regional comparative studies further highlight environmental effects. In Chakwal, higher fruit set, number of fruits per tree, and oil content were recorded, whereas Sangbhatti conditions favored larger fruit size and higher overall fruit yield (Awan and Rab, 2014). Cultivar-specific responses were also evident: Leccino performed best in terms of fruit number, yield, and oil content, Pendolino exhibited higher fruit set percentage, and Coratina produced larger fruits but with comparatively lower oil content.

Similarly, under arid sub-tropical conditions of Quetta, significant differences among cultivars were observed in oil content and yield components. Kalamata (21%), Leccino (20%), and Arbequina (17%) showed the highest oil production, while Pendolino (16%) and Arbosana (10%)

performed less favorably (Asif *et al.*, 2022). These findings confirm that genotype × environment interactions play a decisive role in cultivar performance.

2. Yield, oil quality, and biochemical traits

Climatic conditions strongly influence olive oil composition and quality, particularly fatty acid profiles and phenolic content. Studies have shown that temperature, rainfall, and altitude significantly affect oil characteristics (Awan *et al.*, 2015). For instance, olives grown in Chakwal exhibited higher levels of palmitic, palmitoleic, stearic, and linoleic acids, whereas those grown in Sangbhathi had higher oleic and linolenic acid content. The wetter conditions in Sangbhathi were also associated with increased polyphenol concentration, which contributes to antioxidant activity and oil stability.

Oil quality parameters such as peroxide value (PV) and acidity generally remained within acceptable limits for virgin olive oil as defined by international standards, although variations were observed across locations (Ullah *et al.*, 2018; Awan *et al.*, 2020). In some cases, PV exceeded recommended limits, particularly in Chakwal, likely due to environmental stress and differences in enzymatic activity, such as lipxygenase.

Morphological and biochemical characterization studies further revealed substantial diversity among olive genotypes. For example, Qureshi *et al.* (2020) reported significant variation in leaf morphology, fruit weight, and fatty acid composition among eight olive genotypes from the Potohar region. The genotype Mariana exhibited the highest fruit weight (5.41 g) and favorable fatty acid composition, indicating its suitability for semi-arid conditions. Similarly, Sumrah *et al.* (2021) found that table olive varieties such as Ascolana, Earlik, Gemlik, and Hamdi performed well under Pothwar conditions, producing high yields (up to 22.66 kg/tree), larger fruits (6.29 g), and higher oil recovery (24.66%).

3. Propagation, grafting, and plant establishment

Propagation techniques, particularly grafting, significantly influence plant establishment and early growth. Hussein *et al.* (2016) demonstrated that grafting time affects multiple growth parameters, including sprouting percentage, shoot length, and leaf development. Grafting in July resulted in higher sprouting rates and number of sprouts, while June grafting promoted longer shoots and greater leaf development. Among the cultivars tested, Frantoio showed superior overall performance, suggesting its suitability as a scion under local conditions.

4. Phenology, pollination, and fruit set

Phenological traits and reproductive biology are critical for determining olive productivity. Pollen viability and germination capacity, which directly affect fertilization success, vary among cultivars and are influenced by environmental conditions, particularly temperature (Iqbal *et al.*, 2020). Several cultivars, including Gemlik, Coratina, Frantoio, Nabali, and Moraiolo, showed promising pollen performance, while Ottobratica was identified as a suitable pollinizer due to its high pollen viability.

Fruit set and yield are closely linked to pollination dynamics. Studies conducted under Pothwar conditions revealed that cultivars such as Coratina, Frantoio, and Leccino exhibit partial self-incompatibility, whereas Ottobratica is fully self-incompatible (Iqbal *et al.*, 2020). Cross-pollination significantly improves fruit set and yield, emphasizing the importance of selecting compatible cultivar combinations in orchard design. In most cases, fruit set percentages remained relatively low, indicating the need for improved pollination management strategies under local conditions.

5. Environmental and nutritional influences

Nutrient availability and seasonal dynamics play an important role in olive growth and productivity. Farhat *et al.* (2021) reported that calcium levels peak during periods of active vegetative growth, while magnesium levels increase during fruit development and dormancy. Soil analysis from olive-growing regions indicated alkaline conditions with low organic matter and deficiencies in nitrogen and phosphorus, while potassium, calcium, and magnesium were generally adequate. These findings highlight the importance of targeted nutrient management to optimize yield and quality.

6. Local germplasm and future prospects

The evaluation of local and exotic germplasm has contributed to the identification of promising cultivars for different regions. Locally developed varieties such as Zaitoon-1 and Zaitoon-2 have shown good adaptability, with average yields of approximately 23 kg per plant and oil content around 19.34% (BARI, 2022). These cultivars have demonstrated successful performance across multiple districts in Punjab, indicating strong potential for expansion.

In addition, studies on wild olive species (*Olea ferruginea*) have explored their potential as an alternative oil source. Although current oil quality is relatively low and classified as lampante due to processing limitations, improvements in harvesting and processing practices could enhance its commercial value (Anwar *et al.*, 2013).

Despite the extensive research conducted, significant gaps remain, particularly in the systematic evaluation of cultivars across different agro-ecological zones such as Baluchistan (Palwasha *et al.*, 2022). Future research should focus on integrating morphological, biochemical, and molecular approaches to better characterize olive germplasm and develop region-specific recommendations for sustainable olive production.

V – Identification of the major olive varietal trials established in Pakistan

1. Varietal tests and performance

As outlined in the previous sections, thousands of olive plants were imported from countries where olive cultivation is well established as a commercial crop. The primary objective was to promote olive cultivation in Pakistan by introducing these exotic cultivars and evaluating their performance under local conditions. These varieties were planted across diverse agro-ecological zones to identify both the most promising cultivars and the areas best suited for olive production. In parallel, the multiplication of selected varieties was initiated through the establishment of

mother blocks in suitable regions. However, the development of nursery systems remained inadequate, limiting the large-scale availability of planting material.

The varieties recommended for dissemination were predominantly exotic, sourced mainly from Mediterranean countries such as Italy and Spain, as well as from North Africa. Nevertheless, it is important to recognize that olive cultivars do not perform uniformly across different environments, and their adaptability is highly dependent on local climatic and edaphic conditions.

From a research perspective, a well-structured evaluation and selection system based on adaptability trials is essential to identify cultivars that are best suited to specific agro-climatic zones. Evidence suggests that olive varieties performing well under sub-mountainous agro-climatic conditions offer strong potential for the successful establishment of commercial olive cultivation and the development of a sustainable olive industry in such regions, provided that other agronomic and infrastructural requirements are met.

Although a substantial number of varietal trials were established under the PIDSA project with the aim of generating reliable data in a timely manner, the lack of consistent follow-up and systematic monitoring limited their effectiveness and the overall utility of the results.

2. Olive varieties genetic characterization studies

In Pakistan, limited information is available on the genetic diversity and divergence of both cultivated and indigenous wild olive populations, despite its importance for crop improvement and germplasm utilization (Naz *et al.*, 2019). Several molecular studies have therefore been conducted to characterize olive genetic resources using different marker systems.

A. Genetic diversity and differentiation between wild and cultivated olives

Initial studies using Randomly Amplified Polymorphic DNA (RAPD) markers revealed substantial genetic diversity among olive genotypes collected from regions such as Buner, Bajaur, Malakand, and Upper Dir (Naz *et al.*, 2019). A total of 36 loci were amplified across 30 genotypes, all of which were polymorphic, indicating high genetic variability. Gene diversity values ranged from 0.067 to 0.515, confirming the presence of both low and highly variable loci.

Multivariate analyses clearly distinguished wild and cultivated genotypes, demonstrating significant divergence between them. Wild olive populations from Malakand, Buner, and Bajaur were genetically closer to each other, while those from Upper Dir were more distinct. These findings highlight the potential of wild germplasm as a valuable genetic resource for breeding and cultivar development. However, the study also emphasized the need for broader sampling and the use of more advanced genotyping tools to better understand population structure.

Similarly, Amplified Fragment Length Polymorphism (AFLP) analysis confirmed clear genetic separation between *Olea europaea* (cultivated) and *Olea cuspidata* (wild) populations in Azad Jammu and Kashmir (Hussain *et al.*, 2017). The results suggested that cultivated olives were likely introduced from abroad and subsequently propagated through grafting onto local wild rootstocks. This distinction is important for maintaining genetic diversity and guiding grafting strategies to avoid genetic erosion.

DNA fingerprinting and varietal identification

Molecular tools have also been widely applied for varietal identification and authentication. Chloroplast DNA (cpDNA) markers have proven effective in distinguishing olive cultivars through phylogenetic analysis (Noman *et al.*, 2015). Using concatenated chloroplast gene sequences, more than 100 unknown samples were analyzed, resulting in the identification of 49 plants belonging to 10 known varieties, including Arbosana, Frantoio, Koroneiki, Leccino, and Coratina. However, approximately 51% of samples could not be assigned to known varieties, indicating the presence of uncharacterized germplasm or the lack of reference sequences.

Phylogenetic reconstruction and SNP analysis further confirmed clear clustering of major cultivars, while sequence similarity was higher within cultivars (>98.7%) than between cultivars (~96-97%). These findings demonstrate the utility of chloroplast markers for reliable and cost-effective varietal identification and highlight their potential for germplasm conservation and nursery certification.

A large-scale study by Ramazan and Ali (2014) further supported the effectiveness of DNA-based identification. Out of 965 unknown olive plants analyzed, 515 were successfully classified into 27 varieties using chloroplast DNA markers and genome sequence analysis. However, a substantial proportion (47%) remained unidentified due to the absence of reference genome sequences. The study emphasized the importance of expanding reference databases and using multiple marker regions (concatenated sequences) to improve identification accuracy. It also contributed to the development of a valuable DNA sequence repository for indigenous olive germplasm.

B. SSR and RAPD marker-based genetic analysis

Simple Sequence Repeat (SSR) markers have been extensively used to assess genetic diversity and population structure. In one study, 63 SSR markers amplified 618 alleles across 13 olive varieties, of which 582 were polymorphic, indicating high allelic diversity (Iqbal *et al.*, 2021). Cluster analysis grouped the genotypes into two major clusters: one including varieties such as Manzanilla, Arbequina, and Koroneiki, and the other comprising Bari Zaitoon, Coratina, Gemlik, Frantoio, Pendolino, and Ottobratica. Certain markers, such as UDO-24, demonstrated high discriminatory power by identifying multiple varieties individually.

RAPD marker systems have also been used for DNA fingerprinting and varietal differentiation (Iqbal *et al.*, 2019). In this study, 59 out of 62 markers were polymorphic, generating 583 alleles, of which 498 were polymorphic. Genetic similarity among varieties ranged from 0.548 to 0.728, indicating moderate genetic divergence. Specific primer combinations were able to distinguish all studied varieties, demonstrating the effectiveness of RAPD markers for varietal identification and nursery certification, although some cultivars such as Bulkasar selection and Arbequina lacked unique alleles.

C. Implications for breeding and germplasm management

Overall, these studies consistently demonstrate a high level of genetic diversity among both wild and cultivated olive populations in Pakistan. The clear genetic distinction between indigenous wild olives and introduced cultivars provides opportunities for their use in breeding programs, particularly for improving adaptability to local environmental conditions. At the same time, the

presence of a large proportion of unidentified genotypes highlights the need for more comprehensive reference databases and advanced molecular tools. The integration of different marker systems (RAPD, SSR, AFLP, and cpDNA sequencing) can significantly enhance the accuracy of varietal identification, support germplasm conservation, and ensure the propagation of true-to-type planting material. These findings are particularly relevant for the development of a sustainable olive industry, as they provide a scientific basis for cultivar selection, breeding strategies, and the establishment of certified nurseries in Pakistan.

VI – Strategic considerations and policy gaps in the development of the olive sector in Pakistan

The promotion of olive cultivation as an alternative oilseed crop for edible oil production represents a promising opportunity for Pakistan. Large areas of the country, particularly marginal lands and regions not currently utilized for major cash crops, are well suited for olive production. However, to fully realize this potential, strong policy support and widespread awareness are required to encourage both consumers and industry stakeholders to adopt olive oil as a viable and healthier alternative to conventional vegetable oils.

The review of the olive sector indicated that numerous initiatives have been undertaken at federal and provincial levels, along with contributions from international donors, particularly Italy, as well as local NGOs and community organizations. Despite significant financial investments and research support, these efforts have not yet translated into a substantial breakthrough in olive cultivation or domestic olive oil production. This suggests that existing interventions, although extensive, lack coherence, coordination, and long-term strategic alignment.

One of the major gaps identified is the lack of standardization and coordination in research activities. Multiple institutions are engaged in varietal evaluation through adaptability trials and genetic characterization using molecular tools such as DNA markers, polymorphism analysis, and Simple Sequence Repeats (SSR). However, there is no unified system for data collection, evaluation protocols, or reporting standards aligned with international practices. This limits the comparability and practical application of research findings. Similarly, certification systems for olive planting material and nurseries, whether imported or locally developed, are either weak or absent, and are not governed by accredited bodies in accordance with international standards.

Furthermore, legislative and policy frameworks for genetic improvement of olive crops remain underdeveloped. Issues such as varietal registration, plant certification, disease resistance breeding, and quality assurance require formal regulation at both national and provincial levels to ensure sustainable sector growth.

Institutional coordination between federal and provincial stakeholders is also weak, often leading to duplication of efforts and inefficient resource utilization. Moreover, collaboration among technical experts, including breeders, pathologists, agronomists, data analysts, and market specialists, is insufficient. There is a clear need for an integrated support system that connects all stakeholders across the olive value chain, including growers, researchers, extension services, processors, commercial actors, and policymakers. Establishing a dedicated body, such as a Pakistan Olive Oil Council, could play a critical role in coordinating sectoral activities, monitoring progress, and facilitating policy reforms related to production, processing, marketing, and trade.

Several structural and economic constraints further hinder sector development. These include competition with established cash crops due to the absence of crop zoning policies, price volatility, underdeveloped market infrastructure, weak industrial linkages, and limited adoption of recommended agronomic practices by farmers. Additionally, the lack of a comprehensive and consistent olive development policy has restricted long-term planning and investment.

To address these challenges, a cluster-based approach to olive cultivation is recommended. Identifying and developing agro-ecological clusters dedicated to olive production can enhance productivity and efficiency. These clusters should be supported through targeted subsidies, improved market linkages, public-private partnerships, and access to specialized agronomic technologies. Organizing smallholder farmers into cooperatives at village and regional levels would further strengthen production systems, facilitate processing, and improve market access.

At the policy level, Pakistan currently lacks a comprehensive legal and regulatory framework governing the olive value chain, from production to processing and marketing, aligned with international standards. While the National Food Security Policy (2018) highlights the importance of promoting oilseed crops for import substitution, a dedicated and coherent olive policy is still missing. Such a policy should clearly define the roles and responsibilities of federal and provincial governments, particularly in the context of the 18th Constitutional Amendment, and establish a coordinated roadmap for sector development.

Finally, integrated policy interventions are required across the entire value chain. These should include financial incentives, infrastructure development, support for cooperative systems, and strengthened linkages between producers and processing industries. A sustainable olive sector strategy should focus on expanding cultivation, promoting high-yielding and stress-tolerant cultivars, improving processing technologies, and enhancing value addition. Aligning these efforts within a unified national framework will be essential to reduce dependence on imported edible oils and to unlock the full potential of the olive industry in Pakistan.

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Assessment of the olive value chain in Pakistan

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Abstract. The development of Pakistan's olive value chain requires a clear understanding of existing resources, institutional support, production trends, and territorial potential. This study analyzes the proposed olive value chain through a SWOT framework, highlighting the main strengths, weaknesses, opportunities, and threats affecting its development. It also examines available data on olive production and consumption to assess the current status and future prospects of the sector. Particular attention is given to public-sector services and facilities provided at federal and provincial levels, including government initiatives designed to support olive cultivation, processing, and value chain development. The study further maps existing services, facilities, and provincial interventions, while assessing wild olive resources with agronomic potential in suitable provinces. By combining value chain analysis, institutional mapping, and resource assessment, the study provides a basis for identifying gaps, improving coordination, and strengthening strategic planning. Overall, the findings support the development of a more structured, sustainable, and competitive olive value chain in Pakistan.

Keywords. Value chain analysis – SWOT analysis – Resources management – Wild olive resources.

Évaluation de la chaîne de valeur oléicole au Pakistan

Résumé. Le développement de la chaîne de valeur oléicole au Pakistan nécessite une compréhension claire des ressources disponibles, du soutien institutionnel, des tendances de production et du potentiel territorial. Cette étude analyse la chaîne de valeur oléicole proposée à travers une approche SWOT, en mettant en évidence les principales forces, faiblesses, opportunités et menaces influençant son développement. Elle examine également les données disponibles sur la production et la consommation d'olives afin d'évaluer la situation actuelle et les perspectives du secteur. Une attention particulière est accordée aux services et infrastructures du secteur public aux niveaux fédéral et provincial, ainsi qu'aux initiatives gouvernementales visant à soutenir la culture, la transformation et le développement de la chaîne de valeur oléicole. L'étude cartographie également les services, installations et interventions provinciales existants, tout en évaluant les ressources en oliviers sauvages présentant un potentiel agronomique dans les provinces adaptées. En combinant analyse de la chaîne de valeur, cartographie institutionnelle et évaluation des ressources, l'étude fournit une base pour identifier les lacunes, améliorer la coordination et renforcer la planification stratégique du secteur oléicole au Pakistan.

Mots-clés. Analyse de la chaîne de valeur – Analyse SWOT – Gestion des ressources – Oliviers sauvages.

I – Introduction

Agricultural growth is fundamental to Pakistan's economic stability and long-term financial sustainability. The agricultural sector plays a pivotal role in the national economy, contributing approximately 21% to the gross domestic product (GDP) and employing nearly 45% of the labor force (Pakistan Economic Survey, 2022; PBS, 2022). However, rapid population growth and the expansion of the middle-income class have significantly increased the demand for agricultural commodities, particularly edible oils.

Over the past two decades, agricultural growth has remained relatively modest, fluctuating between 1% and 4%, barely keeping pace with population growth. Consequently, Pakistan's dependence on imported food commodities, especially edible oils, has increased substantially. For instance, edible oil imports reached approximately USD 3.56 billion during the first 11 months of the fiscal year ending June 30, 2022, representing nearly 60% of the USD 6 billion loan agreement with the International Monetary Fund (Tribune Express, 2022). According to the Pakistan Bureau of Statistics, this marked a 44% increase compared to USD 2.47 billion recorded during the same period in the 2020-2021 fiscal year (PBS, 2022). This growing import bill, combined with rising global prices, has made edible oils increasingly unaffordable in domestic markets, necessitating government subsidies.

Edible oil constitutes a staple component of the national diet, and its demand is relatively inelastic. Pakistan ranks among the world's largest consumers of edible oil, with a per capita consumption of approximately 22 kg per year (SBP, 2022). Despite this high demand, domestic production remains insufficient. The country relies heavily on a combination of locally produced oilseeds and imported raw and refined oils. While cottonseed is largely sourced domestically, soybean is entirely imported, and rapeseed and sunflower are both locally produced and imported. Overall, the edible oil sector remains highly dependent on imported oilseeds and refined palm oil to meet national demand.

In this context, olive (*Olea europaea* L.) cultivation presents a promising alternative for enhancing domestic edible oil production. Over the past two decades, olive has been introduced and progressively promoted in Pakistan as a high-value crop suitable for marginal and rainfed areas. According to the Ministry of National Food Security and Research (MNFSR) and the Ministry of Climate Change, approximately 4.1 million hectares of land have been identified as suitable for olive cultivation across diverse agro-ecological zones (MCC, 2022; Tribune Express, 2022). Estimates suggest that up to 15.4 million hectares could potentially support olive cultivation, particularly in Punjab, Khyber Pakhtunkhwa, Balochistan, the former FATA regions, and parts of Sindh.

Government-led initiatives, supported by technical and financial collaboration with the Italian government, have accelerated the expansion of olive cultivation in recent years. Large-scale plantation efforts have been established in Balochistan, Khyber Pakhtunkhwa, and Punjab. These initiatives include the provision of subsidized planting material, drip irrigation systems, and olive processing equipment to farmers through publicly funded development programs. Despite these efforts, domestic production remains limited. As of 2020, Pakistan imported approximately 4,000 tons of olive oil, while local production has averaged around 1,500 tons of olive oil and 830 tons of table olives annually since 2010, with most of the output consumed domestically.

To reduce import dependency and enhance food security, Pakistan must significantly scale up olive cultivation and strengthen the entire olive value chain. This includes improving productivity, expanding processing capacity, and enhancing market competitiveness. The development of a sustainable olive sector will depend on supportive government policies, private sector engagement, and the creation of an enabling environment for investment and innovation. Furthermore, productivity gains will require the adoption of advanced agronomic practices, strengthened research and development, human capacity building, and improved marketing systems.

Currently, the olive and olive oil sector in Pakistan is in an emerging phase and faces several structural and institutional challenges. Addressing these constraints will require coordinated efforts from both public and private stakeholders to unlock the sector's full potential.

This chapter aims to provide a comprehensive overview of the olive value chain in Pakistan by synthesizing existing inter-institutional knowledge related to olive cultivation, germplasm resources, varietal adaptation, orchard establishment, production systems, processing, and market development. Particular attention is given to the distribution of wild and cultivated olive germplasm, the adaptation of local and imported ecotypes under different agro-climatic conditions, and agronomic strategies for converting wild olive stands into productive orchards. The analysis is based on an extensive review of available reports, scientific literature, online resources, and stakeholder consultations involving public institutions, private sector actors, and international organizations.

II – SWOT analysis of the proposed olive value chain

SWOT analysis is a well-established strategic assessment tool that has been widely applied for several decades in policy development, business planning, and sectoral evaluations. The acronym SWOT refers to Strengths, Weaknesses, Opportunities, and Threats, which are systematically organized into a four-quadrant framework to evaluate the viability and strategic positioning of a given initiative within a specific context. A robust SWOT analysis relies heavily on accurate contextual knowledge, making it essential to integrate sector-specific and region-specific information.

This analytical approach is commonly employed by policymakers, businesses, and development practitioners due to its simplicity and effectiveness in identifying key internal and external factors influencing a sector. In the context of the olive sector in Pakistan, strengths and weaknesses are considered internal factors, reflecting the current structural and operational conditions of the sector. In contrast, opportunities and threats are external factors, shaped by the broader economic, environmental, and institutional environment, and indicative of potential future developments.

By integrating these four dimensions, the SWOT framework provides a comprehensive overview of the sector and supports informed decision-making, strategic planning, and the effective implementation of development interventions.

The SWOT analysis of the Pakistani olive value chain presented in this study is structured across four thematic areas:

- a. Production and processing: encompassing technical, agronomic, and environmental aspects, including nurseries, cultivation practices, and oil extraction facilities;
- b. Marketing: addressing commercial dynamics, market access, value addition, and consumer demand;
- c. Legislation, certification, and policies: covering regulatory frameworks, quality standards, financial incentives, and institutional support mechanisms;
- d. Research, education, training, and extension services: including scientific research, capacity building, knowledge transfer, and technical assistance.

Enhancing commodity productivity is critical for improving the competitiveness of enterprises within the value chain. This requires the establishment of an enabling environment through effective government policies, including the provision of services, appropriate pricing mechanisms, and efficient policy implementation. Furthermore, value chain development is driven by technological adoption, a culture of innovation, human capital development, and improved management practices.

The present SWOT analysis of the olive value chain in Pakistan is based on a comprehensive desk review of past and ongoing project reports, peer-reviewed publications, and stakeholder consultations. These consultations involved researchers, scientists, technicians, olive growers, and olive oil processors operating in key regions, including Balochistan, Khyber Pakhtunkhwa, and Punjab.

The findings indicate that the olive value chain in Pakistan holds substantial potential for growth and expansion, particularly in light of recent public sector initiatives and increasing private sector engagement. The results of this analysis provide a strategic foundation to guide investment decisions by both government and private stakeholders, with the aim of promoting olive cultivation and strengthening the olive oil industry in the country.

A summary of the key findings is presented in the SWOT matrix (Table 1), which outlines the main factors influencing the development and future prospects of the olive and olive oil value chain in Pakistan.

1. Strengths

- Pakistan possesses substantial agro-ecological diversity, with climatic zones ranging from hot and arid lowlands to cooler northern highlands. These conditions are suitable for cultivating a wide range of olive varieties. Additionally, naturally occurring wild olive populations indicate strong ecological adaptability and genetic resources.
- The country has extensive areas of cultivable waste and marginal lands. Out of a total land area of 79.6 million hectares, only 22.1 million hectares are currently cultivated, offering significant potential for expansion of olive cultivation.
- Approximately 30.9 million hectares (about 39.6% of total land area) are classified as arable land, where olives can be integrated into existing cropping systems.
- Nearly 16 million hectares of land are affected by soil erosion. Large-scale olive plantation could contribute to soil conservation, reduction of desertification, and sustainable land management, while generating economic returns.
- Expansion of olive cultivation can enhance biodiversity, increase carbon sequestration, and promote efficient water use, particularly through the adoption of micro-irrigation systems.
- Olive cultivation offers attractive economic returns. Studies indicate a high internal rate of return, estimated at approximately 31% at a 10% discount rate, suggesting strong investment feasibility.
- The government, particularly the Ministry of Planning, Development and Special Initiatives, has prioritized reducing dependence on edible oil imports, creating a favorable policy environment for olive sector development.
- National and provincial agricultural policies recognize oilseed crops, including olives, as strategic commodities for import substitution and value chain development.

- The Strategic Trade Policy Framework (2020-2025) supports agricultural mechanization, value chain integration, and agribusiness development, indirectly benefiting the olive sector.
- Infrastructure initiatives such as the China-Pakistan Economic Corridor (CPEC) may further enhance market access and logistics for olive production in corridor-adjacent regions (Ahmad, 2020).
- Locally produced olive oil demonstrates promising quality characteristics, with the potential to meet international standards and access export markets.
- There is significant potential for value addition and by-product development due to the availability of raw material and the possibility of increasing productivity through improved agronomic practices and expanding plantation areas.
- Pakistan has a large and cost-effective labor force, both skilled and unskilled, which can support the development of the olive value chain.
- Olive cultivation also carries cultural and religious significance, which may encourage adoption and long-term investment, given the longevity and sustainability of olive trees.

2. Weaknesses

- Limited agro-ecology-specific research and insufficient scientific data on varietal performance, adaptability, and best management practices constrain sector development.
- There is a lack of certified nurseries and standardized plant propagation systems, along with inadequate implementation of Good Agricultural Practices, leading to low orchard productivity.
- Post-harvest management practices are poorly developed. Inadequate knowledge regarding harvesting techniques, fruit handling, and quality preservation leads to reduced oil quality and increased losses.
- Value addition remains limited, with minimal development of processed products such as table olives, olive-based foods, and by-products.
- Inadequate infrastructure for packaging, storage, and transportation, particularly among smallholder farmers, results in post-harvest losses and reduced profitability due to the perishable nature of olives.
- The absence of a structured and regulated marketing system forces farmers to rely on intermediaries, leading to lower farm-gate prices, high transaction costs, and inefficient market access.
- Weak linkages between producers and processing industries reduce returns, especially for small-scale farmers.
- Olive orchards require several years (typically 3 to 4) to reach economic productivity, creating financial constraints for farmers without access to interim income sources such as intercropping.
- The number of modern olive oil processing units is limited, and existing facilities often have low capacity.
- Processing infrastructure is underdeveloped, particularly in terms of storage systems, bottling facilities, and compliance with standard operating procedures. Most units are publicly owned, which may limit operational efficiency.

- Limited awareness among producers, processors, and consumers regarding olive oil quality standards, certification, and regulatory requirements.
- Fragmented landholdings and dispersed production areas reduce economies of scale and discourage private sector investment in processing and value addition.
- The absence of comprehensive national and provincial strategies, data systems, and coordinated action plans for the olive sector contrasts with more developed oilseed sectors such as canola and sunflower.
- Weak legislative and regulatory frameworks, including the absence of specific laws on traceability, labelling, quality standards, and food safety (e.g., Olive Oil Act), hinder sector formalization.

3. Opportunities

- The availability of relatively low-cost labor provides an opportunity to reduce production costs while promoting rural employment, particularly for women and youth.
- National policies emphasize value addition in agriculture and highlight the need for public-private partnerships and innovative financing models for value chain development.
- Government support through the Strategic Trade Policy Framework (2020-2025) offers opportunities for mechanization, modernization, and integration into global value chains.
- Pakistan's heavy reliance on imported palm oil, despite unsuitable agro-climatic conditions for its cultivation, creates a strong opportunity to promote olives as a viable domestic alternative.
- The country's strategic geographic location, combined with infrastructure development under CPEC, can facilitate improved access to domestic and regional markets.
- Ongoing collaboration between federal/provincial governments and international donors provides financial and technical support for sector development, including rural development, agro-tourism, and market modernization.
- Policy initiatives from MNFSR aim to improve market intelligence, promote digital platforms, and enhance marketing systems, which can benefit olive producers.
- Growing domestic and international demand for olive oil presents a favorable market trend and opportunities for niche market development.
- National branding initiatives such as "Emerging Pakistan" provide opportunities for product differentiation, branding, and export promotion.
- The Geographical Indications (Registration and Protection) Act, 2020 offers the potential to protect and market region-specific olive products, enhancing competitiveness in international markets.
- Olive cultivation can be integrated into rural development strategies, particularly in marginalized areas where conventional crops are not viable, thereby improving livelihoods and land use efficiency.

4. Threats

- The absence of a comprehensive national policy and research framework for oilseeds, including olives, poses a significant constraint to coordinated sector development.

- A lack of integrated policy planning across the edible oil value chain, from production to processing and marketing, limits efficiency, value addition, and sustainability.
- Public sector investments are largely project-based (e.g., under the Public Sector Development Program), with limited continuity, coordination, and private sector engagement beyond project lifespans.
- Insufficient involvement of private sector stakeholders threatens the long-term sustainability and scalability of the olive value chain.
- Established edible oil industries favor imports over domestic processing due to past policy incentives (e.g., tariff reductions on oilseed imports), reducing incentives for local production.
- Market distortions caused by private intermediaries and traders can destabilize input and output prices, discouraging investment in emerging sectors such as olives.
- Climate change poses a significant risk, with increasing frequency of extreme events such as floods, droughts, irregular rainfall, and smog, potentially affecting olive productivity.
- Water scarcity, particularly groundwater depletion in regions such as Balochistan, represents a major constraint for sustainable expansion of olive cultivation.
- Political instability and inconsistent policy commitment may hinder long-term investments and institutional development in the olive sector.
- Weak farmer organizations and limited experience with cooperative or associative models reduce collective bargaining power and sector resilience.

Table 1. A summary of the key findings of the SWOT analysis.

Strengths	Weaknesses
1. Favorable agro-ecological diversity for the cultivation of a wide range of olive varieties. 2. Availability of vast cultivable wastelands and marginal lands suitable for olive cultivation. 3. Availability of arable land suitable for commercial olive plantations. 4. Large-scale olive plantations can contribute to reducing soil erosion and desertification while generating economic benefits. 5. Expansion of olive cultivation can enhance biodiversity and contribute to carbon sequestration. 6. Olive cultivation is economically profitable, with an estimated internal rate of return (IRR) of 31%, exceeding prevailing market interest rates. 7. Edible oil production, including olives, has been prioritized in the national development agenda by the Ministry of Planning, Development and Special Initiatives. 8. Promotion of oilseed crops, including olives, has been incorporated into federal food security policies and provincial agriculture and horticulture strategies. 9. Support from the Ministry of Commerce through the Strategic Trade Policy Framework (STPF) 2020–2025, promoting agricultural mechanization and integration into global value chains. 10. The China–Pakistan Economic Corridor (CPEC) can enhance the strategic importance of olive cultivation and olive oil production in corridor-adjacent regions. 11. Locally produced olive oil possesses distinct quality characteristics with potential to meet international standards and export requirements. 12. Potential availability of local raw materials for olive oil extraction, value addition, and by-product generation. 13. Availability of both skilled and unskilled labor to support olive value chain activities. 14. Olive trees hold religious and cultural significance in Pakistan and are regarded as a long-term beneficial crop.	1. Limited agro-ecological research, olive adaptability trials, and scientific and technological support for the olive value chain. 2. Lack of certified olive nurseries and insufficient knowledge regarding the implementation of Good Agricultural Practices (GAPs). 3. Limited technical knowledge and technologies related to post-harvest handling and management. 4. Limited development of olive-based value-added products. 5. Inadequate competencies in packaging, storage, and transportation systems. 6. Absence of an established and regulated marketing system with improved market infrastructure. 7. Reduced farmer income due to the dominance of intermediaries in fresh olive marketing channels. 8. Weak linkages between olive producers and agro-processing industries. 9. Lack of economic returns from olive orchards during the first four years after plantation. 10. Limited availability of modern olive oil extraction and processing units. 11. Limited administrative and consumer awareness regarding olive oil quality standards. 12. Low interest among processors and industrial investors due to the absence of concentrated olive production clusters. 13. Absence of a comprehensive olive policy, strategic action plans, and reliable sectoral data for sustainable development. 14. Insufficient extension services provided by federal and provincial institutions. 15. Weak coordination among public institutions and private sector stakeholders at federal and provincial levels. 16. Low productivity and unresolved pest and disease issues requiring research support. 17. Limited reliable and systematized local data on cultivation techniques, cultivar performance, and olive oil production costs. 18. Lack of legislation concerning traceability, labeling, quality standards, food safety requirements, and production and marketing regulations (e.g., Olive Oil Act).

Opportunities	Threats
1. Availability of relatively inexpensive labor. 2. National Food Security Policy supports value addition in agro-based products. 3. Support from the Ministry of Commerce through the Strategic Trade Policy Framework (STPF) 2020–2025. 4. Increasing national demand for edible oils. 5. Significant potential for growth in olive cultivation and olive oil production in Pakistan. 6. Continued support from federal and provincial governments in collaboration with international donors for the development of the olive sector. 7. Policy measures by the Ministry of National Food Security and Research aimed at improving market systems in coordination with provincial governments. 8. Launch of the national brand-building strategy “Emerging Pakistan” by the Ministry of Commerce. 9. Existing legislation for the recognition and protection of geographical indications (GIs). 10. High investment potential in the processing sector following the promotion of olive plantation initiatives and the declaration of “Olive Valley” regions in Punjab and KP. 11. Opportunities for identifying and promoting climate-smart olive varieties through adaptability trials and genetic improvement programs. 12. Collaboration with federal and provincial departments and progressive farmers can enhance olive productivity and sector development. 13. Availability of medium- and long-term support from international donors. 14. Potential for rural development through the establishment of olive oil supply chains and value chain activities in economically disadvantaged districts.	1. Absence of well-established model nurseries supplying certified planting material and limited standardization and quality control systems. 2. Lack of a comprehensive research and policy framework focused on sustainable olive production and value chain development. 3. Absence of a national framework supporting all stages of the edible oil value chain, including value addition, nutritional profiling, and food safety compliance. 4. PSDP-funded projects are generally limited to defined project durations and often fail to ensure long-term coordination and investment from private stakeholders, raising sustainability concerns. 5. Low level of engagement and investment from private sector stakeholders. 6. Limited investment in olive processing facilities by major industrial actors. 7. Market instability caused by private sector traders affecting input supply and agricultural product prices. 8. Climate change-related events, including floods, droughts, heat waves, fog, smog, and irregular rainfall, may negatively affect olive productivity. 9. Water scarcity and declining water quality may reduce olive yields and orchard sustainability. 10. Political instability may negatively affect the development and sustainability of the olive and olive oil sector. 11. Domestic crushing and distribution sectors often prefer imported edible oils over locally produced oilseeds and olive oil. 12. Government policies facilitating imports of edible oils and oilseeds, including the elimination of tariffs and duties since 2005, may discourage local production.

III – Analysis of the available data on olive consumption and production

The development of the olive value chain, similar to other horticultural sectors, involves multiple stages from production to final consumption, each presenting specific technical, logistical, and economic challenges. These stages include pre-planting, cultivation, harvesting, post-harvest handling, processing, transportation, marketing, and export (Rana *et al.*, 2022).

In developing countries such as Pakistan, rapid urbanization, rising income levels, changing dietary patterns, and the expansion of information and communication technologies (ICTs) are transforming agri-food systems. Additionally, structural changes in retail markets and emerging export opportunities are driving a shift toward more integrated and market-oriented value chains. These dynamics are fostering increased private sector participation aimed at improving productivity, efficiency, product quality, and market competitiveness. Simultaneously, consumer demand for safe, high-quality, convenient, and affordable food products is reinforcing the importance of efficient and well-coordinated value chains.

1. Fresh olive supply/value chain

The olive value chain begins with producers, who constitute the primary actors in the system. From farm to consumer, fresh olives pass through several intermediaries, including pre-harvest contractors, commission agents, wholesalers, and retailers, forming distinct marketing channels (Table 2).

Currently, detailed analyses of profit margins across different actors within these channels are lacking. However, available evidence indicates that olive orchards begin generating economic returns approximately 5-6 years after planting. Break-even is typically achieved around 10 years, after which orchards can yield an estimated annual profit margin of approximately 25%, based on variable costs. These long gestation periods represent a critical economic consideration for farmers and investors.

Table 2. Fresh olive marketing channels.

Channels	Functioning Mechanism
Channel – 1	The farmers sell fresh olives to the pre-harvest contractor, and the pre-harvest contractor sells the olives to the wholesaler who auctions and deducts his commission and the produce is sold to the retailer whereas the retailers sell fresh olives to the consumers.
Channel – 2	The olive grower sells produce to the wholesaler who sells to the retailer and retailer sells the produce to the consumer
Channel – 3	The olive produced is sold by the growers to the retailer and from the retailer the produce is sold to consumers.
Channel – 4	The olive farmers sell olives to the pre-harvest contractor who directly sells produce to the olive consumers.
Channel – 5	The consumer directly purchases the fresh olives from the farmers at farm gate.

2. Imported olive oil supply/value chain

Pakistan relies heavily on imported olive oil, sourced primarily from major producing and exporting countries such as Spain, Italy, Turkey, Tunisia, as well as the United Arab Emirates, Denmark, the European Union, and China. Imports include both branded and non-branded products, ranging from extra virgin to refined and pomace oils.

The olive oil supply chain for imported products typically follows a linear structure:

Importers → Distributors → Retailers → Consumers

Pakistan imports edible oil worth approximately USD 3.5 billion annually (Piracha, 2022), with olive oil imports averaging around 3,700-4,000 tons per year. In some cases, non-branded olive oil is blended locally with other vegetable oils (e.g., canola oil) before being marketed.

The imported olive oil market is largely unregulated in terms of price control mechanisms. There is limited information available on profit margins across different actors in the supply chain, and retail prices vary significantly across regions. Over the period 2019-2022, olive oil imports fluctuated in both volume and value (Table 3), reflecting global market dynamics and domestic demand patterns.

3. Locally processed olive oil supply/value chain

Over the past decade, public sector initiatives have primarily focused on promoting olive cultivation across different agro-ecological regions. As a result, sufficient quantities of olives are now becoming available for commercial processing into olive oil. However, the processing segment of the value chain remains in a developmental phase.

To date, most olive oil extraction units have been imported, primarily from Italy, and installed through public sector projects at federal and provincial levels. Some initial efforts have also been made to develop local manufacturing capacity for processing equipment. The locally processed olive oil supply chain can be summarized as follows:

Olive marketing channels → Oil extraction → Value addition (by-product) → Consumers

A significant portion of the oil extracted is used for household consumption by farmers. Although public sector facilities often provide oil extraction services free of cost, logistical constraints can limit farmers' access to these units.

Initially, small-scale extraction units (approximately 50 kg/hour capacity) were distributed across key research and production centers, including the National Agricultural Research Centre (NARC), Barani Agricultural Research Institute (BARI) Chakwal, Agricultural Research Institute (ARI) Tarnab, and facilities in Balochistan. Currently, approximately 20 extraction units are operational in the public sector, alongside a small number of private and community-based units established with support from development programs.

Most processing infrastructure has been deployed under the federal initiative "*Promotion of Olive Cultivation on a Commercial Scale in Pakistan (Phase I & II)*" implemented by MNSFR in collaboration with provincial authorities.

According to a 2022 impact assessment, approximately 40% of olive growers have access to extraction facilities. Some processing units, such as those at BARI Chakwal, ARI Tarnab, and

ARI Quetta, are equipped with laboratories for oil quality analysis and value-added product development. Mobile testing units have also been introduced.

Despite these advancements, domestic production of olive oil remains relatively low. Estimates suggest that production reached approximately 1,400 tons in 2022, although this figure may be underestimated. The government has set an ambitious target of increasing production to 20,000 tons annually by 2027.

Interestingly, Pakistan also exports small quantities of olive oil (approximately 19 tons in 2021-2022), primarily through re-export of imported products as shown in Table 4. This apparent inconsistency between imports and exports reflects global trade practices, where major producing countries such as Spain and Italy both import and re-export olive oil to enhance value addition and market positioning.

A previous market study conducted in 2016 by the Punjab Economic Research Institute (PERI), supported by the Italian government “*Market Analysis for Value Chain and Olive Oil Consumption in Pakistan*”, aimed to investigate the dynamics of the market of olive products within the edible oil sector in the country, focusing on the product development, supply chain, consumer preferences and uses, demand and marketing prospects for local and regional markets. The study estimated that domestic consumption of locally produced olive oil was approximately 5 tons at that time.

Given recent sectoral developments, the OliveCulture project has deemed essential to update the study of 2016, to better understand evolving consumption patterns and inform future marketing strategies.

In terms of value addition, public sector initiatives have promoted the development of olive-based products such as pickles, jams, baked goods, syrups, vinegar, tea, confectionery, and cosmetics (POCCSP, 2022). These technologies have been transferred to local communities and small-scale entrepreneurs, resulting in limited but growing commercialization. However, the table olive sector remains underdeveloped due to limited investment, lack of appropriate processing technology, and low private sector engagement. Processing activities such as de-pitting and slicing are often carried out manually by small producers. Furthermore, critical aspects related to food safety, quality assurance, and compliance with international standards, such as Hazard Analysis and Critical Control Points (HACCP), have not yet been systematically implemented or evaluated across processing units and value-added product chains.

Table 3. Import of olive oil during 2019-2022.

Country	2019-2020		2020-2021		2021-2022	
	US\$ (000)	Quantity (Ton)	US\$ (000)	Quantity (Ton)	US\$ (000)	Quantity (Ton)
<i>Olive Oil (Others) HS Code 15099000</i>						
Spain	5989.1	2278.1	7813.8	2868.8	7516.1	2586.9
Italy	885.0	248.6	555.7	187.3	2170.9	404.0
Turkey	659.5	260.4	783.3	284.9	632.4	247.3
Tunisia	155.4	69.7	363.8	200.5	148.5	117.0
UAE	1.8	0.4	0.2	0.0	106.2	25.7
Denmark	0.0	0.0	0.0	0.0	44.0	18.5
European Union	24.9	99.8	0.0	0.0	35.0	6.0
China	0.0	0.0	0.0	0.0	31.1	7.5
Portugal	0.0	0.0	25.6	5.8	14.2	3.2
Sweden	0.0	0.0	0.0	0.0	5.1	0.7
United Kingdom	0.9	0.0	0.6	0.0	0.5	0.0
Germany	0.0	0.0	0.0	0.0	0.0	0.0
Greece	0.6	0.1	0.0	0.0	0.0	0.0
Malaysia	0.3	0.1	0.0	0.0	0.0	0.0
Sub Total	7717.6	2957.4	9543.1	3547.4	10703.9	3416.8
<i>Olive Oil (Virgin) HS Code 15091000</i>						
Spain	1637.5	419.8	2818.7	788.6	2471.6	593.2
Italy	34.0	8.8	198.6	39.5	185.3	33.6
Tunisia	47.8	13.0	227.2	59.3	116.9	28.0
Turkey	58.3	17.0	121.6	27.6	76.4	17.8
European Union	4.2	0.2	3.3	0.2	24.6	5.0
China	0.0	0.0	0.2	0.0	7.5	1.7
United States	7.9	2.0	0.1	0.0	4.9	1.2
UAE	0.1	0.0	6.2	1.1	2.7	0.3
Sweden	0.0	0.0	0.0	0.0	2.5	0.1
United Kingdom	0.0	0.0	0.1	0.0	1.4	0.1
Germany	0.0	0.0	2.3	0.0	0.0	0.0
Egypt	0.0	0.0	8.4	2.1	0.0	0.0
Sub Total	1789.8	460.7	3386.8	918.5	2893.6	681.0
Grand Total	9507.4	3418.1	12929.8	4465.9	13597.6	4097.9

Source: Federal Board of Revenue. <https://www.fbr.gov.pk/>.

Table 4. Olive oil exports during 2019-2022.

Country	2019-2020		2020-2021		2021-2022	
	US\$ (000)	Quantity (Ton)	US\$ (000)	Quantity (Ton)	US\$ (000)	Quantity (Ton)
<i>Olive Oil (Virgin) HS Code 15091000</i>						
Malaysia	-	-	-	-	0.56	0.06
Trinidad and Tobago	-	-	-	-	0.45	0.04
United Arab Emirates	-	-	-	-	0.34	0.04
United States	0.38	0.01	-	-	3.40	0.39
Sub Total	0.38	0.01	-	-	4.75	0.53
<i>Olive Oil other Fractions HS Code 15099000</i>						
Canada	0.68	0.04	5.16	0.98	-	-
Hong Kong, China	0.12	0.01	-	-	-	-
Mozambique	4.78	3.85	11.43	7.33	50.16	17.98
Oman	19.09	0.31	-	-	-	-
South Africa	1.26	0.21	-	-	-	-
United Arab Emirates	0.22	0.04	-	-	-	-
United Kingdom	-	-	0.22	0.12	-	-
United States	0.81	0.49	0.96	0.05	-	-
Sub Total	26.96	4.95	17.77	8.48	50.16	17.98
Grand Total	27.35	4.96	17.77	8.48	54.91	18.51

Source: Federal Board of Revenue. <https://www.fbr.gov.pk/>.

IV – Public sector (federal and provincial) services and facilities to develop olive value chain

This section aims to assess the current status of public sector resources, institutional structures, infrastructure, equipment, and inputs supporting the development of the olive value chain in Pakistan. An important starting point for evaluating the availability and effectiveness of public sector services is the spatial distribution of olive orchards. The current extent and distribution of olive plantations across Pakistan are presented in Table 5, providing a baseline for understanding regional development patterns and infrastructure needs.

Table 5. Olive trees plantation in Pakistan by public and private sector (in number of plants).

Provinces/ Territories	PIDSA (2012- 2016)	PSDP (2014-2020)	Olive Valley (2015- 2020)	5 million olive (2013- 2019)	Private sector plantation	Total plantation
Baluchistan	159,379	865,447	-	-	2,500	1,027,326 8,381 acres
Khyber Pakhtunkhwa	265,273	431,465	-	590,000	2,500	1,289,238 12,134 acres
Punjab	116,772	316,527	1,210,411	-	10,000	1,653,710 12,687 acres
Islamabad Capital Territory	35,768	48,465	-	-	-	84,233 726 acres
Azad Jammu & Kashmir	421	36,624	-	-	-	37,045 291 acres
Gilgit Baltistan	2,545	14,207	-	-	-	16,752 131acre
	580,158	1,712,735	1,210,411	590,000	15,000	4,108,304
Total	5,802 acres	13,306 acres	8,966 acres	5,900 acres	375acre	34,349 acres

Source: Ministry of National Food Security and Research.

The areas currently identified as suitable for olive cultivation are summarized in Table 6.

Table 6. Olive cultivation/plantation areas in Pakistan.

Olive cultivation ecologies	Administrative region/Districts
Islamabad Capital Territory	Islamabad, Rawalpindi
Punjab	(Olive Valley) Chakwal, Attock, Jhelum, Soon Valley, Mianwali and Khushab
Khyber Pakhtunkhwa (KP) and Newly Merged Districts	Peshawar, Mardan, Swabi, Swat, Karak, Dir, Bajur, Mohmand, Kurram, South Waziristan, North Waziristan, Abbotabad, Haripur, Mardan, Battagram, Kohat, D.I.Khan, Mansehra, Noshara, Laki Marwat, Wana
Olive Cultivation Ecologies	Administrative Region/Districts
Balochistan	Quetta, Loralai, Qila SaifUllah, Zhob, Musa Khel, Barkhan, Zhob, Khuzdar, Makhlar, Barkan, Dukki, Pashin, Sherani,
Azad Jammu & Kashmir (AJK)	Bagh, Poonch, Kotli, Jhelum Valley, Muzafarabad, Bhimber, Mirpur, Rawala Kot, Neelam Valley, Sudhanoti
Gilgit Baltistan (GB)	All GB

Source: Various reports published by national/international Projects and internet

It is necessary to highlight that the provision of resources, structures, equipment and implements are fundamentally essential to develop state of an art olive value chain on a leading-edge basis; following criteria need to be considered as an integral part of the value chain;

- Olive cultivation using research-based modern technologies and an agronomic tactical management support system;

- Development of qualified human resources in the value chain perspective;
- Provision of technical assistance to value chain clients;
- Ensure quality, sanitary and phytosanitary (SPS) safety standards;
- Establish reference laboratories for oil quality certification;
- Promotion of establishing modern oil extraction units on a public-private partnership as well as encouraging private sector alone/independently availing SME approach (Small and Medium-sized Enterprises);
- A vibrant marketing system in place enables the provision of essential services and facilities;
- Feasible financial assistance, particularly to stakeholders having a meagre resource.

A key driver of olive sector development has been the government-funded megaproject “*Promotion of Olive Cultivation on a Commercial Scale in Pakistan*” (POCCSP). Phase I (2014-2021) established the foundational elements of the olive value chain, including plantation development, nursery establishment, and initial processing infrastructure. Phase II (2022-2024) aimed to consolidate these achievements and further expand the sector.

This initiative is implemented by the Pakistan Oilseed Department (POD) under the Ministry of National Food Security and Research (MNFSR), with coordinated activities across federal and provincial levels. The project operates through multiple components implemented in major regions, including Balochistan, Khyber Pakhtunkhwa (KP), Punjab, Gilgit-Baltistan (GB), and Azad Jammu and Kashmir (AJK), ensuring a geographically inclusive approach.

In addition to federal initiatives, provincial governments are implementing their own targeted programs to support olive growers, further strengthening the value chain at the local level. These programs provide services such as technical support, input provision, and infrastructure development. Furthermore, donor-funded initiatives, such as the GRASP project in Balochistan, are contributing to olive sector development, particularly by supporting SMEs involved in production and processing.

Overall, these projects aim to engage all stakeholders across the olive value chain, from production to processing, through coordinated efforts at national, provincial, and international levels. Key areas of focus include research and development, capacity building, planning, and monitoring of project activities.

The development of the olive sector in Pakistan is therefore the result of integrated efforts combining public sector investments, international technical cooperation, particularly with the Government of Italy, and collaboration among various institutional actors. These coordinated interventions are gradually establishing the technical, organizational, and commercial foundations necessary to strengthen and sustain the olive value chain in the country.

V – Mapping provincial government initiatives for services and facilities to develop olive value chain

1. Balochistan

Balochistan is widely regarded by researchers and practitioners as one of the most suitable provinces in Pakistan for olive cultivation, particularly in its ecologically favorable zones. The province offers significant potential for transitioning from traditional, water-intensive crops to olives, which are considered a climate-resilient and low-water-demand crop. This transition provides an opportunity to enhance farm incomes, promote sustainable land use, and support poverty reduction.

Olive cultivation also generates multiple socio-economic and environmental benefits, including improved ecosystem services, enhanced biodiversity, development of rural entrepreneurship, employment generation, and increased income through value addition. Furthermore, it contributes to reducing dependence on imported edible oils (GRASP Pakistan). However, given the long gestation period of olive trees before reaching full productivity, sustained government support remains essential to promote the olive value chain effectively.

The Board of Investment and Trade (BIT, 2020) has highlighted that olives produced in Balochistan are characterized by high nutritional value and oil content, making them economically attractive for both smallholders and large-scale (corporate) farming. Within Balochistan, Loralai area is the largest olive oil producer, having more than one million olive trees, mainly Spanish and Italian varieties.

According to the Balochistan Forest Department, wild olive forests cover approximately 41,000 hectares in the Sherani district, of which around 6,000 hectares are state-owned, while the remainder is under community management. Several districts, including Quetta, Pishin, Loralai, Killa Saifullah, Khuzdar, Zhob, Musakhel, Barkhan, Harnai, Mastung, and Qalat, have been identified as highly suitable for olive cultivation in terms of both yield and oil quality.

Recognizing the province's agro-climatic advantages and increasing water scarcity, the Government of Balochistan has prioritized olive cultivation as a drought-resistant, high-value crop. Over the past two decades, the provincial government, in collaboration with federal institutions and international partners, has implemented multiple initiatives to develop the olive value chain by providing services, infrastructure, and technical support. The key projects and interventions are summarized below:

A. Development of olive production and processing in Balochistan

This project, implemented with a budget of PKR 190 million over three years, aimed to introduce olives as a climate-resilient crop and expand vegetative cover. The project focused on standardizing propagation and cultivation techniques, thereby enabling large-scale plantation development and increasing farmers' incomes. Key achievements include:

- Establishment of nurseries producing approximately 675,000 olive plants;
- Plantation of around 6,000 acres of olive orchards on farmers' fields;
- Development of three mother plant blocks for propagation of quality planting material.

B. Promotion of olive cultivation for economic development and poverty alleviation (PIDSA-funded)

This federally supported project, financed under the Pakistan-Italy Debt Swap Agreement (PIDSA) and implemented between 2012 and 2015, targeted five districts: Loralai, Zhob, Musakhel, Barkhan, and Killa Saifullah. The project aimed to:

- Utilize marginal lands, forest areas, and sub-mountainous regions for large-scale olive cultivation;
- Promote employment generation and poverty alleviation;
- Strengthen public-private partnerships for olive cultivation and oil extraction;
- Establish new orchards and processing facilities with community participation;
- Provide oil extraction units through collaborations with community-based organizations (CBOs), NGOs, and farmer groups;
- Conduct training programs, technical studies, and awareness campaigns to promote olive cultivation.

C. AFNEPAK Project

The AFNEPAK (Afghanistan, Nepal and Pakistan) project complemented the PIDSA initiative by providing technical assistance, capacity building, and training to support olive cultivation and processing activities.

D. Promotion of olive cultivation on a commercial scale in Pakistan

This major federal initiative (2014-2021), implemented by POD under MNFSR, included a significant component for Balochistan. Key achievements in the province include:

- Distribution of certified, true-to-type olive plants (accounting for approximately 56% of total national distribution);
- Installation of drip irrigation systems for approximately 45% of beneficiary farmers;
- Establishment of nursery infrastructure, including shaded tunnels in Quetta, Loralai, and Khuzdar;
- Organization of 17 training programs for 1,462 stakeholders, covering orchard management, pruning, nursery techniques, processing, packaging, and marketing;
- Upgradation of olive value-addition laboratories at ARI Quetta;
- Installation of weather stations (e.g., at ARI Quetta, UET Khuzdar, and Loralai) to provide agro-meteorological data and advisory services to farmers.

E. Growth for rural advancement and sustainable progress (GRASP)

The GRASP project (2019-2024), funded by the European Union and implemented by the International Trade Centre, focuses on poverty reduction and inclusive rural development through support to SMEs. In Balochistan, the project targets ten districts, including Zhob, Pishin, Quetta,

Nushki, Kharan, Khuzdar, Panjgur, Kech, and Lasbela, with olive identified as a priority climate-smart crop. The project adopts an integrated value chain approach, including:

- Enhancing agricultural practices and productivity;
- Supporting value addition and processing capacities;
- Promoting food safety standards among SMEs;
- Strengthening market linkages through private sector partnerships;
- Improving access to market information and financial services;
- Promoting gender-inclusive participation, particularly for women in farming and processing activities.

F. Additional initiatives and support measures

Various national and international organizations have contributed to the development of the olive sector in Balochistan through targeted interventions, including:

- Grafting of natural olive forests using improved Italian and Spanish varieties with support from conservation and development partners;
- Installation of drip irrigation systems through collaborations with development agencies and provincial departments;
- Plantation of approximately 50,000 olive saplings in Zhob district;
- Support to academic institutions such as the Balochistan University of Engineering and Technology, Khuzdar, including provision of plants, nursery infrastructure, and weather monitoring systems under national afforestation programs;
- Financial support from Zarai Taraqati Bank Limited (ZTBL), which recognizes olive cultivation as a viable agribusiness and provides loans for orchard development, drip irrigation systems, and olive oil extraction equipment. The bank also supports farmer training and capacity building in production and value addition.

2. Punjab

The Government of Punjab recognizes the olive value chain as a sector with significant potential to contribute to socio-economic development and employment generation, particularly in the Potohar region. This region has been identified as highly suitable for olive cultivation and has been designated as the “Olive Valley” under a sector development approach aimed at creating an enabling environment aligned with international standards.

Although Punjab does not yet have a fully dedicated olive research institute, BARI, Chakwal has been conducting olive research since 1991 through a specialized research team, achieving notable progress in varietal evaluation and orchard management practices. Since 2011, government attention toward the olive sector has increased substantially, leading to the implementation of projects that provide technical support, infrastructure, and inputs for olive cultivation across suitable agro-ecological zones.

A. Key achievements and current status

- More than 1,000 farmers have been registered with BARI as beneficiaries of olive development programs, with projections to reach 2,000 during the project lifecycle;
- Approximately 750 farmers have received certified, disease-free, true-to-type olive plants free of cost, resulting in the establishment of plantations over 7,888 acres (as of April 2019);
- Financial incentives and technical support have been provided for water resource development and the installation of drip irrigation systems;
- A pilot-scale technical assistance program is being implemented under the Olive Valley initiative, with management support from a national private sector service provider; however, further strengthening through multidisciplinary expertise is required;
- Mechanization support has been enhanced through the provision of 30 tractor-mounted post-hole diggers (2.5 ft diameter), supplied on a loan basis to facilitate orchard establishment;
- Certified planting material has been distributed with subsidies, both directly and through private corporate growers such as Izhar Farms;
- Value addition remains limited, with less than 5% of total production processed into products such as pickles and preserves. Recently, Unique Value established the first commercial olive food processing unit in Chakwal;
- The marketing system is still underdeveloped. Currently, a few private entities, such as Unique Value Pakistan, Bagh-e-Zaitoon, Izhar Farms, and Olive Foundation Pakistan, are engaged in domestic marketing of olive oil and table olives;
- Only one olive oil extraction facility is operational at BARI Chakwal (established in 2017), providing free processing services to farmers. The facility currently has sufficient capacity to handle production in the short term (2-3 years).

B. Key constraints and gaps

- Most olive growers are small- to medium-scale farmers who face financial constraints due to the long gestation period (up to 8-9 years for full productivity);
- There is a lack of certified nurseries. Although private nurseries exist, they are largely uncertified, and the regulatory framework for plant certification remains underdeveloped;
- Limited development of the domestic nursery industry has resulted in continued dependence on imported planting material;
- Production challenges persist, particularly during flowering and fruit set stages, along with pest and disease pressures, including outbreaks such as anthracnose (notably reported in 2022);
- Insufficient availability of olive oil extraction units and processing enterprises limits value chain development;
- Table olive processing infrastructure is minimal, with only one processing system installed as of 2022;
- Packaging and bottling technologies remain inadequate to meet international quality and certification standards.

The Government of Punjab has realized that the research and development (R&D) arena of olive value chain expansion is not moving at its real potential due to several above-identified gaps and challenges that need to be addressed in future endeavors for improvement. Hence, launched a project for 2019-2023, allocating total funds of PKR 283.121 million (Agriculture Department, 2019). The primary emphasis is establishing the Centre of Excellence for olive Research and Training (CEFORT) at BARI Chakwal, to study olive adaptability in Potohar, Thal and Southern Punjab, including the Cholistan.

C. Government response and future strategy

Recognizing these challenges, the Government of Punjab has initiated a major project (2019-2023) with a total allocation of PKR 283.121 million to strengthen research, innovation, and capacity building in the olive sector.

A central component of this initiative is the establishment of CEFORT at BARI Chakwal. This center aims to support the sustainable development of the olive value chain by generating locally adapted technologies and data for key agro-ecological regions, including Potohar, Thal, and Southern Punjab (including Cholistan). The key objectives of the project are the following:

- Strengthen capacities in olive cultivation, orchard management, post-harvest handling, processing, and value addition;
- Develop and adapt technologies through both experimental (on-station) and participatory (farmer-based) research;
- Establish a repository of olive genetic resources and support their conservation and management;
- Conduct socio-economic research to support value chain development.

To achieve these objectives, the project includes the following interventions:

- Establishment of three state-of-the-art laboratories, namely, Olive Oil Quality Laboratory, Value Addition/Product Development Laboratory and Disease Diagnostic and Integrated Pest Management (IPM) Laboratory;
- Conduct field diagnostic surveys to identify key constraints faced by stakeholders;
- Implementation of adaptability trials in Thal and Southern Punjab regions;
- Development of a demand-driven research program with continuous expert evaluation (including approximately 20 research trials);
- Strengthening linkages with national and international research institutions;
- Establishment of olive multiplication blocks in collaboration with the private sector;
- Import and evaluation of promising olive germplasm (including genetic characterization);
- Training of trainers (approximately 100 master trainers and extension agents);
- Organization of national olive festivals and scientific conferences/workshops;
- Provision of advisory services to farmers, including the use of ICT-based tools.

The value chain development component is expected to be implemented in subsequent phases, in consultation with stakeholders and under the guidance of the proposed Olive Advisory Board. This approach aims to facilitate commercialization, enhance technology adoption, and integrate

market intelligence into the research and development system, thereby improving responsiveness to private sector needs.

3. Khyber Pakhtunkhwa

Khyber Pakhtunkhwa (KP) possesses substantial agro-ecological potential for olive cultivation, particularly in regions such as the Malakand Division, Peshawar Valley, the merged districts of the former Federally Administered Tribal Areas (FATA), and areas located on the right bank of the Indus River. These zones are characterized by suitable climatic conditions and soil profiles conducive to olive production.

The province has approximately 880,000 hectares of cultivable wasteland that could be utilized for olive cultivation. Recognizing this potential, the Government of KP has adopted a proactive approach over the past two decades by implementing multiple projects, often in collaboration with federal institutions and international partners, to promote olive cultivation and develop the associated value chain. These initiatives aim to enhance rural livelihoods, generate employment, and support sustainable agricultural development.

The major initiatives undertaken in the province are summarized below:

A. Promotion of the production and marketing of olive oil in Pakistan (2008)

This project, funded by the Italian Government with an allocation of PKR 39.185 million, was implemented by the Istituto Agronomico per l'Oltremare in collaboration with the Pakistan Oilseed Development Board. The project focused on promoting olive cultivation in districts including Charsadda, Bajaur, Bannu, Buner, Lower Dir, Malakand, Mardan, Swabi, Swat, Kurram, North and South Waziristan, Tank, and Khyber. Key achievements include:

- Training of approximately 1,000 smallholder farmers in olive cultivation and grafting techniques;
- Establishment of demonstration orchards in Malakand and Mardan (Sangbatti), with documented oil production outputs;
- Installation of an olive oil extraction unit at Tarnab with a capacity of 500 kg/hour;
- Capacity building of approximately 30 technical staff through training conducted by the Pakistan Council of Scientific and Industrial Research.

B. Distribution of olive saplings

The KP Agriculture Department has distributed approximately 9,300 olive saplings free of cost among farmers in Bajaur and other tribal districts to promote olive cultivation and expand plantation areas.

C. Provision of oil extraction facilities

Olive oil extraction units have been installed in key producing districts, including Bajaur, Dir, Mardan, Nowshera, and Abbottabad. These facilities support local farmers by enabling on-site oil extraction and reducing post-harvest losses.

D. Expansion of olive cultivation

Approximately 50% of the tribal districts, such as Bajaur, Kurram, North and South Waziristan, are considered suitable for olive cultivation. Currently, olive trees are being cultivated in Dir, Swat, Abbottabad, Mardan, Peshawar, Nowshera, and southern districts. Increasing farmer interest has led to a growing market for fresh olives, with farm-gate prices ranging from PKR 20 to 100 per kilogram.

E. Promotion of olive cultivation on a commercial scale in Pakistan (POCCSP – Provincial Component)

Under the federal POCCSP initiative, the KP component has been implemented through the provincial Department of Agricultural Research. The project aims to provide comprehensive support, including infrastructure, inputs, and technical services, for olive value chain development. Key achievements under Phase I include:

- Plantation of approximately 431,465 olive trees over 12,000 acres across districts such as Dir, Nowshera, Swat, Abbottabad, and Mardan;
- Introduction of drip irrigation systems to enhance water-use efficiency and expand cultivable land;
- Designation of the Agriculture Research Institute (ARI) Tarnab, Peshawar, as a Centre of Excellence for olive research, and recognition of Sangbatti (Mardan) as an “Olive Valley”;
- Establishment of olive oil extraction units;
- Initiation of registration processes for private olive nurseries;
- Development of model olive orchards in locations such as Manki Sharif (Nowshera), Bajaur, Dir Lower, and Malakand;
- Provision of matching grants to farmers for nursery development and establishment of processing and extraction facilities.

F. Ten billion tree Tsunami program (Phase I: 2019-2023)

Under this national afforestation initiative led by the Ministry of Climate Change, olive cultivation has been integrated as a key component in KP. Key outcomes include:

- Plantation of approximately 8,000 olive trees over 27 hectares in suitable areas;
- Survival rates exceeding 95% over the first two years;
- Estimated future production of approximately 112,000 liters of olive oil annually once full maturity is reached;

- Expansion of plantations in areas such as Amangarh (near Peshawar);
- Identification of over 70 million wild olive trees, with ongoing grafting programs implemented jointly by forestry and agriculture departments to convert them into productive orchards.

G. Provincial olive development initiative

The Agriculture and Livestock Departments have proposed a five-year olive development project (valued at PKR 2,000 million) under the Prime Minister's National Agriculture Emergency Program. The project aims to expand olive cultivation across all seven tribal districts in a phased manner.

H. Phased expansion strategy

In the first phase, large-scale olive cultivation is being initiated in Bajaur district, with planned expansion to South Waziristan, North Waziristan, Kurram, Orakzai, Khyber, and Mohmand districts. An initial allocation of PKR 80 million has been designated for the first phase (2021-2022).

4. Azad Jammu and Kashmir

The Government of Azad Jammu and Kashmir (AJK) recognizes olive cultivation as a promising opportunity to enhance rural livelihoods and improve economic conditions. Provincial leadership has emphasized the importance of promoting olives as a commercial crop to support farmer prosperity and regional development.

Under the federal project POCCSP (Phases I & II), the Department of Agriculture AJK has been actively supporting the development of the olive value chain. This support includes the provision of planting material, training, and technical assistance across various agro-ecological zones of the region.

Farmers are being encouraged to establish olive orchards through the distribution of olive saplings and participation in training and awareness programs focused on cultivation practices, orchard management, and post-plantation care. Efforts are also underway to strengthen local nursery development to reduce dependence on external suppliers.

A. Key achievements

- Distribution of 44,676 olive saplings to farmers free of cost under Phase I;
- Under Phase II, approximately 30,000 saplings distributed on a 33% cost-sharing basis;
- Survey and identification of wild olive trees in districts including Muzaffarabad, Bagh, Poonch, Sudhnoti, and Kotli;
- Establishment of olive plantations over approximately 400 acres;
- Implementation of adaptability trials for exotic olive varieties at Ghathor and Danna (Muzaffarabad);

- Support for the establishment of olive mother blocks and germplasm units;
- Organization of training programs for farmers and stakeholders, covering best practices in cultivation, pruning, nursery management, processing, packaging, and marketing.

B. Key constraints

- Absence of public sector olive oil extraction facilities;
- Lack of drip irrigation systems to support water-efficient cultivation;
- Limited development of local plant propagation systems and nursery infrastructure;
- Absence of upgraded laboratories for value addition and quality analysis;
- Lack of weather stations and agro-meteorological services to support decision-making by farmers.

5. Gilgit-Baltistan

Gilgit-Baltistan (GB) offers considerable potential for olive cultivation, particularly in districts such as Diamir, Gilgit, Ghizer, and the sub-divisions of Darel/Tangir and Chilas. Recognizing this potential, the federal project POCCSP has initiated activities to promote olive cultivation and lay the foundation for the development of the olive value chain in the region. These efforts have focused on plantation development, varietal adaptability testing, and capacity building of farmers and stakeholders.

A. Key achievements

- Establishment of olive plantations covering approximately 267 acres;
- Conduct of adaptability trials for exotic olive varieties at the Mountain Agricultural Research Centre (MARC), Juglot, and Paeen Nagar;
- Support for the establishment of olive mother blocks and germplasm units;
- Training of approximately 222 farmers and stakeholders in olive cultivation practices, nursery development, processing, packaging, and marketing.

B. Key constraints

- Absence of olive oil extraction facilities in the public sector;
- Lack of drip irrigation systems to support efficient water use;
- Limited development of local nurseries and plant propagation systems;
- Absence of value-addition laboratories and facilities for quality analysis;
- Lack of weather stations and technical advisory services for farmers.

VI – Assessment and sampling of wild olives with agronomic potential in suitable provinces

Olive has been identified as a highly promising crop for expansion due to its low water requirements and adaptability to a wide range of ecological conditions, including marginal environments with limited water resources. Across different ecological zones of Pakistan, diverse morphological and ecological types of wild olive have existed for centuries. These wild olives can be readily distinguished from cultivated varieties based on their smaller fruit size and lower oil content, which is sometimes negligible.

Despite their abundance, limited efforts have been made, both in Pakistan and globally, to comprehensively explore the diversity and divergence between wild and cultivated olive populations. However, this genetic diversity represents a valuable resource for breeding programs, particularly for the introgression of desirable agronomic traits and resistance to biotic and abiotic stresses. For instance, Naz *et al.* (2019) demonstrated significant divergence between cultivated and wild olive genotypes, highlighting the potential of both local and exotic germplasm for genetic improvement. Overall, the high level of diversity within wild olive populations offers substantial opportunities for the development of improved cultivars through targeted breeding and genetic manipulation. To fully exploit this potential, extensive sampling and the application of advanced genotyping tools are required to better characterize the population structure of wild olives in Pakistan.

Until the 1980s, no systematic efforts were made to utilize wild olives for research or commercial purposes. A major initiative began in 1986, when the Pakistan Oilseed Development Board (PODB) launched a program to promote olive cultivation by grafting wild olive trees. Approximately 5.5 million wild plants were grafted using unidentified olive varieties; however, the outcomes were not particularly successful.

Subsequent efforts, particularly from the early 2000s onward, focused on converting wild olives into productive trees using improved and scientifically validated grafting techniques. Research indicated that “T-grafting” could achieve success rates of 80-90% (POD, 2021). Similarly, Mukhtar *et al.* (2001) compared T-grafting and bark grafting techniques throughout the year and found that both methods achieved peak success rates (up to 100%) between August and mid-September, with negligible success during other periods.

Building on these findings, the government launched a pilot project (2004-2008) titled “*Rapid Conversion of Wild Olives into Bearing Species*”, targeting regions such as KP, FATA, Balochistan, and AJK. The project also emphasized farmer training in proper grafting techniques. According to the PERI report, converting approximately eight million wild olive trees into productive varieties could potentially generate up to US \$1 billion annually.

Farmers have largely adopted budding and T-grafting techniques due to their high success rates and the relatively short time required for trees to begin fruiting (3-4 years) (Shoaib and Shehbaz, 2022). Data provided by POD on grafting activities across provinces are summarized in Table 7.

Table 7. Number of wild olive trees grafted into productive trees.

Province	Number of trees grafted
Khyber Pakhtunkhwa	3.50 million
Baluchistan	2.70 million
Punjab (Potohar)	1.80 million
Total	8.00 million

Source: Pakistan Oilseed Department (POD)

Over the past two decades, coordinated efforts involving public and private sector investments, strategic planning, and farmer participation, supported by training programs, media outreach, workshops, and technology transfer initiatives, have yielded tangible results. Approximately eight million wild olive trees have been successfully converted into productive ones, significantly increasing farmer interest across Punjab, Balochistan, KP, tribal areas, GB, and AJK.

From an agro-economic perspective, farmers report that grafted olive trees require relatively low input costs, including minimal land preparation, irrigation, fertilizers, and pesticides. Detailed contributions of various stakeholders in promoting wild olive grafting are presented in Table 8.

Table 8. Contributions of various stakeholders to the promotion of wild olive grafting.

Province/ Agro-ecology	Organization/ Project	Wild olive trees found and grafted
KP	Forest & Agriculture Departments 10 billion trees afforestation project	70 million wild olive trees found 40 million wild olive trees grafted
Bajaur, Kurrum, KP, Orajzai, Waziristan districts	10 billion trees afforestation project	35 million wild olive trees found 500,000 wild olive trees grafted
Punjab, Baluchistan, KP	Rapid conversion of wild olives into bearing species 2004- 2008 PODB	About eight million wild olive plants found 3.5 million olive trees grafted More than 4,000 trees had started bearing fruit since 2004-2005
Bajaur District	DAO, Agriculture Extension Department Bajaur (GOP funded)	400,000 wild olive trees grafted 30,000 wild olive trees grafted are bearing fruits
Tribal Areas	Shah Khalid, a tribal elder and farmer	36,000 million wild olive trees growing in mountainous tribal areas
Bajaur	Director Agriculture Bajaur (GOP funded)	400,000 wild olive trees grafted
Different provinces	Greenfield project	8 million wild olive trees grafted
Punjab, Balochistan KP, Sindh, AJK, GB, ICT	Olive Promotion Cultivation on Commercial Scale in Pakistan MNFSR	Pilot intervention for conversion of 5 million wild olive plants
AJK	Al-Khidmat Foundation	114,000 wild olive plants grafted 22,000 are bearing fruits

Source: Various project reports of POD

Historically, wild olive trees, despite their abundance, had limited commercial value and were primarily used for timber and firewood. However, government-led initiatives and technological support have transformed these resources into economically viable assets. Currently, fruits from grafted trees are increasingly being processed for oil extraction and other value-added products, marking a significant shift in the utilization and economic importance of wild olives in Pakistan.

VII – Mapping of existing services and facilities

1. Mapping of registered olive plant nurseries and registered olive varieties

Regarding olive plant nurseries supplying plantlets to growers, a total of eight nurseries is currently registered with the Federal Seed Certification and Registration Department (FSC&RD), while four additional nurseries are in the process of registration (Table 9).

Under the POCCSP project, eleven double-shaded nursery tunnels have been established across various project components: two at BARI Chakwal, two at ARI Tarnab, one at NTHRI Mansehra, two at BARDC Quetta, two at the sub-station Loralai, one at ARI sub-station Baghbana (Khuzdar), and one at ARI Quetta. These nurseries are equipped with integrated irrigation, heating, and cooling systems (temperature control), along with other essential facilities, enabling large-scale production of high-quality olive saplings.

The FSC&RD has also designated BARI Chakwal as a mother orchard hosting 86 olive varieties, and Izhar Farms (Kallar Kahar) with 38 varieties. The olive varieties registered for commercial cultivation include: Gemlik, Koroneiki, Hamdi, Pendolino, Jerboui, Ascolana, Manzanilla, Picual, Hojiblanca, BARI Zaitoon-I, BARI Zaitoon-II, ZAR Bratica, Tarnab Picual, and Cherat Zaitoon.

Table 9. Nurseries registered or in the process of registration with the Federal Seed Certification and Registration Department.

Name of the Nursery	Status
Barani Agricultural Research Institute, Chakwal	Registered
Izhar Farms Pvt. Ltd., Kallar Kahar, Chakwal	Registered
Al Atta Farm, Bikhari Kalan, Chakwal	Registered
The Farms Nursery, Neela Dhulla, Chakwal	Registered
Sehgal Farms, Kallar Kahar, Chakwal	Registered
Agricultural Research Institute, Peshawar	(in process)
Shah Gulab Nursery, Nowshera	Registered
Munawar Afreedi Nursery, Khyber Agency	(in process)
Zaitoonkhwa Nursery Farm, Talash, Lower Dir	Registered
Zaikor olive nursery, Kohat	Registered
Balochistan Agri. Res. & Dev. Centre, Quetta	(in process)
Agriculture Research Institute, Loralai	(in process)

2. Mapping of olive oil extraction units

Olive oil extraction facilities have been established across various provinces through the POCCSP project as well as through provincial development initiatives. In total, twenty-five extraction units are currently operational within major olive-growing clusters (Table 10). These units operate under different service models: some provide extraction free of charge, while others retain approximately 10% of the extracted oil as a service fee. During the 2022 harvesting season, however, the POCCSP project directed all units to process olives free of cost in response to the exceptional flood-related challenges faced by farmers, with operational expenses covered by the project.

At present, private sector participation in olive processing remains limited. However, it is anticipated that increased production volumes and growing consumer demand will encourage greater involvement from industry stakeholders in the near future.

3. Mapping of olive processing/table olive value addition units

Globally, a wide range of value-added products are derived from olives, olive oil, and pomace. While olives are typically categorized for oil production or table consumption, certain varieties can serve dual purposes, reflecting the versatility of the crop.

In Pakistan, table olives represent a particularly promising segment for value addition. To support this, the POCCSP project has established three table olive processing units at BARI Chakwal, ARI Quetta, and ARI Tarnab. These units operate under the supervision of trained personnel. Additionally, a laboratory has been set up to standardize processing methods and recipes for various value-added products. As a result, several products have been developed and standardized, including olive soap, pickles, biscuits (cookies), jam, olive chutney, olive syrup, liquid handwash, balms (with shea butter, cocoa butter, and beeswax), olive leaf tea, pomace pellets, medicated oil, and olive paste products. Although these products are being marketed, their distribution remains limited.

Recognizing the high market potential of table olives, the OliveCulture Project organized a training workshop in October 2022, in collaboration with national counterparts. The training, titled *“Table Olive and Value Addition Processing Protocols and Hygiene Safety,”* was delivered by an Italian expert across three provincial sites. It aimed to operationalize newly established processing units and standardize olive handling procedures across different scales, from semi-industrial to household levels. Participants included plant managers, operators, food technologists, laboratory technicians, farmers, processors, youth, women, and government officials. An additional training session was conducted at a facility managed by civil society and PPAF in Lower Dir (KP).

Despite these efforts, most olive varieties currently grown in Pakistan, including those suitable for table use, are primarily utilized for oil extraction. This trend is largely driven by government subsidies for oil extraction, while no comparable incentives exist for table olive production.

Table 10. Mapping of olive oil extraction units.

Khyber Pakhtunkhwa				
N°	Unit Model	Capacity	Location	Working condition
1	ALFA LAVAL	500kg/hr	Agriculture Research Institute Tarnab, Peshawar	No
2	OLIMIOGOLD	100kg/hr	Model Farm Service Center, Lower Dir	Yes
3	MoriTem FORMA	250kg/hr	PPAF Associated Community, Lower Dir	Yes
4	KOCAKMAZ	200kg/hr	Israr Farm, Dherai Thalash, Lower Dir	Yes
5	KOCAKMAZ	200kg/hr	Agriculture Research Institute, Mingorra, SWAT	Yes
6	MoriTem FORMA	250kg/hr	ARS - Kohat	Yes
7	OLIMIOGOLD	100kg/hr	Model Farm Service Center Bajaur	Yes
8	OLIMIOGOLD	100kg/hr	Agriculture Extension Orakzai	NA
9	MoriTem FORMA	500kg/hr	CCRI – Pir Sabak, Nowshera	Yes
10	MoriTem FORMA	500kg/hr	Olive Model Farm Sangbatti, Mardan	Yes
11	OLIMIOGOLD	100kg/hr	National Tea & High Value Crops Research Institute, Mansehra	Yes
12	MoriTem FORMA	250kg/hr	HARS - Abbottabad	NA
Balochistan				
N°	Unit Model	Capacity	Location	Working condition
13	PIERALISI	600kg/hr	Balochistan Agricultural Research and Development Centre, Quetta	Yes
14	PIERALISI	600kg/hr	Agriculture Research Institute, Loralai	Yes
15	MoriTem FORMA	250kg/hr	PPAF Associated Community, Zhob	NA
16	OLIMIOGOLD	100kg/hr	Agriculture Officer, Zhob	Yes
17	MoriTem FORMA	250kg/hr	PPAF Associated Community, Muslim Bagh	NA
18	OLIMIOGOLD	100kg/hr	Agri. Res. Station, Khuzdar	Yes
19	OLIMIOGOLD	100kg/hr	Panjgoor	NA
Punjab				
N°	Unit Model	Capacity	Location	Working condition
20	OLIMIOGOLD	100kg/hr	National Agriculture Research Centre, Islamabad	No
21	OLIMIOGOLD	100kg/hr	Barani Agriculture Research Institute, Chakwal	Yes
22	PIERALISI	600kg/hr	Barani Agriculture Research Institute, Chakwal	No
23	Alfa Laval	500kg/hr	Allah Ditta Unique Values, Chakwal	NA
24	PIERALISI	600kg/hr	Barani Agriculture Research Institute, Attock	Yes
25	NA	NA	Zahid Iqbal Allied Foods, Faisalabad	NA

Source: OliveCulture – POCCSP

4. Mapping of research and development institutes involved in olive promotion

Numerous public and private organizations, companies, and academic institutions are actively engaged in research and development related to olive cultivation. Their work focuses on enhancing the socio-economic and environmental benefits of the sector. A detailed list of these institutions is provided in Table 11.

Table 11. List of the research and development institutions involved in olive promotion.

Name of institute/Organization	Activity focus
Pakistan Oilseed Department, Islamabad	At national and international level; i) Policy formulation, ii) Coordination, iii) Research, iv) Project development, v) Data compilation at national and provincial level
National Agricultural Research Centre, Islamabad	Research on varieties; i) Development, ii) Selection, iii) Evaluation, iv) Genetic markers
Barani Agricultural Research Institute, Chakwal and CEFORT	i) Diagnostic field survey, ii) Adaptability trials, iii) Stakeholder consultations, iv) Research experiments /Trials, v) Establishment of olive multiplication blocks in private sector, vi) Collection and import of olive Germplasm, vii) Organize training of trainers, viii) Olive festival, ix) Conference, x) workshops/seminars, xi) Olive advisory services to olive stakeholders
Mountain Agriculture Research Center GB	i) Promotion of olive plantation, ii) Olive orchards development and management
Agricultural Research Institute, Tarnab (ARI), Peshawar	i) Diagnostic field survey, ii) Adaptability trials, iii) Stakeholder consultations, iv) Research experiments /Trials, v) Establishment of olive multiplication blocks in private sector, vi) Collection and import of olive germplasm, vii) Organizing trainings, viii) Olive festival, conference, workshops/seminars, ix) Olive advisory services to olive stakeholders
National Tea & High-value Crops Research Institute, Mansehra	NA
Agricultural Research Institute (ARI), Sariat, Quetta	i) Olive cultivar adaptability study, ii) Promotion of olive plantation, iii) Olive orchards development and management
Baluchistan Agricultural Research & Development Centre, Quetta	i) Olive Cultivar Adaptability study, ii) Promotion of olive plantation, iii) Olive orchards development and management
Agriculture Extension Department, Muzaffarabad, AJK	i) Promotion of olive plantation, ii) Olive orchards development and management
Institute of Biotechnology and Genetic Engineering, The University of Agriculture, Peshawar KP	i) Molecular diversity and associated phenotypic and biochemical divergence in olive gene pool
University of Agriculture Peshawar	i) Evaluation of olive cultivars in varied environments, ii) Olive oil quality, iii) Molecular divergence
Pir Mehr Ali Shah Arid Agriculture University Rawalpindi	i) Morphological characterization, ii) Phenological characterization, iii) Adaptability of Olive Cultivars

VIII –Considerations and recommendations

The available information on efforts and activities undertaken by public, private, and national and international organizations to strengthen the olive value chain in Pakistan has been comprehensively reviewed. The current assessment of resources, infrastructure, equipment, and inputs supporting olive-related activities is based on an extensive analysis of reports, scientific publications, online sources, and consultations with multiple stakeholders.

It is important to note that, prior to 2000, provincial government initiatives in olive cultivation were not systematically documented or quantified, except for plantation efforts initiated in collaboration with the Italian government during the mid-1980s. The structured development of the olive sector effectively began in 2000, with a strong focus over the following decade on large-scale plantation

establishment using improved agricultural practices, including the introduction of exotic olive varieties and the grafting of wild olive trees.

Current progress indicates that over 4 million olive saplings have been planted across approximately 15,000 hectares in diverse agro-ecological zones. Significant efforts have been made in stakeholder capacity building, supported in part by the OliveCulture Project. Several local and internationally standardized nurseries have been established, along with oil extraction units and value-addition laboratories to facilitate processing. Public-private partnerships are also being encouraged to ensure long-term sustainability.

Based on GIS-based assessments by PARC, several regions have been identified as suitable for olive cultivation and value chain development. However, further adaptive research is required to validate these findings and expand the crop's potential.

Despite the progress achieved, there remains a strong need to expand access to services, infrastructure, equipment, and inputs to further strengthen the olive value chain. Adoption of drip irrigation systems is particularly critical to address water scarcity. Given that many stakeholders are resource-constrained and relatively new to the sector, continued government financial support, particularly through subsidies, is essential. Sustainable development will also require comprehensive training in good agricultural practices, processing techniques, value addition, and oil extraction aligned with international standards.

The continued expansion of the olive sector is expected to generate significant socio-economic benefits, including employment opportunities. It is estimated that, within 4-5 years, olive plantations could produce approximately 12 million Liters of oil annually, valued at around PKR 18 billion. However, this projection depends on achieving average yields of 20-50 kg per tree and the adoption of effective management practices across the value chain.

Stakeholder consultations, field visits, and discussions with researchers and farmers indicate that public sector investments and technological interventions have been commendable. However, several key recommendations have been identified to ensure sustained growth and development of the olive sector:

- A comprehensive national policy is essential to address production, processing, marketing, and trade-related challenges. Current project-based approaches may not ensure long-term sustainability. A coordinated policy framework, developed in consultation with provincial governments and industry stakeholders, should define clear implementation strategies, institutional roles, and support mechanisms, including farmer cooperatives and market integration systems.
- Provincial governments should align their initiatives with federal strategies and integrate olive sector development into their core budgets and institutional mandates to sustain progress beyond project cycles.
- An integrated approach is needed to expand olive cultivation, focusing on high-yielding, stress-tolerant cultivars validated through standardized adaptability trials. Climate change impacts, pest pressures, and yield variability highlight the need for improved crop management and effective technology transfer to farmers.
- Enhanced coordination among federal and provincial agencies, research institutions, private sector actors, and NGOs is crucial. Establishing a national advisory body would facilitate

policy planning, data management, quality control, certification systems, and alignment with international standards, while strengthening linkages across the value chain.

- Since smallholder farmers represent over 70% of olive producers, access to affordable credit and subsidies is critical. Incentive-based policies and market stabilization measures can encourage adoption of olive cultivation. However, organizing smallholders into functional groups or cooperatives remains a key challenge.
- Promoting olive cultivation through agro-ecological clusters can enhance efficiency and impact. These clusters should be supported with infrastructure, market linkages, targeted subsidies, and tailored agronomic practices. Engagement of civil society organizations can further strengthen these initiatives.
- Additional oil extraction units are needed in key olive-growing regions such as Potohar and Sangbatti. Feasibility studies developed by SMEDA (2017) can guide potential investors and entrepreneurs in establishing such facilities.
- Limited availability of registered nurseries is a major constraint. Existing nursery clusters, particularly in Pattoki (Kasur District), Peshawar, and Mardan, should be further developed to supply certified olive planting material. Leveraging their expertise can significantly improve nursery standards and plant quality.

Based on stakeholder consultations and sector analysis, olive cultivation represents a highly viable alternative oilseed crop for Pakistan. The country's agro-ecological conditions, particularly marginal and underutilized lands, are well suited for olive production. With appropriate policy support, infrastructure development, financial incentives, and awareness campaigns, the olive sector has strong potential to replace a portion of imported edible oils and promote a healthier domestic alternative, *i.e.*, olive oil.

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Action plan and policy recommendations for a holistic development of the Pakistani olive value chain*

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Abstract. The sustainable development of Pakistan's olive sector requires a coordinated and participatory strategy capable of strengthening the entire olive value chain. This chapter presents an action plan and policy recommendations developed through a bottom-up approach involving a wide range of stakeholders, including public institutions, farmers, processors, researchers, private actors, and development partners. The work was primarily based on a SWOT analysis of the Pakistani olive value chain, which served as the main methodological framework for identifying strengths, weaknesses, opportunities, and threats affecting the sector. The chapter examines the current status of olive cultivation and processing in Pakistan while highlighting the main challenges affecting the sector. Strategic interventions and policy measures are proposed to improve sustainability, strengthen institutional coordination, support farmer capacities, and enhance value addition and market integration. The recommendations were presented and discussed during a stakeholder forum and received endorsement from the Ministry of National Food Security and Research.

Keywords. Action plan – Integrated management – SWOT analysis– Rural development.

Plan d'action et recommandations politiques pour le développement holistique de la chaîne de valeur oléicole pakistanaise

Résumé. Le développement durable du secteur oléicole au Pakistan nécessite une stratégie coordonnée et participative capable de renforcer l'ensemble de la chaîne de valeur oléicole. Ce chapitre présente un plan d'action et des recommandations politiques élaborés selon une approche « bottom-up » impliquant un large éventail d'acteurs, notamment les institutions publiques, les agriculteurs, les transformateurs, les chercheurs, le secteur privé et les partenaires du développement. Le travail repose principalement sur une analyse SWOT de la chaîne de valeur oléicole pakistanaise, utilisée comme cadre méthodologique central pour identifier les forces, faiblesses, opportunités et menaces du secteur. Le chapitre examine la situation actuelle de la culture et de la transformation des olives au Pakistan, tout en mettant en évidence les principaux défis affectant le secteur. Des interventions stratégiques et des mesures politiques sont proposées afin d'améliorer la durabilité, renforcer la coordination institutionnelle, soutenir les capacités des agriculteurs et favoriser la valorisation des produits ainsi que leur intégration au marché. Les recommandations ont été présentées lors d'un forum des parties prenantes et ont reçu l'approbation du ministère de la sécurité alimentaire nationale et de la recherche.

Mots-clés. Programme d'action – Gestion intégrée – Analyse SWOT – Développement rural.

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I – Introduction

This chapter presents the Action Plan and Policy Recommendations (AP&PR) for the holistic development of the Pakistani olive value chain. It is grounded in the recognition that, while agriculture remains a cornerstone of Pakistan's economy, the country continues to rely heavily on imports for key commodities such as edible oils. Addressing this imbalance requires a strategic shift toward diversification and the promotion of high-value, sustainable crops.

Within this context, olive cultivation represents a promising opportunity. Well-suited to Pakistan's agro-climatic conditions, olive farming has the potential to generate economic benefits, support rural livelihoods, and contribute to environmental sustainability. Moreover, increasing domestic olive oil production could help reduce the national import bill and strengthen food security.

The development of the olive sector has gained increasing attention at the national level, reflecting a broader commitment to fostering agricultural innovation and resilience. In this framework, the OliveCulture Project, funded by the Italian Agency for Development Cooperation (AICS), and implemented by CIHEAM Bari in collaboration with the Ministry of National Food Security and Research (MNFSR) and the Pakistan Oilseed Department (POD), aims to strengthen the olive value chain through a holistic and participatory approach. The project engages a wide range of stakeholders, including institutions, farmers, businesses, and consumers, to improve productivity, quality, and market integration. Particularly, the project aims to guide and support the Pakistan Oilseed Department of MNFSR to organize actions, make the interventions more organic and provide the appropriate know-how for its development. The project interacts very closely and operates in coordination with the *"Promotion of Olive Cultivation on Commercial Scale in Pakistan - Phase II"* (POCCSP -II) and its provincial components.

A key outcome of this initiative is the AP&PR presented in this chapter. Its development was supported by a multi-stakeholder process, including workshops, consultations, and study visits, and involved the contribution of a dedicated stakeholder group forming the basis of the future Pakistan Olive Oil Council. The analysis underpinning the AP&PR is based on a comprehensive assessment of the sector, including a SWOT analysis that identifies internal strengths and weaknesses, as well as external opportunities and threats.

Building on this analytical framework, the chapter outlines strategic priorities and policy recommendations aimed at supporting the sustainable growth of the olive value chain across its key components, production, processing, marketing, governance, and research. Particular attention is given to aligning sector development with broader national priorities, including rural development, economic diversification, and climate change adaptation.

In this regard, olive cultivation is not only considered a means of increasing self-reliance in edible oils, but also as a climate-smart agricultural practice capable of contributing to resilience in the face of environmental challenges. Given Pakistan's vulnerability to climate change and the availability of marginal lands suitable for olive cultivation, the sector offers significant untapped potential.

Overall, this chapter provides a structured and forward-looking framework to guide policymakers and stakeholders in strengthening the Pakistani olive value chain. Its effective implementation will depend on coordinated national efforts, sustained institutional support, and continued international cooperation.

II – Context and sustainability dimensions of the olive value chain

The sustainable development of the olive value chain requires a thorough understanding of its context, examined through the interconnected environmental, economic, and social dimensions of sustainability.

1. Environmental dimension

From an environmental perspective, Pakistan has consistently ranked among the ten countries most vulnerable to climate change over the past two decades, according to the Climate Risk Index. While the global climate crisis disproportionately affects the Global South, Pakistan has been particularly impacted by climate change induced natural disasters. Extreme weather events, including prolonged droughts and devastating flash floods, have caused widespread damage to crops and infrastructure, resulting in the loss of livelihoods and human lives. These events have had far-reaching consequences, with the agricultural sector being among the most severely affected.

The 2022 floods were especially catastrophic, inundating nearly three-quarters of the country and leaving close to a million people without access to safe and adequate housing. These events once again drew global attention to the urgency of addressing climate change. Pakistan played a key role at COP27 in Sharm El-Sheikh, Egypt, advocating for the establishment of a dedicated “Fund for Loss and Damage” to support developing countries that are particularly vulnerable to the adverse impacts of climate change.

In the absence of a single technological solution to address the complex challenges posed by climate change, Pakistan must adopt a diversified and long-term strategic approach. This includes promoting high-value, climate-resilient crops that are both heat- and drought-tolerant and suitable for cultivation across different agro-climatic zones. In this regard, olive cultivation stands out as a promising and cost-effective option. As a resilient crop capable of withstanding harsh environmental conditions, olive farming can contribute meaningfully to both climate change mitigation and adaptation strategies.

Nevertheless, climate change remains a major source of concern, as it exacerbates existing vulnerabilities such as income inequality, food insecurity, and gender disparities. These pressures can, in turn, intensify competition over scarce natural resources, including water and arable land. Although olive trees possess natural characteristics that make them relatively resistant to harsh climatic conditions, the potential impact of climate change on productivity and losses cannot be overlooked. Recognizing these opportunities, both federal and provincial governments are actively promoting olive cultivation, supported by the availability of suitable land and favorable environmental conditions. Notably, olive trees also play an important role in carbon sequestration, contributing to the development of a cleaner and greener environment.

Environmentally sustainable olive production can help mitigate climate change by reducing greenhouse gas emissions. Scientific studies have highlighted the positive environmental impacts of olive cultivation, including its role in preserving biodiversity, improving soil quality, and acting as a barrier against desertification. Olive trees have also been shown to capture atmospheric carbon dioxide and store it in biomass and soil, contributing to temperature regulation.

On the other hand, Pakistan faces significant challenges related to land degradation, including water erosion and soil incompatibility, which limit the cultivation of many plant species. Approximately 16 million hectares of land, i.e., about 20% of the country's total area, are affected directly or indirectly by soil erosion. Expanding olive cultivation could help address these issues by reducing erosion and desertification, while also generating economic benefits. However, it is important to note that in certain semi-arid and hilly areas with poor soil fertility and severe erosion, the feasibility of olive cultivation remains limited.

At the policy level, the Government of Pakistan has prioritized the Sustainable Development Goals (SDGs) as part of its broader development agenda, aiming to achieve upper middle-income country status by 2030. Pakistan was among the first countries to adopt the SDGs through a unanimous parliamentary resolution. Olive cultivation contributes to several of these goals, including poverty reduction (Goal 1), zero hunger (Goal 2), decent work and economic growth (Goal 8), responsible consumption and production (Goal 12), climate action (Goal 13), life on land (Goal 15), and partnerships for development (Goal 17).

To support this vision, the federal government has launched various initiatives to promote olive cultivation and production. Encouraged by favorable climatic conditions and growing prospects, provincial governments have also taken concrete steps. The Potohar and Sargodha regions in Punjab, as well as several districts in Khyber Pakhtunkhwa (KP), have been designated as olive valleys. Large-scale plantations are also underway in Balochistan and the merged areas of KP, while Azad Jammu and Kashmir (AJK) and Gilgit-Baltistan (GB) are increasingly considered suitable for olive cultivation.

2. Economic dimension

From an economic perspective, over the past seven decades Pakistan has undergone a structural transformation, shifting from an agrarian-based economy to one increasingly driven by the services sector. Between 2011 and 2021, the services sector overtook agriculture as the dominant contributor to the national economy and currently accounts for approximately 52% of GDP, compared to 38% in 1960. Over the same period, the contribution of agriculture declined significantly, from 46% to around 23%, while the industrial sector (non-manufacturing) increased its share from 16% to approximately 20.9%. In 2021, agriculture contributed about 22.96% to GDP, industry 18.7%, and services accounted for more than half of the overall economic output (Figure 1).

Despite its declining share in GDP, agriculture remains a critical sector, particularly for rural livelihoods. However, its productivity continues to be constrained by several structural challenges, including rigid cropping patterns, over-reliance on a limited number of major crops, narrow genetic diversity, low-quality seed inputs, and inefficient water use and management systems. As a result, many rural areas remain underdeveloped and, in several cases, face persistent poverty and food insecurity, even though wheat, rice, sugarcane, and cotton dominate agricultural production.

Within this context, olive cultivation presents a promising economic opportunity. At the farm level, the olive plant offers a high-profit potential across its entire value chain, from cultivation to processing. Studies have shown that olive farming can be a financially viable investment, with an internal rate of return (IRR) of approximately 31% at a 10% discount rate, indicating strong profitability compared to prevailing market interest rates.

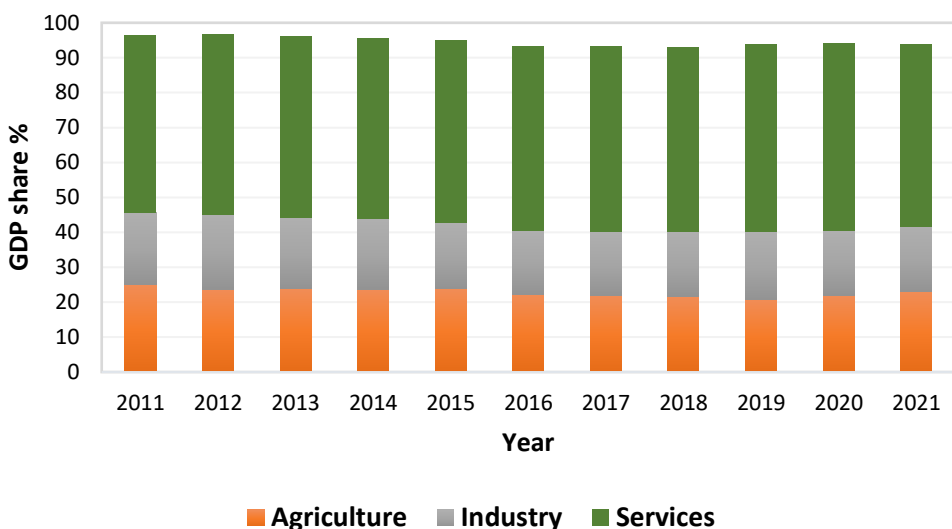


Figure 1: Share of different sectors in the GDP (%) of Pakistan from 2011-2021.

Beyond primary production, olive processing, including the production of oil, pickles, and other by-products, can further enhance income generation and improve living standards, particularly for rural communities, youth, and women. The development of a comprehensive olive value chain is therefore essential to maximize these benefits. In this regard, the sector offers substantial investment opportunities across multiple stages, from cultivation and processing to marketing and distribution.

According to recent estimates from the Pak Olive Project, the economic potential of the sector is considerable. The projected annual income from the cultivation of 50,000 acres is estimated at approximately PKR 14.58 billion from the eleventh year onward, while the cumulative income over a 25-year period is expected to reach around PKR 249.125 billion.

Table 1: Expected income from 50,000 acres of olive plantation.

Title	Calculations
Average fruit production per plant	15 kg/plant
Average oil production	12 %
Number of plants/acres after 5 years of plantation	108 (assuming 80% survival rate)
Average production/acre	1,620 kg
Average oil production/acre	195 Liters
Lowest price/liter	Rs.1500/-
Income/acre	Rs. 146,250/-
Average oil production/annum (50,000 acres)	10 million liters
Expected income (50,000 acres/annum)	14.58 billion Rs./annum (on year 11 & onward)
Cumulative income based on 25 years	249.125 billion Rs.

Source: Pak Olive Project

Overall, Pakistan has significant potential to expand domestic edible oil production through the development of the olive sector. Realizing this potential will require strengthening the capacities of both public and private stakeholders, particularly in areas such as orchard management, nursery development, value addition, business planning, and market integration.

3. Social dimension

From a social perspective, agriculture remains a major source of employment and livelihood in Pakistan, particularly in rural areas where a large proportion of the population depends directly or indirectly on agricultural activities. However, the sector faces increasing challenges related to unemployment, poverty, rural-to-urban migration, unequal land distribution, and the growing impacts of climate change. In a country where nearly 64% of the population is under the age of 30, the creation of sustainable livelihood opportunities has become an important national priority. Despite the continued importance of agriculture, rural economies in Pakistan are becoming increasingly diversified, with a growing share of the population engaged in non-farm activities due to declining agricultural profitability, land fragmentation, and urban expansion.

Within this context, the development of the olive value chain has the potential to generate significant social benefits, particularly in marginal and disadvantaged regions. Olive cultivation can contribute to rural development by creating employment opportunities in nursery management, plantation establishment, orchard maintenance, harvesting, processing, packaging, marketing, and agrotourism activities. The sector also offers opportunities for the development of small-scale and cottage industries, especially for women and youth, through value-added products such as table olives, olive oil, soaps, cosmetics, and artisanal products. Furthermore, olive cultivation on marginal and underutilized lands can improve household incomes without directly competing with major traditional crops, thereby supporting livelihood diversification and reducing economic vulnerability in rural communities.

The expansion of olive cultivation may also contribute to reducing rural migration by creating new economic opportunities at the local level and strengthening the participation of the private sector in rural economies. In addition, training programs, technical assistance, and international cooperation initiatives have enhanced local capacities and increased awareness regarding modern olive production and processing practices. Consequently, the olive sector is increasingly viewed not only as an agricultural activity, but also as a potential driver of inclusive rural development, social stability, and improved living conditions in olive-growing areas of Pakistan.

Following the growing recognition of the economic, environmental, and social importance of olive cultivation, Pakistan has increasingly prioritized the development of the olive sector through national policies, institutional support, and international cooperation initiatives. In recent decades, several public and private interventions have contributed to the expansion of olive plantations, the introduction of adapted cultivars, the establishment of processing facilities, and the strengthening of technical capacities along the olive value chain. These efforts have laid the foundation for the gradual development of olive production and processing activities in different regions of the country.

increased to around 135 plants per acre, which is now commonly practiced in several regions. Assuming a density of 108 plants per acre, yielding approximately 2,160 kilograms of olives per acre, it is estimated that around 260 kilograms of olive oil can be extracted per acre under optimal soil and water conditions, provided that good agricultural practices are fully implemented.

Since the launch of the “*Promotion of Olive Cultivation on Commercial Scale in Pakistan (POCCSP)*” project in 2014, plantations have been established in different phases up to 2021, resulting in considerable variation in the age of olive trees across the country. A major constraint in conducting comprehensive technical, economic, and social evaluations is that only about 17% of the sampled orchards have started producing fruit, with productivity levels ranging from less than 1% to full capacity. Notably, only three out of 670 surveyed farmers reported orchards operating at 100% production capacity. While 129 farmers provided responses reflecting current conditions, a clearer picture of the sector’s performance will emerge once at least 50% of orchards reach full productivity. A more accurate assessment of the socio-economic impact is expected within the next 4-5 years, when a larger proportion of plantations becomes fully productive. At that stage, the availability of olive fruit in greater quantities will also enhance the effectiveness of supporting facilities such as extraction units and value addition laboratories.

The evaluation of olive plantation initiatives highlights overall positive impacts on farmers, local communities, and the environment. Most indicators suggest that olive cultivation has had beneficial effects, particularly through the productive use of marginal and previously barren lands. Survey results indicate that 303 farmers utilized such lands for olive cultivation, many of whom owned less than 10 acres. Additionally, respondents reported positive spillover effects on surrounding vegetation, suggesting that expansion of olive cultivation could further support ecological improvement.

Among the provinces, olives grown in Balochistan exhibit the highest oil content, ranging between 18-20%, which is comparable to international standards. In contrast, olives cultivated in Punjab typically yield around 12% oil content.

As olive cultivation is still at an early stage in Pakistan, there is a clear need to enhance farmers’ knowledge of best agricultural practices. In particular, improving integrated farm management and increasing productivity require targeted training and capacity-building efforts. Farmers, especially those new to olive cultivation, require support in areas such as planting techniques, fertilizer application, pest management, pre- and post-harvest handling, and irrigation practices to ensure consistent quality and yields.

Although olive trees are drought-tolerant, supplementary irrigation at critical phenological stages is essential to achieve optimal yields. High-efficiency irrigation systems, such as drip irrigation, not only conserve water but also improve fruit quality and reduce the incidence of pests and diseases. The provision of subsidized drip irrigation systems represents a significant opportunity for the government to further encourage olive cultivation. In contrast, many large and medium-sized farms continue to rely on inefficient practices such as flood irrigation for crops like rice, leading to excessive groundwater extraction. These practices have contributed to widespread issues of waterlogging and soil salinity, rendering large areas of land unsuitable for cultivation. Drip irrigation offers a viable alternative for improved water management. Although maintenance challenges exist, these can be addressed through targeted training programs. While only 17% of surveyed farmers currently use drip irrigation, most recognize its potential to reduce water use by up to 50%, while also mitigating land degradation caused by erosion and desertification.

The contribution of renewable energy to the olive sector remains limited, although it has increased slightly from 2.4% to 3.02%. Expanding the use of renewable energy across the entire olive value chain, from cultivation to processing and transportation, would support the development of a fully “green” olive production system.

Additionally, training and extension services are typically provided by government agricultural departments; however, additional efforts are needed to ensure that knowledge of best practices is effectively disseminated among farmers. Currently, improper harvesting techniques and inadequate tools are commonly used, which negatively affect both yield and quality. Similarly, poor handling practices during transportation, such as stacking sacks of olives, can damage the fruit and reduce oil quality. While hand-picking remains the least damaging harvesting method, it is labor-intensive and costly.

With regard to value addition infrastructure, facilities such as oil extraction units, laboratories, and weather stations have been established and are operational. However, farmers’ access to these services needs to be improved through increased availability, better outreach, and awareness initiatives. Expanding these facilities and enhancing digital access would further strengthen their utilization and impact.

Box 1 summarizes the main agronomic and technical requirements for olive cultivation in Pakistan, including cultivar selection, soil and climatic conditions, plantation management, irrigation, fertilization, pollination, and harvesting practices.

2. Processing

Olive processing, including the production of oil, pickles, and other value-added products, is aimed at obtaining edible oil and palatable olives, while enhancing profitability and improving the living standards and health of youth, women, and rural communities. The overarching goal is to develop a strong and sustainable olive value chain. This sector offers significant investment opportunities.

A. Olive oil

Olive cultivation is considered a national priority, and supporting farmers can contribute significantly to increasing domestic edible oil production and strengthening the national economy. Establishing effective linkages across the sector is essential for developing the entire olive value chain.

Currently, the supply of olive fruit varies across regions, largely due to differences in tree age, with less than 20% of trees presently bearing fruit. However, olive supply for oil extraction is expected to increase rapidly in the coming years. Some processing units already have storage facilities within their premises, and a few offer opportunities for producing value-added products. Certain units also assist farmers in developing olive-based products, while others are connected with meteorological services to provide relevant support.

Figure 3 presents the different steps of the extraction process of olive oil.

BOX 1: Olive cultivation requirements

a) Varieties: A wide range of olive varieties are cultivated in Pakistan. Among the most prominent are Frantoio, Arbosana, Arbequina, Coratina, Koroneiki, Leccino, Pendolino, Gemlik, Picual, and Hojiblanca.

b) Soil and climatic requirements: Olive trees perform best in deep, fertile soils and under moderate climatic conditions. Ideally, temperatures should average around 10°C and not fall below -10°C. However, heat-tolerant varieties are now available that can withstand temperatures up to 37°C. Although olive trees are relatively drought-resistant, irrigation is often required for optimal growth and yield. The trees require a chilling period (winter dormancy) of approximately 60-80 days, with average temperatures between 4-7°C, to ensure proper flower bud differentiation. This corresponds to about 250 chilling hours, depending on the cultivar. During the winter months (November to February), temperatures should ideally not exceed 22°C. Olive trees can tolerate short periods of gradual temperature decline to -10°C. Optimal fruit yield and quality are achieved in regions with mild winters and long, warm, and dry summers. Soils that are neutral to slightly saline, with about 5% clay content, are suitable. The optimal soil pH ranges between 5.6 and 8.5 (not below 5 or above 8.5). While nitrogen is essential for growth, boron deficiency can significantly affect plant development.

c) Land preparation: The soil should be thoroughly ploughed prior to planting. Pits measuring approximately 2.5×2.5 feet should be prepared at least one week before plantation.

d) Planting time: Olive trees can be planted during both spring and autumn. However, autumn planting is preferred, if there is no likelihood of frost during winter.

e) Planting geometry: Initially, olive plantations in Pakistan followed a spacing of 20×20 feet, accommodating approximately 107 plants per acre. This has now been increased to around 135 plants per acre in many regions. Trees are typically planted in a square layout, maintaining equal spacing between rows and plants. A spacing of 18×18 feet is considered optimal, provided regular pruning is carried out. Under suitable soil and irrigation conditions, this spacing allows for approximately 135 trees per acre.

f) Irrigation requirements: Although olive trees are hardy and drought-tolerant, timely irrigation is essential, particularly during the first two years after planting. In rainfed areas, annual rainfall ranges from 150 to 500 mm but is often irregular and insufficient for crop needs. In the absence of rainfall, trees should be irrigated two to three times annually, typically: i) before flowering; ii) after flowering; iii) 30-45 days before fruit maturation. Additional irrigation may be required during flowering under certain conditions.

g) Pollination requirements: Olive trees are monoecious, bearing flowers along the shoots in panicles. Both self- and cross-pollination can occur; however, the use of self-pollinating varieties is increasingly encouraged.

h) Fertilizer requirement

Fertilizer application depends on soil conditions (soil testing is recommended), as well as the variety and age of the trees. As a general guideline, after three years of plantation, approximately 300 kg/ha of phosphorus, 200 kg/ha of potash, 200 kg/ha of nitrogen, along with an adequate quantity of farmyard manure, should be applied.

i) Fruit harvesting: Olives typically mature between September and October. Harvesting methods include: i) hand-picking individual fruits for pickling or high-quality oil production; ii) shaking branches and collecting fallen fruits; iii) mechanical shaking of trunks and branches.

j) Harvesting for pickle: Fruits intended for pickling are harvested when they are light green. After washing, they are treated in a 1-2% sodium hydroxide (NaOH) solution for approximately 12 hours. The fruits are then washed 5-6 times and placed in an 8-10% sodium chloride (NaCl) solution for 14-21 days. Subsequently, they are washed again and preserved in a fresh brine solution (5-6%), with the pH adjusted to a safe level (below 4.6) using organic acids.

k) Harvesting for oil : Fruits for oil production are harvested when color changes begin (from green to purple), typically between September and October. The harvested fruits are then processed for oil extraction.

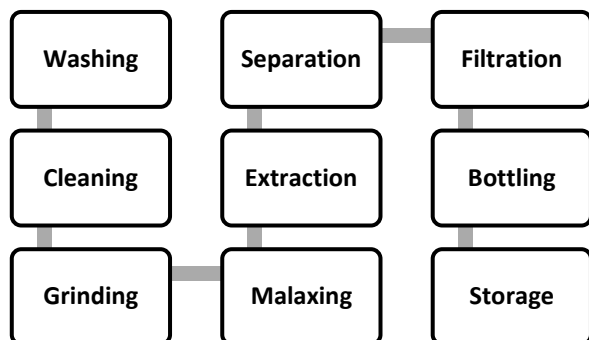


Figure 3. Olive oil extraction process.

Despite government efforts to provide olive oil extraction and processing facilities, a study by Khaity Technologies (“Impact Assessments”) revealed that 63% of farmers face high transportation costs when delivering olives to extraction units of their choice. Olive oil is sold in the domestic market at premium prices ranging from PKR 2,500 to PKR 3,000 per litre, making it more profitable for farmers to sell oil rather than raw olives. While some studies report olive fruit prices at around PKR 100 per kilogram due to market dynamics, farmers typically sell olives at PKR 150 to 300 per kilogram.

To maintain superior extra virgin olive oil quality, olives should ideally be milled within 24 hours of harvesting. However, most farmers are located far from extraction facilities, and many share limited processing units. As a result, delays in processing are common, which negatively impacts oil quality. Given the wide geographical distribution of olive farms, there is a clear need for a decentralized network of smaller mills closer to farms, as well as larger-capacity extraction facilities. At present, the number of extraction units remains limited, most of which have been established by the government or through collaborations with international organizations for research and development (Table 2). Additionally, the high cost of imported extraction machinery poses a challenge.

Poor rural infrastructure and fragmented landholdings further complicate timely processing and hinder the production of high-quality extra virgin olive oil. Storage also plays a critical role in maintaining quality, yet proper storage facilities are largely unavailable domestically. The use of inappropriate storage containers further degrades the quality of both olives and olive oil. Non-corrosive storage containers are imported and accessible only to a limited number of farmers. However, initiatives under the POCCSP project, such as providing lockable fruit baskets and non-welded stainless-steel containers, have contributed to safer transportation and better preservation of oil quality.

Another key challenge is the lack of technical knowledge among managers and operators of extraction units. Ensuring high-quality olive oil requires proper understanding of post-harvest handling practices, including transportation, storage, and pre-processing management, as well as best practices during extraction. While provincial agriculture departments offer extension services, additional capacity building is needed. In this regard, the OliveCulture Project initiated hands-on training programs for managers and operators of both public and private extraction units at the start of the 2022 crushing season. Training also covered techniques for table olive processing, and these activities are expected to continue in subsequent seasons.

Table 2. Olive oil extraction units in Pakistan (Public and Private Sector).

Brand	Capacity (kg/hr)	Number of units	Location	Phasing	Project
Pieralisi	600	3	GRS Attock, ARI Loralai and BARDC Quetta	2-Phase	Federal Project
Pieralisi	600	1	BARI, Chakwal	2-Phase	Punjab Govt.
Mori Tem	500	3	CCRI Pir Sabaq, Sanghbhatti Swat	2-Phase	ADP KP Government
Alfa Lavel	500	1	ARI, Tarnab	3-Phase	Italian grant with PODB
FORMA - Mori-Tem	250	3	Zhob, Muslim Bagh, Lower Dir	2-Phase	PPAF
FORMA - Mori-Tem	250	2	BARS Kohat, ARS Abbottabad	2-Phase	ADP KP Government
Kocomaz	200	1	Israr Farm Dherai Thalash, Lower Dir	2- Phase	SMEDA
(Turkish Brand) Oliomio Gold, Mori-Tem	200	1	Agriculture Research Station Khuzdar	2-Phase	ADP Balochistan
Oliomio Gold, Mori-Tem	200	1	Agri. Ext. Bajour	2-Phase	ADP KP Government
Oliomio Gold, Mori-Tem	100	6	Islamabad, Chakwal, Zhob, Rakhni, Lower Dir, and Shinkhari Mansehra	2-Phase	Federal Project
Oliomio Gold, Mori-Tem	100	2	Faisalabad, Chakwal	2-Phase	Private sector USAID matching grant
Oliomio Gold, Mori-Tem	100	1	Agri. Ext. Orakzai	2-Phase	ADP KP Government

B. Table olives

In addition to olive oil, table olives represent another important value-added product with strong potential in Pakistan. However, their processing requires specialized techniques. Table olive varieties are typically larger in size, and harvesting time depends on the desired maturity stage. Processed table olives can be marketed in various forms, including green or black, whole or sliced, and with or without pits.

Currently, most table olive processing in Pakistan is carried out manually, with limited availability of machinery for efficient and large-scale production. Although USAID supported the establishment of table olive processing units in the Potohar region in 2018 under a grant-matching program, these facilities face a shortage of raw material.

Under the POCCSP project, three value addition laboratories (table olive processing units) equipped with the necessary facilities, equipment, and chemicals have been established at Barani Agricultural Research Institute (BARI) Chakwal, Tarnab (Peshawar), and Agricultural Research Institute (ARI) Quetta. Despite these efforts, access to such facilities remains limited: 48% of respondents (276 individuals) reported having no access to value addition labs, 35% (200 respondents) indicated the question was not applicable, and 9% (54 respondents) were unaware of these facilities.

Although table olives have clear market demand and promising future potential domestically, there is limited emphasis on cultivating varieties specifically suited for table olive production. Most currently grown varieties are primarily used for oil extraction. Both government policies and farmer practices are focused on oil production, largely because oil extraction is subsidized, whereas table olive production receives no such support.

Furthermore, only a small number of commercial players are engaged in table olive production, and technological adoption remains minimal. Small-scale farmers and processors rely heavily on manual methods for de-pitting and slicing, as commercial-grade machinery is not widely available. Nonetheless, it is important to note that, unlike olive oil, which competes with substitutes such as palm, soybean, and canola oils, table olives have no direct substitutes. With the growing popularity of Mediterranean cuisine in Pakistan, including foods such as pizza, pasta, and sandwiches, the domestic demand for table olives is expected to rise significantly.

IV – Marketing

There is a lack of up-to-date and comprehensive market information on Pakistan's olive sector. Limited efforts have been made to understand key aspects such as product diffusion, product development, supply chains, consumer preferences, usage patterns, demand, and marketing prospects in local and regional markets. This gap has resulted in weak linkages for product development and poor market integration of locally produced olives. Notably, the study conducted by Pakistan Edible Oil Research Institute (PERI) titled *“Market Analysis for Value Chain and Olive Oil Consumption in Pakistan”* dates back to 2016, highlighting the need for more recent analyses.

Significant improvements are also required in branding and certification, which are essential for developing a competitive, supply-driven, and export-oriented olive value chain in Pakistan. In this context, regulatory frameworks offer valuable guidance and should be considered by emerging olive-producing countries like Pakistan to align with international standards. These regulations aim to prevent fraud in olive marketing by enhancing transparency through proper labelling, which ensures information about oil quality, origin, and storage conditions.

With growing awareness of the health benefits associated with agri-food products such as olives, demand for olive oil and value-added olive products is steadily increasing. This creates opportunities for revenue generation through both domestic sales and exports. However, access to markets remains a major challenge for farmers, with distance identified as one of the most significant barriers. As a relatively new entrant in olive cultivation and production, Pakistan requires enhanced cooperation among national and international stakeholders to strengthen its marketing systems.

1. Marketing channels of olive

The value chain concept is increasingly recognized as an effective and profitable strategy in agricultural and food systems. Sustainable development goals can be achieved by systematically integrating social, environmental, and economic considerations into all stages of the value chain. Identifying and optimizing marketing channels is essential to ensure benefits for both farmers and consumers. In developing countries such as Pakistan, the lack of well-structured agricultural markets remains a major constraint. A study titled *“Economics and Marketing of Olive in Punjab”*,

conducted in the Potohar region, analyzed olive cultivation and marketing systems and mapped trade flows within the olive supply chain (Figure 4).

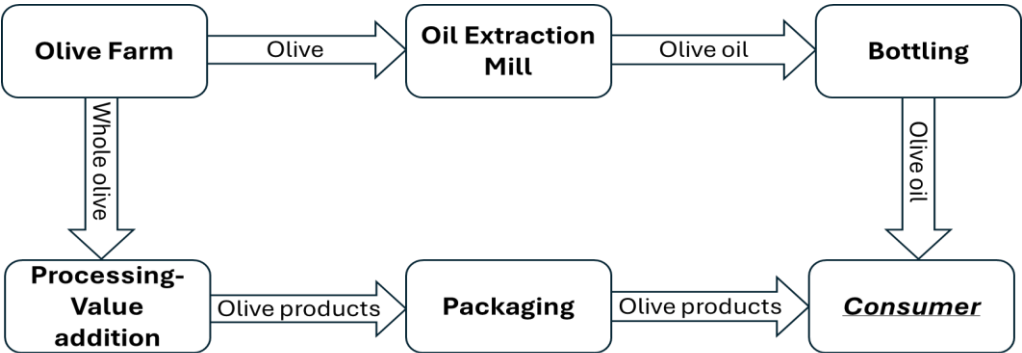


Figure 4. Trade flows in olive supply chain.

Based on focus group discussions involving farmers, agricultural extension agents, commission agents, retailers, and consumers, the study identified existing marketing channels in Potohar (Figure 5).

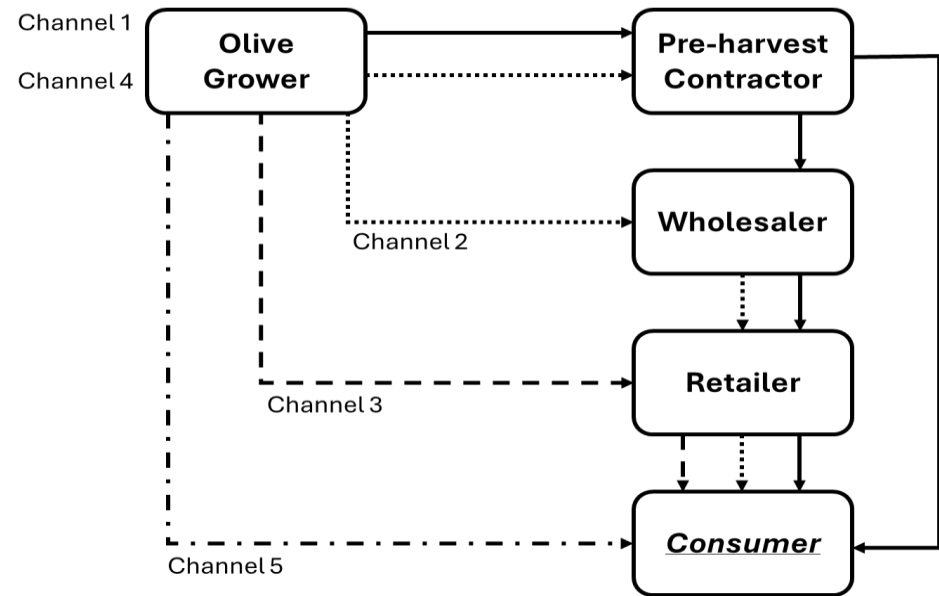


Figure 5. Identification of marketing channels in olive supply chain.

2. Domestic demand for olive oil

Olive oil imports in Pakistan have increased steadily over time. However, despite growing awareness of its health benefits, consumption remains limited due to high prices, low consumer awareness, and dietary preferences. Pakistani cuisine often involves deep frying and high oil consumption, leading consumers to prefer cheaper alternatives such as palm, sunflower, and canola oils. Since olive oil is largely imported, it remains relatively expensive and is mainly available in supermarkets and urban retail outlets. Consequently, affordability represents a major barrier to consumption, with approximately 70% of non-users reporting that they cannot afford olive oil. Even among middle- and high-income households, olive oil consumption remains relatively low compared to other edible oils.

3. Import of olive oil

To meet domestic demand, Pakistan relies heavily on imported olive oil. Out of a total edible oil import bill of USD 3.6 billion, approximately USD 3.4 billion was spent on palm oil in 2021, while only USD 13 million was spent on olive oil, representing just 0.36% of total edible oil imports. This indicates a relatively low demand for olive oil compared to widely used alternatives like palm oil.

Pakistan's per capita edible oil consumption is estimated at around 22 kg annually; however, olive oil accounts for only a very small share. In 2021, approximately 4,488 tons of olive oil were imported, compared to about 3.1 million tons of palm oil (94.6% of total edible oil imports). Per capita olive oil consumption is approximately 0.017 kg per year, which is extremely low compared to leading olive-producing and consuming countries such as Greece, Spain, Italy, Morocco, and Turkey. This comparison suggests that higher domestic consumption is closely linked to sustained investment in the olive sector.

Despite low consumption levels, there has been a significant increase in olive oil imports over the past two decades, from PKR 36 million (253 tons) in 2001-2002 to PKR 2,107 million (4,590 tons) in 2020-2021 (Figure 6). This upward trend reflects a gradual shift in consumer preferences toward healthier dietary options, increased awareness of olive oil benefits, and the growing influence of international cuisines that incorporate olive oil.



Figure 6. Import of olive oil in Pakistan (Source: Pakistan Bureau of Statistics 2020-2021).

The rising consumption trend presents opportunities for domestic producers to capture market share currently held by imported products. Additionally, there is potential for entering export markets. However, as a relatively new sector, research on olive cultivation and marketing in Pakistan remains limited. This lack of comprehensive market research represents both a weakness and an opportunity for stakeholders, researchers, and agribusinesses to explore.

4. Constraints in market development

The main constraints affecting market development are as follows:

- a. **Lack of cost-effective packaging:** Appropriate packaging is essential to preserve olive oil quality. Typically, olive oil is stored in tinted glass bottles to prevent light exposure and corrosion. In Pakistan, there is often a shortage of new glass bottles, forcing producers to reuse bottles for packaging extra virgin olive oil. Manufacturers also impose minimum order quantities that exceed the needs of small-scale producers. As a result, plastic bottles are sometimes used, which negatively affects oil quality.
- b. **Insufficient branding of Pakistani olive products:** There have been limited efforts to promote locally produced olive oil. Apart from initiatives such as the annual Olive Festival in Punjab, marketing activities remain minimal. While some participation in international trade fairs and exhibitions has occurred, exporting olive oil remains challenging without compliance with international standards.
- c. **Weak market linkages:** There is a lack of effective business linkages among farmers, processors, wholesalers, and retailers. Most large retail chains do not stock locally produced olive oil. Instead, sales are primarily conducted through informal channels such as word of mouth, small organic stores, or online platforms like social media pages.
- d. **Absence of quality standards and testing facilities:** Currently, most olive farms and processing units lack certifications such as Good Agricultural Practices (GAP), HACCP, or ISO. Traceability systems required for international trade are also absent. Olive oil is often sold without proper testing, making it unclear whether it meets virgin or extra virgin standards. Laboratory testing facilities are limited and costly. However, initiatives under the POCCSP-II project aim to establish laboratories and sensory evaluation facilities, while the OliveCulture Project is contributing through infrastructure design and technical training.
- e. **Limited private sector participation:** Large food processing companies have not yet entered the olive sector due to inconsistent supply and variable quality of olives. Edible oil processors typically require between 100 and 400 tons of olive oil annually, which is difficult to source domestically. Consequently, major retail and wholesale chains do not stock local olive oil. Increased private sector investment in cultivation, milling, and storage could significantly boost production volumes and quality, enabling both domestic market expansion and export potential.
- f. **Lack of demand-side strategy:** While government initiatives have focused on strengthening the supply side, there has been limited emphasis on demand generation. Market-based research on consumer preferences and behavior remains insufficient. As a result, domestic demand for olive oil and related products is still relatively low.

Overall, olive cultivation represents a strategic opportunity for Pakistan to convert degraded and marginal lands into productive agricultural systems. It can contribute to increasing domestic edible oil production, mitigating climate change impacts, and providing sustainable livelihoods to rural communities, particularly in areas with limited economic opportunities beyond agriculture.

Nevertheless, highly productive agricultural land and freshwater resources remain scarce and are primarily allocated to traditional food and cash crops.

V – Legislation, certification and policies

Regarding policy development, the need to establish a comprehensive national framework for the olive oil value chain in Pakistan was identified several years ago. In the absence of such a framework, various components of the value chain remain underdeveloped, fragmented, or evolving in isolation, without benefiting from accumulated knowledge and prior experiences. These components span a wide range of sectors, including sapling production and import, cultivar selection, plantation management, phytosanitary measures, pest control, harvesting, processing technologies, commercialization, quality standards, legal frameworks, monitoring systems, and research.

To address these challenges, the Government of Pakistan has mobilized key organizations involved in agricultural research and development to fully harness the country's potential for olive production. This effort is aligned with broader national objectives such as achieving self-reliance in edible oil production and addressing climate change mitigation and adaptation goals.

In this context, the POCCSP-II Project proposed the establishment of an Olive Advisory Council to address bottlenecks in value addition and to promote olive cultivation nationwide. Complementing this initiative, the recently established Pakistani Olive Stakeholder Group brings together representatives from the Pakistan Chambers of Commerce, Pakistan Business Council, academia, entrepreneurs, researchers, and progressive growers. This group is tasked with contributing to the development of an appropriate institutional and regulatory mechanism.

The establishment of the Pakistani Olive Stakeholder Group under the MNFSR has been finalized through the Italian-funded OliveCulture Project. Building on this, the proposed Pakistan Olive and Olive Oil Council is expected to be established through formal approval by the MNFSR, ideally via an Act of Parliament or a Presidential Ordinance, similar to the establishment of institutions such as the Pakistan Tobacco Board. This Council would oversee matters related to quality, standards, certification, and policy guidance for the olive sector. To this end, the Stakeholder Group has drafted a comprehensive regulatory framework titled *“Pakistan Olive and Olive Oil Council: Establishment and Regulations,”* comprising 22 articles that define the Council's purpose, structure, scope, and responsibilities (Annex I). Furthermore, a logo of Pakistan Olive Oil Council has been designed and proposed by the Pakistani Olive Stakeholder Group (Annex II).

Strong emphasis has also been placed on strengthening the capacities of both public and private sectors in areas such as nursery development, value addition, and marketing. The private sector is expected to play a key role across the entire value chain, supported through training and capacity-building initiatives, particularly in the production of locally adapted nursery plants.

Recent government-led policy initiatives relevant to the olive sector include:

- The Strategic Trade Policy Framework (STPF) 2020-2025 by the Ministry of Commerce, which aims to promote agricultural mechanization and integrate Pakistan's agriculture sector into global value chains. As part of the broader agricultural sector, the olive industry stands to benefit from these measures.

- Policy measures by MNFSR, implemented in coordination with provincial governments, focus on improving market intelligence, enhancing market access, strengthening regulatory frameworks, and promoting grading and packaging practices. The use of ICT tools for disseminating market information, as well as the development of farmer-centered marketing systems and e-marketing platforms, is also encouraged. These efforts are supported by a growing market niche for olive oil.
- The national branding initiative “Emerging Pakistan”, launched by the Ministry of Commerce, aims to support brand development among traders, investors, and firms. Olive oil processors can leverage this initiative to establish and promote their brands. Additionally, medium- and long-term support from international donors presents further opportunities for sector development.
- The Geographical Indications (Registration and Protection) Act, 2020, which provides legal protection for products originating from specific regions. This framework enables the registration of local olive and olive oil products, facilitating their entry into global markets.
- Rural development policies under the MNFSR which aim at promoting olive cultivation in some of the country’s poorest districts. These initiatives target marginal and degraded lands, estimated at over 7 million hectares, that are unsuitable for traditional crops but well-suited for olive cultivation, thereby supporting rural livelihoods and environmental sustainability.

VI – Research, education, training and extension

Pakistan, as an agrarian economy, has a well-established network of educational, research, and training institutions. However, continuous improvement in both quality and capacity remains essential, particularly in the context of ongoing innovations and advancements in agricultural research. The agriculture sector employs approximately 45% of the national workforce and contributes around 24% to the country’s GDP.

Numerous public and private organizations, as well as academic and research institutions, are actively engaged in studying the socio-economic and environmental benefits of olive cultivation. Key institutions involved in olive-related research across Pakistan include:

- National Agricultural Research Centre, Islamabad
- Barani Agricultural Research Institute, Chakwal
- Agricultural Research Institute, Tarnab (Peshawar)
- National Tea and High-Value Crop Research Institute, Shinkiari (Mansehra)
- Agricultural Research Institute, Sariab (Quetta)
- Balochistan Agricultural Research and Development Centre, Quetta
- Department of Agriculture, Muzaffarabad
- Mountain Agriculture Research Centre, Juglot (Gilgit)

A major component of the POCCSP initiative has been training and capacity development. Between 2014 and 2021, a total of 63 training sessions were conducted, benefiting more than 4,370 farmers and stakeholders. These programs provided hands-on training in best practices

related to olive cultivation, pruning, nursery establishment, processing, packaging, and marketing. Local experts with specialized knowledge were engaged to deliver these trainings.

The OliveCulture Project has further strengthened these efforts. During its first season (September-November 2022), Italian specialists trained 241 beneficiaries, including scientists, technicians, farmers, and women, on Good Agricultural Practices (GAP). In addition, 360 technicians and stakeholders received training on olive oil and table olive processing through both theoretical and practical sessions conducted in Balochistan, KP (including newly merged districts), and Punjab.

Research, development, and training activities are also supported by dedicated institutions such as the Center of Excellence for Olive Research and Training (CEFORT), established by the Government of Punjab at BARI Chakwal with technical assistance from USAID. This institution plays a key role in providing practical training and advancing expertise in olive farming, nursery management, value addition, branding, and marketing.

Finally, the growing emphasis on evidence-based decision-making highlights the importance of reliable data collection, monitoring, and evaluation systems. Effective measurement of activities, outcomes, and progress toward development goals is essential for strengthening the olive value chain. However, it remains unclear whether a comprehensive monitoring and evaluation system has been fully established, what type of data is being collected, whether it is standardized, and how effectively it is being analyzed and utilized.

VII – SWOT analysis

SWOT analysis has been widely used for decades as one of the most common strategic assessment tools for the development, evaluation, and implementation of strategies. The term SWOT is an acronym for Strengths, Weaknesses, Opportunities, and Threats. These four elements form a structured four-quadrant framework that is used to assess the viability of a strategy or initiative within a specific context. Therefore, a thorough understanding of the contextual environment is essential for conducting an effective SWOT analysis.

By examining internal factors (strengths and weaknesses) alongside external factors (opportunities and threats), the SWOT framework provides a comprehensive overview of a given situation. It also offers valuable insights that support the effective design and implementation of strategies. This method is widely employed by policymakers, businesses, corporations, and individuals as a practical tool for setting realistic objectives. It helps identify internal capabilities and limitations, as well as external risks and prospects.

In the context of Pakistan's olive sector, strengths and weaknesses are considered internal factors that reflect the current status of the sector. In contrast, opportunities and threats are external factors arising from the broader environment and represent potential future developments.

The SWOT analysis of the Pakistani olive supply chain has been structured into four thematic areas:

1. Production and processing (including nurseries, farms, mills, etc.), focusing on technical and environmental aspects (Table 3);
2. Marketing, addressing commercial aspects (Table 4);

3. Legislation, certification, and policies, covering administrative, financial, and institutional support (Table 5);
4. Research, education, training, and extension services, focusing on scientific support, knowledge transfer, and technical assistance (Table 6).

Table 3. SWOT matrix on production and processing.

Strengths		Weaknesses	
1.	Millions of wild olive plants exist in Pakistan, demonstrating strong agro-climatic suitability for olive cultivation.	1.	Limited cultivated areas under olives despite increasing demand for olive oil.
2.	Olive cultivation offers a valuable opportunity to utilize marginal, waste, and virgin lands unsuitable for conventional crops.	2.	Low productivity due to poor adoption of GAP and inadequate irrigation, leading to high sapling mortality.
3.	Promising olive oil yields have been observed in certain geographical regions.	3.	Limited and costly availability of key inputs such as fertilizers, pesticides, and water.
4.	Potential to significantly increase productivity (yield per hectare) through the adoption of GAP and standard operating procedures (SOPs).	4.	Limited knowledge of best practices among farmers, technicians, and processors.
5.	Existing capacity and infrastructure for seedling production.	5.	Inconsistent supply of good-quality olives for processing.
6.	Olive cultivation contributes to climate change mitigation, enhances biodiversity, increases carbon sequestration, reduces soil erosion and desertification, improves landscapes, and lowers irrigation water requirements.	6.	Farms fragmentation increases operational costs.
7.	Increasing adoption of efficient irrigation systems such as micro-irrigation.	7.	Limited use of mechanization and modern tools for cultivation and harvesting.
8.	Public sector (federal and provincial) support in establishing olive oil extraction facilities.	8.	Inadequate post-harvest handling, including delayed transportation and lack of proper containers.
9.	Feasibility of organic olive farming.	9.	Processing mills are often located far from farms and insufficient to meet farmers' needs.
10.	High potential profitability of olive farming with proper practices, infrastructure, and investment.	10.	Lack of farmer clusters, cooperatives, and associations.
		11.	Limited awareness of the sector's development potential.
		12.	Insufficient focus on table olive production.
		13.	Limited utilization of by-products (e.g., pomace, pellets) from processing.
		14.	Limited development of non-food olive products.
		15.	Minimal development of organic olive farming and certified organic products.
		16.	Olive cultivation is still a relatively new and emerging sector in Pakistan.
		17.	Lack of adequate storage facilities.
Opportunities		Threats	
1.	Government support for nursery development under POCCS project.	1.	Emergence of new pests and diseases affecting agricultural production.
2.	Vast suitable land area (over 4 million hectares) for olive cultivation, particularly in Balochistan, KP, Potohar (Punjab), Newly Merged Districts, and selected areas of Sindh (e.g., Ghorakh Hill, Dadu, Umarkot).	2.	Limited capacity of the national research system to rapidly adopt and disseminate new technologies.
3.	Strong agricultural labor base, with good availability of workers in rural olive-growing areas.	3.	Insufficient research and innovation support (e.g., weather stations, laboratories).
4.	Increasing global focus on climate resilience, creating opportunities for olive-based agro-systems.	4.	Limited availability and rising cost of inputs and machinery.
		5.	Climate change may negatively affect crop cycles, especially as Pakistan ranks among the most climate-vulnerable countries.
		6.	Risk of groundwater depletion due to expansion of irrigated agriculture.
		7.	Loss of skilled labor due to rural-to-urban migration and international migration.

Table 4. SWOT matrix on marketing.

Strengths	Weaknesses
- Existing plantations, once fully productive, can potentially meet Pakistan's current olive oil consumption. - Introduction of a national brand, "PakOlive," under a Geographical Indication framework. - Development of value-added products (e.g., olive pickles, jam, biscuits, cakes, olive morrabba), with knowledge transferred to the private sector. - Presence of private entrepreneurs engaged in olive-based businesses.	- Inconsistent quality of olive oil produced in certain regions. - High domestic demand results in limited availability of locally produced olive oil. - Limited consumer demand for olive oil, table olives, and value-added products. - Consumption is mainly limited to restaurants and higher-income consumers. - Lack of cost-effective and suitable packaging solutions. - Absence of quality standards and limited access to testing facilities, especially for exports. - Low consumer awareness of olive oil quality and origin. - Inefficient distribution systems. - Limited participation of large private-sector players in domestic marketing. - Insufficient knowledge of olive oil marketing and sales dynamics. - Absence of a demand-side marketing strategy.
Opportunities	Threats
- Olive oil represents a niche market with strong growth potential due to increasing consumer preference for healthier diets. - Government subsidies and support programs encourage olive cultivation at a commercial scale. - Rising domestic demand for table olives driven by the expansion of the fast-food and restaurant industry. - Import restrictions create an opportunity for local producers to replace imported olive oil in retail markets.	- Imports from Spain, Italy, and Turkey already meet current demand, limiting space for local producers. - Increasing olive production in neighboring countries (Afghanistan, India, Iran) intensifies competition. - Limited demand for organic products in Pakistan. - Low household income limits the affordability and consumption of olive oil. - Declining global purchasing power due to inflation makes olive oil less competitive internationally. - Seed oil remains more affordable and competitive than olive oil. - Heavy reliance on imports of edible oils and oilseeds. - Low overall health awareness among consumers. - Influx of non-certified imported olive oil undermines local production. - Rising costs of inputs (fertilizers, fuel, energy, etc.).

Table 5. SWOT matrix on legislation, certification, and policies.

Strengths	Weaknesses
1. The olive oil sector is increasingly being prioritized in national and provincial agricultural policies, encouraging both public and private investment across the value chain. 2. Significant medium- and long-term financial and technical support is available from international donors. 3. Olive cultivation has strong potential to reduce poverty, improve socio-economic conditions in rural areas, and support cottage industries involving youth and women. 4. Olive oil holds cultural and religious significance in Pakistan, alongside its recognized health benefits, supporting its acceptance among consumers. 5. Olive sector development aligns with Pakistan's National Development Agenda 2030 and contributes to multiple Sustainable Development Goals, including poverty reduction, food security, economic growth, responsible production, climate action, and partnerships.	1. Olive farms and processors largely lack certifications such as GAP, HACCP, ISO, Organic, and Geographical Indication (GI). 2. Absence of a functional certification system for olive plant propagation aligned with international standards. 3. Lack of an effective legislative and regulatory framework covering traceability, quality standards, food safety, development policies, and marketing. 4. Absence of comprehensive feasibility studies and business plans for medium- to large-scale investments. 5. Lack of government support services for transportation, increasing production costs and farmer dissatisfaction with market prices. 6. Limited development and experience in farmer cooperatives and associations. 7. Weak integration with complementary sectors such as agri-tourism and handicrafts. 8. Absence of a comprehensive National Strategic Plan for olive sector development. 9. Limited policy focus on table olives as a viable domestic market opportunity.
Opportunities	Threats
1. International projects and collaborations provide opportunities to expand domestic olive oil production. 2. Rural development policies support the expansion and strengthening of the olive value chain, particularly in suitable and marginal lands. 3. Potential certification and recognition by the International Olive Council (IOC) could facilitate access to global markets. 4. Recent initiatives by key ministries (Commerce, National Food Security and Research, Planning) aim to strengthen food value chains and supply systems.	1. Limited access to government loans and subsidies for small-scale entrepreneurs. 2. Lack of government procurement mechanisms to support farmers during market downturns. 3. Poor rural infrastructure (healthcare, education, markets, postal services) reduces the attractiveness of rural livelihoods. 4. Economic instability reduces consumer purchasing power, limiting demand for relatively expensive products like extra virgin olive oil. 5. Dominance of foreign companies in the market may limit benefits to the local economy. 6. Rural-to-urban migration reduces agricultural labor availability and cultivated land (urbanization). 7. Political instability discourages both domestic and foreign investment in the olive sector. 8. Policies facilitating imports (e.g., reduced tariffs on oilseeds) increase competition for local olive producers. 9. Persistent underdevelopment, poverty, and food insecurity in rural areas constrain sector growth.

Table 6. SWOT matrix on research, education, training, and extension services.

Strengths	Weaknesses
- Public research and educational institutions in Pakistan are actively engaged in olive cultivation and processing, providing human resources and infrastructure. - Presence of an institutional network of international research and educational organizations supporting the olive sector. - Government departments regularly organize training sessions and seminars for stakeholders.	- Incomplete knowledge of local and international olive varieties, particularly regarding quality traits and adaptability to different agro-ecological zones. - Limited knowledge of best practices in farming, processing, and marketing. - Low awareness of the nutritional and health benefits of extra virgin olive oil. - Shortage of trained and skilled workforce for key activities such as pruning, harvesting, and drip irrigation management. - Limited availability of reliable and systematized local data on cultivation techniques, varietal performance, production costs, and monitoring systems. - Insufficient market research to evaluate the full potential of Pakistani olive oil in domestic and international markets.
Opportunities	Threats
- Increasing use of social media platforms for awareness, knowledge sharing, and guidance on olive farming and marketing. - Availability of effective communication tools (TV, radio, and internet) to disseminate information and provide training through campaigns and programs. - Access to extensive international knowledge and research on olive cultivation and processing that can be adapted to local conditions.	- Emergence of new pests and diseases affecting olive cultivation. - Limited capacity of the national research system to rapidly adopt and implement new technologies. - Insufficient support from research and innovation systems (e.g., weather stations, laboratories, extension services).

VIII –Needs and policy gaps

Based on the SWOT analysis and across the identified thematic areas, the key needs and policy gaps in Pakistan's olive sector, from farm to fork, are outlined below:

1. Production and processing

- Expand olive cultivation, particularly in marginal and virgin lands, to enhance production and contribute to climate change mitigation;
- Ensure certification of olive seedlings in terms of phytosanitary status and varietal authenticity, while reducing field mortality rates;
- Improve yields both at the farm level and during processing;
- Increase the availability and affordability of essential inputs (e.g., fertilizers, pesticides, water) and agricultural machinery;
- Enhance the quality of olives, olive oil, and table olives;
- Upgrade storage systems and packaging technologies;
- Promote the production of certified organic olives and olive oil;

- Encourage a more balanced and accessible distribution of oil mills across olive-growing regions;
- Improve mechanization systems for cultivation and harvesting;
- Promote the development and utilization of non-food products and by-products (e.g., soap, olive wood products);
- Increase farm profitability by reducing costs and/or enhancing revenues.

2. Marketing

- Reduce dependence on imported seed oils;
- Increase consumer awareness of the health benefits of olive oil to stimulate demand;
- Promote the consumption of olive oil and table olives, particularly locally produced products.

3. Legislation, certification, and policies

- Develop new legislation and update existing regulatory frameworks to ensure business registration and compliance with international standards (sanitary, quality, trade, and export requirements);
- Strengthen certification systems, particularly for international standards such as GAP, HACCP, ISO, and organic agriculture;
- Promote horizontal and vertical cooperation across the supply and value chains;
- Encourage multidisciplinary agricultural development, integrating sectors such as tourism and handicrafts;
- Increase subsidies to support quality production;
- Improve farmers' access to credit;
- Address rural-to-urban migration, particularly among youth and skilled labor;
- Strengthen international cooperation and attract investments from public and private stakeholders;
- Establish the proposed Pakistan Olive and Olive Oil Council;
- Develop a National Strategic Plan for the olive sector, along with a National Action Plan for organic agriculture.

4. Research, education, training, and extension services

- Enhance knowledge and adaptability of olive varieties to diverse regional conditions;
- Improve knowledge and dissemination of best practices in farming, processing, transportation, trading, and marketing;
- Promote the adoption of quality standards and certification systems;
- Support the development of geographical indications;
- Assess and improve the environmental, economic, and social sustainability of the olive sector, including research on local adaptation of varieties;
- Increase the availability of trained and skilled personnel;

- Strengthen extension services to effectively transfer knowledge and innovations to stakeholders.

IX – Strategic objectives

The following strategic objectives are defined for the holistic development of Pakistan's olive value chain. These objectives are derived by combining identified strengths and weaknesses with external opportunities and threats across each thematic area.

1. Production and processing

- Expand olive cultivation in suitable regions such as Balochistan, KP, Potohar (Punjab), and the Newly Merged Districts, where agro-climatic conditions favor olive production and labor availability is high. This expansion can also contribute to climate change mitigation;
- Strengthen knowledge, expertise, and technical capacity across all stages of olive and table olive production, from farming to processing and trade;
- Modernize mechanization and equipment to improve efficiency and competitiveness in cultivation, processing, transportation, storage, packaging, and marketing;
- Promote advanced irrigation techniques (e.g., smart irrigation systems) to optimize water use, given increasing water scarcity and costs;
- Encourage organic farming as a strategy for climate change mitigation and sustainable production;
- Improve farm profitability and increase workers' incomes to reduce rural-to-urban migration and outward migration;
- Strengthen cooperation among farmers to improve productivity and business performance;
- Foster collaboration among value chain actors to enhance coordination, management, and competitiveness.

2. Marketing

- Increase the consumption of olive oil and table olives by leveraging favorable production conditions, expanding cultivation areas, and responding to growing consumer demand for healthier foods;
- Improve olive oil quality through certification and standardization at both farm and processing levels to compete effectively with imported oils and seed oils;
- Promote the national brand "PakOlive" to enhance competitiveness and improve quality perception in the market;
- Encourage the development and promotion of innovative value-added products to meet evolving consumer preferences;
- Modernize marketing strategies and tools to increase value addition and market penetration.

3. Legislation, certification, and policies

- Develop and implement a comprehensive National Strategic Plan for the olive sector;

- Strengthen and update the regulatory framework, particularly for the organic sector (e.g., National Action Plan for Organic Agriculture).
- Improve regulations related to plant propagation materials (seedlings), quality standards (e.g., organic certification, geographical indications, GlobalGAP), certification systems, food safety, traceability, and trade (import/export);
- Establish the Pakistan Olive and Olive Oil Council to oversee regulatory, certification, and policy matters;
- Promote inter-ministerial coordination among key institutions (Commerce, National Food Security and Research, Planning, Education) to optimize resources and program implementation;
- Leverage financial and technical support from international agencies and foreign partners to stimulate investment in the olive sector;
- Increase subsidies and promote the establishment of cooperatives among value chain actors, both horizontally and vertically;
- Support the development of complementary sectors such as agri-tourism and handicrafts to reduce rural outmigration.

4. Research, education, training, and extension services

- Strengthen research, education, and training systems through improved infrastructure (e.g., laboratories) and enhanced human resource capacity.
- Develop efficient extension services to facilitate knowledge transfer across the value chain, including the use of modern ICT tools.
- Enhance partnerships among international, national, and research institutions to enhance knowledge exchange and innovation.
- Establish a robust and standardized national data collection and monitoring system to support evidence-based decision-making.

X – Action points

The following key action points are proposed based on the identified needs, gaps, and strategic objectives:

- Provide subsidies for inputs and tools at both cultivation and processing levels (e.g., seedlings, eco-friendly pesticides, fertilizers, herbicides, pheromones, nets, plastic crates, glass bottles, stainless steel containers);
- Invest in physical infrastructure and assets to support development, modernization, and adaptation (e.g., plantations, machinery and equipment, agricultural vehicles, irrigation systems, reservoirs, storage facilities, farm shops, solar panels, and rural road networks);
- Support organic agriculture through subsidies for conversion, certification, quality control, and marketing;
- Promote extra virgin olive oil and table olives through fairs, seminars, conferences, school education programs, awareness campaigns, and promotional materials;

- Strengthen knowledge transfer to olive sector stakeholders through training systems, extension services, and ICT-based platforms;
- Support research and innovation, including experimental and demonstration fields, laboratory development, smart farming technologies, Agriculture 4.0 approaches, and digital transformation;
- Facilitate the establishment of producer cooperatives and associations within the value chain framework;
- Provide financial support to entrepreneurs through mechanisms such as subsidized loans, microcredit schemes, and tax incentives;
- Promote investments in agri-tourism, olive parklands, handicrafts, and renewable energy to enhance the multifunctionality of olive farming systems;
- Establish a comprehensive certification system covering genetic and phytosanitary quality of planting material, as well as product quality (registration, inspection, labelling, and certification).

XI – Conclusions

Despite existing challenges in olive production and processing, the expansion of olive cultivation in Pakistan is expected to generate positive economic outcomes and increase employment opportunities. This optimistic outlook is supported by several factors. Olive cultivation is primarily being promoted on underutilized and marginal lands where alternative crops are often not economically viable, thereby minimizing opportunity costs for farmers. In addition, the government has subsidized several key cultivation inputs through initiatives such as the POCCSP-II project, under which farmers contribute only partially to the costs of irrigation systems, technical training, and, in some cases, harvesting and pruning tools. The government has also facilitated access to olive oil extraction facilities, often free of cost, enabling farmers to process their produce locally and market olive oil at higher value. Furthermore, the OliveCulture Project has contributed to strengthening the sector through capacity-building activities, including the training of olive mill managers and operators.

These factors have collectively encouraged olive cultivation by improving profitability prospects. If farmers are able to produce high-quality olives with optimal yields, and if demand for locally produced olive products increases, the sector can achieve long-term economic sustainability for farmers, processors, and traders. However, demand-side considerations must not be overlooked. If supply outpaces demand, domestic prices may decline, negatively affecting farmers' incomes. Therefore, improving the quality of Pakistani olive oil and enhancing consumer perception of its health benefits are critical to stimulating demand and maintaining market balance.

Nonetheless, Pakistan's olive sector is still in its early stages of development and faces multiple challenges. These include the need for stronger international cooperation in technology transfer and knowledge sharing, as well as coordinated domestic reforms to establish a comprehensive regulatory framework and increase public awareness of the environmental, economic, and health benefits of olive cultivation and consumption. In this context, the Pakistani Olive Stakeholder Group has proposed the establishment of a Pakistan Olive Oil Association/Council, which is essential for ensuring coordinated and sustainable sector development. Such an institution would

strengthen regulatory oversight, improve quality standards, support certification systems, and enhance competitiveness in international markets.

However, despite its potential, Pakistan's agriculture sector has long faced stagnation due to several structural constraints. Key challenges affecting olive cultivation include:

- High mortality rates of olive plants and low productivity due to insufficient irrigation, fertilizers, and pest management inputs;
- Limited availability of certified, disease-free, true-to-type planting material at affordable cost;
- Underutilization of vast areas of suitable marginal land for olive cultivation;
- Political instability, leading to inconsistent policy implementation;
- Insufficient number of processing and extraction units, causing delays and potential post-harvest losses;
- Limited scientific knowledge among farmers and reliance on outdated agricultural practices;
- Inadequate access to modern technologies that could improve productivity and profitability;
- Shortage of high-quality research and feasibility studies on olive cultivation;
- Limited information on varietal adaptability across different agro-climatic zones.
- Lack of a trained and skilled workforce;
- Weak marketing systems and insufficient support for product commercialization;
- Poor buyer-seller linkages, particularly affecting new producers entering the market.

The absence of a comprehensive regulatory framework has left the olive sector largely dependent on market forces. Addressing these challenges requires a coordinated, evidence-based strategy to support farmers through improved access to information, training, inputs, and services. Moreover, there is an urgent need for government intervention to utilize marginal lands effectively for olive cultivation, thereby reducing reliance on imported edible oils and improving economic resilience. At the same time, production growth must be balanced with demand stimulation to ensure market stability. Currently, locally produced olive oil is often more expensive than imported alternatives due to limited economies of scale. Increasing domestic demand for locally produced olive oil will be essential to achieving price competitiveness and market equilibrium. Furthermore, greater emphasis should be placed on research and data generation to support informed decision-making and investment planning. Well-documented, research-based information on olive cultivation in Pakistan is essential for both domestic and international stakeholders.

Overall, Pakistan has strong potential to become a significant player in the global olive market. The country benefits from diverse agro-climatic conditions and vast areas of marginal land suitable for olive cultivation. Approximately 10 million acres have been identified as suitable for olives, with over 40,000 acres already under cultivation. Combined with its strategic geographic location and agrarian economic base, Pakistan is well-positioned to develop a competitive olive sector.

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Annexes

Annex I



First Draft

Establishment and Regulations of Pakistan Olive and Olive Oil Council (POOC)/Advisory Group (AG)

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Act of Parliament

Year 2023, Pakistan

WHEREAS it is expedient to establishment and regulations of Pakistan Olive and Olive Oil Council/Advisory Group for the purposes hereinafter appearing;

AND WHEREAS the Provincial Assemblies of Balochistan, Khyber Pakhtunkhwa (KP/NWFP), Punjab and Sindh have passed resolutions under Article 144 of the Constitution of the Islamic Republic of Pakistan to the effect that Majlis-e-Shoora (Parliament) may suitably amend the aforesaid Act;

It is hereby enacted as follows:

1. Title and Commencement

- i. This Act may be called the Pakistan Olive and Olive Oil Council/Advisory Group establishment and regulations Act, 2023.
- ii. It shall come into force at once.

2. Purpose and Scope

The purpose of this act of Parliament and regulation is to establish Pakistan Olive and Olive Oil Council (POOC)/Advisory Group (AG) of an inter-institutional committee and to determine the legal status, principles, advisory procedures, duties and powers, financial and matters relevant to develop and implementation of integrated plan for the rural strategy for the olive sector and strategic interventions along the entire olive oil value chain in the country.

3. Set-up of Pakistan Olive Oil Council (POOC)/Advisory Group (AG)

- a) The Pakistan Olive and Olive Oil Council/advisory group shall have its headquarter in Islamabad. It shall become a legal entity upon the approval of the M/o National Food Security and Research (MNFSR) act of Parliament.
- b) The Pakistan Olive and Olive Oil Council/advisory group shall function as a statutory body under Pakistan Oilseed Department (POD) of the MNFSR.
- c) The legislative body shall be comprised of members representatives of the Olive Value Chain covering olive farmers/producers, olive traders, Olive oil processing industry, professionals and concerned ministries. These members shall have the authority of the Board of Directors. The term of the office of the Board of Directors shall continue until the first General Assembly meeting.

4. Activities of the Pakistan Olive and Olive Oil Council/Advisory Group

The POOC/AG shall carry out the following activities for the purposes of Article-1;

- a) Submit all the decisions taken annually to all relevant stakeholders.
- b) Develop plans, implement plans, collect data and determine a common strategy within the framework of the developments in olive and olive oil sectors.
- c) Carry out research and investigations on olive and olive oil and related sectors at national and international level and transfer these to relevant stakeholders in the olive value chain.
- d) Carry out activities to improve the production, consumption and trade of olives and olive oil.
- e) Cooperate with organizations that perform similar activities in other countries.
- f) Take urgent functional measures according to the conjuncture of olive and olive oil related sectors and monitor the results.
- g) Regarding the purpose and field of activity, organize meetings, symposiums, panels, seminars, conferences, congresses and workshops, promote olive and olive oil and by-products and establish advisory groups to participate in all these activities.

- h) Contribute to the determination and implementation of the necessary policies for the realization of high-quality production, standardization and certification, monitoring of the market and development of quality control systems in the Olive sector.
- i) To ensure necessary measures taken and implemented, including production planning and diversification of production, in order to solve the structural problems of the olive sector, meet the needs and increase international competitiveness.
- j) Within the framework of production and industrial activities in the sector, the environment, public health, protection of producers, consumer rights and rural development to ensure the necessary measures.
- k) Organize campaigns and promote the consumption of the product encouraging product branding. Contribute to the determination and application of national and international rules for the trade of olives and olive oil products and by-products.
- l) To inform the olive and olive oil producers and consumers about organic farming and good agricultural practices and to encourage production and consumption.
- m) To increase the marketing power of olive and olive oil and finished products at national and international level, take measures to improve the continuity, profitability, trade, consumption and standardization of the industry and ensure the reconciliation of all segments of the sector in the determination of national policies.
- n) Coordination and collaboration with other allied Ministries and International organizations to carry out subject related activities beneficial to the public sector as well as to the Olive sector.

5. Membership of the POOC/AG, Suspension & Termination of Membership

- a) Producers, traders, industrialists, merchants, chambers of commerce & trade, professional & public associations that are in the field of olive and olive oil, research institutions and teaching universities can be members of the POOC/AG.
- b) The membership of the members who do not comply with the aims of the POOC/AG and fail to fulfil their membership obligations despite two consecutive written observations shall be suspended by the Board of Directors for at least one to three months. An Appeal against the decision can be submitted to the Board of Directors within seven days of the notification. The final decision on appeal must be made within fifteen days after its submission. The suspended members/members of the Council cannot take benefit from any activities of the Council and cannot vote during the suspension period.
- c) The Council membership ends;
 - i. Leaving voluntarily
 - ii. Death
 - iii. Failure to fulfil the obligations specified in the regulation
 - iv. Violation of the rules set by the POOC/AG
 - v. Offenses against the security of the State & the constitution
 - vi. All others punitive offenses.
- d) The decision to terminate the membership of the Council shall be taken by the Board of Directors. An Appeal against the decision can be submitted to the Board of Directors within seven days of the notification. The final decision on appeal must be made within fifteen days after its submission.

6. Bodies of the POOC/AG

(1) The POOC/AG shall be composed of the following bodies:

- a) General Assembly
- b) Board of Directors
- c) Supervisory Board
- d) Research and Advisory Committee

7. Formation and meetings of the POOC/AG General Assembly

- a) The General Assembly of the POOC/AG shall be constituted by the participation of representatives from specified groups mentioned in Article 5 (a).

- b) The General Assembly of the POOC/AG shall hold its ordinary meetings once a year upon the invitation of the Board of Directors. The General Assembly of the POOC/AG may also be called for an extraordinary meeting upon the written request of the Board of Directors or one fifth of the members. The Decisions of the General Assembly shall be taken by the absolute majority of the attendants.
- c) The suspended member/members & those who do not pay their membership fees may not vote at the General Assembly.
- d) At least ten days before the meeting, all members of the General Assembly should be informed in writing about time, place and agenda of the meeting.

8. Duties and powers of the General Assembly:

- a) Authorize the Board of Directors to cooperate with organizations that perform similar activities in other countries.
- b) Elect the members of the Board of Directors and the Supervisory Board.
- c) Discuss the Annual & Audit Reports.
- d) Decide on the release of the accounts of the Board of Directors and the Supervisory Board.
- e) Negotiate and decide the budget.
- f) Decide on the revenues and expenses of the POOC/AG.
- g) Determine entry and annual fees.
- h) Decide to open representative offices in Pakistan and abroad.
- i) Determine the daily allowance amount and principles to be paid to the members.
- j) Appoint members of the Research and Advisory committee.
- k) Decide on other matters authorized by law.
- l) Authorizes the Board of Directors regarding financial matters.

9. Formation and term of office of the Board of Directors:

- a) The Board of Directors shall be elected by the General Assembly from among the group specified in Article 5(a). It consists of XY members and one opted member. The term of office of the Board of Directors is three years. In case the Board of Directors becomes vacant, the substitute member is appointed as a member of the Board of Directors in order to complete the remaining term of the member.
- b) The Board of Directors shall appoint a chairman, a deputy chairman and a secretary. The division of duties among the members will be decided in the first meeting. The term of office of the chairman and his deputy is limited to two consecutive terms. They cannot be re-elected as chairman or vice chairman unless a term passes.
- c) Registered members shall carry out the secretarial services related to the of the POOC/AG mandate as described in Article-4.
- d) Conduct the General Assembly meeting within three months following the establishment.
- e) Represent the POOC/AG until the General Assembly meeting.

10. Board meetings:

- a) The Board of Directors convenes at least once a month, and decisions are taken by majority vote of the participants.
- b) The Board of Directors cannot take decisions that will cause economic disadvantages of olive sector.
- c) Apart from the extraordinary meetings, the Board of Directors shall determine the agenda of the ordinary meetings at least three days before the meeting and notify the attendees in writing.

11. Duties of the Board of Directors:

- a) Meet at least once a month, evaluates the developments in the olive and olive oil and related sectors for the purposes of the Council and takes decisions on the strategies to be implemented, implement them, monitor the results, conduct and represent the POOC/AG activities.
- b) Prepare the Annual Report and submit it to the General Assembly.

- c) Personnel recruitment if required.
- d) Prepare the budget and submit it to the approval of the General Assembly.
- e) Perform regular collection and follow-up of entrance fee and annual fee.
- f) Submit a report to the Agricultural Steering Committee at least once a year, if required.
- g) Implement the decisions taken by the General Assembly and monitor the results.
- h) Manage financial matters of the Council.
- i) Take and make final decisions regarding membership.
- j) Call the General Assembly for ordinary or extraordinary meeting.
- k) Determine the agenda of the meetings of the Board of Directors in line with the proposals coming from within or from the members of the Council.
- l) Suggest to the General Assembly about the daily allowances to be given to the members of the Board of Directors, Supervisory Board, Research and Advisory Board and the travel allowance and payment principles.
- m) Establish the secretariat and the cadres to carry out technical affairs to assist the General Assembly in the coordination and realization of the Council's activities, call the Research and Advisory Board for a meeting, decide the reports prepared by the Research and Advisory Board and apply for information and opinions when necessary.

12. Payments to be made to the members of the Board of Directors:

Members of the Board of Directors shall be paid daily allowance determined by the General Assembly for their duty travels inside/outside Pakistan. The amount of payment is included in the Council's budget. Members of the Board of Directors may not be paid under a different name.

13. Formation and term of office of the Supervisory Board

The Supervisory Board shall be selected by the General Assembly. It consists of XY members. The term of office of the members is limited to three years. The vacant memberships are filled by the same procedure, and these members complete the remaining period.

14. Duties and Powers of the Supervisory Board:

- a) To supervise the activities and expenditures of the Board of Directors.
- b) To submit an audit report to the General Assembly.
- c) Call the General Assembly for an extraordinary meeting when necessary.

15. Payments to the members of the Supervisory Board:

Members of the supervisory Board shall be paid daily allowance determined by the General Assembly for their duty travels inside/outside Pakistan. The amount of payment is included in the Council's budget. Members of the Supervisory Board cannot be paid under a different name.

16. Formation, Duties and Powers of the Research and Advisory Committee:

- a) The members of Research and Advisory committee shall be selected by the General Assembly among the research organizations, teaching universities and specialized professional members. It consists of a total of XX members. The term of office is three years. New vacancies are brought to the vacant memberships by the same procedure. Newly appointed members complete the remaining period. The members of the Research and Advisory committee elect a chairman and a vice chairman among themselves. The term of office of the chairman and his deputy is limited to two consecutive terms. They cannot be re-elected unless a period has passed.
- b) The Research and Advisory committee convened upon the invitation of the Board of Directors and informs the Board of Directors by expressing its opinions on the relevant areas of the Council.
- c) The Research and Advisory committee shall prepare its annual report & submit it to the Board of Directors.

17. Payments to Research and Advisory Committee members:

The members of the Research and Advisory Committee shall be paid daily allowance determined by the General Assembly for their duty travels inside / outside Pakistan. The amount of payment is included in the POOC/AG's budget. Members of the Research and Advisory committee cannot be paid under a different name.

18. Revenues of the POOC/AG:

The revenues of the POOC/AG are as follows:

- a) Entrance fee and annual fee.
- b) Fees charged for services rendered.
- c) Donations and other incomes, funds and aids provided nationally & internationally.
- d) Revenues from consultancy services.
- e) Advertisement, promotion and publication revenues.

19. POOC/AG Expenses

The expenses of the POOC/AG are as follows:

- a) Education, advertising, promotion and publication expenses.
- b) Allowance and travel payments.
- c) Office expenses.
- d) Other costs.

20. Book/Record Keeping:

The POOC/AG shall keep the following books:

- a) Income-expense book.
- b) Asset registry.
- c) Member registry.
- d) Audit book.
- e) Decision book.
- f) Incoming-outgoing document registry.
- g) The books shall be certified within seven days following the establishment and shall be renewed in the first week of each financial year.

21. Check/Supervision

- a) The supervision of the POOC/AG shall be carried out by the supervisors appointed by the M/o National Food Security and Research (MNFSR) act of Parliament.
- b) It is ensured that their criticisms and recommendations are complied with.

22. POOC/AG Promulgation

- a) This Regulation shall enter into enactment on the date of its publication.

The provisions of this Act shall be executed by the M/o National Food Security and Research (MNFSR) act of Parliament.

Annex II

Proposed new logos of Pakistan Olive and Olive Oil Council (POOC)/Advisory Group (AG).



Selection of olive cultivars and their potential by province*

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Abstract. The expansion of olive cultivation in Pakistan has emphasized the importance of selecting olive cultivars adapted to the country's diverse agroclimatic conditions to ensure sustainable productivity, economic profitability, and high-quality olive oil production. Pakistan presents a wide range of environmental conditions, particularly across Balochistan, Khyber Pakhtunkhwa, and Punjab, where variations in temperature, rainfall, altitude, humidity, and soil characteristics strongly influence varietal performance and adaptability. The evaluation of olive cultivars under local conditions has enabled the identification of varieties with stable productivity, suitable phenology, tolerance to abiotic and biotic stresses, and desirable oil and fruit quality characteristics. Factors such as cultivar acclimatization, orchard suitability, and cross-pollination requirements, are essential for improving fruit set and ensuring economically viable yields. The study also emphasizes the importance of integrating agronomic, morphological, and productive traits into varietal selection strategies tailored to regional climatic conditions. In addition, the development of climate-suitable varietal zoning and provincial recommendations represents an important step toward strengthening the olive value chain and supporting the long-term sustainability and growth of the olive sector in Pakistan.

Keywords. Cultivar selection – Agroclimatic zones – Olive phenology – Sustainable production.

Sélection des cultivars d'olivier et de leur potentiel par province

Résumé. Le développement rapide du secteur oléicole au Pakistan nécessite une sélection rigoureuse des cultivars d'olivier capables de s'adapter aux diverses conditions agroclimatiques du pays afin d'assurer une production durable, une rentabilité économique et une huile d'olive de haute qualité. Le Pakistan présente une grande diversité de conditions environnementales, notamment dans les provinces du Baloutchistan, du Khyber Pakhtunkhwa et du Pendjab, où les variations de température, de précipitations, d'altitude, d'humidité et de caractéristiques des sols influencent fortement les performances et l'adaptabilité des variétés. L'évaluation des cultivars dans les conditions locales a permis d'identifier des variétés présentant une productivité stable, une phenologie adaptée, une tolérance aux stress biotiques et abiotiques, ainsi que des caractéristiques qualitatives favorables pour l'huile et les fruits. Une attention particulière est accordée à l'acclimatation variétale, à l'aptitude des vergers et aux exigences de pollinisation croisée, éléments essentiels pour améliorer la nouaison et garantir des rendements économiquement viables. L'étude souligne également l'importance d'intégrer les caractéristiques agronomiques, morphologiques et productives dans des stratégies de sélection variétale adaptées aux conditions climatiques régionales. Enfin, l'élaboration d'un zonage variétal adapté au climat et de recommandations provinciales constitue une étape importante pour renforcer la chaîne de valeur oléicole et soutenir le développement durable du secteur oléicole au Pakistan.

Mots-clés. Sélection variétale – Zones agroclimatiques – Phénologie de l'olivier – Production durable.

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I – Introduction

Olive cultivation has gained increasing importance in Pakistan as a strategic agricultural sector with strong potential to reduce edible oil imports, enhance rural livelihoods, and utilize marginal lands effectively. The country's diverse agro-climatic zones, particularly in rainfed and semi-arid regions, provide favorable conditions for olive production. Over the past decades, significant efforts have been made to introduce, adapt, and expand olive cultivation, transforming it from an experimental crop into an emerging commercial industry.

Indeed, the olive was introduced in parts of Dera Ismail Khan (Now in present-day Khyber Pakhtunkhwa (KP)) in 1866, and efforts have been made for long to grow olive for domestic and agronomic purposes. The first attempt was by Mr. Henderson, who imported 100 European olive plants and planted them in Rawalpindi. During 1907-1910, the program was restarted with the help of an Italian expert who established a small saplings orchard at Soon Valley, Garhi Dopatta, and Chhattar in 1907. Plantations were also established at Khari Murat in the Attock District, Sakesar, and Rakh Chandia in 1910. All these plantations were handed over to the Agriculture Department in 1927 and eventually ended up with the Forest Department in 1935. The plantation was also done at the Agriculture Research Institute Tarnab Peshawar KP in 1912. In 1935 some of the saplings were imported from Palestine, the USA, and Italy. In 1950-1952, olive plants were again imported from Syria, Egypt, and Turkey and planted in Rawalpindi and Faisalabad region. In 1960 five thousand plants were procured from Italy and were planted at different locations of Pakistan.

The Pakistan Oilseed Developments Board (PODB) started work on olives in the year 2000 and adopted a two-pronged approach for the promotion of olive cultivation in the country (i) conversion of wild olives into bearing species by top working, and (ii) establishment of new plantation. A five-year project (2000-2004) "*Accelerated Promotion of Olive in NWFP/KP and Potohar*" was initiated. Another five-year duration project (2005-2009) "*New Plantation of Olive in NWFP/KP, Potohar and Balochistan and maintenance of Orchards Established by PODB*" was initiated.

Since then, experiments have been conducted in a haphazard manner, which has not resulted in either increasing the area or production of olives, and the yield was too low to be of any commercial importance.

The real development and commercialization of the olive sector in Pakistan began in 2012 through an olive promotion project funded under the Pakistan–Italy Debt Swap Agreement (PIDSA). Building on this initiative, the Government of Pakistan launched a flagship olive cultivation project in 2014. As a result, nearly 5 million olive plants have now been cultivated across the country. In parallel, a dedicated olive value chain has gradually emerged, including olive oil extraction units, table olive processing facilities, and olive certification laboratories, all of which continue to develop and expand.

The cultivated plants include mainly 21 different varieties, namely, Arbequina, Arbosana, Coratina, Koroneiki, Earlik, Gemlik, Frantoio, Picual, Ottobratica, Leccino, Pendolino, Chemlali, Ascolana, Manzanilla, Sevillano, Oliana, Chetoui, Souri, Nabali, Nocellara, and Hojiblanca, grown across the country (suitable areas) mainly in marginal and undulated land.

However, detailed studies on the acclimatization suitability and economic potential of specific olive varieties were previously missing. To address this gap, Italian experts conducted

comprehensive technical and agronomic evaluations of the phenological performance of olive varieties cultivated in Pakistan. Based on these assessments, Pakistani olive-growing areas were classified into five varietal zones according to microclimatic suitability, productive performance, and vegetative response. The classification also considered the origin and purpose of the varieties (oil or table olives), morphological traits (tree vigor, growth habit, canopy density, and fruit characteristics), as well as bio-agronomic and productive attributes, including tolerance to abiotic and biotic stresses, productivity under good agricultural practices (GAP), planting distance, and management practices. These evaluations established an important foundation for future olive research and for the production of premium-quality extra virgin olive oil in Pakistan. In addition, this chapter presents a holistic agronomic approach aimed at assisting farmers in selecting high- and stable-yielding cultivars to maximize economic returns.

Accordingly, the main objectives of this study were: (i) to identify olive varieties suitable for different agroclimatic conditions; (ii) to select high- and consistent-yielding cultivars capable of ensuring both the quantity and quality of extra virgin olive oil production in the country; and (iii) to identify pest- and disease-resistant varieties adapted to their respective climatic conditions for sustainable cultivation.

II – Methodological considerations and limitations

The selection of olive varieties across different provinces is based on data collected over a three-year period, complemented by observations of varietal performance and adaptation to diverse climatic zones over the past four decades. These observations have been supported by the active involvement of both technical experts and farmers, whose practical experience has contributed significantly to understanding varietal behavior under local conditions.

The study has identified distinct patterns in the performance of olive varieties across various macro-zones, allowing for the recommendation of cultivars that are well acclimatized and capable of producing economically viable yields under prevailing environmental conditions. This approach ensures that only those varieties demonstrating both adaptability and productive potential are suggested for cultivation within each specific zone.

However, the list of recommended varieties should not be considered exhaustive. Additional cultivars with suitable characteristics may further enhance varietal selection, particularly when evaluated under specific microclimatic conditions. It is important to note that each province encompasses diverse microclimates, which may influence varietal performance and suitability.

Furthermore, the study highlights important concerns regarding the certification and traceability of olive varieties. In several cases, plant material and established plantations could not be reliably identified as belonging to a single variety. Since morphological characterization alone may not provide definitive identification, it is recommended that such assessments be complemented with genetic analysis to ensure accuracy.

III – Cross-pollination

Following the identification and selection of suitable olive varieties for different agro-climatic zones, it is essential to consider the biological factors that influence their productivity. Among these, pollination plays a critical role in determining fruit set and, ultimately, economic yield. In

olive cultivation, understanding cross-pollination dynamics is particularly important for orchard design and varietal planning.

The viability and sustainability of the olive industry depend on achieving an economic yield of fruit for both oil production and table olives. Despite the abundance of flowers produced by olive trees, only a small proportion successfully develop into fruits (Di Marco *et al.*, 1990; Martin, 1990; Ghrisi *et al.*, 1999; Cuevas *et al.*, 2001), with typically only about 1-2% reaching maturity (Martin, 1990). This low fruit-to-flower ratio is influenced by several factors, including the proportion of male to hermaphroditic flowers, climatic conditions during fruit set, and compatibility relationships among cultivars (Dal Pero Bertini, 1960).

Most olive cultivars are self-incompatible, meaning that self-pollination is often insufficient for effective fertilization. Therefore, the presence of compatible cultivars within the same orchard is essential. In addition, some cultivars exhibit cross-incompatibility, where pollen from certain varieties cannot fertilize others. For this reason, growers must carefully consider cross-compatibility when designing orchards to maximize fruit set and yield, particularly in isolated plantations where pollen sources are limited. It is generally recommended to plant a mixture of compatible varieties to enhance pollination efficiency.

Although olive pollen can be dispersed by wind over long distances, sometimes up to hundreds of kilometers, this is more effective in traditional olive-growing regions with high tree density. In contrast, in countries like Pakistan, where olive cultivation is still expanding and tree density remains relatively low, it is strongly recommended to plant different cultivars together within the same orchard to ensure adequate pollination.

Olive cultivars can also be classified into compatibility groups (e.g., G1 and G2), where combinations between varieties from different groups tend to result in higher fruit set. Furthermore, the role of wild olive populations as potential pollen donors should be investigated, particularly regarding their compatibility with cultivated varieties.

Olive trees produce both hermaphroditic (fruit-bearing) and staminate (male) flowers, the latter serving exclusively as pollen donors. Each flower can produce up to 200,000 pollen grains, reflecting the species' adaptation to wind pollination. For successful fertilization, it is essential that sufficient quantities of compatible pollen are available during the flowering period. This depends largely on the synchronization of bloom among compatible cultivars. While trees of the same cultivar tend to flower simultaneously under similar environmental conditions (Dal Pero Bertini, 1960), bloom timing and duration can vary between cultivars and across years (Griggs *et al.*, 1975; Ghrisi *et al.*, 1999), with climatic conditions playing a key role in determining the length of the flowering period (Lavee *et al.*, 2002).

IV – Pakistan ATLAS of climate suitable varietal map per province

Figure 1 represents a graphical orientation for the main olive cultivars (commonly named varieties) suggested for the main three olive-suited provinces of Pakistan. The selection is based on observations from different adaptability trials in each province considered and observed throughout the years for their stability, behavior, and performances. Nonetheless, this is a non-exhaustive list of other possible cultivars/varieties that could be considered in future adaptability trials.

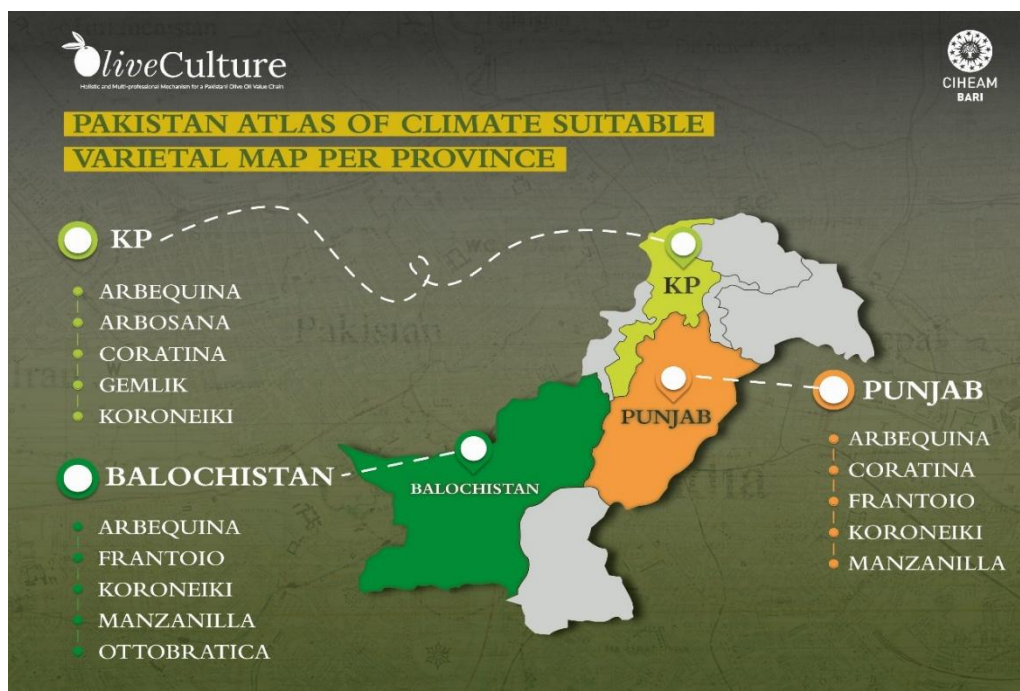


Figure 1. Pakistan ATLAS of climate suitable varietal map per province.

V – Selection of best-yielding olive varieties divided by provinces

The following tables (1-8) present a comprehensive selection of best-yielding olive varieties specifically adapted to Balochistan, Khyber Pakhtunkhwa (KP), and Punjab provinces of Pakistan. Each variety includes detailed morphological characteristics, regional phenology, oil content, and bio-agronomic traits to support optimal cultivar selection for commercial oil production under local climatic conditions.

Table 1. Comprehensive profile of Arbequina olive cultivar under Pakistani conditions.

Arbequina		
Origin	Spain	
Suitable regions	Balochistan, Khyber Pakhtunkhwa, Punjab	
Area of suitability	Cold and hot	
Purpose	Oil (not suitable for table olives due to small size and large pit)	
Morphological characteristics		
Vigor	Weak (small to medium-sized tree, 3-5m height at maturity, slower growth, less branching)	
Growth habit	Spreading (outward branching)	
Canopy density	Medium (allows light penetration and airflow for healthy fruit and disease reduction)	
Fruit characteristics		
Fruit weight	Small (1-2g)	
Shape and color	Oval, dark purple to black when ripe	
Oil content (% of fresh weight)		
Region	Cold area	Hot area
Balochistan	16%	15%
Khyber Pakhtunkhwa	14%	12%
Punjab	13%	-
Phenology by region		
Balochistan	Stage	Timing
	Start of vegetative growth (Bud bursting)	Late March
	Full bloom	Late April
	Fruit turning (Veraison)	End of September
	Time of harvest	Mid-November to early December (best oil: end Oct-Nov)
Khyber Pakhtunkhwa	Stage	Timing
	Start of vegetative growth (Bud bursting)	Early March
	Full bloom	April
	Fruit turning (Veraison)	Mid-September
	Time to harvest	October-November (best oil: end October-November)
Punjab	Stage	Timing
	Start of Vegetative Growth (Bud Bursting)	Late February
	Full Bloom	Late March
	Fruit Turning (Veraison)	Early September
	Time of harvest	October-November
Bio-agronomic and productive characteristics		
Sensitivity to biotic stress	Medium resistance to verticillium wilt	
Sensitivity to abiotic stress	Resistant to cold; tolerant to salinity	
Productivity (with GAP)	High and constant; early bearing; early harvest for quality oil	
Planting distance	6x4m (18x12ft)	
Production characteristics	Light, smooth oil; intense fruity fragrance; deep green color; high oleic acid; medium polyphenols	

Table 2. Comprehensive profile of Arbosana olive cultivar under Pakistani conditions.

Arbosana	
Origin	Spain
Suitable regions	Khyber Pakhtunkhwa
Area of suitability	Hot
Purpose	Oil (good characteristics for quantity and quality)
Morphological characteristics	
Vigor	Weak (small to medium-sized tree, 4m height at maturity)
Growth habit	Open-upright (branches grow vertically)
Canopy density	Medium (balanced shade and sunlight penetration)
Fruit characteristics	
Fruit weight	Small to medium
Shape and color	Oval-shaped with smooth skin; green when young, reddish-purple to black when ripe
Oil content (% of fresh weight)	15%
Phenology (Khyber Pakhtunkhwa)	
Stage	Timing
Start of vegetative growth (Bud bursting)	February-March
Full bloom	March-April
Fruit turning (Veraison)	October
Time of harvest	November
Bio-agronomic and productive characteristics	
Sensitivity to biotic stress	Sensitive to olive mites, Verticillium wilt, olive knot, Olive Psyllids
Sensitivity to abiotic stress	Sensitive to cold climates
Productivity (with GAP)	High and constant
Planting distance	6x4m (18x12ft)
Production characteristics	Intense green fruity aroma, pungent; blended into other oils; medium level of polyphenols

Table 3. Comprehensive profile of Coratina olive cultivar under Pakistani conditions.

Coratina		
Origin	Italy	
Suitable regions	Khyber Pakhtunkhwa - Punjab	
Area of suitability	Cold and hot	
Purpose	Oil (highly esteemed for olive oil production)	
Morphological characteristics		
Vigor	Strong (medium to large-sized tree, 5-7m height at maturity, robust growth and branching)	
Growth habit	Spreading (upright and outward-branching)	
Canopy density	Dense (protects fruit from sunburn, promotes uniform ripening)	
Fruit characteristics		
Fruit weight	Medium-large	
Shape and color	Elongated, cylindrical; green when young, purple or black when ripe; smooth skin	
Oil content (% of fresh weight)		
Region	Cold area	Hot area
Khyber Pakhtunkhwa	16%	14%
Punjab	12-14%	-
Phenology by region		
Khyber Pakhtunkhwa	Stage	Timing
	Start of vegetative growth (Bud bursting)	March
	Full bloom	Late March to early April
	Fruit turning (Veraison)	October-November
	Time to harvest	November (mid or end-November)
Punjab	Stage	Timing
	Start of Vegetative Growth (Bud Bursting)	February-March
	Full Bloom	March-April
	Fruit Turning (Veraison)	October
	Time of harvest	November (early to mid-November)
Bio-Agronomic and productive characteristics		
Sensitivity to biotic stress	Susceptible to olive peacock spot and wood rot	
Sensitivity to abiotic stress	Particularly tolerant of cold	
Productivity (with GAP)	High and constant	
Planting distance	6-7x6m (18-21x18ft)	
Production characteristics	Good organoleptic characteristics; green with golden reflection; rich in polyphenols; very high fruity, powerful flavor with intense spicy notes	

Table 4. Comprehensive profile of Frantoio olive cultivar under Pakistani conditions.

Frantoio		
Origin	Italy	
Suitable regions	Balochistan - Punjab	
Area of suitability	Hot	
Purpose	Oil (highly esteemed for olive oil production)	
Morphological characteristics		
Vigor	Strong (medium sized tree, 4-6m height at maturity)	
Growth habit	Spreading (upright and outward branching)	
Canopy density	Medium dense (provides good coverage of the fruit, allows adequate light penetration and airflow)	
Fruit characteristics		
Fruit weight	Medium	
Shape and color	Elliptical to ovoid; Green, turning purple to black when fully ripe	
Oil content (% of fresh weight)		
Region	Cold area	Hot area
Balochistan	-	16-18%
Punjab	-	12%
Phenology by region		
Balochistan	Stage	Timing
	Start of vegetative growth (Bud bursting)	Late March
	Full bloom	Late April
	Fruit turning (Veraison)	October-November
	Time to harvest	November-December
Punjab	Stage	Timing
	Start of Vegetative Growth (Bud Bursting)	February-March
	Full Bloom	March-April
	Fruit Turning (Veraison)	October
	Time of harvest	October-November
Bio-agronomic and productive characteristics		
Sensitivity to biotic stress	Susceptible olive knot, medium resistant to verticillium wilt	
Sensitivity to abiotic stress	Quite sensitive to cold and Frost	
Productivity (with GAP)	High and constant	
Planting distance	6-7x6m (18-21x18ft)	
Production characteristics	Rich, fruity flavor balanced by an aromatic, grassy nose, olive oil is dark green color, higher than average polyphenol value	

Table 5. Comprehensive profile of Gemlik olive cultivar under Pakistani conditions.

Gemlik	
Origin	Turkey
Suitable regions	Khyber Pakhtunkhwa
Area of suitability	Cold
Purpose	Dual (olive oil and table olives)
Morphological characteristics	
Vigor	Medium
Growth habit	Spreading (branches grow horizontally, wide and sprawling appearance)
Canopy density	Dense (thick and packed foliage, ample shade and coverage)
Fruit characteristics	
Fruit weight	Large
Shape and color	Elongated oval to cylindrical; Reddish-purple to dark purple; sometimes greenish black
Oil content (% of fresh weight)	14%
Phenology (Khyber Pakhtunkhwa)	
Stage	Timing
Start of vegetative growth (Bud bursting)	March
Full bloom	March-April
Fruit turning (Veraison)	October
Time of harvest	November
Bio-agronomic and productive characteristics	
Sensitivity to biotic stress	Sensitive to verticillium wilt, olive knot, and olive psyllids
Sensitivity to abiotic stress	Resistant to cold climate
Productivity (with GAP)	High and constant
Planting distance	6x5m (18x15ft)
Production characteristics	Used for both table and oil purposes, it tastes very intensive and burns with the high polyphenol

Table 6. Comprehensive profile of Koroneiki olive cultivar under Pakistani conditions.

Koroneiki		
Origin	Greece	
Suitable regions	Balochistan, Khyber Pakhtunkhwa, Punjab	
Area of suitability	Hot	
Purpose	Oil (known for high oil content)	
Morphological characteristics		
Vigor	Medium-strong (small to medium-sized tree, 3-4 m height at maturity)	
Growth habit	Spreading (robust growth a vigorous branching)	
Canopy density	Sparse (good coverage, protects fruits from sunburn)	
Fruit characteristics		
Fruit weight	Small	
Shape and color	Oval, dark purple to black when ripe	
Oil content (% of fresh weight)		
Region	Cold area	Hot area
Balochistan	-	16-18%
Khyber Pakhtunkhwa	-	14%
Punjab	-	10-12%
Phenology by region		
Balochistan	Stage	Timing
	Start of vegetative growth (Bud bursting)	April
	Full bloom	Late April
	Fruit turning (Veraison)	October-November
	Time of harvest	Mid-November to early December (best oil: end October-November)
Khyber Pakhtunkhwa	Stage	Timing
	Start of vegetative growth (Bud bursting)	March
	Full bloom	April
	Fruit turning (Veraison)	October-November
	Time to harvest	Mid to end November
Punjab	Stage	Timing
	Start of Vegetative Growth (Bud Bursting)	Late February
	Full Bloom	Late March
	Fruit Turning (Veraison)	October
	Time of harvest	November
Bio-agronomic and productive characteristics		
Sensitivity to biotic stress	Resistant to olive leaf spot, Sensitive to olive knot	
Sensitivity to abiotic stress	Resistant to drought but does not tolerate cold	
Productivity (with GAP)	High and constant	
Planting distance	6x5m (18x15ft)	
Production characteristics	Very high level of polyphenols, green color, a fruity and delicate flavor, very strong aroma, rich in precious organoleptic substance	

Table 7. Comprehensive profile of Manzanilla olive cultivar under Pakistani conditions.

Manzanilla		
Origin	Spain	
Suitable regions	Balochistan - Punjab	
Area of suitability	Cold and hot	
Purpose	Dual (olive oil and table olives)	
Morphological characteristics		
Vigor	Weak medium (medium sized tree, 4-7m height at maturity)	
Growth habit	Spreading (open canopy, good sunlight penetration)	
Canopy density	Medium (decent coverage of the fruit branches)	
Fruit characteristics		
Fruit weight	Small	
Shape and color	Elliptical to ovoid; Green, turning purple to black when fully ripe	
Oil content (% of fresh weight)		
Region	Cold area	Hot area
Balochistan	16%	14%
Punjab	-	10%
Phenology by region		
Balochistan	Stage	Timing
	Start of vegetative growth (Bud bursting)	Late March
	Full bloom	April
	Fruit turning (Veraison)	September
	Time to harvest	October
Punjab	Stage	Timing
	Start of Vegetative Growth (Bud Bursting)	Early March
	Full Bloom	April
	Fruit Turning (Veraison)	August
	Time of harvest	September
Bio-agronomic and productive characteristics		
Sensitivity to biotic stress	Very sensitive to verticillium wilt, sensitive to anthracnose and olive knot	
Sensitivity to abiotic stress	Tolerant to cold and drought	
Productivity (with GAP)	High and alternate	
Planting distance	6x4m (18x12ft)	
Production characteristics	Used for both table and oil purposes, low amount of polyphenols medium fruit size, with deep green color, sweet taste, slight bitterness and some spicy presence in the throat	

Table 8. Comprehensive profile of Ottobratica olive cultivar under Pakistani conditions.

Ottobratica	
Origin	Italy
Suitable regions	Balochistan
Area of suitability	Cold
Purpose	Oil (one of the finest olive oils)
Morphological characteristics	
Vigor	Strong
Growth habit	Erect (branches grow vertically)
Canopy density	Dense (packed foliage, extensive coverage)
Fruit characteristics	
Fruit weight	Small
Shape and color	Elongated oval to cylindrical; Reddish-purple to dark purple; sometimes greenish black
Oil content (% of fresh weight)	18-20%
Phenology (Balochistan)	
Stage	Timing
Start of vegetative growth (Bud bursting)	Late March
Full bloom	Late April
Fruit turning (Veraison)	October-November
Time of harvest	November-December
Bio-Agronomic and Productive Characteristics	
Sensitivity to biotic stress	Tolerant to olive knot and leaf spot
Sensitivity to abiotic stress	Resistance to drought, humidity, and strong temperature change
Productivity (with GAP)	High and alternate
Planting distance	6-7x6m (18-21x18ft)
Production characteristics	Oil is yellow in color with greenish nuances, characterized by bitterness and vegetable scent flavors and naturally rich in polyphenols.

VI – Conclusions and future perspectives

Overall, the present study provides a valuable foundation for guiding olive cultivation in Pakistan. It offers scientifically grounded recommendations on the selection of olive cultivars best suited to the agroclimatic conditions of key provinces, including Balochistan, Khyber Pakhtunkhwa, and Punjab.

By aligning cultivar selection with regional climatic conditions, a critical constraint in the sector has been addressed, namely, the mismatch between olive varieties and local environments. This approach supports improved productivity, better adaptation, and enhanced resilience of olive plantations. Furthermore, the study highlights the economic potential of olive cultivation, emphasizing both oil production and table olive processing as key components for strengthening the value chain. The optimized selection and management of olive varieties can therefore contribute significantly to the long-term sustainability, profitability, and expansion of Pakistan's olive sector, while supporting broader agricultural development goals.

- **Balochistan**

Olive cultivation presents an opportunity for agricultural development in the province of Balochistan. Situated in the arid and semi-arid regions of the country, the province boasts agroecology and agroclimatic conditions that favor the cultivation of *Olea europaea*. Particularly in the areas north of Quetta, including Zhob, Killa Saifullah, Loralai, and surrounding areas, the conditions align favorably for the growth and flourishing of olive orchards.

Balochistan's terrain and varying altitudes contribute to diverse microclimates, providing suitable niches for olive cultivation. The region experiences a predominantly dry climate with low precipitation, which is conducive to olive cultivation, as the tree thrives in well-drained soils and can withstand periods of drought. Additionally, winter-summer day and night temperature fluctuations characteristic of the Balochistan climate further support the necessary chilling hours needed for optimal flowering of the olive tree.

Balochistan can be divided into two distinct areas: the area north of Quetta experiences colder winters and mild summers. The region south of Quetta is characterized by a warmer climate with hot summers and milder winters. By harnessing the adaptability of olive trees to the province's agroecology and agroclimatic suitable conditions, Balochistan will greatly benefit, economically and environmentally, from the establishment of thriving olive orchards.

Moreover, as a drought-tolerant crop, olives can be a valuable addition to Balochistan's agricultural portfolio, offering resilience in the face of water scarcity and climatic variability. The province may contain additional suitable areas for olive cultivation due to favorable soil and climatic conditions; however, thorough site assessment, soil analysis, and appropriate management practices are essential to ensure the successful establishment and sustainable productivity of olive orchards in the region.

- **Khyber Pakhtunkhwa**

Khyber Pakhtunkhwa (KP) exhibits diverse agroclimatic conditions across its variable topography, ranging from plains to mountains, which supports a wide range of agronomic and horticultural crops including olives. Geographically, the province is divided into two zones, the northern zone, and the southern zone. The region features distinct and particular climatic zones: arid southern areas with hot summers with temperature exceeding 40°C and mild winters having temperature regime from 15 to 25°C, characterized by low humidity conducive to olive cultivation. Central regions experience semi-arid conditions with hot summers, cool winters, and moderate rainfall, necessitating good drainage for successful olive farming. Northern areas offer mild summers, cold winters, and less humidity providing suitable conditions for certain olive varieties.

KP's agroecology includes plains, valleys, foothills, and high-altitude areas, each presenting specific advantages and considerations for olive cultivation. Factors such as temperature, optimal rainfall (between 400-600 mm annually with good drainage), and humidity levels (preferably low to moderate to minimize diseases) significantly influence olive farming practices in the region. Given this climatic diversity, conducting scientific studies to identify appropriate olive varieties and determine optimal cultural practices tailored for each location. The region experiences a Mediterranean-like climate with hot, dry summers and mild, wet winters, which are ideal conditions for olive trees. The well-drained soils and abundant sunlight further support the growth

and productivity of olives. Additionally, the elevation variations allow for the cultivation of different recommended olive varieties, enhancing the overall yield and quality of the produce.

- **Punjab**

The climate of Punjab for olive plantations is characterized by higher humidity and seasonal monsoon rains. The province experiences hot summers and relatively mild winters. The area receives most of its rainfall during the monsoon season (July to September), which can be both a boon and a challenge for olive cultivation. The monsoon provides necessary water for olive trees, especially during dry spells, potentially reducing the need for supplementary irrigation. However, excessive rainfall can lead to waterlogging, root rot, and other waterborne diseases, while high humidity levels can promote fungal infections like anthracnose on olive fruit and other pests. It can affect olive cultivation if not managed properly. The olive varieties recommended for cultivation can tolerate higher humidity levels and occasional periods of heavy rainfall. The climate may also present unique challenges in terms of pest and disease management for olive cultivation. With appropriate management practices, olive farming can thrive in Punjab's diverse climatic conditions.

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Olive orchard management for sustainable production

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Abstract. The rapid development of olive cultivation in Pakistan has created an increasing need for scientifically grounded and locally adapted agronomic practices enabling sustainable productivity, efficient resource use, and high-quality olive production. Olive cultivation is strongly influenced by pedo-climatic conditions, orchard design, cultivar selection, irrigation management, pruning systems, soil fertility, and phytosanitary protection, all of which must be carefully integrated to support resilient production systems. Sustainable approaches based on Good Agricultural Practices, integrated management, and environmentally responsible farming are becoming essential for improving orchard performance while preserving soil health, biodiversity, and water resources. Moreover, balanced fertilization strategies, efficient irrigation methods, cover cropping, reduced tillage, and integrated pest and disease management are key components of modern olive cultivation. Similarly, proper harvesting and post-harvest handling practices play a decisive role in maintaining fruit integrity and optimizing olive oil quality. The adoption of these agronomic and sustainable management tools represents a crucial step toward strengthening the long-term effectiveness, productivity, and environmental sustainability of the olive sector in Pakistan.

Keywords. Good Agricultural Practices – Integrated Pest Management – Soil fertility – Irrigation management.

Gestion des vergers oléicoles pour une production durable

Résumé. L'expansion rapide de l'oléiculture au Pakistan a mis en évidence la nécessité de pratiques agronomiques adaptées aux conditions locales afin d'assurer une production durable, une utilisation rationnelle des ressources et une huile d'olive de qualité. La culture de l'olivier dépend fortement des conditions pédo-climatiques, du choix variétal, de la conception des vergers, de la gestion de l'irrigation, des systèmes de taille, de la fertilité des sols et de la protection phytosanitaire. L'intégration cohérente de ces facteurs est essentielle pour développer des systèmes de production résilients et performants. Les approches fondées sur les Bonnes Pratiques Agricoles, la gestion intégrée et les méthodes de culture respectueuses de l'environnement contribuent à améliorer les performances des vergers tout en préservant les sols, les ressources en eau et la biodiversité. Une attention particulière est accordée à la fertilisation raisonnée, aux techniques d'irrigation efficaces, aux cultures de couverture, à la réduction du travail du sol ainsi qu'à la gestion intégrée des ravageurs et des maladies. De plus, les pratiques appropriées de récolte et de post-récolte jouent un rôle déterminant dans la préservation de l'intégrité des fruits et l'amélioration de la qualité de l'huile d'olive. L'adoption de ces stratégies agronomiques durables constitue ainsi une étape essentielle pour renforcer la productivité et la durabilité du secteur oléicole au Pakistan.

Mots-clés. Bonnes Pratiques Agricoles – Lutte intégrée – Fertilité des sols – Gestion de l'irrigation.

I – Introduction

The rapid expansion of olive cultivation in Pakistan, with millions of trees established across diverse agro-ecological zones, has marked a significant step toward developing a national olive industry. However, this growth has not always been accompanied by equally robust, standardized knowledge on orchard management and agronomic practices. As a result, many olive plantations

are managed under inconsistent or suboptimal conditions, limiting their productive potential and the quality of outputs.

Olive production is inherently a complex and knowledge-intensive system that requires careful adaptation to local pedo-climatic conditions. Factors such as cultivar selection, orchard design, pruning strategies, nutrient management, irrigation scheduling, and pests and diseases control must be harmonized to ensure sustainable productivity. In the absence of comprehensive, locally adapted guidelines, growers often rely on fragmented information or practices transferred from other regions, which may not be suitable for Pakistan's unique environmental conditions.

Moreover, there is an increasing global emphasis on adopting agricultural systems that are environmentally sustainable, resource-efficient, and safe for both producers and consumers. This is particularly relevant for olive cultivation, which is often perceived as a low-input crop but still requires careful management to minimize environmental impact while maintaining economic viability. Approaches such as Good Agricultural Practices (GAP), integrated agriculture, and organic farming provide structured frameworks to achieve these objectives by promoting efficient input use, ecological balance, and long-term soil and plant health.

In this context, the development and dissemination of clear, science-based, and locally relevant guidelines for olive orchard management are essential. Such guidelines should not only address the technical aspects of cultivation but also integrate principles of sustainability, climate resilience, and environmental stewardship. This chapter aims to bridge the existing knowledge gap by outlining key agronomic practices and sustainable management strategies tailored to the needs of olive growers in Pakistan, thereby supporting the long-term productivity and competitiveness of the sector.

II – Olive cultivation: Main agronomic aspects

1. Pedo-climatic inclination

A thorough understanding of the environmental characteristics of a given territory is a fundamental prerequisite for effective olive orchard management. Such knowledge enables farmers to make informed decisions regarding key aspects of cultivation, including the selection of suitable cultivars based on local conditions, the establishment of natural protective systems that enhance biodiversity and support beneficial insect populations, and the optimization of agronomic practices such as soil preparation, fertilization, and plant protection.

The defining features of any agricultural environment are primarily determined by three interconnected factors: soil, climate, and vegetation. Soil (pedological characteristics) plays a central role in determining crop adaptability and guiding soil management practices. Maintaining optimal soil conditions enhances plant growth, resilience, and productivity, while also preserving soil health. Climatic conditions are equally critical, influencing the suitability of specific olive cultivars and enabling satisfactory yields with minimal external inputs. Vegetation, both natural and cultivated, contributes to the development of ecological balance by supporting biological control mechanisms and protecting soil from erosion and degradation.

Planning agricultural activities based on these factors allows for the optimization of production while reducing dependence on external inputs such as fertilizers and pesticides. In this context,

the concept of inherent suitability refers to the natural capacity of a given area to sustain olive cultivation efficiently and sustainably with minimal intervention. Among all environmental variables, soil and climate remain the most decisive determinants of this suitability. Table 1 summarizes the key soil parameters to consider when assessing the suitability of a site for establishing a new olive orchard.

Table 1. Key soil parameters for evaluating planting site suitability.

Pedological parameters	Optimal Values
Soil weaving	Medium texture
Drainage	Good; there must be a quick draining of surface water
Useful depth	50-100 cm; The pitch must not exceed 100 cm from the surface
pH	6-8.5
Active limestone	8-15%
Salinity	Less than 6 mS/cm ¹

Olive trees require specific environmental conditions related to climate, exposure, and topography. Climatic factors, particularly minimum winter temperatures and the accumulation of chilling hours, represent the main limiting constraints for their cultivation. Temperatures below -6 to -7 °C can cause significant damage to leaves, branches, and trunks, while values below -10 °C may result in plant death. Additionally, even mild frost events (2-3°C below zero) during sensitive phenological stages, such as bud break in spring (April-May), can severely affect plant development. The extent of damage depends not only on temperature intensity but also on duration, plant physiological stage, humidity, and site exposure (Table 2).

Table 2. Temperatures relating to the main phenological phases, below which the development of the stages can be significantly slowed down or compromised.

Phenological phase	Average T (°C)	Optimal T (°C)
Beginning of budding	10.5-11	15
Beginning of blossoming	15	18
Beginning of the anthesis	18-19	20
Beginning of the fruit set	21-22	23
From blossoming to flowering	10	18-22
From the beginning of flowering to fruit set	15	23-25
From fruit set to veraison	20	21-22
From veraison to complete ripening	15	15-18
From complete ripening to the end of the harvest	5	7-8
From the end of the harvest to the blossoming	-5	0-5

The olive tree is a heliophilous species, requiring high light availability for optimal growth and productivity. Therefore, south and southwest exposures are generally preferred, along with orchard designs that maximize light interception. Traditionally, olive cultivation is recommended up to elevations of 600-700 meters above sea level, particularly in well-exposed areas. However,

field experiences in Pakistan suggest that olive trees can adapt to diverse microclimatic conditions, including higher-altitude plateaus such as those found in Balochistan.

Environmental conditions also influence oil quality. Oils produced in lower-altitude areas tend to be richer in solid glycerides, whereas those from higher altitudes contain a higher proportion of liquid glycerides, making them generally more digestible and often more desirable from a nutritional and commercial perspective. Latitude, altitude, and exposure collectively affect temperature regimes, which in turn influence the biochemical composition of olive oil during fruit maturation.

In addition to temperature and radiation, other climatic factors such as wind, snow, and hail also affect olive productivity. Moderate wind during flowering can enhance pollination, particularly in self-incompatible cultivars, whereas strong and persistent winds may cause mechanical damage and increase evapotranspiration, especially in arid regions. In such environments, the establishment of windbreaks using locally adapted species is essential to reduce water loss, protect plants, and improve overall orchard performance.

2. Olive groves, orchard systems and varieties

A. Olive groves

a) Planting material

The establishment of new olive groves should rely exclusively on self-rooted plants grown in containers. This approach ensures the development of a well-structured root system, uniform plant growth, and earlier entry into production. All nursery material must be accompanied by proper genetic and phytosanitary certification, guaranteeing its authenticity, local adaptability, and high agronomic quality.

b) Planting operations

Planting is best carried out during spring or early autumn to favor optimal plant establishment. Rows should preferably be oriented along a north-south axis to maximize light interception and ensure uniform canopy illumination throughout the day.

c) Planting density

Plant spacing depends on the chosen training system. For the mono-cone system, a spacing of approximately 6 m between rows and 5-6 m between plants within rows is recommended. For vase systems, common configurations include 6×6 m or 5×6 m, allowing adequate canopy development and light distribution.

B. Orchard systems (Form of farming)

The choice of orchard system should promote rapid vegetative growth, early fruiting, optimal light distribution within the canopy, consistent productivity, and reduced labor costs for pruning and harvesting. Additionally, the system should respect the natural growth habit of the olive tree to minimize excessive pruning interventions.

For olive groves intended for manual harvesting, simple vase and polyconic vase training systems are recommended. In contrast, the mono-cone system is more suitable for mechanized

harvesting. In particular, during the early growth stages, the mono-cone system enhances early production, supports balanced canopy development, reduces alternate bearing, and improves harvesting efficiency under mechanical shaking.

C. Variety selection

The selection of suitable olive cultivars is a critical step in orchard planning. Genetic characteristics determine the plant's adaptability to soil and climatic conditions, resistance to pests and diseases, precocity, yield potential, fruit quality, and susceptibility to alternate bearing. Cultivars should be selected based on their economic potential and their compatibility with local environmental conditions. In addition to widely cultivated commercial varieties, the inclusion of locally adapted or native cultivars can help preserve regional identity while enhancing product quality, whether for oil or table olive production.

In monovarietal orchards, it is advisable to include an appropriate proportion of compatible pollinizer cultivars (generally around 10%) where necessary. This ensures effective cross-pollination, improves fruit set, and enhances overall productivity, particularly in varieties with limited self-fertility.

D. Pruning

Pruning is a fundamental practice used to regulate the natural growth of the olive tree and adapt it to the selected training system. Its main objectives are to maintain canopy efficiency, regulate the distribution and renewal of fruiting branches, improve light penetration and air circulation, and reduce the risk of pest and disease development. Proper pruning also helps manage crop load and mitigate alternate bearing.

a) Training pruning

Training pruning is carried out during the juvenile phase to establish the structural framework of the tree. During the first years, pruning should be light, as excessive cutting can delay growth and postpone the onset of production.

- At planting: Seedlings should be cut at approximately 100 cm height, retaining lateral shoots to support early growth.
- Third year: If growth is weak, competing branches should be removed. In well-developed plants, branches below 50 cm and any suckers should be eliminated.
- Fourth year: As primary branches develop, competing shoots and poorly positioned branches should be removed.

Under proper management, the main branches will form favorable angles with the trunk, ensuring structural strength, resistance to environmental stresses, and efficient light interception.

b) Production pruning

Production (or maintenance) pruning is performed during the bearing phase to sustain productivity and maintain the balance between vegetative growth and fruiting. Excessive pruning should be avoided, as it disrupts the equilibrium between the canopy and root system and reduces yield potential.

Pruning intensity should be adjusted according to plant age and expected production. Light pruning is recommended following a heavy crop year, while more intensive pruning may be applied when a low-yield year is anticipated. The goal is to regulate vegetative growth, maintain optimal canopy volume relative to available resources, and limit alternate bearing. This practice is typically carried out annually or biennially, preferably from late winter to early spring, after the risk of severe frost has passed.

c) Management of pruning residues

Pruning residues can be removed, burned, or, preferably, recycled within the orchard. When shredded and incorporated into the soil, residues contribute to organic matter content, improve soil structure, and partially restore nutrients removed by plant growth. This practice is particularly suitable for young orchards, where pruning material consists mainly of small-diameter branches. Over time, it contributes to natural soil mulching.

d) Timing of pruning

Pruning is generally carried out during late winter or early spring, after the risk of severe frost. Low temperatures can damage exposed tissues and delay wound healing, increasing the risk of infection. In regions prone to late frosts, pruning should be delayed to protect plants and promote faster healing. Since pruning influences flower bud differentiation, its timing should also consider plant vigor; in vigorous trees, pruning can be delayed until floral structures are visible, whereas in weaker plants it should be carried out earlier (before February). Excessive delay should be avoided, as it can weaken plants and hinder new shoot development. Pruning after the onset of active growth may also remove developing buds and reduce productivity.

Summer pruning is generally limited to the removal of suckers and water sprouts, particularly in young or establishing orchards. In regions characterized by extreme heat and dry conditions, such as Punjab and Potohar, a two-stage pruning approach may be beneficial. Partial canopy retention before peak summer can protect trees from sunburn, while subsequent pruning at the onset of the monsoon season improves air circulation and reduces humidity-related risks.

3. Nutritional requirements of the olive tree

A. Soil analysis and foliar diagnostics

The adoption of a rational fertilization strategy is essential to maintain adequate soil fertility, prevent nutritional imbalances in plants and fruits, and minimize environmental impact. Determining the appropriate quantity and type of nutrients to be supplied requires an integrated approach based on soil analysis, foliar diagnostics, and estimation of nutrient removal (restitution criterion).

Soil physical, mechanical, and chemical analyses should be conducted prior to orchard establishment to guide basal fertilization and evaluate the initial fertility status of the site. These analyses provide critical information on nutrient availability and soil properties, allowing for tailored nutrient management. It is recommended to repeat soil analysis every 4-5 years to monitor changes and adjust fertilization practices accordingly. Tables 3-5 present the reference ranges for key soil physical, chemical and nutritional parameters used to assess soil fertility status and guide fertilization management in olive orchards.

Table 3. Reference values for the interpretation of soil analyses.

Assessment	pH in H ₂ O 1:2.5	Total limestone (CaCO ₃)	Total limestone (CaCO ₃) %	Organic matter (g / Kg =% 0)			Total Nitrogen (% 0)		
				Sand 60%	Medium	Clay 35%	Sand 60%	Medium	Clay 35%
Low	6.0-6.7	1-4	1.0-2.5	<12	<14	<17	<0.8	<1.0	<1.2
Normal	6.8-7.2	5-15	2.6-5.0	12-15	14-21	17-26	0.8-1.2	1.0-1.6	1.2-1.6
High	7.3-8.1	16-25	5.1-10	>15	>21	>26	>1.2	>1.6	>1.6

Table 4. Reference values for physiochemical soil analysis.

Assessment	Carbon Nitrogen Ratio (C/N)	Assimilable P		Exchangeable K			Exchangeable Ca mg/kg	Exchangeable Mg mg/kg
		Olsen mg/Kg	Bray 1 mg/Kg	Sand 60% mg/kg	Medium mg/kg	Clay 35%		
Low	6.0-6.7	1-4	1.0-2.5	0.6-1.0	1.0-1.5	1.25 - 2.0	<1000	60-100
Normal	9.1-11.0	10-15	16-30	81-150	101-250	151 - 300	1000-2000	100-150
High	11.1-20.0	16-25	31-50	151-250	251-350	301-450	>2000	>150

Table 5. Reference values for soil micronutrient status and related parameters.

Assessment	Soluble B mg/kg	Absorbable Cu mg/kg	Absorbable Fe mg/kg	S mg/kg	Mo Index pH +10 mg/kgMo	Total soluble salts %	Cation exchange capacity CSC meq/100g
Low	0,20-0,40	<1,0	<5,0	5-10	<6,3	/	6,0-12,0
Normal	0,41-1,00	1,1-6,0	5,1-130	11-15	6,3-8,2	<1,5	12,1-20,0
High	1,01-1,50	>6,0	>130	16-25	8,2	1,50-3,50	20,1-25,0

In addition to soil testing, foliar diagnostics offer a reliable method to assess the nutritional status of the olive grove during cultivation. This approach combines visual evaluation of vegetative growth and deficiency symptoms with laboratory analysis of leaf tissues. Leaf samples, collected at appropriate times and following standardized procedures, are analyzed to determine the concentration of essential nutrients. Table 6 shows the optimal percentage values by weight of the elements referring to the dry matter of the olive leaves. Leaf and fruit analyses together provide a comprehensive assessment of plant nutrition, enabling the identification of deficiencies, excesses, and nutrient imbalances that may affect productivity and fruit quality.

Table 6. Reference values for soil macronutrient status.

Nitrogen (N)	2.10 %
Phosphorus (P)	0,35 %
Potassium (K)	1.05 %
Total	3,50 %

B. Fertilization plan

a) Basic (Pre-planting fertilization)

Basic fertilization should be carried out before planting to improve the soil's physical, chemical, and biological properties. This typically involves the incorporation of well-decomposed organic matter, such as manure or other stabilized organic amendments, which enhance soil structure, microbial activity, and nutrient availability.

Application rates should ideally be based on soil analysis results. In the absence of analytical data, a general recommendation is to apply 30-50 t/ha of mature manure or equivalent organic material. Phosphorus and potassium requirements should be determined according to soil nutrient status.

b) Fertilization during plant establishment

During the early growth phase, nitrogen plays a key role in supporting vegetative development. In the first year, nitrogen should be applied in three split applications: the first at the onset of vegetative growth, followed by two additional applications at 15–20-day intervals. From the second to the fourth year, nitrogen should be applied in two doses during the main growth period (typically from March to July), ensuring continuous nutrient availability.

c) Production fertilization

Fertilization during the production phase aims to maintain a balanced nutrient supply in relation to the tree's vegetative growth and yield potential. Fertilization strategies must be adapted to local soil conditions, as determined by periodic soil analyses (recommended every 4-5 years), and complemented by field observations such as shoot growth, leaf color, canopy density, and the presence of suckers.

Nitrogen management is particularly critical. To ensure efficient uptake and minimize losses, nitrogen applications should be split into two or more doses aligned with key phenological stages. Typically, half of the nitrogen is applied at vegetative restart and the remainder during advanced fruit set. Nitrogen applications during flowering should be avoided, as they may increase flower drop and negatively affect fruit set.

Excessive nitrogen fertilization should be carefully avoided, as it can lead to excessive vegetative growth, increased susceptibility to pests and cold stress, delayed fruit ripening, and reduced oil quality and yield. As a general guideline, nitrogen application rates should not exceed approximately 3 kg per quintal of olives produced (or expected) per year.

In rainfed conditions, particularly in dry environments, nitrogen applications should be concentrated in the rainy season (late winter to early spring), and late applications should be

avoided. Fast-acting nitrogen sources (e.g., nitrates) are recommended at the beginning of the vegetative cycle, while other forms such as ammonium-based fertilizers or urea may be used later. When nitrogen application exceeds 60 kg/ha, it should always be applied in split doses.

Phosphorus and potassium fertilization should also be guided by soil analysis. Where needed, these nutrients can be applied annually at rates up to 30 kg/ha (P) and 40 kg/ha (K), or alternatively every 4-5 years if soil levels are below optimal thresholds. Their application is preferably carried out in autumn after harvest, in conjunction with soil tillage, or at the end of winter.

Organic fertilization remains an important component of sustainable nutrient management. Application of approximately 20 t/ha of mature manure every 3-4 years is recommended, with a corresponding reduction (about 30%) in mineral nitrogen inputs during the year of application. In the absence of manure, green manure practices using leguminous crops (e.g., broad beans or lupines) can be adopted. These can be sown in alternate rows and incorporated into the soil at the beginning of flowering to improve soil fertility and structure.

In irrigated orchards, particularly under drip irrigation systems where the inter-row is kept free of weeds, fertilizers should be applied locally along the tree row. This targeted application allows for a reduction of approximately 20% in fertilizer input while maintaining efficiency.

Finally, attention should also be given to secondary nutrients and micronutrients. Olive trees are sensitive to deficiencies in calcium, magnesium, and trace elements such as iron, manganese, and boron. Maintaining appropriate nutrient balance is essential, with optimal Ca/Mg ratios around 2 and Ca/K ratios generally ranging between 2 and 3.5, although higher values may occur under specific environmental conditions.

4. Parasitic diseases and pests

Although the olive tree is a species well adapted to Mediterranean environments and traditionally considered resilient, modern cultivation systems require more precise and sustainable plant protection strategies to ensure consistent yields and high-quality production.

The intensive and indiscriminate use of broad-spectrum pesticides has led to several critical issues, including the development of pest resistance, disruption of natural predator-prey relationships, and a decline in beneficial organisms. Moreover, excessive reliance on chemical control increases the risk of toxic residues in olive fruits and oil, posing potential threats to human health and the environment. In this context, there is a growing need to shift toward more sustainable approaches to plant protection. Integrated Pest Management (IPM) represents a key strategy in modern olive cultivation, aiming to balance effective pest control with environmental and economic sustainability. Table 7 presents the main olive diseases and insect pests with a brief description of their symptoms, epidemiology, biology and control measures.

Table 7. Major olive diseases and pests: Symptoms, epidemiology, and management.

Category	Disease/Pest	Symptoms and damage	Epidemiology/Biology	Management
Fungi	Peacock eye (<i>Spilosea oleagina</i>)	Brown circular leaf spots (10-12 mm), velvety appearance, often with concentric rings; affects leaves, twigs, fruits; causes defoliation, fruit drop, and plant weakening	Develops slowly; favored by high humidity and free water; optimal temperature 13–16°C; confined to leaf cuticle; severe in spring and autumn	Resistant cultivars; pruning to improve aeration; avoid excessive nitrogen; copper-based fungicides in autumn and late winter; reduce canopy humidity
Fungi	Anthracnose (<i>Colletotrichum acutatum</i>)	Leaf spots, necrosis, fruit rot with sunken lesions and orange spores; fruit drop, mummification; reduced oil quality and yield	Favored by high humidity and rainfall, especially in autumn; linked to susceptible cultivars and high inoculum presence	Resistant cultivars; pruning and sanitation; removal of infected material; copper-based fungicides; early harvesting to avoid wet conditions
Bacteria	Olive knot (<i>Pseudomonas savastanoi</i>)	Tumor-like swellings on twigs, branches, leaves, and fruits; cracking surface; branch dieback and plant weakening	Enters through wounds (pruning, hail, insects); spreads via rain; survives in plant tumors	Use certified plant material; avoid injuries; prune properly; remove infected tissues; protect against frost and pests
Insects	Olive psyllid (<i>Euphyllura olivina</i>)	White waxy secretions and honeydew; affects buds, flowers, shoots; causes flower drop and reduced fruit set; promotes sooty mold; yield losses up to 60%	Three generations/year; active in spring and autumn; optimal temperature 20-25 °C; high mortality above 32 °C	Monitoring (traps, inspection); early control of first generation; pruning to improve airflow; use of neem oil, horticultural oils, insecticidal soaps
Insects	Olive fly (<i>Bactrocera oleae</i>)	Larval feeding in fruit pulp; fruit drop; reduced yield; poor oil quality (high acidity, bad odor); facilitates secondary infections	Overwinters as pupae or larvae; multiple generations (3-4/year); oviposition in summer; development favored by moderate temperatures (<30 °C)	Monitoring and trapping; timely harvesting; removal of infested fruits; biological and chemical control when thresholds exceeded

5. Water requirements, irrigation methods, and water management

Water availability is a critical factor influencing olive tree productivity. Soil water deficit during the vegetative season, particularly in summer, represents one of the main constraints to yield and is a major contributor to alternate bearing. Adequate water supply promotes vegetative growth, advances flowering, reduces production alternation, and improves fruit development. Furthermore, irrigation increases the pulp-to-stone ratio, enhances lipid synthesis, and improves oil quality by influencing its chemical composition. It also shortens the unproductive period during the early stages of orchard establishment.

A. Irrigation methods

Irrigation can be applied using various techniques, however, localized (drip) irrigation is considered the most efficient and suitable method for olive cultivation. Drip irrigation ensures high water-use efficiency (up to 90%), providing uniform and controlled water distribution with short irrigation intervals (typically every 2-4 days) and relatively low volumes per application (approximately 120-150 L per plant per irrigation event). This system is adaptable to different soil types and topographical conditions and operates at relatively low pressure (1-2 atmospheres), resulting in reduced management costs. Compared to traditional irrigation methods, drip systems limit weed development, enable precise nutrient delivery through fertigation, and allow the use of moderately saline water without significant adverse effects.

B. Critical water demand periods

The olive tree requires the greatest water supply from March to September, corresponding to the period of active vegetative growth. Within this period, certain phenological stages are particularly sensitive to water stress: i) flower development, ii) fruit set, and iii) fruit growth. Water deficits during these stages can significantly reduce yield and fruit quality.

C. Irrigation volumes and scheduling

In traditional olive orchards, where planting density and spacing are variable and irrigation systems are not fixed, it is difficult to define irrigation volumes on a per-hectare basis. In such cases, supplemental irrigation is recommended during critical phenological stages, with approximate applications of 300 L per plant per irrigation event. In specialized or high-density orchards equipped with micro-irrigation systems, irrigation scheduling should be adjusted based on plant water requirements, soil characteristics, and climatic conditions. Reference irrigation schedules (shifts) are typically based on fully productive orchards with moderate vigor and planting density.

Rainfall should be considered when planning irrigation, however, only effective rainfall contributes significantly to soil moisture. Precipitation below certain thresholds can be considered negligible, as it does not sufficiently replenish soil water reserves. Conversely, rainfall exceeding the following thresholds should be considered effective: 30 mm for sandy soils, 40 mm for medium-textured soils, and 50 mm for clay soils.

Proper irrigation management requires integrating these factors to optimize water use efficiency while maintaining plant productivity and fruit quality.

Table 8. Watering volumes (water return) and irrigation shifts for micro-irrigation systems.

Month	Watering (mm/day)*	Interval (days)		Rain (mm)**
		Drip	Microjet	
April	1.0	3	5	2.0
May	2.0	2	3-4	2.0
June	2.5	2	2-3	2.5
July	2.0	1-2	3-4	2
August	2.0	1-2	3-4	2

*The quantity of water to be returned to the crop based on its water needs.

** It is important to evaluate rainfall to irrigate only when necessary; the tool to use is the rain gauge.

6. Methods of harvesting and storing olives

Olive harvesting is one of the most labor-intensive operations in the production chain, accounting for up to 50% of total production costs in many European countries. For this reason, mechanization, either partial or full, has been widely adopted in these regions to reduce labor requirements and improve efficiency. In contrast, in Pakistan, where labor costs are comparatively lower, mechanized harvesting is still limited and not yet widely adopted. Nevertheless, regardless of the harvesting method employed, it is essential to handle olives carefully to avoid mechanical damage. Practices such as stepping on olives collected on nets must be strictly avoided, as they initiate fermentation processes that lead to significant organoleptic defects in the oil.

A. Structure and maturation of the olive

The olive fruit (drupe) undergoes a progressive color change during maturation. Initially green, it becomes yellowish with reddish patches and eventually turns purplish or black at full maturity, depending on the variety.

Olives typically weigh between 1 and 8 grams and are composed of approximately: 40-50% water, 15-32% oil (fatty substances), and 25-35% dry matter. The composition of the fruit is influenced by several factors, including cultivar, climatic conditions, agronomic practices, and orchard location.

Oil accumulation begins at the onset of veraison (color change), when the fruit loses its intense green color and gradually develops darker pigmentation. This process continues until full maturation. However, harvesting should not be delayed excessively, as overripe fruits are associated with quality deterioration.

B. Early and late harvesting

The timing of harvest significantly influences both yield and oil quality. The decision to harvest early or late depends on the desired characteristics of the final product:

- Early harvest: Produces oils that are more intensely fruity, with higher aromatic complexity and better overall quality.
- Late harvest: Results in oils that are milder, less fruity, and often higher in apparent oil yield due to fruit dehydration.

In some situations, early harvesting may also be necessary to avoid damage from late-season pest infestations, particularly the olive fly *Bactrocera oleae*.

It is important to note that the perceived increase in oil yield at later stages of ripening is often misleading, as it results mainly from water loss rather than increased oil synthesis. For optimal quality, harvesting should begin when approximately 10% of the fruits have undergone color change and be completed before this exceeds 50%. Early harvesting generally ensures better preservation of organoleptic properties, including aroma and flavor.

C. Main harvesting methods

Only harvesting methods that preserve fruit integrity and ensure high oil quality should be adopted. The principal methods include: i) Manual harvesting (hand picking), ii) facilitated harvesting (assisted tools), and iii) mechanical harvesting.

The collection of olives fallen naturally on the ground is strongly discouraged, as these fruits are often overripe or deteriorated, leading to poor oil quality. Similarly, traditional beating of branches with sticks should be avoided, as it damages both fruits and tree structure and increases susceptibility to diseases.

a) Manual harvesting

Manual harvesting consists of picking olives directly from the tree by hand. Although labor-intensive and costly, it remains the most selective and least damaging method. Manual or hand harvesting has several advantages including:

- Minimal damage to fruits and trees;
- Reduced risk of pest-related damage;
- Lower need for cleaning and processing;
- Production of high-quality oil with superior organoleptic characteristics.

b) Facilitated harvesting

Facilitated harvesting involves the use of tools such as manual or pneumatic combs, rakes, or hook shakers, combined with nets or sheets placed under the canopy to collect the falling fruits. Combs are typically mounted on telescopic rods, allowing access to upper canopy areas, while hook shakers use mechanical vibration to detach fruits. These tools improve harvesting efficiency while maintaining relatively low levels of fruit damage. This method represents a compromise

between manual and mechanical harvesting, increasing productivity while preserving acceptable quality standards.

c) Mechanical harvesting

Mechanical harvesting is mainly adopted in large-scale orchards to reduce labor costs and improve operational efficiency. It involves the use of trunk or branch shakers equipped with vibrating arms, often combined with fruit interception systems such as nets, conveyor systems, or inverted umbrellas.

The successful adoption of mechanical harvesting requires appropriate orchard design and pruning systems. Trees should be trained to facilitate machine operation, typically with a vertical structure and a trunk height of at least 70 cm to allow proper grip of the shaking mechanism. Harvested fruits are collected using interceptor systems and transported via trailers or wagons equipped with automated loading systems. Although still limited in Pakistan due to economic and logistical constraints, mechanical harvesting represents a promising option for future intensification of olive production systems.

7. Regulation on Good Agricultural Practices

A. Management of soil fertility

Effective soil fertility management under Good Agricultural Practices (GAP) requires optimizing nitrogen dynamics within the soil-plant system, considering inputs, outputs, and internal transformations. This is particularly important in systems with successive crops, where maintaining both economic viability and environmental sustainability is essential. The primary objective is to ensure adequate crop nutrition while minimizing nitrogen losses through runoff, volatilization, and leaching into surface and groundwater.

A comprehensive understanding of the agronomic context is crucial to establishing a balanced relationship between fertilizer use, crop requirements, and environmental protection. The behavior and environmental impact of nitrogen depend on multiple interacting factors, including soil characteristics, climatic conditions, crop demand, and management practices. Therefore, nitrogen fertilization should be based on a balance approach, whereby the quantity applied compensates for the difference between crop requirements and the soil's natural nitrogen supply. Analytical data can be used to estimate both the crop's nitrogen uptake and the soil's capacity to supply nitrogen over time. The availability of nitrogen is influenced by seasonal variations in temperature, moisture, and soil aeration, as well as soil texture and structure.

To reduce nitrate losses through percolation, appropriate land management strategies must be adopted. These include maintaining soil cover, incorporating crop residues, and minimizing periods when the soil remains bare. Although less common in perennial systems, crop rotation in olive orchards, particularly through the use of cover crops, can provide substantial benefits. By alternating olive trees with cover crops such as legumes, soil fertility can be improved through nitrogen fixation. Cover crops also suppress weed growth, reducing the need for herbicides, and help manage pests and diseases by breaking their cycles. Additionally, these crops improve soil structure and prevent erosion. Implementing this practice involves introducing cover crops like clover or vetch during the off-season, planting annual or biennial crops between young olive trees

until they reach full canopy coverage, and growing green manure crops to be incorporated into the soil. An example rotation plan might involve planting legumes for the first two years, incorporating them as green manure in the third year, rotating with cereals or other non-legume cover crops in the fourth and fifth years, and allowing a fallow period or reintroducing legumes in the sixth year. Timing rotations around the olive tree growth cycle and harvest period, choosing compatible crops that do not compete heavily with the olive trees for resources, and managing cover crops properly are crucial considerations. While traditional olive orchards may not typically use crop rotation, integrating cover crops and practicing strategic fallowing can provide significant benefits to soil health, pest management, and overall orchard productivity.

a) Grassing (Cover cropping)

The establishment of vegetative ground cover (grassing) is a key practice for improving soil health and reducing environmental risks. Ground cover absorbs excess nitrates, thereby limiting their leaching into groundwater, and contributes to improving soil structure, biodiversity, and organic matter content. Grassing systems may be classified as:

- Spontaneous grassing, which relies on natural vegetation and is particularly useful in reducing nitrate leaching and protecting soil during vulnerable periods;
- Controlled (sown) grassing, commonly used in organic systems, involving selected species to ensure effective soil coverage and nutrient management.

The species to be considered suitable for this function should satisfy the following conditions:

- Establish easily with low input requirements
- Compete minimally with olive trees
- Avoid creating phytosanitary issues
- Contribute to soil protection and nutrient cycling

Grassing also reduces soil erosion, enhances water infiltration, and contributes to carbon sequestration. Periodic mowing or shredding creates a natural mulching effect, further improving soil conditions.

b) Tillage and soil structure

Tillage practices significantly influence soil structure, organic matter dynamics, and water movement. Deep ploughing redistributes organic substances throughout the soil profile, potentially increasing mineralization and nitrate nitrogen production, which is beneficial for plant nutrition but can also lead to leaching. However, in arable olive orchards, excessive ploughing may decrease organic matter levels over time, affecting soil fertility and structure negatively.

Primary and secondary tillage operations mainly affect soil macro-porosity, influencing water infiltration and runoff. Excessive tillage increases the risk of erosion and nutrient loss. For olive cultivation, minimizing tillage intensity can help maintain soil organic matter content and preserve soil structure, especially on sloping terrain where erosion control is crucial. Nonetheless, the choice of tillage intensity should be adapted to soil type and local conditions. In some soils with poor structure, occasional intervention may be necessary to maintain adequate porosity for root development.

c) Land management and water control

Land management practices in hydraulic-agricultural systems play a critical role in optimizing olive crop cultivation, particularly concerning water management and erosion control. In sloping olive orchards, the primary goal is to mitigate surface runoff, which can be achieved through strategically placed ditches that slow down water flow. This helps prevent soil erosion and retains water on-site for olive tree uptake, essential in maintaining soil moisture levels and preventing nutrient leaching. Conversely, in flat olive orchards, effective drainage systems such as underground drains or open ditches facilitate excess water removal, reducing the risk of waterlogging and enhancing root health.

In plain lands, hydraulic-agricultural management provides significant environmental and agronomic benefits by swiftly evacuating water, along with dissolved nitrates, to surface hydrological networks. This rapid water disposal minimizes the time nitrate-laden water spends percolating towards aquifers, thereby protecting groundwater quality. Properly designed drainage infrastructure, tailored to soil texture, structure, and rainfall characteristics, optimizes water movement while safeguarding against erosion and nutrient loss. Techniques like field ballasting enhance surface water evacuation to ditches, further supporting erosion control and nutrient retention.

Regarding olive crop management, these practices ensure optimal soil moisture levels and nutrient availability, crucial for healthy olive tree growth and productivity. By integrating hydraulic-agricultural strategies tailored to local conditions, olive growers can sustainably manage water resources, prevent soil erosion, and enhance overall orchard resilience against environmental challenges. This approach not only supports agricultural productivity but also promotes environmental stewardship in olive cultivation.

d) Types of nitrogen fertilizers and their application

Using fertilizers and soil improvers to supply nitrogen to olive crops requires careful consideration of the chemical forms of nitrogen present in these products. The selection and expected responses must be calibrated based on how each form of nitrogen behaves in soil and contributes to plant nutrition. Nitrogen can exist in various forms such as nitrate, ammonium, and organic nitrogen compounds, each influencing soil fertility and nutrient uptake differently. For olive cultivation, understanding these nitrogen forms' dynamics helps optimize fertilizer application strategies to enhance both production outcomes and environmental sustainability.

Different nitrogen forms vary in availability, mobility, and environmental impact:

- **Nitric nitrogen (NO_3^-):** Immediately available to plants but highly susceptible to leaching. Best applied during peak crop demand and preferably in split applications. The main fertilizers containing only nitrogen in the nitric form are calcium nitrate (N=16%) and potassium nitrate (N=15%; K₂O=45%).
- **Ammoniacal nitrogen (NH_4^+):** Less mobile and retained in soil; requires microbial conversion before plant uptake, resulting in slower release. The main fertilizers containing only ammoniacal nitrogen are anhydrous ammonia (N=82%), ammonium sulphate (N=20-21%), ammonia solutions (minimum content: 10% N), ammonium phosphates (diammonium phosphate 18/46 and monoammonium phosphate: 12/51).

- **Nitric + ammoniacal fertilizers:** Provide both immediate and sustained nitrogen availability. Depending on the ratio of nitric to ammoniacal nitrogen, these fertilizers provide flexible solutions for various stages of crop growth and specific field intervention needs. One prominent example of a nitro-ammonia fertilizer is ammonium nitrate.
- **Urea nitrogen:** Requires enzymatic and microbial transformation before becoming available; highly soluble but subject to volatilization and leaching if mismanaged. The fundamental product is urea (N=46%), the solid mineral fertilizer with the highest nitrogen content.
- **Organic nitrogen fertilizers:** Derived from organic matter; release nitrogen gradually through mineralization, improving soil structure and long-term fertility. Among the main organic fertilizers are leather, hornwort, dried blood, meat and fish meal, manure and dried manure.
- **Organo-mineral fertilizers:** Combine organic and mineral nitrogen sources, ensuring both immediate and sustained nutrient availability.
- **Slow-release fertilizers:** Designed to release nitrogen gradually, improving efficiency and reducing environmental losses.
- **Cyanamide fertilizers:** Require multiple transformation steps before becoming available, resulting in delayed nitrogen release.
- **Organic amendments and livestock effluents:** Vary widely in composition and nutrient availability:
 - Cattle manure: Primarily improves soil structure; provides slow and sustained nutrient release over several years.
 - Bovine slurry: Offers moderate immediate nutrient availability with a residual effect; composition varies depending on management.
 - Poultry manure: High in readily available nitrogen, similar to synthetic fertilizers, but requires careful handling due to volatilization risks.
 - Compost: Stabilized organic material with balanced nutrient release and strong soil conditioning properties. Its quality depends on raw materials and processing methods.

The selection and application of these materials must consider their nutrient content, mineralization rate, and potential environmental risks (e.g., heavy metals in compost).

B. Phytosanitary protection

Phytosanitary protection within the framework of GAP is based on the rational, responsible, and regulated use of plant protection products to ensure crop health while minimizing risks to the environment, human health, and product quality. The application of phytosanitary products must be limited to those officially authorized and carried out in strict compliance with label recommendations, including dosage, timing, safety intervals, and application methods. Chemical interventions should not be routine but instead guided by technical criteria. In particular, treatments against insect pests should be performed only when established economic thresholds are exceeded, whereas disease management should rely on preventive measures when environmental conditions favor pathogen development, and on curative treatments when infections are detected.

For fungal and bacterial diseases, integrated strategies combining agronomic practices and targeted treatments are essential. In the case of viral diseases, control relies primarily on the use of certified, healthy propagation material compliant with phytosanitary regulations, along with effective management of insect vectors responsible for disease transmission.

Farmers adopting GAP must follow a structured and traceable approach to crop protection. This includes:

- Strict adherence to GAP principles, ensuring that all plant protection measures are justified, targeted, and environmentally sustainable;
- Maintenance of a detailed field record (“campaign notebook”), documenting all phytosanitary treatments, including product type, dosage, timing, and purpose, as well as other agronomic practices such as fertilization, pruning, tillage, and irrigation;
- Continuous monitoring and technical updating, through regular assessment of phytosanitary conditions in the orchard and consultation with agricultural advisors, extension services, technical bulletins, and specialized publications.

III – Conclusions

This chapter provides a comprehensive overview of the fundamental principles and practices required for effective olive orchard management, with a strong emphasis on GAP and sustainability. It brings together key agronomic components necessary to optimize both productivity and product quality under diverse pedo-climatic conditions.

The framework presented outlines the importance of proper orchard establishment, including site suitability, cultivar selection, planting systems, and training forms, as the foundation for long-term performance. It further highlights the role of balanced nutrition, supported by soil analysis and foliar diagnostics, in maintaining soil fertility and preventing nutrient imbalances.

Particular attention is given to sustainable soil and water management strategies, such as grassing, reduced tillage, and efficient irrigation methods, which contribute to improved soil structure, water use efficiency, and environmental protection. In parallel, the adoption of integrated pest management and responsible phytosanitary practices is emphasized to ensure effective control of pests and diseases while minimizing chemical inputs and associated risks. The present work also addresses optimal harvesting practices and post-harvest handling, underlining their critical role in preserving fruit integrity and ensuring high-quality olive oil production.

Overall, the approaches presented in this chapter aim to support the development of productive, resilient, and environmentally sustainable olive production systems. Their implementation will contribute to improving yield stability, enhancing product quality, and promoting the long-term sustainability of olive cultivation.

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Policy framework for promoting olive production as a climate change mitigation strategy in Pakistan*

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Abstract. Olive cultivation is increasingly recognized as a sustainable agricultural system capable of contributing to climate change mitigation through carbon sequestration, reduction of greenhouse gas emissions, and restoration of marginal lands. In Pakistan, the rapid expansion of olive plantations under favorable agro-climatic conditions offers not only economic opportunities but also important environmental benefits. This study evaluates the role of olive groves as carbon sinks by assessing biomass accumulation, carbon stocks, carbon sequestration rates, and greenhouse gas emissions associated with olive cultivation and oil production systems in selected areas of Khyber Pakhtunkhwa and Punjab. The findings indicate that olive orchards exhibit a positive net carbon balance, demonstrating their capacity to offset emissions generated during agricultural and processing activities. In addition, the potential integration of olive cultivation into voluntary and compliance carbon markets is explored within the framework of international climate policies and Pakistan's Nationally Determined Contributions. The development of appropriate policy instruments, carbon accounting systems, farmer cooperatives, and institutional support mechanisms is identified as essential for promoting olive-based carbon projects and strengthening the contribution of the olive sector to climate change mitigation and sustainable rural development in Pakistan.

Keywords. Carbon sequestration – Carbon footprint – Carbon markets – Climate change mitigation.

Cadre politique pour la promotion de l'oléiculture comme stratégie d'atténuation du changement climatique au Pakistan

Résumé. L'oléiculture s'impose comme un système agricole durable contribuant à l'atténuation du changement climatique grâce à la séquestration du carbone, à la réduction des émissions de gaz à effet de serre et à la valorisation des terres marginales. Au Pakistan, l'expansion rapide des plantations d'oliviers dans des conditions agroclimatiques favorables représente une opportunité économique et un levier important pour la durabilité environnementale. Cette étude évalue le rôle des oliveraies comme puits de carbone à travers l'analyse de l'accumulation de biomasse, des stocks de carbone, des taux de séquestration et des émissions de gaz à effet de serre liées aux systèmes de production oléicole et de transformation oléicoles. Les résultats montrent que les vergers oléicoles présentent un bilan carbone net positif, démontrant leur capacité à compenser les émissions générées par les activités agricoles et industrielles. Enfin, le potentiel d'intégration de l'oléiculture dans les marchés volontaires et réglementés du carbone est analysé dans le cadre des politiques climatiques internationales et des Contributions Déterminées au niveau National du Pakistan. Le développement d'outils politiques adaptés, de systèmes de comptabilisation du carbone et de mécanismes institutionnels apparaît essentiel pour promouvoir les projets carbone liés à l'oléiculture et renforcer la contribution du secteur à l'atténuation du changement climatique et au développement rural au Pakistan.

Mots-clés. Séquestration du carbone – Empreinte carbone – Marché de droits d'émission de carbone – Atténuation des effets du changement climatique.

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I – Introduction

Forest ecosystems and soils represent major terrestrial carbon reservoirs, with a strong capacity to absorb and store atmospheric carbon dioxide (CO₂). Through photosynthesis, trees capture CO₂ and convert it into biomass, storing carbon in trunks, branches, leaves, roots, and fruits, as well as in soil organic matter. This process, known as carbon sequestration, is a key mechanism for mitigating climate change (Lopez-Bellido *et al.*, 2016). Compared with annual crops, tree-based systems exhibit greater potential for long-term carbon storage due to their perennial nature, larger biomass, and reduced soil disturbance. As a result, tree plantations play a central role in nature-based solutions to climate change (Proietti *et al.*, 2016).

While forests and grasslands are typically considered carbon sinks, conventional agricultural systems often act as sources of greenhouse gases (GHGs), mainly due to soil tillage, the use of synthetic fertilizers and pesticides, and fossil fuel consumption in farm operations (Ceschia *et al.*, 2010). In this context, there is an increasing interest in developing sustainable agricultural systems that enhance carbon sequestration while reducing emissions. Agroforestry systems and orchards, including olive groves, are particularly promising due to their long-life cycle, lower tillage intensity, and capacity to increase soil organic matter (Nair *et al.*, 2010). The overall climate benefit of such systems depends on achieving a balance between carbon sequestration and the minimization of their carbon footprint.

The term carbon footprint refers to the total climatic impact of a system, expressed as the sum of all greenhouse gas emissions and removals across its life cycle (Peters, 2010). It encompasses emissions generated during all stages of production, from raw material acquisition to processing and waste management. In olive production systems, the carbon footprint includes emissions associated with nursery operations, land preparation, irrigation, fertilization, pesticide application, transportation, and oil extraction processes. Carbon footprint assessments help identify key emission sources and guide strategies for reducing environmental impacts.

Olive (*Olea europaea* L.) is one of the most important tree crops globally, both economically and ecologically. Beyond its role in edible oil production, olive cultivation contributes to soil conservation and climate change mitigation. The relationship between olive farming and climate change is bidirectional: olive trees are sensitive to climatic variations, yet they also act as effective carbon sinks by storing CO₂ in perennial biomass and soil, thereby enhancing soil organic matter and long-term carbon storage.

According to the assessment done in 2017 by the International Olive Council, the global olive-growing area, estimated at approximately 10.5 million hectares, has the capacity to capture around 47 million tons of CO₂ annually. On average, one hectare of olive grove can sequester approximately 4.5 tons of CO₂ per year. Furthermore, considering the full life cycle of olive oil production, it is estimated that the production of one kilogram of olive oil can result in a net removal of up to 10 kg of CO₂ from the atmosphere.

Carbon sequestration rates in olive groves vary widely depending on factors such as tree density, age, management practices, and environmental conditions. For instance, Sofo *et al.* (2005) reported sequestration rates of 9.54 and 2.74 t CO₂/ha/year in mature and young olive groves in southern Italy, respectively. Other studies have shown values ranging from 1.51 t CO₂/ha/year in 11-year-old groves (Proietti *et al.*, 2014) to between 2.05 and 4.10 t CO₂/ha/year under different

management systems in southern Spain (Lopez-Bellido *et al.*, 2016). Nevertheless, practices such as the use of cover crops can further enhance soil carbon storage (Nieto *et al.*, 2010).

The environmental performance of olive production systems can be effectively evaluated using Life Cycle Assessment (LCA), a standardized methodology that quantifies inputs, outputs, and environmental impacts across the entire life cycle of a product, from “cradle to grave” (De Luca *et al.*, 2018). LCA has been widely applied in Europe to assess the carbon footprint of olive cultivation and olive oil production, providing a comprehensive understanding of both emissions and carbon sequestration (Espadas-Aldana *et al.*, 2019; Fernández-Lobato *et al.*, 2021).

In recent years, increasing attention has been given to enhancing terrestrial carbon stocks through afforestation and sustainable land management practices. This has led to the emergence of carbon credits as a tradable commodity in both voluntary and compliance carbon markets. A carbon credit represents one ton of CO₂ equivalent (CO₂eq) either reduced or sequestered. Olive plantations, due to their carbon sequestration capacity, offer significant potential for generating carbon credits, thereby providing an additional income stream for growers.

In Pakistan, olive cultivation is expanding rapidly due to favorable agro-climatic conditions, including suitable soils, a conducive climate, and the presence of extensive wild olive resources, alongside the increasing adoption of Good Agricultural Practices (GAP) aligned with international standards. However, experiences from other countries indicate that excessive intensification of olive production can lead to negative environmental consequences, including increased GHG emissions, soil degradation, biodiversity loss, and pressure on water resources. Therefore, it is essential to assess and manage these impacts to ensure the long-term sustainability of the sector.

The present study aimed at evaluating the carbon sequestration potential of olive groves in Pakistan and exploring policy mechanisms to promote carbon credit trading as an additional revenue source for olive growers. Specifically, the main objectives of the study were: i) quantifying carbon sequestration rates of olive trees under different management regimes in selected areas of Khyber Pakhtunkhwa and Punjab, ii) assessing the carbon footprint of olive cultivation by estimating GHG associated with production and oil extraction processes, iii) determining the net carbon balance and the potential generation of carbon credits from olive plantations, and iv) identifying policy measures and strategic options for promoting carbon credit trading within the olive sector in Pakistan.

II – Methodology

1. Assessment of carbon sequestration

The evaluation of carbon sequestration in olive groves included both above-ground and below-ground biomass. Field data were collected from selected sites in Khyber Pakhtunkhwa (KP) and Punjab where *Olea europaea* plantations have been established. The data collection protocol is summarized below, while the detailed questionnaire is provided in Annex I.

At each site, ten representative trees of the same age group were randomly selected. Care was taken to ensure spatial coverage across the entire grove (Torrús-Castillo *et al.*, 2023). The following parameters were recorded for each sampled tree:

- a. Variety name
- b. Planting year (tree age)
- c. Spacing
- d. Number of plants per hectare
- e. Number of stems per plant (for multi-stem systems)
- f. Diameter at Breast Height (DBH, cm), measured at 1.37 m above ground using a caliper (Figure 1a)
- g. Tree height (m), measured using a Vertex hypsometer (Figure 1b)



Figure 1. Measuring tree diameter with Caliper (a) and height of stems with Vertex Hypsometer (b).

A. Determination of above-ground biomass

Above-ground biomass (AGB) per tree was estimated using field measurements of DBH and tree height through established allometric equations:

$$AGB = 0.623 \times (DBH)^{1.352} \times (H)^{0.703}$$

$$AGB = 7.8863 + 0.0556 \times (DBH^2 \times H)$$

Where AGB is expressed in kilograms (kg), DBH in centimeters (cm), and H in meters (m).

B. Determination of below-ground biomass

Below-ground biomass (BGB) was estimated from AGB using root-to-shoot ratios recommended by the IPCC (2006):

- 0.56 for AGB < 20 t/ha
- 0.28 for AGB > 20 t/ha

C. Conversion to carbon stock and CO₂ equivalent

Biomass values were converted to carbon stock using a conversion factor of 0.47 (IPCC, 2006). Carbon stock was subsequently converted into CO₂ equivalent (CO₂eq) by multiplying by 3.67 (EPA, 2023).

D. Carbon sequestration rate

The annual carbon sequestration rate (t CO₂/ha/year) was calculated by dividing total carbon stock by tree age (Torrús-Castillo *et al.*, 2023). Sequestration rates were analyzed across different age classes and planting densities.

2. Assessment of carbon footprint

The carbon footprint of olive production was assessed using a LCA approach, covering stages from field establishment to oil extraction. Nursery operations were excluded. The following emission sources were considered:

A. Land preparation

Data on previous land use and management practices were collected to estimate emissions associated with land-use change. Fuel consumption for land preparation was calculated based on tractor operating hours per hectare and converted into GHG emissions using standard emission factors.

B. Fertilizers and pesticides application

Information on the application rates of manure, chemical fertilizers, and pesticides was obtained through farmer interviews. These inputs were converted into GHG emissions per hectare using established emission factors.

C. Irrigation

Irrigation-related emissions were estimated based on the energy source used for groundwater extraction (diesel, electricity, or solar). Systems powered by solar energy were considered emission-free for this component.

D. Oil extraction

Emissions from oil extraction were calculated based on energy consumption at processing facilities. Both electricity use and fuel consumption (diesel or petrol generators) were considered, particularly in areas affected by power outages.

All collected data were compiled and analyzed using Microsoft Excel to quantify total greenhouse gas emissions and carbon sequestration.

3. Policy context and government priorities

The Government of Pakistan has prioritized carbon sequestration and climate change mitigation through various policies, strategies, and action plans at both federal and provincial levels. These initiatives emphasize nature-based solutions, including afforestation and sustainable agricultural practices.

The present study reviews the existing policy framework related to carbon sequestration and carbon trading within the olive sector. The findings are aligned with the “Action plan and policy recommendations for a holistic development of the Pakistani olive value chain” (Chapter III), with the objective of integrating carbon-related considerations into future policy development.

III – Field survey findings

1. Olive farming practices

Olive cultivation in the surveyed areas is practiced under diverse systems and spatial arrangements. The majority of plantations are established as structured orchards, either as monocultures or with intercropping of annual crops. In some cases, mixed orchards combining olive with citrus species (e.g., lemon) were observed, while other systems include linear plantations along field boundaries or scattered individual trees.

In regularly established groves, planting density varied considerably, with spacing ranging from 10x12 ft to 20x30 ft. Common configurations included 10x15, 12x12, 15x15, 15x20, 20x20, and 25x25 ft. The recommended standard spacing is 20x20 ft (approximately 6x6 m), corresponding to about 109 trees per acre. According to surveyed growers, tree survival rates after 13 years ranged between 80% and 85%, while fruit production typically begins approximately four years after planting. The main olive varieties cultivated in the study area include Arbequina, Coratina, Manzanilla, BARI-1, BARI-2, and Frantoio.

Irrigation practices vary across farms: approximately 80% of farms are irrigated, while 20% rely solely on rainfall. Among irrigated farms, 72% use solar-powered systems, whereas the remaining 28% depend on diesel or electricity-driven tube wells. Intercropping practices were observed in 36% of farms, involving annual crops such as wheat and mustard, as well as perennial crops like citrus.

The surveyed farms are located at altitudes ranging from 300 to 922 meters above sea level. Notably, 68% of olive plantations have been established on previously uncultivated or marginal lands, while 32% were developed on agricultural land formerly used for cereal and pulse production.

2. Attributes of sampled farms

A total of 22 farms were selected for detailed analysis, located in the provinces of KP and Punjab (Figure 2). Farm sizes varied widely, ranging from 0.5 to 120 acres. The age of olive trees ranged from 4 to 22 years. A summary of the key characteristics of the sampled farms is presented in Table 1.



Figure 2. Location of samples farm.

Table 1. Attributes of samples farms.

Farm	Location	X	Y	Elevation (m)	Area (Acre)	Irrigation System
1	Maraji Bala (Manki Shareef) - Noshera - KP	3109002	1077325	550	44	Solar (Drip)
2	Manki Shareef	3110164	1080381	449	17	Solar
3	Manki Shareef	3111005	1079557	485	--	Rainfed
4	Pir Sabaq Farm -Nowsheara	3116511	1089768	283	120	Rainfed
5	Shami Road – Peshawar – KP	3072079	1088489	310	0.8	Electric pump
6	PFI - Peshawar	3065163	1087556	364	0.43	Canal
7	Sangbhatti – Swabi -KP	3139230	1119048	400	22	Solar (Drip)
8	Sangbhatti – Swabi	3139334	1118948	400	4.5	Solar (Drip)
9	Sangbhatti - Swabi	3139430	1118648	400	37	Solar (Drip)
10	Sangbhatti - Swabi	3139400	1118248	400	19	Solar (Drip)
11	Shabaz Ghari- Mardan – KP	3127401	1114410	331	0.8	Solar
12	Shabaz Ghari - Mardan	3127479	1114520	332	50	Solar
13	Haji Lawang – Bajaur – KP	3069030	1171586	836	1.5	Solar
14	Khar - Bjaur	3064546	1166118	878	0.5	Electric pump
15	Khar - Bajaur	3064475	1166261	868	5.5	By tanker
16	Salarzai - Bajaur	3069048	1179106	922	-	Rainfed
17	Mian Shah Kalay - Bajaur	3078154	1176532	762	18.5	Rainfed
18	BARI – Chakwal – Punjab	3184055	971440	525	1.08	Solar
19	BARI - Chakwal	3184123	971418	505	0.72	Solar
20	Arshad Qadri Orchard -Chakwal	3178877	959111	615	50	Solar
21	Arshad Qadri Orchard -Chakwal	3178679	959150	629	40	Solar
22	Master Rafique Orchard - Chakwal	3178578	960861	605	10	Solar

The Diameter at Breast Height (DBH), measured at approximately 1.37 m above ground level, ranged from 1.53 cm to 25.60 cm, with an average of 10.08 cm. Tree height varied from 2.05 m to 6.82 m, with an average of 3.95 m. Figure 3 shows the relationship between tree age and DBH in olive trees. A quadratic trendline indicated a positive relationship, with DBH increasing as tree age increases ($R^2 = 0.7635$).

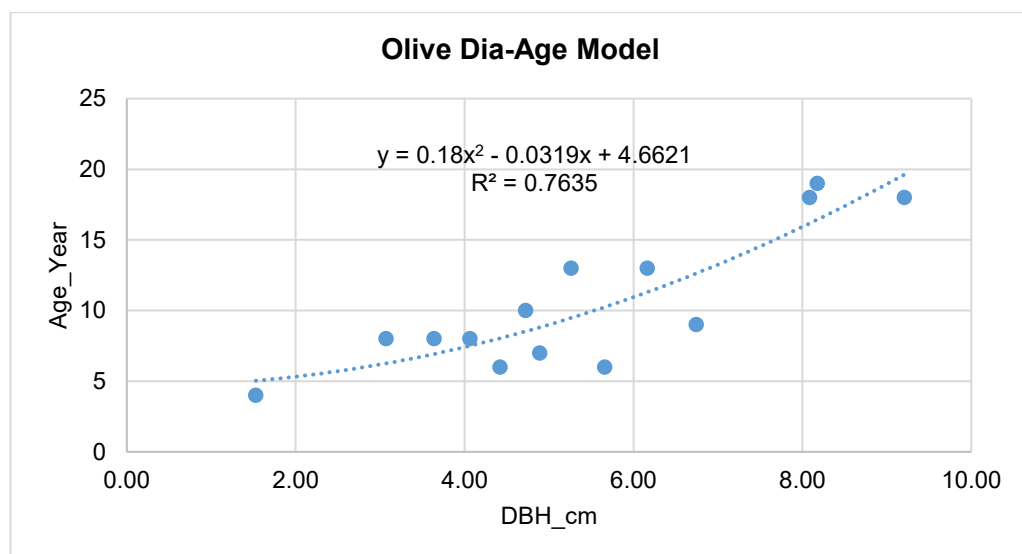


Figure 3. Relationship between DBH and age of olive trees.

3. Biomass and carbon stocks

Plant biomass consists of above-ground biomass (AGB) and below-ground biomass (BGB). Above-ground biomass includes stems, branches, twigs, leaves, and fruits, while below-ground biomass comprises root systems. In the sampled farms, AGB ranged from 0.84 to 196.70 t/ha, with an average of 50.67 t/ha. Below-ground biomass was estimated from AGB using root-to-shoot ratios recommended by the IPCC (2006), resulting in values ranging from 0.47 to 55.07 t/ha, with an average of 14.63 t/ha.

The corresponding above-ground carbon stock varied between 0.39 and 92.45 tC/ha, with a mean of 23.81 t C/ha, while below-ground carbon stock ranged from 0.22 to 25.88 t C/ha, averaging 6.88 t C/ha (Table 2).

Table 2. Mean and range of biomass and carbon stocks in sampled farms.

Variable	Mean (ton/ha)	Range (ton/ha)
Above-ground biomass	50.67	0.84-196.70
Below-ground biomass	14.63	0.47-55.07
Above-ground carbon stock (t C/ha)	23.81	0.39-92.45
Below-ground carbon stock (t C/ha)	6.88	0.22-25.88

4. Carbon sequestration

Carbon sequestration was estimated based on total biomass (AGB + BGB). Biomass was converted to carbon stock using a factor of 0.47, following IPCC (2006) guidelines, which assume that carbon constitutes 47% of dry biomass. Carbon stock was then converted to CO₂ equivalent (CO₂eq) using a factor of 3.67. The annual carbon sequestration rate was calculated by dividing the accumulated CO₂ by the age of the trees. Results indicate an average sequestration rate of 4.69 t CO₂/ha/year for olive groves aged 4-24 years, planted at a spacing of 15x15 ft (approximately 478 trees/ha), with an average survival rate of 85% (Table 3, Figure 4). It should be noted that these estimates are preliminary, as they are based on a limited dataset comprising 22 sample plots, with some age classes represented by a single observation (e.g., 4-year-old groves). More robust estimates will require a larger number of sample plots across a wider range of geographic conditions.

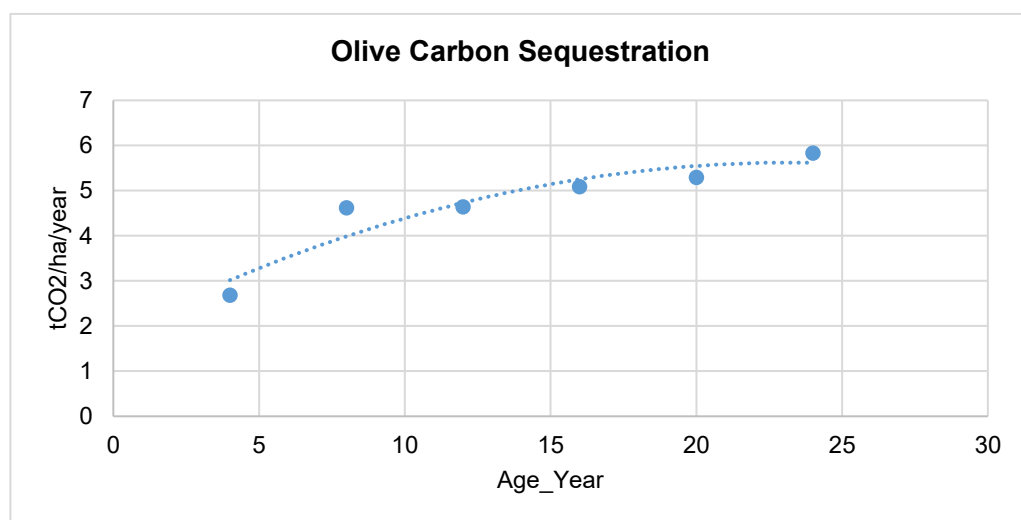


Figure 4. Olive carbon sequestration rate.

Table 3. Carbon sequestration rates and biomass accumulation across different age classes of olive groves.

Age (Year)	Survival % age	Plant density (Number of plants per ha)	Aboveground biomass (t/ha)	Belowground biomass (t/ha)	Total biomass (t/ha)	Carbon sequestration (tCO ₂ /ha/year)
4	90	430	4.875	1.365	6.240	2.683
8	90	430	16.767	4.695	21.461	4.615
12	85	406	25.286	7.080	32.366	4.640
16	85	406	37.003	10.361	47.364	5.092
20	80	382	48.068	13.459	61.527	5.292
24	80	382	63.590	17.805	81.395	5.834
Average		406	32.598	9.127	41.726	4.693

5. Carbon footprint

The total carbon footprint of olive cultivation and processing was estimated at 0.898 t CO₂eq/ha/year. This includes emissions from land preparation (0.162 t CO₂eq/ha), fertilizer application (0.461 t CO₂eq/ha), pesticide use (0.126 t CO₂eq/ha), and oil extraction (0.240 t CO₂eq/ha). Irrigation-related emissions were not included, as most farms rely on solar-powered systems. Detailed estimates of GHG emissions from individual operations are given in the following tables (4-6).

A. GHG emissions from land preparation

GHG emissions from land preparation were estimated at 0.162 t CO₂eq/ha/year. These emissions arise primarily from diesel consumption by machinery such as bulldozers and tractors used for land leveling, plowing, and intercultural operations.

Table 4. GHG emissions from land preparation.

Activity	Source of Emissions	Energy consumption per acre per year (Liter)	Emission per Liter (KgCO ₂ /L)	Annual emissions per acre (tonCO ₂)	Annual emissions per ha (tonCO ₂)
Land preparation	Energy (Diesel) consumption by bulldozer and tractor	92.40	2.7	0.066	0.162

B. GHG emissions from fertilizers and pesticides applications

The use of chemical fertilizers and pesticides contributes significantly to the carbon footprint due to emissions associated with their production, packaging, transport, and application. Although farmyard manure is also applied, its contribution to emissions is relatively minor. Total emissions were estimated at 0.461 t CO₂eq/ha/year from fertilizers and 0.126 t CO₂eq/ha/year from pesticides (Table 5).

C. GHG emissions from oil extraction

Olive oil extraction involves mechanical processing, typically powered by electricity. However, due to frequent power outages, diesel generators are often used, resulting in additional emissions. The estimated emissions from oil extraction amount to 0.240 t CO₂eq/ha/year (Table 6).

Table 5. GHG emissions from fertilizers and pesticides.

Activity		Quantity used per year (Kg per acre)	Equivalent carbon emissions (kg CE/kg)*	Annual emissions per acre (tonCO ₂ eq)	Annual emissions per ha (tonCO ₂ eq)
Fertilizers	Urea (N:46%)	50	1.35	0.135	0.378
	DAP (P:46%, N:18%)	50	0.2	0.017	0.042
	Potash (K:60%)	50	0.15	0.016	0.041
	Total	150	1.7	0.186	0.461
Pesticides	Insecticides	1.5	4.65	0.007	0.016
	Fungicides	1.5	4.65	0.044	0.110
	Total	3	4.65	0.051	0.126

*Values taken from Lal, 2004

Table 6. GHG emissions from oil extraction.

Activity	Diesel consumption per 500 kg fruit (Liter)	Fruit Production Per Acre (Kg)	Emission per Liter (KgCO ₂ /L)	Annual Emissions per Acre (tonCO ₂ eq)	Annual Emissions per ha (tonCO ₂ eq)
Oil extraction	6	3000	2.7	0.097	0.24

6. Net Carbon balance

Based on the findings, the average carbon sequestration rate of olive groves was estimated at 4.69 t CO₂eq/ha/year, while the total carbon footprint was approximately 0.99 t CO₂eq/ha/year. This results in a net carbon balance of 3.70 t CO₂eq/ha/year, indicating that olive cultivation under the studied conditions acts as a net carbon sink.

The net carbon balance can be further improved through the adoption of sustainable management practices, including reduced use of chemical fertilizers and pesticides, minimized soil tillage, promotion of organic inputs, implementation of cover cropping, and incorporation of pruning residues into the soil.

IV – Evaluation of olive cultivation for carbon credit trading in Pakistan

Pakistan is among the countries most vulnerable to climate change and is therefore prioritizing both mitigation and adaptation strategies. Under its Nationally Determined Contributions (NDCs), Pakistan government has committed to GHG emissions by 50% by 2030, of which 15% is unconditional and 35% is conditional upon international financial support.

Pakistan's current GHG emissions are estimated at approximately 500 million tons of CO₂ equivalent (CO₂eq) and are projected to rise to nearly 1,600 million tons by 2030. After the energy sector, agriculture is the second-largest contributor, accounting for about 200 million tons of CO₂eq in 2018 (Government of Pakistan, 2021). This highlights the significant potential for emission reduction and carbon sequestration within the agricultural sector.

In response, the Government of Pakistan has developed the "Draft Policy Guidelines for Trading in Carbon Markets" (October 2023), which provide an operational framework for carbon trading. The policy outlines two primary market mechanisms: compliance markets and voluntary carbon markets (VCM). Compliance markets are driven by regulatory requirements at national, regional, or international levels, whereas voluntary markets facilitate the trading of carbon credits on a non-mandatory basis.

Carbon markets function as trading systems where carbon credits are bought and sold, with each credit representing one ton of CO₂ (or its equivalent in other greenhouse gases) that has been reduced, avoided, or sequestered.

The international compliance carbon market is evolving under Article 6 of the Paris Agreement, which enables countries to cooperate in achieving their NDC targets through carbon trading mechanisms. Article 6 establishes rules for the generation, verification, and transfer of carbon credits, while ensuring environmental integrity and preventing double counting through corresponding adjustments. Following agreements reached at COP26, international standards for these markets have been further strengthened. Several countries have expressed interest in entering bilateral agreements with Pakistan to purchase carbon credits under this framework.

In parallel, VCM operates independently of regulatory obligations and allows entities, including private companies, governments, and non-governmental organizations, to purchase carbon credits to offset their emissions. The global value of the voluntary carbon market reached approximately USD 2 billion in 2021-2022 and is projected to grow significantly, potentially reaching USD 40 billion by 2030, driven by increasing demand for corporate climate commitments. The recently developed policy guidelines also define eligibility criteria for participation in compliance carbon markets. These criteria are evaluated in relation to olive-based carbon projects in the following section (Table 7).

Table 7. Olive cultivation eligibility assessment for carbon credits.

Eligibility criteria	Applicability in olive culture
The potential projects must be aligned with Pakistan's NDC priorities.	Olive cultivation falls under the Agriculture Sector which is included in Pakistan's NDC.
Compliance with Cooperative Approaches of the Paris Agreement: these include the specifications for the carbon credits to be real, verified, and additional; authorized for purposes other than NDC; and ensuring safeguards. This alignment is essential to ensure environmental integrity, safeguards, and restrictions on the transfer of carbon credits or mitigation outcomes.	The potential credits from olive plantations are real and can be easily verified through analysis of before and after plantations through pictures and satellite imagery. Olive credits are additional as it is not a business-as-usual case in Pakistan. Olive cultivation has positive environmental impacts and thus fulfills environmental integrity criteria.
Adherence to Article 6, Paragraph 4: these include the activity designed to ensure mitigation and adaptation co-benefits/ economic diversification that does not lead to an increase in global emissions; deliver real, measurable, and long-term benefits; minimize the risk of non-performance over multiple NDC periods; minimize the risk of leakage; ensure environment and social safeguards.	Olive culture ensures mitigation and adaptation co-benefits, leads to economic diversification in the real terms, and does not increase emissions. Olive trees having a long life (more than 100 years) have a high likelihood of permanence of carbon credits. There is no risk of leakage as olive cultivation does not affect deforestation or shifting of emissions to other places.
Preferential authorization for shorter crediting periods	Olive plantations can start generating carbon credits in 3-4 years.
Promotion of nature-based Carbon projects	Olive cultivation is the best case for nature projects of carbon credits

1. Eligibility criteria under the VCM

Olive plantations meet the key eligibility criteria for participation in VCM. Several internationally recognized standards operate within the VCM, including the Verified Carbon Standard (VCS), Gold Standard (GS), Climate, Community and Biodiversity Standards (CCB), and Plan Vivo Standard. Among these, the VCS, administered by Verra, is the most widely used global carbon crediting program. It provides a robust framework to ensure the quality, transparency, and integrity of carbon reduction and sequestration projects. Projects certified under this standard are issued Verified Carbon Units (VCUs), each representing one ton of CO₂ equivalent reduced or sequestered.

Olive plantation projects are eligible under the Afforestation, Reforestation, and Revegetation (ARR) category within the Agriculture, Forestry, and Other Land Use (AFOLU) sector of the VCS. These project types focus on increasing carbon stocks through the establishment and management of tree-based systems, making olive groves particularly suitable candidates. The specific VCS project requirements and their applicability to olive plantation systems are summarized in Table 8.

Table 8. Verified Carbon Standard project requirements and applicability to olive plantations.

Requirement	Applicability to olive plantations
There are currently six AFOLU project categories eligible under the VCS Program: Afforestation, Reforestation and Revegetation (ARR), Agricultural Land Management (ALM), Improved Forest Management (IFM), Reduced Emissions from Deforestation and Degradation (REDD), Avoided Conversion of Grasslands and Shrublands (ACoGS), and Wetland Restoration and Conservation (WRC).	The olive plantations fulfill the ARR Category requirement.
Where an implementation partner is acting in partnership with the project proponent, the implementation partner shall be identified in the project description. The implementation partner shall identify its roles and responsibilities concerning the project, including but not limited to implementation, management, and monitoring of the project, over the project crediting period.	Olive cultivation involves implementation partners, <i>i.e.</i> local landholders who will act in partnership with the project proponent. The roles and responsibilities of these partners will be properly identified.
Activities that convert native ecosystems to generate GHG credits are not eligible under the VCS Program. Evidence shall be provided in the project description that any project areas were not cleared of native ecosystems to create GHG credits (<i>e.g.</i>, evidence indicating that clearing occurred due to natural disasters such as hurricanes or floods). Such proof is not required where such clearing or conversion took place at least 10 years before the proposed project start date. The onus is upon the project proponent to demonstrate this, failing which the project shall not be eligible.	Olive cultivation does not include activity that converts native ecosystems. The olive plantation areas have not been cleared of native ecosystems in the past 10 years. The GIS/RS-based assessment of historical land use/land cover change will be required to assess land use change.
Eligible ARR activities are those that increase carbon sequestration, and/or reduce GHG emissions by establishing, increasing, or restoring vegetative cover (forest or non-forest) through the planting, sowing, or human-assisted natural regeneration of woody vegetation. Eligible ARR projects may include timber harvesting in their management plan. The project area shall not be cleared of native ecosystems within the 10 years prior to the project's start.	As olive plantation increases carbon sequestration, hence fulfill the ARR requirements. Timber harvesting will also be included in the olive project plan. The project areas will not include areas that have been cleared of native ecosystems in the past 10 years.
Scale: projects should have reasonable scales to be financially viable	There is a need to establish cooperatives/associations of olive growers and prepare carbon projects nesting several farmers together to fulfill the scale criterion.

V – Recommendations for developing a policy framework to valorize olive production as a climate change mitigation strategy

Promoting olive cultivation as a climate change mitigation strategy and integrating it into carbon markets in Pakistan requires a comprehensive and coordinated policy framework. This framework should encompass sustainable agricultural practices, integration into carbon trading mechanisms, awareness and capacity building, private sector engagement, institutional linkages, and the establishment of a robust Measurement, Reporting, and Verification (MRV) system.

1. Promoting sustainable farming practices for carbon sequestration in olive groves

- Encourage agroforestry systems by integrating olive trees with compatible crops and species to enhance carbon sequestration and biodiversity.
- Promote climate-resilient olive varieties adapted to local conditions, particularly under increasing drought stress. The “crop per drop” approach should be emphasized to maximize water-use efficiency and productivity.
- Adopt optimal planting density. A standard spacing of 20x20 ft (6x6 m), equivalent to 109 plants per acre or 269 plants per hectare, is recommended, with flexibility based on site-specific conditions.
- Implement efficient irrigation systems such as drip irrigation and rainwater harvesting to optimize water use and enhance biomass production.
- Maintain proper canopy structure through regular pruning to improve growth and productivity.
- Improve soil management through the use of cover crops (especially legumes) and incorporation of residues as green manure to enhance soil organic carbon and reduce erosion.
- Incorporate pruning residues into the soil to improve fertility and carbon storage.
- Reduce reliance on chemical fertilizers by promoting organic inputs such as compost and manure.
- Encourage integrated pest management and the use of plant-based pesticides to minimize chemical inputs.
- Promote organic farming practices in olive cultivation.
- Expand the use of solar-powered irrigation systems to eliminate emissions from diesel and electricity use.
- Promote renewable energy solutions, including solar-powered oil extraction units.

2. Integration of olive-based carbon projects into carbon trading policy

- Recognize olive cultivation as a priority sector for carbon sequestration within national carbon trading policies and NDC targets.
- Prioritize olive-based carbon projects due to their long lifespan and high carbon sequestration potential.

- Conduct detailed feasibility studies to assess the viability of olive carbon projects under both voluntary markets and compliance mechanisms (e.g., Article 6 of the Paris Agreement).
- Provide financial incentives (e.g., soft loans, subsidies, and credit facilities) to encourage farmers to adopt carbon-oriented olive farming practices.
- Facilitate private sector participation through incentives and supportive regulatory frameworks.
- Simplify procedures for project registration, certification, and issuance of No Objection Certificates (NOCs) to reduce barriers for growers.

3. Awareness raising

- Implement nationwide awareness campaigns targeting farmers, processors, policymakers, and the general public on the environmental and economic benefits of olive cultivation.
- Utilize print, electronic, and digital media platforms to disseminate information.
- Promote participation in carbon farming initiatives, enabling farmers to generate income through carbon credit schemes.

4. Capacity building

- Develop and deliver targeted training programs for farmers, extension workers, and government officials on carbon accounting, project development, and carbon market mechanisms.
- Key training areas should include carbon stock measurement, GHG accounting, project documentation, MRV systems, and carbon credit marketing.
- Strengthen institutional capacity to support certification, validation, and verification of carbon projects at both voluntary and compliance levels.
- Establish dedicated units within provincial agriculture departments to support the development and implementation of olive carbon projects.

5. Formation of olive grower cooperatives and clusters

- Organize smallholder farmers into cooperatives, associations, or clusters to overcome financial and technical barriers associated with carbon project development.
- Promote aggregation (“nesting”) of multiple farms into single carbon projects at district or sub-district levels to achieve economies of scale and reduce transaction costs.
- Ensure legal registration and institutional support for such farmer organizations to facilitate participation in carbon markets.

6. Private sector engagement

- Encourage private sector participation as investors, intermediaries, and buyers within carbon markets.

- Promote public-private partnerships for the development and financing of olive carbon projects.
- Raise awareness among investors about the economic potential of olive-based carbon credits as a sustainable investment opportunity.

7. Strengthening institutional linkages

- Develop and strengthen the Agricultural Knowledge and Innovation System (AKIS) to enhance knowledge exchange, innovation, and technology adoption in olive cultivation.
- Foster collaboration with national and international organizations working in climate change mitigation, sustainable agriculture, and carbon markets.
- Enhance coordination among key institutions, including the Ministry of National Food Security and Research (MNFSR), the Ministry of Climate Change (MoCC), provincial agriculture and forestry departments, and ongoing olive development initiatives.
- Establish linkages with international carbon standards and certification bodies to facilitate market access for olive carbon credits.

8. Establishment of a Measurement, Reporting and Verification (MRV) system

- Develop a dedicated MRV framework tailored to olive-based carbon projects.
- Integrate this system within national institutions (e.g., MNFSR) and link it with provincial systems and the National Carbon Registry under MoCC.
- Establish standardized carbon accounting protocols aligned with international methodologies.
- Ensure that carbon credits meet key quality criteria: real, measurable, additional, permanent, and free from double counting.
- Conduct comprehensive national-level studies on GHG accounting and carbon credit potential in olive cultivation.
- Expand future carbon accounting to include all carbon pools: above-ground biomass, below-ground biomass, litter, deadwood, and soil organic carbon.
- Develop locally calibrated allometric equations for more accurate biomass estimation.
- Apply standardized LCA approaches (e.g., using SimaPro software) to evaluate environmental impacts (Annex II).

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Annexes

Annex I

Data collection form

Olive carbon sequestration and footprint

Location:

Name of grower:

X: _____ Y: _____ Elevation: _____

Area under olive orchard (in acres): _____

Date of plantation: _____

Survival %: _____

Source of irrigation: _____

Spacing: _____

Intercropping: _____

Landuse before olive: _____

Crops grown before olive: _____

Ploughing done before planting: Yes _____ No _____

If yes, then mention tractor hours per acre: _____

Fertilizer use (per year): Name of fertilizer _____

Dose per plant per year: _____ or Dose per acre per year: _____

Pesticides use (per year): Name of Pesticide _____

Dose per plant per year: _____ or Dose per acre per year: _____

Yield of fruits per plant: _____ Yield of fruits per acre: _____

Yield of oil per plant: _____ Yield of oil per acre: _____

Oil extraction machine is run on: a) Electricity _____ b) Diesel _____ c) Petrol _____

Fuel consumption per kg oil: a) Electricity units _____ b) Diesel _____ c) Petrol _____

Tree N°	Variety	Shoot/Stem N°	Diameter at base (cm)	DBH (cm)	Height (m)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Annex II

Life cycle assessment method for environmental impacts assessment of olive culture using the Simapro software

The suggested tool for environmental assessment of the oil supply chain is SimaPro software, and it could be a future supplement and implementation of the methodology given under Section II-2 for the measurement of some environmental indicators, not only related to CO₂ emission, to go along with the calculation of carbon storage capacity. Starting from the calculation of CO₂ emission, the amount of CO₂ the tree can store would be subtracted from this, resulting in the actual amount of CO₂ emitted into the atmosphere.

As reported at Section II-2, the main objective is to carry out an initial assessment and quantification of the environmental impact associated with olive cultivation and oil production in Pakistan, to be conducted with the LCA or life cycle analysis, in accordance with the guidelines of ISO 14040. The specific objectives are as follows:

- **Quantify environmental impact:** measure and assess the environmental effects of the oil supply chain considering the main impact categories such as GHG emissions and land use.
- **Identify key factors:** key environmental impact factors include fertilizer and pesticide use, fuel and irrigation water consumption, and yield for each type of legume.
- **Recommendations for improvement:** provide recommendations or information on sustainable practices or interventions that can help reduce the environmental impact associated with oil production in the target context.

The functional unit (FU) in LCA is the object of the assessment; therefore, in the inventory phase of LCA, all inputs used to produce it are considered; it serves as a reference point against which stock inputs and outputs are measured (ISO, 2006). This includes the quantification, based on field data (primary), of chemical inputs, such as agrochemicals and their active ingredients, as well as the fertilizers used, based on the titers and units of fertilizer, the energy consumption associated with the cultivation process, and the amount of water used.

LCA is recognized worldwide as the main tool for assessing the environmental performance of a product or service and provides an in-depth analysis of the environmental impact of a product's life cycle. For this purpose, cultivation data collection is carried out, directly from the producer, through a general description of the farm and data collection field (cultivation method), from which field information on cultivation operations (tillage, planting, fertility management and insect and pathogen control, irrigation, harvesting), as well as an inventory of the capital used in cultivation (machinery, equipment, facilities) are obtained.

The computer program SimaPro is used as a tool for calculating the main environmental impact categories, through which is possible to collect, analyze and monitor data on the environmental performance of products and services. The software enables various applications, such as the calculation of carbon and water footprints, biodiversity, and provides the basis for eco-design of products and environmental product declarations (EPDs).

The impact assessment is done following the EPD method in accordance with ISO 14040 to assess the environmental impacts of olive throughout their life cycle. In addition to the EDP method (2018), environmental assessment was also integrated using Eco-Indicator 99.

Through the combination of these two methods, the following indicators can be calculated:

- **Global warming (GWP100)** - measured in kilograms of carbon dioxide equivalent (kg CO₂eq): this category assesses the potential of greenhouse gas emissions and their contribution to global warming. The higher the indicator, the greater the impact generated on global warming by the production process analyzed.

- **Ozone depletion (ODP)** - measured in kilograms of tri-chloro fluoro methane equivalent (kg CFC-11 eq): this category assesses the potential of substances to deplete the ozone layer. The higher the indicator, the greater the potential of inputs used in the ozone depletion phenomenon.
- **Photochemical oxidation** - measured in kilograms of ethylene equivalent (kg C₂H₄eq): this category assesses the potential of substances to contribute to photochemical smog formation. The higher the indicator, the greater the potential of substances used in the process of photochemical smog formation.
- **Acidification** - measured in kilograms of sulfur dioxide equivalent (kg SO₂eq): this category assesses the potential of substances to cause the formation of acid rain. The higher the indicator, the greater the contribution the substances used have in the process of acid rain formation.
- **Eutrophication** - measured in kilograms of phosphate equivalent (kg PO₄eq): this category assesses the potential of substances to cause nutrient enrichment and eutrophication of water bodies. The higher the indicator, the greater the negative impact the substances used have in the process of eutrophication of water bodies.
- **Abiotic depletion, fossil fuels/components** - measured in megajoule equivalent (MJ eq) for fossil fuels, and in kilograms of antimony (kg Sb eq) for components: this category assesses the consumption of nonrenewable fossil resources as well as non-fossil naturally occurring elements. The higher the indicator, the greater the negative contribution the substances used have in the abiotic depletion process.
- **Water resource scarcity** - measured in cubic meters equivalent (m³ eq): this category, which is based on the AWARE Method, represents the amount of available water that remains per area in a watershed after demand from humans and aquatic ecosystems has been met. The higher the indicator, the more water is removed from the available watershed.
- **Land use** - measured in terms of damage, as a result of land conversion or land occupation and expressed as fraction potentially disappearing (PDF) *m²*year/m² or m²a. Land use (in anthropogenic systems) has an impact on species diversity. Based on field observations, a scale expressing species diversity by land use type was created. Species diversity depends on land use type and area size.

The inclusion also of Eco-Indicator 99, during the environmental assessment, allowed the grouping of the different indicators, from the impact categories, within 3 damage categories:

1. **Damage to human health** - in which the various disabilities caused by diseases are weighted; these harms are expressed in terms of years of life lost and years of life lived in disability. These data are summarized in Disability Adjusted Life Years (DALY, an index also used by organizations such as the World Bank and WHO. This category includes aspects such as carcinogens, respiratory organics, respiratory inorganics, climate change impacts, radiation, and ozone depletion.
2. **Damage to ecosystem quality** - this is the loss of species in each area over a given period (PDF*m²yr). This category includes elements such as ecotoxicity, acidification/eutrophication, and land use impacts.
3. **Damage against resources** - this is the excess energy required to compensate for future extraction of minerals and fossil fuels (MJ surplus energy requirement to compensate for lower future ore grade). This category includes impacts related to the depletion of minerals and fossil fuels (Cardone *et al.*, 2018).

Toward responsible olive tourism in Pakistan: Potential assessment and participatory planning*

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Abstract. Olive cultivation in Pakistan is emerging as a multidimensional driver of sustainable rural development, combining economic growth, environmental conservation, and cultural valorization. The present study explores the potential of olive-based tourism as an innovative approach capable of linking olive production with local traditions, gastronomy, landscapes, biodiversity, and community participation. Drawing on Mediterranean experiences and the rapid expansion of olive plantations in Pakistan, the study highlights how olive tourism can diversify rural incomes, create employment opportunities, promote local products, and strengthen territorial identity. Moreover, it highlights the importance of responsible and participatory tourism models that involve local communities, women, and youth while preserving natural and cultural heritage. The institutional, infrastructural, and policy requirements necessary for developing sustainable olive tourism destinations in Pakistan have been analyzed. By integrating agriculture, culture, and tourism within a common territorial strategy, olive tourism is presented as a promising tool for enhancing rural resilience, encouraging sustainable investment, and supporting long-term socio-economic development in olive-growing regions.

Keywords. Rural development – Cultural heritage – Tourism – Socio-economic development.

Vers un tourisme oléicole responsable au Pakistan : Évaluation du potentiel et planification participative

Résumé. L'oléiculture au Pakistan s'affirme progressivement comme un moteur multidimensionnel du développement rural durable, combinant croissance économique, préservation de l'environnement et valorisation culturelle. La présente étude explore le potentiel du tourisme oléicole comme approche innovante capable de relier la production oléicole aux traditions locales, à la gastronomie, aux paysages, à la biodiversité et à la participation communautaire. S'inspirant des expériences méditerranéennes et de l'expansion rapide des plantations d'oliviers au Pakistan, l'étude met en évidence la manière dont le tourisme oléicole peut diversifier les revenus ruraux, créer des opportunités d'emploi, promouvoir les produits locaux et renforcer l'identité territoriale. Elle souligne également l'importance des modèles de tourisme responsables et participatifs impliquant les communautés locales, les femmes et les jeunes, tout en préservant le patrimoine naturel et culturel. Les exigences institutionnelles, infrastructurelles et politiques nécessaires au développement de destinations de tourisme oléicole durable au Pakistan sont également discutées. En intégrant agriculture, culture et tourisme dans une stratégie territoriale commune, le tourisme oléicole apparaît comme un outil prometteur pour renforcer la résilience rurale, encourager les investissements durables et soutenir le développement socio-économique à long terme des régions oléicoles.

Mots-clés. Développement rural – Patrimoine culturel – Tourisme – Développement socioéconomique.

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I – Introduction

Olive cultivation is emerging as a promising component of rural development in Pakistan, particularly in regions characterized by rich natural landscapes, cultural heritage, traditional lifestyles, and strong community identity. Beyond its agricultural and economic value, the olive sector offers opportunities for the diversification of rural livelihoods through the promotion of sustainable and responsible tourism linked to olive-growing areas.

Olive tourism, also referred to as olive oil tourism or olive oil cultural tourism, represents a form of rural tourism centered on olive cultivation, olive oil production, local gastronomy, and the cultural landscapes associated with olive-growing regions. Such tourism initiatives may include visits to olive groves and olive mills, olive harvesting experiences, tasting sessions, local food experiences, handicrafts, cultural activities, and interaction with local communities. Beyond its economic value, olive tourism also contributes to the preservation of rural traditions, local heritage, and agricultural landscapes. In many Mediterranean countries, olive oil tourism has evolved into an important tool for local development, combining agriculture, gastronomy, culture, nature, and heritage into integrated tourism experiences that strengthen local economies while preserving cultural and environmental resources.

In Pakistan, several olive-growing regions possess significant potential for the development of community-based tourism initiatives. These areas are often characterized by scenic landscapes, traditional architecture, local crafts, music, cuisine, archaeological sites, and living cultural traditions that can enrich visitors' experiences and generate additional income opportunities for rural communities. The integration of olive cultivation with tourism activities, therefore, represents an innovative approach to enhancing the olive value chain while promoting inclusive and sustainable rural development.

Simultaneously, increasing awareness has emerged regarding the risks associated with uncontrolled tourism development, particularly in environmentally and culturally sensitive areas. Rapid globalization, changing lifestyles, and external cultural influences may threaten local traditions, cultural identity, and natural heritage if tourism is not properly managed. For this reason, the principles of responsible, participatory, and sustainable tourism are essential to ensure that tourism development contributes positively to local communities while safeguarding environmental and cultural resources for future generations.

Within this context, the concept of "Olive Oil Roads," successfully implemented in several Mediterranean countries, offers a valuable reference model for Pakistan. These tourism itineraries connect olive farms, mills, local food production, handicrafts, cultural attractions, festivals, and natural sites into integrated visitor experiences that highlight territorial identity and local excellence. Such approaches also align with contemporary community-led rural development models that emphasize stakeholder participation, local entrepreneurship, women and youth engagement, and the multifunctionality of agriculture.

Therefore, the main goal of the present study was to explore the potential of olive oil tourism in Pakistan and propose a framework for the development of a responsible participatory tourism strategy linked to olive-growing regions. Moreover, it aims to assess the tourism potential associated with olive landscapes and local heritage resources, identify opportunities and challenges for community involvement, and outline strategic directions for the development of

sustainable tourism initiatives that can support rural livelihoods, strengthen the olive value chain, and promote the conservation of cultural and natural heritage. Particular attention is given to the adaptation of international good practices, especially the Mediterranean experience of “Olive Oil Roads,” to the Pakistani context. The proposed approach emphasizes stakeholder participation, local capacity building, responsible resource management, cultural preservation, and the creation of authentic tourism experiences capable of generating long-term social, economic, and environmental benefits for local communities.

II – Methodology and approach

The methodological approach adopted for this study was designed to assess the potential of olive-growing regions for the development of responsible and participatory tourism initiatives in Pakistan. The study combined desk-based research, field investigations, stakeholder consultations, and the analysis of international good practices in sustainable rural tourism.

The work was carried out in close coordination with relevant stakeholders from the public and private sectors, local communities, civil society organizations, and tourism service providers to ensure a participatory and context-specific planning process (Annex I).

1. Desk review and preliminary assessment

The study commenced with a comprehensive review of available literature, reports, policy documents, and secondary data related to olive cultivation, rural development, sustainable tourism, and community-based tourism practices in Pakistan and Mediterranean countries. Particular attention was given to international experiences related to “Olive Oil Roads” and integrated rural tourism models.

Based on this preliminary assessment, potential olive-growing regions with tourism value were identified for further investigation. The selection considered factors such as landscape quality, accessibility, cultural and historical significance, local traditions, existing tourism activities, and the presence of olive-related production systems.

2. Field surveys and site assessments

Field visits were conducted in selected olive-growing areas to evaluate their suitability for the development of olive oil tourism initiatives. The surveys focused on documenting the environmental, cultural, and socio-economic characteristics of the sites, as well as the availability of tourism-related infrastructure and services.

3. Stakeholder consultations

A participatory approach was adopted throughout the study through consultations with a wide range of stakeholders, including local farmers, community leaders, women and youth groups, tourism operators, local entrepreneurs, civil society organizations, academic institutions, and public authorities. The consultations aimed to:

- Understand local perceptions, expectations, and concerns regarding tourism development;

- Identify opportunities for community participation and entrepreneurship;
- Assess existing capacities and training needs;
- Explore mechanisms for stakeholder collaboration and benefit-sharing;
- Ensure that the proposed tourism model reflects local priorities and socio-cultural realities.

This participatory process contributed to strengthening local ownership and ensuring that the proposed initiatives align with principles of responsible and sustainable tourism.

III – Development of the Responsible Participatory Tourism Framework

Based on the findings of the desk review, field surveys, and stakeholder consultations, a Responsible Participatory Tourism Framework was developed for olive-growing regions in Pakistan. The framework integrates international good practices with local conditions and focuses on sustainable rural development, environmental conservation, cultural preservation, and inclusive community participation. The methodology therefore combined analytical assessment with participatory planning to develop a practical and locally adaptable approach for promoting olive oil tourism as a tool for sustainable rural development in Pakistan.

IV – Selection of high-potential areas for olive tourism

To assess the potential for olive oil tourism in Pakistan, a combination of desk-based research and field surveys was undertaken in selected olive-growing regions. The assessment focused on identifying areas where olive cultivation could be integrated with tourism-related activities in a sustainable and community-oriented manner.

The analysis considered not only the presence of olive production, but also the broader territorial characteristics that could contribute to the development of attractive rural tourism experiences. These included natural landscapes, cultural and historical heritage, traditional lifestyles, local gastronomy, handicrafts, and the availability of tourism infrastructure and services.

An inventory of tourism assets and visitor activities associated with selected olive-growing areas was prepared as part of the assessment process. To support the identification of the most suitable locations, a standardized evaluation framework was developed based on a set of environmental, socio-cultural, and infrastructural criteria. The assessment considered several key factors, including:

- Accessibility and connectivity to major transportation routes;
- Availability of accommodation and hospitality facilities;
- Safety and security conditions;
- Existing tourism flows and visitor interest;
- Presence of natural, cultural, historical, and archaeological attractions;
- Opportunities for community participation and local entrepreneurship;
- Availability of complementary services and tourism-related infrastructure.

Based on this evaluation, five areas were identified as having particularly strong potential for the initial development of olive oil tourism initiatives (Table 1). These areas demonstrate favorable conditions for integrating olive cultivation with sustainable rural tourism experiences and may serve as pilot destinations for the future establishment of thematic “Olive Oil Roads” in Pakistan. A map showing the geographical location of the selected sites is provided in Annex II.

V – Assessment of potential sites for olive tourism

The resource base for tourism consists of the natural, cultural, and social environment that together form the foundation of tourism products and visitor experiences. The sustainable use of these resources is essential for supporting local livelihoods and promoting responsible tourism development.

To better understand the tourism potential of the five selected areas, an assessment was conducted focusing on their main tourist attractions, environmental and cultural features, and possible tourism-related activities. Consultations were also held with local communities, tour operators, and tour guides to identify existing opportunities and potential visitor experiences associated with olive-growing areas.

The following tables (Table 2-11) and figures (Figure 1-5) summarizes the key physical, cultural, and biological features of the selected sites and presents a list of potential tourism activities that could be developed within the framework of olive tourism.

Table 1. Selected olive-growing areas with potential for tourism development.

Site	Area/District and Province	Assessment Ranking	Remarks
1	Lower Swat, Khyber Pakhtunkhwa	Excellent (10/10)	Lower Swat possesses significant potential for olive tourism due to its rich natural landscapes, cultural heritage, and established tourism profile. The presence of archaeological sites from the Gandhara civilization further enhances its attractiveness for both domestic and international visitors. Wild olive populations and expanding olive orchards are found in several locations. The area is well connected by road and offers adequate accommodation facilities in nearby towns. Tourism activities are concentrated mainly during summer, although visitor flows continue during winter. The area offers strong potential for the development of integrated olive tourism experiences linked with cultural, archaeological, and recreational tourism.
2	Lower Chitral, Khyber Pakhtunkhwa	Very Good (9/10)	Lower Chitral is characterized by outstanding natural scenery and a rich cultural environment. The traditional culture and lifestyle of the Kalasha communities constitute an important attraction for visitors. The area contains wild olive sites and newly established olive orchards. Accessibility by road is generally adequate, while Chitral is also connected by air to Islamabad and Peshawar. Boarding and lodging facilities of moderate standard are available. Tourism activity is concentrated during summer, whereas winter tourism remains limited because of severe weather conditions and restricted accessibility. The area demonstrates good potential for the development of olive tourism products for both domestic and foreign visitors.
3	Upper Dir, Khyber Pakhtunkhwa	Good (8/10)	Upper Dir offers potential for nature-based and rural tourism, particularly in areas such as Kumrat Valley, known for its mountain landscapes and traditional rural lifestyle. Wild olive stands and expanding olive plantations are present in several locations. The area is accessible, although tourism infrastructure and accommodation facilities remain limited. Trekking routes connecting Upper Dir with Chitral and Swat add recreational value to the region. Tourism activity is largely seasonal, with peak visitation occurring during summer. Due to current security considerations and limited infrastructure, the area is presently more suitable for domestic tourism.
4	Chakwal, Punjab	Excellent (10/10)	Chakwal District, located in the Potohar region, demonstrates high potential for olive tourism due to its accessibility, tourism infrastructure, and expanding olive cultivation. The region combines natural attractions with cultural and rural tourism assets, while olive plantations are increasingly integrated into the landscape. Several olive farms are easily accessible through the motorway network. The government of Punjab has declared the Potohar region as "Olive Valley" and around 1.2 million olive trees have been planted in orchards over 8000 acres. The area also hosts an olive research center, which may support educational and technical tourism activities. Kallar Kahar serves as a central tourism hub with accommodation and visitor services. Due to its accessibility and year-round tourism potential, the area is considered highly suitable for the development of olive tourism initiatives targeting both domestic and international markets.
5	Musakhel, Balochistan	Good (7/10)	Musakhel possesses potential for the development of rural and olive-related tourism due to the presence of wild olive groves and increasing olive cultivation activities. The area is accessible through southern Punjab and nearby hill destinations such as Fort Munro, which already attracts domestic tourists during summer. Tourism infrastructure within Musakhel remains limited, particularly regarding accommodation and visitor facilities; however, the area can be visited through short excursions from nearby tourism centers. At present, the region is considered more appropriate for domestic tourism because of security and accessibility constraints.

Table 2. Lower Swat Valley, Khyber Pakhtunkhwa Province.

Aspect	Description			
Short description of the area	Lower Swat Valley is one of the most established tourist destinations in Pakistan and possesses significant natural, cultural, and archaeological value. The area is characterized by mountain landscapes, rivers, forests, alpine pastures, and traditional rural settlements. The presence of important Gandhara and Buddhist archaeological sites enhances its attractiveness for both domestic and international tourism. The valley also contains wild olive populations and increasing olive plantations. In addition, the area is well known for the production of fruits such as apples, peaches, persimmons, and pomegranates. The combination of olive cultivation, natural scenery, and cultural heritage provides strong potential for the development of olive tourism products.			
Accessibility	Lower Swat Valley is easily accessible from Islamabad and Peshawar through the motorway network, with an approximate travel time of 2-3 hours. The region is connected to the rest of the country through Malakand Pass, Karakar Pass, and Shangla Pass. Public transportation services are also available. Tourism activity peaks during the summer season, although visitor flows continue during winter.			
Boarding and lodging facilities	Saidu Sharif, Mingora, and surrounding areas offer a range of accommodation facilities, including hotels and guest houses of different categories. While a limited number of hotels provide good-quality services, many accommodation facilities are of moderate standard and require improvements in infrastructure, hygiene, and overall visitor services.			
Key elements of the destination				
Outstanding features	physical			
	<table> <tr> <th>Main features</th><th>Potential tourism activities</th></tr> <tr> <td> – Mountain landscapes and valleys – Alpine pastures, forests, rivers, and streams – Scenic rural environment – Natural forests and alpine ecosystems – Wild herbs, mushrooms, wildflowers, and medicinal plants – Wildlife species including leopard, fox, wolf, snow cock, rock partridge, and other birds – Fruit orchards, olive groves, and wild olive stands – Agricultural landscapes </td><td> – Trekking and camping – Landscape photography – Horseback riding – Nature-based recreation – Birdwatching and wildlife observation – Nature photography – Exploration of medicinal plants and wild flora – Visits to olive orchards and olive mills – Participation in olive harvesting and related agricultural activities </td></tr> </table>	Main features	Potential tourism activities	– Mountain landscapes and valleys – Alpine pastures, forests, rivers, and streams – Scenic rural environment – Natural forests and alpine ecosystems – Wild herbs, mushrooms, wildflowers, and medicinal plants – Wildlife species including leopard, fox, wolf, snow cock, rock partridge, and other birds – Fruit orchards, olive groves, and wild olive stands – Agricultural landscapes
Main features	Potential tourism activities			
– Mountain landscapes and valleys – Alpine pastures, forests, rivers, and streams – Scenic rural environment – Natural forests and alpine ecosystems – Wild herbs, mushrooms, wildflowers, and medicinal plants – Wildlife species including leopard, fox, wolf, snow cock, rock partridge, and other birds – Fruit orchards, olive groves, and wild olive stands – Agricultural landscapes	– Trekking and camping – Landscape photography – Horseback riding – Nature-based recreation – Birdwatching and wildlife observation – Nature photography – Exploration of medicinal plants and wild flora – Visits to olive orchards and olive mills – Participation in olive harvesting and related agricultural activities			
Outstanding features	biological			
	<table> <tr> <th>Main features</th><th>Potential tourism activities</th></tr> <tr> <td> – Traditional rural lifestyle and local hospitality – Local cuisine and handicrafts – Gandhara and Buddhist archaeological heritage, including Bazira, Amluk Dara, Gumbat Stupa, Udegram, Shingardar Stupa, Butkara Stupa, and Swat Museum – Historical contribution of the Italian Archaeological Mission in the preservation of Swat heritage </td><td> – Village tours – Cultural and archaeological visits – Handicraft and local product experiences – Traditional homestays – Cultural photography and heritage interpretation </td></tr> </table>	Main features	Potential tourism activities	– Traditional rural lifestyle and local hospitality – Local cuisine and handicrafts – Gandhara and Buddhist archaeological heritage, including Bazira, Amluk Dara, Gumbat Stupa, Udegram, Shingardar Stupa, Butkara Stupa, and Swat Museum – Historical contribution of the Italian Archaeological Mission in the preservation of Swat heritage
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Outstanding features	cultural			

Table 3. Rapid assessment checklist – Lower Swat.

Features	Overall Grading in Various Segments					Remarks
	Excellent	Good	Satisfactory	Poor	NA	
Tourist attractions						
Landscape beauty	X					
Historical/archaeological sites	X					
Local people culture	X					
Sites of religious significance	X					
Folk music, dance and art		X				
Natural attractions/Olive groves	X					
Wildlife sighting			X			
Accessibility						
Accessibility by air				X		Suspended
Accessibility by road		X				
Accessibility by train					X	
Local road network			X			
Availability of public transport		X				
Boarding lodging facilities for tourists						
Availability of hotel accommodation		X				
Availability of rest houses (governmental)			X			
Availability of community guest houses					X	
Availability of camping sites				X		
Availability of restaurants		X				
Availability of local traditional food		X				
Safety and security for visitors			X			
Medical and health facilities		X				
Telecom facilities		X				
Existing tourist domestic flow		X				
Existing foreign tourist flow			X			4000 in 2023; Slowly Improving
Potential for developing as an olive tourism destination	X					

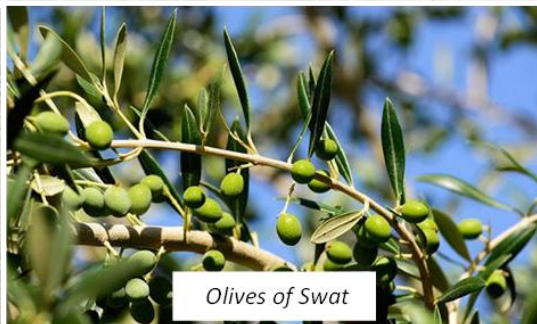
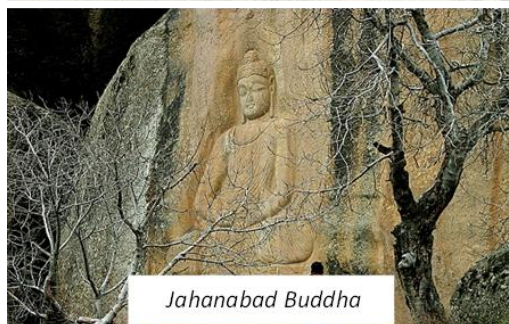
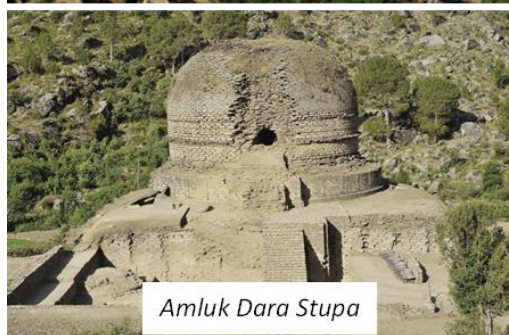
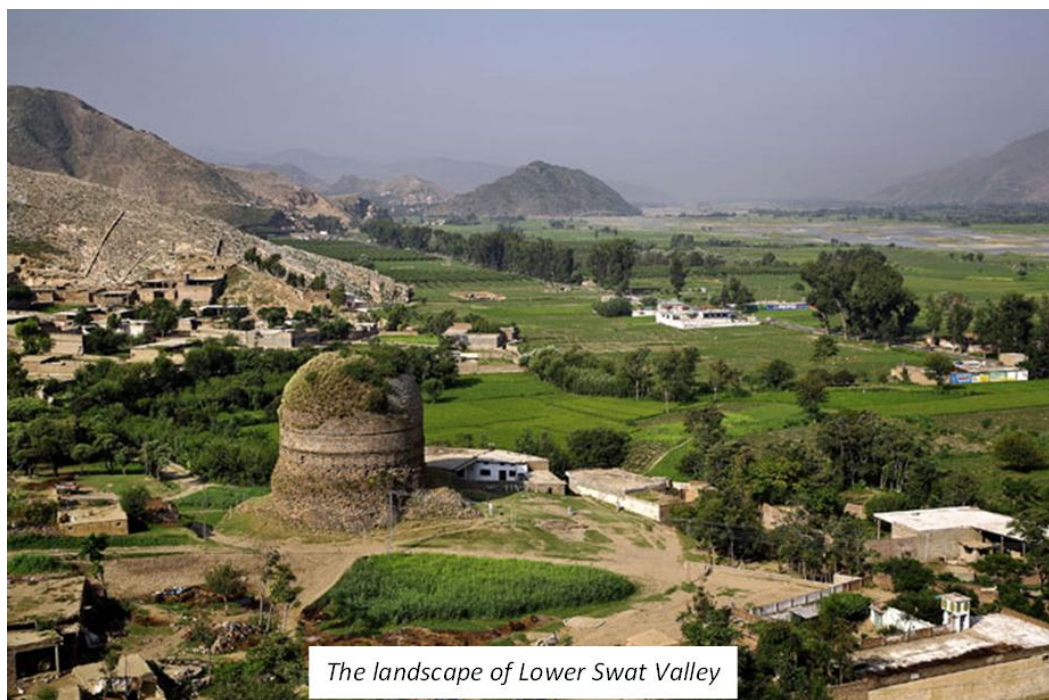


Figure 1. Natural landscapes, Buddhist heritage, and olive resources of Lower Swat Valley.

Table 4. Lower Chitral, Khyber Pakhtunkhwa Province.

Aspect	Description	
Short description of the area	Lower Chitral is a well-known tourist destination characterized by outstanding mountain landscapes, rich cultural heritage, and traditional rural lifestyles. The unique culture and traditions of the Kalasha communities represent one of the main attractions of the area. The region is recognized for its handicrafts, gemstones, woven carpets, embroidery, and woolen products. Wild olive populations and increasing olive plantations are found in several locations. In addition, the valley is rich in fruit orchards producing peaches, apricots, apples, grapes, and damsons. The combination of natural beauty, cultural heritage, and olive cultivation provides good potential for the development of olive tourism products for both domestic and international visitors.	
Accessibility	Lower Chitral is accessible from Islamabad and Peshawar through Malakand, Dir, and the Lawari Tunnel, with an approximate travel time of 10-12 hours by road. The area is also connected with Gilgit-Baltistan through Shandur Pass. Public transport services operate regularly from Peshawar, Mardan, Dir, and Swat, while private bus services are also available from Islamabad. Chitral is additionally connected by domestic flights from Islamabad and Peshawar, subject to weather conditions. Summer is the main tourism season, whereas winter tourism remains limited because of harsh weather and difficult accessibility. Seasonal Kalasha festivals significantly influence tourist flows throughout the year.	
Boarding and lodging facilities	Chitral town offers approximately 30 hotels and guest houses with varying standards of accommodation. While several facilities meet acceptable tourism standards, many remain of low to moderate quality. Another concentration of accommodation facilities is located in Bamburit Valley, where a number of small hotels and guest houses provide services primarily for domestic visitors.	
Key elements of the destination	Main features	Potential tourism activities
Outstanding physical features	– Mountain landscapes and valleys – Alpine pastures, forests, rivers, and streams – Scenic rural environment – Alpine ecosystems and natural forests – Wild herbs, mushrooms, medicinal plants, and wildflowers – Wildlife species in Chitral Gol National Park and surrounding mountains, including snow leopard, ibex, markhor, fox, wolf, snow cock, and several bird species – Fruit orchards, walnut trees, and wild and cultivated olive groves – Agricultural landscapes – Kalasha culture and traditional settlements in Bamburit, Bhir, and Rambur valleys – Seasonal Kalasha festivals – Chitrali music, dance, and local traditions – Polo festivals and traditional sports – Traditional rural lifestyle and local cuisine – Historical and heritage sites, including Chitral Fort	– Trekking and camping – Landscape photography – Horseback riding – Nature-based recreation – Trekking to high pastures and mountain passes – Wildlife observation and birdwatching – Nature photography – Study of medicinal plants, butterflies, and gemstones – Visits to olive groves and participation in olive harvesting – Purchasing local handicrafts and agricultural products
Outstanding biological features		
Outstanding cultural features		– Village and cultural tours – Participation in local festivals and cultural events – Photography and heritage interpretation – Visits to handicraft centers and local markets – Traditional homestay experiences – Sightseeing tours of historical sites and museums

Table 5. Rapid assessment checklist – Lower Chitral.

Features	Overall Grading in Various Segments					Remarks
	Excellent	Good	Satisfactory	Poor	NA	
Tourist Attractions						
Landscape beauty	X					
Historical/archaeological sites		X				
Local people culture	X					
Sites of religious significance	X					
Folk music, dance and art	X					
Natural attractions/Olive groves	X					
Wildlife sighting		X				
Accessibility						
Accessibility by air			X			
Accessibility by road		X				
Accessibility by train						
Local road network			X			
Availability of public transport			X			
Boarding lodging facilities for tourists						
Availability of hotel accommodation		X				
Availability of rest houses (governmental)			X			
Availability of community guest houses						
Availability of camping sites				X		
Availability of restaurants			X			
Availability of local traditional food		X				
Safety and security for visitors			X			
Medical and health facilities		X				
Telecom facilities			X			
Existing tourist domestic flow		X				
Existing foreign tourist flow			X			1627 in 2023; Slowly improving
Potential for developing as an olive tourism destination	X					

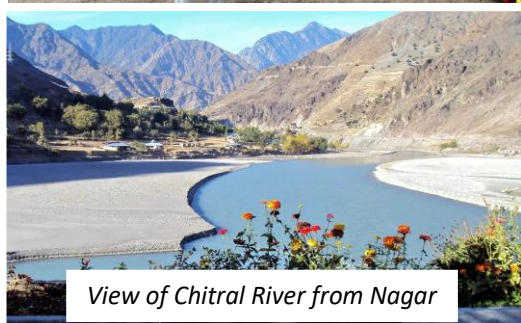


Figure 2. Natural landscapes, cultural heritage, and biodiversity of Lower Chitral Valley.

Table 6. Upper Dir, Khyber Pakhtunkhwa Province.

Aspect	Description
Short description of the area	Upper Dir is recognized for its outstanding mountain scenery, natural landscapes, and the hospitality associated with Pakhtoon culture. Valleys such as Kumrat, Doog Dara, and Ushirai Dara are particularly known for their scenic beauty, forests, rivers, and traditional rural lifestyle. The area contains several wild olive sites and increasing olive plantations. Upper Dir is also connected through trekking routes with Chitral and Upper Swat, adding recreational and adventure tourism value. The natural environment, combined with rural culture and olive cultivation, offers potential for the development of olive tourism products, particularly for domestic tourism.
Accessibility	Upper Dir is accessible from Islamabad and Peshawar through Malakand, Swat, and Chakdara, with an approximate travel time of about five hours. Dir town is connected with other parts of the country through road networks, and public transport services are available from Peshawar, Mardan, and Swat. Several private bus companies also operate services between Dir and major cities of Pakistan. Summer is the main tourist season, while tourism activity during winter remains limited because of harsh weather conditions and heavy snowfall affecting accessibility. Most tourist sites in the area are reasonably accessible by road.
Boarding and lodging facilities	Dir town currently offers a limited number of hotels and guest houses, most of which are of low to moderate standard. Kumrat Valley represents the second main accommodation cluster, where a few better-quality hotels, several small lodges, and camping facilities are available for visitors. Overall, tourism infrastructure and accommodation facilities remain limited in relation to the growing number of tourists visiting the area.
Key elements of the destination	
Outstanding features	physical
	biological
Outstanding features	cultural

Table 7. Rapid Assessment Checklist – Upper Dir.

Features	Excellent	Overall Grading in Various Segments			NA	Remarks
		Good	Satisfactory	Poor		
Tourist Attractions						
Landscape beauty	X					
Historical/archaeological sites				X		
Local people culture		X				
Sites of religious significance		X				
Folk music, dance and art		X				
Natural attractions/Olive Groves	X					
Wildlife sighting		X				
Accessibility						
Accessibility by air					X	
Accessibility by road		X				
Accessibility by train					X	
Local road network			X			
Availability of public transport		X				
Boarding lodging facilities for tourists						
Availability of hotel accommodation			X			
Availability of rest houses (governmental)			X			
Availability of community g-houses					X	
Availability of camping sites				X		
Availability of restaurants			X			
Availability of local traditional food			X			
Safety and security for visitors			X			
Medical and health facilities		X				
Telecom facilities			X			
Existing tourist domestic flow		X				
Existing foreign tourist flow				X		Improving slowly
Potential for developing as an olive tourism destination		X				

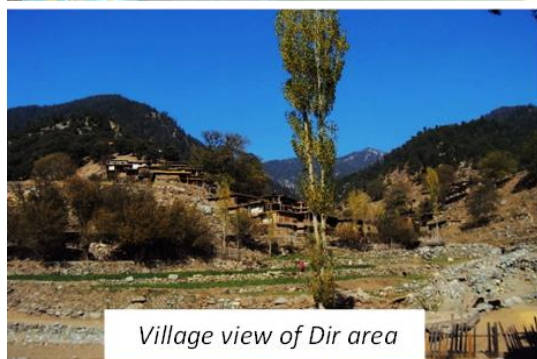
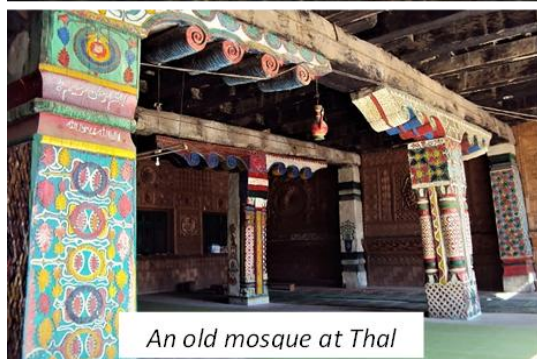
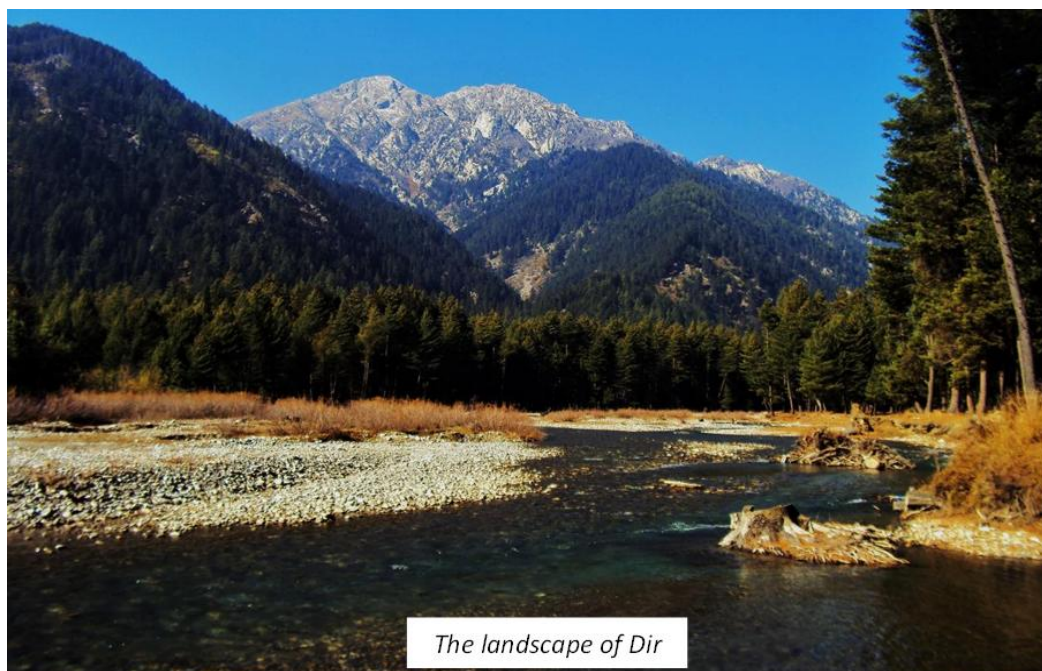


Figure 3. Natural landscapes and cultural heritage of Upper Dir.

Table 8. Chakwal District, Punjab Province.

Aspect	Description	
Short description of the area	Chakwal District, located in the Potohar region of Punjab, possesses significant natural, cultural, and agricultural tourism potential and is already recognized as an important tourist destination. The area is characterized by hilly landscapes, traditional rural settlements, and the distinct Potohari culture and lifestyle. The Potohar region has been promoted as an "Olive Valley," with extensive olive plantations established alongside naturally occurring wild olive stands. The district also hosts the Olive Research Center (CEFORT-BARI Chakwal), which represents an important institutional resource for olive-related activities. The combination of olive cultivation, cultural heritage, natural landscapes, and existing tourism attractions provides strong potential for the development of olive tourism products targeting both domestic and international visitors.	
Accessibility	Chakwal is easily accessible from Islamabad and Lahore through Motorway M-2. Kallar Kahar, one of the main tourism centers in the district, can be reached within approximately two hours from Islamabad and three hours from Lahore. Public transport services are available from Islamabad, Rawalpindi, and Lahore. The area remains accessible throughout the year, although the main tourism season extends from October to April when weather conditions are more favorable. Several olive plantation sites are conveniently located near the motorway network.	
Boarding and lodging facilities	Kallar Kahar serves as the main accommodation and visitor service center within the region. The area offers boarding and lodging facilities of good to moderate standard, including hotels, guest houses, restaurants, and motorway service areas. A motel operated by the Tourism Development Corporation of Punjab (TDCP) is also located near Kallar Kahar Lake.	
Key elements of the destination	Main features	
	Potential tourism activities	
Outstanding physical features	– Hilly landscapes of the Salt Range – Khewra Salt Mines – Salt Range wetland complex and lakes – Natural springs and rural landscapes – Chinji National Park with shrubland and desert ecosystems – Fruit orchards, olive groves, and agricultural fields – Olive research and demonstration facilities at BARI Chakwal	– Trekking and camping – Landscape photography – Horseback riding – Boating, recreational activities – Birdwatching and wildlife observation – Study of wild flora, butterflies, and medicinal plants – Visits to olive groves and participation in olive harvesting – Educational visits
Outstanding biological features	– Subtropical vegetation and shrubland ecosystems – Wildlife species including urial, Bengal fox, golden jackal, Indian wolf, Indian pangolin, bird species – Wetland habitats and agricultural landscapes – Wild olive populations and cultivated olive orchards	– Wildlife observation and birdwatching – Nature photography – Ecological and environmental tours – Visits to orchards and olive farms
Outstanding cultural features	– Potohari culture, music, and traditional rural lifestyle – Seasonal and olive-related festivals – Local cuisine and handicrafts – Historical and archaeological sites including Ketas Raj Temples, Malot,	– Village tours – Sightseeing tours of heritage sites and museums – Cultural photography – Visits to handicraft shops and olive centers

Table 9. Rapid Assessment Checklist – District Chakwal.

Features	Overall Grading in Various Segments					Remarks
	Excellent	Good	Satisfactory	Poor	NA	
Tourist Attractions						
Landscape beauty	X					
Historical/archaeological sites	X					
Local people culture	X					
Sites of religious significance	X					
Folk music, dance and art	X					
Natural attractions/Olive Groves	X					
Wildlife sighting		X				
Accessibility						
Accessibility by air		X				
Accessibility by road	X					
Accessibility by train						,
Local road network			X			
Availability of public transport		X				
Boarding lodging facilities for tourists						
Availability of hotel accommodation		X				
Availability of rest houses (governmental)			X			
Availability of community guest houses						,
Availability of camping sites				X		
Availability of restaurants			X			
Availability of local traditional food			X			
Safety and security for visitors			X			
Medical and health facilities		X				
Telecom facilities			X			
Existing tourist domestic flow		X				
Existing foreign tourist flow				X		Improving slowly
Potential for developing as an olive tourism destination	X					

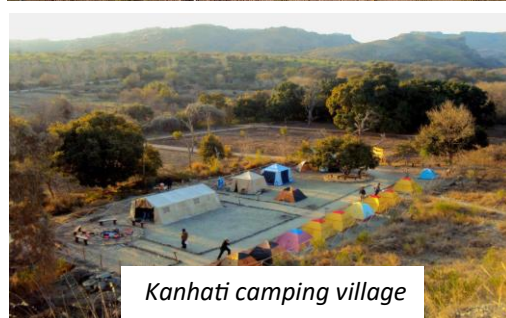
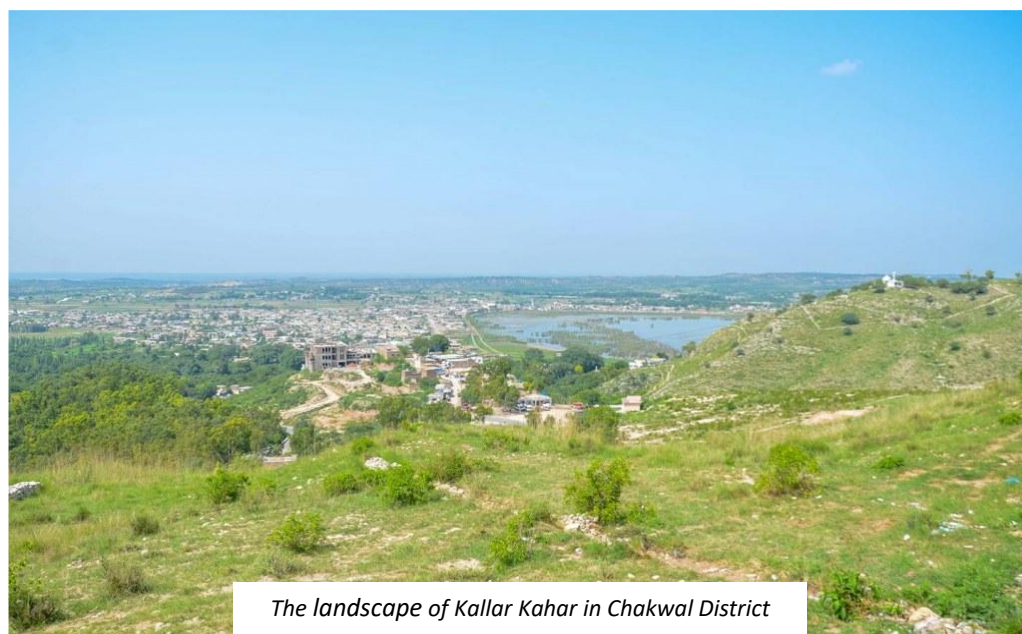


Figure 4. Natural landscapes, cultural heritage and olive orchards of Upper Dir.

Table 10. Musakhel, Balochistan Province.

Aspect		Description	
Short description of the area		Musakhel has considerable potential for the development of rural and olive-related tourism. Burg Pusht village of the Buzdar tribe represents a particularly suitable location for olive tourism due to its mountain scenery, traditional rural environment, wild olive forests, and expanding olive orchards. The area offers opportunities for nature-based and community-oriented tourism experiences linked with olive cultivation and local culture. At present, the area is considered more suitable for domestic tourism activities.	
Accessibility		Musakhel is accessible through Dera Ghazi Khan, Fort Munro, and Rakhni. Fort Munro, located near the border of Punjab and Balochistan, is an established hill resort frequently visited by domestic tourists from southern Punjab and surrounding areas. Musakhel can be conveniently visited through day trips from Fort Munro. Public transport services are available from Rakhni and Dera Ghazi Khan. Due to existing security concerns, the area is presently less suitable for international tourism.	
Boarding and lodging facilities		At present, there are no formal boarding and lodging facilities available within the Musakhel area. The nearest accommodation facilities are located at Fort Munro, where several guest houses and visitor facilities are available, including a motel and restaurant operated by the Tourism Development Corporation of Punjab (TDCP). There is potential for the future development of community-managed guest rooms and small-scale accommodation facilities for visitors.	
Key elements of the destination		Main features	Potential tourism activities
Outstanding features	physical	– Mountain landscapes of the Koh-e-Sulaiman range – Natural forests and rural scenery – Valleys and traditional settlements – Natural forests and wild vegetation – Wild herbs, wildflowers, and medicinal plants – Wildlife species including urial, fox, wolf, partridge, and several bird species	– Trekking and camping – Landscape photography – Camel riding – Nature-based recreation – Trekking to high pastures and mountain areas – Wildlife observation and birdwatching
	biological	– Fruit orchards, olive groves, and agricultural landscapes	– Nature photography – Study of wild flora and medicinal plants – Visits to olive groves and participation in olive harvesting
Outstanding features	cultural	– Tribal Balochi culture and traditions – Traditional rural lifestyle and local hospitality – Local cuisine and village life – Heritage and recreational importance of Fort Munro	– Village tours – Sightseeing visits to Fort Munro – Cultural photography – Traditional homestay experiences

Table 11. Rapid Assessment Checklist – Musakhel Area.

Features	Overall Grading in Various Segments					Remarks
	Excellent	Good	Satisfactory	Poor	NA	
Tourist Attractions						
Landscape beauty		X				
Historical/archaeological sites				X		
Local people culture		X				
Sites of religious significance		X				
Folk music, dance and art	X					
Natural attractions/Olive Grows	X					
Wildlife sighting			X			
Accessibility						
Accessibility by air				X		Via Multan
Accessibility by road		X				
Accessibility by train					X	
Local road network			X			
Availability of public transport			X			
Boarding lodging facilities for tourists						
Availability of hotel accommodation			X			At Fort Manro
Availability of rest houses (governmental)			X			
Availability of community guest houses					X	
Availability of camping sites				X		
Availability of restaurants			X			
Availability of local traditional food		X				
Safety and security for visitors			X			
Medical and health facilities			X			
Telecom facilities			X			
Existing tourist domestic flow				X		
Existing foreign tourist flow				X		
Potential for developing as an olive tourism destination		X				

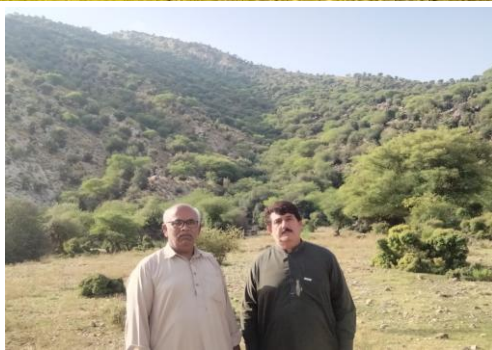


Figure 5. Natural landscapes and olive orchards of Burg Pusht and the surrounding area of Musakhel.

VI – SWOT analysis

The following SWOT analysis was developed based on field observations, stakeholder consultations, and discussions conducted during site visits and the Round Table on Olive Oil Tourism held at Kallar Kahar on 24 September 2023 (Table 12). The consultation involved representatives of local communities, public institutions, and non-governmental organizations (List of participants is given in Annex III).

Table 12. SWOT analysis of olive tourism development in selected areas of Pakistan.

Strengths	Weaknesses
– Attractive mountain landscapes and scenic rural environments – Presence of archaeological, historical, and cultural heritage sites – Availability of trekking routes, short walks, and outdoor recreational opportunities – Presence of wild olive stands and cultivated olive orchards – Rich biodiversity, including wildlife, medicinal plants, and wildflowers – Traditional handicrafts and local artisan activities – Availability of fresh and dry fruit products – Hospitable local communities and traditional rural lifestyles – Reasonable road accessibility to most sites – Diverse local gastronomy and traditional food products	– Limited tourism infrastructure and visitor facilities, including picnic areas, public toilets, parking, and first-aid services – Low standards of accommodation facilities and hygiene conditions in some areas – Limited capacity of local communities in tourism management and visitor handling – Insufficient visitor information, interpretation, and signage systems – Weak solid waste management practices – Seasonal nature of tourism activities – Perceptions of security concerns among international tourists – Inadequate public transportation facilities
Opportunities	Threats
– Growing interest among government institutions, NGOs, and development projects in promoting olive tourism – Potential to diversify tourism products through olive-related tourism experiences – Opportunities for developing community-based guest houses and eco-lodges – Potential for establishing visitor information centers and olive tourism trails with proper signage – Development of promotional and marketing materials through print, digital media, and social media platforms – Opportunities for involving women and youth in tourism services, handicrafts, and olive-based value-added products – Potential for promoting local products through olive and handicraft outlets	– Unplanned tourism development may negatively affect natural landscapes and environmental quality – Overcrowding may contribute to pollution and disturbance of local communities and traditional lifestyles – Increased tourism pressure may disturb wildlife and sensitive natural habitats – Growing demand for firewood and natural resources may increase pressure on forests – Inflation and rising prices may negatively affect local residents – Risk of increased littering and waste generation without proper management systems – Potential social impacts associated with unmanaged tourism activities

VII – Key findings of the SWOT analysis

The SWOT analysis indicates that the five selected areas possess significant potential for the development of olive tourism due to their attractive landscapes, biodiversity, cultural heritage, and traditional rural environments. The presence of olive groves, historical and archaeological sites, local gastronomy, handicrafts, and nature-based attractions provides favorable conditions for the promotion of community-based olive tourism initiatives. These areas offer opportunities for the development of new tourism products capable of attracting both domestic visitors and, in some locations, international tourists interested in nature, culture, and rural experiences.

Among the selected areas, Chakwal and Lower Swat appear to be the most suitable locations for the initiation of pilot olive tourism projects. Both areas combine attractive natural and cultural resources with relatively better infrastructure, accessibility, and accommodation facilities compared to the other selected sites.

Nevertheless, the assessment highlighted several limitations that may constrain tourism development. These include the limited availability and quality of tourism infrastructure, insufficient boarding and lodging facilities, inadequate hygiene standards, and the lack of trained personnel in the hospitality sector. In several areas, visitor information systems, signage, waste management, and public facilities also remain underdeveloped.

The analysis further indicates opportunities for strengthening the local hospitality sector through the development of community-based guest houses, eco-lodges, and traditional homestay facilities. Stakeholders consulted during the study expressed interest in developing tourism activities linked to local culture, landscapes, handicrafts, and olive-related products. Development agencies, NGOs, and local institutions may also play an important role in supporting such initiatives and creating additional livelihood opportunities for local communities, particularly for women and youth.

The main concerns identified under the threats analysis relate to the potential environmental and social impacts of uncontrolled tourism development. Increased tourist pressure may lead to environmental degradation, disturbance to wildlife, waste management problems, pressure on natural resources, and disruption of local lifestyles and cultural values. Local communities also expressed concerns regarding overcrowding, pollution, and the broader social impacts associated with unmanaged tourism activities.

These findings highlight the importance of adopting a responsible and sustainable tourism approach in the planning and development of olive tourism initiatives. Appropriate planning measures, visitor management practices, environmental safeguards, and codes of conduct for visitors and tourism service providers will be necessary to minimize negative impacts and ensure that tourism development contributes positively to local communities and the conservation of natural and cultural resources.

VIII –Responsible Participatory Olive Tourism Plan

Based on the assessment of the selected sites, stakeholder consultations, and the findings of the SWOT analysis, a Responsible Participatory Olive Tourism Plan (RPTP) was developed to provide a strategic framework for the promotion of olive tourism in Pakistan. The plan also draws upon the experience and good practices of the “Olive Oil Roads” successfully implemented in Italy and other Mediterranean countries.

The growing expansion of olive cultivation in Pakistan has created new opportunities for diversifying rural economies and promoting sustainable tourism activities in olive-growing regions. Many of the selected areas assessed during the study possess attractive natural landscapes, rich cultural heritage, traditional lifestyles, and hospitable communities, making them suitable destinations for the development of olive tourism initiatives. The findings of the assessment indicate that olive tourism may become an important complementary activity capable of strengthening the olive value chain while generating additional livelihood opportunities for local communities.

The SWOT analysis further demonstrated that the selected areas possess favorable geographical, environmental, and cultural characteristics for the promotion of community-based tourism. In particular, the areas of Chakwal and Lower Swat were identified as the most suitable locations for initiating pilot olive tourism projects because of their accessibility, relatively better infrastructure, tourism facilities, and existing visitor flows (Figure 6).



Figure 6. A group of tourists visiting olive grove in Chakwal area during an experimental olive tour organized by the Sustainable Tourism Foundation in Pakistan.

The assessment highlighted the importance of adopting a responsible and participatory approach to tourism development. Uncontrolled tourism activities may create pressure on natural resources, wildlife, cultural heritage, and local communities. Therefore, the proposed tourism model emphasizes sustainability, community participation, environmental protection, and cultural preservation as essential elements of tourism planning and management.

The overall aim of RTP is to promote tourism activities that contribute to improving local livelihoods while ensuring the sustainable use of natural and cultural resources. In this context, the plan is guided by the following key objectives:

- Conservation of the natural and cultural heritage of olive-growing areas to ensure long-term social, environmental, and economic benefits;
- Minimization of the negative environmental and socio-cultural impacts associated with tourism activities;
- Promotion of inclusive economic opportunities and equitable benefit-sharing for local communities, including women and youth;
- Improvement of the quality of tourism services and visitor experiences through capacity building and community participation;
- Strengthening of the relationship between olive cultivation, local identity, gastronomy, and rural tourism development.

The following sections outline the proposed strategic directions, community participation mechanisms, tourism development approaches, and recommendations for the implementation of responsible olive tourism initiatives in Pakistan.

1. Strategic framework for the development of responsible olive tourism

To achieve the objectives of RPTP, a series of strategic actions are proposed to support the sustainable development and management of olive tourism in the selected areas. These actions are based on field assessments, stakeholder consultations, and international good practices adapted to the local context.

A. Protection of natural and cultural heritage

The conservation of natural landscapes, biodiversity, and cultural heritage represents a fundamental principle of the proposed olive tourism framework. Tourism activities and facilities should therefore be planned and implemented in a manner that minimizes environmental degradation and protects the cultural identity of local communities.

All tourism interventions should be developed in consultation with local stakeholders and relevant public institutions. Coordination with responsible government departments will be necessary to support environmental protection measures, land-use regulations, and heritage conservation efforts. Local communities may also play an important role in monitoring tourism-related activities and supporting the implementation of environmental management measures.

B. Community awareness and stakeholder sensitization

Since olive tourism is still a relatively new concept in Pakistan, awareness raising among local communities and stakeholders is considered essential for successful implementation. Community participation and local ownership should form the basis of tourism planning and management processes.

Awareness programs should involve community leaders, teachers, social workers, women and youth groups, local entrepreneurs, and tourism service providers. These activities should focus

on the potential economic opportunities associated with olive tourism, while also addressing possible environmental and socio-cultural impacts.

Special attention should be given to promoting environmental responsibility, waste management practices, energy-efficient technologies, cultural preservation, and respect for local traditions and beliefs. Awareness campaigns may also encourage the adoption of sustainable practices such as recycling, water conservation, and the use of renewable energy technologies.

C. Institutional arrangements

Effective coordination among public institutions, local communities, tourism operators, and other stakeholders is essential for the successful development and management of olive tourism initiatives. For this purpose, a multi-level coordination structure is proposed.

a) Destination Olive Tourism Management Committees

At the local level, Destination Olive Tourism Management Committees (DOTMC) are proposed to facilitate coordination among tourism service providers, olive growers, local communities, and relevant institutions. The main responsibilities of the DOTMC would include:

- Supporting the development and promotion of olive tourism activities;
- Facilitating coordination among local stakeholders and government departments;
- Promoting responsible tourism practices and environmental awareness;
- Supporting the implementation of codes of conduct and visitor management measures;
- Assisting in conflict resolution among stakeholders.

The proposed committees should include representatives from local administration, tourism, agriculture, forestry, olive development institutions, local businesses, community organizations, women and youth groups, and tourism service providers.

b) Provincial Olive Tourism Coordination Committees

At the provincial level, Provincial Olive Tourism Coordination Committees (POTCC) may facilitate coordination among provincial departments and private-sector stakeholders involved in tourism and olive development. Their role would include:

- Develop coordination among different public and private sector partners to facilitate olive tourism programs in selected areas of the province;
- Facilitate coordination among tourism, agriculture, forestry, and local government departments;
- Create effective coordination with law enforcement agencies to provide a safe and secure environment to the visitors of olive tourism areas;
- Sensitize of all the stakeholders about the negative and positive environmental, cultural, and economic impacts of the tourism program.
- Provide support to DOTMC for the development of various facilities and activities for the visitors;
- Provide support to DOTMC to implement a code of conduct for eco-friendly and culture-friendly tourism in the designated areas.

The POTCC should include representatives from local administration, tourism, agriculture, forestry, olive development institutions, local businesses, community organizations, women and youth groups, and tourism service providers.

c) National Olive Tourism Coordination Committee

At the national level, a National Olive Tourism Coordination Committee (NOTCC) may provide strategic guidance and facilitate coordination among national institutions, development organizations, and private-sector stakeholders. Its responsibilities may include:

- Supporting national policy guidance for olive tourism development;
- Facilitating technical and financial support mechanisms;
- Promoting olive tourism at national and international levels;
- Encouraging collaboration among public institutions, tourism organizations, and donor agencies.

The NOTCC should include representatives from the public sector, including Pakistan Tourism Development Corporation, provincial tourism departments, the Pak Olive Project, the Green Pakistan Project, as well as representatives from farmers' organizations, Sustainable Tourism Foundation, Agri-tourism Development Corporation, Pakistan Association of Tour Operators, and representatives of Italian Agency for Development Cooperation (AICS) in Islamabad.

D. Development of olive tourism infrastructure and services

a) Development of Olive Tourism Routes

Based on the information gathered during the assessment stage, various routes of olive tourism in Pakistan can be developed by linking the destinations through a systemic plan. Each olive route will have a starting point and an ending point. Various tourist attractions offering tourists immersive experiences related to olive oil, such as visits to olive groves, olive oil mills, tasting sessions, cooking classes, and cultural activities as well as sites of archaeological and cultural interest in the vicinity of olive groves will be marked on the Olive Tourism Routes. Moreover, facilities for visitors such as accommodations, restaurants, tourist information centers and souvenir shops will also be marked on these olive routes. Proper signposting, route maps, visitor information materials, and digital mapping tools should be developed to facilitate visitor access and interpretation. An example is given in Figure 7.

After the 18th amendment to the constitution of Pakistan, the Provincial Tourism Departments have the mandate to develop and promote tourism in all the territories under their respective control. Therefore, it is important to establish close coordination with provincial tourism departments to get their support and assistance for the development of these routes in the selected areas and start a proper signposting initiative. There are good possibilities that certain activities related to olive tourism will be sponsored and facilitated by these provincial-level tourism departments. Moreover, developing liaisons with the Pakistan Tourism Development Corporation at the national level can also be greatly helpful in undertaking various promotion and marketing activities related to Olive Tourism Routes.



Figure 7. Olive Tourism Route in the area of Chakwal District of Punjab.

b) Development of tourism activities

A variety of tourism activities may be developed to diversify visitor experiences and strengthen local economic opportunities (Figure 8). Potential activities include:

- **Olive grove and olive mill visits:** Offering guided tours of olive groves and olive oil mills, where visitors can learn about the cultivation of olive trees and the olive oil extraction process, having the opportunity to taste various olive oils, can be an additional sensory experience for the visitors. Different options for a half-day trip to a day-long trip can be developed and promoted through a dedicated website or social media page.
- **Olive oil tasting experiences:** To create combined tours joining other nearby tourist sites that highlight both olive oil and sightseeing of cultural and heritage sites. Various multi-day trip options can be developed in association with the Pakistan Association of Tour Operators (PATO) and provincial tourism departments. Tour guides can be trained to conduct group tours in a professional manner. For this purpose, dedicated training programs for tour guides can be organized for selected locally educated youth. This will not only bridge the gap in finding trained tour guides but will also create decent job opportunities.
- **Cooking classes and local gastronomy activities:** Tourists are always interested to know about the local food and cuisine. In combination with olive oil tasting, cooking classes can also be arranged for interested visitors. Visitors can learn to prepare traditional dishes from the region that highlight olive oil as a key ingredient.
- **Participation in olive harvesting:** During the olive harvest season, tourists can be invited to participate in the picking of olives. They can experience the traditional methods or modern techniques used in harvesting. This can be a great way to engage visitors in the entire process.

- **Olive festivals and cultural events:** Organizing olive festivals celebrating the local culture, music, and food can be an excellent idea to attract a good number of visitors to olive-producing areas. Olive oil tastings, cooking competitions, and demonstrations by local chefs using olive oil in creative ways can be included to generate the interest of visitors to attend these festivals. The festivals held at Chakwal for the last many years, at Kallar Khar, and the olive Galas organized by the OC Project at Tarnab (March 2023) and Islamabad (November 2024) have attracted large masses.
- **Educational workshops:** Workshops and seminars about the health benefits of olive oil, the history of olive oil production, and its significance in the local culture can also be organized for groups of students, special interest tourists, and groups of youth and media. Experts from olive projects, research centers, institutions, and health specialists/nutritionists can be invited to share their knowledge on this subject.
- **Collaborations with restaurants:** Partnerships can be established with local restaurants to feature olive oil-themed dishes on their menus. A campaign can be launched which promotes use of locally sourced olive oil in special dishes in participating restaurants.



Figure 8. Olive tourism promotion activities; a) Olive oil tasting, b) Olive harvesting, c) Olive festival at Bari Chakwal, and d) Olive Gala at Tarnab.

c) Visitors Information Centres (VIC)

Establishing a Visitors Information Centre (VIC) is a very useful tool for enhancing the interest of visitors arriving in a new tourist area. A VIC managed by DOTMC will not only serve the purpose of disseminating information about olive tourist places in the selected regions, but it will also provide a useful venue to sell various services/products provided by the farmers/local community. The VIC should be established at a suitable location at the entry point of the selected areas, or at

the central place which could support a cluster of olive farms in the vicinity. It should be properly signposted, and its location must be available on Google Map. Information about different tourist spots, olive farms, and activities for the visitors should be displayed using a well-designed poster-cum-map on the one wall of this Centre.

The VIC should have a reception-cum-information counter, where visitors could contact local staff, get information, and book local tour guides and rooms in hotels, Eco-Lodges, camping sites, etc. This Centre should also have display racks for local handicrafts/olive products and other value-added products from the farms of surrounding areas for sale to visitors at fixed prices. A percentage of income from the sale of booking of hotels and profit from the sales of handicrafts and olive products should be collected in a separate account, and this amount should be used to meet the operational cost of the Centre. The staff should be local, knowledgeable, and educated young persons with good communication skills.

d) Boarding and lodging facilities

The assessment identified the need to improve accommodation standards within the selected areas. Proposed interventions include:

- Upgrading existing hotels and guest houses;
- Promoting eco-friendly accommodation practices;
- Developing village eco-lodges and homestay facilities;
- Supporting camping and nature-based accommodation options.

Training programs in hospitality management, hygiene, housekeeping, and food services should also be organized to improve service quality.

e) Development of picnic and recreational areas

There are several good spots in the selected areas with nice views of the surroundings. Picnic spots can be developed at such sites for day visitors in the olive farms or at nearby locations. The most suitable sites should be selected with the help of the DOTMC and developed through matching grants with selected local entrepreneurs. Selected picnic locations should be equipped with basic facilities such as seating areas, waste disposal systems, parking spaces, and visitor information signage.

f) Solid waste management

Improved waste management systems are essential to minimize the environmental impacts of tourism activities. Suggested measures include:

- Installation of waste collection and sorting facilities;
- Promotion of recycling and composting practices;
- Awareness campaigns on environmental cleanliness;
- Adoption of waste management guidelines by tourism service providers.

E. Marketing and promotion

The promotion of olive tourism requires the development of integrated marketing and communication strategies targeting both domestic and international visitors.

F. Signposting and tourist information

Tourism sites, olive routes, and visitor facilities should be properly signposted using standardized and informative signage systems. A special theme selected for each site/valley should be reflected through these signboards. Efforts should be devoted to preparing signboards durable, attractive, and informative.

G. Printed and digital information materials

Tourism information leaflets, maps, brochures, and guide materials should be prepared in both Urdu and English languages. These materials should include brief introduction about the area, main attractions, accommodation, activities, special events and festivals, local products, transportation, and visitor guidelines.

H. Digital marketing and social media

Dedicated websites and social media platforms may be used to promote olive tourism destinations, local products, festivals, landscapes, and visitor experiences. Collaboration with national tourism organizations and tourism departments can further support online promotion efforts.

I. Networking with tour operators

Collaboration with national and international tour operators will be important for the development of tourism packages and market outreach. Exposure visits and familiarization tours may also be organized to encourage the inclusion of olive tourism destinations in tourism itineraries. To maximize the economic benefits for the local people, special emphasis should be placed on promoting the tour packages where most of the services are provided by the local farmers and community to olive enthusiasts.

J. International farm trips for olive tourism services providers

To get first-hand experience in the olive tourism business, and understand the dynamics of the olive tourism market, there is a need to arrange foreign farm trips for olive tourism services providers. A group would visit one or two Mediterranean countries where olive tourism is in practice and, at the same time, they can attend olive tourism fairs or expos to meet with the international market players. This exposure will greatly help them to understand the dynamics of the demand and supply side of olive tourism. Moreover, it will help them to open opportunities for international olive tourism for Pakistan.

K. Olive-based souvenirs and local products

The development and promotion of olive-related products and local handicrafts may contribute to local income generation and destination branding. Such products may include olive oil-based cosmetics, soaps, food products, handicrafts, textiles, and locally produced souvenirs (Figure 9).



Figure 9. A range of olive-related value-added products and handicrafts available in Pakistan.

L. Production of documentary films

Documentary films can serve as an effective tool for promoting olive tourism destinations and raising public awareness about the tourism potential of olive-growing areas in Pakistan. Professionally produced documentaries highlighting natural landscapes, olive cultivation, local culture, gastronomy, heritage sites, and community experiences can support the promotion of olive tourism at both national and international levels.

Collaboration with public and private television channels, media organizations, and digital platforms may facilitate the production and dissemination of short documentary films and promotional content. Such productions may contribute to increasing visitor interest in the selected areas and strengthening the visibility of Pakistan's emerging olive tourism sector.

M. Visitor safety and security

Close coordination with local authorities and law enforcement agencies will be necessary to ensure visitor safety and emergency response preparedness. Basic first aid facilities and safety information should be available at key tourism sites.

N. Capacity building of tourism service providers

Training programs should be organized for local tourism stakeholders in areas such as hospitality management, tour guiding, visitor communication, hygiene and food safety, environmental management, first aid and emergency response.

O. Olive tourism education and codes of conduct

Awareness and educational programs should be implemented for both visitors and local communities to promote environmentally responsible behavior and respect for local cultural traditions. Codes of conduct for visitors and tourism operators may also be developed and enforced through community participation mechanisms.

P. Monitoring and evaluation

The implementation of olive tourism initiatives should be supported by a monitoring system capable of assessing environmental, social, cultural, and economic impacts over time. Monitoring activities may include:

- Assessment of tourism impacts on natural resources and landscapes;
- Evaluation of community participation and income generation;
- Monitoring of visitor satisfaction and service quality;
- Assessment of environmental management and waste reduction measures;
- Evaluation of the effectiveness of tourism infrastructure and services.

2. Action Plan and estimated budget for implementing a Responsible Participatory Tourism Plan

The effective implementation of RPTP can greatly contribute to the economic enhancement and sustainable livelihoods of rural communities through the development, promotion, and management of olive tourism in the selected areas across Pakistan. As highlighted in the SWOT analysis of the potential areas for olive tourism, it is very encouraging to know that the five identified potential sites for olive tourism have good geographical features, interesting biological conditions, very rich natural and cultural environment which make these areas suitable to promote community-based olive tourism.

A. Pilot areas and Action plan

Based on the assessment findings, the areas of Chakwal and Lower Swat are considered the most suitable locations for initiating pilot olive tourism projects. These areas possess comparatively better infrastructure, accessibility, visitor facilities, olive resources, and tourism experience than the other selected sites. The implementation of pilot projects in these areas may provide useful experience and lessons for the future expansion of olive tourism initiatives to other regions of Pakistan. Subsequent phases may include replication of the approach in Lower Chitral,

Upper Dir, Musakhel, and other emerging olive-growing areas. Table 13 provides an action plan for the short to medium-term.

Table 13. Action plan for pilot projects.

Activity	Lead agency	Supporting agencies*	Technical assistance	Time frame
Formation of DOTMC, POTCC, and NOTCC (at both sites)	TBD	PTDC, TDCP, KPTA, BTDC, ATDC, Community	STFP	Year 1
Development of Olive Routes in selected areas (at both sites)	TBD	PTDC, TDCP, KPTA, BTDC, ATDC, NRSP/NGO, Community	STFP	Year 1
Development of Visitor Information Centre (at both sites)	TBD	PTDC, TDCP, KPTA, BTDC, ATDC, Community	STFP	Year 1
Development of olive tourism activities (at both sites)	TBD	PTDC, TDCP, KPTA, BTDC, ATDC, NRSP/NGO, Community	STFP	Year 1
Development and improvement of boarding and lodging facilities (six facilities/site)	TBD	PTDC, TDCP, KPTA, BTDC, ATDC, NRSP/NGO, Community	STFP	Year 1 and 2
Development of picnic spots (four points/site)	TBD	PTDC, TDCP, KPTA, BTDC, ATDC, Community	STFP	Year 1 and 2
Training of tour guides/tour operators (one/site)	TBD	PTDC, TDCP, KPTA, BTDC, ATDC, Community	STFP	Year 1 and 2
Development of micro-enterprises for olive products and handicrafts (two/site)	TBD	ATDC, NRSP/NGO/Community	STFP	Year 1 and 2
Develop Ecotourism Education Program (at both sites)	TBD	ATDC and Community	STFP	Year 1
Printing of Information Brochure (5,000 copies)	TBD	PTDC, TDCP, KPTA, BTDC, ATDC	STFP	Year 1
Printing of olive package tour leaflets (2000 copies)	TBD	PTDC, TDCP, KPTA, BTDC, ATDC	STFP	Year 1
Development of olive tourism website	TBD	PTDC, TDCP, KPTA, BTDC, ATDC, Community	STFP	Year 1
Farm trip for media persons and tour operators	TBD	Press club, PATO and ATDC	STFP	Year 1
International farm trip for olive tourism services providers	TBD	PTDC, TDCP, KPTA, BTDC, ATDC, Community	STFP	Year 1
Fixing of sign boards (10/site)	TBD	PTDC, TDCP, KPTA, BTDC, ATDC, Community	STFP	Year 1
Networking with tour operators and exposure visit	TBD	PTDC, TDCP, KPTA, BTDC, ATDC, Community	STFP	Year 1
Organize training for guest house staff (one/site)	TBD	PTDC, TDCP, KPTA, BTDC, ATDC, Community	STFP	Year 1
Setting up of waste management system (at both sites)	TBD	PTDC, TDCP, KPTA, BTDC, ATDC, Community	STFP	Year 1
Establishing monitoring system	TBD	PTDC, TDCP, KPTA, BTDC, ATDC, Community	STFP	Year 1

*ATDC: Agri-Tourism Development Corporation; PTDC: Pakistan Tourism Development Corporation; TDCP: Tourism Development Corporation of Punjab; KPTA: Khyber Pakhtunkhwa Tourism Authority; BTDC: Balochistan Tourism Department; NRSP: National Rural Support Program; PATO: Pakistan Association of Tour Operators; STFP: Sustainable Tourism Foundation Pakistan.

Tables 14 and 15 provide an estimated budget for the implementation of the action plan at the two selected sites. Stakeholders may pool up resources to implement various components, or a project proposal can be developed to avail donor funding.

Table 14. Estimated budget for Chakwal/Kallar Kahar cluster.

Activity	Unit cost Pak Rs.	Number	Amount in Million Pak Rs.	Potential source of funding
Formation of DOTMC, POTCC, and NOTCC at their meetings	100,000	3	0.3	STFP
Development of Olive Route (at 1 site)	Lump sum	1	1.0	NRSP/NGO
Development of Visitor Information Centre (at 1 site)	Lump sum	1	0.5	Donor Agency
Development of olive tourism festival activities (at 1 site)	Lump sum	1	1.0	Sponsorship from different partners
Development and improvement of boarding and lodging facilities (6 facilities)	Lump sum	6	1.0	50% by the Owner and Donor agency
Development of picnic spots (4 points at 1 site)	250,000	4	1.0	Donor Agency
Training of tour guides/tour operators (10 guides)	50,000	1	0.5	TDCCP
Development of micro-enterprises for olive products and handicrafts (2/site)	200,000	2	0.4	NRSP
Development of Ecotourism Education Program (at 1 site)	Lump sum	1	0.3	STFP
Printing of Information brochure (5,000 copies)	60	5000	0.3	TDCCP
Printing of olive package tour leaflets (2000 copies)	50	2000	0.1	PATO
Development of a website on olive tourism	Lump sum	1	0.2	TDCCP
Farm trip for media persons and tour operators	Lump sum	1	0.4	Sponsorship/PTD C
International farm trip for olive tourism services providers	Lump sum	1	0.4	Sponsorship/PTD C
Fixing of sign boards (1/location)	40,000	20	0.8	TDCCP
Networking with Tour Operators & Exposure Visit	Lump sum	1	0.3	PATO
Organize training for guest house staff (12 persons)	25,000	1	0.3	TDCCP
Setting up of waste management system at 1 site	Lump sum	1	0.2	TDCCP
Establishing monitoring system	Lump sum	1	0.5	STFP
Misc. Expenses	Lump sum		0.5	Donor Agency
Office Overheads	Lump sum		2.0	Donor Agency
Total				11.00 million

Table 15. Estimated budget for Lower Swat cluster.

Activity	Unit Cost Pak Rs.	Number	Amount in Million Pak Rs.	Potential source of funding
Formation of DOTMC, POTCC, and NOTCC at its meetings	100,000	3	3	STFP
Development of Olive Route (at 1 site)	Lump sum	1	1.0	NRSP/NGO
Development of Visitor Information Centre (at 1 site)	Lump sum	1	0.5	Donor Agency
Development of olive tourism festival activities (at 1 site)	Lump sum	1	1.0	Sponsorship from different partners
Development and improvement of Boarding and lodging facilities (6 facilities)	Lump sum	6	1.0	50% by the Owner and Donor agency
Development of picnic spots (4 points/site)	250,000	4	1.0	Donor Agency
Training of tour guides/tour operators (10 guides)	50,000	1	0.5	TDCP
Development of micro-enterprises for olive products and handicrafts (2 at 1 site)	200,000	2	0.4	NRSP/NGO
Development of Ecotourism Education Program (at 1 site)	Lump sum	1	0.3	STFP
Printing of Information Brochure (5,000 copies)	60	5000	0.3	TDCP
Printing of olive package tour leaflets (2000 copies)	50	2000	0.1	PATO
Development of a website on olive tourism	Lump sum	1	0.2	TDCP
Farm trip for media persons and tour operators	Lump sum	1	0.4	Sponsorship/PTD C
International farm trip for olive tourism services providers	Lump sum	1	0.4	Sponsorship/PTD C
Fixing of sign boards (10/location)	40,000	20	0.8	TDCP
Networking with Tour Operators & Exposure Visit	Lump sum	1	0.3	PATO
Organize training for guest house staff (12 persons)	25,000	1	0.3	TDCP
Setting up of waste management system at 1 site	Lump sum	1	0.2	TDCP
Establishing monitoring system	Lump sum	1	0.5	STFP
Misc. Expenses	Lump sum		0.5	Donor Agency
Office Overheads	Lump sum		2.0	Donor Agency
Total				12.00 million

Annexes

Annex I

List of stakeholders consulted

1. Dr. Marco Marchetti, Coordinator, OliveCulture Project
2. Dr. Costantino Parma, Technical Expert, OliveCulture Project
3. Dr. Muhammad Azhar Iqbal, Senior Scientist, BARI Chakwal
4. Dr. Muhammad Ramazan, Senior Scientist, BARI Chakwal
5. Mr. Malik Fatah Khan, RGM, National Rural Support Program/ Lawa Olive Farm
6. Mr. Bilal Khan, Lawa Olive Farm/Restaurant owner at Kallar Kahar
7. Mr. Zulfiqar Ali, GM Program, Human Development Foundation
8. Mr. Ahmad Khan Buzdar, Burg Olive Farm, Musakhel
9. Mr. Mahboobul Haq, CEO, Human Development Foundation
10. Mr. Tariq Tanveer, CEO, Agri-Tourism Development Corporation
11. Mr. Syed Yousaf Ali Shah, President, Olive Foundation Pakistan
12. Dr. Abdul Rehman, CEO, Ghaziupr Foods Pvt. Ltd
13. Mr. Arslan Haider, CEO, Green Oliver, Chakwal
14. Mr. Taimoor Hussain, Admn Manager, Izhar Olive Farms, Pvt. Ltd
15. Dr. Farooq Awan, AGRC (Ext) Nowshara, Soon Valley, Khoshab
16. Mr. Abubakar, Farm Manager, Ali Abbas Farms, Nowshera, Khoshab
17. Mr. Mudassar Hussain, CEO, Al- Zatoonia, Bahawalpur
18. Mr. Shahid Munir, Field Eng. SAWARI Chakwal
19. Mr. Khawaja Mazahar, CEO, Green House Farm, AJK
20. Dr. Ramzan, BARI Chakwal
21. Dr. Asif Ali, GM, Sign Marketing, Islamabad
22. Mr. Fahamad Mehmood, Skill Development officer, Helping Hand
23. Mr. Hafiz Umair, Olive Pakistan, Lahore
24. Mr. Muhsmd Asim, CEO, Eco-Pakistan Discoveries, Islamabad
25. Mr. Wahid Arjumand Zia, GM, TDPC, Lahore
26. Mr. Mian Moazam, Manager, Tourism Development Corp. Punjab
27. Mr. Arif Tufail, Director Operations, Incredible Journeys Pvt. LTD
28. Mr. Tariq Rabbani, Manager, TDCP Resort, Kallar Kahar
29. Mr. Nasir Khokar, Travel Vlogger

Annex II

List of the Participants
National Round Table on Olive Oil Tourism at TDCP Motel Kallar Kahar
September 24, 2023

Name	Organization	Designation	Contact Number
Aftab-ur-Rehman Rana	STFP (Sustainable Tourism Foundation Pakistan)	President	0300-9742158
Zulfiqar Ali	Human Development Foundation	GM Program	0300-5271135
Mehboob Haq	Human Development Foundation	CEO	0300-0543375
Tariq Tanveer	Agri-Tourism Development Corporation of Pakistan	CEO	0321-6627199
Syed Yousaf Shah	Olive Foundation	President	0300-4004408
Dr. Abdul Rehman	Ghazi Pure Food, Pvt. Ltd	Managing Director	0300-6642595
Arsalan Haider	Green Oliver	CEO	
Taimoor Hussain	Izhar Farm (Pvt. Ltd)	Admin Manager	0334-1522896
Dr. Farooq Ahmad	AGR(EXT) Naushera Khushab	Senior Agri Officer	0302-6776330
Ahmed Khan Buzdar	Burg Olive Oil Musa Khel	CEO, Farmer	0333-7847210
M. Abu Bakar	Al-Abbas Farm Naushera Khushab	Farm Manager	0303-7109734
Mudassar Hussain	Olive Foundation Pakistan Punjab	President OFP (Punjab)	0300-9683601
Shahid Munir	SAWCRI (Soil & Water Conservation Research Institute), Chakwal	Field Engineer	0303-6674369
Khawaja Manhas	Green House Farm	CEO	0321-8504321
Irfan Khalid	Human Development Foundation	Deputy Manager Projects	0309-5559484
Mansoor Aslam	Human Development Foundation	RPM Islamabad	0309-5559486
Arif Ahmad	Private		0333-8788887
Malik Ahmed	Lawa Olive Farm	Director	0300-5122033
Moazam Main	Tourism Development Corporation of Pakistan	Manager	0321-9148148
Dr. Ramzan	CEFORT, Bari Chakwal	S. Scientist	0333-6837737

Annex III

Map showing the location of five selected areas for Olive Tourism



Conclusions

The development of the olive sector in Pakistan represents one of the most promising pathways for agricultural diversification, rural development, environmental sustainability, and long-term reduction of the country's dependence on imported edible oils. Over the past decades, considerable efforts have been made to transform olive cultivation from a marginal opportunity into a structured and strategic sector. These efforts have involved national and provincial institutions, research organizations, international cooperation partners, technical experts, farmers, and private stakeholders, all contributing to the progressive establishment of a national olive value chain.

This monograph highlights the main efforts that have shaped this progress. It documents the evolution of the sector, the institutional frameworks and the international cooperation initiatives that have encouraged olive expansion, the assessment of existing resources and services, and the strategic interventions needed to consolidate future development. Particular importance has been given to understanding the value chain as a whole, from nursery production, cultivar selection, orchard establishment, agronomic management and irrigation to harvesting, processing, quality control, marketing, branding, and rural diversification. This integrated perspective is essential because the success of olive cultivation in Pakistan cannot depend only on increasing planted areas, but also on strengthening the technical, economic, institutional, and commercial foundations of the sector.

Indeed, Pakistan possesses significant potential for olive development. Its diverse agroclimatic zones, large areas of marginal and underutilized land, wild olive resources, and favorable environments in several provinces, particularly Punjab, Khyber Pakhtunkhwa, Balochistan, and other suitable regions, provide a strong foundation for the development of the sector. Additionally, the identification of adapted cultivars, the development of varietal zoning, and the promotion of locally appropriate agronomic practices are crucial achievements that can guide future expansion. Nevertheless, sustainable orchard management, efficient irrigation, soil conservation, integrated pest and disease management, and proper harvesting and post-harvest practices remain essential to ensuring productivity, profitability, and high-quality olive oil.

Beyond production, the monograph underlines the need to build a competitive and well-governed value chain. Improved coordination among institutions, stronger farmer organization, enhanced technical training, reliable quality standards, modern processing facilities, and market-oriented value addition are all necessary to move the sector from a project-supported phase toward a mature and economically sustainable industry. The development of national branding, certification systems, and stronger links between producers, processors, markets, and consumers will be decisive for increasing the visibility and credibility of Pakistani olive oil and olive-based products.

The potential of olive cultivation in Pakistan also extends beyond economic profit. Olive groves can contribute to climate change mitigation through supporting carbon sequestration, restoring marginal lands, the reducing soil erosion, and promoting more resilient farming systems. In this context, olive cultivation is not only an agricultural activity but also a climate-smart land-use strategy. The possibility of linking olive production with carbon accounting mechanisms and climate policies further reinforces its strategic relevance within Pakistan's broader sustainability agenda.

Moreover, olive cultivation offers new opportunities for rural innovation and territorial development. Responsible olive tourism, adapted to Pakistan's social and cultural context, can help diversify rural incomes, valorize landscapes and local traditions, offer new opportunities for women and youth, and strengthen community participation. This multidimensional potential makes the olive sector a valuable entry point for connecting agriculture, environment, culture, and rural entrepreneurship.

Overall, the progress achieved demonstrates that Pakistan has already laid important foundations for a viable olive sector. Building on the results and outcomes of the project, the financing of a scale-up initiative in continuity with the previous actions further confirms the commitment of the Italian Government and CIHEAM Bari to supporting the Government of Pakistan in the full development of the olive sector. Future efforts should focus on consolidating technical knowledge, improving productivity, strengthening institutional governance, ensuring quality and traceability, supporting farmer cooperatives, encouraging private investment, and integrating olive development into wider agricultural, environmental, and rural development policies.

In conclusion, olive cultivation in Pakistan stands at a decisive stage. The efforts made so far have created a strong basis for growth, but the next phase must transform this accumulated knowledge, infrastructure, and institutional commitment into a sustainable, competitive, and inclusive value chain. If properly supported, the olive sector can become a strategic pillar of Pakistan's agricultural transformation, contributing to food security, climate resilience, rural livelihoods, environmental protection, and the emergence of a distinctive national identity around olive production.

Memories

Training Sessions

Training on Olive Good Agricultural Practices, September 2022 (Punjab, Balochistan, KP).



Options Méditerranéennes, B 78, 2026 - OliveCulture Pakistan: Building a Sustainable, Climate-Smart and Competitive Value Chain







Women participatory meeting, October 2022.





Table olive and value addition processing protocol and hygiene safety training, October 2022.



GAP focusing on pruning training, January-February 2023.





Olive nursery standard operating procedures and management training, March 2023.





Participatory rural appraisal meeting with women groups, April 2023.



Business basics and soft skills training for women and youth, June 2023.



Soap and cosmetics training for women and youth, July 2026.





Olive pickles production training for women and youth, September 2023.



Olive mill processing plant protocols and hygiene safety, September-October 2023.



Olive oil quality analysis training, November 2023.



GAP focusing on pruning training, November- December 2023.



Events and Festivals

Project participation in Olive Gala Tarnab, Peshawar, March 2023.





Project participation in Pak-Olive National Gala, Islamabad, November 2023.





Round table conference on olive oil tourism, December 2023.



Pakistan olive oil council advisory group visit to Italy, November 2022.



Action plan and policy recommendations Conference, March 2023.



Participation of olive value chain stakeholders in Agrilevante 2023, October 2023.



Distribution ceremony of equipment and raw material to Olive Business Development Groups (OBDGs), October 2023.



Project participation in Euro Village, Islamabad, February 2024.



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SERIES B: Studies and Research
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OliveCulture Pakistan: Building a Sustainable, Climate-Smart and Competitive Value Chain

Edited by:
Marco Marchetti, Costantino Parma, Zeinab Hamouche

Pakistan's olive sector is emerging as a strategic pathway for agricultural diversification, edible oil import substitution, rural development, and climate-resilient land use. This monograph presents an integrated assessment of the sector, encompassing its historical development, institutional support, value chain structure, varietal potential, agronomic management, environmental contributions, and opportunities for rural innovation. It highlights the role of national and provincial initiatives, and Pakistan-Italy cooperation in promoting olive cultivation, strengthening technical capacities, and supporting processing and market development.

By linking varietal selection, agroclimatic zoning, sustainable agronomic practices, quality standards, governance, and market-oriented value addition, the monograph identifies the main levers needed to develop a competitive and resilient olive sector. It also explores the contribution of olive groves to carbon sequestration and climate change mitigation, as well as the potential of a responsible olive tourism to enrich rural economies and valorize landscapes, culture, and local products. Overall, the monograph presents olive cultivation as a promising, climate-smart, and multidimensional sector capable of supporting Pakistan's long-term agricultural transformation and sustainable rural development.

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