Synthesis Report: TEEBAgriFood Initiative in Uttarakhand

Project: The Economics of Ecosystems and Biodiversity: Promoting a Sustainable Agriculture and Food Sector

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Introduction

TEEB and TEEBAgriFood Framework

The Economics of Ecosystems and Biodiversity (TEEB), a global initiative, hosted by the United Nations Environment Programme (UNEP) was initiated with the aim to make "nature's invisible values visible". The TEEB initiative seeks to draw attention to the invisibility of nature in the economic choices we make across the domains of international, national, and local policy-making, public administration, and business. TEEB sees this invisibility as a key driver of the ongoing depletion of ecosystems and biodiversity. The TEEB India initiative was launched in 2011 focusing on forests, inland wetlands, and marine and coastal ecosystems. The overall study report was released at the 21st session of the UNFCCC COP held in 2015 in Paris.

The objective of TEEB is to mainstream the values of biodiversity and ecosystem services into decision-making at all levels and it does this by offering a structured approach to valuation that helps decision-makers to

- Recognize the wide range of benefits provided by ecosystems and biodiversity
- Demonstrate their values in economic terms
- Where appropriate, capture those values in decision-making

TEEB Agriculture and Food Systems (TEEBAgrifood)[1] is an offshoot of TEEB, especially applied to food systems and hence is likely the first of its kind to address food systems. The aims of TEEBAgriFood are bold and ambitious: to contribute a framework approach for better understanding and managing the impacts and externalities of agriculture and food value chains, and to bring together a global network of scholars and decision-makers dedicated to disclosing and valuing those impacts. The TEEBAgriFood Framework offers a structured approach to valuation that helps decision-makers recognize the wide range of benefits provided by ecosystems and biodiversity, demonstrate their values in economic terms and where appropriate, capture those values in decision-making.

[1] https://teebweb.org/our-work/agrifood/understanding-teebagrifood/evaluation-framework/

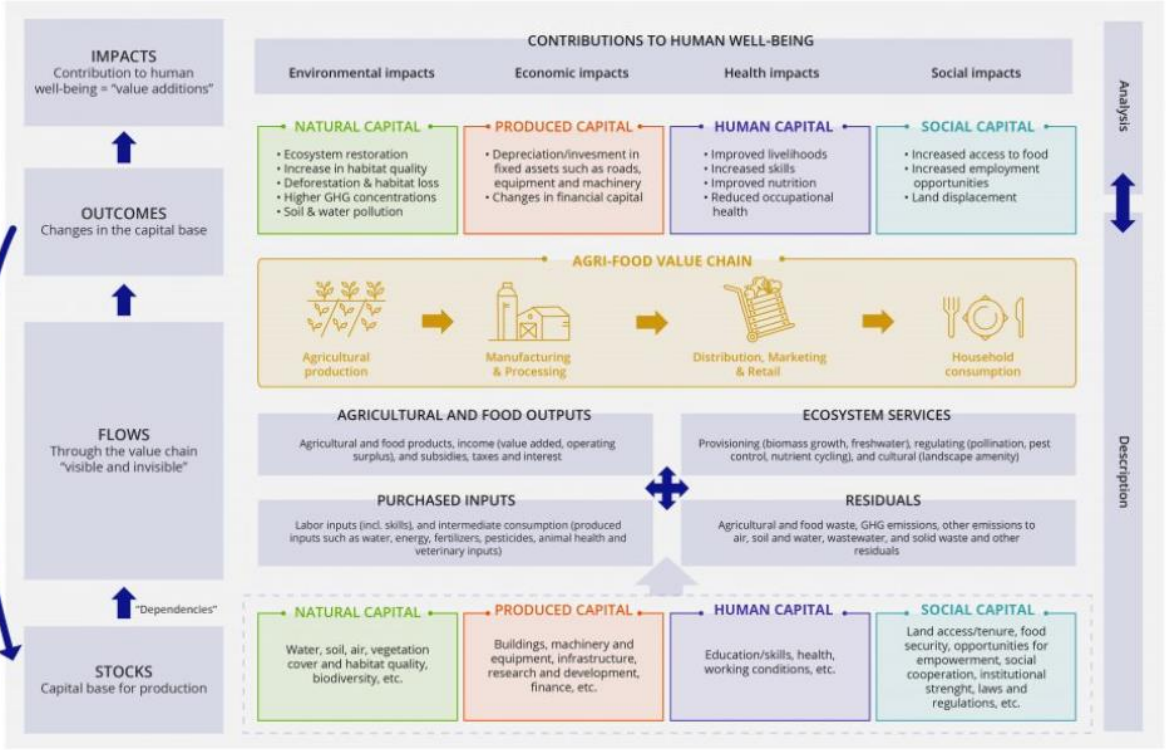

Figure 1: TEEB for Agriculture and Food framework

TEEBAgriFood applications in India under the EUPI funded project "Economics of Ecosystems and Biodiversity: Promoting a Sustainable Agriculture and Food Sector"

The UNEP global project titled "Economics of Ecosystems and Biodiversity: Promoting a Sustainable Agriculture and Food Sector" and funded by the European Union was launched in 2019 and was implemented in 7 countries, namely, Brazil, China, India, Indonesia, Malaysia, Mexico, and Thailand.

As per the need identified by the Project Steering Committee (PSC), led by the Ministry of Agriculture and Farmers Welfare (MoAFW) and the Ministry of Environment, Forest and Climate Change (MoEFCC), the TEEBAgriFood framework has been applied in assessing the impacts of government policy and programmatic interventions on organic farming and agroforestry. The aim is to inform planning processes by providing comprehensive scientific evidence to support the scaling of organic farming and agroforestry interventions with the help of modelling and economic valuation conducted for various scenarios from 2020 till 2050. Six scenarios, combining Business-as-Usual (BAU), Optimistic and Pessimistic policy scenarios along with climate scenarios (RCP 4.5 and RCP 8.5) have been assessed taking 2020 as the base year.

TEEBAgriFood Initiative in Uttarakhand

Uttarakhand, located in the Western Himalayas spans an area of 53,484 Km^2. The state is 90 percent mountainous with forests covering 60–65% and with 14.5% of the land under cultivation (Nicolaysen, Francis, & Lieblein, 2014). Uttarakhand is amongst the most biodiverse state in the country and includes several nationally important protected areas, serving as important habitats for various keystone and charismatic species. Uttarakhand hosts 743 reported bird species out of an estimated 1300 in India.

Agriculture, forestry, fishing and livestock is an indispensable part of Uttarakhand's economy – as the primary sector it contributes to approximately 10 percent of the state's GDP. In 2021-2022, the agriculture sector alone contributed 9.23 percent to the states' GDP. The average operational landholding size is less than one hectare, with approximately 92% classified as small or marginal holdings. The sector serves as a key source of employment, engaging 61.48% of the workforce in the hill districts of Uttarakhand (Directorate of Economics & Statistics, Government of Uttarakhand, 2023).

Presently, agricultural systems in Uttarakhand are challenged by climate change, ecosystem degradation and biodiversity loss leading to other cascading effects. As per the Economic Survey of Uttarakhand, land under agriculture has decreased by 15.48 percent since the state's formation. As of census 2011, 226,949 farmers left farming, impacting the local economy. The reasons include low land productivity and lack of agricultural diversification, increased water stress and changes in crop yields.

Moreover, there has been a significant transformation in dietary preferences. The reliance on millets as a food source has gone down from 40% to 4-5%, while the consumption of cereals has risen from 30% to 85% in the state. As a downhill of such other changes in nutrition sources more than half of the health problems in the state are non-communicable in nature including - diabetes, heart conditions, anaemia. Malnutrition in children and mothers remains one of the most important risk factors that are responsible for most of the morbidity in the state.

Area under Organic farming and Agroforestry in Uttarakhand

The state of Uttarakhand has embraced a pro-organic approach, considering hill areas are organic by default. In 2003, the state established the Uttarakhand Organic Commodity Board (UOCB) to promote organic agriculture in the state. UOCB issues authentic certificate to organic produce, ensuring that organic food growers have fair prices for their produce. Over the years, the state of Uttarakhand covered a substantial area under organic agriculture of 2.3 lakh hectare in 2022-23, an increase of 26496 ha from 2015-16. Moreover, organic agriculture holds a significant position in Uttarakhand Vision 2030. The state government is committed to enhancing organic farming as a means to reduce the use

of chemical fertilizers and pesticides, enhance soil health, and promote sustainable agriculture. To achieve this objective, the state government has undertaken several initiatives to promote organic farming, such as, establishment of organic farming clusters, provision of subsidies for organic farming, and promotion of organic farming through training and awareness programs. Uttarakhand government has taken steps to declare the state as an organic state through the Organic Agriculture Act, which regulates the sale of chemicals in ten notified regions.

Agroforestry on the other hand covers an area of 7,131 square kilometres in the state, accounting for 2.17% of the total geographical area. As per Forest Survey of India 2014, the volume of growing stock under agroforestry is 7,131 million cumecs. The eight types of agroforestry systems prevalent the state are: agri-silviculture, silvi- pasture, agri-silvi-pastoral, agri-silvi-horticulture, wood lots, agri-silvi-olericulture, silvi-horticulture, and silvi-olericulture (Gusain et al., 2021). The National Forest Policy, Agriculture Policy, Task Force on Greening India, National Bamboo Mission, and National Policy on Farmers recognize agroforestry as a sustainable agriculture program for efficient nutrient cycling, soil organic matter enhancement, and tree cover improvement. Moreover, the National Agriculture Policy encourages farmers to adopt agroforestry for higher income generation and encourages its practice in shifting cultivation areas.

Uttarakhand Vision 2030 outlines the future roadmap for the state of Uttarakhand based on the Sustainable Development Goals (SDGs) framed by the United Nations. The overall objective of the Vision 2030 is to transform Uttarakhand into a prosperous, healthy state such that the people are educated and gainfully employed in an equitable society, synergy is enhanced between the environment and the inhabitants, and that the development process is sustainable and inclusive. The vision aims to advance agroforestry and organic farming in the state as a strategy to improve soil health, conserve water, decrease reliance on chemical fertilizers and pesticides, address soil erosion, and promote sustainable agriculture.

In this regard, the TEEBAgriFood study of Uttarakhand conducted between 2019-2023 supports the government's vision of making Uttarakhand an organic state. It underscores the potential for creating a carbon sink, preventing soil erosion and nutrient loss, and, consequently, boosting farmer incomes by enhancing policy measures related to organic farming and agroforestry. By making visible the invisible benefits of nature and highlighting the associated trade-offs of policy choices through scientific evidence, the project assesses the impacts of decisions on natural, social, human, and produced capital. Essentially, the analysis entails contrasting the existing policy situation with various potential future situations. These include a business-as-usual (BAU) scenario, an optimistic scenario, and a pessimistic scenario, with the aim of ascertaining how diverse interventions could influence the four capitals across the agricultural system.

The aims and objectives under TEEBAgriFood initiative in Uttarakhand were:

- Conducting economic valuation of ecosystem services, considering scenarios for scaling up organic farming and agroforestry across natural, human, social, and produced capitals.
- Proving technical insights and on-field demonstration plot results to support the future expansion of agroforestry and organic farming practices in the state.
- Mainstreaming values of Biodiversity and Ecosystem services into decision making. Assessment contributes to the following key policies/initiatives
    - National Mission on Clean Ganga (Namami Gange)
    - National Agroforestry Policy
    - Paramparagat Krishi Vikas Yojana
    - Uttarakhand Vision 2030

The TEEBagrifood evaluation in Uttarakhand benefited from extensive stakeholder consultations[2] at both the state and national levels, as coordinated by the Project Steering Committee. During the meetings, it was agreed that the evaluation scenarios would be developed in accordance with current organic farming and agroforestry policies.

One distinguishing component of the TEEBAgriFood evaluation in Uttarakhand is the examination of demonstration plots, which give on-the-ground assessments of organic farming techniques in two villages in the state: Sunkiya (hills) and Bidaura (plains). This synthesis report summarises the important findings from the TEEBAgriFood study in Uttarakhand and its implications for various policy efforts in the state. This synthesis report summarises the key findings of the TEEBAgriFood assessment in Uttarakhand and the strategy for mainstreaming the results into policy; however, detailed methodology and findings are presented in the demonstration plot, scenario modelling and valuation study reports.

[2] Reports for stakeholder consultation in Uttarakhand: https://teebweb.org/our-work/agrifood/country-implementation/eupi2019/india/

Study Area

The study area in Uttarakhand was determined to be districts of Nainital, Almora and Udham Singh Nagar in the Kosi and Kailash watersheds, covering a combination of sites that include both hilly and plain areas. The location map for the two watersheds is provided in Figure 2 below:

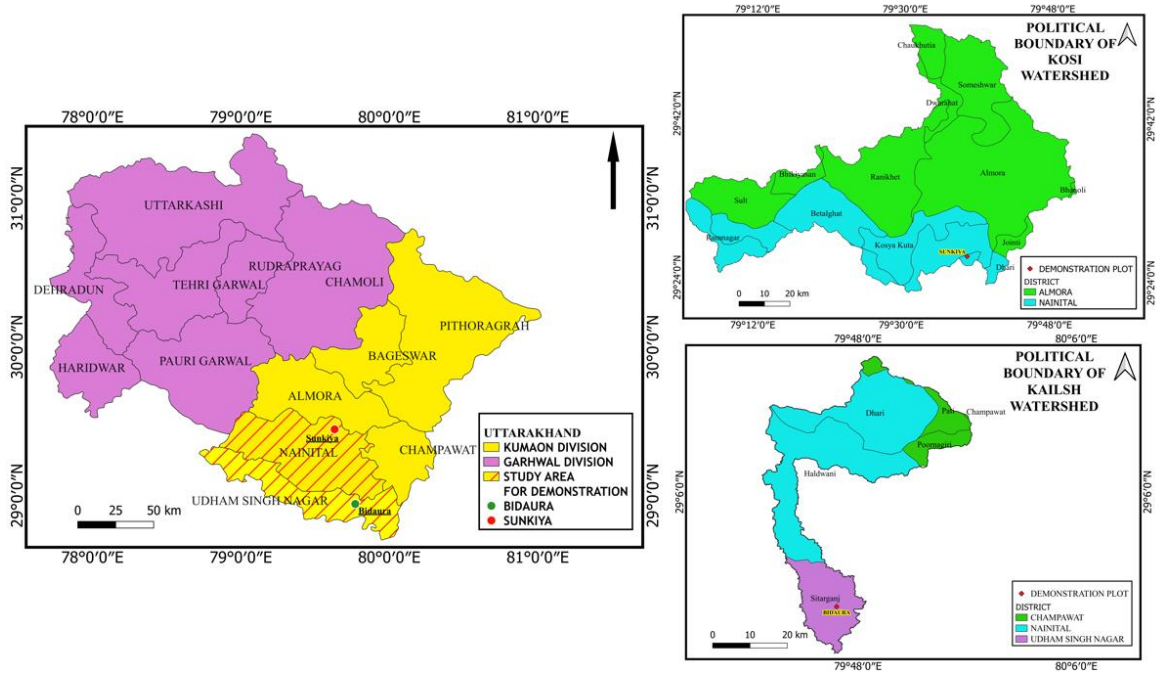

Figure 2: Location of Watersheds in Uttarakhand

Located within the boundaries of Nainital and Almora district, Kosi is a gauged watershed encompassing an area of approximately 1835.66 km^2. The Champawat, Nainital, and Udham Singh Nagar districts of Uttarakhand share a border with the Kailash watershed, which is the other part of the research area. The extent of Kailash watershed is 415.85 km^2 with elevation ranging between 204 - 2129 meters. The digital elevation model for Kosi and Kailash watershed is provided in Figure 3 above.

Given the vast altitudinal range in the state, from 187 masl to 7000 masl, the districts covered under the study capture variation in agroecological zones and demographic factors. The large agro-climatic variations in Uttarakhand are advantageous to the state and enable it to produce off-season vegetables and fruits that have a high market value.

Policy Scenario Analysis

To determine whether the policy would be beneficial at a societal level, we also need to consider non-market impacts, including impacts on untraded ecosystem services and biodiversity. Scenario-based policy analysis can help policymakers grasp the interconnectivity of society, the economy, and the environment, resulting in better decision-making. Policy scenario analysis driven by an ecosystems approach employing several modelling tools can play a pivotal role in demonstrating the evidence to the decision makers for sustainable and equitable food systems.

The policy scenario analysis undertaken in the TEEBAgriFood assessments in India involves comparing policy scenarios to business-as-usual and analysing policy options within a simulation framework. For Uttarakhand, the policy scenarios produced focus on scaling up organic farming and agroforestry interventions in the state in accordance with the Uttarakhand Vision 2030, with the help of the policies; PVKY, RKVY, and the National Agroforestry Policy and Namami Gange.

The scenarios developed represent both hilly and plain regions of Uttarakhand. Six scenarios have been created, considering different policy interventions (BAU, optimistic, and pessimistic) and climate change projections (RCP4.5 and RCP8.5). The assessment period for these scenarios is until 2050. Decadal assessments are presented for clarity. These scenarios have been created by combining the three policy scenarios (BAU, optimistic, and pessimistic) with two climate change scenarios (medium and high greenhouse gas emission scenarios, RCP4.5 and RCP8.5).

The scenarios developed for hills (table 2) and plains (table 3) are presented below:

Table 1: Scenarios for hill region of Uttarakhand

Business as Usual (BAU) Scenario	Pessimistic Scenario	Optimistic Scenario
• Builds on existing policies and initiatives (as of 2021) and SDGs implemented by the Uttarakhand Vision 2030 • Organic Agriculture: Organic farming increases from current 36% of total cultivated	• Assumes the emergence of unforeseen factors that may possess threat to current goals and hamper the modernization and green transformation of Uttarakhand • Organic Agriculture:	• Assumes progress in agricultural modernization by organic policies and initiatives implemented under UK Vision 2030 • Organic Agriculture: Organic farming increases to cover 95%

area to 65% of the total cultivated area as per the scaling potential • Agroforestry: Area under agroforestry continues to be maintained at 12% of the cropped area in the study area	Organic farming continues to cover 36% of the total cultivated area due to low yields and weak post-harvest processing infrastructure • Agroforestry: Area under agroforestry reduces to 6% of the cropped area in the study area due to growing urbanisation and commercialisation	of the total cultivated area based on Uttarakhand's vision to establish the entire state as an organic state • Agroforestry: Area under agroforestry grows at 3.5% per annum as per growth trends for agroforestry in the study area.

Table 2: Scenarios for plain regions of Uttarakhand

Business as Usual (BAU) Scenario	Pessimistic Scenario	Optimistic Scenario
• Builds on the existing policies and initiatives (as of 2021) and SDGs implemented by the Uttarakhand Vision 2030 • Organic Agriculture: Organic farming increases to cover 38% of the state's total cultivated area (250,000 ha out of 647788 ha) • Agroforestry: Area under agroforestry continues to be maintained at 12% of the cropped area in the study region	• Assumes the emergence of unforeseen factors that may possess a threat to current goals and hamper the modernization and green transformation of Uttarakhand • Organic Farming: Organic farming continues to cover 4% of the total cultivated area (current status) • Agroforestry: Area under agroforestry reduces to 6% of the cropped area in the study region to increase in	• Assumes progress in agricultural modernization by organic farming policies and initiatives implemented under UK Vision 2030 • Organic Agriculture: Organic farming increases to cover 75% of the total cultivated area based on the scaling potential in the study area • Agroforestry: Area under agroforestry grows at a 3.5% per annum as per growth trends for agroforestry in the study area.

	urbanisation and land use change.	

Capitals Assessed

The TEEBAgriFood framework applies a capitals approach to build resilience, mainstream best practices, protect biodiversity and contribute to a more sustainable food system. The four capitals include – produced, natural, human and social. This approach is designed to be universally applicable across multiple scales and contexts. It allows for a thorough understanding of the stocks, flows, outcomes, and impacts within eco-agri-food systems by incorporating the long-term values of these capitals and the changes in these capitals it aids in making formed policy decisions and evaluating the trade-offs.

This holistic strategy of addressing these four capitals together intends to create avenues for supporting various national and international commitments, including most of the sustainable development goals, while also providing an efficient mechanism for implementing an effective system of true cost accounting, where the environmental, social, cultural, and economic cost and benefits are considered, leading to a more comprehensive understanding of the actual cost of production. In this regard, the TEEBAgriFood assessment in Uttarakhand looked at assessing various elements under the four capitals

Table 3: Elements of Capitals assessed

Natural	Produced	Human	Social
• Soil Erosion • Sediment Yield • Nutrient Export • Water Yield • Carbon Sequestration • Soil Health	• Timber Provisioning Services • Crop Provisioning Services	• Dietary Patterns • Human Health	• Women Empowerment • Benefit to cost ratio (organic farming vs conventional farming)

Demonstration Plots

In Uttarakhand, a field study was conducted as part of the TEEBAgriFood assessment, focusing on two contrasting geographical regions: Sunkiya village in the hilly terrain of Nainital district and Bidaura village in the plains of Udham Singh Nagar. The majority of villages had land holdings below 1 hectare, indicating marginal farmers. The primary aim of the demonstration trials was to educate farmers in producing their organic inputs and advocating for quality biofertilizers and biopesticides. The objective was to showcase the benefits of organic farming to farmers without compromising crop yield, emphasizing the importance of timely and quality input for guaranteed yields. The trial studies aimed to examine the externalities associated with transitioning from conventional to organic agriculture, considering ecosystem services and disservices, as well as social structure outcomes influencing human development.

The demonstration plot studies specifically looked evaluating soil health, crop yield, farmers' income, the status of women's empowerment, and expertise in organic farming practices after the intervention (transition to organic farming).

Summary of Results

The results of the policy scenario analysis for Uttarakhand suggest that in comparison to the Business as Usual (BAU) scenario, the optimistic policy scenario, depicts higher carbon sequestration, improved sediment and nutrient export control, and water purification services through the expansion of area under organic farming and agroforestry. Moreover, the expansion of agroforestry acreage results in a higher supply of timber and an augmented income for farmers. Some of the key findings are summarised below:

Water Yield: According to the analysis, rainfall will increase in both the Kosi and Kailash watersheds under future RCP 4.5 and RCP 8.5 climatic scenarios. While the water production in the Kosi and Kailash watersheds increases during the monsoon season, it drops during the lean season, resulting in higher runoff during monsoons. Results indicate a dominant impact of climate change, as water yield increased under future BAU scenarios as well. Despite this increase, in an optimistic scenario, vigorous crop management can control water yield through upscaling of organic farming and agroforestry measures. As valuated, the water expenses yield 120.66 million USSD in 2020, and 140.96 million USSD in BAU RCP 8.5. However, in the optimistic RCP 4.5 scenario, it will be 132.68 million USSD.

Erosion control: Under the future BAU scenarios, greater runoff results in increased soil erosion subsequent sediment yield for both the watersheds. The upscaling of organic farming and agriculture in optimistic scenario revealed that upscaling organic farming and agroforestry is beneficial for controlling soil erosion and sediment yield in both

watersheds, even at RCP 4.5 and 8.5. For instance, currently, in Kosi watershed the present soil erosion control services is 8.2 million USSD which is projected to increase to 12.2 million USD by 2050. However, under the optimistic scenario it will be 11.7 million USD by 2050.

Water purification: Organic agriculture could be deemed sustainable due to lower non-point source pollution. Increased organic agriculture area resulted in less N, P, and K release, which eventually led to stream water purification. Under the optimistic scenario, both watersheds' N and P releases have decreased. The Namami Ganga initiative also promotes organic farming in the vicinity of rivers through its “Artha Ganga” vertical; as part of this programme, organic farming will help to reduce the amount of fertiliser released into water bodies.

Carbon storage: Uttarakhand is largely a forest-covered state that serves as a significant carbon sink. Further increasing agroforestry cover under an optimistic scenario increases carbon sequestration and may aid in obtaining carbon credits for residents. Organic agriculture and agroforestry will help to save carbon stocks and create a more sustainable agricultural system.

Crop yield: The productivity yield gap between conventional and organic farming has been previously extensively examined at both regional and temporal scales (Ponisio et al., 2015; Yadav et al. 2002; Hazra et al. 2014; Aulakh et al. 2009; Sharma 2009; Davari and Sharma 2009). A complete review of organic agriculture for the current agroclimatic conditions used for rice and wheat yields was conducted under the TEEBAgriFood assessment. The InVEST crop provisioning module was used in organic agricultural conditions with declining N, P, and K rates under the research watersheds under appropriate climatic bins. The BAU, optimistic, and pessimistic scenarios were translated into area under organic farming and accompanying yield. Rice and wheat yields dropped at first, but rebounded with time under the optimistic scenarios. In addition, the demonstration plots study conducted in Sunkiya and Bidaura villages demonstrated yield recovery in organic farming systems in the second year of intervention in addition to increase in soil microbial activity, functional groups, soil enzymatic activity and soil organic carbon.

Timber provisioning: An increase in agroforestry area in an optimistic scenario has resulted in increased timber provisioning services for both watersheds. Thus, adopting an optimistic scenario as a strategy will help to earn 683.84 lakh rupees in the Kosi watershed and 160.52 lakh INR in the Kailash watershed of the state.

Women’s Empowerment: As participation of women in terms of group membership was high in comparison to men, women SHGs can be encouraged with a special emphasis on

organic farming and their value-added products, goods, and services. Their knowledge and abilities can be improved through training and capacity development programmes for SHGs in basic literacy and financial literacy. The Mahila Jagriti Yojana of Uttarakhand State (Women Empowerment and Child Development) aims to empower women by increasing their skills.

Contribution to Sustainable Development Goals

The paper emphasises organic agriculture and agroforestry as critical options for accomplishing the 17 SDGs and their 169 objectives. The research reveals numerous advantages in the social, health, economic, and environmental areas. Table 1 summarises the findings, illustrating how organic agriculture and agroforestry contribute to each of the 17 UNSDGs.

Table 4: Linkages of TEEBAgriFood assessment in Uttarakhand with UNSDGs

Goal	Contributions
SDG 1: No poverty	- Increased incomes for poor and marginal farmers - Sustainable production and associated incomes - Job opportunities for farmers (lowering rates of rural to urban migration)
SDG 2: Zero hunger	- Diversified cropping system impacting dietary patterns - Sustained productivity - Diverse genetic resources
SDG 3: Good health and well-being	- Positive impact on health due to reduced exposure to chemicals
SDG 4: Quality education	- Improved understanding of sustainable agricultural practices
SDG 5: Gender equality	- Identification of major challenges associated with women empowerment in the hills and plains
SDG 6: Clean water and sanitation	- Decrease fertilizer leaching - Improved access to water yields and access to safe water - Increase in water infiltration and groundwater recharge due to agroforestry
SDG 7: Affordable and clean energy	- A possible source of energy are the animals in integrated farms that incorporate organic principles

SDG 8: Decent work and economic growth	- Safer and healthier working environment through decreased chemical use - Enhanced income through timber and crop provisioning
SDG 9: Industry, innovation, and infrastructure	- Enhance organic agriculture through training and facilities, focusing on certification, traceability, marketing, and harvest/postharvest technologies for farmers.
SDG 10: Reduced inequalities	- Steady incomes to small and marginal farmers
SDG 11: Sustainable cities and communities	- Sustainable sourcing of organic produce
SDG 12: Responsible consumption and production	- Sustainable production through chemical-free farming practices such as organic farming - Sustainable sourcing of organic produce
SDG 13: Climate action	- Reduced fertilizer use contributing to reduction in GHG emissions - Greater carbon sink through agroforestry
SDG 14: Life below water	- Reduced impact through decline in leaching of harmful chemical from conventional agriculture
SDG 15: Life on land	- Improved soil health; microbial activity, functional groups, enzymatic activity and soil organic carbon through organic farming.
SDG 16: Peace and justice, strong institutions SDG 17: Partnerships for the goals	- Under organic contract farming, international agribusiness firms can provide sustainable livelihoods to small farmers in developing countries, making these firms key partners in rural development and agricultural modernization

Policy Options

The results of the TEEB AgriFood applications show that adopting organic farming practices over time helps recover yield loses through proper handholding of farmers and has positive impacts on ecosystem services. To generate accurate long-term productivity estimates, additional assessments are required that assess changes in soil health parameters through a representative sample size and corresponding yields of organically cultivated crops.

The TEEBAgriFood applies a whole system thinking to the economics of agriculture, which is concerned with complex and extensive eco-agri-food value chains from supporting ecosystems, to productive farms, to intermediaries such as aggregates, wholesalers and retailers, to food manufacturers and distributors, and consumers. In this regard, application in Uttarakhand highlighted the following opportunities across agricultural production, manufacturing, marketing distribution and household consumption, for scaling up organic agriculture and agroforestry that should be pursued further.

Agricultural production

- **Soil health**: While Organic farming approaches can increase soil quality, tillage is still necessary for weed control and cover crop incorporation, posing concerns of soil loss and degradation. Addressing these challenges through effective models for organic farming implementation is important. The National Mission for Sustainable Agriculture (NMSA) prioritises Soil Health Management (SHM) aims to restore soil health. This policy takes an imitative approach to controlling soil erosion. Some of them involve agronomic, cultural, or structural practices. The soil health card is issued to each farmer family and contains unified information about the soil in their farms as well as technical advice. This can particularly help in exploring opportunities for addressing challenges associated with uptake of organic farming practices while addressing soil loss and degradation.

- **Water**: Water policies aim to balance the state's hydrology and rivers to prevent soil erosion and ensure enough water supply and quality. Water harvesting, also known as rainwater harvesting, can be pushed in order to maintain adequate moisture levels in each location.

- **Farmer Livelihoods**: To meet the villagers' domestic requirement for fuel wood, fodder, minor forest produce, and lumber, appropriate species need to be selected and planted. This will enhance farmer’s economic situation by making tree plantation activity more job-oriented for the poor and vulnerable parts and has the potential to address the issue of rural to urban migration from hills to the plains in Uttarakhand. Additionally, special efforts can be made to boost the productivity of Eucalyptus and Poplar plantations in order to supply wood to a variety of forest-based industries. The benefits assessed on ecosystem services can help build effective communication plans and outreach strategies to demonstrate the benefits to farmers.

- **Input support** (such as organic input shops) and increase farmers' technical competence to establish homemade bio-fertilizers such as BGA, Azolla, and bio

insecticides, as well as composting (vermicomposting, NADEP, BD compost, and coir pith composting processes) at the local level is required.

- **Appointing district level PKVY officers**: Currently, the agricultural officers in charge of PKVY are involved in various tasks, impeding the smooth implementation of the program. Therefore, the appointment of specialized officers at the district level is necessary to streamline and enhance the progress. This is particularly crucial in Uttarakhand, where the Agricultural Technology Management Agency (ATMA) is operational. To ensure effective dissemination of technology, the training components under PKVY should be transferred to ATMA in the region.

- **Incentivise organic input production and farmer uptake**:

    - Encouraging and incentivizing large-scale bio-input suppliers such as Panchamruth, Panchagavya, and Beejamruth.

    - Incentivise organic farming practices for the farmers through handholding during the transition periods while moving from conventional to organic farming practices

- **Establish R&D facilities for low-cost production of bio-inputs**: The scientific basis of organic agriculture practices must be demonstrated for organic produce to be more widely accepted.

- **Farmer trainings and capacity building**: Developing a farmer-friendly training programme for organic crop production practices in local languages, including diagrams, figures, and drawings. This standard package of practices should be developed at the block and crop levels. Educating farmers about significant indigenous breeds in their agricultural systems and integrated farming system should be increased.

- **Scaling organic production**: Utilised early PKVY programme experience to identify areas for expansion. Identify and map the default organic growing areas, declare them as organic, and make steps to get them recognised and marketed.

Agricultural Processing & Marketing Distribution and Retail

- **Market Presence**: Set up separate organic certified stalls in existing APMC markets at the block/mandal level, maintained by PGS certified clusters to secure premium prices. Promote local processing and value addition through mini-processing plants

at the cluster or federation level before entering the wholesale supply chain, ensuring maximum returns for cluster farmers.

- **Regional Centres and FPOs**: Establish regional centres for market promotion in each zone through a community-Public Private Partnership model. In addition, government-backed Farmer Producer Organizations (FPOs), including cooperatives and producer companies, should be established across all districts and states. FPOs will handle activities such as capacity building, production, processing, certification, and marketing, forming connections with the private sector.

- **Collaborative Marketing Strategies**: Collaborate with specialized Regional Councils (marketing) and private firms involved in marketing organic produce for market surveys, demand estimation, and product development.

- **Organic Cluster Development**: Identify complete villages/blocks/mandals as organic clusters to build a brand and provide logistical services at a lower cost. Selection should be contiguous, and a whole-area approach (saturation) can be adopted to establish organic brands.

- **Technological Intervention and Market Linkages**: Use information and communication technologies for digitizing organic farms, crops, and prices, developing virtual marketplaces, and connecting to eNAM. Link the PGS-INDIA web portal to national and global markets, focusing on rainfed and tribal areas where farmers use fewer fertilizers.

- **Capacity building of agri-entrapeneurs**: A burgeoning market for organic agriculture is attracting start-ups and agri-entrepreneurs, with some private enterprises (including farmer producer companies) reaping significant profits from distributing organic produce. Encourage agri-entrepreneurs to learn how to identify and capture market opportunities for organic agriculture.

Agricultural Consumption

- **Increasing demand for PKVY cluster produce** by popularising PGS certification among distributors, merchants, and consumers at premium rates. To promote authenticity and transparency, the details on PGS-certified product labels should be comparable to private labelling. Processed food must be branded in accordance with Food Safety and Standards Authority of India (FSSAI) laws. E-platforms and mobile apps are used for direct marketing of organic goods. In addition to PGS certification, third-party certification may be encouraged provided clusters (farmer-producer

enterprises) are willing to pay a subsidised fee. Certification procedures can be eased by filling out data online twice a year during both the kharif and rabi seasons.

Conclusion

The TEEBAgriFood evaluation in Uttarakhand provides evidence for the effects of scaling up organic farming and agroforestry in the state on ecosystem services. The findings indicate beneficial effects on soil erosion control, carbon sequestration, nutrient export control, and farmer earnings. The demonstration plot research undertaken as part of this assessment shows that with optimal input utilisation, bio-input availability, and good farming practices, yield declines during the transition from conventional farming practices to organic farming are minor. Furthermore, the study shows an increase in soil organic carbon and microbial population after 18 months of transitioning to organic farming. The study provides data to scale up organic farming policies in the state, such as Paramparagat Krishi Vikas Yojana, Rashtriya Krishi Vikas Yojana, Namami Gange and National Agroforestry Policy.

Through imbibing a holistic approach to enhance soil health and reduced environmental impact it looks at addressing critical United Nations Sustainable Development Goals. Organic farming could contribute to reaching SDGs 2 and 3, which focus on sustainable agriculture and healthy lives, respectively. The current assessment indicates that positive policy options will contribute to achieving the safe and sustainable cities goal (SDG 11), upscaling organic farming and agroforestry can help conserve natural resources even in the face of climate change (SDG 12) and gender equality (SDG5) can be accomplished by developing women-centric policies that focus on organic farming and agroforestry.

In totality, optimistic scenarios for organic farming and agroforestry can be used to update policies towards greater expansion of area under these practices while the pessimistic climatic scenario demonstrates the urgency for integrating sustainable agricultural practices (organic farming and agroforestry) to combat the impacts of declining yields, soil degradation and climate change while enhancing farmer livelihoods. Further demonstrating that assessments such as TEEBAgriFood should be expanded to other agro-climatic zones of the state and country, given its valued focus on increasing ecosystem health and biodiversity for a better future for humanity in the face of population pressure and climate change challenges.

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Annexure: Presentation on TEEBAgriFood Assessment in Uttarakhand

A Study Process for The Economics of Ecosystems & Biodiversity for Agriculture and Food Initiative in India

Presented by: Govind Ballabh Pant University of Agriculture & Technology

Scope of the study

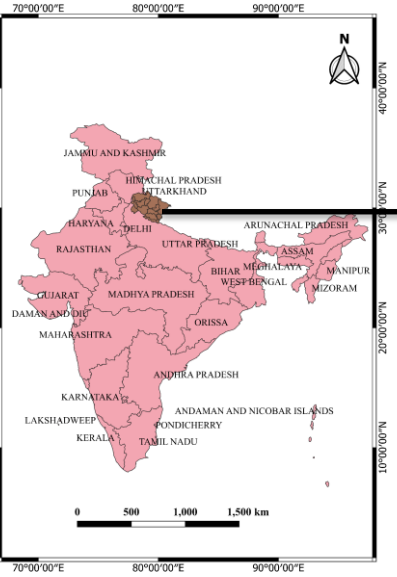
Aims and Objectives

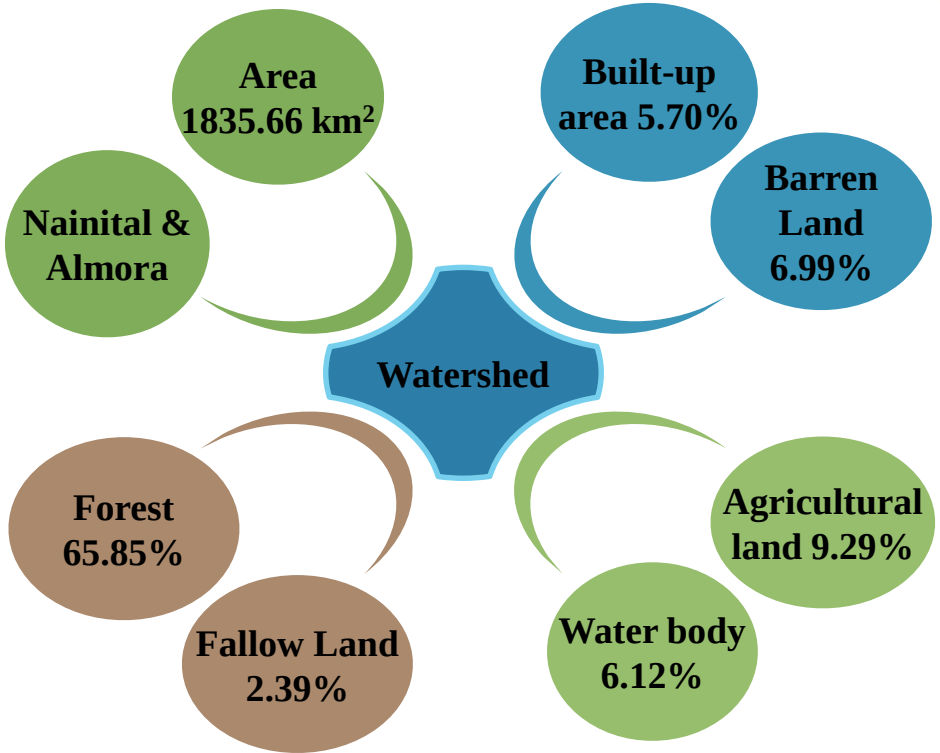
- Conduct economic valuation of ecosystem services, considering scenarios for scaling up organic farming and agroforestry across natural, human, social, and produced capitals.
- Provide technical insights and on-field demonstration plot results to support the future expansion of agroforestry and organic farming practices in the state.
- Mainstream values of Biodiversity and Ecosystem services into decision making

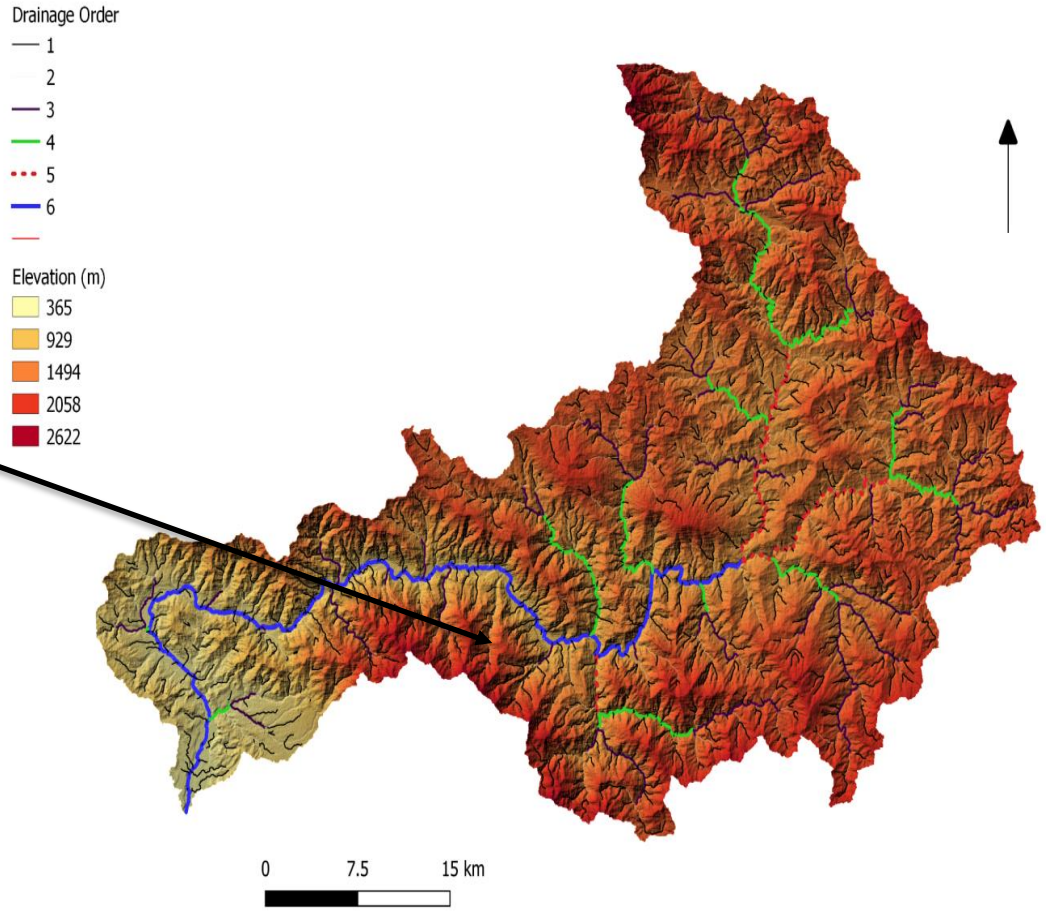
Assessment contributes to the following key policies/initiatives

- National Mission on Clean Ganga (Namami Gange)
- National Agroforestry Policy
- Paramparagat Krishi Vikas Yojana
- Uttarakhand Vision 2030

STUDY REGION 1: KOSI WATERSHED







STUDY REGION 2: KAILASH WATERSHED

Area 415.85 sq km

Nainital Champawat, &USN

Built-up area 10.13%

Barren Land 6.19 %

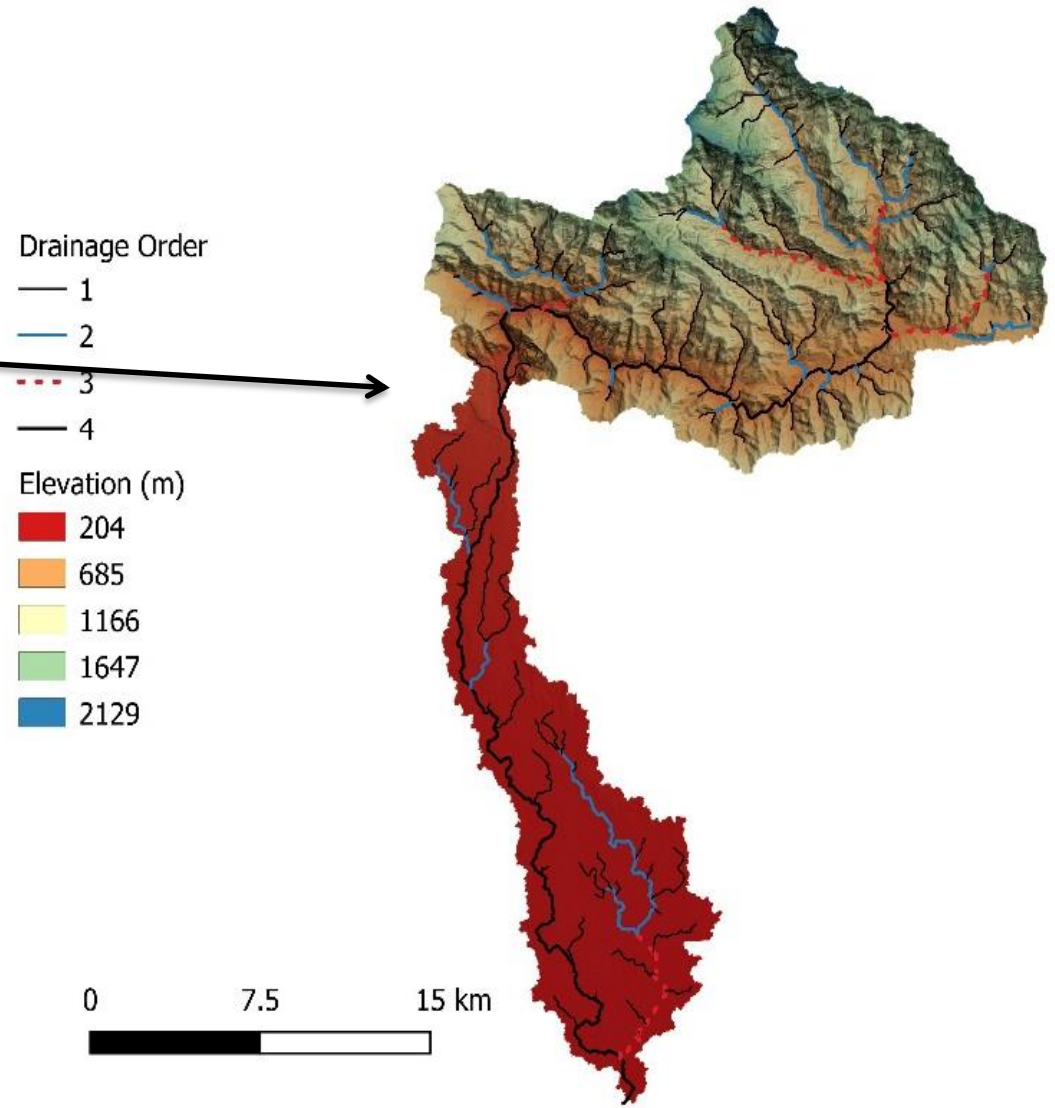
Watershed

Forest 61.95%

Fallow Land 6.16%

Agricultural land 5.71%

Water body 9.25%

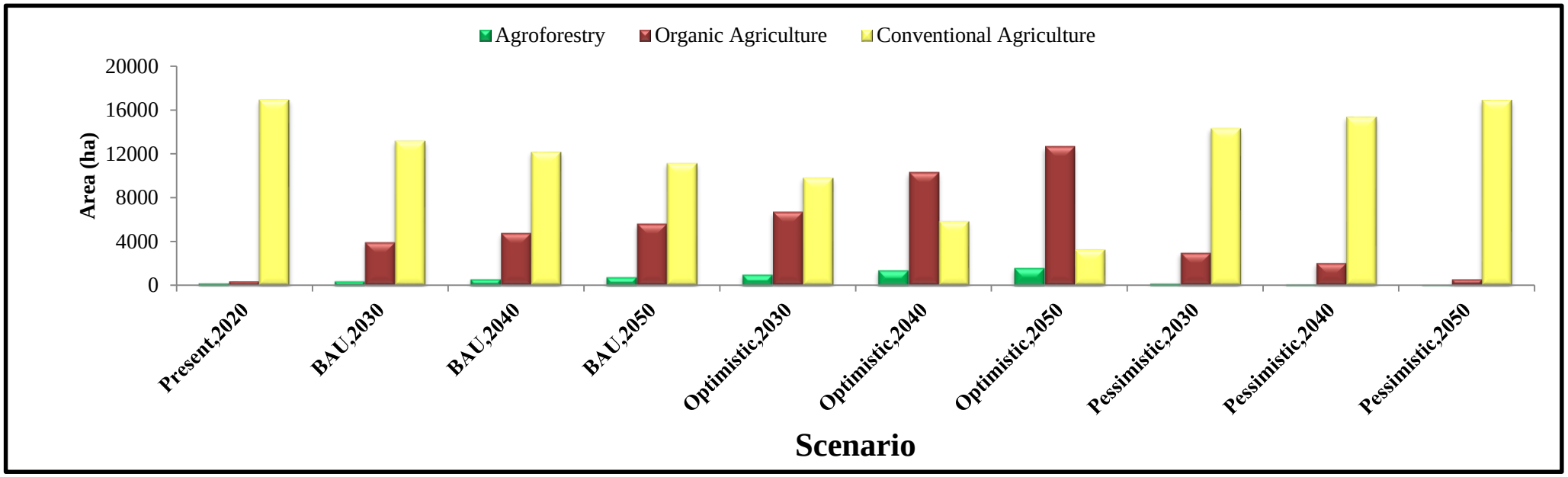


POLICY SCENARIOS FOR THE STUDY AREA IN THE HILLS & PLAINS OF UTTARAKHAND

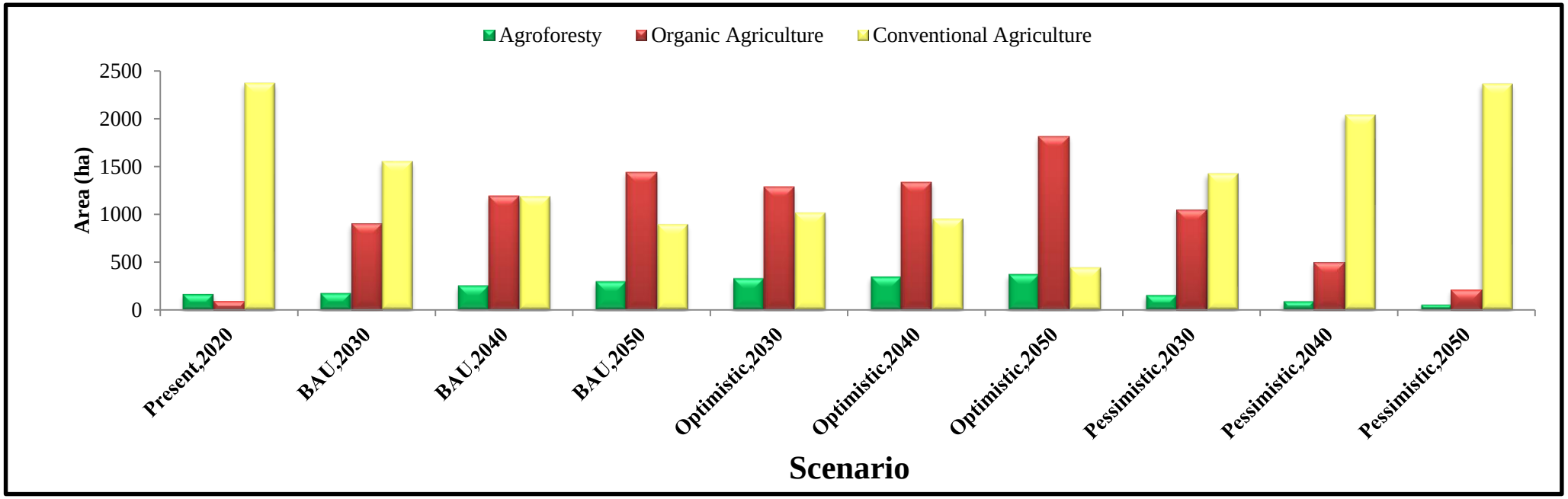
	Business As Usual			Optimistic			Pessimistic		
Kailash watershed									
U.S.Nagar									
Organic Farming	38%	↑	2050	75%	↑	2050	4%	→	2050
Agro forestry	12%	→	2050	3.5%	↑	2050	6%	↓	2050
Kosi watershed									
Nainital									
Organic Farming	65%	↑	2050	95%	↑	2050	36%	→	2050
Agro forestry	12%	→	2050	3.5%	↑	2050	6%	↓	2050

LULC CHANGE UNDER VARIOUS SCENARIOS (2020, 2030, 2040 and 2050)

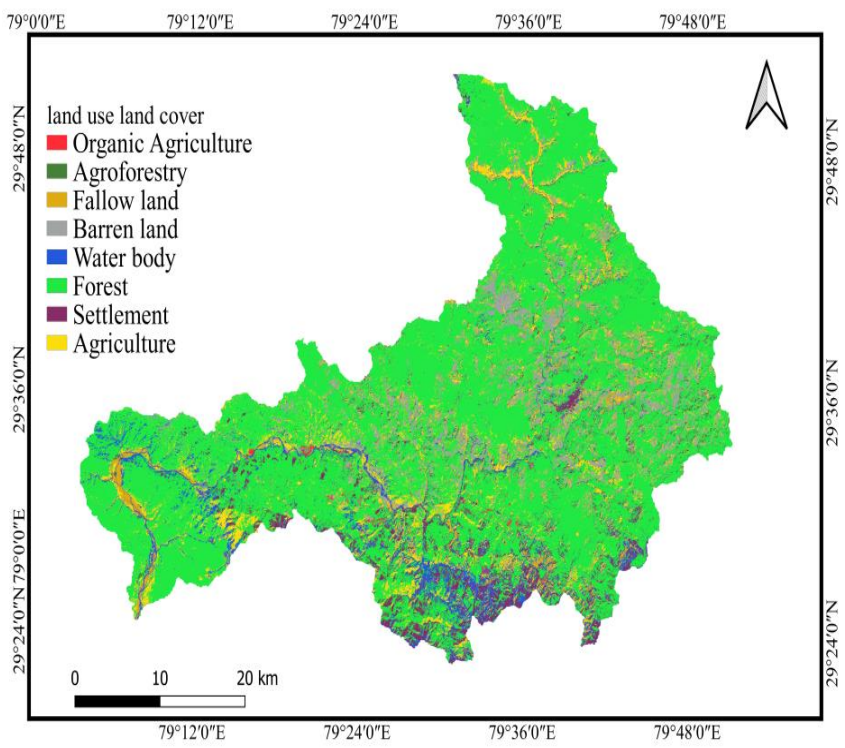
Kosi



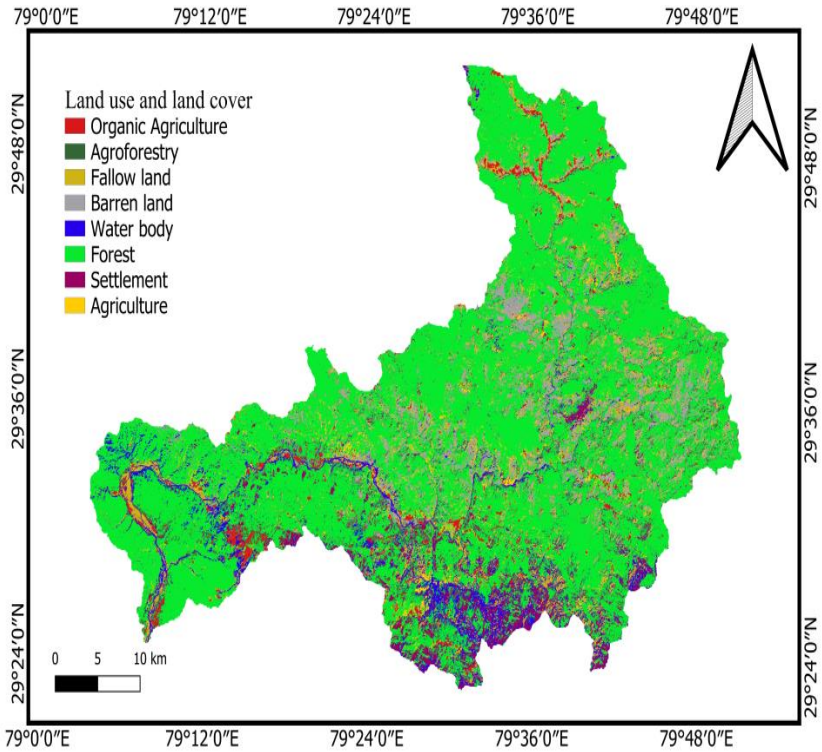
Kailash



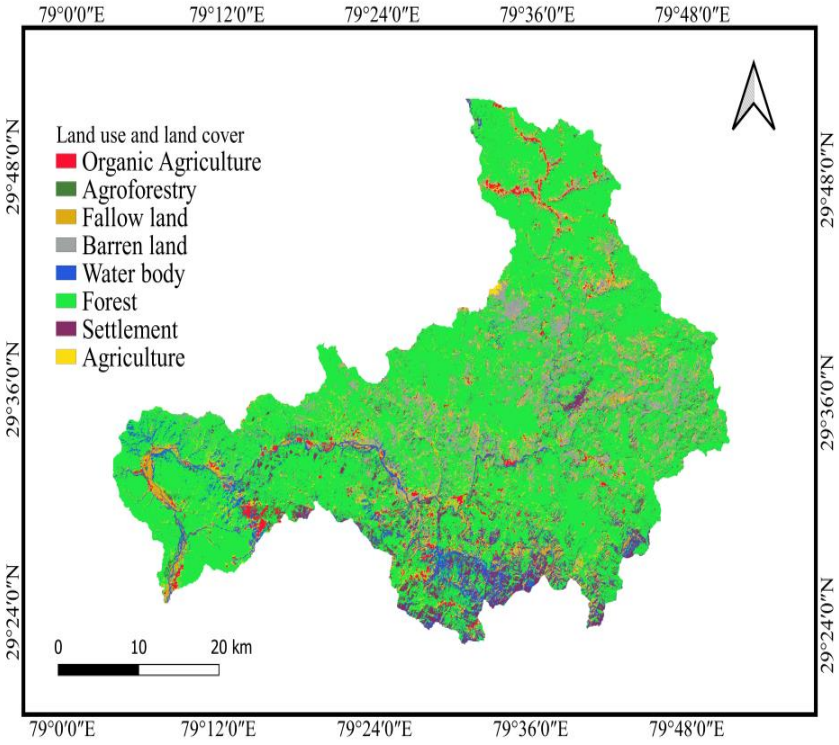
LULC CHANGE UNDER VARIOUS SCENARIO IN KOSI WATERSHED



Present (2020)

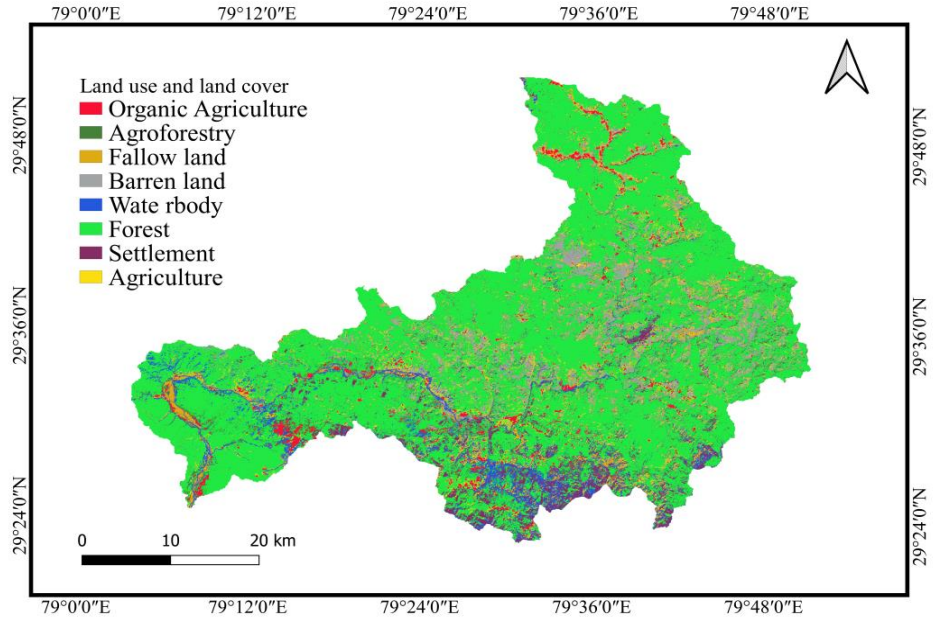


BAU (2030)

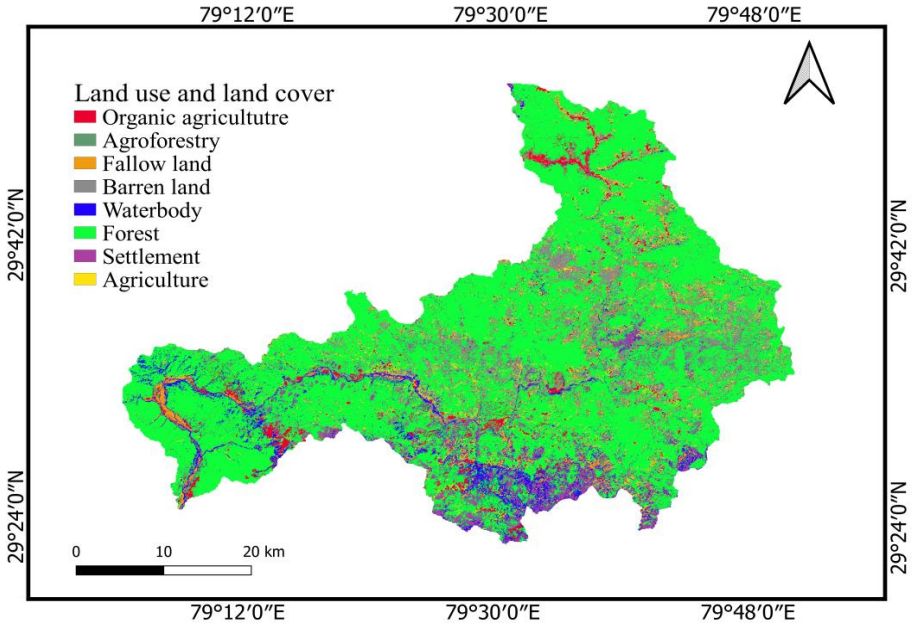


BAU (2050)

- In the base year (2020) the percentage of organic agriculture area is 2% of total agriculture area and it will become 22% in **BAU (2030)** and 32% in **BAU (2050)** of total agriculture area.
- The percentage of the agro-forestry in the base year (2020) is 1% under the total agriculture area. In the **BAU (2050)** the area of the agro-forestry will be 4% of the total agriculture area.



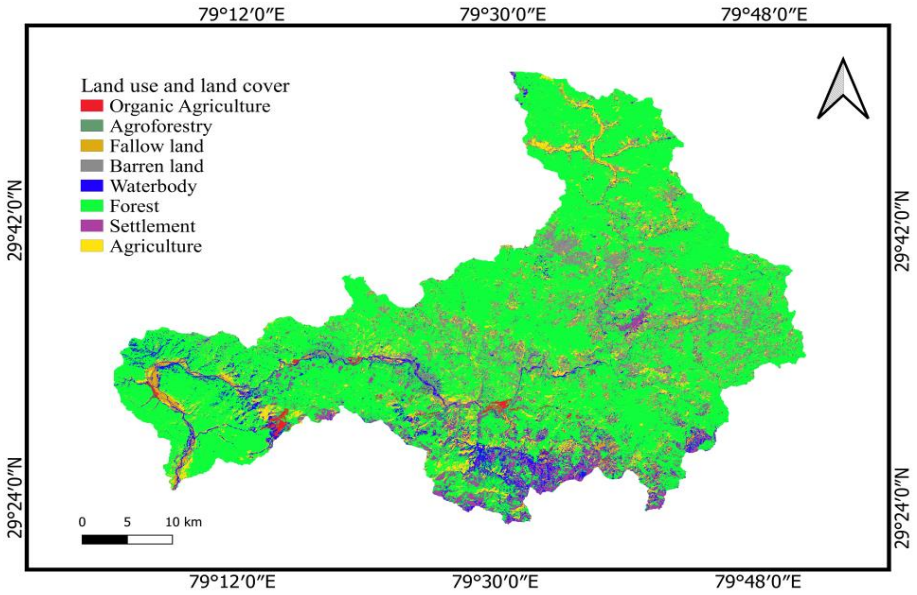
Optimistic (2030)



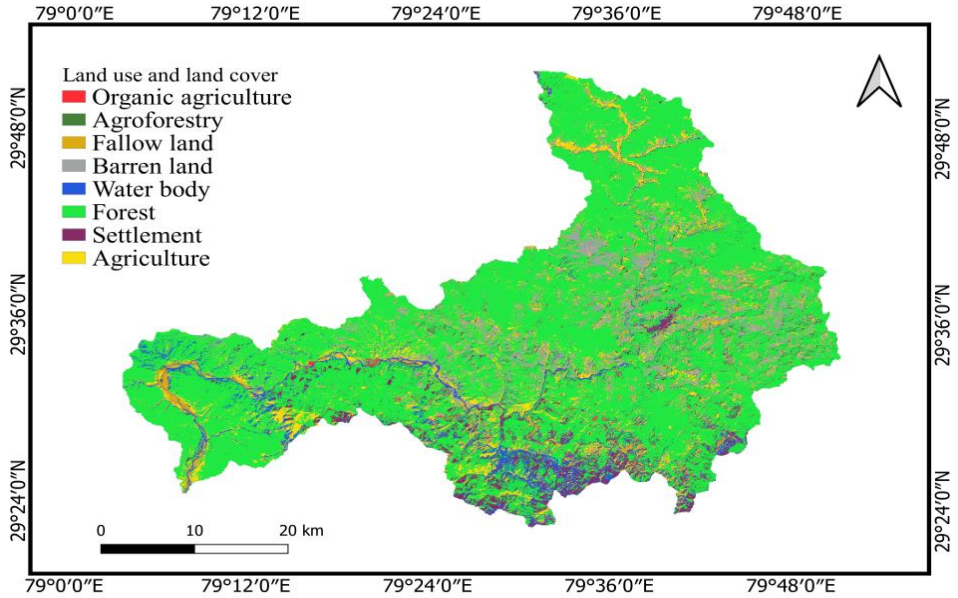
Optimistic (2050)

❑ In the **optimistic scenario** 2030, the proportion of organic agriculture is 38% of the total agricultural area. This percentage increases to 72% in the **optimistic scenario 2050**.

❑ The percentage of agro-forestry area in the **optimistic scenario 2030** is 6% and in **optimistic scenario 2050** its 9% of the total agricultural area



Pessimistic (2030)

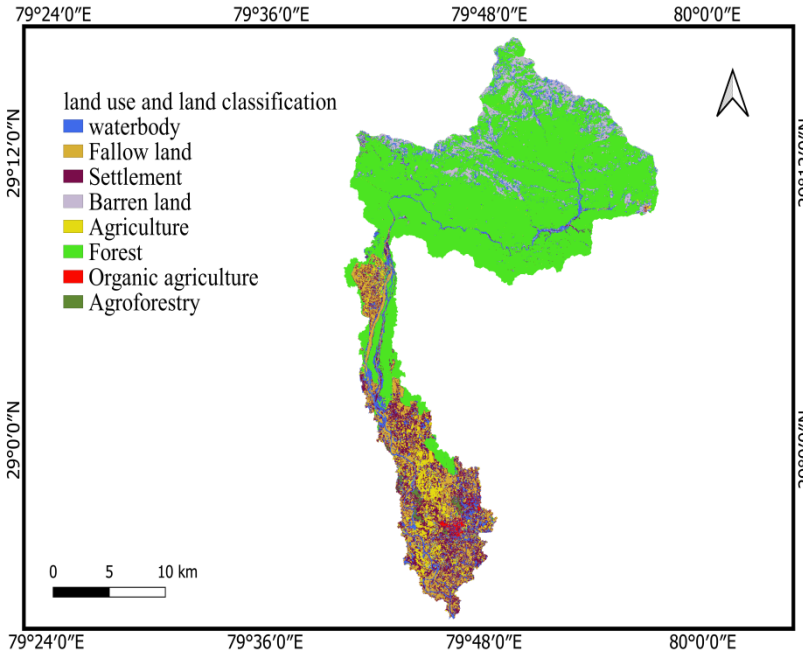


Pessimistic (2050)

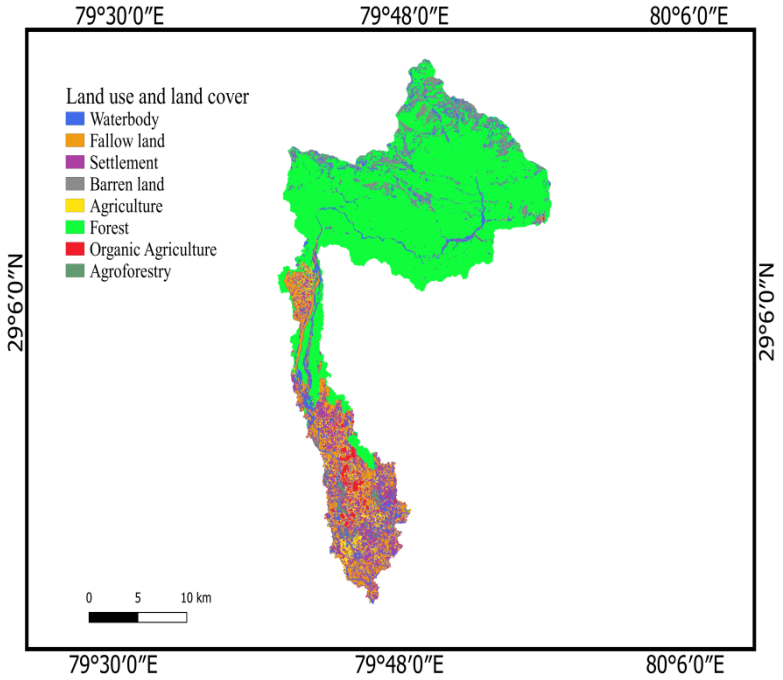
❑ In the **pessimistic scenario 2030** the proportion of organic agriculture will be 17% . And it will become 3% in the **pessimistic scenario** 2050 of the total agriculture area.

❑ The Agro-forestry area percentage will be 1% in **pessimistic scenario 2030 and ultimately lead to** 0.5% in **2050.**

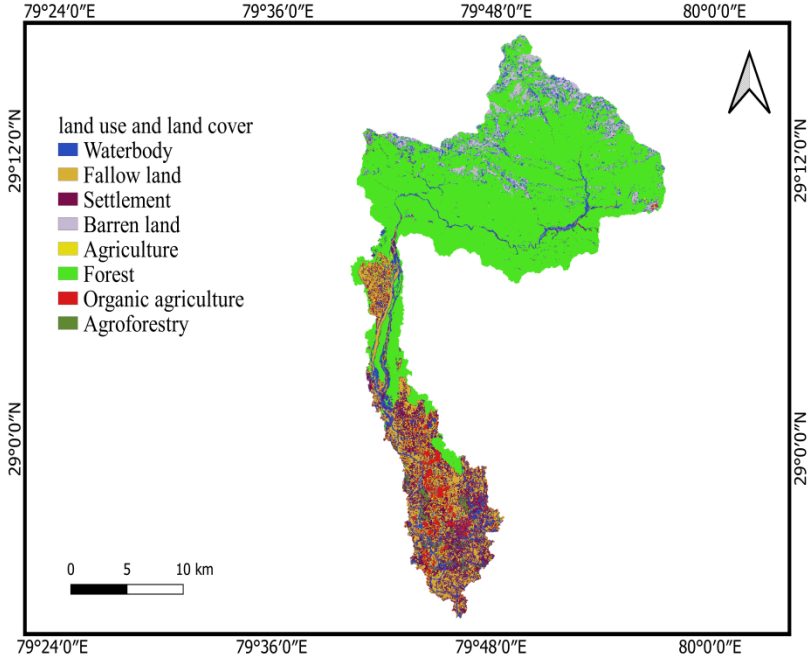
LULC Change under various scenarios in Kailash Watershed



Present (2020)

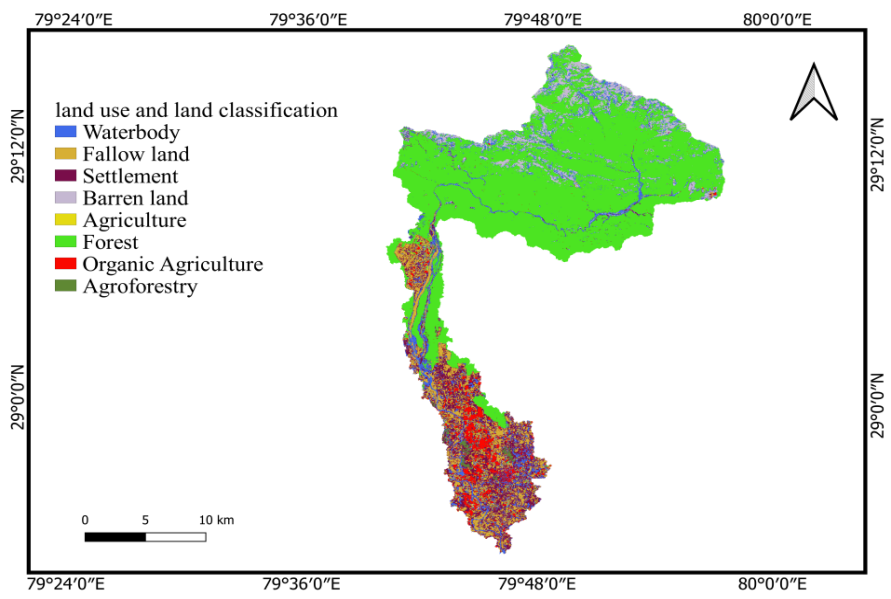


BAU (2030)

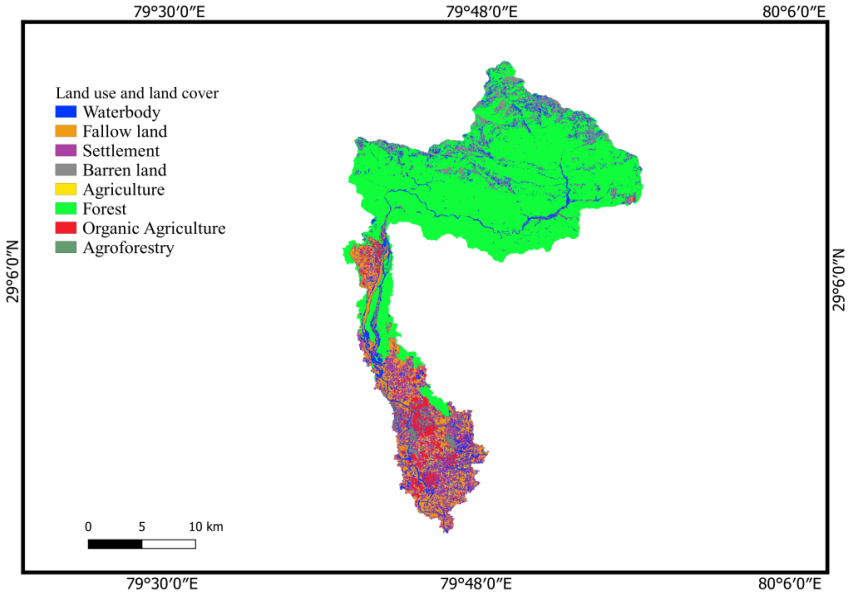


BAU (2050)

- In the base year 2020 the watershed area has 4% of organic agriculture of the total agriculture area.
- In the BAU 2030 scenario the organic agriculture will be 34% of the total agriculture area and in BAU 2050 scenario it will be 55%.
- The agro-forestry in the base year is 7% which will be 12% and 33% in the scenario BAU 2030 and BAU 2050 respectively.

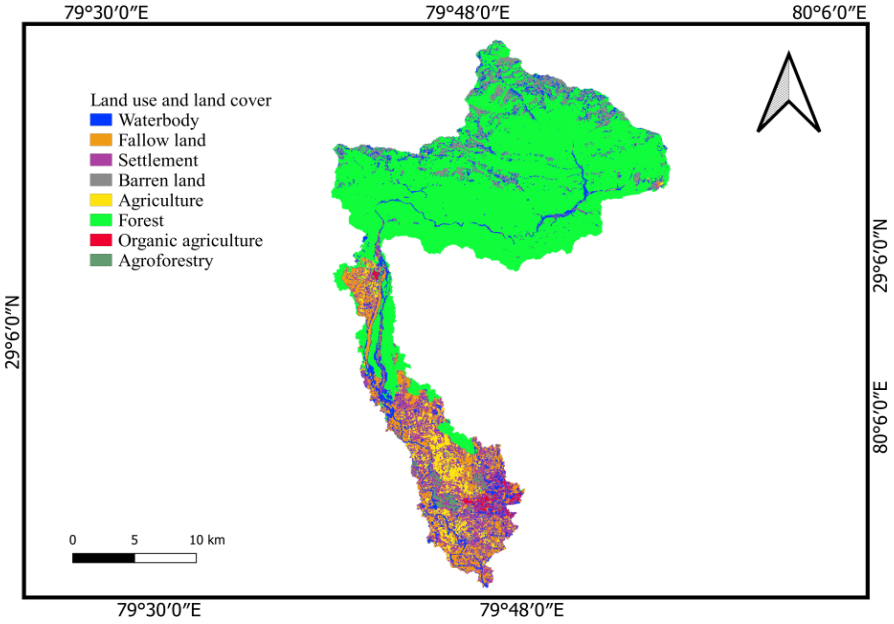


Optimistic (2030)

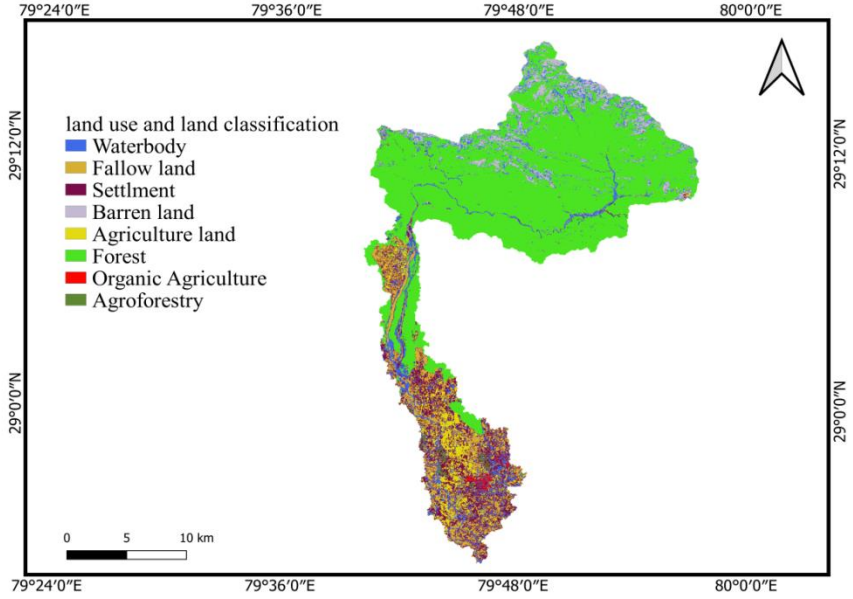


Optimistic (2050)

- In the **optimistic 2030** the organic agriculture will be **49%** and will become **69%** under the total agriculture area in **optimistic 2050** scenario .
- The Agro-forestry area percentage will be **12%** **optimistic scenario 2030 and will become** in **14%** in**2050** under the total agriculture.



Pessimistic (2030)



Pessimistic (2050)

- In the **Pessimistic 2030** the organic agriculture is 40% which will become **8%** of the total agriculture area.
- The Agro-forestry area percentage will decline from **6% to 2%** from the **optimistic scenario 2030 to 2050** upon the total agriculture.

ECOSYSTEM SERVICES & THEIR BIOPHYSICAL MODELING

Water Quantity

Water Yield Model (SWAT)

Water Quality (Amelioration)

Nutrient Delivery Ratio (InVEST)

Soil Erosion

RUSLE, Sediment Yield (InVEST

Soil Health

Physical and Chemical analysis by lab testing (*demonstration plots*)

Carbon Pools & Sequestration

Carbon Sequestration (TerrSet & InVEST)

Timber Provisioning

Net Present Value

Crop Provisioning Services

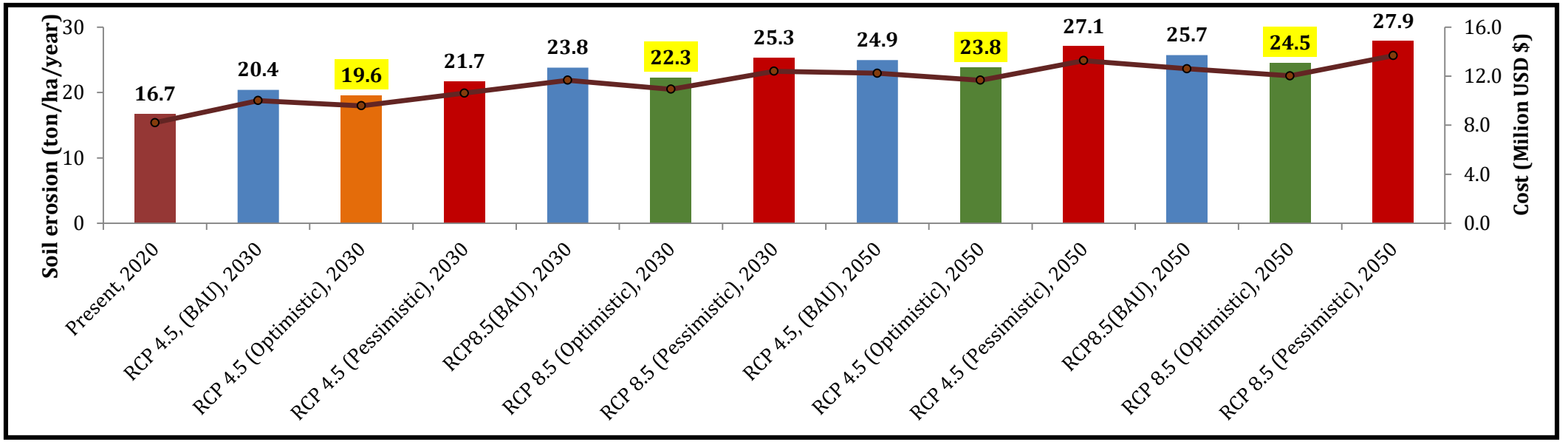
Crop Provisioning Services (InVEST)

Modeling Future Scenarios (RCP 4.5 & RCP 8.5 alongwith LULC changes)

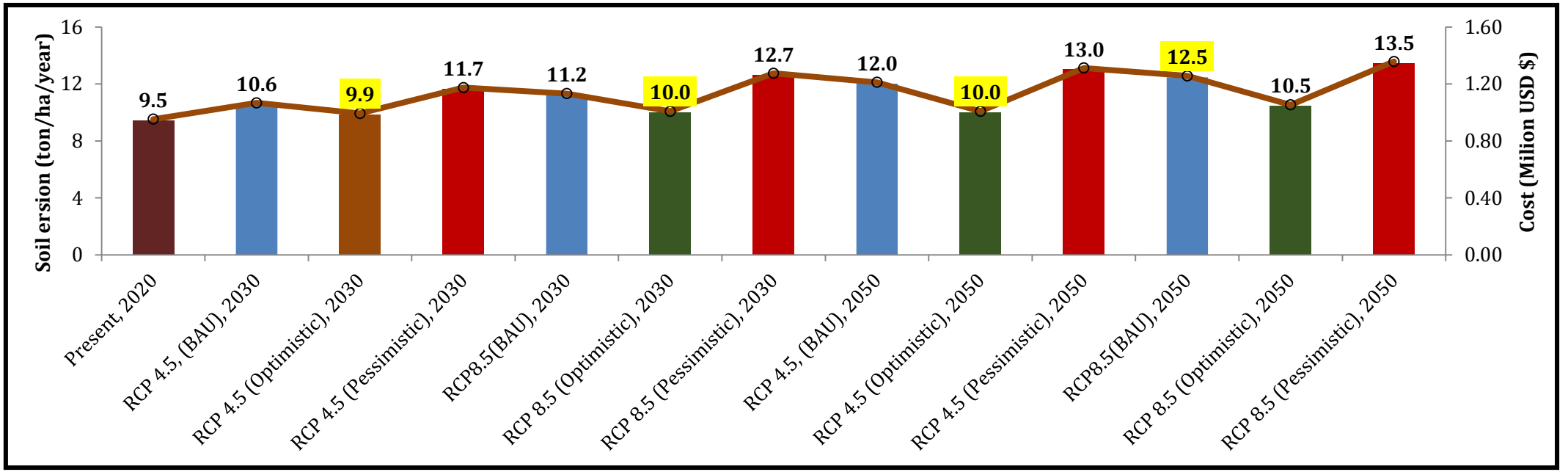
CATEGORY: ✔ Regulating Services ✓ Provisioning Services

Soil Erosion (2020-2050)

Kosi

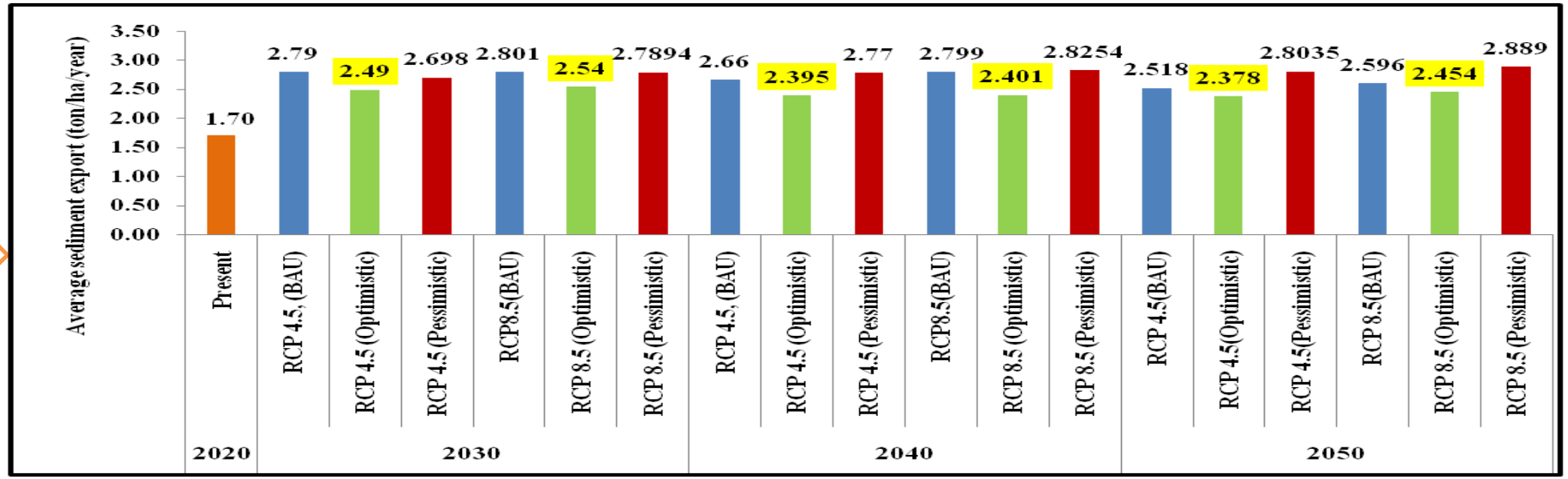


Kailash



Sediment Export (2020-2050)

Kosi



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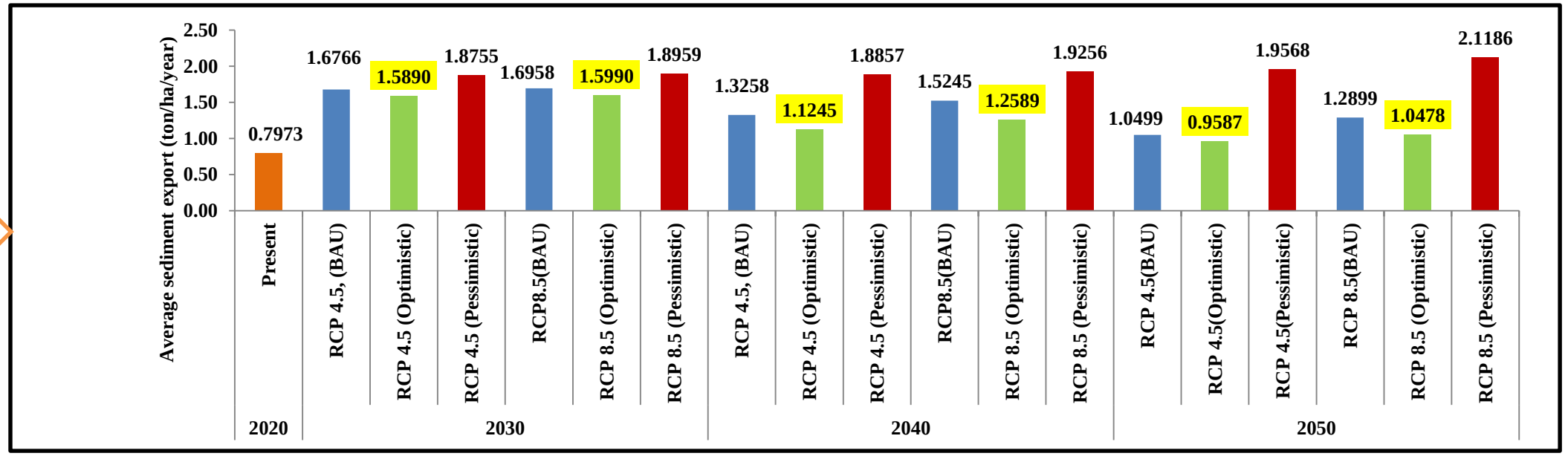
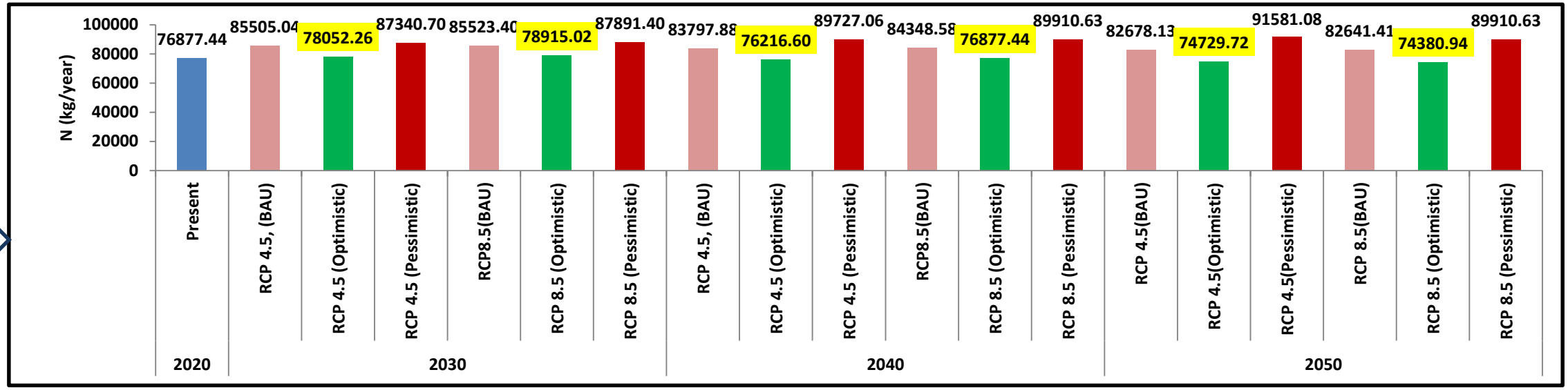
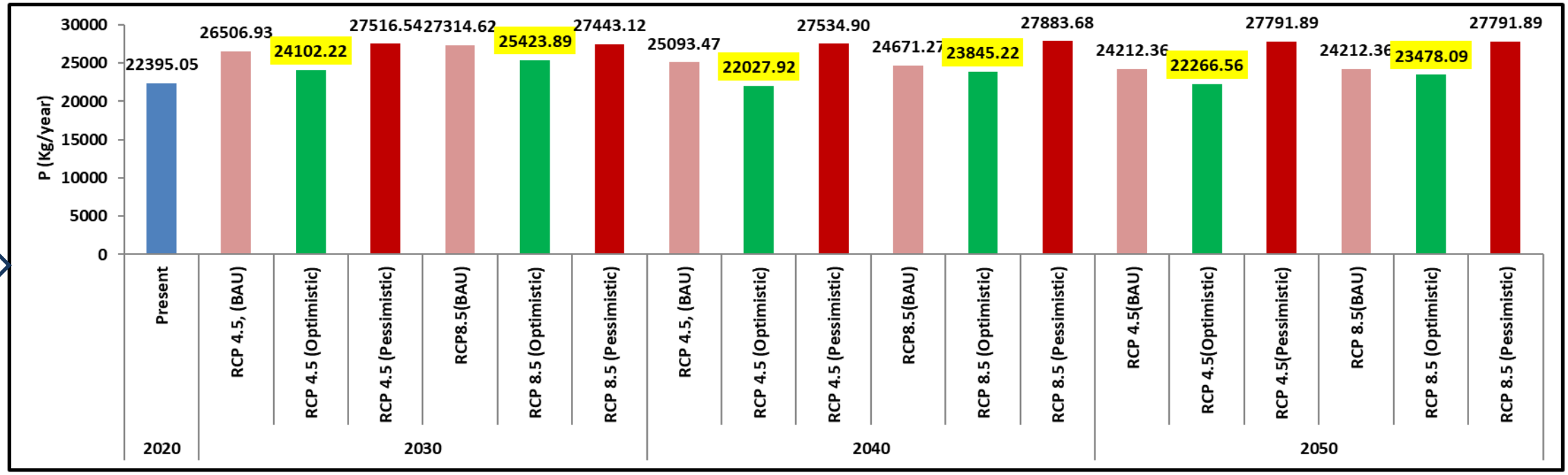


NUTRIENT EXPORT (NITROGEN AND PHOSPHORUS) FOR KOSI WATERSHED

Nitrogen

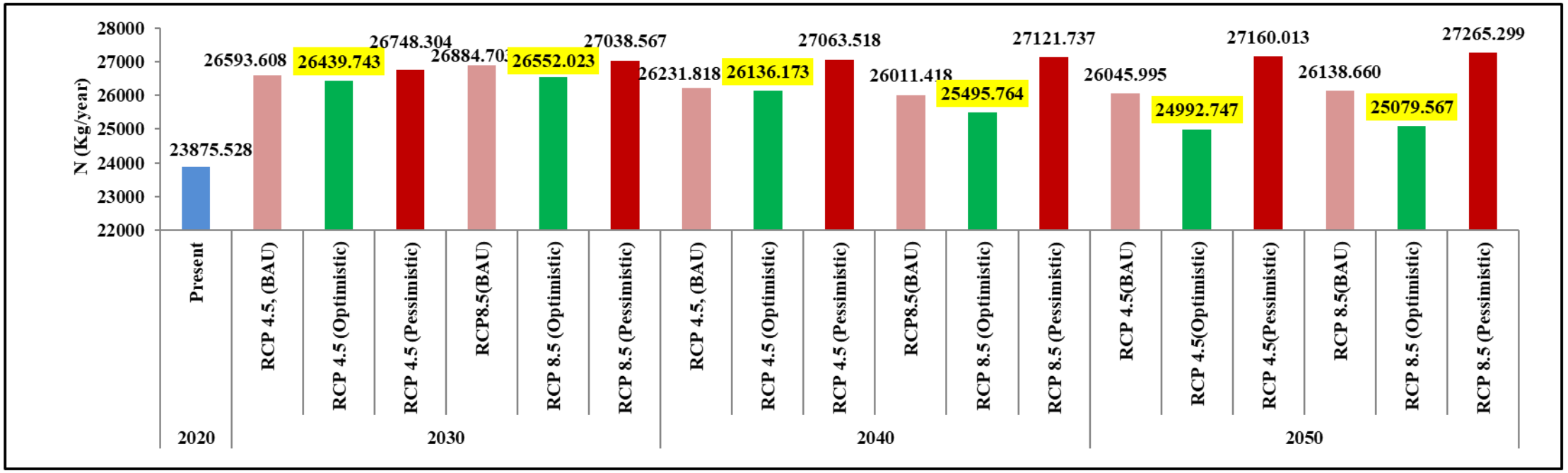


Phosphors

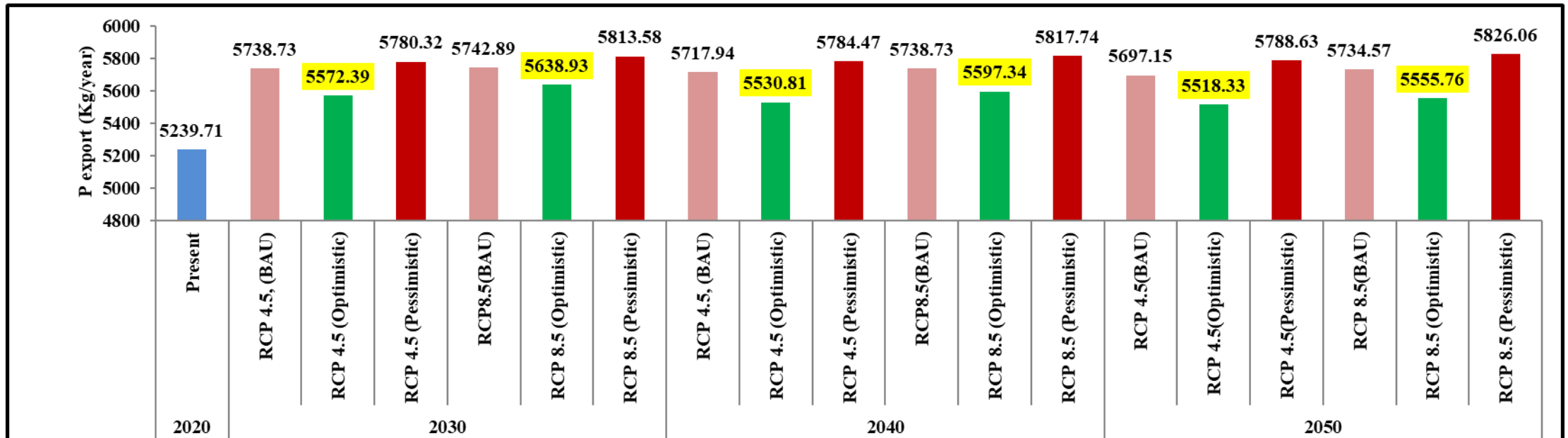


NUTRIENT EXPORT (NITROGEN AND PHOSPHORUS) FOR KAILASH WATERSHED

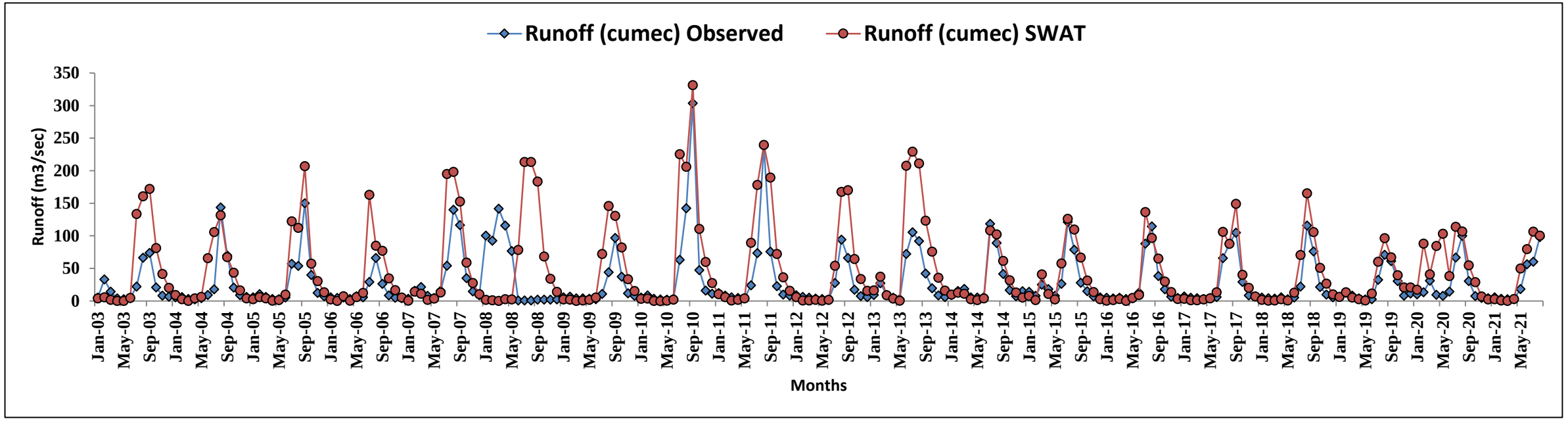
Nitrogen

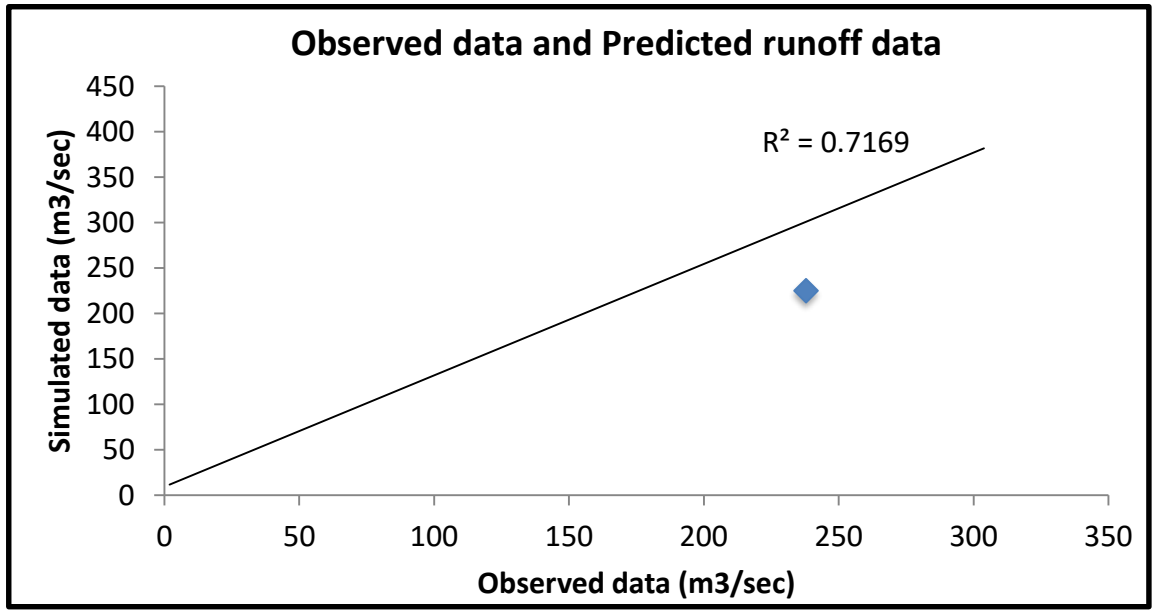


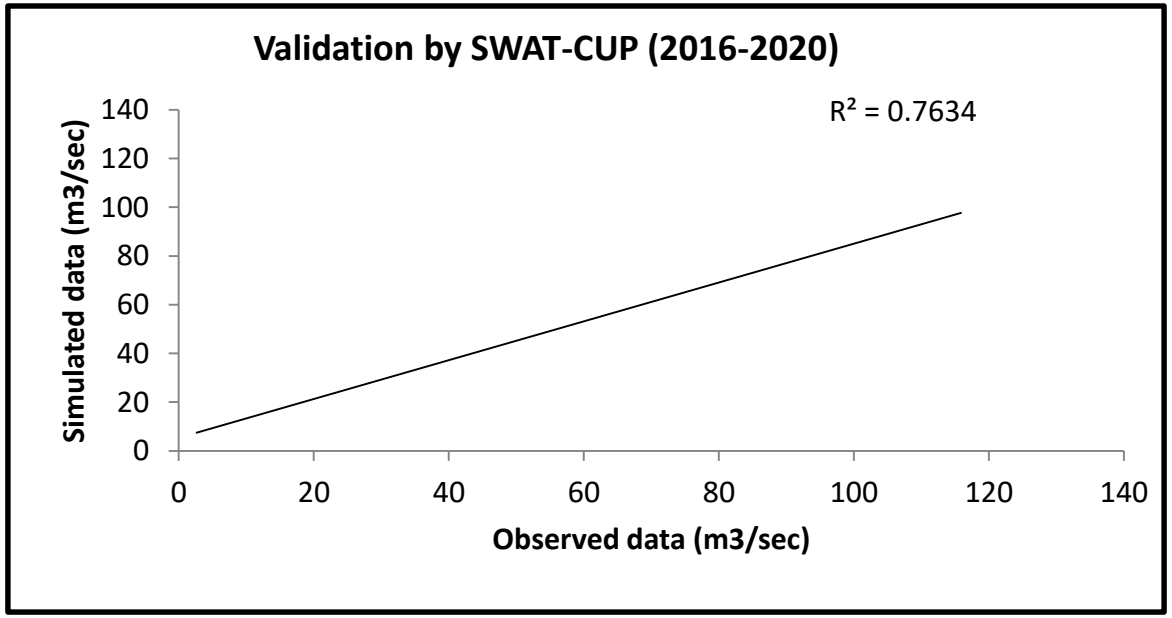
Phosphors



SURFACE RUNOFF (KOSI)

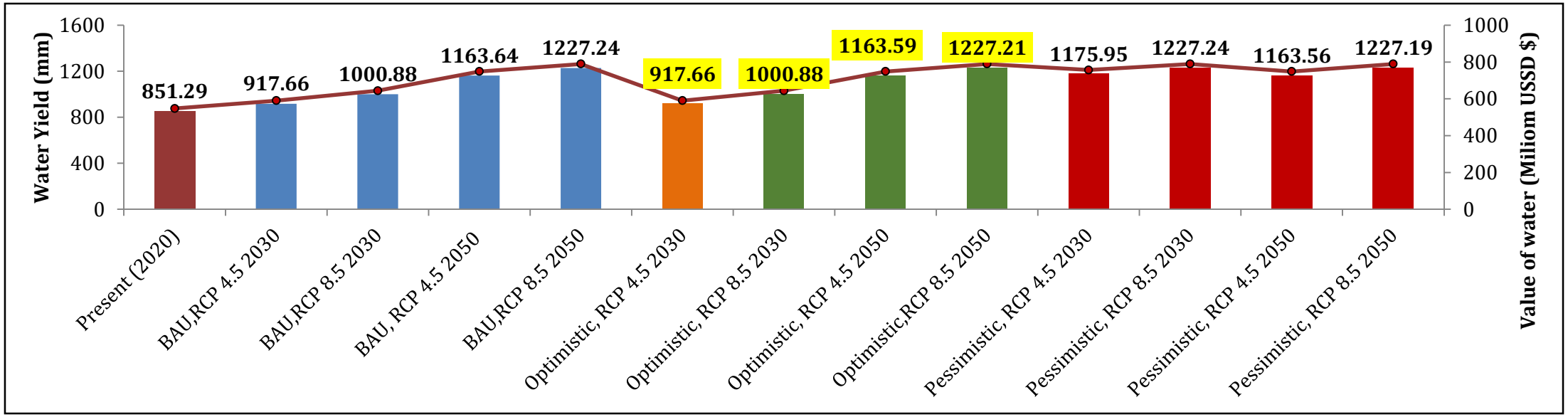




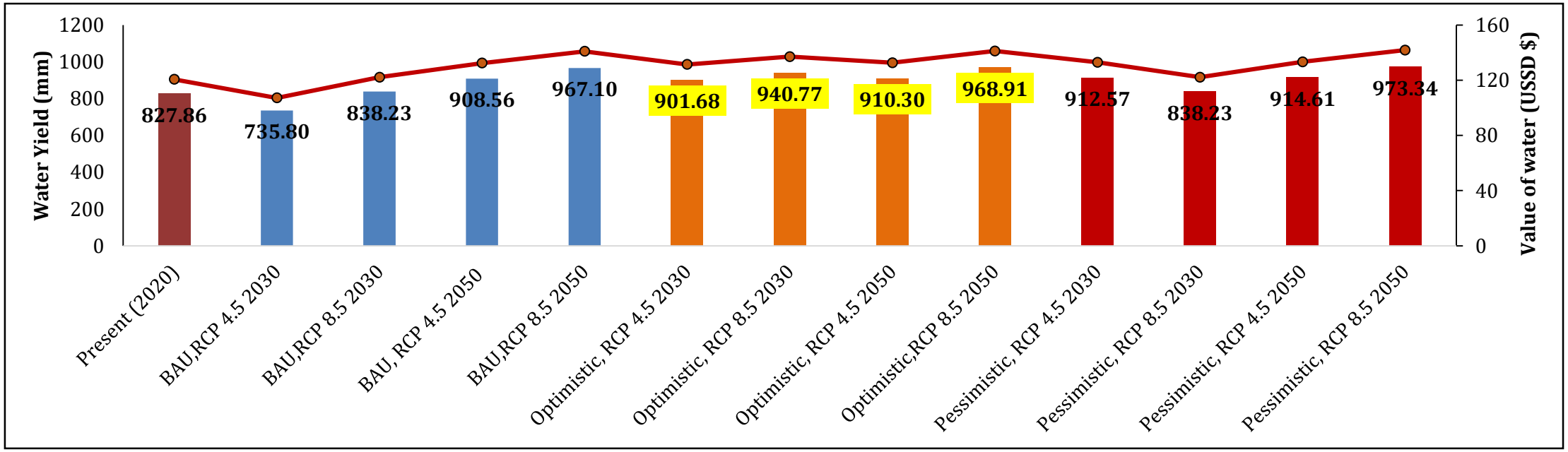


WATER YIELD

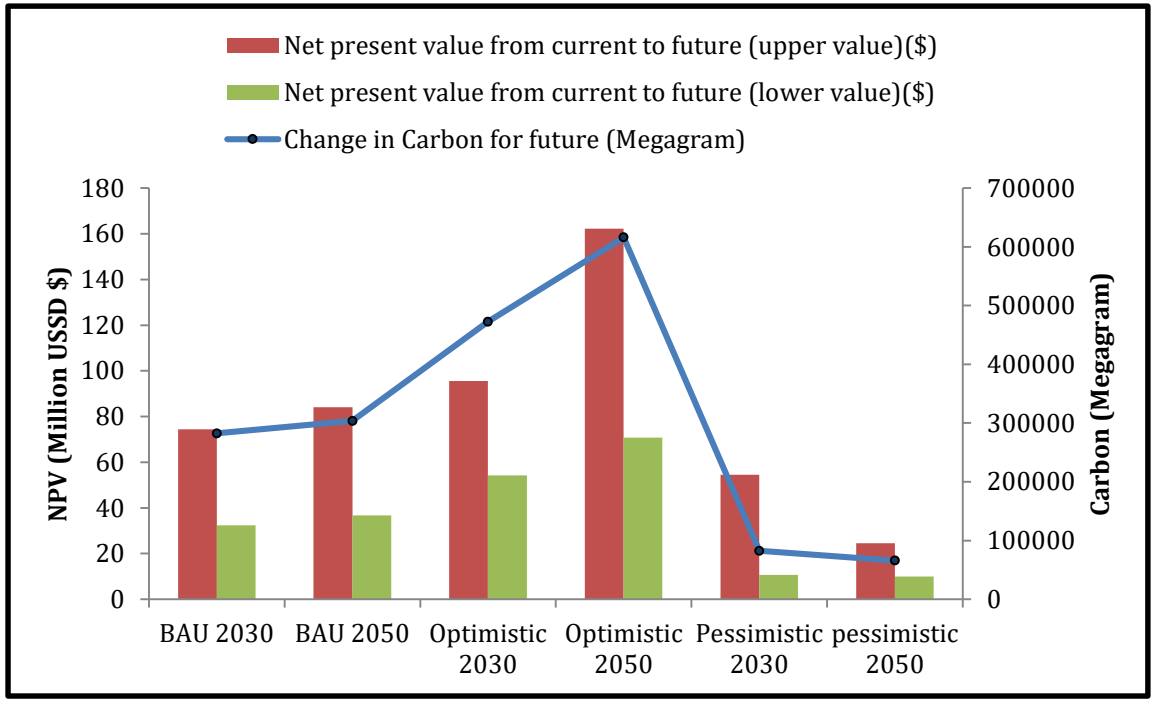
Kosi



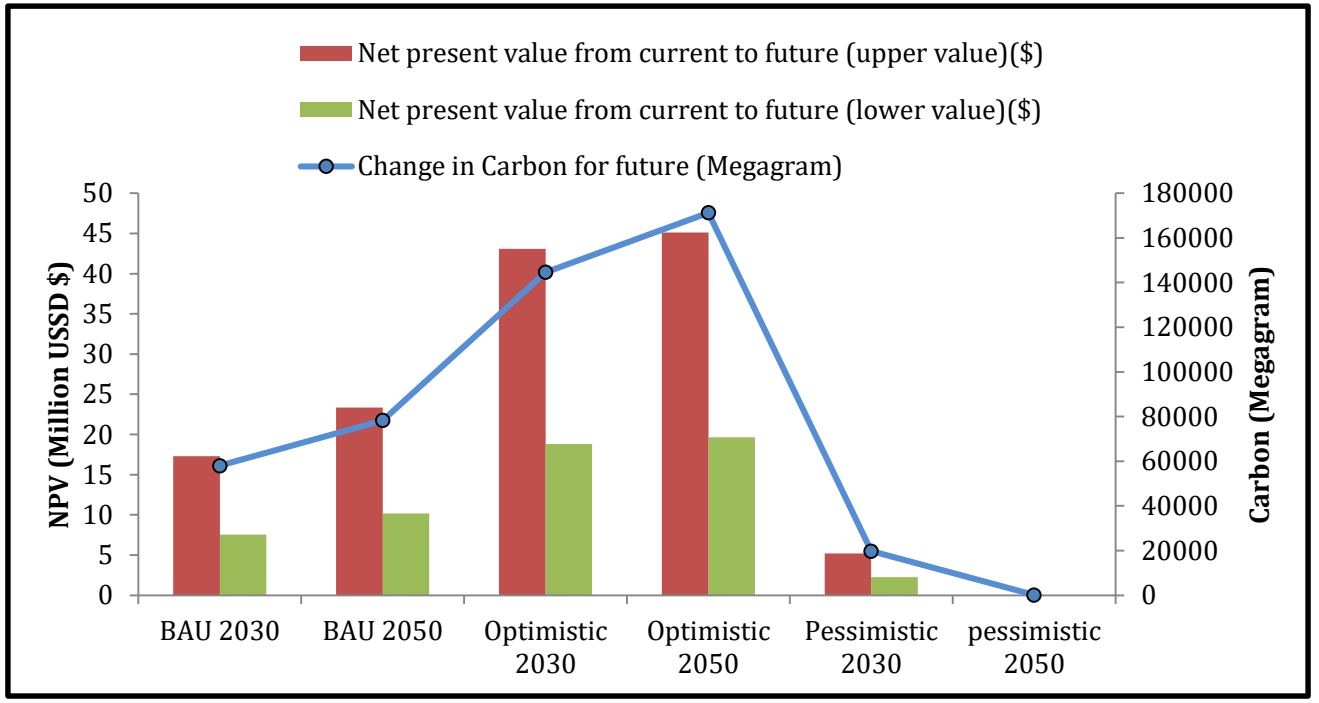
Kailash



CARBON SEQUESTRATION



Kosi

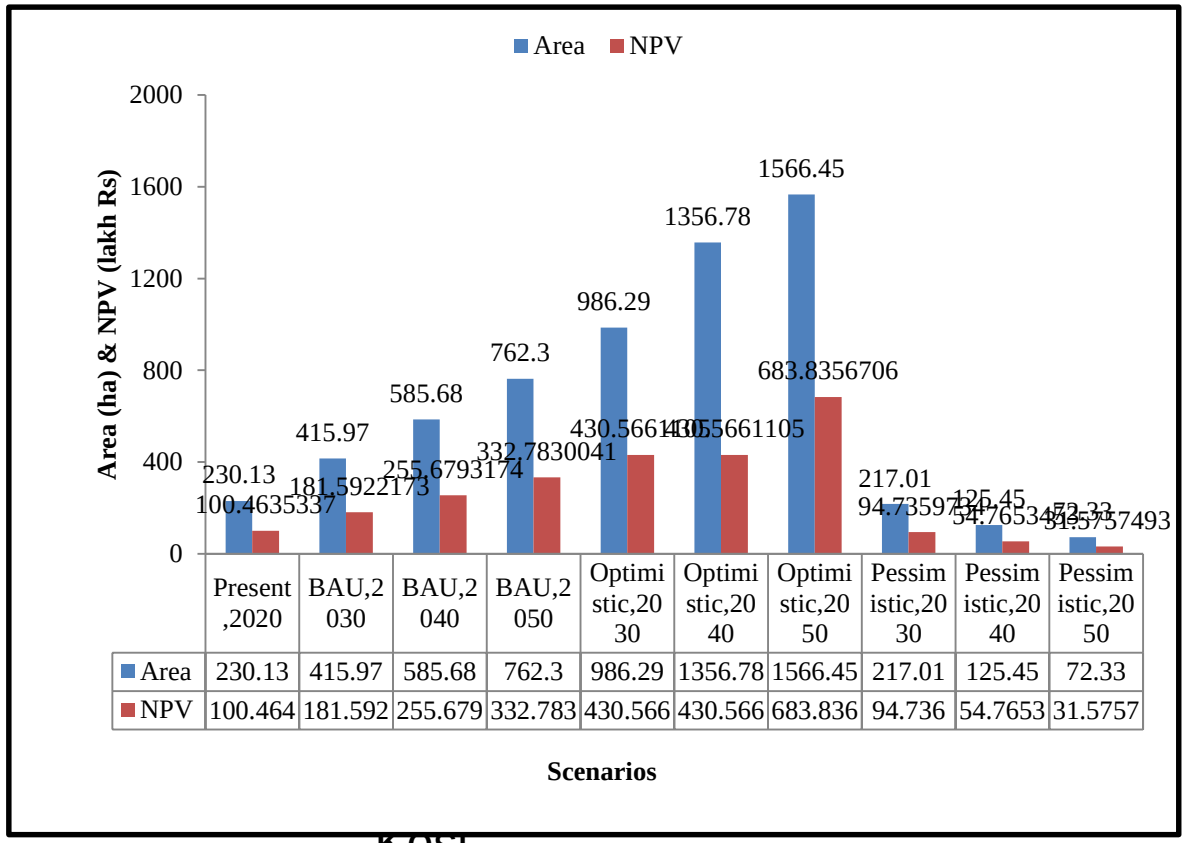


Kailash

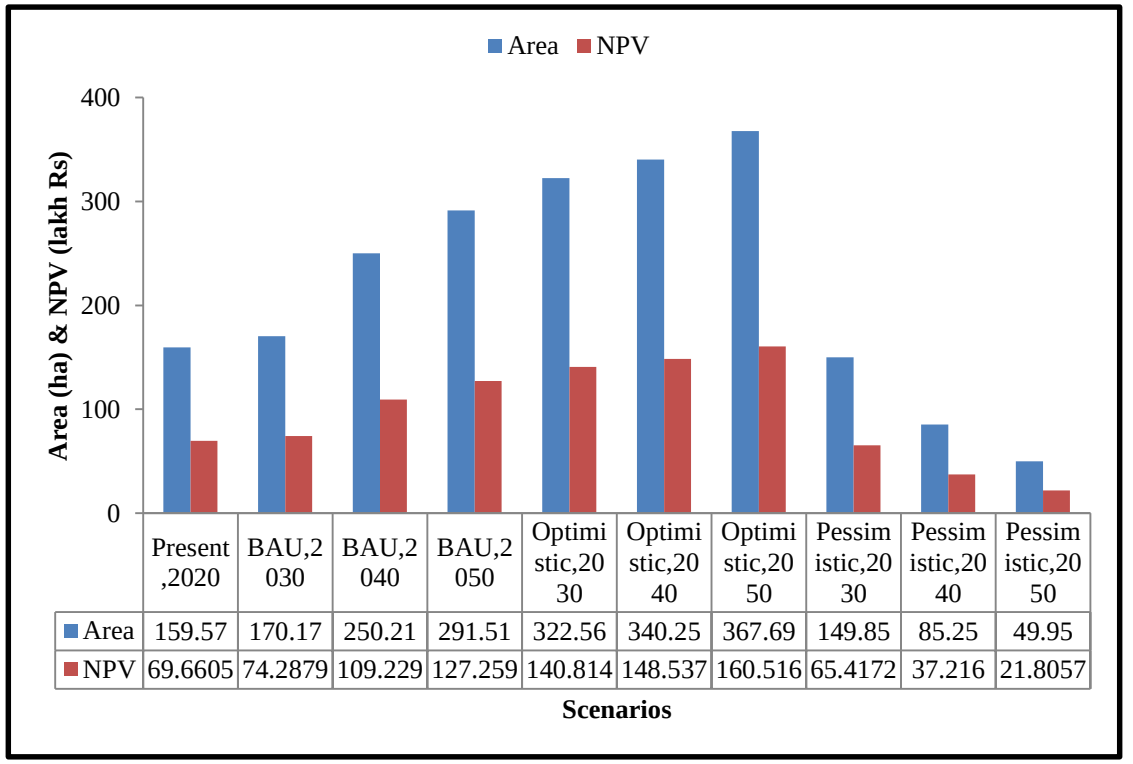
- Intervention of organic farming and agroforestry will sequester more carbon in future optimistic and BAU scenarios.
- In the present (2020) the Kosi watershed has 1% of agro-forestry area of the total agricultural area and in Kailash watershed it 4% of the total agricultural area.

(https://www.rff.org/publications/explainers/social-cost-carbon-101/)

TIMBER PROVISIONING SERVICES



Kosi

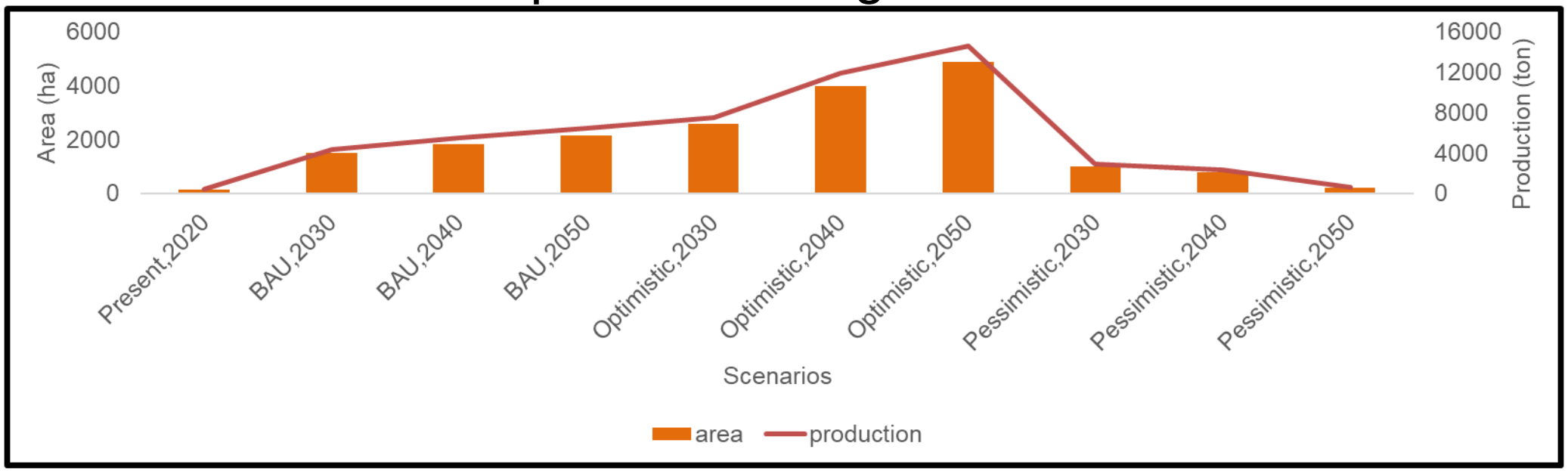


Kailash

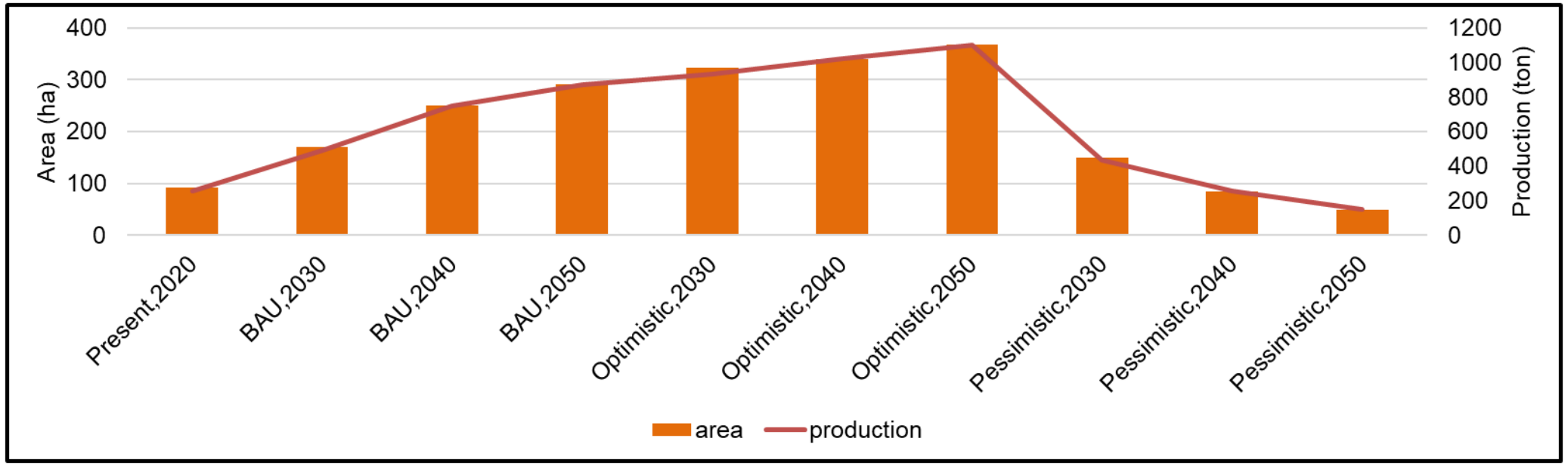
- NPV of timber 32170 (INR/ha/year) (**Verma et al., 2014.**)
- Value adjusted based on 2023 inflation rate.

Crop Provisioning

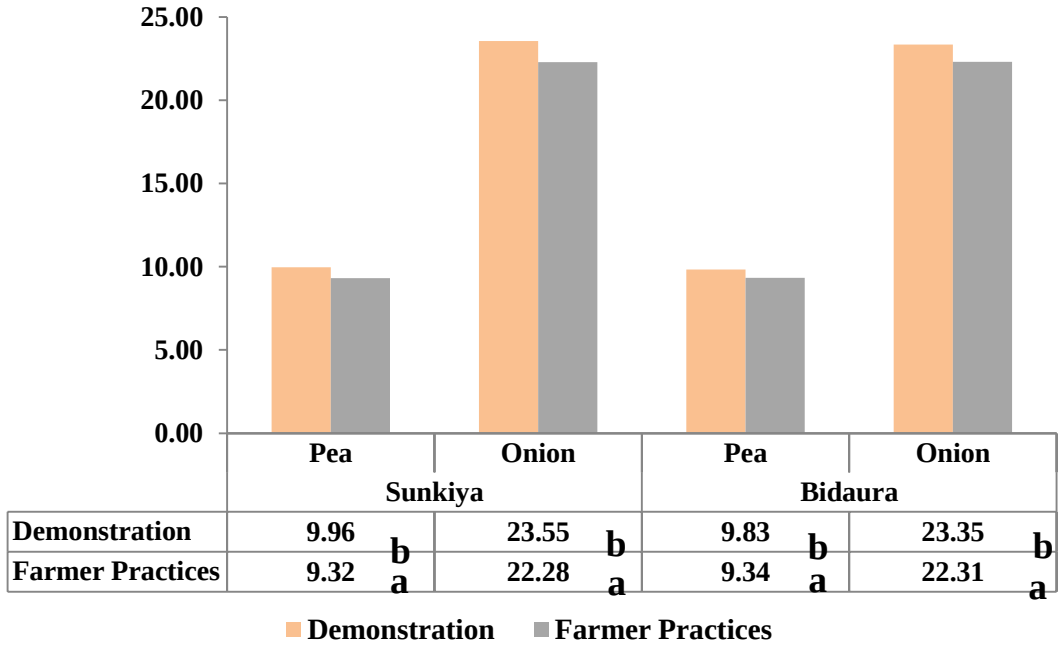
Kosi



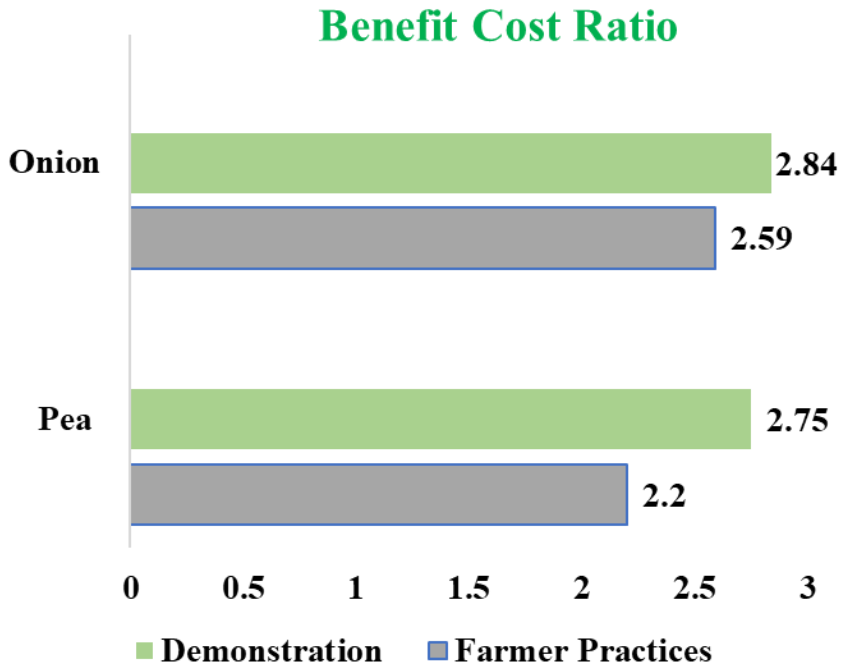
Kailash



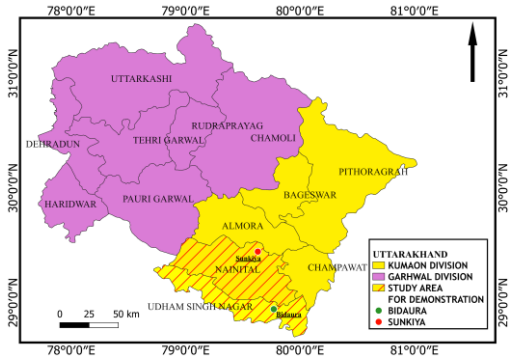
Results of Demonstration Plot Study



	Sunkiya		Bidaura	
	Pea	Onion	Pea	Onion
Demonstration	9.96 b	23.55 b	9.83 b	23.35 b
Farmer Practices	9.32 a	22.28 a	9.34 a	22.31 a



Yield- Pea & Onion two years (2021-23) trial (tons/ha)
(Different alphabets indicate significance in results)



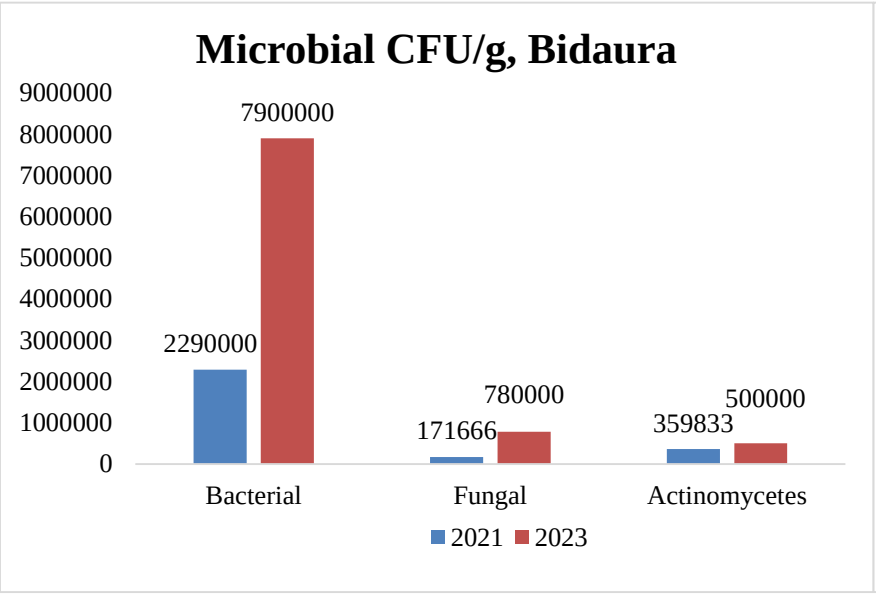
Demonstration Plot

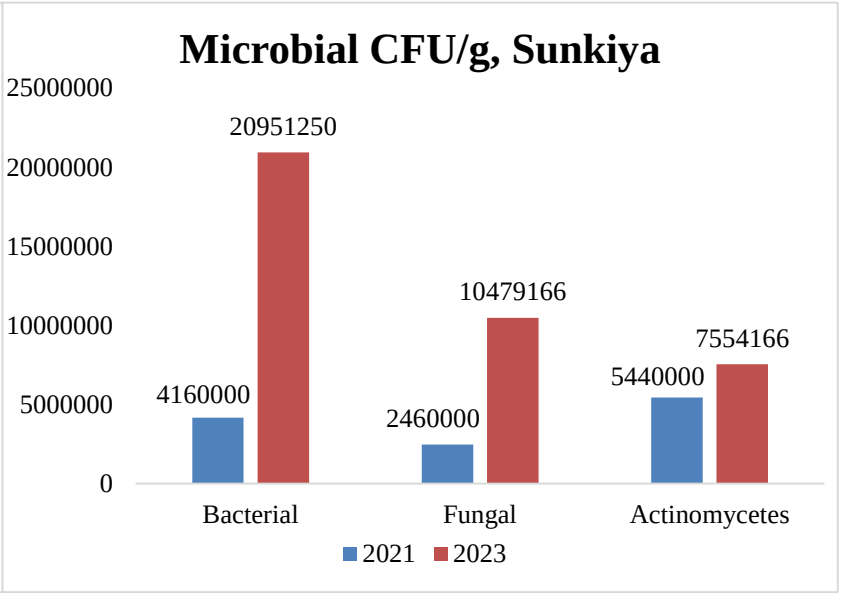
District	Village	Crops	Number of farmers for Demonstration	About the Study area
1. Nainital	Sunkiya	**Year 1**- Pea and Onion **Year 2**- Pea and Onion	14	4 Nos of PGS Groups consisting 133 farmers
2. Udham Singh Nagar	Bidaura	**Year 1**- Pea and Onion **Year 2**- Pea and Onion	10	Conventional farming (Using Chemical fertilizers and pesticides)

Farmers Practices- *Farmers performing conventional farming practices in the field*
Demonstration- *Demonstrated organic inputs (Bio-Agent) and organic farming practices*

Effect on Soil Health Parameters before and after Intervention

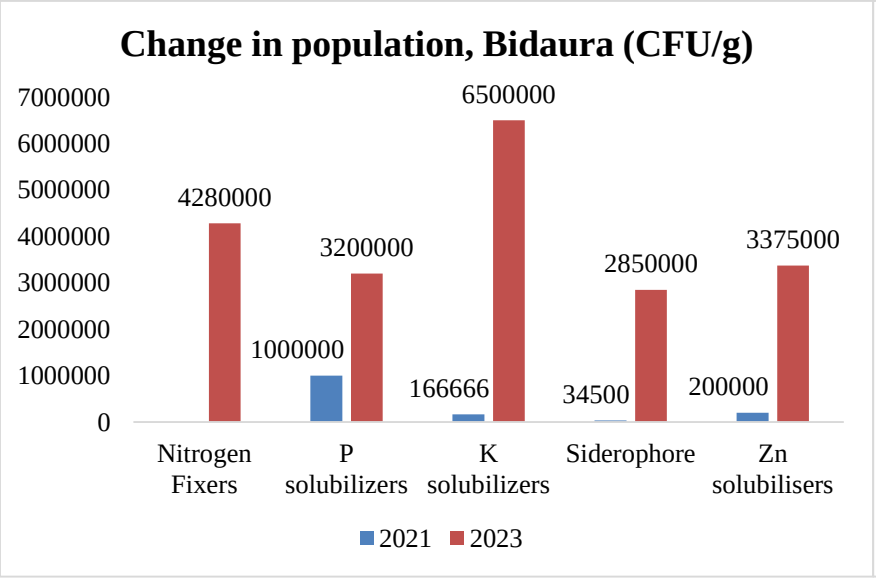
Change in the population of functionally active microbes (*colony forming unit*)

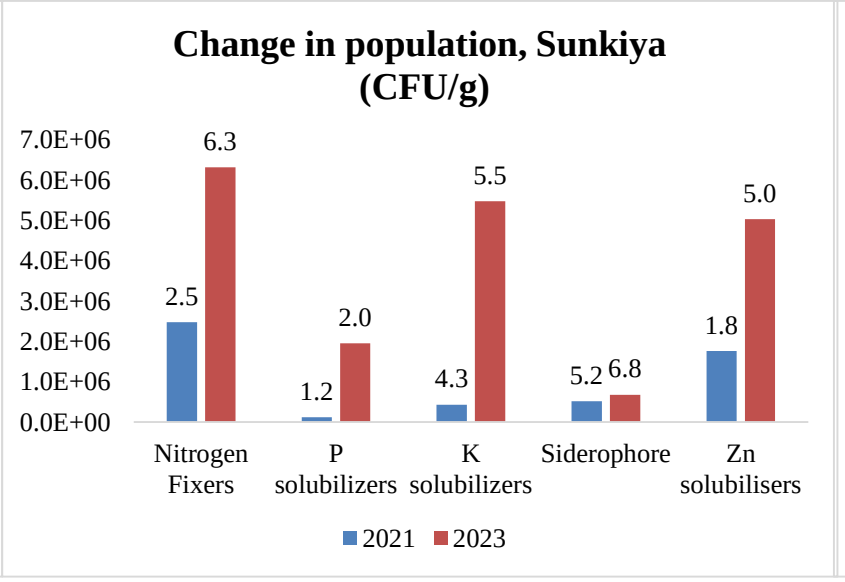


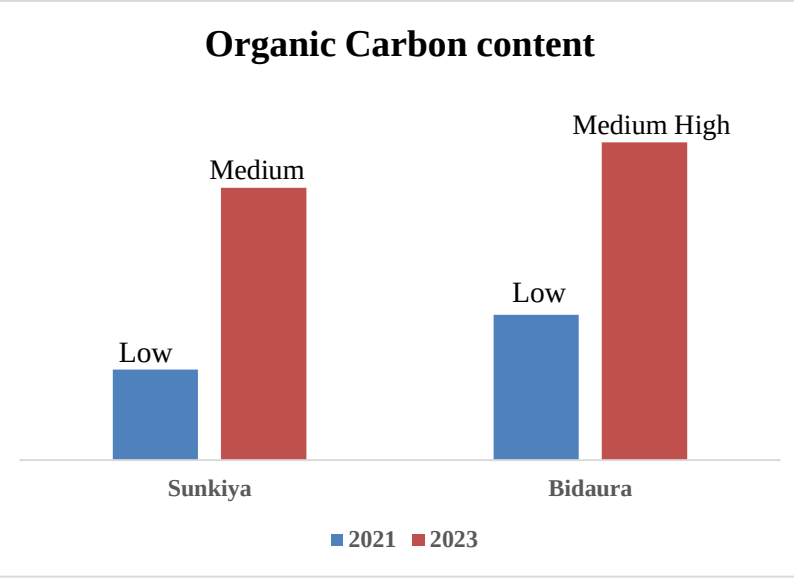


S. No	Bidaura (U.S. Nagar)		Sunkiya (Nainital)	
	2021	2023	2021	2023
Acid Phosphatase (µgNP.g-1.dm.h-1)	394.34	697.2	786.33	864.07
Alkaline Phosphatase (µgNP.g-1.dm.h-1)	455.27	657.69	370.62	774.81
Urease Activity (µgNH4-N.ml-1)	398.31	607.33	534.0	1378.07
Dehydrogenase Activity (µgTPF.g-1.dm.6h-1)	14.6	20.49	13.99	36.39

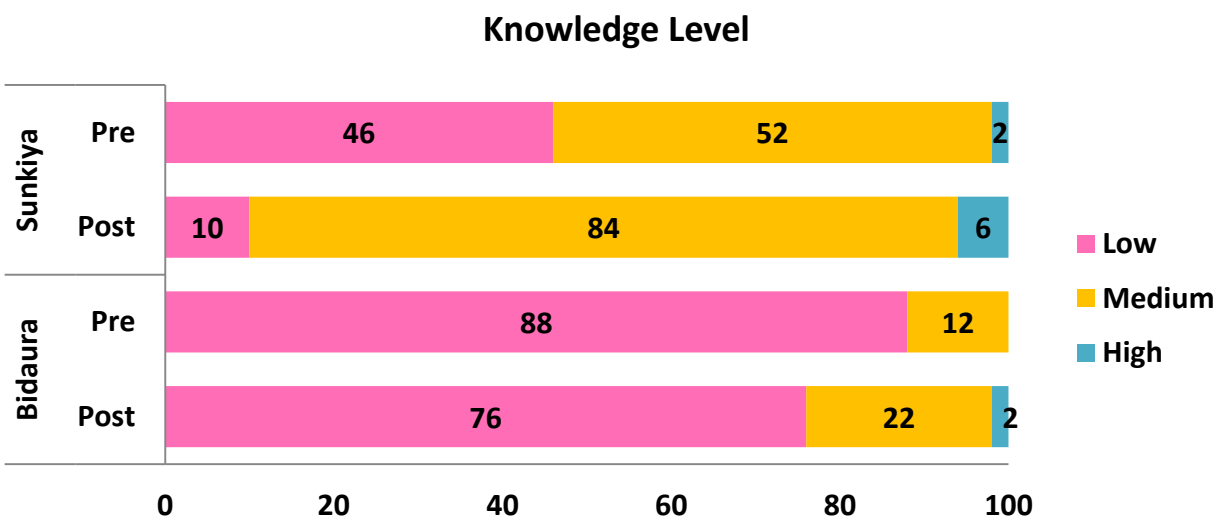
Change in the population of functionally active microbes



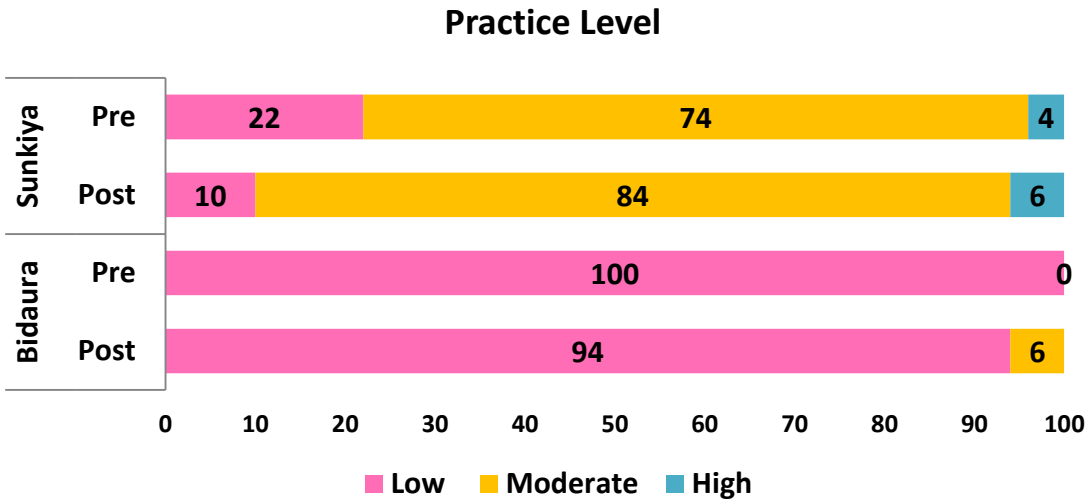




Knowledge and Practice Level Pre and Post intervention



Knowledge Level of the respondents



Practice Level of the respondents

Chi Square Values for knowledge and Organic practice level of the respondents

Chi Square Test		
Knowledge Level	Between Bidaura and Sunkiya	16.2811* *p*-value is .000291.
Organic Practice Level	Between Bidaura and Sunkiya	70.6731* *p*-value is < .00001.

*Significant at 5% level

Social Capital

Women Empowerment in Agriculture Index

Bidaura's baseline WEAI score	**0.667 (Low)**

5DE (5 Domain of Empowerment) score: 0.65 (disempowered women)

GPI (Gender Parity Index) score: 0.83 (Women participation is less than men)

Top three key constraints for women:

1. Workload
2. Group membership
3. Control over use of income

Sunkiya's baseline WEAI score	**0.548 (Low)**

5DE(5 Domain of Empowerment score: 0.52 (disempowered women)

GPI(Gender Parity Index) score: 0.85 (Women participation is less than men)

Top three key constraints for women:

1. Control over use of income
2. Workload
3. Group membership

Key Outcomes for Policy mainstreaming

- SDG 2 and SDG 3 which is zero hunger and good health well being are achieved by organic agriculture even in future climatic scenario
- Present assessment indicates that following optimistic policy scenarios will help to achieve sustainable practices goal SDG 11
- Bio-inputs should be included as integral part of organic farming packages and practices
- Gender Equality (SDG5) can be also achieved by tailoring women centre policy focusing on organic farming and agroforestry
- Up scaling organic farming and agro forestry can be useful for conserving natural resources even under climate change scenario.
- Optimistic scenarios for both organic agriculture and agro forestry can be adopted for policy framing by state as well as central government.

THANK YOU