Participatory Forest Management Plan, (PFMP)

Subtropical Broadleaf Evergreen Forests
Khushab Forest Division

2022 – 2031

Soon Valley Conservation Committee
&
Forestry, Wildlife and Fisheries Department
Government of Punjab

March 2022

Credentials:

Writing and Data Analysis
Sardar Fida Hussain
Raja Tariq Mehmood
Dr. Hammad Gillani
Nadeem Bukhari

Data Collection Team
Sardar Fida Hussain
Raja Tariq Mehmood
Naseem Iqbal Butt DFO Khushab
Amir Nawaz RFO Naushera, Khushab

Peer Review
Jamil Ahmad CF Sargodha + Focal Point Punjab
Frans Werter, Consultant

Technical Assistance:
Helvetas Swiss Intercooperation Pakistan
Punjab Forestry Wildlife and Fisheries Department

Financed by:
Forest Carbon Partnership Facility (FPCF) of the World Bank through National REDD+ Office, Ministry of Climate Change, Pakistan.

Participatory Forest Management Plan (PFMP)
Subtropical Broadleaf Evergreen Forests of Khushab Forest Division

Endorsement

1. **Chairman, Soon Valley Conservation Committee**

2. **REDD+ Focal Person, Punjab Forest Department**

Disclaimer:
This Participatory Forest Management Plan is not a funding commitment from Forest, Wildlife & Fisheries Department Punjab. It is a proposal to be considered for future implementation of REDD+ Programme if funds are committed by the Punjab government and/or any other donor(s). The success of this plan is contingent to the commitment of all stakeholders involved in the implementation of this plan. Benefit Sharing Mechanism and institutional setup for implementation of REDD+ approved by the Government of Punjab will form the basis for implementing this Plan. Information on these aspects are suggestive and not binding on the Forest, Wildlife & Fisheries Department Punjab and any other stakeholders mentioned in this document.

وضاحت

پنجاب کا محکمہ جنگلات، جنگلی حیات و ماہی گیری اس منصوبے کے لیے مالی وسائل فراہم کرنے کا پابند نہیں ہوگا۔ اس منصوبہ پر عمل درآمد کرنے کے لیے مالی اور انتظامی سفارشات دی گئی ہیں۔ تاہم ان پر عمل پنجاب کے محکمہ جنگلات، جنگلی حیات و ماہی گیری کے بنائے گئے انتظامی و مالی رہنما اصولوں کے تحت ہوگا۔

Contents

List of Figures

List of Tables

Acronyms

AGB	Above Ground Carbon
BGB	Below Ground Carbon
FD	Forest Department
BURs	Biennial Update Reports
CERs	Certified Emission Reduction
TFCC	Task Force on Climate Change
Corg	Organic Carbon
FPIC	Free, Prior, Informed Consent
FCPF	Forest Carbon Partnership Facility
FD	Forest Department
GHGEs	Green House Gas Emissions
GIS	Geographical Information System
GoP	Government of Pakistan
IPCC	Intergovernmental Panel on Climate Change
MoCC	Ministry of Climate Change
PES	Payment for Ecosystem Services
PFMP	Participatory Forest Management Plan
R-PP	Readiness Preparation Project
REDD+	Reducing Emissions from Deforestation and Forest Degradation
tCO_2-eq	Tonnes Carbon dioxide (Carbon credit)
UNFCCC	UN Framework Convention on Climate Change

Executive Summary

Soon Valley Forest located in District Khushab of Punjab is one of the sites selected by the Forest, Wildlife and Fisheries Department (FD) in consultation with key stakeholders as a pilot site to demonstrate the implementation of REDD+. This is part of a larger project being implemented by the Ministry of Climate Change, Government of Pakistan and the Provincial Forest departments in which a total of 15 Participatory Forest Management Plans are being developed for REDD+ implementation in all six entities of Pakistan.

The Government of Pakistan has joined global efforts to address deforestation and forest degradation to mitigate climate change and its impact by initiating REDD+ activities. REDD+ has three phases; i. readiness, ii. demonstration through implementation, and iii. result-based payments. The first two phases when combined are known as the REDD+ Readiness Phase. Pakistan has made substantial progress in meeting REDD+ readiness requirements. Pakistan has developed a National REDD+ Strategy in 2021. Whereas the Punjab Forests, Wildlife and Environment Fisheries Department has developed a Subnational / Provincial REDD+ Action Plan. This action plan is a decentralised framework for Punjab to proceed with REDD+ implementation. Preparation of Participatory Forest Management Plans is an important step to implement this action plan by integrating and implementing REDD+ activities in forest management in various socio-ecological systems.

The local stakeholders were engaged in preparation of this Participatory Forest Management Plan. The plan will guide the implementation of REDD+ by projecting business as usual and reduced emission scenarios derived from detailed participatory assessment of socio-economic circumstances, ecological condition, and challenges (drivers), and assessment of the forest resource which have been described in this plan. The plan also presents stakeholders' analysis of their roles and obligations, use rights of forest dependent communities, conflict resolution and benefit-sharing mechanisms. This information is crucial for determining an inclusive set of activities and successful implementation of REDD+.

The forest cover change analysis of past 10 years in Soon valley reveals that the forest cover is increasing at a rate of 244.6 ha per annum sequestering 4834 tonnes CO_2-eq per year. This increase is clearly a case of steady progress in forest cover. The activities included in this PFMP if properly implemented, will further enhance this trend through collaborative forest management efforts of the stakeholders. This plan has proposed distribution of carbon and non-carbon benefits accrued by the implementation of plan according to which 80% benefits will go to the Government, and 20% will go to the customary right holders and users. These benefits will only be distributed if the targets are achieved. The plan therefore provides scenarios to reduce or increase benefits so that the stakeholders can enjoy results-based payment and benefits. The success of this plan, therefore, is contingent on the commitment of all the stakeholders involved. A specific and definitive distribution of benefits in case of REDD+ programme is yet to be developed by the government, which will form basis for sharing of benefits in the case of private forests. This proposed ratio will be finalized or confirmed only after finalizing AJK based benefit sharing mechanism.

The initial period of this plan will be 10 years; however, the plan will be a living document and open for annual reviews. A budget forecast to implement activities mentioned is also provided in this plan. The implementation of activities described in the plan will be guided by annual operational plans to be developed by the provincial FD in consultation with the relevant stakeholders. The plan will be implemented by village and district committees to be notified by the provincial FD in consultation with the relevant stakeholders.

خلاصہ

پنجاب کے ضلع خوشاب میں واقع وادی سون کا جنگل محکمۂ جنگلات، جنگلی حیات اور فشریز کی جانب سے منتخب کردہ اُن تین مقامات میں سے ایک ہے جہاں ایک پائلٹ سائٹ کے طور پر اہم شراکت داروں سے مشاورت کے ساتھ ریڈ پلس کے نفاذ کا عملی مظاہرہ کیا جائے گا۔ یہ ایک بڑے منصوبے کا حصہ ہے جو وزارتِ موسمیاتی تبدیلی، حکومتِ پاکستان اور صوبائی محکمۂ جنگلات کے ذریعے لاگو کیا جا رہا ہے جس میں پاکستان کے تمام چھ علاقوں میں ریڈ پلس پر عمل درآمد کی غرض سے مجموعی طور پر جنگلات کے شراکتی انتظام کے لیے پندرہ منصوبے بنائے جا رہے ہیں۔

حکومتِ پاکستان نے جنگلات کی کٹائی اور تنزلی سے نمٹنے اور موسمیاتی تبدیلی کے اثرات کم کرنے کے لیے ریڈ پلس سرگرمیوں کا آغاز کر کے عالمی کوششوں میں شمولیت اختیار کی ہے۔ ریڈ پلس کے تین مراحل ہیں۔ (i) تیاری (ii) عمل درآمد کے ذریعے مظاہرہ، اور (iii) نتائج پر مبنی ادائیگیاں۔ پہلے دو مراحل کو مشترکہ طور پر ریڈ پلس کی تیاری کا مرحلہ کہا جاتا ہے۔ پاکستان نے ریڈ پلس کی تیاری کی ضروریات کو پورا کرنے کے لیے خاطر خواہ پیش رفت کی ہے۔ پاکستان نے 2021ء میں ایک قومی ریڈ پلس حکمتِ عملی تیار کی ہے۔ جب کہ پنجاب کے جنگلات، جنگلی حیات اور فشریز کے محکمے نے صوبائی سطح پر ایک جامع ریڈ پلس ایکشن پلان تیار کیا ہے۔ پنجاب میں ریڈ پلس پر عمل درآمد کو آگے بڑھانے کے لیے یہ ایکشن پلان ایک صوبائی فریم ورک ہے۔ مختلف سماجی ماحولیاتی نظاموں میں جنگل کے انتظام کے لیے ریڈ پلس سرگرمیوں کو مربوط اور لاگو کر کے جنگلات کے شراکتی انتظام کے منصوبوں کی تیاری اس ایکشن پلان پر عمل درآمد کے لیے ایک اہم قدم ہے۔

مقامی فریقین نے جنگلات کے شراکتی انتظام کے منصوبے کی تیاری میں حصہ لیا۔ ریڈ پلس پر عمل درآمد میں رہ نمائی کے لیے اس منصوبے کے تحت دو مختلف منظر ناموں یعنی موجودہ حالات اور اخراج میں کمی کا اندازہ لگایا جائے گا۔ اس مقصد کے لیے سماجی اقتصادی حالات کے تفصیلی شراکتی تجزیے، ماحولیاتی صورتِ حال اور چیلنجز اور منصوبے میں واضح کردہ جنگلاتی وسائل کا جائزہ لیا جائے گا۔ یہ منصوبہ فریقین کے کردار اور ذمّے داریوں کے ساتھ اُن کے تجزیے، جنگلات پر انحصار کرنے والی لوگو کے حقوق کے استعمال، تنازعات کے حل اور مشترک فوائد کے حصول کا طریقۂ کار بھی پیش کرتا ہے۔ ریڈ پلس پر کامیاب عمل درآمد اور شراکتی سرگرمیوں کی تفصیلات کا تعیّن کرنے کے لیے یہ معلومات ضروری ہیں۔

جنگل کے رقبے کے تجزیے سے پتا چلتا ہے کہ 2011ء کے بعد سے اس جنگل میں 244.6 ہیکٹر سالانہ کی شرح سے اضافہ ہو رہا ہے جس سے سالانہ 4,834 ٹن کاربن ڈائی آکسائڈ کا انجذاب عمل میں آ رہا ہے۔ یہ اضافہ واضح طور پر جنگلات کے رقبے میں مسلسل اضافے کی ایک مثال ہے۔ اس PFMP میں شامل سرگرمیاں اگر مناسب طریقے سے لاگو ہوتی ہیں تو جنگلات کے مربوط انتظام کے لیے فریقین کی کوششیں اس رجحان کو مزید فروغ دیں گی۔

مجوزہ منصوبے کے مطابق اس منصوبے پر عمل درآمد سے حاصل ہونے والے کاربن اور نان کاربن محصولات میں سے 80 فی صد حکومت کو حاصل ہوں گے، جبکہ 20 فی صد جنگل کے استعمال کے حقوق رکھنے والے صارفین کو ملیں گے۔ یہ فوائد صرف اہداف حاصل ہونے کی صورت میں تقسیم کیے جائیں گے اس لیے یہ منصوبہ فوائد میں کمی یا اضافے کا منظر نامہ پیش کرتا ہے تاکہ فریقین نتائج پر مبنی ادائیگی اور فوائد سے مستفید ہو سکیں۔ لہٰذا اِس منصوبے کی کامیابی اس میں شامل تمام فریقین کے عزم پر منحصر ہے۔

حکومت کی طرف سے ریڈ پلس پروگرام کے معاملے میں فوائد کی ایک مخصوص اور قطعی تقسیم فی الحال تیار نہیں ہوئی ہے جو جنگلات کے سلسلے میں فوائد کے اشتراک کی بنیاد بنائے گی۔ مشترک فوائد پر مبنی پنجاب کے طریقۂ کار کے طے ہونے کے بعد ہی اس مجوزہ تناسب کو حتمی شکل دی جائے گی یا اس کی تصدیق کی جائے گی۔

اس منصوبے کی ابتدائی مدّت دس سال ہوگی تاہم یہ منصوبہ ایک زندہ دستاویز ہوگا اور سالانہ جائزے کے لیے پیش ہوگا۔ اس منصوبے میں مذکورہ سرگرمیوں پر عمل درآمد کے لیے رہ نمائی متعلقہ فریقین کی مشاورت سے صوبائی محکمۂ جنگلات کی طرف سے تیار کیے جانے والے سالانہ آپریشنل منصوبوں کی مدد سے کی جائے گی۔ اس منصوبے کو گاؤں اور ضلعی کمیٹیوں کے ذریعے لاگو کیا جائے گا اور اس کے بارے میں متعلقہ فریقین کی مشاورت سے صوبائی محکمۂ جنگلات کے ذریعے مطلع کیا جائے گا۔

1. Introduction

1.1 The Context of PFMP

Pakistan has been implementing REDD+ activities since 2010 to mitigate climate change through reduced carbon emissions from the forestry sector. The Government of Pakistan (GoP), Ministry of Climate Change (MOCC) is implementing a REED+ readiness programme funded by the Forest Carbon Partnership Facility (FCPF) of the World Bank. This Participatory Forest Management Plan (PFMP) is to demonstrate integration and implementation of REDD+ activities in forest management in various socio-ecological systems.

The Participatory Forest Management Plans (PFMPs) translate REDD+ concepts and processes at practical level considering complex socio-economic conditions, burden of rights and concessions, as well as obligations in the forest. This is the reason that in addition to forest stock assessment, the preparation of PFMPs for REDD+ sites require a detailed assessment of the roles and rights of stakeholders in forest management and revenues so that trade-offs become clearer for redressal and communities are not deprived of their legitimate access to forest for their livelihoods. The core thrust of PFMPs in REDD+ perspective is to find contextually relevant options to address drivers of deforestation and forest degradation to mitigate global climate change. REDD+ also provides mechanisms for the enhancement, measurement, and trade of carbon.

This PFMP provides information including description of the site, GIS supported forest stock assessment, socio-economic situation, analysis of stakeholders with their interests and influences, emissions reduction scenarios, future interventions with estimated budget and implementation mechanism and key challenges for implementation. The activities that will maintain forest as carbon pool have been exclusively explained in this plan giving a lead and support role to stakeholders, as well as the expected outputs. It is expected that the implementation of the PFMP will enable the stakeholders of Scrub Forests of Khushab Forest Division to trade carbon credits in the national and international market in foreseeable future like any other product, by increasing and maintaining the carbon stock sequestered in the forest. The PFMP will thus act as a road map for implementation, monitoring, reporting and verification of resources improvement, and distribution of benefits among stakeholders.

A budget forecast to implement activities mentioned in PFMPs is also provided. Solarisation of houses as alternate source of energy will not only benefit the target population but will act as a role model for other communities.

1.2 Objectives of PFMP

The specific objectives of this plan are as under:

1 To promote sustainable Forest management in the scrub forests of Khushab.
2 To protect, improve forest health and enhance Carbon stocks in scrub Forests while addressing drivers of deforestation and forest degradation
3 To enable the neighbouring Forest community and Forest Department staff to manage forests jointly and efficiently for multiple uses.

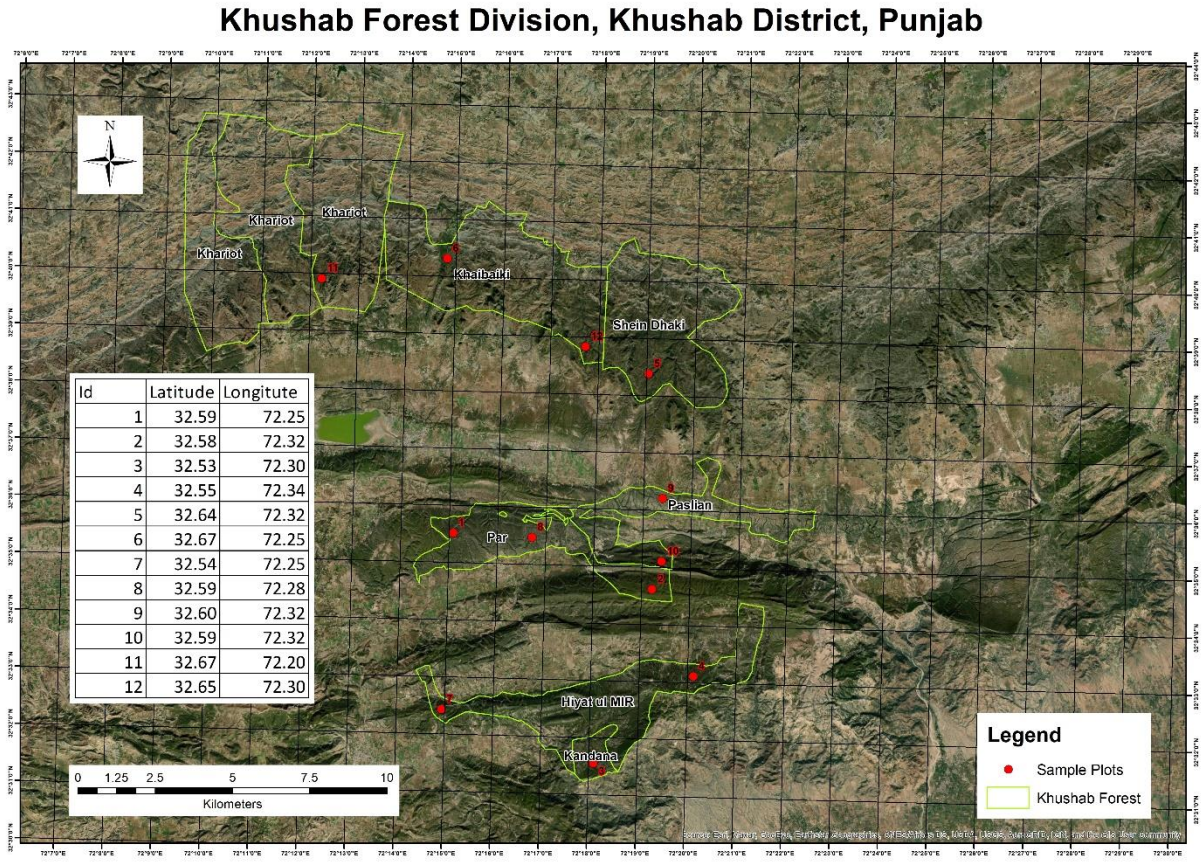
1.3 Methodology

A multi-disciplinary team consisting of two Participatory Forest Management experts, a sociologist, a GIS specialist, two Range Forest Officers, two Forest Guards and three community representatives (nominated by the community) collected data for preparation of the management plan.

The overall methodology for preparation of the plan has been guided by PFMP Manual (version 1.0, 2021) for practitioners prepared under Forest Carbon Partnership Facility (FCPF) of the Ministry of Climate Change (MOCC), Islamabad. A multi-layered methodology was adapted for the preparation of PFMP, which includes the following steps:

i. Selection of site in light of the REDD+ guidelines and procedure. Scrub forests in the Soon Valley of Khushab district was one of the two potential sites selected for preparation of PFMP.
ii. Participatory data collection. Local community living in the surroundings of the forests participated in providing socio-economic data and sharing details on forest-community interaction., They also participated in collecting forest resource assessment data. They also participated in identifying forest management activities and implementation mechanism. Under the Free Prior Informed Consent (FPIC), the community was briefed on relevant concepts, causes and effects of activities. They participated in identifying drivers of deforestation and forest degradation and demand of timber and firewood. The solutions to problems and demands of community were translated into interventions in prioritised order and listed. The exercise was conducted through PRA using spot observations, Focused Group discussion, mapping, semi structure interviews, transect walk and ranking.
iii. Participator Forest Inventory was conducted to collect data from 12 sample plots selected in the PFMP site. The location of sample plots is provided in following map (**Figure 1**). The sample plots were chosen through stratified random sampling among each forest stratum. The soil, topography, water availability, and status of vegetation vary spatially within a land-use category and the overall area proposed for the site. Trees, biomass stock, and growth rate are not distributed uniformly in a site. Therefore, a sampling design is followed for locating the sample plots in each of the selected forest strata. The location of sampling plots could determine the biomass stock or growth rate estimates. Based on forest type and forest density, three forest stratum (>70%, 40%-70%, 10%-40% tree canopy cover) were formed to carry out the systematic stratified sample on the map.
iv. Sample points were nested circular plots of 17.64 m, 5.64 m, and 0.56 m radius. All living trees and standing dead woods with DBH above 5cm, and stumps were measured from the full plot of 17.84 meters (~1000 m^2). Fallen trees and stumps, dead wood with diameter above 5cm were also recorded from the plot. The plot included two subplots; 5.64 meters (~100 m^2) for collecting data of seedlings and shrubs and 0.56-meter plots (~1 m^2) for data on litter, leaves, grasses, etc. From a plot of 5.64 m, all seedlings were counted, and shrubs were cut down and fresh weight of the sample was recorded. This sample was clipped and collected in the bags to find out oven dried biomass in the lab. The above-ground non-tree biomass including leaves, litter, grasses, etc. collected from 0.56 m radius sub-plot and weighed. Soil organic carbon values were taken from the national forest inventory, carried out in 2018. The data from these samples was analysed for estimation of carbon stock. The coordinates of each sample plot were noted, and fixed-point photos were taken during the inventory
v. Data analysis and development of PFMP: The data were analysed, GIS map prepared and put together in the form of PFMP with a 10-year perspective including an annual forestry operational plan. The plan was reviewed individually, jointly and sent to experts for peer review.
vi. The plan was sent for endorsement by the Punjab Forest Department and relevant community.

Figure 1. Sample points location map of Khushab Forest, Punjab



1.4 Policy Alignment

The objectives of this local PFMP are aligned with the following provincial, national, and global policies/strategies/commitments related to REDD+.

Global Commitment: To reduce current global 23% carbon emission contributed from AFOLU sector (IPCC 6th Assessment Report, 2021, p245).

National Policies/commitments: Pakistan's report on intended Nationally Determined Contributions seeks 20% reduction of the current national GHG emissions (GOP, 2017). Pakistan intends to set a cumulative ambitious aim of conditional and voluntary contributions of overall 50% reduction of its projected emissions by 2030, with a 15% drop below business as usual (BAU) from the country's own resources, and an additional 35% drop below BAU subject to international financial support. (NDC, GOP 2021).

National forest policy 2015 also emphasises on enhancing role and contribution of forests in reducing carbon emissions and enhancing forest carbon pool.

The National Climate Change Policy (NCCP) 2012 under Section 4.4 on Forestry Sector states that the climate change is likely to have multi-faceted adverse effects on the ecosystem as a whole, particularly on the already vulnerable forestry sector in Pakistan. Mitigations in the forestry sector entail

restoration of Pakistan's forests through sustainable forest management, with particular focus on how these are affected by climate change. This will not only benefit state forests but forests dependent communities and the whole society in general. The most likely impacts of climate change will be decreased productivity, changes in species composition, reduced forest area, unfavourable conditions for biodiversity, higher flood risks and the like, as portrayed in the Planning Commission Task Force on Climate Change (TFCC) Report (GoP, 2008).

Provincial Policies/commitments:

The goal set under provincial forest policy 2019 is to develop, maintain and maximize forest resources in a scientific, environmentally sustainable, ecologically stable, economically viable and socially acceptable manner. The climate change policy of province of the Punjab acknowledges the role of forests in mitigation and adaption and most particularly to improve resilience of communities and their livelihoods in future scenarios of changes in local climate. The activities mentioned in this PFMP to manage Subtropical Broadleaved Evergreen Forests (SBEF) of Khushab (hereinafter called SBEF Khushab) align well with the actions suggested in the climate change policy of the province for managing forest and pastures.

2. Participatory Forest Management Planning

A technical team consisting of two Participatory Forest Management experts, a sociologist, a GIS specialist, Divisional Forest Officer two Range Forest Officers, two Foresters, two Forest Guards and five community representatives (nominated by the community) conducted a participatory socio-economic, ecological and forest stock assessment of SBEF of Khushab. Based on the data and information gathered during PFMP survey, participatory planning sessions were held with communities and stakeholders to elaborate and analyse the assessment results and identify management interventions.

2.1 Ecological description

2.1.1 Location

The scrub forests for the pilot site are situated in the civil tehsil of Naushehra of Khushab District. The total area of scrub forests in Khushab is 35883 hectare with net area about 29293 hectare. The area of pilot site of Khushab selected for demonstration of REDD+ is 13,386 hectare (Figure 2). The dominant land cover in the area is cropland but within the PFMP site dominant land cover is forest followed by shrublands and grasslands. Mainly agriculture is practiced in the valley plains and hilly slopes are covered with forests and shrubs.

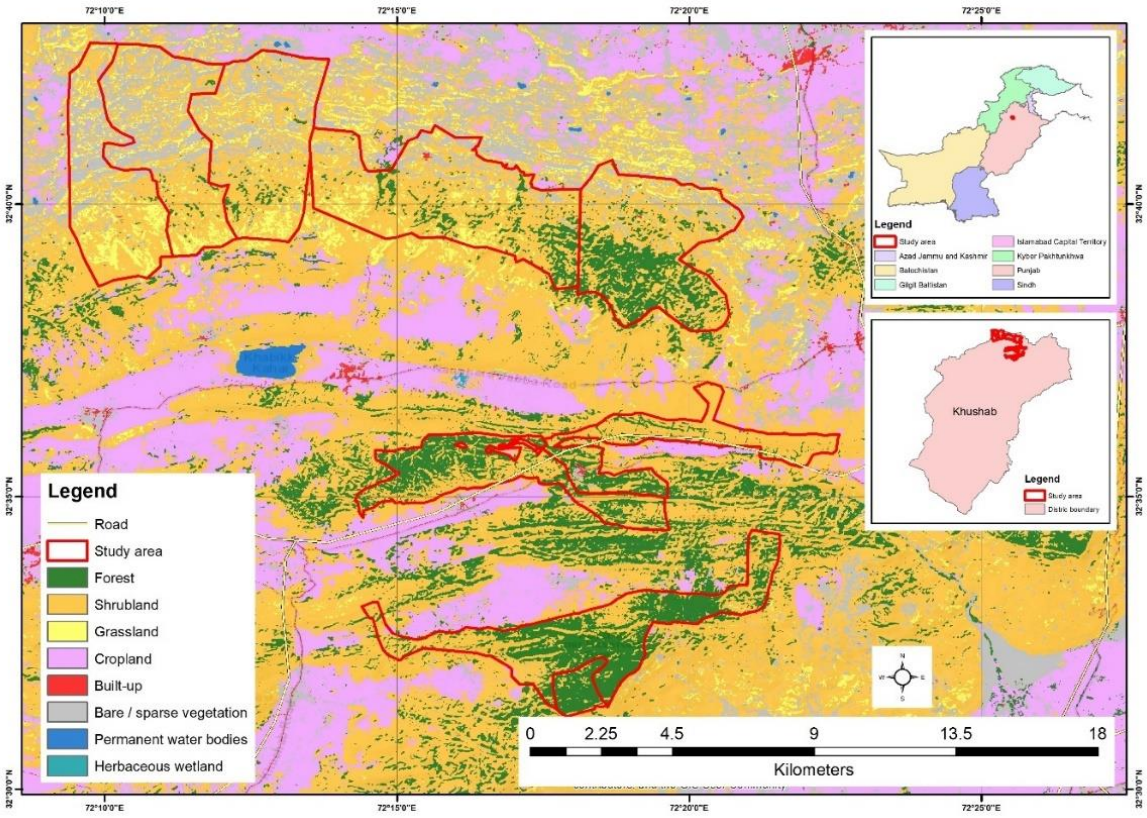


Figure 2. Land use / Land Cover map of Khushab PFMP Site

Mean elevation of the area is 705 m ranging from 480m to 1036 m. The central coordinates are 32.6178 º North and 72.2741 º East, however, the forests are scattered between 32.433º to 42.533º

North latitude and 71.95º to 72.35º East longitude. Some important locations along with coordinates are as under:

- Naushehra Town 32.569° N & 72.154 E
- Uchhali Lake 32.558º N & 72.023 E
- Khabeki Lake 32.621° N & 72.213° E
- Jahlar Lake 32.498 N & 72.087 E
- Amb Temples 32.508° & 71.936° E
- Akrand Cliff Fort 32.657° & 72.263 E

It is situated in Khushab District, but it can be seen from adjoining districts of Mianwali and Chakwal. Administratively falls in District Khushab, Punjab Province, Pakistan. Geographically valley is located between coordinates of 32.436º 32.688º North and 71.845º to 72.501º East.

The tract is bounded by Pothohar plateau consisting of scrub forest of Mianwali Forest Division to the North, Punjab plains to the South, Indus River at some distance to the west, Scrub Forest of Chakwal Forest Division at the eastern boundaries. The elevation of the forests is varying, ranging from 457 to 1169 meter; highest point is Soon-Sakesar top. The scrub range is a continuous range of low, flat lopped mountains rising abruptly out of the flat Punjab plains. The line of high precipitous cliffs is intersected by a number of deep gullies and ravines, some of them deserving the name of "Canons" affording sections which distinctly reveal the inner architecture of the range, as well as the details of its stratigraphy.

2.1.2 Site description

Soon-Sakesar is the highest point of salt range in the Scrub Forest in Pothohar and is located to the North-West of Khushab city and it is compound of Saki and sar. Saki related to Sakia or Buddha and sar, to pond. Valley starts from Padhrar village and end at Sakesar that is the highest peak of Scrub range. The length of Soon Valley is 35 miles (56 km), and average width is 9 miles (14 km). The area of Soon Valley is 300 square-miles (780 square-kilometres). Although not as cold as the valleys up north, Soon valley consists of beautiful lakes, waterfalls, jungles, natural pools and ponds. Soon valley is also blessed with ancient civilization, natural resources, and fertile farms. There are some special features of this valley that distinguish it from other areas, without knowing about them it is very hard to understand its importance. Sabhral, Khura, Naushehra, Mardwal, Kufri, Angah, Ugali, Uchali, Tiveen and Bagh Shams-ud-Din are important towns in soon valley.

The forests selected for the pilot site are part of Salt Range which starts from river Jhelum just near Jalalpur and runs in a general east – west direction in shape of irregular arc culminating at the peak of Sakesar and crossing river Indus near Kalabagh at Mari Indus. This mountain range is over the length of 175 KM and the height ranges from 250 to 1520 m from the sea level. The total area of the scrub range is 4334 Sq. Km falling in the sub-tropical region. It was named as scrub range in the British Colonial period during 1808, owing to large deposit of salt, which are present at Khewra, Katha, Warcha and Kalabagh. The salt is present at its lowest, bottom rock containing large beds of pure common salt, all throughout its extent. In this way, an immense quantity of rock-salt is embedded and available for extraction in all parts of these mountains.

The general characteristic formation of scrub range is that it consists of two distinct hills running parallel to each other on a general east-west direction. Each of these hills is made up of a number of parallel ridges. But this parallelism is modified by a marked tendency to a linked or a looped formation. The main ridges bend in towards one another and mingle in a knotted mass. Then they again separate, run parallel and again unite. This is noticeable not only in the main ridge but also in separate components. The steep cliffs to south can be observed in the entire length of scrub range.

The scrub range is the most important hill range in the country for the study of physical as well as stratigraphical geology. It has always attracted the attention of geologists, not only because it contains a very large portion of the fossiliferous stratified record of the region, but because of the easily accessible nature of the deposits and the clearness with which various geological formations are exposed in its hills. In its barren cliffs and dried gullies, the scrub range has wealth of geo-dynamical and tectonic illustrations, that this imposing line of hills can rightly be called a field-museum of geology. Sedimentary rocks and preserved fossils portray a complete picture of geological and biological history of the region. The severe tilting of the rocks during geological ages has resulted in exposure of these layers near the surface at many places.

2.1.3 Geology and Rock

In scrub range, sandstone and limestone are the common rock which are scattered over the entire area. The sandstone is laminated by white or cream dark red or purple, brown color. Most of the scrub range is heavily salt infested as the water from salt-water spring's deposits on the soil, all along its routes. The weathering of pure limestone leaves no perceptible soil, as calcium carbonate is carried away in solution by rainwater. The weathered surface of the rock is left with sharp projections and numerous hollows and is exceedingly irregular. In places, where limestone is not so pure, being mixed with shale, clay or sand, weathering produces some insoluble matters which produces small amount of soil. The soil in the limestone portions although thin and shallow, is fertile due to nutritive property of calcium carbonate. There are extensive areas of sheet rock from which surface soil has entirely disappeared. The fertile red marl is exposed at numerous places due to extensive erosion and steep geological tilt resulting in slips. However, soil lying between the scrub range and river Jhelum is heavily saline due to run off water during rainy season and most of the areas are rich in salinity. Drilling of good supply of water is very expensive in whole tract.

The groundwater is available at a depth of 40 to 50 m. It is added that the sub soil water level is increasing year after year inducing upward movement of the salts and impairing the soil potential for forestry. Development of water resources and ground water recharging interventions have therefore, been proposed.

2.1.4 Vegetation type

The vegetation on the north side is much thicker ranging from scanty patches of trees and shrubs to dense vegetation of *Acacia modesta, Kau* (*Olea ferrugineae*) and *Dodonaea viscosa*. The vegetation is not comprised of tall trees; medium sized trees are present due to scanty rainfall and slow growing characteristics of species. The major forest type of Scrub Forest Khushab is Subtropical Broad-Leaved Evergreen Forest (scrub). The most important factors governing the distribution of the vegetation are: (i) Underlying rock. (ii) The aspect. Vegetation is poor on sandstone and red marl. Southern slopes are often devoid of vegetation.

The predominating species are *Olea ferrugineae* (Kau), *Acacia modesta* (Phulai) and *Dodonaea viscosa* (Sanatha) with *Monotheca buxifolia*, (Gurgura) and *Gymnosporia royleana* (Pataki) as the chief auxiliaries. Phulai (*Acacia modesta*) is a predominant species on hotter aspects and in sandstone areas where it seems to be the only tree species that can withstand the excessively arid conditions met with. Kau (*Olea cuspidata*) is found throughout the forests in varying proportion. It is profuse in limestone and favours cool northerly aspects. In some places it occurs as a pure crop while in others it is mixed with Phulai, Sanatha and other auxiliary species. Sanatha (*Dodonaea viscosa)* is found practically everywhere in varying degree. At places it is gregarious and occurs in fairly big patches. It regenerates profusely from seed and its seedlings are found even in places which are grazed fairly heavily. It gives a good protective cover to the soil.

Grasses are abundant throughout the area. Good fodder grasses like pharion (*Digitari bicornis*), palwan (*Bothriochloa pertusa*) and khar (*Haloxylon recurvum*) are found in places where the incidence of grazing is less. In areas subjected to heavy grazing useless grasses like lamb (*Arsitida depressa*), Khawi (*Cymbopogon jawarancusa*) and deela (*Cyprus pilosis*) are available.

The vegetation in the areas is not very promising due to steep slopes of base rock and presence of soil is confined to *nullahs* and areas with comparatively less gradient. The average density or average land cover is around 30%. However, the vegetation can be noticed in the small valleys and on the berms of *nullahs*. The natural vegetation of the area is comprised of *Acacia modesta* and *Capparis aphylla*. The crop of *Acacia modesta* is quite good in the depression and along *nullahs* where natural regeneration can also be observed. The second major species i.e. *Capparis aphylla* is also present in the area. The plants of *Capparis aphylla* can be observed in crevices of rocks and even on steep slopes where soil was available. The third dominating species is *Gymnosporia royleana*, commonly known as Pataki, also naturally coming up in the area. It is observed that, the density of both *Acacia modesta* and *Capparis aphylla* has increased during last ten to fifteen years. In addition, it was observed that the trees and shrubs of *Zizyphus nummularia* and *Zizyhpus mauritiana* which are common species of scrub range are present only a few places. The comparison of the reported vegetation to the existing crop reveals the fact that at number of places certain species are almost extinct. Grazing concessions for local population exist in the areas which have noticeable impact on natural regeneration. In addition, there are threats to vegetation in shape of encroachments, mining, fires and extraction of raw material for industrial use. Apart from the traditional vegetation of scrub range, two tree species famous for their flowering, namely *Butea frondosa* and *Tecoma undulata* are rarely found in forest area. Both the species exist on the private land located in scrub range and that too in scattered form, blooming from April to June. Since the entire scrub range falls in the barani (rainfed) tract of the province, therefore, the agriculture also depends on the rainfall. On the northern side of the range irrigated agriculture is practiced, since the area falls between the mountain range and river Jhelum, while the water table is also high and can be explored through tube wells. The main crops are maize and vegetable. The cultivated flora in the agriculture lands includes *Acacia nilotica, Melia azadirachta, Dalbergia sissoo* and *Morus* alba.

2.1.5 Climate

Scrub range has low annual precipitation which is averagely about 498.78 mm annually (Record of last six years from 2007 to 2012). Mostly there is rainfall in month of July, August and September and fewer amounts are received in January and February. The summer rains are due to monsoon, while winter rains are associated with the western disturbances. Winter rain is well distributed as compared to summer rain. There is great variation in extreme temperature of summer and winter. The length of winter season is longer and is accompanied by frost. Summer and winter both are cooler than those of adjacent plains. The average minimum temperature is 1^{o}C (January) and average maximum temperature is 36^{o}C (June). Temperature falls below freezing during winter and summer is comparatively pleasant as compared to that of adjoining areas.

About 60% of annual rainfall is received during monsoon season (July to September) 28% from Feb to June and rest of 12% from Oct to January which are driest month of the year. The seasonal variations in temperature are considerable. The highest mean maximum monthly temperature of 42.8 C was recorded in June 2009, while the mean minimum lowest temperature of 0.8 C. was registered during January 2008. The relative humidity (in evening at about 5 PM) varies from 35-55% during January to April. In May and June, it falls to 20 to 30 %. It is maximum during monsoon period when it may reach 50 to 70% declining again to 30 to 40% after monsoon season.

2.2 Socioeconomic Profile

2.2.1 Legal Position

All the forests of the scrub range are declared as Reserved Forests. The population heavily depended on the natural forest for grazing livestock, NTFPs, timber and fuelwood. Located in relatively remote area and in the absence of economical and sustainable substitutes for fuelwood, the population still mainly relies on natural forests for heating and cooking.

2.2.2 Population

There are three to four villages around each forest. The population of these village varies from three to five thousand per village. **Awan** tribe is the major tribe of this area. the landowners usually belong to this tribe and called ***Malik***. It has been worked out that nearly **sixty thousand people and eight thousand households** are meeting their fuel wood and grazing needs from these forests. The inhabitants of these villages have rights and concessions in these forest. They can collect dead dry fuel wood for domestic use, small timber for agricultural implement and construction of shelters for livestock. They are allowed to graze their livestock and collect grass from the forest on subsidized rates. Certain villages (Thoa Mahram Khan) do not have concessions in forest but can graze their cattle on full rates which is also a great facility for livestock rearing community.

These villages are connected with main communication network through farm to market roads. The condition of roads is very poor, and these roads needs immediate repair and maintenance. These villages and hamlets are at a distance ranging from 15 to 30 kilometres from tehsil headquarter and other relatively bigger towns.

2.2.3 Livelihoods

Historically, the major source of livelihood in Noushehra district Khushab has been agro-pastoralism. However, pastoralism is not their sole source of sustenance. The people have very small land holding ranging from half acre to six acre per household. Therefore, the people have very little stake in agriculture. Wherever water is available people grow vegetable for home use and sale. Major crops are cauliflower, potato in the summers as off season crops and wheat in winter and peanut. Fish rearing is another good source of income, people have made small ponds and mini dams to rear fish. The women take equal part in farming specially harvesting of crops, rearing of livestock and procurement of fuel wood and water is the responsibility of rural women.

2.2.4 Dependence on forests

The timber and fuel wood consumption has been worked out by conducting the survey and interviews of community members and staff of forest department. It has been estimated that per capita timber consumption per annum is 0.0463 cubic meter whereas per capita fuel wood consumption is 0.201 cubic meter per annum. Therefore, 2778 cubic meter small timber and 12060 cubic meter fuel wood is being provided by these forests annually.

The population is slowly switching to other sources of income including Government Jobs, businesses, and trade. Migration to other parts of the country (e.g., Sargodha, Lahore Karachi, Islamabad) in search of job opportunities, education, and health care. The uneducated and unskilled individuals are still heavily dependent on farming and natural resources. The community is keen to capitalize on the potentials of eco-tourism and fish farming to generate alternate employment especially for youth. The major source of income is government or private service. Military is the service of choice for the young male population. Young females prefer to join education and health department.

2.2.5 Health and education

There are two Basic Health Units and one Rural Health Centre in this area. Tehsil Head quarter Hospital is situated at Noushehra which around 15 to 30 kilometre away from these villages. Health workers like Lady Health Worker, nurses, Homeopaths and Hakeems are also providing health facilities to the rural population.

Rural population is now well aware of the importance of education. Eighty percent children of the school going are going to schools. There are primary school in each village, the bigger villages have middle and high school as well. Number of private educational institutions are also working in the area. People prefer to send their children to private schools, which are considered to have better education standard and discipline. Children has to go to Noushehra and Khushab for higher education.

2.3 Stakeholder Analysis

The stakeholder analysis (**Annex 2**) was conducted to acquire information about major actors, and their interest and influence on forest resources utilization, management, or restoration. The stakeholder analysis was conducted at two levels; first their interest and influence on forest management; and then their interest and influence on carbon pool. The interest and influence explored through stakeholder analysis indicate who is doing what in managing forest and who has the legal rights in the forest. The stakeholders identified were categorized as primary and secondary based on the level of their participation and partnership in social, technical, financial, and legal aspects of forest management and REDD+.

The SBEF Khushab fall in the legal category of Reserved Forest. Forest Department is the owner, manager, and controller of the forest. The communities have use rights and privileges, thus an important stakeholder. The community provides voluntary assistance to the Forest department in the protection of forests in events of forest fire. The community will also form a Village Conservation Committee to protect the forests. Other stakeholders include the Revenue Department as government agency tasked as custodian of land, Tourism department to facilitate and enhance tourism and security agencies which intervene only if called by relevant authorities.

During stakeholder analysis it was found that the community and the forest department are interested in exploring alternative sources of energy to protect the forest. Few households use Liquid Petroleum Gas (LPG) in addition to fuelwood for cooking. The purpose however is not to reduce fuel-wood extraction. Instead, LPG is used by those who can afford to pay for it because unlike in the past fuelwood now a days is only available in remote areas. Buying LPG is expensive; however, it is an alternative source of energy. Most households rely on fuelwood for both heating and cooking. Some individuals were reported illicitly collecting additional firewood for sale in order to earn cash income. The stakeholders and their roles identified were further analysed by using the influence-interest matrix to explore their type and level of influence and interest in forest management and carbon pools. **Table 1** helps in understanding the actual influence and interests and may help identifying the need for increasing the involvement of specific stakeholders.

It was found that the Forest Department and local community with land adjacent to the forest are the major players with greater interest in forest management. The households with legal rights for grazing and collection of forest products but no land inside or adjacent to the forest and some of these who also harvest wood to sell for cash income fall under neglected players and need special attention to safeguard their interest.

The law enforcement agencies also occasionally contribute to forest protection when called in events of forest offenses, but since the protection of forest is not their core area of responsibility they fall in the category of marginal players in the matrixes.

The Ministry of Climate Change has a high interest, but until now little influence on local forest management and carbon pools on ground. This may change through REDD+ programme and the distribution of resources for carbon sequestration.

The Revenue Department deals with matters related to land as records and decision related to land are entrusted with this department. The Revenue Department has little interest in forest management and only get involved when there is a dispute regarding land ownership. Therefore, it falls in the category of marginal players.

Table 1. Interest influence matrix on forest management and carbon pools

	Neglected players: Need special attention to safeguard their interests	**Major players:** Need to be fully involved
INTEREST **Hight** Score 2 and 3	Local community members who harvest for selling (Illegal harvesters)	Forest Department Local community members with use rights and irrigated land and settlements inside or around the forest Local community with use rights and no land ownership. Village Conservation Committee
	Marginal players Low priority	**Risk factors** Need to be addressed
INTERST **Low** Score 0 and 1	Law enforcement agencies Revenue Department	None
	INFLUENCE Low Score 0 and 1	**INFLUENCE High** Score 2 and 3

The major players in forest management are those having major interests and influence on using and protecting carbon pools. The stakeholders themselves may not be aware of this since the concepts are new. They may need awareness raising about this, especially of the importance and benefits of management of carbon pools.

2.4 Forest institutions

The socio-economic data of SBEF Khushab (**Annex 1**) indicates institutional dimensions which may be relevant in management of drivers of deforestation (**Table 2**) and maintaining future trend in favour of REDD+. The following institutions are relevant for management of SBEF Khushab.

2.4.1 Traditional Jirga (Counsel of wise people)

In every village there is an informal system of conflict resolution, called Jirga. The *Jirga* makes decisions pertaining to all communal matters of the village. This includes conflict resolution. If the *jirga* is not able to resolve any conflict, the parties involved in the conflict may take the case to the formal judicial system. It is important to note that seeking intervention of the *jirga* for conflict resolution is not mandatory. Most cases which involve conflict over communal resources however are resolved through the *jirga*.

2.4.2 Village Conservation Committee

In Soon valley there is no formal Village Conservation Committee (VCC), however the elderly people and educated segment of community play some role in protecting forest from illegal cuttings as well as from forest fire.

2.5 Analysis of drivers of deforestation, forest degradation and barriers to enhancement

Table 2 provides data on drivers of deforestation and degradation and degree of severity and ranking of the drivers and barriers. As indicated in socio-economic data (Annex 1), the community depends on forest resources for their domestic needs for timber, firewood and grazing their livestock and other forest products. As stated earlier, the SBEF Khushab falls in Reserved Forest category owned by the government where the local community has few rights and certain concessions.

Table 2. Major drivers of deforestation, forest degradation and barriers to enhancement

Ranking	Major drivers	Underlying causes	Degree Of severity
Deforestation			
2	Illegal cutting and theft of wood by locals for sale	1. Lack of Livelihoods Alternatives	2
Forest Degradation			
1	Cutting of Trees for Energy/fuelwood	1. Lack of Alternate Energy Sources	1
Barriers to Enhancement			
3	Over grazing / exploitation	1. Livestock raring for livelihoods	3
4	Lack of water availability	1. Over exploitation of ground water for agriculture	2

2.6 Carbon stock assessment of Khushab Forest

This part of field survey was conducted in July 2021 to collect data from 12 sample plots selected in Khushab Forest. The location of sample plots is provided in following map (Figure 2). At the observation points, sample plots were nested circular plots of 17.64 m, 5.64 m, and 0.56 m radius. All living trees and standing dead woods with DBH above 5cm and stumps were measured from the full plot of 17.84 meters (~1000 m^2). Fallen trees and stumps, dead wood with diameter above 5cm were also recorded from 17.84-meter plot. The plot included two subplots; 5.64 meters (~100 m^2) for collecting data of seedlings and shrubs and 0.56-meter plots (~1 m2) for data on litter, leaves, grasses, etc. From a plot of 5.64 m, all seedlings were counted, and shrubs were cut down and fresh weight of the sample was recorded, collected the sample in bags to find the oven dried biomass in the lab. The above-ground non-tree biomass including leaves, litter, grasses, etc. was collected from 0.56 m radius sub-plot and weighed and soil organic carbon values are taken from the national forest inventory, which was carried out in 2018 as the time required to detect a significant change in soil organic carbon is generally more than 10 years. The data from these samples was analysed for estimation of carbon stock (table 5). The coordinates of each sample plot were noted, and fixed-point photos taken during the inventory.

2.6.1 Plot level Carbon Stock Estimation

Based on the field data carbon stock (tons per hectares) for Above Ground Carbon (AGB) and Below Ground Carbon (BGB) was worked out using the standard sets for tree species, tree DBH and hight,

and dry biomass of shrubs and litter (**Table 3**). The tree species level carbon stock is given in Annex 3. Based on this data individual plots level carbon stock values are given in table 5. The estimated stock of carbon per hectares (ha) was then used to estimate the total carbon stock in the selected site of Khushab Forest.

Table 3. Plot level above and below ground carbon stock

Plot No.	Average AGC (tonnes/ha)	Average of BGC (tonnes/ha)
1	0.166025607	0.041506402
2	0.112600363	0.028150091
3	0.285957747	0.071489437
4	0.30555403	0.076388508
5	0.042472372	0.010618093
6	0.625327303	0.156331826
7	0.092931833	0.023232958
8	0.131376157	0.032844039
9	0.157429354	0.039357339
10	0.536856367	0.134214092
11	0.700212856	0.175053214
12	0.619463987	0.154865997
Average	**0.269213894**	**0.067303473**

2.6.2 Forest Cover Assessment

The change in forest cover was assessed by using Landsat multispectral 30m spatial resolution satellite images on the path (151) and row (037) and google Earth Engine Cloud Computing platform for the classification of forest cover by applying Random Forest Machine Learning Algorithm. The analysis indicates an increase of 2445.93 ha in forest cover in the past 10 years at an average rate of 244.59 hectare (ha) per year (**Table 4**). The amount of carbon trapped in 5 carbon pools (above ground biomass, below ground biomass, soil organic carbon, deadwood and litter on forest floor) is here grouped into three carbon pools (above ground, below ground and soil).

Table 4. Forest cover assessment (2011 -2021)

No	Landsat Satellite Sensor	Landsat data acquisition	Forest Cover (ha)
1	Landsat-8	2021-06-07	10943.28
2	Landsat-5	2011-06-05	8497.35
Change in Forest Cover in last 10 years			2445.93
Per year change in forest cover			244.59

The forest cover change analysis of past 10 years reveals that the forest cover is increasing at a rate of 244.9 ha per annum. At the current rate and with 10% enhancement PFMP site with total area of 13,386 ha will have 100% forest cover by the year 2031. However, this process can be expedited if the current trend is enhanced by increasing forest cover by 20% and 50% in addition to the current positive trend. In such scenarios the forest cover will reach 100% by 2030 with 20% enhancement effort and by 2028 with 50% enhancement activities as shown in the table 5.

Table 5. Forest cover scenarios based on trend in the past 10 years

Rate of change per year (ha)	244.59	24.5	48.9	122.30
Year	**Forest Cover (ha) - Business as usual**	**Forest Cover (ha) - 10% increase (244.59 + 24.5)**	**Forest Cover (ha)- 20% increase (244.59 + 48.9)**	**Forest Cover (ha) - 50% increase (244.59 + 122.30)**
2011	8497			
2012	8742			
2013	8987			
2014	9231			
2015	9476			
2016	9720			
2017	9965			
2018	10210			
2019	10454			
2020	10699			
2021	10943	10943	10943	10943
2022	11188	11212	11237	11310
2023	11432	11481	11530	11677
2024	11677	11750	11824	12044
2025	11922	12019	12117	12411
2026	12166	12289	12411	12778
2027	12411	12558	12704	13145
2028	12655	12827	12998	13512
2029	12900	13096	13291	
2030	13145	13365	13585	
2031	13389	13634		
2032				

These scenarios are presented visually in **Figure 3** (Forest cover Scenarios)

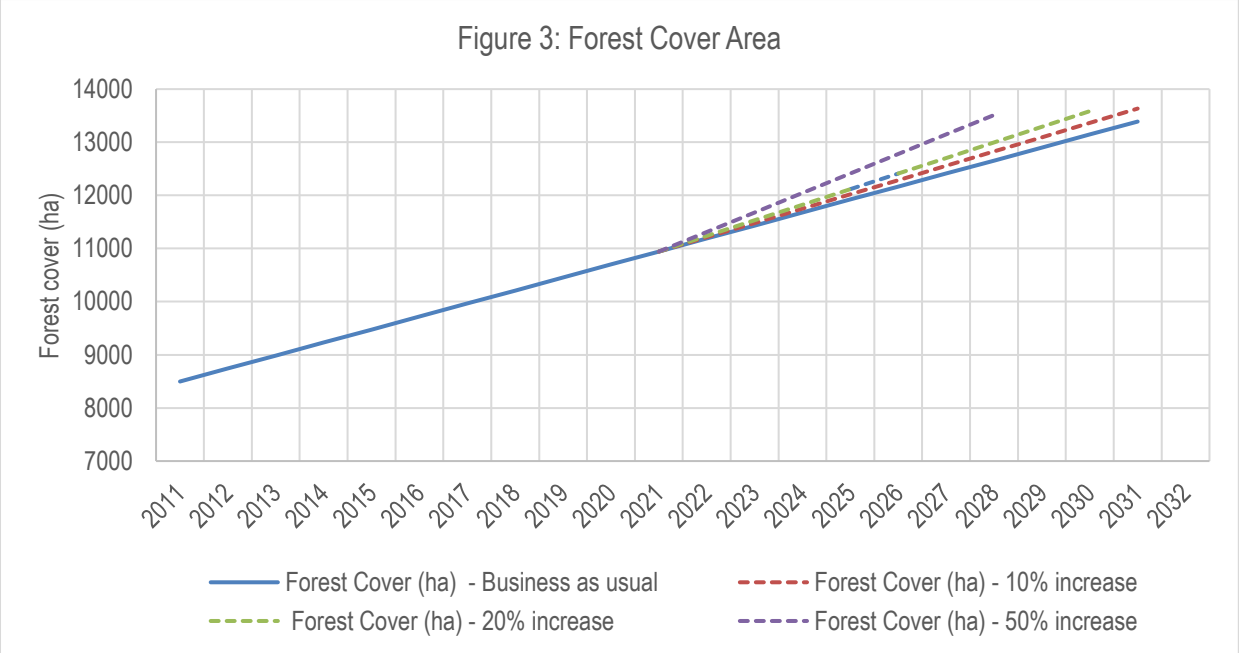


Figure 3. Forest cover scenarios

2.6.3 Carbon stock estimation and CO2 emissions

The field data and biomass collected from 12 samples was used to calculate Above Ground Biomass (AGB) using locally developed allometric equations (Ismail et al, 2018) for 2011-2021 (**Table 6**). In Khushab forest, the cumulative carbon stock in the carbon pools (above, below, deadwood, litter and soil) was estimated to as 45,799 tonnes of Organic Carbon (Corg) back in 2011 which increased to 58,982 tonnes in 2021. This change corresponds to the increase in forest cover from 8,497.35 ha in 2011 to 10,943.28 ha in year 2021 reducing CO_2 emissions at the rate of 4,834 tonnes of CO_2 eq. per annum (see figure 4 and table 6).

Figure 4. Forest Cover Maps used for Change Analysis

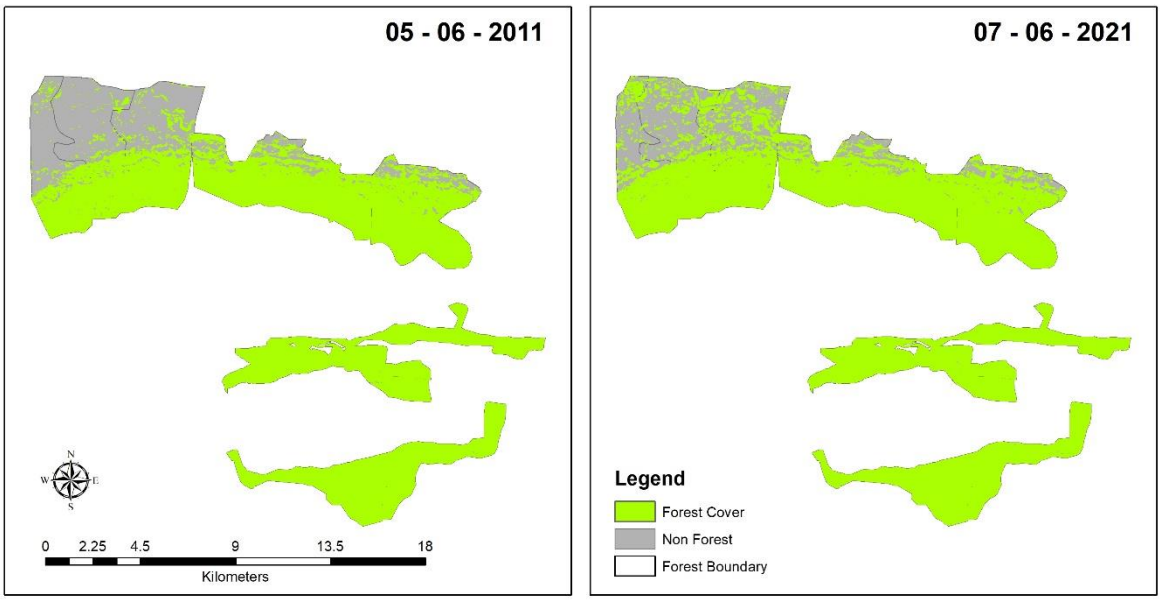


Table 6. Carbon stock estimation (2011-2021)

Carbon pool	Mean carbon stock (tonnes C stock per hectare)	Forest Cover (ha)	Total stock (tonnes C stock)	CO_2 (ton CO_2 eq)
2011 (2011-06-05)				
Above	0.27	8497.35	2,287.60	
Below	0.07		571.90	
Deadwood	0.00		-	
Litter	0.05		452.62	
Soil*	5		42,486.75	
Cumulative			45,799	167,929.23
2021 (2021-06-07)				
Above	0.27	10943.28	2,946.08	
Below	0.07		736.52	
Deadwood	0.00		-	
Litter	0.05		582.91	
Soil	5		54,716.40	
Cumulative			58,982	216,267.02
Rate of change per year				
2021-2011		**244.59**	**1,318.30**	**4,834**

* Soil Carbon Value taken from NRO Inventory

2.6.4 CO2 Sequestration Scenarios from Forest Enhancement

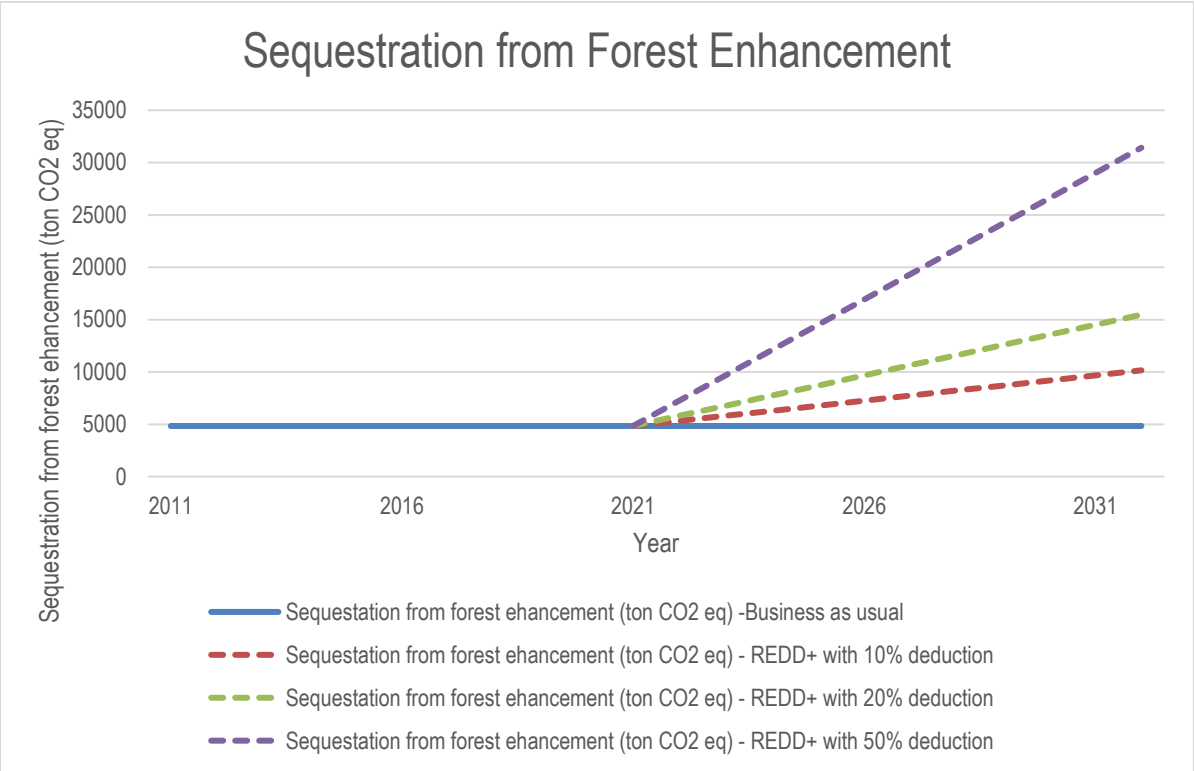
This section presents the future CO_2 emissions sequestration scenarios applying 10%, 20% and 50% enhancement to current sequestration rate over the past 10 years due to forest cover increase (As per definition of forest adopted by Pakistan for REDD+). The current average CO_2 sequestration rate in Khushab forest is 4,834 tonnes CO_2 eq per annum because of forest cover increase which can be boosted further by 483 tonnes with 10% enhancement, 967 tonnes with 20% enhancement and 2417 tonnes with 50% enhancement of forest cover. Figure 5 shows the enhancement trend under different scenarios.

Table 7. CO_2 emissions sequestration trend and different enhancement scenarios

Rate of change per year	4834	483	967	2417
Year	**Sequestration from Forest enhancement (tonne CO_2 eq) - Business as usual**	**Sequestration from Forest enhancement (tonne CO_2 eq) - REDD+ with 10% addition**	**Sequestration from Forest enhancement (tonne CO_2 eq) - REDD+ with 20% addition**	**Sequestration from Forest enhancement (tonne CO_2 eq) - REDD+ with 50% addition**
2011	4834			
2012	4834			
2013	4834			
2014	4834			
2015	4834			
2016	4834			
2017	4834			
2018	4834			
2019	4834			

Rate of change per year	4834	483	967	2417
Year	Sequestration from Forest enhancement (tonne CO_2 eq) - Business as usual	Sequestration from Forest enhancement (tonne CO_2 eq) - REDD+ with 10% addition	Sequestration from Forest enhancement (tonne CO_2 eq) - REDD+ with 20% addition	Sequestration from Forest enhancement (tonne CO_2 eq) - REDD+ with 50% addition
2020	4834			
2021	4834	4834	4834	4834
2022	4834	5317	5801	7251
2023	4834	5801	6767	9668
2024	4834	6284	7734	12084
2025	4834	6767	8701	14501
2026	4834	7251	9668	16918
2027	4834	7734	10634	19335
2028	4834	8217	11601	21752
2029	4834	8701	12568	24169
2030	4834	9184	13535	26586
2031	4834	9668	14501	29003
2032	4834	10151	15468	31420

Figure 5. Emissions reduction scenarios – Forest Cover Increase



2.6.5 CO_2 Emissions Trend – forest degradation

Fuelwood and Timber consumption for the pilot site was estimated based on population of the area, population growth rate and per capita fuelwood and timber consumption statistics collected during the field survey. The total population of the pilot site in 2017 was 60,000 with a growth rate of 1.84 per annum. The fuelwood and timber consumption per capita per annum was calculated as 0.201 m^3 and 0.0463 m^3 respectively. Based on this data emissions from forest degradation are calculated and presented in Table 8.

Table 8. Forest degradation emissions trend

Year	Population	Fuelwood Consumption (FC) (m^3/year)	Timber Consumption (TC) (m3/year)	Fuelwood Emissions[1] (FC*D*BEF2*CF*44/12) (tonnes CO_2 eq)	Timber Emission (TC*D*BEF2*CF*44/12) (tonnes CO_2 eq)	Emission from Forest Degradation (tonnes CO_2 eq) - Business as usual
2011	53673	10788	2485	20186	4650	24836
2012	54679	10991	2532	20564	4737	25301
2013	55704	11197	2579	20950	4826	25776
2014	56749	11406	2627	21343	4916	26259
2015	57812	11620	2677	21743	5008	26751
2016	58896	11838	2727	22150	5102	27253
2017	60000	12060	2778	22565	5198	27763
2018	61104	12282	2829	22981	5294	28274
2019	62228	12508	2881	23404	5391	28794
2020	63373	12738	2934	23834	5490	29324
2021	64539	12972	2988	24273	5591	29864
2022	65727	13211	3043	24719	5694	30413
2023	66936	13454	3099	25174	5799	30973
2024	68168	13702	3156	25637	5906	31543
2025	69422	13954	3214	26109	6014	32123
2026	70700	14211	3273	26589	6125	32714
2027	72000	14472	3334	27079	6238	33316
2028	73325	14738	3395	27577	6352	33929
2029	74674	15010	3457	28084	6469	34554
2030	76048	15286	3521	28601	6588	35189
2031	77448	15567	3586	29127	6709	35837
2032	78873	15853	3652	29663	6833	36496

[1] Wood Density (D)

Acacia modesta	*0.835*
Dodonaea viscosa	*0.840*
Prosopis glandulosa	*0.707*
Olea Ferruginea	*0.887*
Ziziphus mauritiana	*0.583*
Average	**0.770**

Biomass Expansion Factor: BEF2 1.35 (IPCC Table 3A.1.10)

CF = carbon fraction of dry matter 0.5

2.6.6 Net Emissions from Deforestation and Forest Degradation

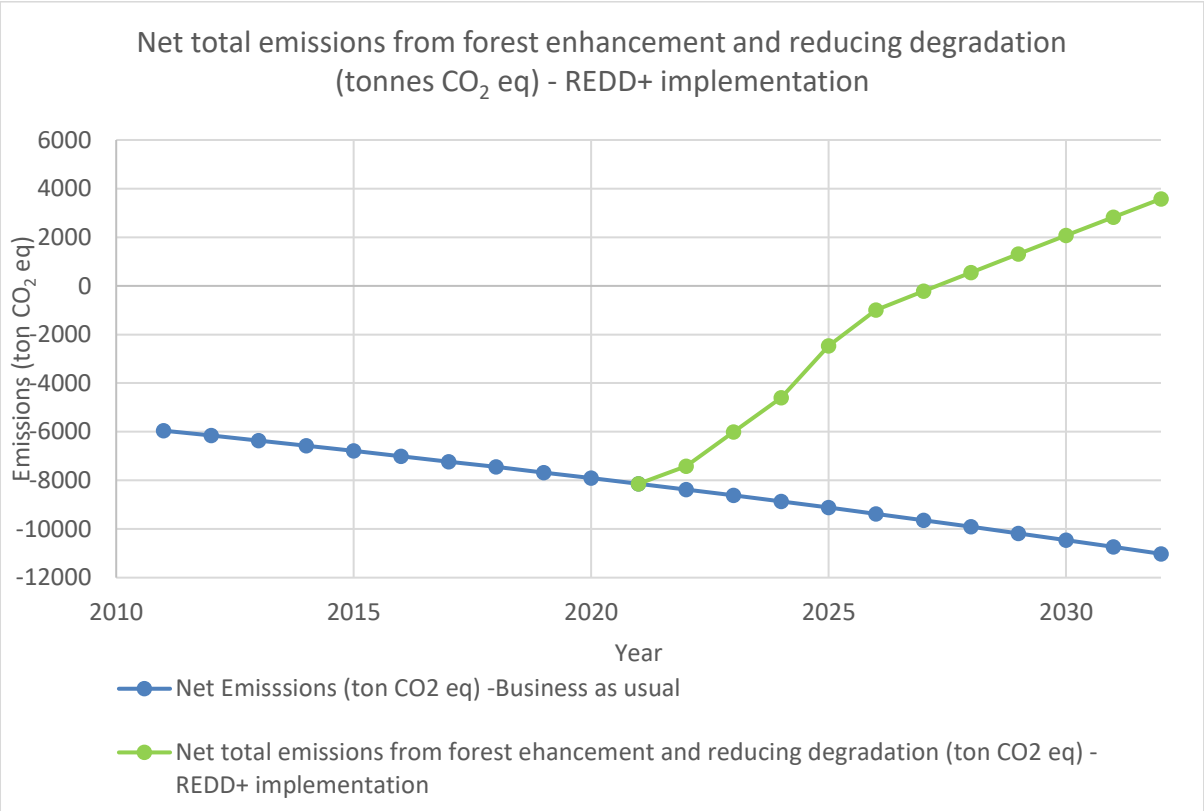
The table 9 below provides a net CO_2 sequestration scenario based on 20% forest cover enhancement in addition to existing positive trend and reducing emissions from forest degradation in an incremental manner annually from 5% to 25% with REDD+ activity. In this scenario, the forest will start sequestering more carbon and the business-as-usual scenario of increasing emissions will be reversed and forest will become net sequester of CO_2 from the 5th year of REDD+ implementation.

Table 9. Sequestration scenario from forest enhancement and reducing degradation

Rate of change per year	4834					967	
Year	**Annual Sequestration from forest enhancement (tonnes CO_2 eq) -Business as usual**	**Annual Emission from Forest Degradation (tonnes CO_2 eq) - Business as usual**	**Net Emissions (tonnes CO_2 eq) - Business as usual**	**5-25% Reduction in Degradation emissions (tonnes CO_2 eq)**	**Net emissions from degradation (tonnes CO_2 eq)**	**Sequestration from forest enhancement (tonnes CO_2 eq) - REDD+ with 20% enhancement**	**Net total emissions from forest enhancement and reducing degradation (tonnes CO_2 eq) - REDD+ implementation**
2011	4834	10788	-5955				
2012	4834	10991	-6157				
2013	4834	11197	-6363				
2014	4834	11406	-6573				
2015	4834	11620	-6786				
2016	4834	11838	-7004				
2017	4834	12060	-7226				
2018	4834	12282	-7448				
2019	4834	12508	-7674				
2020	4834	12738	-7904				
2021	4834	12972	-8139				-8139
2022	4834	13211	-8377	661	13211	5801	-7411
2023	4834	13454	-8620	673	12781	6767	-6014
2024	4834	13702	-8868	1370	12332	7734	-4598
2025	4834	13954	-9120	2791	11163	8701	-2462
2026	4834	14211	-9377	3553	10658	9668	-990

Rate of change per year	4834					967	
Year	Annual Sequestration from forest enhancement (tonnes CO_2 eq) -Business as usual	Annual Emission from Forest Degradation (tonnes CO_2 eq) - Business as usual	Net Emissions (tonnes CO_2 eq) - Business as usual	5-25% Reduction in Degradation emissions (tonnes CO_2 eq)	Net emissions from degradation (tonnes CO_2 eq)	Sequestration from forest enhancement (tonnes CO_2 eq) - REDD+ with 20% enhancement	Net total emissions from forest enhancement and reducing degradation (tonnes CO_2 eq) - REDD+ implementation
2027	4834	14472	-9638	3618	10854	10634	-220
2028	4834	14738	-9905	3685	11054	11601	547
2029	4834	15010	-10176	3752	11257	12568	1311
2030	4834	15286	-10452	3821	11464	13535	2070
2031	4834	15567	-10733	3892	11675	14501	2826
2032	4834	15853	-11020	3963	11890	15468	3578

Figure 6. Sequestration scenarios – Forest Enhancement and Reduced Degradation



3. Proposed Intervention

A number of interventions have been proposed here based on the participatory forest inventory, socio-economic data, drivers of deforestation and stakeholders' analysis. The analysis ascertained that in order to achieve effective results for sustainable forest management and incremental Carbon sequestration, the activities required under this PFMP need to cater to all the related issues holistically. The following interventions are, therefore, suggested for managing the **SBEF Khushab** as a REDD+ pilot site:

Table 10. Proposed interventions addressing major drivers deforestation and degradation and Barriers to Enhancement

S. #	**Details of Interventions**	**Drivers of deforestation and degradation and Barriers addressed**
1	Notification of the relevant forums after stakeholders reaching at collective decisions	Illegal cutting of trees and theft of wood by locals for sale
2	Appointment of community forest guards (Twelve)	Illegal cutting of trees and theft of wood by locals for sale Addressing issues of over grazing and firewood collection
3	Preparation for implementation of endorsed PFMP and periodical follow up meetings (communities and other stakeholders)	Illegal cutting of trees and theft of wood by locals for sale Addressing issues of over grazing and firewood collection
4	Introduction of energy efficient stoves, heaters and geysers fueled by agriculture waste pallets and briquettes.	Addressing issues of firewood collection
5	Community / youth motivational events	Illegal cutting of trees and theft of wood by locals for sale
6	Nursery establishment and maintenance for planting activities (4 nurseries to collectively produce 300,000 (Three hundred thousand) plants per year)	Illegal cutting of trees Addressing issues of over grazing and firewood collection
7	Trainings to promote alternative sources of livelihoods (e.g., NTFPs collection)	Illegal cutting of trees and theft of wood by locals for sale
8	Introduction of solar energy as an alternative source of household energy.	Addressing issues firewood collection
9	Construction of water ponds for water resource development for planting, ground water recharge and enhancement of biodiversity of both flora and fauna.	Barrier to restoration - Lack of water availability
10	Training /exposure of forest officials and community in accordance with their roles in REDD+	All
11	Establishment of a Biomass briquetting plant	Addressing issues firewood collection
12	Soil conservation and planting works in blank, degraded and low-density patches (approximately two million plants (2,000,000) plants in 10 years)	Forest Enhancement

The total indicative budget of the PFMP implementation is PKR **648.2 million (Table 11)**

Figure 7. Visuationsation of budget in percentages

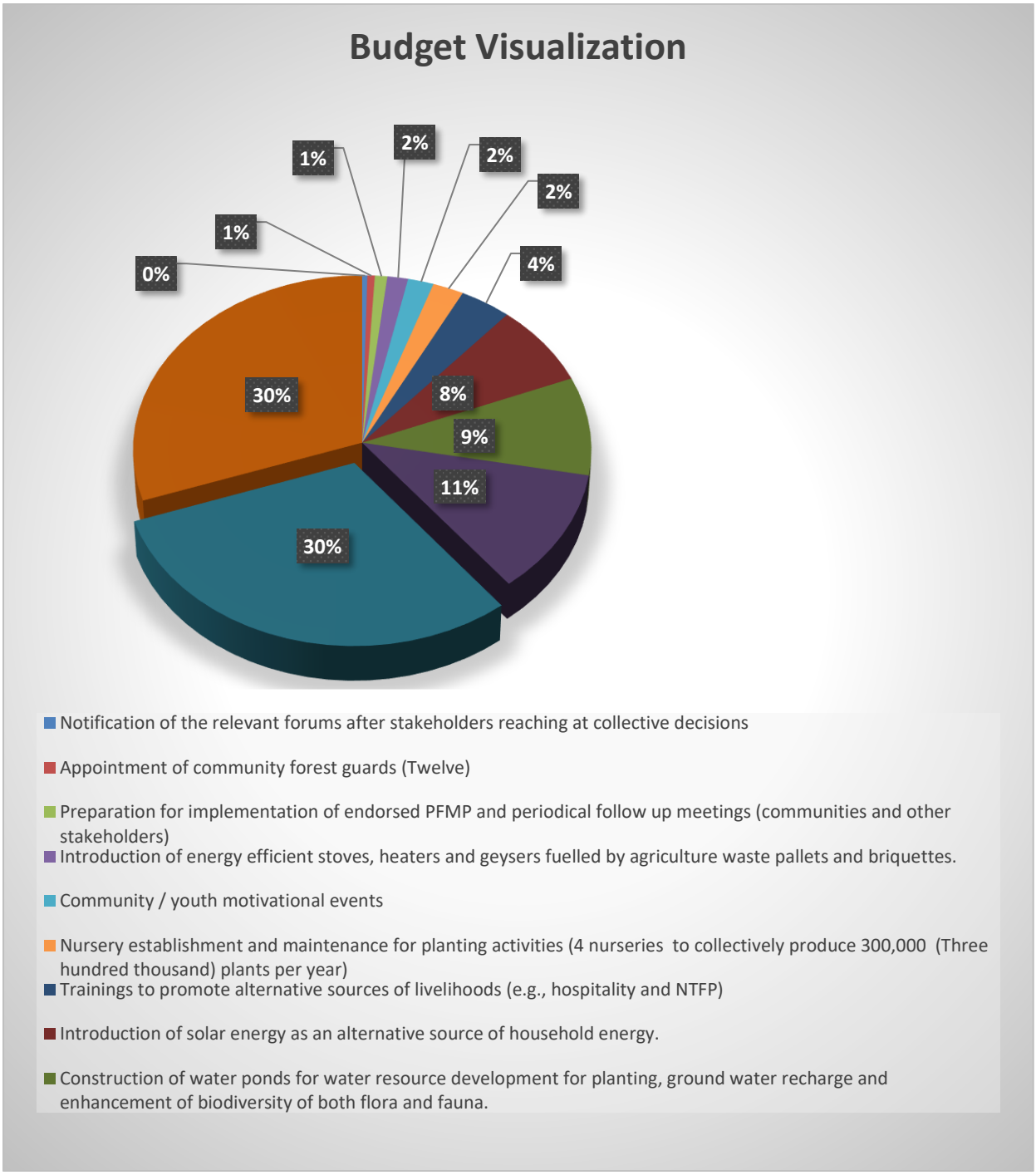


Table 11. Indicative operational plan and budget of the PFMP for 10 years

				Operational Plan											
S.N.	**Details of Activity**	**Unit**	**Unit cost**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total units**	**Total cost (Million)**
1	Notification of the relevant forums after stakeholders reaching at collective decisions		500,000											12	6
2	Appointment of community forest guards (Twelve)	Number	60,000	12	12	12	12	12	12	12	12	12	12	120	7.2
3	Preparation for implementation of endorsed PFMP and periodical follow up meetings (communities and other stakeholders)	Number	100,000	12	12	12	12	12	12	12	12	12	12	120	12
4	Introduction of energy efficient stoves, heaters and geysers fueled by agriculture waste pallets and briquettes.	Numbers	20000	100	100	100	100	100						500	10
5	Community / youth	Numbers	500,000	5	5	5	5	5	5	5	5	5	5	50	25

				Operational Plan											
S.N.	**Details of Activity**	**Unit**	**Unit cost**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total units**	**Total cost (Million)**
	motivational events														
6	Nursery establishment and maintenance for planting activities (4 nurseries to collectively produce 300,000 (Three hundred thousand) plants per year)	Numbers	10	300000	300000	300000	300000	300000	300000	300000	300000	300000	300000	3,000,000	30
7	Trainings to promote alternative sources of livelihoods (e.g., hospitality and NTFP)	Numbers	100,000	50	50	50	50	50	50	50	50	50	50	500	50
8	Introduction of solar energy as an alternative source of household energy.	Numbers	100,000	100	100	100	100	100						500	50
9	Construction of water ponds for water resource	Numbers	1,000,000	1	3	3	5							12	12

				Operational Plan											
S.N.	**Details of Activity**	**Unit**	**Unit cost**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total units**	**Total cost (Million)**
	development for planting, ground water recharge and enhancement of biodiversity of both flora and fauna.														
10	Training /exposure of forest officials and community in accordance with their roles in REDD+	Numbers	500,000	4		4			2		2			12	6
11	Establishment of Biomass briquetting plant	Numbers	20,000,000		1	1								2	40
12	Planting in blank and low-density patches (approximately two million plants (2,000,000) plants in 10 years)	Numbers	200	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	2,000,000	400
															648.2

4. Implementation Mechanism for the PFMP

4.1. Resources for activities

The Forest Department as custodian of the forest and having linkages with national and international funding sources will take a lead this activity. The key stakeholders identifying in this plan, especially the FD and the Village Conservation Committees will jointly look for resources for implementation of activities identified in this plan. The FD will submit proposals for potential funding sources including the Ministry of Climate Change, Public Sector Development Programme (PSDP), international donors and private sector investors.

4.2. Suggested institutional mechanism for implementation of activities

Village and district level REDD+ implementation committees notified by the Forest Department will oversee implementation of activities. The notifications will include description of responsibilities of FD, the respective communities, and any other relevant stakeholders. The village level implementation committees will consist of representative of the community surrounding each forest. Presently Village Committees are not in place, however, these will be constituted in due course of time. The members of joint VCC of surrounding villages of each forest will represent the community in the village level implementation committee to be notified by the FD. The in-charge forest guard will represent the department in the village implementation committee. The representative of the community will be responsible to harness support of the community for implementation of activities. The village implementation committee will be supervised by subdivision level committee chaired by the sub-divisional forest officer with members from the VCC. The District Conservation Committee will consist of Divisional Forest officer, District officer agriculture, and deputy commissioner responsibility of the district committee will be to monitor progress on implementation of activities and harnessing support from the relevant actors including government departments. The district committee will also act as final forum for conflict resolution.

4.3 Benefit Distribution Mechanism

The implementation of the REDD+ interventions package and other support activities will increase the volume of carbon stock in the forest. The increase in carbon stock in the forest pool measured by variable means and the trade of carbon will generate substantial income for the stakeholders in due course of time. The income earned by trading carbon stock will be distributed in proportions as per the use rights held by stakeholders or mechanism specifically developed for benefit sharing. It is expected that the income generated by this mechanism will be significant and the stakeholders are expected to value standing trees rather than cutting it for other uses. Since the community will be reducing harvest of fuel wood, restrict grazing for encouraging regeneration and voluntarily participate in restocking of forest, they will expect a major share from results base payments from reduced carbon emissions.

This plan has proposed distribution of carbon and non-carbon benefits accrued by the implementation of plan according to which 80% benefits will go to the Government, and 20% will go to the customary right holders and users. These benefits will only be distributed if the targets are achieved. The plan therefore provides scenarios to reduce or increase benefits so that the stakeholders can enjoy results-based payment and benefits. The success of this plan, therefore, is contingent on the commitment of all the stakeholders involved. A specific and definitive distribution of benefits in case of REDD+ programme is yet to be developed by the government, which will form basis for sharing of benefits in the case of private forests. This proposed ratio will be finalized or confirmed only after finalizing AJK based benefit sharing mechanism.

5. Conflict and grievance redressal mechanism

5.1 Conflict within the community

Traditionally, a *jirga* system resolves conflicts within the community and the decisions taken are acceptable for the parties. Under REDD+ redressal, it is suggested that the same *jirga* may take lead role to resolve conflicts arising among the community regarding implementation of REDD+ activities. The structure and function of *jirga* system has been described in earlier section in this document.

5.2 Conflict between the villages

The VCCs with the help of *jirgas* of the village will settle any disputes between the villages. Any unsettled disputes will be referred to the district implementation committee which will be the final authority for conflict resolution.

5.3 Community's grievance towards the Forest Department

The REDD+ is a new concept for communities as well as for the FD, therefore both partners (Community and the FD) might be facing some conflict of interest in due course of time. In case of any such grievances arises, these will be dealt through the grievance redressal mechanism developed under the REDD+ obligation. This mechanism is also reflected well in Provincial REDD+ Action Plan.

References:

IPCC, 2021: Climate Change 2021: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change *[Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland.*

GCISC, 2018. Pakistan's second national communication on climate change. gcisc.org.pk/SNC_Pakistan.pdf

GoP, 2017. Pakistan's intended Nationally Determined Contributions. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Pakistan%20First/Pak-INDC.pdf

ADB, 2017. Climate change profile of Pakistan. Asian Development Bank 6 ADB Avenue, Mandaluyong City, 1550 Metro Manila, Philippines

Annex 1. Socio-economic Data of SBEF Khushab

I. Stakeholder group (names)	Communities of villages - Users of SBEF Khushab
2. General information Location of stakeholder groups (e.g., different villages/hamlets in and outside forest area) and names and indicate on map if possible	See Figure 1 for location
3. Social organization in the forest area	
A. Traditional organizations (e.g., Jirga)	
Organization (name; purpose; membership) Every village has a Jirga or Council of elderly people	Managing matters related to village including communal resources and conflict resolution/ all households through selected members
B. Formal organization (e.g., social; welfare organization or village development committee	
Organization (name; purpose; membership)	None
Organization (name; purpose; membership)	None
4. Use of forest and forest area (for what are you using the forest area?)	
Timber for personal use like house construction, etc. (where; locate on the map)	Yes, all over the forest, minor uses as small implements and tool handles, shelters for animals etc
Timber for commercial selling (where; locate on the map)	No
Firewood (where; locate on the map)	Yes, all over the forest
Grazing (where; locate on the map)	Yes, all over the forest,
Grass cutting (where; locate on the map	Yes, all over the forest,
Other products, e.g., mushroom, vegetables, stones, minerals, medicinal plants (where; locate on the map)	Mushrooms, medicinal plants from all over the forest
Forest areas related daily labour/employment (employed by whom; for what?)	Local community works as daily labour inside forest during execution of forest operations
Tourism (what; where; locate on the map)	No existing tourist facilities. Potential exists especially in Sakesar and RAMSAR wetlands sites near forest which are shown in Figure 1
Hunting/Fishing and fish rearing	There is lot of potential for Fishing in the natural lakes development of similar lakes and ponds has been proposed in the plan.
What would it mean if you had no access to these forest products? (Any alternatives? Threat to livelihood?)	The major source of lively hood is pastoral, people earn a lot from rearing cattle's, sheep and goats. People would be forced to migrate if grazing, and firewood is not allowed. People have to buy fodder and costly substitute of energy (mainly LPG) and construction material (concrete). People will not afford buying these products if access to forest products are not available. Specially land less community will suffer a lot.

5. Rights and concessions in forest area	
Do you have formal, legal, or traditional, customary rights on forest products (use)? Which ones? If documented rights, where?	Yes, we have certain rights and privileges, we can collect dead dry wood for fuel, small timber for agriculture use, brush wood for fencing and making shelters for livestock. we can graze our livestock in forest which is our main source of income.
Timber	We collect timber specially tool handles as per need with the permission of the authorities keeping in view the sustainability of produce.
Fodder: grass cutting/grazing	Yes
Firewood	Yes (dead fallen, and pruning of trees)
Other products:	Yes (NTFP) mainly honey, medicinal plants, mushrooms
6. Conflicts / disputes	
On different land uses: Describe nature of conflict, between which groups and put location on map if possible	No major conflict, small disputes are resolved at village and range level.
Do they have effect on forest management? And how?	No
On social issues: Describe nature of conflict, between which groups and put location on map if possible	None
Do they have effect on forest management? And How?	None
Existing Conflict resolution mechanisms: - traditional (e.g., Jirga) - formal (court)	Through local *Jirga*, FOREST DEPARTMENT, Revenue Department, and Court of Law.
7. Other Forest Management Projects	
Are there any other Forest Management Projects in the area? If so, which projects? What are their activities?	Ten Billion Trees Tsunami project is under implementation. This will have positive impacts on forest cover. It is also providing job opportunities to unskilled labour.

Annex 2: Stakeholder Analysis

STAKEHOLDER	**INTEREST in Forest**		**INFLUENCE on Forest**	
	Type of interest	Level of interest*	Type of influence	Level of influence*
Forest Department	Sustainable management of forest resources and avoid forest degradation as legal representative of the Government	3	Legal controller: decision on use, protection, and improvement of forest resources Ban on timber fuel wood extraction	3
Community -households with no land ownership	Grazing, Timber Fuel wood, NTFP, Water	3	Local use and control of forest benefits; De facto control to stop any illegal harvesting of timber and grazing by outsiders in areas near their settlements	2
Community-Households with land holding	Grazing, Timber Fuel wood, NTFP, Water Protecting cropland, establishing tourist facilities on their properties	3	Local use and control of forest benefits; De facto control to stop any illegal harvesting of timber and grazing by outsiders Control on free grazing, securing cropland and adjoining forests	3
Law & Enforcement Agencies	None	0	Legal action on need basis	1
Village Conservation Committee and *Jirga*	Protection of Forest, mainly extraction of fuel wood and small timber	2	Maintaining timber extraction ban. Consensus building among communities for forest protection, advocacy for rights of the legal users, conflict resolution	3
Illegal cutting of wood (they have legal rights for domestic use but also harvest for sale)	Illegal harvesting of timber and firewood for cash income	2	Manipulation / illegal act	1
Revenue Department	None	0	Land monitoring and related dispute management	2
Tourism Department	Sustainable management of forest resources and avoid forest degradation to enhance tourism as l representative of the Government	3	Advise on use, protection, and improvement of forest resources to enhance tourism	3
Ministry of Climate Change	Sustainable management of forest resources and avoid forest degradation		Indirect influence through policies and (international) lobby	

***Scale**	**Level of interest**	**Level of influence**
0	None	Negligible or ignored
1	Little	Little
2	Significant	Significant

Annex 3. Plot Level Carbon Stock

Plot No.	Latitude	Longitude	Species Name	Scientific Name	DBH (cm)	Tree height (m)	Wood Density (g/cm3)	AGB (kg)	AGB (ton/ha)	AGC (ton/ha)	BGC (ton/ha)
1	72.25	32.59	Kahu	Olea ferruginea	6	2.4	0.805	4.22775	0.04	0.02	0.00
1	72.25	32.59	Kahu	Olea ferruginea	11	4.6	0.805	26.04486	0.26	0.12	0.03
1	72.25	32.59	Kahu	Olea ferruginea	6	4.3	0.805	7.469444	0.07	0.04	0.01
1	72.25	32.59	Kahu	Olea ferruginea	10	3.4	0.805	16.09887	0.16	0.08	0.02
1	72.25	32.59	Kahu	Olea ferruginea	7	2.4	0.805	5.712016	0.06	0.03	0.01
1	72.25	32.59	Kahu	Olea ferruginea	9	3	0.805	11.59908	0.12	0.05	0.01
1	72.25	32.59	Kahu	Olea ferruginea	6	3	0.805	5.256461	0.05	0.02	0.01
1	72.25	32.59	Kahu	Olea ferruginea	9	2.7	0.805	10.4656	0.10	0.05	0.01
1	72.25	32.59	Kahu	Olea ferruginea	18	4.6	0.805	68.11071	0.68	0.32	0.08
1	72.25	32.59	Kahu	Olea ferruginea	6	43.9	0.805	72.12212	0.72	0.34	0.08
1	72.25	32.59	Kahu	Olea ferruginea	6	4.6	0.805	7.977645	0.08	0.04	0.01
1	72.25	32.59	Phulai	Olea ferruginea	10	4.3	0.835	20.98197	0.21	0.10	0.02
1	72.25	32.59	Kahu	Olea ferruginea	18	5.5	0.805	81.08822	0.81	0.38	0.10
1	72.25	32.59	Kahu	Olea ferruginea	6	3.7	0.805	6.45042	0.06	0.03	0.01
1	72.25	32.59	Kahu	Olea ferruginea	7	5.2	0.805	12.1485	0.12	0.06	0.01
1	72.25	32.59	Kahu	Olea ferruginea	12	5.5	0.805	36.74748	0.37	0.17	0.04
1	72.25	32.59	Kahu	Olea ferruginea	10	5.2	0.805	24.372	0.24	0.11	0.03
1	72.25	32.59	Phulai		15	5.2	0.835	55.73532	0.56	0.26	0.07
1	72.25	32.59	Kahu	Olea ferruginea	15	4.9	0.805	50.74969	0.51	0.24	0.06
1	72.25	32.59	Kahu	Olea ferruginea	14	6.1	0.805	54.92824	0.55	0.26	0.06
1	72.25	32.59	Kahu	Olea ferruginea	9	4.9	0.805	18.72339	0.19	0.09	0.02
1	72.25	32.59	Kahu	Olea ferruginea	7	4	0.805	9.404025	0.09	0.04	0.01
1	72.25	32.59	Kahu	Olea ferruginea	13	5.8	0.805	45.24754	0.45	0.21	0.05
1	72.25	32.59	Kahu	Olea ferruginea	10	3	0.805	14.24762	0.14	0.07	0.02
1	72.25	32.59	Kahu	Olea ferruginea	7	3.7	0.805	8.715014	0.09	0.04	0.01
1	72.25	32.59	Phulai	Acacia modesta	27	7.3	0.835	244.4591	2.44	1.15	0.29
1	72.25	32.59	Kahu	Olea ferruginea	9	6.1	0.805	23.1865	0.23	0.11	0.03
1	72.25	32.59	Kahu	Olea ferruginea	6	2.7	0.805	4.742792	0.05	0.02	0.01
1	72.25	32.59	Kahu	Olea ferruginea	12	6.1	0.805	40.65515	0.41	0.19	0.05
1	72.25	32.59	Kahu	Olea ferruginea	10	4.9	0.805	22.9987	0.23	0.11	0.03

Plot No.	Latitude	Longitude	Species Name	Scientific Name	DBH (cm)	Tree height (m)	Wood Density (g/cm3)	AGB (kg)	AGB (ton/ha)	AGC (ton/ha)	BGC (ton/ha)
1	72.25	32.59	Kahu	Olea ferruginea	11	5.5	0.805	31.00733	0.31	0.15	0.04
1	72.25	32.59	Kahu	Olea ferruginea	9	5.2	0.805	19.84141	0.20	0.09	0.02
1	72.25	32.59	Phulai	Olea ferruginea	27	4.3	0.835	145.8372	1.46	0.69	0.17
1	72.25	32.59	Kahu	Olea ferruginea	6	3.7	0.805	6.45042	0.06	0.03	0.01
1	72.25	32.59	Kahu	Olea ferruginea	10	4	0.805	18.86611	0.19	0.09	0.02
1	72.25	32.59	Kahu	Olea ferruginea	13	4.6	0.805	36.08618	0.36	0.17	0.04
1	72.25	32.59	Kahu	Olea ferruginea	10	4.3	0.805	20.2459	0.20	0.10	0.02
1	72.25	32.59	Kahu	Olea ferruginea	11	4.3	0.805	24.38572	0.24	0.11	0.03
1	72.25	32.59	Kahu	Olea ferruginea	7	4	0.805	9.404025	0.09	0.04	0.01
1	72.25	32.59	Kahu	Olea ferruginea	6	2.7	0.805	4.742792	0.05	0.02	0.01
2	72.28	32.62	Kahu	Olea ferruginea	7	3	0.805	7.101884	0.07	0.03	0.01
2	72.28	32.62	Kahu	Olea ferruginea	8	3.7	0.805	11.31015	0.11	0.05	0.01
2	72.28	32.62	Kahu	Olea ferruginea	6	3.4	0.805	5.939454	0.06	0.03	0.01
2	72.28	32.62	Kahu	Olea ferruginea	10	3	0.805	14.24762	0.14	0.07	0.02
2	72.28	32.62	Kahu	Olea ferruginea	11	3	0.805	17.16093	0.17	0.08	0.02
2	72.28	32.62	Kahu	Olea ferruginea	10	2.7	0.805	12.85532	0.13	0.06	0.02
2	72.28	32.62	Kahu	Olea ferruginea	11	3.7	0.805	21.05888	0.21	0.10	0.02
2	72.28	32.62	Kahu	Olea ferruginea	6	3	0.805	5.256461	0.05	0.02	0.01
2	72.28	32.62	Kahu	Olea ferruginea	10	3.7	0.805	17.48384	0.17	0.08	0.02
2	72.28	32.62	Kahu	Olea ferruginea	16	4.6	0.805	54.12099	0.54	0.25	0.06
2	72.28	32.62	Kahu	Olea ferruginea	11	4.6	0.805	26.04486	0.26	0.12	0.03
2	72.28	32.62	Kahu	Olea ferruginea	6	4.3	0.805	7.469444	0.07	0.04	0.01
2	72.28	32.62	Kahu	Olea ferruginea	10	4.6	0.805	21.62338	0.22	0.10	0.03
2	72.28	32.62	Kahu	Olea ferruginea	8	4.6	0.805	13.98798	0.14	0.07	0.02
2	72.28	32.62	Kahu	Olea ferruginea	6	4.6	0.805	7.977645	0.08	0.04	0.01
2	72.28	32.62	Kahu	Olea ferruginea	18	4.9	0.805	72.44279	0.72	0.34	0.09
2	72.28	32.62	Kahu	Olea ferruginea	8	3.7	0.805	11.31015	0.11	0.05	0.01
2	72.28	32.62	Kahu	Olea ferruginea	12	4.3	0.805	28.90007	0.29	0.14	0.03
2	72.28	32.62	Kahu	Olea ferruginea	7	4	0.805	9.404025	0.09	0.04	0.01
2	72.28	32.62	Kahu	Olea ferruginea	17	4	0.805	53.15189	0.53	0.25	0.06
2	72.28	32.62	Kahu	Olea ferruginea	16	4.3	0.805	50.67331	0.51	0.24	0.06
2	72.28	32.62	Kahu	Olea ferruginea	10	3.7	0.805	17.48384	0.17	0.08	0.02

Plot No.	Latitude	Longitude	Species Name	Scientific Name	DBH (cm)	Tree height (m)	Wood Density (g/cm3)	AGB (kg)	AGB (ton/ha)	AGC (ton/ha)	BGC (ton/ha)
2	72.28	32.62	Kahu	Olea ferruginea	6	3	0.805	5.256461	0.05	0.02	0.01
2	72.28	32.62	Kahu	Olea ferruginea	7	2.1	0.805	5.014057	0.05	0.02	0.01
2	72.28	32.62	Kahu	Olea ferruginea	8	2.1	0.805	6.507131	0.07	0.03	0.01
2	72.28	32.62	Phulai	Acacia modesta	9	2.4	0.835	9.668267	0.10	0.05	0.01
2	72.28	32.62	Kahu	Olea ferruginea	8	2.7	0.805	8.316001	0.08	0.04	0.01
2	72.28	32.62	Kahu	Olea ferruginea	7	3	0.805	7.101884	0.07	0.03	0.01
2	72.28	32.62	Kahu	Olea ferruginea	10	3.7	0.805	17.48384	0.17	0.08	0.02
2	72.28	32.62	Kahu	Olea ferruginea	11	4.3	0.805	24.38572	0.24	0.11	0.03
2	72.28	32.62	Kahu	Olea ferruginea	6	4.9	0.805	8.485051	0.08	0.04	0.01
2	72.28	32.62	Kahu	Olea ferruginea	17	4	0.805	53.15189	0.53	0.25	0.06
2	72.28	32.62	Kahu	Olea ferruginea	10	4	0.805	18.86611	0.19	0.09	0.02
2	72.28	32.62	Kahu	Olea ferruginea	12	4.6	0.805	30.86635	0.31	0.15	0.04
2	72.28	32.62	Kahu	Olea ferruginea	14	5.2	0.805	47.00381	0.47	0.22	0.06
2	72.28	32.62	Kahu	Olea ferruginea	11	4.3	0.805	24.38572	0.24	0.11	0.03
2	72.28	32.62	Kahu	Olea ferruginea	8	3	0.805	9.216666	0.09	0.04	0.01
2	72.28	32.62	Kahu	Olea ferruginea	7	2.7	0.805	6.407878	0.06	0.03	0.01
2	72.28	32.62	Kahu	Olea ferruginea	10	3.7	0.805	17.48384	0.17	0.08	0.02
2	72.28	32.62	Kahu	Olea ferruginea	8	3	0.805	9.216666	0.09	0.04	0.01
2	72.28	32.62	Kahu	Olea ferruginea	9	3.4	0.805	13.1062	0.13	0.06	0.02
2	72.28	32.62	Kahu	Olea ferruginea	10	4	0.805	18.86611	0.19	0.09	0.02
2	72.28	32.62	Kahu	Olea ferruginea	20	6.1	0.805	110.1956	1.10	0.52	0.13
3	72.3	32.53	Kahu	Olea ferruginea	20	6.1	0.805	110.1956	1.10	0.52	0.13
3	72.3	32.53	Kahu	Olea ferruginea	14	5.8	0.805	52.2901	0.52	0.25	0.06
3	72.3	32.53	Kahu	Olea ferruginea	13	5.2	0.805	40.67322	0.41	0.19	0.05
3	72.3	32.53	Kahu	Olea ferruginea	9	4.9	0.805	18.72339	0.19	0.09	0.02
3	72.3	32.53	Kahu	Olea ferruginea	23	5.5	0.805	130.8454	1.31	0.61	0.15
3	72.3	32.53	Kahu	Olea ferruginea	18	5.2	0.805	76.7685	0.77	0.36	0.09
3	72.3	32.53	Kahu	Olea ferruginea	15	5.5	0.805	56.80623	0.57	0.27	0.07
3	72.3	32.53	Kahu	Olea ferruginea	6	4.9	0.805	8.485051	0.08	0.04	0.01
3	72.3	32.53	Kahu	Olea ferruginea	7	4.9	0.805	11.46396	0.11	0.05	0.01
3	72.3	32.53	Kahu	Olea ferruginea	11	5.5	0.805	31.00733	0.31	0.15	0.04
3	72.3	32.53	Kahu	Olea ferruginea	6	4.3	0.805	7.469444	0.07	0.04	0.01

Plot No.	Latitude	Longitude	Species Name	Scientific Name	DBH (cm)	Tree height (m)	Wood Density (g/cm3)	AGB (kg)	AGB (ton/ha)	AGC (ton/ha)	BGC (ton/ha)
3	72.3	32.53	Kahu	Olea ferruginea	22	6.4	0.805	139.0953	1.39	0.65	0.16
3	72.3	32.53	Kahu	Olea ferruginea	11	5.8	0.805	32.65698	0.33	0.15	0.04
3	72.3	32.53	Kahu	Olea ferruginea	20	7.3	0.805	131.3063	1.31	0.62	0.15
3	72.3	32.53	Kahu	Olea ferruginea	14	4.3	0.805	39.04622	0.39	0.18	0.05
3	72.3	32.53	Kahu	Olea ferruginea	8	4.6	0.805	13.98798	0.14	0.07	0.02
3	72.3	32.53	Kahu	Olea ferruginea	14	6.1	0.805	54.92824	0.55	0.26	0.06
3	72.3	32.53	Kahu	Olea ferruginea	14	6.1	0.805	54.92824	0.55	0.26	0.06
3	72.3	32.53	Kahu	Olea ferruginea	36	6.4	0.805	363.7525	3.64	1.71	0.43
3	72.3	32.53	Kahu	Olea ferruginea	12	5.5	0.805	36.74748	0.37	0.17	0.04
3	72.3	32.53	Kahu	Olea ferruginea	13	5.5	0.805	42.96188	0.43	0.20	0.05
3	72.3	32.53	Kahu	Olea ferruginea	20	6.1	0.805	110.1956	1.10	0.52	0.13
3	72.3	32.53	Kahu	Olea ferruginea	19	5.5	0.805	90.11412	0.90	0.42	0.11
3	72.3	32.53	Kahu	Olea ferruginea	6	4.6	0.805	7.977645	0.08	0.04	0.01
3	72.3	32.53	Kahu	Olea ferruginea	8	4.6	0.805	13.98798	0.14	0.07	0.02
3	72.3	32.53	Kahu	Olea ferruginea	7	4.9	0.805	11.46396	0.11	0.05	0.01
3	72.3	32.53	Kahu	Olea ferruginea	9	4.6	0.805	17.60374	0.18	0.08	0.02
3	72.3	32.53	Kahu	Olea ferruginea	6	4.6	0.805	7.977645	0.08	0.04	0.01
3	72.3	32.53	Kahu	Olea ferruginea	8	3.7	0.805	11.31015	0.11	0.05	0.01
3	72.3	32.53	Kahu	Olea ferruginea	11	4.9	0.805	27.7014	0.28	0.13	0.03
3	72.3	32.53	Kahu	Olea ferruginea	10	4.3	0.805	20.2459	0.20	0.10	0.02
3	72.3	32.53	Kahu	Olea ferruginea	7	4.3	0.805	10.0918	0.10	0.05	0.01
3	72.3	32.53	Kahu	Olea ferruginea	6	3	0.805	5.256461	0.05	0.02	0.01
3	72.3	32.53	Kahu	Olea ferruginea	14	5.2	0.805	47.00381	0.47	0.22	0.06
3	72.3	32.53	Kahu	Olea ferruginea	13	4.3	0.805	33.78738	0.34	0.16	0.04
3	72.3	32.53	Kahu	Olea ferruginea	10	4.3	0.805	20.2459	0.20	0.10	0.02
3	72.3	32.53	Kahu	Olea ferruginea	7	3.7	0.805	8.715014	0.09	0.04	0.01
3	72.3	32.53	Kahu	Olea ferruginea	11	4.3	0.805	24.38572	0.24	0.11	0.03
3	72.3	32.53	Kahu	Olea ferruginea	8	4.3	0.805	13.09691	0.13	0.06	0.02
3	72.3	32.53	Kahu	Olea ferruginea	18	6.1	0.805	89.711	0.90	0.42	0.11
3	72.3	32.53	Kahu	Olea ferruginea	16	6.1	0.805	71.28464	0.71	0.34	0.08
3	72.3	32.53	Kahu	Olea ferruginea	28	7.6	0.805	263.3895	2.63	1.24	0.31
3	72.3	32.53	Kahu	Olea ferruginea	13	4.6	0.805	36.08618	0.36	0.17	0.04

Plot No.	Latitude	Longitude	Species Name	Scientific Name	DBH (cm)	Tree height (m)	Wood Density (g/cm3)	AGB (kg)	AGB (ton/ha)	AGC (ton/ha)	BGC (ton/ha)
3	72.3	32.53	Kahu	Olea ferruginea	9	4.6	0.805	17.60374	0.18	0.08	0.02
3	72.3	32.53	Kahu	Olea ferruginea	10	4.9	0.805	22.9987	0.23	0.11	0.03
3	72.3	32.53	Kahu	Olea ferruginea	8	4.6	0.805	13.98798	0.14	0.07	0.02
3	72.3	32.53	Kahu	Olea ferruginea	6	4.3	0.805	7.469444	0.07	0.04	0.01
3	72.3	32.53	Kahu	Olea ferruginea	11	2.7	0.805	15.48394	0.15	0.07	0.02
3	72.3	32.53	Kahu	Olea ferruginea	16	5.5	0.805	64.43295	0.64	0.30	0.08
3	72.3	32.53	Kahu	Olea ferruginea	10	4.9	0.805	22.9987	0.23	0.11	0.03
3	72.3	32.53	Kahu	Olea ferruginea	13	5.5	0.805	42.96188	0.43	0.20	0.05
3	72.3	32.53	Kahu	Olea ferruginea	14	5.5	0.805	49.64869	0.50	0.23	0.06
3	72.3	32.53	Phulai	Acacia modesta	42	6.7	0.835	532.6141	5.33	2.50	0.63
3	72.3	32.53	Phulai	Acacia modesta	20	6.1	0.835	114.202	1.14	0.54	0.13
3	72.3	32.53	Phulai	Acacia modesta	14	5.5	0.835	51.45374	0.51	0.24	0.06
3	72.3	32.53	Phulai	Acacia modesta	15	5.5	0.835	58.87151	0.59	0.28	0.07
3	72.3	32.53	Phulai	Acacia modesta	17	6.1	0.835	83.15709	0.83	0.39	0.10
3	72.3	32.53	Phulai	Acacia modesta	13	4.6	0.835	37.39815	0.37	0.18	0.04
3	72.3	32.53	Phulai	Acacia modesta	16	6.1	0.835	73.87631	0.74	0.35	0.09
3	72.3	32.53	Phulai	Acacia modesta	14	6.1	0.835	56.92525	0.57	0.27	0.07
3	72.3	32.53	Phulai	Acacia modesta	17	6.1	0.835	83.15709	0.83	0.39	0.10
3	72.3	32.53	Phulai	Acacia modesta	10	4	0.835	19.55202	0.20	0.09	0.02
3	72.3	32.53	Phulai	Acacia modesta	14	5.2	0.835	48.71271	0.49	0.23	0.06
3	72.3	32.53	Phulai	Acacia modesta	12	4.6	0.835	31.98855	0.32	0.15	0.04
3	72.3	32.53	Phulai	Acacia modesta	11	4.3	0.835	25.2723	0.25	0.12	0.03
3	72.3	32.53	Phulai	Acacia modesta	14	5.8	0.835	54.19119	0.54	0.25	0.06
3	72.3	32.53	Phulai	Acacia modesta	10	4.6	0.835	22.40953	0.22	0.11	0.03
3	72.3	32.53	Mesquite	Prosopis glandulosa	7	4.6	0.707	9.495797	0.09	0.04	0.01
3	72.3	32.53	Mesquite	Prosopis glandulosa	6	4.6	0.707	7.028316	0.07	0.03	0.01
3	72.3	32.53	Mesquite	Prosopis glandulosa	19	6.1	0.707	87.83293	0.88	0.41	0.10
3	72.3	32.53	Mesquite	Prosopis glandulosa	20	7	0.707	111.0388	1.11	0.52	0.13
3	72.3	32.53	Mesquite	Prosopis glandulosa	18	6.1	0.707	79.03551	0.79	0.37	0.09
3	72.3	32.53	Mesquite	Prosopis glandulosa	10	5.5	0.707	22.67997	0.23	0.11	0.03
3	72.3	32.53	Mesquite	Prosopis glandulosa	8	4.6	0.707	12.32343	0.12	0.06	0.01
3	72.3	32.53	Mesquite	Prosopis glandulosa	6	4.6	0.707	7.028316	0.07	0.03	0.01

Plot No.	Latitude	Longitude	Species Name	Scientific Name	DBH (cm)	Tree height (m)	Wood Density (g/cm3)	AGB (kg)	AGB (ton/ha)	AGC (ton/ha)	BGC (ton/ha)
3	72.3	32.53	Mesquite	Prosopis glandulosa	6	3.7	0.707	5.682828	0.06	0.03	0.01
3	72.3	32.53	Kahu	Olea ferruginea	11	5.5	0.805	31.00733	0.31	0.15	0.04
3	72.3	32.53	Kahu	Olea ferruginea	17	5.8	0.805	76.38602	0.76	0.36	0.09
3	72.3	32.53	Kahu	Olea ferruginea	15	6.1	0.805	62.84691	0.63	0.30	0.07
3	72.3	32.53	Kahu	Olea ferruginea	24	6.1	0.805	157.2991	1.57	0.74	0.18
3	72.3	32.53	Kahu	Olea ferruginea	8	4.6	0.805	13.98798	0.14	0.07	0.02
4	72.34	32.55	Phulai	Acacia modesta	45	6.7	0.835	609.3978	6.09	2.86	0.72
4	72.34	32.55	Kahu	Olea ferruginea	9	5.5	0.805	20.95787	0.21	0.10	0.02
4	72.34	32.55	Kahu	Olea ferruginea	15	6.1	0.805	62.84691	0.63	0.30	0.07
4	72.34	32.55	Kahu	Olea ferruginea	14	4.9	0.805	44.35526	0.44	0.21	0.05
4	72.34	32.55	Kahu	Olea ferruginea	12	4.9	0.805	32.82956	0.33	0.15	0.04
4	72.34	32.55	Kahu	Olea ferruginea	11	4	0.805	22.7238	0.23	0.11	0.03
4	72.34	32.55	Kahu	Olea ferruginea	17	4.3	0.805	57.03919	0.57	0.27	0.07
4	72.34	32.55	Phulai	Acacia modesta	14	4.6	0.835	43.21899	0.43	0.20	0.05
4	72.34	32.55	Phulai	Acacia modesta	15	5.2	0.835	55.73532	0.56	0.26	0.07
4	72.34	32.55	Kahu	Olea ferruginea	20	6.4	0.805	115.4819	1.15	0.54	0.14
4	72.34	32.55	Kahu	Olea ferruginea	18	5.2	0.805	76.7685	0.77	0.36	0.09
4	72.34	32.55	Kahu	Olea ferruginea	11	4.3	0.805	24.38572	0.24	0.11	0.03
4	72.34	32.55	Kahu	Olea ferruginea	12	4.9	0.805	32.82956	0.33	0.15	0.04
4	72.34	32.55	Kahu	Olea ferruginea	14	4.9	0.805	44.35526	0.44	0.21	0.05
4	72.34	32.55	Phulai	Acacia modesta	28	4.6	0.835	167.2188	1.67	0.79	0.20
4	72.34	32.55	Kahu	Olea ferruginea	14	4.9	0.805	44.35526	0.44	0.21	0.05
4	72.34	32.55	Kahu	Olea ferruginea	10	4.6	0.805	21.62338	0.22	0.10	0.03
4	72.34	32.55	Kahu	Olea ferruginea	28	6.1	0.805	212.5231	2.13	1.00	0.25
4	72.34	32.55	Kahu	Olea ferruginea	25	5.2	0.805	145.7706	1.46	0.69	0.17
4	72.34	32.55	Kahu	Olea ferruginea	26	5.5	0.805	166.224	1.66	0.78	0.20
4	72.34	32.55	Kahu	Olea ferruginea	10	4.3	0.805	20.2459	0.20	0.10	0.02
4	72.34	32.55	Kahu	Olea ferruginea	12	5.2	0.805	34.78988	0.35	0.16	0.04
4	72.34	32.55	Kahu	Olea ferruginea	14	5.2	0.805	47.00381	0.47	0.22	0.06
4	72.34	32.55	Sinatha	Dodonaea viscosa	15	3.7	0.947	45.20929	0.45	0.21	0.05
4	72.34	32.55	Sinatha	Dodonaea viscosa	9	4	0.947	17.99801	0.18	0.08	0.02
4	72.34	32.55	Kahu	Olea ferruginea	7	3.7	0.805	8.715014	0.09	0.04	0.01

Plot No.	Latitude	Longitude	Species Name	Scientific Name	DBH (cm)	Tree height (m)	Wood Density (g/cm3)	AGB (kg)	AGB (ton/ha)	AGC (ton/ha)	BGC (ton/ha)
4	72.34	32.55	Kahu	Olea ferruginea	10	4	0.805	18.86611	0.19	0.09	0.02
4	72.34	32.55	Phulai	Acacia modesta	28	4.9	0.835	177.8545	1.78	0.84	0.21
4	72.34	32.55	Kahu	Olea ferruginea	9	3.7	0.805	14.23371	0.14	0.07	0.02
4	72.34	32.55	Kahu	Olea ferruginea	10	4.6	0.805	21.62338	0.22	0.10	0.03
4	72.34	32.55	Kahu	Olea ferruginea	17	4.9	0.805	64.7947	0.65	0.30	0.08
4	72.34	32.55	Kahu	Olea ferruginea	14	5.8	0.805	52.2901	0.52	0.25	0.06
4	72.34	32.55	Kahu	Olea ferruginea	14	4.9	0.805	44.35526	0.44	0.21	0.05
4	72.34	32.55	Kahu	Olea ferruginea	11	4	0.805	22.7238	0.23	0.11	0.03
4	72.34	32.55	Kahu	Olea ferruginea	7	4	0.805	9.404025	0.09	0.04	0.01
4	72.34	32.55	Kahu	Olea ferruginea	11	4.9	0.805	27.7014	0.28	0.13	0.03
4	72.34	32.55	Kahu	Olea ferruginea	18	5.8	0.805	85.40229	0.85	0.40	0.10
4	72.34	32.55	Kahu	Olea ferruginea	14	4.9	0.805	44.35526	0.44	0.21	0.05
4	72.34	32.55	Kahu	Olea ferruginea	11	4.9	0.805	27.7014	0.28	0.13	0.03
4	72.34	32.55	Kahu	Olea ferruginea	10	4.6	0.805	21.62338	0.22	0.10	0.03
4	72.34	32.55	Kahu	Olea ferruginea	9	4.9	0.805	18.72339	0.19	0.09	0.02
4	72.34	32.55	Kahu	Olea ferruginea	14	5.5	0.805	49.64869	0.50	0.23	0.06
4	72.34	32.55	Kahu	Olea ferruginea	12	5.2	0.805	34.78988	0.35	0.16	0.04
4	72.34	32.55	Kahu	Olea ferruginea	9	3.7	0.805	14.23371	0.14	0.07	0.02
4	72.34	32.55	Kahu	Olea ferruginea	9	3.4	0.805	13.1062	0.13	0.06	0.02
4	72.34	32.55	Kahu	Olea ferruginea	11	3.7	0.805	21.05888	0.21	0.10	0.02
4	72.34	32.55	Phulai	Acacia modesta	22	5.5	0.835	124.3323	1.24	0.58	0.15
4	72.34	32.55	Kahu	Olea ferruginea	18	5.2	0.805	76.7685	0.77	0.36	0.09
4	72.34	32.55	Kahu	Olea ferruginea	14	4.6	0.805	41.70282	0.42	0.20	0.05
4	72.34	32.55	Kahu	Olea ferruginea	14	4.6	0.805	41.70282	0.42	0.20	0.05
4	72.34	32.55	Kahu	Olea ferruginea	15	4.6	0.805	47.71486	0.48	0.22	0.06
4	72.34	32.55	Kahu	Olea ferruginea	13	4.6	0.805	36.08618	0.36	0.17	0.04
4	72.34	32.55	Phulai	Acacia modesta	34	6.1	0.835	321.7435	3.22	1.51	0.38
4	72.34	32.55	Kahu	Olea ferruginea	11	4.6	0.805	26.04486	0.26	0.12	0.03
4	72.34	32.55	Kahu	Olea ferruginea	12	5.5	0.805	36.74748	0.37	0.17	0.04
4	72.34	32.55	Kahu	Olea ferruginea	10	4.6	0.805	21.62338	0.22	0.10	0.03
4	72.34	32.55	Kahu	Olea ferruginea	22	5.8	0.805	126.3533	1.26	0.59	0.15
4	72.34	32.55	Kahu	Olea ferruginea	11	4.6	0.805	26.04486	0.26	0.12	0.03

Plot No.	Latitude	Longitude	Species Name	Scientific Name	DBH (cm)	Tree height (m)	Wood Density (g/cm3)	AGB (kg)	AGB (ton/ha)	AGC (ton/ha)	BGC (ton/ha)
4	72.34	32.55	Kahu	Olea ferruginea	14	4.6	0.805	41.70282	0.42	0.20	0.05
4	72.34	32.55	Kahu	Olea ferruginea	12	4.6	0.805	30.86635	0.31	0.15	0.04
4	72.34	32.55	Kahu	Olea ferruginea	11	4	0.805	22.7238	0.23	0.11	0.03
4	72.34	32.55	Kahu	Olea ferruginea	10	4	0.805	18.86611	0.19	0.09	0.02
4	72.34	32.55	Kahu	Olea ferruginea	17	4.3	0.805	57.03919	0.57	0.27	0.07
4	72.34	32.55	Kahu	Olea ferruginea	14	4.3	0.805	39.04622	0.39	0.18	0.05
4	72.34	32.55	Kahu	Olea ferruginea	14	5.8	0.805	52.2901	0.52	0.25	0.06
4	72.34	32.55	Kahu	Olea ferruginea	17	6.7	0.805	87.93406	0.88	0.41	0.10
4	72.34	32.55	Phulai	Acacia modesta	15	6.4	0.835	68.25632	0.68	0.32	0.08
4	72.34	32.55	Phulai	Acacia modesta	11	4.9	0.835	28.70853	0.29	0.13	0.03
4	72.34	32.55	Phulai	Acacia modesta	14	4.9	0.835	45.96787	0.46	0.22	0.05
4	72.34	32.55	Kahu	Olea ferruginea	11	5.5	0.805	31.00733	0.31	0.15	0.04
4	72.34	32.55	Kahu	Olea ferruginea	10	4.6	0.805	21.62338	0.22	0.10	0.03
4	72.34	32.55	Kahu	Olea ferruginea	7	4.6	0.805	10.77841	0.11	0.05	0.01
4	72.34	32.55	Kahu	Olea ferruginea	11	5.8	0.805	32.65698	0.33	0.15	0.04
4	72.34	32.55	Kahu	Olea ferruginea	14	6.1	0.805	54.92824	0.55	0.26	0.06
5	72.32	32.64	Phulai	Acacia modesta	9	4	0.835	15.91743	0.16	0.07	0.02
5	72.32	32.64	Sinatha	Dodonaea viscosa	6	2.7	0.947	5.557698	0.06	0.03	0.01
5	72.32	32.64	Sinatha	Dodonaea viscosa	6	2.4	0.947	4.95416	0.05	0.02	0.01
5	72.32	32.64	Sinatha	Dodonaea viscosa	6	3.4	0.947	6.959969	0.07	0.03	0.01
5	72.32	32.64	Sinatha	Dodonaea viscosa	6	3.4	0.947	6.959969	0.07	0.03	0.01
5	72.32	32.64	Sinatha	Dodonaea viscosa	6	3	0.947	6.159624	0.06	0.03	0.01
5	72.32	32.64	Kahu	Olea ferruginea	5	3.4	0.805	4.160875	0.04	0.02	0.00
5	72.32	32.64	Phulai	Acacia modesta	7	4.6	0.835	11.17028	0.11	0.05	0.01
5	72.32	32.64	Sinatha	Dodonaea viscosa	6	3.7	0.947	7.558729	0.08	0.04	0.01
5	72.32	32.64	Phulai	Acacia modesta	11	6.7	0.835	38.96087	0.39	0.18	0.05
5	72.32	32.64	Sinatha	Dodonaea viscosa	6	2.7	0.947	5.557698	0.06	0.03	0.01
5	72.32	32.64	Sinatha	Dodonaea viscosa	6	3.4	0.947	6.959969	0.07	0.03	0.01
5	72.32	32.64	Sinatha	Dodonaea viscosa	6	4.3	0.947	8.752842	0.09	0.04	0.01
5	72.32	32.64	Kahu	Olea ferruginea	6	4.6	0.805	7.977645	0.08	0.04	0.01
5	72.32	32.64	Sinatha	Dodonaea viscosa	5	3.7	0.947	5.295256	0.05	0.02	0.01
5	72.32	32.64	Sinatha	Dodonaea viscosa	6	3	0.947	6.159624	0.06	0.03	0.01

Plot No.	Latitude	Longitude	Species Name	Scientific Name	DBH (cm)	Tree height (m)	Wood Density (g/cm3)	AGB (kg)	AGB (ton/ha)	AGC (ton/ha)	BGC (ton/ha)
5	72.32	32.64	Sinatha	Dodonaea viscosa	6	3.4	0.947	6.959969	0.07	0.03	0.01
5	72.32	32.64	Sinatha	Dodonaea viscosa	7	2.7	0.947	7.508878	0.08	0.04	0.01
5	72.32	32.64	Sinatha	Dodonaea viscosa	6	3.4	0.947	6.959969	0.07	0.03	0.01
6	72.25	32.67	Phulai	Acacia modesta	15	4.6	0.835	49.44961	0.49	0.23	0.06
6	72.25	32.67	Phulai	Acacia modesta	13	4.9	0.835	39.7768	0.40	0.19	0.05
6	72.25	32.67	Phulai	Acacia modesta	17	4.3	0.835	59.11294	0.59	0.28	0.07
6	72.25	32.67	Phulai	Acacia modesta	27	4.9	0.835	165.6664	1.66	0.78	0.19
6	72.25	32.67	Phulai	Acacia modesta	29	5.8	0.835	224.5369	2.25	1.06	0.26
6	72.25	32.67	Phulai	Acacia modesta	31	6.1	0.835	268.6588	2.69	1.26	0.32
6	72.25	32.67	Phulai	Acacia modesta	31	6.4	0.835	281.5469	2.82	1.32	0.33
6	72.25	32.67	Phulai	Acacia modesta	17	5.2	0.835	71.16011	0.71	0.33	0.08
6	72.25	32.67	Phulai	Acacia modesta	13	4.9	0.835	39.7768	0.40	0.19	0.05
6	72.25	32.67	Phulai	Acacia modesta	39	6.4	0.835	440.7282	4.41	2.07	0.52
6	72.25	32.67	Phulai	Acacia modesta	15	6.4	0.835	68.25632	0.68	0.32	0.08
6	72.25	32.67	Phulai	Acacia modesta	14	6.4	0.835	59.65607	0.60	0.28	0.07
6	72.25	32.67	Phulai	Acacia modesta	17	6.1	0.835	83.15709	0.83	0.39	0.10
6	72.25	32.67	Phulai	Acacia modesta	15	5.2	0.835	55.73532	0.56	0.26	0.07
6	72.25	32.67	Phulai	Acacia modesta	18	5.8	0.835	88.50722	0.89	0.42	0.10
7	72.25	32.54	Kahu	Olea ferruginea	7	3.7	0.805	8.715014	0.09	0.04	0.01
7	72.25	32.54	Kahu	Olea ferruginea	11	4.9	0.805	27.7014	0.28	0.13	0.03
7	72.25	32.54	Kahu	Olea ferruginea	12	4.9	0.805	32.82956	0.33	0.15	0.04
7	72.25	32.54	Kahu	Olea ferruginea	14	3	0.805	27.47794	0.27	0.13	0.03
7	72.25	32.54	Kahu	Olea ferruginea	6	3	0.805	5.256461	0.05	0.02	0.01
7	72.25	32.54	Kahu	Olea ferruginea	6	3.4	0.805	5.939454	0.06	0.03	0.01
8	72.59	32.28	Kahu	Olea ferruginea	8	3.7	0.805	11.31015	0.11	0.05	0.01
8	72.59	32.28	Kahu	Olea ferruginea	14	0.9	0.805	8.485051	0.08	0.04	0.01
8	72.59	32.28	Kahu	Olea ferruginea	10	3.7	0.805	17.48384	0.17	0.08	0.02
8	72.59	32.28	Kahu	Olea ferruginea	12	3	0.805	20.3378	0.20	0.10	0.02
8	72.59	32.28	Kahu	Olea ferruginea	12	3	0.805	20.3378	0.20	0.10	0.02
8	72.59	32.28	Kahu	Olea ferruginea	6	2.4	0.805	4.22775	0.04	0.02	0.00
8	72.59	32.28	sinatha	Dodonaea viscosa	6	2.7	0.947	5.557698	0.06	0.03	0.01
8	72.59	32.28	sinatha	Dodonaea viscosa	24	4.9	0.947	148.8457	1.49	0.70	0.17

Plot No.	Latitude	Longitude	Species Name	Scientific Name	DBH (cm)	Tree height (m)	Wood Density (g/cm3)	AGB (kg)	AGB (ton/ha)	AGC (ton/ha)	BGC (ton/ha)
8	72.59	32.28	Kahu	Olea ferruginea	6	2.1	0.805	3.711155	0.04	0.02	0.00
8	72.59	32.28	sinatha	Dodonaea viscosa	14	4.6	0.947	48.86819	0.49	0.23	0.06
8	72.59	32.28	sinatha	Dodonaea viscosa	13	4.6	0.947	42.2865	0.42	0.20	0.05
8	72.59	32.28	sinatha	Dodonaea viscosa	6	4.6	0.947	9.348362	0.09	0.04	0.01
8	72.59	32.28	sinatha	Dodonaea viscosa	11	4.3	0.947	28.57567	0.29	0.13	0.03
8	72.59	32.28	sinatha	Dodonaea viscosa	10	2.4	0.947	13.42823	0.13	0.06	0.02
9	72.32	32.6	Phulai	Acacia modesta	6	1.7	0.835	3.129323	0.03	0.01	0.00
9	72.32	32.6	Phulai	Acacia modesta	9	3	0.835	12.02078	0.12	0.06	0.01
9	72.32	32.6	Phulai	Acacia modesta	10	3.4	0.835	16.68417	0.17	0.08	0.02
9	72.32	32.6	Kahu	Olea ferruginea	6	2.7	0.805	4.742792	0.05	0.02	0.01
9	72.32	32.6	Kahu	Olea ferruginea	13	3.4	0.805	26.8666	0.27	0.13	0.03
9	72.32	32.6	Phulai	Acacia modesta	15	5.5	0.835	58.87151	0.59	0.28	0.07
9	72.32	32.6	Phulai	Acacia modesta	11	3	0.835	17.78484	0.18	0.08	0.02
9	72.32	32.6	Phulai	Acacia modesta	13	4.6	0.835	37.39815	0.37	0.18	0.04
9	72.32	32.6	Phulai	Acacia modesta	11	4	0.835	23.54996	0.24	0.11	0.03
9	72.32	32.6	Kahu	Olea ferruginea	8	4.6	0.805	13.98798	0.14	0.07	0.02
9	72.32	32.6	Kahu	Olea ferruginea	6	3.7	0.805	6.45042	0.06	0.03	0.01
9	72.32	32.6	Phulai	Acacia modesta	14	5.8	0.835	54.19119	0.54	0.25	0.06
9	72.32	32.6	Kahu	Olea ferruginea	8	4.3	0.805	13.09691	0.13	0.06	0.02
9	72.32	32.6	Kahu	Olea ferruginea	6	4.6	0.805	7.977645	0.08	0.04	0.01
9	72.32	32.6	Kahu	Olea ferruginea	6	4.3	0.805	7.469444	0.07	0.04	0.01
9	72.32	32.6	Kahu	Olea ferruginea	9	4.9	0.805	18.72339	0.19	0.09	0.02
9	72.32	32.6	Phulai	Acacia modesta	10	4.3	0.835	20.98197	0.21	0.10	0.02
9	72.32	32.6	Kahu	Olea ferruginea	8	3	0.805	9.216666	0.09	0.04	0.01
9	72.32	32.6	Kahu	Olea ferruginea	10	4.3	0.805	20.2459	0.20	0.10	0.02
9	72.32	32.6	Kahu	Olea ferruginea	10	4	0.805	18.86611	0.19	0.09	0.02
9	72.32	32.6	Kahu	Olea ferruginea	13	5.5	0.805	42.96188	0.43	0.20	0.05
9	72.32	32.6	Kahu	Olea ferruginea	10	4.3	0.805	20.2459	0.20	0.10	0.02
9	72.32	32.6	Kahu	Olea ferruginea	11	4	0.805	22.7238	0.23	0.11	0.03
9	72.32	32.6	Kahu	Olea ferruginea	13	4.6	0.805	36.08618	0.36	0.17	0.04
9	72.32	32.6	Kahu	Olea ferruginea	14	4.9	0.805	44.35526	0.44	0.21	0.05
9	72.32	32.6	Phulai	Acacia modesta	7	3	0.835	7.360084	0.07	0.03	0.01

Plot No.	Latitude	Longitude	Species Name	Scientific Name	DBH (cm)	Tree height (m)	Wood Density (g/cm3)	AGB (kg)	AGB (ton/ha)	AGC (ton/ha)	BGC (ton/ha)
9	72.32	32.6	Phulai	Acacia modesta	8	3	0.835	9.551753	0.10	0.04	0.01
9	72.32	32.6	Kahu	Olea ferruginea	16	5.5	0.805	64.43295	0.64	0.30	0.08
9	72.32	32.6	Kahu	Olea ferruginea	18	6.1	0.805	89.711	0.90	0.42	0.11
9	72.32	32.6	Kahu	Olea ferruginea	12	5.8	0.805	38.70253	0.39	0.18	0.05
9	72.32	32.6	Kahu	Olea ferruginea	10	5.2	0.805	24.372	0.24	0.11	0.03
9	72.32	32.6	Beri	Ziziphus mauritiana	5	2.4	0.7114	2.625148	0.03	0.01	0.00
9	72.32	32.6	Beri	Ziziphus mauritiana	6	3	0.7114	4.659076	0.05	0.02	0.01
9	72.32	32.6	Beri	Ziziphus mauritiana	7	2.1	0.7114	4.44422	0.04	0.02	0.01
9	72.32	32.6	Beri	Ziziphus mauritiana	4	1.8	0.7114	1.282464	0.01	0.01	0.00
9	72.32	32.6	Beri	Ziziphus mauritiana	6	3.7	0.7114	5.717344	0.06	0.03	0.01
9	72.32	32.6	Kahu	Olea ferruginea	10	5.2	0.805	24.372	0.24	0.11	0.03
9	72.32	32.6	Kahu	Olea ferruginea	9	5.5	0.805	20.95787	0.21	0.10	0.02
9	72.32	32.6	Kahu	Olea ferruginea	7	4.9	0.805	11.46396	0.11	0.05	0.01
9	72.32	32.6	Kahu	Olea ferruginea	8	4.6	0.805	13.98798	0.14	0.07	0.02
9	72.32	32.6	Kahu	Olea ferruginea	10	5.8	0.805	27.113	0.27	0.13	0.03
9	72.32	32.6	Kahu	Olea ferruginea	11	5.2	0.805	29.35551	0.29	0.14	0.03
9	72.32	32.6	Kahu	Olea ferruginea	13	6.1	0.805	47.53037	0.48	0.22	0.06
9	72.32	32.6	Kahu	Olea ferruginea	16	7.3	0.805	84.94096	0.85	0.40	0.10
9	72.32	32.6	Kahu	Olea ferruginea	11	6.1	0.805	34.30459	0.34	0.16	0.04
9	72.32	32.6	Kahu	Olea ferruginea	14	5.5	0.805	49.64869	0.50	0.23	0.06
9	72.32	32.6	Kahu	Olea ferruginea	8	4.9	0.805	14.87767	0.15	0.07	0.02
9	72.32	32.6	Phulai	Acacia modesta	11	5.5	0.835	32.13465	0.32	0.15	0.04
9	72.32	32.6	Kahu	Olea ferruginea	12	5.5	0.805	36.74748	0.37	0.17	0.04
9	72.32	32.6	Phulai	Acacia modesta	17	4.3	0.835	59.11294	0.59	0.28	0.07
9	72.32	32.6	Kahu	Olea ferruginea	18	7.3	0.805	106.8973	1.07	0.50	0.13
9	72.32	32.6	Phulai	Acacia modesta	16	6.1	0.835	73.87631	0.74	0.35	0.09
9	72.32	32.6	Phulai	Acacia modesta	12	4.9	0.835	34.02313	0.34	0.16	0.04
9	72.32	32.6	Kahu	Olea ferruginea	7	3.4	0.805	8.02466	0.08	0.04	0.01
9	72.32	32.6	Phulai	Acacia modesta	26	7	0.835	217.9841	2.18	1.02	0.26
10	72.34288	32.63093	Kahu	Olea ferruginea	26	6.1	0.805	183.9	1.84	0.86	0.22
10	72.34288	32.63093	Kahu	Olea ferruginea	15	6.1	0.805	62.84691	0.63	0.30	0.07
10	72.34288	32.63093	Phulai	Acacia modesta	28	7.6	0.835	272.9654	2.73	1.28	0.32

Plot No.	Latitude	Longitude	Species Name	Scientific Name	DBH (cm)	Tree height (m)	Wood Density (g/cm3)	AGB (kg)	AGB (ton/ha)	AGC (ton/ha)	BGC (ton/ha)
10	72.34288	32.63093	Phulai	Acacia modesta	17	7	0.835	95.1115	0.95	0.45	0.11
10	72.34288	32.63093	Kahu	Olea ferruginea	17	5.8	0.805	76.38602	0.76	0.36	0.09
10	72.34288	32.63093	Kahu	Olea ferruginea	12	5.2	0.805	34.78988	0.35	0.16	0.04
10	72.34288	32.63093	Kahu	Olea ferruginea	7	3.7	0.805	8.715014	0.09	0.04	0.01
10	72.34288	32.63093	Kahu	Olea ferruginea	11	5.5	0.805	31.00733	0.31	0.15	0.04
10	72.34288	32.63093	Phulai	Acacia modesta	31	7.6	0.835	332.9608	3.33	1.56	0.39
10	72.34288	32.63093	Kahu	Olea ferruginea	7	1.8	0.805	4.313692	0.04	0.02	0.01
10	72.34288	32.63093	Phulai	Acacia modesta	34	9.1	0.835	475.3925	4.75	2.23	0.56
10	72.34288	32.63093	Phulai	Acacia modesta	25	7.3	0.835	210.36	2.10	0.99	0.25
10	72.34288	32.63093	Phulai	Acacia modesta	22	7.9	0.835	177.0411	1.77	0.83	0.21
10	72.34288	32.63093	Kahu	Olea ferruginea	9	2.1	0.805	8.189158	0.08	0.04	0.01
10	72.34288	32.63093	Kahu	Olea ferruginea	7	2.4	0.805	5.712016	0.06	0.03	0.01
10	72.34288	32.63093	Phulai	Acacia modesta	18	5.5	0.835	84.03631	0.84	0.39	0.10
10	72.34288	32.63093	Phulai	Acacia modesta	14	5.2	0.835	48.71271	0.49	0.23	0.06
10	72.34288	32.63093	Kahu	Olea ferruginea	9	2.4	0.805	9.329092	0.09	0.04	0.01
10	72.34288	32.63093	Kahu	Olea ferruginea	7	2.4	0.805	5.712016	0.06	0.03	0.01
11	72.2	32.67	Phulai	Acacia modesta	15	5.5	0.835	58.87151	0.59	0.28	0.07
11	72.2	32.67	Phulai	Acacia modesta	31	6.4	0.835	281.5469	2.82	1.32	0.33
11	72.2	32.67	Phulai	Acacia modesta	12	5.8	0.835	40.10962	0.40	0.19	0.05
11	72.2	32.67	Kahu	Olea ferruginea	28	6.1	0.805	212.5231	2.13	1.00	0.25
11	72.2	32.67	Kahu	Olea ferruginea	33	7	0.805	334.9861	3.35	1.57	0.39
11	72.2	32.67	Phulai	Acacia modesta	21	4.9	0.835	101.4342	1.01	0.48	0.12
11	72.2	32.67	Phulai	Acacia modesta	6	2.4	0.835	4.381456	0.04	0.02	0.01
11	72.2	32.67	Phulai	Acacia modesta	22	4.9	0.835	111.0763	1.11	0.52	0.13
11	72.2	32.67	Phulai	Acacia modesta	20	7.6	0.835	141.5356	1.42	0.67	0.17
12	72.3	32.65	Kahu	Olea ferruginea	9	5.8	0.805	22.07288	0.22	0.10	0.03
12	72.3	32.65	Sinatha	Dodonaea viscosa	7	4.3	0.947	11.82576	0.12	0.06	0.01
12	72.3	32.65	Kahu	Olea ferruginea	14	7.3	0.805	65.45109	0.65	0.31	0.08
12	72.3	32.65	Kahu	Olea ferruginea	21	4.9	0.805	97.87579	0.98	0.46	0.12
12	72.3	32.65	Sinatha	Dodonaea viscosa	5	2.4	0.947	3.47063	0.03	0.02	0.00
12	72.3	32.65	Phulai	Acacia modesta	22	5.5	0.835	124.3323	1.24	0.58	0.15
12	72.3	32.65	Kahu	Olea ferruginea	18	7.9	0.805	115.4643	1.15	0.54	0.14

Plot No.	Latitude	Longitude	Species Name	Scientific Name	DBH (cm)	Tree height (m)	Wood Density (g/cm3)	AGB (kg)	AGB (ton/ha)	AGC (ton/ha)	BGC (ton/ha)
12	72.3	32.65	Kahu	Olea ferruginea	23	7.6	0.805	179.4067	1.79	0.84	0.21
12	72.3	32.65	Phulai	Acacia modesta	34	6.4	0.835	337.1783	3.37	1.58	0.40
12	72.3	32.65	Kahu	Olea ferruginea	18	5.5	0.805	81.08822	0.81	0.38	0.10
12	72.3	32.65	Kahu	Olea ferruginea	31	5.5	0.805	234.317	2.34	1.10	0.28
12	72.3	32.65	Kahu	Olea ferruginea	12	4.9	0.805	32.82956	0.33	0.15	0.04
12	72.3	32.65	Phulai	Acacia modesta	29	7.6	0.835	292.3183	2.92	1.37	0.34
12	72.3	32.65	Kahu	Olea ferruginea	25	6.4	0.805	178.5182	1.79	0.84	0.21
12	72.3	32.65	Kahu	Olea ferruginea	21	5.8	0.805	115.3851	1.15	0.54	0.14
12	72.3	32.65	Kahu	Olea ferruginea	23	5.5	0.805	130.8454	1.31	0.61	0.15
12	72.3	32.65	Kahu	Olea ferruginea	19	5.2	0.805	85.31357	0.85	0.40	0.10