Review Article

The Impact of Agroforestry on Resource Management in Pakistan: A Review

Basheer Ahmad, Nowsherwan Zarif, Saif Ullah Khan, Salman Ahmad and Anwar Ali*

Pakistan Forest Institute (PFI), Khyber Pakhtunkhwa, Peshawar 25000, Pakistan.

Abstract | Around the world, forest ecosystems are in decline, facing various factors both living and non-living that negatively affect their health. Pakistan is not exempt from this challenge, as its population continues to grow, reaching 208 million, leading to increased pressure on food production and forest resources. To tackle this problem, there is a pressing need for effective food structures that not only improve efficiency and financial outcomes but also bring about positive ecological impacts and gain social acceptance. Traditional land management practices like agri forestry offer a promising solution in Pakistan. To plant trees on private lands, agroforestry enables pure rights of timber resources and, when well-managed, can significantly enhance agriculture and mitigate wood shortages. Despite concentrated efforts to familiarize and encourage innovative agri-forestry practices in Pakistan, the achievement of such initiatives is influenced by various factors. This paper examines the current limitations to agri forestry promotion in the country, which include attitudes of extension staff, weak coordination between research and extension, insufficiently trained personnel, limited response from farmers to advice, restrictions in tree species availability, challenges in market mechanisms, and issues with wood pricing. To effectively promote agroforestry, creating typical agro,forestry farms at the community level can be a valuable extension approach. However, effective extension programming needs partners to share an understanding of the challenges and an idea for positive results. Moreover, it necessitates the appropriate selection of messages, messengers, target audiences, and effective communication tools. To further promote agroforestry in Pakistan, this review suggests implementing corrective measures to rationalize prevailing systems and develop upcoming sustainable plans and methods.

Received | March 27, 2023; **Accepted** | May 13, 2023; **Published** | June 26, 2023
***Correspondence** | Anwar Ali, Pakistan Forest Institute (PFI), Khyber Pakhtunkhwa, Peshawar 25000, Pakistan; **Email:** anwerforester@gmail.com
Citation | Ahmad, B., Zarif, N., Khan, S.U., Ahmad, S. and Ali, A., 2023. The impact of agroforestry on resource management in Pakistan: A review. *Pakistan Journal of Forestry,* 73(1): 35-49.
DOI | https://dx.doi.org/10.17582/journal.PJF/2023/73.1.35.49
Keywords | Agroforestry, Forest resource, Sustainable plans, Ecological impacts

Introduction

Pakistan, with a population of 208 million, is primarily an agricultural country, and approximately 64% of its people live in rural areas. Half of the rural population is engaged in agriculture, as per the (Pakistan Economic Survey, 2018). The country faces a critical shortage of fuel, fodder, and fiber. Wood, sourced mainly from collective land-property, state-owned forests, or agroforestry systems,

is the primary domestic energy resource for about 80-90% of rural inhabitants. Agroforestry, commonly practiced through 'Shamlat' lands, state-owned plots covered with trees and grasses located near villages, plays a significant role in addressing this scarcity. The village chief (Numberdar) is in charge of these areas, which are used for various things, including gathering wood fuel and grazing livestock. When properly maintained, this easy type of agroforestry may provide local communities and farmers with crucial resources. Pakistan must, however, create operative land-use strategies for farmer fields that guarantee lucrative food and fibre production, support environmental improvement, and be economically and socially viable. A possible approach is the deliberate blending of woody perennials with crops and/or animals, as seen in agroforestry practices (FAO, 2015b; Burgess and Rosati, 2018). While addressing the rural population's urgent issues, agroforestry can boost agricultural productivity and improve natural resources.

Objectives

1. Investigating the socioeconomic benefits of agroforestry adoption in Pakistan, focusing on its role in enhancing livelihoods, increasing farm resilience to climate change, and promoting sustainable resource use among rural communities.
2. Assessing the role of agroforestry practices in enhancing soil fertility and conservation in Pakistan, including their impact on soil erosion, nutrient cycling, and soil organic matter accumulation.

Material and Methods

In this review, extension tactics for agroforestry promotion in Pakistan are examined. It begins with a succinct description of the nation's current land use and agroforestry status, then identifies any obstacles to agroforestry already in place and presents successful instances of extension activities. The study also highlights methods for improving agroforestry extension, develops conclusions based on the talks, and offers recommendations for future planning. Relevant data was gathered for this research from various sources, including peer-reviewed journals, "grey literature," government publications, and reports from overseas funders. Identified and screened a total of 50 research papers including publications related to agroforestry practices in Pakistan. The Pakistan Forest Institute Peshawar provided access to these databases and search methods.

Results and Discussion

Agro-ecological zones of Pakistan

Pakistan's overall area is approximately 87.98 million hectares (Mha), and its latitude and longitude are 23° to 37° north and 61° to 76° east, respectively. Ten key agroclimatic areas may be used to categorize the nation (Figure 1). There is no such map available on any source to represent the agro ecological zones only. The land cover map provided here is the only possible way to represent the agro-ecological zones. Mountains make up the majority of the land, making up more than two-thirds of the total land area, especially on the northern and western boundaries. The huge Thar Desert (IIIb), marked by sand ridges, covers around 6.5 Mha, whereas the Indus plains (I and II) cover roughly 20.7 Mha. The different elevations around the nation greatly impact Pakistan's prevalent climate, which is mostly arid subtropical. The extreme southern plains receive 125 mm of precipitation per year, whereas the hilly and northern plains receive 500-875 mm. Severe storms account for around 70% of all precipitation from July to September. In the Indus Plains and Thar Desert, summertime is marked by hot temperatures that often surpass 40°C and sometimes reach 53°C. on contrast, during the winter, mean monthly temperatures can drop as low as 2 to 5°C on the plains and below zero in mountainous areas. Pakistan's agricultural ecosystems are under stress as a result of rising food and forest resource needs. With an average population density of about 2.6 people per hectare, According to the Pakistan Economic Survey 2018, Pakistan is now the sixth most populous country in the world. With independence in 1947, the population numbered 32.5 million; by 2017, it had increased to 208 million, indicating an average annual growth rate of 2.7% (PBS, 2017; Pakistan Economic Survey, 2018).

Socio-economic status of Pakistan

According to the (Pakistan Economic Survey, 2018), more than 50% of Pakistan's population lives in rural regions, contributing 18.9%, GDP of the country and employing 42.3% of the workforce. As a result, a successful agricultural strategy is essential to the country's economic development and the reduction of poverty (Ministry of Finance, 2007). A 3:1 dependence ratio is typical for rural families with six members on average and two wage earners (PBS,

2016; Population Census, 2017; Farooq *et al.*, 2018). Additionally, household earnings in rural areas are significantly lower than in metropolitan ones. 24.3% of Pakistan's population still lives in poverty, despite a drop in poverty rates (World Bank, 2018a, b, c). According to Pakistan Economic Survey (2018-19), the country's overall literacy rate is over 62%, with male literacy (72.5%) much higher than female literacy (51.8%). Based on ownership and control, the socio-economic structure of rural Pakistani communities may be divided into three main categories (Baig *et al.*, 1999). In certain cases, a single family controls the local economy and owns the whole hamlet. Alternately, numerous families may collectively own and run the neighborhood, although the dynamics of control are similar to single-family ownership. In the third scenario, a number of small landowners jointly run the village and collaborate with the tenants to supply housing and food (Baig *et al.*, 1999). About 80% of the country's rural population is made up of smallholders or landless individuals, according to the Pakistan Economic Survey (2013).

Agroforestry in Pakistan

Agroforestry practices entail deliberately blending trees or shrubs with livestock, agricultural crops, and other land uses (Nair, 1993). Proper maintenance of Agroforestry systems may maximize productivity within a limited area and timeframe while offering other advantages like animal habitat and stronger soil. In Pakistan, where people have historically grown trees in their house courtyards and grounds for various uses, these customs have a long history. Farmers have kept trees on their land for centuries to improve agricultural productivity, stop soil erosion, retain water, offer shade, and make money. Table 1, Farooq *et al.* (2018) lists the most common tree species on farmlands in Punjab Province. Due to donor-funded programs, expanding public knowledge of their advantages, and frequent governmental assistance, these agroforestry systems have received more attention and recognition in recent decades. When, Garland (1944) worked in Sindh province, the historical and practical roots of agroforestry in Pakistan may be traced back to that year. The Forestry Planning, and Development Project was Pakistan's first large-scale social/agroforestry initiative, launched in 1985 (Dove, 1992). In semi-arid environments, intercropping and livestock integration can potentially reduce crop failure's consequences, according to later studies (Mohammad and Salim, 1989). However, the use of agroforestry goes beyond marginal or degraded sites. The Sindh Province is home to vast forested regions where farmers group trees to make poles and restore damaged soils.

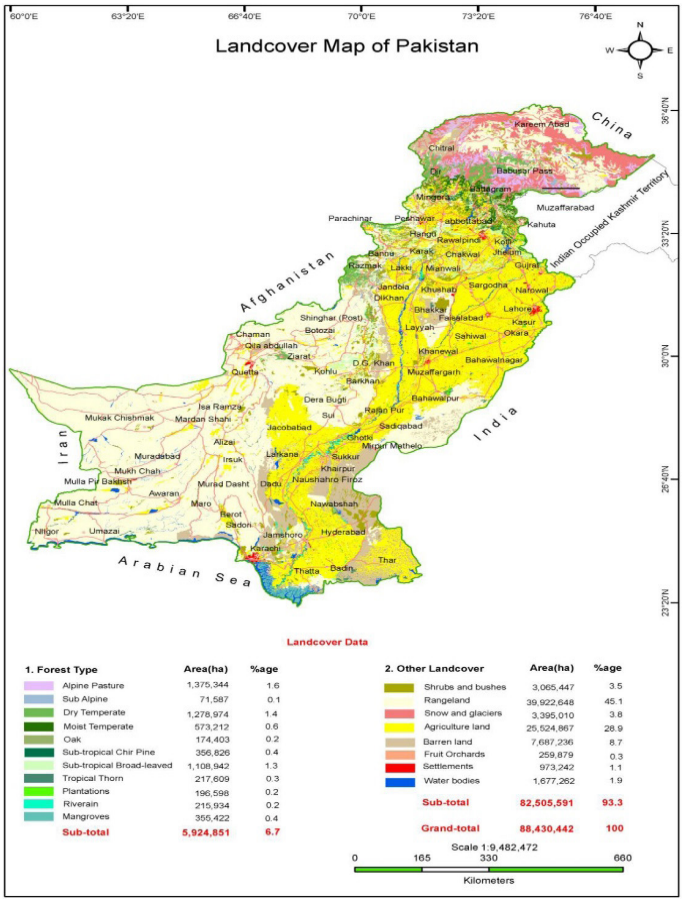

Figure 1: *Land cover map of Pakistan.*

Table 1: *Lists the common names of trees that exist on farmlands, in the Punjab Province along with their scientific names.*

Local name	Scientific name	Local name	Scientific name
Shisham	*Dalbergia sissoo*	Beri	*Ziziphus mauritiana*
Kikar	*Acacia nilotica*	Neem	*Azadirachta indica*
Bakain	*Melia azedarach*	Bohar	*Ficus benghalensis*
Shatoot	*Morus alba*	Amrood	*Psidium guajava*
Poplar	*Populus deltoides*	Malta	*Citrus sinensis*
Sumbal	*Bombax ceiba*	Mango	*Mangifera indica*
Sufaidah	*Eucalyptus camaldulensis*	Jaman	*Syzygium cumin*

Source: *Farooq et al., 2018.*

Benefits of agroforestry

Agroforestry practices yield a diverse array of advantages in Pakistan. Similar to numerous countries sharing comparable climatic and soil conditions, agroforestry furnishes a substantial and noteworthy array of services and goods. These include providing

forest-based products, regulation of soil erosion, alleviation of climate change repercussions, and amplifying cultural services. These methods maintain food production while reducing the adverse effects of the climate, increasing wood yield, and reversing land degradation. This results in increased agricultural revenue (Essa *et al.*, 2011; Ahmad *et al.*, 2017) and increased land productivity. Agroforestry systems, which use the enhanced sun radiation, water, and nutrient intake by all crops in the same area, can boost yields compared to monoculture alternatives by maintaining or increasing revenues from food production.

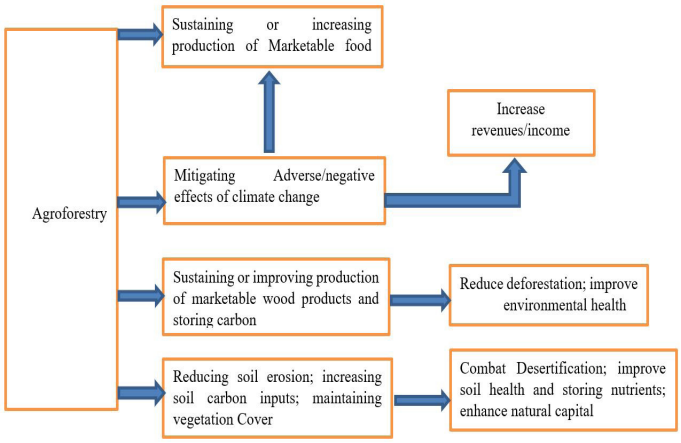

Figure 2: *Agroforestry increases providing, regulating, and cultural services, which enhances productivity and ecosystem service functions.*

Table 2: *Lists the most prevalent fruit trees in Swat Valley, KPK Province (Jamilu et al., 2014).*

Seasons	Scientific name and local name
Winter.	*Pyrus specie* (Nashpati)
	Citrus specie (Naranj)
	Malus domestica (Toot)
	Eriobotrya japonica (Saib)
	Morus specie (Loquat)
Summer	*Diosopyrus* specie (Amlooq)
	Prunus persica, (Shaltaloo)
	Juglans regia, (Akhrot)
	Prunus communus, (Aloocha)
	Prunus armeniaca, (Khoobani)
	Citrullus lanatus, (Kharbooza)
	Prunus dulcis, (Badam)

This improves how well sunshine, water, and nutrients are used. Additionally, trees provide extra marketable and palatable goods like fruits and nuts. According to research done in Africa (Mbow *et al.*, 2014) and South-East Asia, (Roshetko and Bertomeu 2015), the effective use of agro-forestry may sustain agricultural production and increase food security by producing tree-based crops. The underlying crops in the planting area gain from this strategy as well. As a land management technique, agroforestry protects croplands from drying and scorching winds in the form of windbreaks (Abbas *et al.*, 2017).

Climate change mitigation with agroforestry

According to the 2019 Global Climate Risk Index, (Eckstein *et al.*, 2018), Pakistan is predicted to be among the top ten nations most impacted by climate change. In Pakistan, average temperatures are predicted to climb by 4 °C by 2100, quicker than in most other places, according to a 2012 assessment by WWF. Along with these health, agriculture, and water resources concerns, the nation is experiencing more severe droughts and floods regularly (Salam 2018). Pakistani farmers must adjust to climate change, much as farmers in many Asian nations. Future forecasts show that the influence of climate change on rainfall patterns will vary across the nation, with greater rainfall in the Upper Indus Basin and decreased rainfall in the Lower Indus Basin (ADB, 2017).

Agroforestry to store carbon and reduce deforestation

Global targets to decrease greenhouse gas emissions include a primary objective of minimizing deforestation. Trees contribute to carbon sequestration above ground and enhance soil carbon content in cultivated croplands (Abbas *et al.*, 2017). By boosting the production of on-farm timber and fuel wood, agroforestry can balance off or reduce emissions caused by forest harvesting or degradation (Minang *et al.*, 2011; Madalcho and Tefera, 2016; Abbas *et al.*, 2017). According to Abbas *et al.* (2017), agroforestry has much potential for storing atmospheric carbon in soil, above-ground, and below-ground biomass. Asif *et al.* (2018) also emphasized the advantages of implementing agroforestry to increase tree coverage outside forested regions, resulting in more job possibilities, greater farmer incomes, and positive environmental effects. Rahim and Hasnain (2010) report that, as opposed to state-owned forests, a substantial majority of Pakistan's fuel wood (90%) and lumber (72%) originate from trees on reserved or community holdings. Despite having almost, 330 million trees on 19.3 million hectares of agriculture, the country struggles with a wood

deficit, necessitating imports. With borders with China, Afghanistan and India, Gilgit Baltistan is a territory in northern Pakistan that is around 28,000 square miles, (73,000 km^2) in size. Because of the province's colder temperature and high heights, it is distinguished for its extensive natural woods. Locals graze their animals and rely on nearby woodlands for wood fuel and building materials. The government is aggressively encouraging poplar tree production on farms and lands to relieve strain on the area's natural forests.

Combating land degradation and desertification through Agroforestry

According to Jamilu *et al.* (2014), agroforestry has the ability to increase plant cover and prevent soil erosion. It also presents a practical solution for reclaiming large tracts of Pakistani desert. According to the World Resources Institute (WRI), degraded land denotes to land that has lost its natural productivity due to human-induced causes. These factors often include unfavorable changes in the soil's physical, chemical, and/or biological characteristics coupled with vegetation degradation. Agroforestry provides a way to combat land degradation by enhancing vegetative cover (Tolunay *et al.*, 2007; Glover, 2010).

Constraints, to agroforestry system in Pakistan

Despite the many benefits that agroforestry may provide, numerous farmers in Pakistan still hesitate to create and sustain innovative agroforestry systems. Dove (1995a, b) emphasized that human factors, not physical ones, are principally responsible for the growth of agroforestry in Pakistan. Similarly, Zubair and Garforth (2006) emphasized that the farmers attitudes and beliefs influence how trees are handled on farms. Concerns concerning (i) agricultural production, (ii) restricted market access and supply, (iii) land allocation, and (iv) technical assistance are the main barriers to the broad adoption of agroforestry in Pakistan. The lack of water in some areas makes adopting agroforestry practices extremely difficult.

Apprehensions about agricultural production

Crops growing beneath trees may experience less heat stress and suffer fewer negative impacts from parching breezes if there are trees to provide shade. Furthermore, trees help increase the organic matter in farmed soils, and nitrogen-fixing trees may help increase soil nitrogen levels (Baig *et al.*, 1999). Regardless of these benefits, some farmers continue to hold the belief that trees reduce agricultural output because they shade crops, compete for nutrients, and provide a risk of insect, disease, and avian predator damage (Jamilu *et al.*, 2014). Although Sheikh (2001) said that extension specialists ought to debunk such beliefs, a more successful strategy for encouraging adoption would entail locating instances where viable tree species coincide with farmers' requirements and goals. While farmers have significant knowledge of the best planting sites and options for their farms, extension workers may provide information about tree species that complement agricultural products in terms of phenology and root structure. For instance, increased agricultural output far from the tree line in windy settings can balance out yield decrease close to the trees. Further reducing light competition is the adoption of tree species with erect and thin canopies, such as Kikar (*Acacia nilotica*) and black poplar (*Populus nigra*), which most trees in Pakistan drop their leaves during the winter when sunlight is most scarce. Sheikh (2001) asserted that the majority of birds do not use trees as feeding grounds for grain consumption, but rather, birds may greatly lower the populations of dangerous insects.

Concerns for lack of resources and market

The existing market structure and institutional policies impose constraints on the potential of agroforestry. According to Jamilu *et al.* (2014), there are frequently no established marketplaces for selling wood and other tree products at standardized pricing, leaving farm foresters open to abuse by mediators. Farmers also want aid in finding acceptable customers and some government-backed guarantee or assurance that markets would be open to acquiring their trees and logs at fair rates. According to Farooq *et al.* (2017), the main obstacles were a lack of cash and money to buy saplings, poor transportation infrastructure, and unstable root supplies. Additionally, a lack of expertise in woodworking among many rural foresters and craftsmen limits the potential for value addition and efficient marketing.

Poor communication between extension and research

Due to limited technical assistance, the broad adoption of agroforestry may encounter major difficulties (Farooq *et al.*, 2017; Sheikh, 2001). This barrier consists of the lack of methods for technology transfer, the attitudes of foresters and administrators that are uncooperative, the scarcity of qualified employees, the negative reactions of clients, and human behavior.

The issue is further exacerbated by the absence of extensionist follow-up visits (Sheikh, 1991, 2001). Extension workers are essential in guaranteeing the proper implementation of agroforestry to overcome these obstacles. They improve research and outreach activities by addressing multiple factors, including time, location, and composition, and serving as a bridge between practitioners, scientists, and development organizations (Raintree, 1983; Baig *et al*., 1999). In a conventional functional extension paradigm, scientists and field workers work together to create affordable solutions to agricultural problems, and extension specialists effectively transfer these solutions to end users (Baig, 1992). However, a lack of coordination and collaboration among institutions or organizations engaged in agricultural, forestry, and research extension work that aims to support farmers frequently leads to duplication of effort and resource waste. This problem was brought to light in research that looked at the connections between agriculture and forestry extension services and the barriers to successful collaboration in the KPK Province, located in the hilly region of Northern Pakistan. The study found that while both organizations offered farmers extension services and recommend/advice on fruit trees, the success of their overall efforts was hindered by a poor formal and informal working relationship between the two departments. Furthermore, well-structured studies are important for detecting problems because they let researchers set study objectives and develop plans for informing agroforestry practitioners of findings (Sheikh, 2001).

Agroforestry extension in Pakistan (Successes and challenges)

Southern Punjab is characterized by the Thal Desert, which features a hot, arid environment and sandy soil, resulting in a scarcity of vegetation, primarily consisting of prickly plants. This poses a significant challenge to the region's capacity for sustainable agriculture. To address this issue, the government has implemented a program that provides free plants to new settlers, who are encouraged to plant them along agricultural roads, fields, and streams. In addition, a vast network of nurseries has been established to provide farmers with direct access to cuttings and plants. Over time, millions of trees have been planted, transforming the once-barren desert into a lush landscape.

The agricultural land of Sindh Province has also been managed in a similar fashion, thanks to the availability of water from the Indus River. Thanks to these tree extension programmes, farmers can get their hands on trees, seedlings, and cuttings for next to nothing. There have been afforestation and reforestation initiatives in the Himalayan foothills, upper Bhurban plains, Gullies, and Daur of Murree Hills. In 1971, the utilisation of poplar trees began in the towns of Peshawar and Mardan, which are located in the KPK Province. Technical support and extension services have been important in the success of these projects.

Private land in the Kaghan and Mansehra valleys has been successfully planted with chir-pine (*Pinus roxburghii*), further proving the efficiency of these activities. Projects like Pakistan's Forestry Planning and Development Project and Gilgit Baltistan's Agha Khan Rural Support Programme have shown that training and education can encourage widespread tree planting. Training and incentives for farmers are necessary to advance agroforestry in the nation, say Hasan *et al*. (2014). Targeted efforts to improve sustainable agriculture and forestry practices in Pakistan can make great success, as shown by these initiatives.

Under these circumstances, the seven year old Forestry Planning and Development Project was crucial. Over four thousand farmer nurseries worked together to generate over 140 million seedlings, of which 92 million made it to maturity, covering forty thousand hectares. over top of that, soil conservation measures were implemented over 7,000 hectares of land. The Punjab Forest Sector Development Project had a dual purpose: First, it assisted farmers and junior forestry workers in developing a participatory design and management system; second, it enabled the transfer of knowledge and skills to end users by offering short courses in plant culture and field planting. Sheikh (2001) further noted that the project enhanced community and state institutions involved in forest management on a local level. To effectively develop these programmes, it is crucial to solve the significant challenges listed in Table 3.

Sharing awareness of a problem/vision

Achieving successful extension relies on recognizing the need to address a challenge or envision enhancing the current circumstances. Agents of change must familiarize themselves with their target audiences, actively listen their inquiries, and assess their existing knowledge and requirements. Reiterating what people

already know provides minimal value. It has been contended that while many farmers acknowledge the degradation of fertile lands, they might lack the impetus to tackle the issue, often assuming that either nature or governmental interventions will rectify the situation. In certain cases, instigating change can be oriented around specific problems such as overgrazing (exacerbating soil erosion), mismanagement of water resources (leading to waterlogging and salinity), and improper use of agrochemicals (causing soil and water contamination) (Akbar *et al*., 1989a, b, 1990). In rural regions of Pakistan, a lack of awareness regarding an issue can be attributed to low levels of education and literacy. Moreover, a perceived concern like deforestation might take a backseat to the daily struggle for survival and the necessity for firewood. Similarly, people could be closely tied to specific geographical areas and thus unswilling or unable to travel from their villages to observe reforestation initiatives elsewhere. Effective extension efforts must identify such hurdles/constraints, and progress can be augmented by devising an imaginative vision that yields positive outcomes (McDonough and Braungart, 2013).

Extension by suitable people

Extension agents should possess a strong commitment and a sufficient level of expertise to effectively address inquiries from farmers (Baig *et al*., 1999). Furthermore, due to the varied fields of information required for these intricate, interconnected systems, a readiness to collaborate across disciplines is imperative (for example Fike *et al*., 2016). While it is certainly valuable for an extension agent to be well-versed in new technologies and governmental regulations, it holds greater significance for them to exhibit a curious and proactive mindset and be aware of where to access reliable information and sound guidance. An ability to reflect on areas for improvement and a willingness to enhance extension materials continuously are crucial aspects of the role. This process of refining extension materials is expected to be an ongoing endeavor.

Extension materials can be disseminated through various mediums, such as brochures and accessible local-language articles within agricultural magazines and daily newspapers. Historically, messages were transmitted via radio and television, and in contemporary times, the potential of utilizing social media has emerged. In Pakistan, farmers often hold negative perceptions about foresters, and many foresters are reluctant to conduct extension activities despite offered incentives. Challenges and potential hostility frequently mark the existing dynamic between foresters and farmers. In certain instances, foresters have been integrated into extension programs primarily for administrative purposes, resulting in disinterest and diminished credibility within local communities. Establishing a positive impact under such circumstances is daunting (Sheikh, 1992a, b, 2001). Despite having forestry and agricultural extension personnel, Pakistan confronts a significant shortage of adequately trained agroforestry specialists. One potential solution could involve providing ongoing training for extensionists from both sectors, fostering collaboration between foresters and agriculturists, and incorporating social scientists to enable comprehension and build rapport (Vergara, 1989; Baig and Ehrenreich, 1993). There is also a precise need for leadership training and the cultivation of skills that facilitate partnerships and cooperation across different fields of expertise (Brooks *et al*., 1994).

Documentation of target, persons/groups

The effectiveness of extension initiatives also rely on extension personnel accurately identifying the specific needs of significant target demographics. Yocco (2015) argues that disseminating innovations may not seamlessly transition from one social group to another. For example, small-scale farmers are unlikely to seek advice from larger farmers with trees. Similarly, a tenant in Sindh or Balochistan Province might hesitate to approach a sardar (landlord) to discuss tree planting. These methods involve engaging interested farmers in meetings and sharing instances of successful innovation (FAO, 1997). In Pakistan, progressive farmers are generally open to collaboration and involvement in experimenting with innovations such as agroforestry (Baig *et al*., 1999). In reality, generating advantages for communities upstream may necessitate an alternative strategy, such as promoting small-scale industries, enhancing marketing infrastructure, providing healthcare services, or facilitating the establishment of clean drinking water sources (Sheikh, 2001).

Selection of the most suitable media

The chosen communication channel should be tailored to suit the content, the attributes of the intended audience (such as their existing knowledge and requirements), and the prevailing social context

(Wete, 1991). Extension communications ought to be formulated most simply and understandably. Additional key factors encompass the accessibility for the target groups and the associated costs (Hedge, 1989; Baig and Ehrenreich, 1993). Nayman (1988, 1990) discovered that Pakistani farmers were proactive in seeking information, utilizing various approaches to acquire novel agricultural insights for enhancing their farming endeavors. The predominant sources included fellow farmers (91%) and private market agents (65%). Given the limited literacy rates, visual media emerge as a favorable option for non-personal communication, effectively delivering messages (Baig and Ehrenreich, 1993; Baig *et al*., 1998, 1999). Notable examples of primary forms of media encompass.

Direct communication

Effective communication among seasoned practitioners and individuals or collectives has historically proven successful within the rural communities of Pakistan. Certain extension workers with excellent training and credibility can motivate and stimulate farmers into taking proactive measures. In certain situations, even imams and other religious figures are willing to permit extension workers to speak before prayer assemblies in Mosques and other places of worship (Sheikh, 2001).

Practice print and electronic media

The extensive and varied geography and the widespread distribution of extension locations have led to the use of diverse communication methods for agroforestry extension in Pakistan. This often involves utilizing, newspapers, posters, radio, television, and slide shows. These tools have demonstrated effectiveness and efficiency in conveying messages and technical knowledge (Baig and Ehrenreich, 1993; Baig *et al*., 1999; Wattoo *et al*., 2010; Baig and Aldosari, 2013). While various methods have their merits, electronic media such as radio might prove particularly advantageous, given rural communities' comparatively lower literacy rates.

Demo plots and model farms

Because most farmers are more of a do it yourself kind of learner, they place a premium on demonstrations that involve actual work. For example, agroforestry methods in the irrigated plains of Punjab, eucalyptus windbreaks in Sindh, and poplar wood lots in KPK Province have all contributed significantly to the credibility of agroforestry. A lot of farmers have gotten into tree planting because of these demonstrations. Farmers who have found success in reseeding degraded areas with nutritious grasses can also set an example for those who are just starting out in the livestock industry. Seeing fields that have been successfully reseeded by other farmers has left a profound impression on the local farming community (Sheikh, 2001). By utilising the resources of farmers and tackling comparable issues and limits, demonstration plots have demonstrated remarkable success when grown on their property (Baig and Ehrenreich, 1993; Baig *et al*., 1998, 1999). More effective and meaningful development is achieved when farmers are involved, according to Brennan (1989).

Websites and social media

While social media may raise awareness, websites can be a very efficient and cost-effective medium for sharing information. For instance, according to Burgess and Rosati (2018), the Agforward website (www.agforward.eu) has successfully promoted agroforestry throughout Europe. Depending on the project stage and the amount of participation, the messaging's content may change. Agroforestry programs require compelling messaging in the early phases of implementation in order to draw the attention of participating farmers. Later communication initiatives could emphasize advantages, including increased productivity, resource protection, and infrastructural improvements (Hedge, 1989; Baig *et al*., 1998, 1999).

Durable institutional support

With inadequate administrative, financial, and technical support, farmers are hesitant to embrace new ideas. Inadequate data, funding, inputs, or prompt instructions about field activities constitute a disincentive. Support from institutions and the hard work of extension workers familiar with the local culture are the two most important factors in providing quality extension services (Baig *et al*., 1999). There is a lack of evaluation and monitoring over the long term, thus new initiatives only have an impact for as long as they are in place (Sheikh, 2001).

Conclusions and Recommendations

Currently, Pakistan's food and fuel supply is not adequately meeting the demands of a growing population. It is urgent to enhance awareness regarding the advantages of agroforestry (such as

income generation, soil enhancement, and climate regulation) among potential adopters. Skillful incorporation of trees within farming systems can uphold food production, mitigate land degradation, and introduce supplementary income sources. Nonetheless, agroforestry practices encompass many intricate systems, reflecting the cumulative wisdom, experimentation, and innovations amassed by farmers over centuries. It is vital to collaborate closely with individual farmers to determine the most suitable agroforestry practices for their specific farms. Thus, extension workers should be trained to assess farmers' requirements and suggest appropriate agroforestry configurations to meet those needs. Given the limited literacy levels in rural areas, visual aids often prove more effective than written materials. Establishing prototype agri-forestry farms at the village level is also strongly suggested. The devoted extension initiatives undertaken by the Government are laudable and will likely yield positive results, particularly when coupled with economic incentives. However, they demand persistent commitment and continuous evaluation. The present moment calls for collaboration among extension workers, farmers, researchers, and policymakers to propel the advancement of agroforestry in Pakistan.

Recommendations

To increase the nation's resources by productive and conservational function, this study has explored the difficulties and possibilities of agroforestry practices in Pakistan. Agroforestry extension should be a thorough process that includes identifying constraints and objectives, attending to facilitators' and end-users needs, showcasing creative opportunities and resources, and establishing efficient communication channels within a reflective institutional framework (as shown in Table 3). Vergara and MacDicken (1990) put similar emphasis on technology packages, problem-oriented research, diffusion, and the significance of monitoring and assessment. The research highlights the need to incorporate end-user input into co-creating the difficulties and ambitions connected to agroforestry development (Coe *et al.*, 2014). The considerations listed in Table 3 should be adhered to when recommending extension initiatives, which may cover various requirements. According to Jamilu *et al.* (2014) and Farooq *et al.* (2017), the goal of agroforestry extension in certain circumstances may be to raise farmers' understanding of the benefits of agri forestry in terms of higher revenue and soil preservation. We contend that to engage with both the agriculture and forestry sectors effectively; there must be a need to invest in a committed unit of extension workers (Baig *et al.*, 1999). Specialized training of agri forestry would benefit this group (Anwar *et al.*, 2017), fostering improved collaboration between the forestry and agriculture departments.

Table 3: *Recommendations for agroforestry extension in Pakistan.*

Questions	Recommendations
Reason of extension?	The extension workers and end-users should collaboratively develop the challenges and goals for agri forestry development.
Extension by whom?	The objective is to produce agroforestry extension specialists who can effectively link the departments of forestry and agriculture. Non-governmental organisations (NGOs), cooperative societies, local religious and community leaders, and established organisations should all work together with this unit. It should also utilise the expertise of trained local and indigenous knowledge specialists.
Extension for whom?	The main emphasis is on farmers, recognizing the importance of actively involving youth and women.
Extension of what?	The local population can determine which agroforestry initiatives should be given priority by using a participatory approach. Other extension efforts might be focused on addressing land tenure and property rights issues, even though organisations like the Forest Department can be useful in certain technical aspects, like building nurseries and offering advice on planting, species selection, and harvesting techniques. The strategies for the programmes need to be flexible and often reviewed.
Extension using what mass media?	Integrating the study of agroforestry into curricula at the high school and college levels in order to promote a love of trees. Print, radio, and television can all be effective means of reaching a big audience; FM radio stations are particularly powerful in this regard.
Do you use financial inducements?	When appropriate, provide the facilities required to support agroforestry operations. But it's crucial to resolve any possible arguments over water fees and land revenue, mostly in irrigated agricultural lands.
Extension Period?	In order to reduce poverty and boost food availability in rural regions, strengthen institutional backing for the intended goals in mark with government regulations.

To encourage agroforestry and enhance the market for tree-based products made from agricultural land, the government is sometimes needed to provide early grants or subsidies (Anwar *et al*., 2017; Jamilu *et al*., 2014; Rasul and Hussain, 2015; Farooq *et al*., 2018). In some situations, it's vital to address issues like land tenure or to encourage cordial relationships between landlords and tenants (Anwar *et al*., 2017). Laws that prevent the movement of imports across provinces, like poplar wood, may need to be changed in specific circumstances (Shaikh, 2000; Rahim and Hasnain, 2010).

Acknowledgement

It is an honour for me to express my heartiest gratitude and profound indebtedness to the Director Forestry Research Division Dr. Anwar Ali for his constructive criticism, moral support and final review during the review. I am also thankful to Dr. Nowsherwan Zarif for Topic Selection and cooperation during the process. I gratefully acknowledge invaluable help render by Mr. Saif ullah Khan for his cooperation. I would like to extend my thanks and compliments to my Colleague Mr. Salman Ahmad who helped me a lot during my Review paper. I am also thankful to all staff of Forestry Research Division, Pakistan Forest Institute Peshawar for their moral and emotional support which made me able to complete my studies.

Novelty Statement

Exploring the impacts of agroforestry on Resource management in Pakistan to unveil a transformative approach to sustainable agriculture, combining ecological benefits with enhanced socio economic resilience, and offering a blueprint for addressing the countries pressing environmental and resource challenges.

Author's Contrubtion

Basheer Ahmad: Reviewed the manuscript.
Nowsherwan Zarif: Topic Selection
Saif Ullah Khan: Data Analysis
Salman Ahmad: Composed the manuscript.
Anwar Ali: Did Final Revision.

Conflict of interest
The authors have declared no conflict of interest.

References

Abbas, F., Hammad, H.M., Fahad, S., Cerda, A., Rizwa, M., Farhad, W., Ehsan, S. and Bakhat, H.F., 2017. Agroforestry: A sustainable environmental practice for carbon sequestration under the climate change scenarios. A review. Environ. Sci. Pollut. Res. Int., 24: 11177–11191. https://doi.org/10.1007/s11356-017-8687-0

ADB, 2017. Climate change profile of Pakistan. Prepared by: Qamar Uz Zaman Chaudhry; International Climate Technology Expert. Asian Development Bank, Manila, Philippines. ISBN 978-92-9257-721-6 (Print), 978-92-9257-722-3 (e-ISBN) Publication Stock No. TCS178761. https://www.adb.org/sites/default/files/publication/357876/climate-change-profilepakistan.pdf. Accessed 20 Feb 2019.

Ahmad, A., Shahbaz, B., Shehzad, M., Khursheed, K. and Aftab, M., 2017. Analysis of performance of farm forestry and its role in household income in district Faisalabad, Pakistan. J. Glob. Innov. Agric. Soc. Sci., 5: 39–42. https://doi.org/10.22194/JGIASS/5.1.762

Akbar, G., Ashraf, M.M. and Ahmad, M., 1989a. Agroforestry: A new horizon for wood production and increased farm income-I. Sustainable development. A challenge in Pakistan. Prog. Farm., 9: 32–38.

Akbar, G., Ashraf, M.M. and Ahmad, M., 1989b. Agroforestry: A new horizon for wood production and increased farm income-II. History and future prospects. Progr. Farm., 9: 32–40.

Akbar, G., Ashraf, M.M. and Ahmad, M., 1990. Agroforestry: A new horizon for wood production and increased farm income- III. Role in ecosystem sustainability. Progr. Farm., 10: 30–37.

Akbar, G., Baig, M.B. and Asif, M., 2000. Social aspects in launching successful agroforestry projects in developing countries. Sci. Vis., 5: 52–58.

Ali, A., Rahut, D.B. and Imtiaz, M., 2017. Implications of less tail end water on livelihoods of small farmers in Pakistan. Outlook Agric., 46: 36–43. https://doi.org/10.1177/0030727016689735

Amare, D., Wondie, M., Mekuria, W. and Darr, D., 2018. Agroforestry of smallholder farmers

in Ethiopia: Practices and benefits. Small-Scale For., https://doi.org/10.1007/s11842-018-9405-6

Anwar, F., Jamil, M., Fahad, S. and Khan, A., 2017. Role of agroforestry in wood production and farmer's perception in Pakistan: A review. Am. Eurasian J. Agric. Environ. Sci., 17: 300–306.

Aquino, R., Del Castillo, R.A. and Payuan, E., 1987. Mounting a national social forestry program: The Philippine experience. Working paper. East-West Centre, Honolulu, HI, USA.

Asif, E.R., Hussain, S., Ijaz, M. and Niaz, N., 2018. Agroforestry: Needs and practices for adoption in Pakistan. https://agrihunt.com/articles/pak-agrioutlook/agroforestryneeds-and-practices-for-adoption-in-pakistan/. Accessed 12 June 2019.

Axinn, G.H., 1987. The different systems of agricultural extension education with special attention to Asia and Africa. In: eds. Rivera, W.M. and Schram, S.G., Agricultural extension worldwide issues, practices and emerging priorities. Croom Helm, New York.

Baig, M.B., 1992. Technology transfer and agricultural extension in Asian countries. M.S. thesis, Utah State University, Logan, USA.

Baig, M.B. and Aldosari, F., 2013. Agricultural extension in Asia: Constraints and options for improvement. J. Anim. Plant Sci., 23(2): 619–632.

Baig, M.B. and Ehrenreich, J.H., 1993. Promoting agroforestry through extension: A Pakistan example. In: Schultz, R.C. and Colletti, J.P., (Eds) proceedings on third North American Agroforestry conference. Ames, Iowa, pp. 283–286.

Baig, M.B. and Ehrenreich, J.H., 1997. The potential prospects and problems of agroforestry in Pakistan-1: Research and development. Pak. J. Agric. Sci., 34: 22–28.

Baig, M.B., Khan, M.A. and Sultani, M.I., 1998. Agroforestry as a farming system in Pakistan: Potential and problems. Sci. Vis., 3: 25–34.

Baig, M.B., Akbar, G., Straquadine, G.S. and Razzaq, A., 1999. Agroforestry extension and technology transfer to farmers in Pakistan. J. Sci. Vis., 5(1): 42–50.

Brennan, E., 1989. Using farmers and their ideas for effective extension work: A case study from Thailand. In: Proceedings of international conference on MPTS research for small farms: Strategies and methods. Jakarta, Indonesia, pp. 94–97.

Brooks, K.N., Gregersen, H.M. and Ffolliott, P.F., 1994. Role of agroforestry in sustainable land-use systems. In: Rietveld WJ (Ed) Agroforestry and sustainable systems: Symposium proceedings on USDA Forest Service. Gen. Tech. Rep. RM-GTR 261. pp. 99–205.

Burgess, P.J. and Rosati, A., 2018. Advances in European agroforestry: Results from the AGFORWARD project. Agrofor. Syst., 92: 801–810. https://doi.org/10.1007/s10457-018-0261-3

Chaudhry, A.A., 2011. Forest and climate change. Report on world environment day, June 16.

Coe, R., Sinclair, F. and Barrios, E., 2014. Scaling up agroforestry requires research in rather than for development. Curr. Opin. Environ. Sustain., 6: 73–77. https://doi.org/10.1016/j.cosust.2013.10.013

Dove, M.R., 1992. Forester beliefs about farmers: A priority for social science research in social forestry. Agrofor. Syst., 17: 13–41. https://doi.org/10.1007/BF00122925

Dove, M.R., 1995a. The human-ecological background of farm forestry development in Pakistan. In: Saxena NC, Ballabh V (eds) farm forestry in South Asia. Sage Publications, London.

Dove, M.R., 1995b. The shift of tree cover from forests to farms in Pakistan: A long and broad view. In: Dewees, A. (ed). Tree management in farmer strategies: Responses to Agricultural Intensification Arnold JEM. Oxford University Press, Oxford.

Eckstein, D., Hutfil, M.L. and Winges, M., 2018. Global climate risk index 2019. Who suffers most from extreme weather events? Weather-related loss events in 2017 and 1998 to 2017. Germanwatch. https://germanwatch.org/sites/germanwatch.org/files/Global%20Climate%20Risk% 20Index%202019_2.pdf. Accessed on 19 Feb 2019

Essa, M., 2004. Household income and natural forest conservation by agroforestry: An analysis based on two agro-ecological zones: Bagrot and Jalalabad in Northern Pakistan. M.Sc. thesis Norwegian University of Life Sciences, Norway.

Essa, M., Nizami, S.M., Mirza, S.N., Khan, I.A. and Athar, M., 2011. Contribution of agroforestry in farmers' livelihood and its impact on natural

forest in Northern Areas of Pakistan. Afr. J. Biol., 10: 15529–15537. https://doi.org/10.5897/AJB09.1067

Falconer, J., 1987. Forestry extension: A review of the key issues. Network paper 4e. Social Forestry Network. Overseas Development Institute. ODI, London, pp. 34.

FAO, 1985a. Tropical forestry action plan. Committee on Forest Development in the Tropics. Food and Agriculture Organization of the United Nations. FAO, Rome, pp. 159.

FAO, 1985b. Tree growing by rural people. FAO Forestry Paper 64. Food and Agriculture Organization of the United Nations. FAO, Rome, pp. 130.

FAO, 1986. Forestry extension organization. FAO Forestry Paper No. 66. Food and Agriculture Organization of the United Nations. FAO, Rome.

FAO, 1988. Planning forestry extension programs. Regional wood energy development program in Asia, GCP/RAS/ 111/NET Field Document No. 8. Food and Agriculture Organization of the United Nations. FAO, Bangkok, pp. 199.

FAO, 1989. Forestry and food security. FAO Forestry Paper No. 90. Food and Agriculture Organization of the United Nations. FAO, Rome.

FAO, 1997. Improving agricultural extension. A Reference Manual. 3rd Edition, Food and Agriculture Organization of the United Nations. FAO, Rome.

FAO, 2015a. Global forest resource assessment 2015. Desk reference. Food and Agriculture Organization of the United Nations. Rome. http://www.fao.org/3/ai4808e.pdf. Accessed on 22nd Jan 2018.

FAO, 2015b. Agroforestry. Food and agriculture organization of the United Nations. Rome. http://www.fao.org/forestry/agroforestry/80338/en/. Accessed on 6 Nov 2019.

Farooq, T.H., Nawaz, M.F., Khan, M.W., Gilani, M.M., Buajan, S., Iftikhar, J., Tunon, N. and Wu, P., 2017. Potentials of agroforestry and constraints faced by the farmers in its adoption in District Nankana Sahib,Pakistan. Int. J. Dev. Sustain., 6: 586–593.

Farooq, T.H., Gautam, N.P., Rashid, M.H.U., Gilani, M.M., Nemin, W., Nawaz, M.F., Islam, W., Zainab, M. and Wu, P., 2018. Contributions of agroforestry on socio-economic conditions of farmers in central Punjab, Pakistan. A case study. Cerceta˘ri Agronomice ın Moldova, 51: 91–101. https://doi.org/10.2478/cerce-2018-0020

Fike, J., Downing, A., Daniel, J.B., Teutsch, C., Mercie, K. and Pent, G., 2016. Creating silvopastures: Some considerations when thinning existing timber stands. Virginia Cooperative Extension Publication CES-155. http://digitalpubs.ext.vt.edu/vcedigitalpubs/8513366315849431/MobilePagedReplica.action?. Accessed 12 Jan 2019.

Garland, E.A., 1944. Experiments in alternating husbandry in Sind. Indian Farm, 5: 495–498.

Glover, E.K., 2010. Approaches to halt and reverse land degradation in Kenya: Agroforestry development and environmental sustainability. VDM Verlag, Saarbru¨cken.

GOP, 2008. Agricultural statistics of Pakistan 2008. Islamabad, Pakistan: Economics Division, Ministry of Food, Agriculture and Livestock, Government of Pakistan.

GOP, 2013. The state of environment of Pakistan, Report of the Government of Pakistan, pp. 35–77.

Hasan, G., Ashraf, I., Mehmood, C.K., Sagheer, A. and Irshad, M.Q., 2014. Present and future prospects of agroforestry as perceived by farmers in Punjab, Pakistan. Int. Asian Res. J., 2: 11–17.

Hedge, N.G., 1989. Extension and training needs to motivate small scale farmers. In: Proceedings of international conferrence on MPTS research for small farms: Strategies and methods. Jakarta, Indonesia, pp. 98–102.

Jamilu, A., Ammar, H. and Gardish, D.M., 2014. Factors upsetting agroforestry system in Swat, Pakistan. Int. J. Agrofor. Silvic., 1: 86–92.

Kerkhof, P., 1990. Agroforestry for development in Kenya: A survey of project experience. Panos Institute, London, pp. 216.

Khan, M., Mahmood, H.Z., Abbas, G. and Damalas, C.A., 2017. Agroforestry systems as alternative land-use options in the arid zone of Thal, Pakistan. Small-Scale For., 16: 553–569. https://doi.org/10.1007/s11842-017-9372-3

Lowdermilk, M.K., 1972. Diffusion of dwarf wheat production technology in Pakistan's Punjab. Ph.D. thesis. Cornell University, Ithaca, New York.

Ma, W.J., Mao, Z.Q., Yu, Z.R., Van Mensvoort, M.E.F. and Driessen, P.M., 2008. Effects of saline water irrigation on soil salinity and

yield of winter wheat–maize in North China Plain. Irrig. Drain. Syst., 22: 3–18. https://doi.org/10.1007/s10795-007-9027-1

Madalcho, A.B. and Tefera, M.T., 2016. Management of traditional agroforestry practices in Gununo Watershed in Wolaita Zone, Ethiopia. For. Res., 5: 163.

Magsi, H., Lohano, H.D. and Mirani, Z.U., 2014. Marketing system and structure for agroforestry products in Sindh, Pakistan. Eur. Acta Res., 2(7): 9509–9522.

Malik, W. and Prawl, W., 1993. Reforming agricultural extension in Pakistan. In: Proceedings on National Workshop on Reforming Agricultural Extension in Pakistan. FAO, UNDP and Pakistan Agricultural Research Council, Islamabad. Pakistan, pp. 13–42.

Mbow, C., van Noordwijk, M., Prabhu, R. and Simons, T., 2014. Knowledge gaps and research needs concerning agro- forestry's contribution to sustainable development goals in Africa. Curr. Opin. Environ. Sustain. 6: 162–170. https://doi.org/10.1016/j.cosust.2013.11.030

McDonough, W. and Braungart, N., 2013. The upcycle: Beyond sustainability designing for abundance. North Point Press, New York.

Minang, P.A., Bernard, F., van Noordwijk, M. and Kahurani, E., 2011. Agroforestry in REDD?: opportunities and challenges. ASB Policy Brief No. 26, ASB Partnership for the Tropical Forest Margins, Nairobi, Kenya.

Ministry of Finance, 2007. Economic Survey of Pakistan (2006-07). Agriculture. Chapter 2. Government of Pakistan, Islamabad, Pakistan. http://www.finance.gov.pk/survey/chapters/02-Agriculture.PDF. Accessed 15 Sept 2008.

Mohammad, T. and Ehrenreich, J.H., 1993. The scope and development of agroforestry in Pakistan. In: Schultz R.C. and Colletti, P., (Eds). Proceedings of third North American agroforestry conference. Ames, Iowa USA, pp. 377–379.

Mohammad, A. and Salim, M., 1989. Soil quality and sustainability aspects of low input agriculture in semiarid regions of Pakistan. In: Proceedings of international congress on soil quality in semiarid agriculture. Sasktoon Canada, pp. 196–215.

Nair, P.K.R., 1993. An introduction to agroforestry. Kluwer Academic Publishers, Dordrecht, pp. 1–440.

Nayman, O.B., 1988. Seekers of light. An evaluation of official and non-official sources of agricultural information. Lahore, Punjab, Pakistan.

Nayman, O.B., 1990. Distant cousins. An evaluation of official and non-official sources of agricultural information. Lahore, Punjab, Pakistan.

Nile TV International, 2019. Map of Pakistan. http://www.nileinternational.net/en/?p=58583. Accessed 12 Sept 2019.

Pakistan Economic Survey, 2013-14. Environment. Chapter 16. Ministry of Finance, Government of Pakistan, Islamabad, Pakistan. pp. 245–256. http://www.finance.gov.pk/survey/chapters_14/16_Environment.pdf. Accessed 23 Aug 2015.

Pakistan Economic Survey, 2018-19. Education. Chapter 10. Ministry of Finance. Government of Pakistan. Islamabad. http://www.finance.gov.pk/survey/chapters_19/10- Education.pdf. Accessed 15 Aug 2019.

PARC, 2019. Agro-ecological zones of Pakistan. Agricultural maps of Pakistan. http://www.parc.gov.pk/index.php/en/component/content/article/43-maps/19-agrimaps. Accessed 22 Jan 2019.

PBS, 2016. Household size. Chapter 3. Household Integrated Economic Survey HIES (2015-16). Government of Pakistan. Statistics Division. Pakistan Bureau of Statistics, Government of Pakistan. Islamabad. Dec, 2016. http://www.pbs.gov.pk/sites/default/files/pslm/publications/hies15-16/write%20up%2015-16-HIES-final.pdf.

PBS, 2017. Pakistan Bureau of Statistics. Provisional summary results of 6th population and housing census 2017. http://www.pbs.gov.pk/content/provisional-summaryresults-6th-population-and-housing-census-2017-0. Accessed on 22 Jan 2018.

Planning Commission, 1988. Seventh five-year plan 1988-93 and perspective plan. Ministry of Planning. Government of Pakistan, Islamabad. Pakistan.

Population Census, 2017. Pakistan Bureau of Statistics. Islamabad, Pakistan. http://www.pbs.gov.pk/content/population-census. Accessed 17 Sept 2019.

Rahim, S.M.A. and Hasnain, S., 2010. Agroforestry

trends in Punjab, Pakistan. Afr. J. Environ. Sci. Technol., 4: 639–650.

Raintree, J.B., 1983. Strategies for enhancing adoptability of agroforestry innovations. Agrofor. Syst., 1: 173–187. https://doi.org/10.1007/BF00130606

Rasul, G. and Hussain, A., 2015. Sustainable food security in the mountains of Pakistan: Towards a policy framework. Ecol. Food Nutr., 54: 625–643. https://doi.org/10.1080/03670244.2015.1052426

Roshetko, J.M. and Bertomeu, M., 2015. Multi-species and multifunctional smallholder tree farming systems in South-east Asia: Timber, NTFPs, plus environmental benefits. Ann. Silvic Res., 39: 62–69.

RWEDP, 2000. Woodfuel production and marketing in Pakistan: National Workshop 1997, Regional Wood Energy Development Programme, 2000. Food and Agriculture Organization of the United Nations. FAO, Bangkok

Salam, A., 2018. Pakistan is ground zero for global warming consequences. Article Published in "USA TODAY" on July 24, 2018. https://www.usatoday.com/story/news/ world/2018/07/24/pakistan-one-worlds-leading-victims- global-warming/809509002/. Accessed 22 Feb 2019.

Saqib, R. and Tachibana, S., 2014. Contribution of agricultural and forestry extension services to inclusive extension system in North-West Pakistan: A case study of Mansehra and Swat districts of Khyber Pakhtunkhwa Province. J. Agric. Ext. Rural Dev., 6: 175–187.

Scherr, S.J., 1992. The role of extension in agroforestry development: Evidence from Western Kenya. Agrofor. Syst., 18: 47–68. https://doi.org/10.1007/BF00114816

Shahbaz, B., Ali, T. and Awais, M., 2012. Perceived impact of participation in forest management on natural and social capitals in Mansehra district of Pakistan. J. Anim. Plant Sci., 22: 1167–1172.

Shaikh, I.B., 2000. Efficient and sustainable irrigation-management in Pakistan. Pakistan National Committee of ICID, pp. 50–57.

Sheikh, M.I., 1991. Some fodder trees of Pakistan. Forest Planning and Development Project Technical Note 4, pp. 25.

Sheikh, M.I., 1992a. Extending research results-how? GCP/RAS/134/ASB Occasional paper No. 15, pp. 17.

Sheikh, M.I., 1992b. Suitable tree species for different ecological regions and civil division of Pakistan. Forest Planning and Development Project Technical 11, p. 24.

Sheikh, M.I., 2001. Deficiencies in forestry extension programs in Pakistan: constraints and opportunities. In: Woodfuel Production and Marketing in Pakistan. RWEDP Report No.55, Report of the National Workshop Held in Hyderabad, Sind, Pakistan, 20–22 Oct 1998. Food and Agriculture Organization of the United Nations. FAO, Bangkok, Thailand, pp. 158–171.

Sujakhu, N.M., Ranjitkar, S., Niraula, R.J., Salim, M.A., Nizami, A., Schmidt-Vogt, D. and Xu, J., 2018. Determinants of livelihood vulnerability in farming communities in two sites in the Asian Highlands. Water Int., 43: 165–182. https://doi.org/10.1080/02508060.2017.1416445

Tolunay, A., Alkan, H., Korkmaz, M., Fı¨lı¨zbı¨lgı¨n, S., 2007. Classification of traditional agroforestry practices in Turkey. Int. J. Nat. Eng. Sci., 1: 41–48.

Vergara, N.T., 1989. Solution in search of problems: Research/extension constraints in small scale farm forestry. In: Proceedings of international conference on MPTS research for small farms: Strategies and methods. Jakarta, Indonesia, pp. 82–88.

Vergara, N.T. and MacDicken, K.G., 1990. Extension and agroforestry technology delivery to farmers. In: MacDicken KG, Vergara NT (eds) Agroforestry classification and management. Wiley, New York, pp. 354–373.

Vignola, R., Harvey, C.A., Bautista-Solis, P., Avelino, J., Rapidel, B., Donatti, C. and Martinez, R., 2015. Ecosystem based adaptation for smallholder farmers: Definitions, opportunities and constraints. Agric. Ecosyst. Environ., 211: 126–132. https://doi.org/10.1016/j.agee.2015.05.013

Wattoo, M.A., Ali, T., Khan, M.A.J. and Shahbaz, B., 2010. Stakeholders role and interactions in context of forestry extension interventions in the northwest Pakistan. Pak. J. Agric. Sci., 47: 173–177.

Wete, F.N., 1991. New technology for transferring agricultural information. In: Rivers WM, Gustafson DJ (eds) Agricultural extension:

world-wide institutional evolution and forces for change. Elsevier, New York.

World Bank, 2018a. Population density. https://data.worldbank.org/indicator/EN.POP.DNST. Accessed 22 Jan 2018.

World Bank, 2018b. Population ranking. https://data.worldbank.org/datacatalog/Population-ranking-table. Accessed on 22 Jan 2018.

World Bank, 2018c. Country profile Pakistan. World Development Indicators database. http://databank.worldbank.org/data/views/reports/reportwidget.aspx?Report_Name=Country-ProfileandId=b450fd57andtbar=yanddd=yand-inf= nandzm=nandcountry=PAK. Accessed 30 Jun 2019.

WRI, 2019. What is degraded land? https://www.wri.org/faq/what-degraded-land. Accessed 22 Sept 2019.

WWF, 2012. Annual report of world wildlife fund, Pakistan's Yearly Progress Reports. https://www.wwfpak.org/ knowledge_hub_/annual_report_/. Accessed 15 Aug 2014.

Yocco, V., 2015. 5 Characteristics of an Innovation an article published on January 29, 2015 in the "Smashing Magazine". https://www.smashingmagazine.com. Jan 2015.

Zubair, M. and Garforth, C.R.S., 2006. Farm level tree planting in Pakistan; the role of farmers perceptions and attitudes. Agrofor. Syst., 66(3): 217-229. https://doi.org/10.1007/s10457-005-8846-z