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Exploring Livelihood Opportunities in the Kali Kumaon Region of Uttarakhand Himalaya

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ABSTRACT

Sustainable livelihood is a fundamental concept for living a comfortable life. Creating livelihood opportunities through the proper use of natural resources and engaging in both farm and non-farm activities are essential strategies. This paper examines livelihood opportunities in the Kali Kumaon region of the Uttarakhand Himalaya. The study is empirically tested and is based on a case study of five villages located in different river basins of the Kali Kumaon region. These villages are situated at varying altitudes, ranging from 1,100 meters to 3,200 meters. A household-level survey was conducted, and a total of 79 household heads were surveyed during the last two weeks of December 2024. Livelihood opportunities in these villages range from integrated agriculture and livestock farming to tourism, services, and business sectors. The findings of the research reveal that although this region possesses abundant natural resources, a diverse climate, spectacular landscapes, and a rich culture, many people remain economically poor, living below the poverty line, and struggling to meet even their daily food requirements. It is suggested that, in addition to practicing biomass-based agriculture, activities such as the cultivation of cash crops, dairy farming with value addition to food, fruits, and dairy products, as well as tourism development, can enhance livelihood opportunities and sustain livelihoods in the region.

Keywords: Agriculture, Livelihood opportunity, Livestock, Kali Kumaon ,Occupation, Tourism development

RÉSUMÉ

La subsistance durable est un concept essentiel pour mener une vie confortable. Mettre en place des opportunités de subsistance à travers une utilisation judicieuse des ressources naturelles, tout en menant simultanément des activités agricoles et non agricoles, constitue une stratégie cruciale. Le présent article se penche sur les perspectives de subsistance dans la région de Kali Kumaon, dans l'Uttarakhand Himalaya. L'étude repose sur une approche empirique et s'appuie sur l'examen de cinq villages situés dans divers bassins fluviaux de la région de Kali Kumaon, à des altitudes comprises entre 1 100 et 3 200 mètres. Une enquête de type *household survey* a été menée auprès de 79 chefs de ménage durant la seconde quinzaine de décembre 2024. Les opportunités de subsistance recensées dans ces villages couvrent un spectre allant de l'agriculture intégrée avec l'élevage jusqu'aux activités touristiques, de services et de commerce. Malgré la richesse des ressources naturelles, la diversité climatique, les panoramas époustouflants et la culture locale florissante, une partie importante de la population demeure économiquement vulnérable, vivant sous le seuil de pauvreté et peinant à satisfaire ses besoins alimentaires de base. Il est donc suggéré qu'en plus des pratiques agricoles reposant sur la biomasse, on considère la production de cultures

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de rente, l'élevage laitier avec valorisation des produits alimentaires, fruitiers et laitiers, sans oublier le développement du tourisme, pour fortifier les débouchés et pérenniser les moyens de subsistance dans la région.

Mots-clés : agriculture, opportunité de subsistance, élevage, Kali Kumaon, occupation, développement touristique

INTRODUCTION

Sustainable livelihood has become a popular concept among researchers and a major issue in rural development (Kumar *et al*., 2023). It is centred on providing equal opportunities for individuals, households, and communities to access and secure essentials such as food, water, shelter, clothing, and income (Khan *et al*., 2023). Additionally, it is closely linked to the availability of all livelihood capitals/assets, including natural, human, financial, physical, and social capitals. A sustainable livelihood is achieved when these capitals are available and utilized optimally (Sati, 2022). A livelihood strategy encompasses all these capitals, as well as factors like vulnerability and government support. In rural areas worldwide, the livelihoods of individuals and households are shaped by their interactions with the environment and productive relationships (Yiridomoh *et al*., 2021). Furthermore, rural livelihood opportunities are heavily reliant on activities such as agriculture, livestock rearing, and the extraction of natural resources like wild fruits, firewood, and fodder (Kumar, 2023). In recent years, challenges such as droughts, flooding, heatwaves, rising temperatures, cyclones, and outbreaks of diseases have posed significant threats to sustainable livelihoods.

Agriculture is the primary livelihood option and the main source of income in rural areas. Approximately 2.6 billion people worldwide rely on agriculture for their livelihoods. By 2030, the global population is expected to increase by 1.5 billion, with 90% of this growth occurring in developing countries. As a result, the world will need to increase food production by 60-70%. Currently, agriculture produces an average of 23.7 million tons of food annually and provides livelihoods for approximately 2.5 billion people. Moreover, agriculture contributes 29% to the Gross Domestic Product (GDP) and accounts for 65% of employment in developing countries (UNEP, 2024). In rural areas, livelihoods are closely linked to farm and on-farm opportunities, as well as livelihood capitals and assets, levels of income and education, and socio-cultural factors such as caste, religion, and ethnicity (Spears, 2016; Thorat, 2010; Ghosh and Ghosal, 2023; Chaudhuri *et al*., 2023). An increase in livelihood opportunities significantly enhances the overall well-being of a region (Sen, 1973).

The Himalayan region is one of the poorest regions in the world, where livelihoods are predominantly based on biomass-based agricultural systems. Agriculture in the region is largely subsistence-oriented and relies on traditional practices. It is carried out on narrow terraced fields, characterized by low production and productivity. Moreover, the Himalayas represent the most fragile landscape in the world (Sati, 2019), offering limited scope for modern agricultural innovations (Sati, 2004). Despite these challenges, the region is rich in natural resources, including land, water, and forests. Its natural and cultural landscapes are spectacular, complemented by rich faunal, floral, and agro-biodiversity. Securing sustainable livelihoods through natural resource management, sustainable agriculture (Sati, 2024), and the development of natural, adventure, and cultural tourism is essential (Sati, 2020).

The Himalayan region encompasses diverse agro-climatic zones, ranging from river basins to high-altitude areas, which are well-suited for cultivating various crop cultivars and races. This diversity extends to the human population, which further broadens livelihood opportunities (Altieri, 1999; Jarvis *et al*., 2007). Both farm-based and non-farm-based livelihoods can help address the growing demands of the population.

Diversification in occupational structures, along with improvements in welfare services and infrastructure, can reduce pressure on natural resources while enhancing livelihood opportunities. In Uttarakhand, approximately 85% of agriculture is rainfed and highly dependent on monsoonal rainfall, which is often unpredictable. Rainfall occurs primarily during the monsoon season, posing uncertainties for agricultural practices (Sati, 2024; Pretty, 2008; Tilman, 2002). Consequently, crop production is relatively low, leading to food insecurity. Additionally, erratic rainfall patterns and significant temperature variability are altering cropping patterns and adversely impacting rural livelihoods (Srivastava and Bhattacharya, 2018).

Agriculture has been in decline over the past few decades (Sati, 2023). Several factors have contributed to this decline, including climate change, crop damage caused by wild animals, higher earnings in the service sector, and a shift in interest among the younger generation. These drivers have significantly impacted livelihood opportunities in the Himalayan region, leading to a rise in exodus and out-migration both within and outside the State (Deshingkar and Akter, 2009; Jain, 2010; Sati, 2021).

The Kali Kumaon region of the Uttarakhand Himalaya is endowed with rich agrobiodiversity, a favourable agro-climate, abundant natural resources—land, water, and forests—and spectacular natural and cultural landscapes ideal for tourism development, including pilgrimage, nature-based, and adventure tourism. The region also holds significant potential for cultivating high-quality and high-yield crops, along with various opportunities to sustain livelihoods. However, these natural resources and livelihood opportunities have not been harnessed optimally. Consequently, a large portion of the population remains poor, living below the poverty line and struggling with malnutrition and food insecurity.

This study examines sustainable livelihood options and opportunities in the Kali Kumaon region. These options include integrated agriculture and livestock farming, the development of tourism and service sectors, and the value addition of agricultural and horticultural crops through the establishment of food and fruit processing centers at the village level. The major questions raised during the field survey were: What are the primary livelihood options? And can the sustainable use of these options enhance livelihoods? This study hypothesizes that the integration of agriculture and livestock, the development of tourism and service sectors, and the value addition of crops will contribute to achieving sustainable livelihoods in the Kali Kumaon region. As no previous studies have addressed this theme, the present study aims to fill this research gap and pave the way for sustainable livelihood development in the region. Additionally, the findings can serve as a foundation for conducting similar research in other mountainous regions of the world.

Study Area

The Kali Kumaon region is situated in the eastern part of the Kumaon Himalaya and forms an integral part of the Uttarakhand Himalaya (Fig. 1). It encompasses the Kali River and its tributaries, including the Saryu, Ramganga (E), Gauri Ganga, and Dhauli Ganga (E). All these rivers are glacier-fed and perennial. The region primarily comprises two districts—Champawat and Pithoragarh. It is also home to three renowned valleys: Johar Valley (upper Gauri Ganga), Darma Valley (upper Dhauli Ganga E.), and Vyas Valley (upper Kali Ganga). These valleys are famous for natural landmarks such as the Milam Glacier, Panchachuli Mountain Peaks, and sacred sites like Adi Kailash and Om Parvat. The Champawat district shares an international border with Nepal, while the Pithoragarh district borders both Tibet and Nepal. As a result, Nepali cultural influences are evident in these areas. The Kali River naturally forms the border between India and Nepal throughout its course in Uttarakhand, except in the northeastern region where India's territory extends beyond the Kali River, including areas like Kalapani and Lipulekh. A significant portion of these districts is covered by snow year-round, while the remaining areas comprise alpine meadows (Bugyal), the Middle Himalaya, and river valleys. Arable land is limited, with terraced farming practiced on small patches. However, some parts are barren and rocky. Despite these challenges, the Kali Kumaon region is rich in natural resources, including abundant water,

fertile land, and dense forests, which contribute to its rich biodiversity. The region's agrobiodiversity is notable, with almost all crop cultivars and races grown here. Additionally, the region holds immense potential for adventure, natural, and cultural tourism. Its landscapes are spectacular, featuring snow-capped mountain peaks, alpine meadows, middle Himalayan forests, and panoramic river valleys. However, tourism development in the region remains underutilized. Economically and educationally, the region faces significant challenges. The area under cultivation, crop production, and agricultural productivity are notably low, further contributing to poverty and underdevelopment.

Figure 2 illustrates two villages situated in distinct locations: Bangapani (1180 m) in the Gori Ganga River valley and Dantu (3200 m) in the Dhauli Ganga (E) basin. These villages differ in climate, landscape, forest types, agricultural systems, and livestock. Bangapani is located along a roadside and features expansive arable land interspersed with rural settlements. The main crops grown here include paddy, wheat, mustard, barley, maize, oilseeds, pulses, and vegetables such as pumpkin, cucumber, and green leafy varieties.

The area is also known for its fruits, including citrus, mango, and guava. Livestock reared in Bangapani primarily consist of cattle (cows and oxen), buffaloes, and goats. Dantu, on the other hand, is the first village in the Dhauli Ganga River basin. It remains snowbound for six months during the winter season. The village receives limited tourists and trekkers, primarily as it serves as the base camp for expeditions to the Panchachuli Mountain Peak. A few homestays and cottages are available to accommodate visitors. During the winter, residents of Dantu migrate to Joljivi town, situated on the banks of the Kali River. They return to Dantu in the summer to engage in agriculture and livestock farming. The primary crops grown here include potatoes, *rajma* (kidney beans), and apples. The livestock in Dantu consists of yaks, cattle, goats, lambs, sheep, and horses.

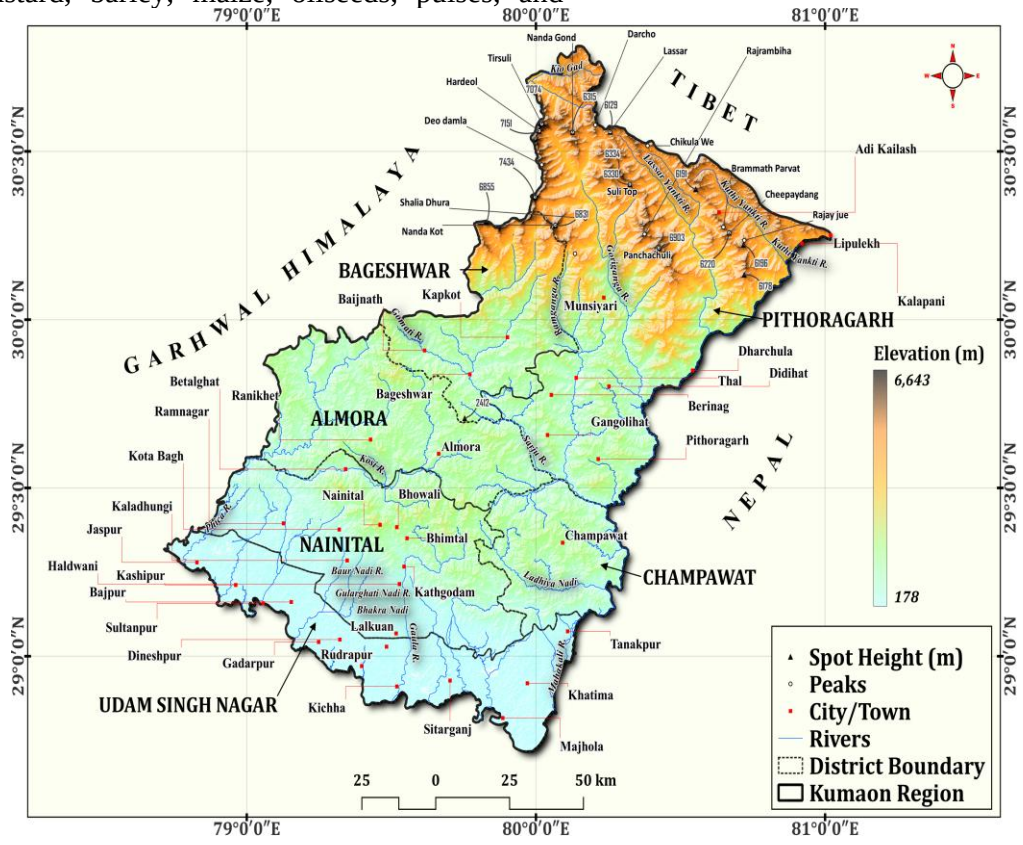

Fig. 1. Location map of the Kumaon Himalaya, showing important rivers, cities, mountain peaks

Fig. 2. Case study villages located in different altitude (a) Bangapani village (1180 m) (b) Dantu village (3220 m)

Data Collection and Survey Methods. In this study, a combination of qualitative and quantitative approaches was employed. An empirical investigation was carried out through case studies of five villages in the Kali Kumaon region, located at varying altitudes and within different river valleys, arranged geographically from west to east. The survey was conducted from 24 to 31 Dec, 2024. Jhopada village is situated at an altitude of 2090 meters in the Saryu River basin, an area known as Danpur. Kweeti village is located at an altitude of 1180 meters in the Ramganga (E) River valley within the Thal region. Bangapani village is found at an altitude of 1150 meters in the Gori Ganga basin within the Johar Valley. Sela village is positioned at an altitude of 2700 meters in the Dhauli Ganga basin in the Darma Valley. Dantu village is located at an altitude of 3220 meters in the Dhauli Ganga basin, also within the Darma Valley.

A total of 79 households from five villages were surveyed, representing 19.6% of the total households in the villages (Table 1). The method of selecting households was purposive sampling. The core theme of the study was to explore options for sustainable livelihoods in the Kali Kumaon region of the Uttarakhand Himalaya. In this regard, the study focused on agricultural and livestock farming, which are the major sources of income and primary livelihood options. Other options included tourism development and value addition in agricultural and horticultural crops through the establishment of small-scale industries. To conduct the household-level survey, a structured questionnaire was designed, with questions framed around variables related to the major options for sustainable livelihoods in the study region. The heads of households were interviewed to answer these questions. The average age of the heads of households was 45 years, and a few of them were illiterate. However, their experience with livelihood sustainability was extensive. In addition, the questions addressed the drivers of declining agriculture and explored ways to promote livelihood sustainability under limited resources. The heads of households' perceptions were assessed in relation to various issues, such as agriculture, horticulture, tourism, and infrastructure.

The collected data were entered into a computer and then analyzed using statistical methods (SPSS) primarily percentiles, descriptive statistics, indices, levels, and correlations. The occupational structure was analyzed, and the average income from each occupation was calculated. These values were then converted into USD based on the exchange rate as of January 1, 2025. Village-specific crop varieties, which serve as the principal crops in each village, were identified. Furthermore, the area, production, and productivity of each crop were calculated by summing the values across all villages. Based

on the production, the value of each crop was then calculated in USD to assess the role of agriculture in livelihood sustainability. A correlation between altitude and occupational structure was established to identify which occupations are most prominent at different altitudes, thereby informing policy formulation.

The perceptions of people regarding farming and the major livelihood options were also assessed. Finally, a policy framework was developed to ensure that economic activities are suitable for sustainable livelihoods in the Kali Kumaon region of the Uttarakhand Himalaya

Table 1. Salient features of the study villages

Village*	Altitude (m)	River valley	Total Households	Surveyed households	% of surveyed households
Jhopada	2090	Saryu (Danpur)	80	20	25
Kweeti	1180	Ramganga (E) (Thal)	100	22	22
Bangapani	1150	Gori Ganga (Johar)	33	12	36.4
Sela**	2700	Dhauli Ganga (Darma)	45	15	33.3
Dantu**	3220	Dhauli Ganga (Darma)	51	10	19.6

*Villages are ordered as per their location along the route; *currently living in the villages; **Seasonal migration

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RESULTS and DISCUSSION

Socio-economic Status and Occupational Structure The five villages are located at different altitudes and in different river valleys (Table 2). Out of the total households, 79 were surveyed, representing 19.6%, with the proportion ranging from a high of 22% to a low of 10%. The literacy rate was 82%, varying from a high of 87% to a low of 24%. However, the level of education is generally low, as there are very few educational institutions, and most are only up to the middle school level. Dantu village, for example, does not even have a primary school, and children must travel to a distant village for primary education. The occupational structure is primarily centred around agriculture and livestock farming, services, and small businesses. The total working population was 85%, with the majority engaged in agriculture and horticulture (55%). Both men and women are working in the agricultural fields, however, the proportion of women is higher than men, and they are known as the backbone of agricultural economy. Men plough fields and sow seeds whereas women work for nourishing crops, harvesting and store them. This is followed by the service sector, including tourism, which employs 19%, and small-scale businesses, which employ 11%. The figures vary depending on the location of the villages.

Agriculture is practiced using traditional methods, with fields ploughed by oxen. However, in recent years, small tractors have been used for ploughing. Those working in the service sector are mainly employed in teaching, driving, and the hotel industry, both within and outside the region. The younger generation, who have completed their education up to the 12th grade, have migrated for work in the hotel industry in metropolitan cities in India, such as Ahmedabad and Chennai. Businesses are conducted at the village level or in small service centers, selling household goods. The output from all working sectors is relatively low, and as a result, a large number of people live below the poverty line (BPL). This economic situation is one of the reasons for the out-migration in search of employment opportunities.

Table 2. Literary rate and occupational structure

Village	Population	Literate	Agriculture & livestock	Service	Business	Total working population
Jhopada	60	48 (80)	31 (51)	12 (20)	04 (7)	47 (78.3)
Kweeti	70	61 (87)	34 (49)	14 (20)	10 (14)	58 (82.9)
Bangapani	40	32 (80)	32 (80)	05 (13)	01 (2.5)	38 (95)
Sela	45	37 (82)	22 (49)	11 (24)	07 (16)	40 (89)
Dantu	32	24 (75)	16 (50)	05 (16)	06 (19)	27 (84.4)
Total	247	202(82)	135 (55)	47 (19)	28 (11)	210 (85)

Note: Figures in parathesis are the percentage

Average Annual Income from Different Occupations. The average per capita annual income of 247 people from five villages was analyzed based on different economic activities (Table 3). The highest income was generated from agriculture, horticulture, and livestock (USD 6506.02), followed by the service and tourism (USD 3180.71), and finally by the business sector (USD 1026.51). One reason for the highest income from agriculture and livestock is that a large proportion of people are engaged in these sectors, although the per capita income is highest in the tourism and service sectors. The output from agriculture and horticulture is low at the per capita level (USD 48.19) due to the use of traditional methods. Some villages like Jhopada, Kweeti, and Bangapani, however, have ideal locations for farming, and the income from this sector is reasonable. It is because these villages are located in the river valley terraces and middle altitude, where arable land is comparatively large and fertile.

The service sector, primarily involving tourism, is emerging as the most prominent livelihood option. The entire region is rich in various types of tourism, such as nature-based, adventure, and cultural tourism, although tourism development remains minimal. The number of people involved in businesses is very small, and as a result, the income from this sector is also low.

Village-wise Principal Crops and Animal Husbandry. Crop and animal diversity vary across the river valleys and the high Himalayas (Table 4). Villages located in the river valleys and middle altitudes exhibit higher crop diversity. These villages grow traditional crops, pulses, oilseeds, fruits (mainly citrus), and vegetables. In contrast, villages in the high Himalayas primarily cultivate Rajma, potatoes, and apples on a large scale. Specifically, Sela and Dantu, located in the high Himalayas, grow two to three crop varieties in the summer. During the winter, these areas remain inactive, and people seasonally migrate to their valley dwellings, mainly in Joljivi near Dharchula. Animal species also vary with altitude. In the lower altitudes, cows, buffaloes, oxen, and goats are reared, whereas in the high Himalayas, goats, sheep, lambs, and horses are more commonly raised. Cows and buffalos provide milk and manure, oxen are used for ploughing agricultural fields, and goat, sheep, and lambs are used for meat and wool, enhancing the farmers income.

Table 3. Average annual income (in USD*)

Village	Agriculture & livestock	Service & Tourism	Business	Total
Jhopada (n=60)	1445.78	867.47	289.16	2602.41
Kweeti (n=70)	1734.94	722.89	433.73	2891.57
Bangapani (n=40)	2024.10	578.31	144.58	2746.99
Sela (n=45)	867.47	433.73	72.29	1373.49
Dantu (n=32)	433.73	578.31	86.75	1098.80
Total (n=247)	6506.02	3180.71	1026.51	10713.26

*1 USD=83 INR as on Jan 1, 2025

Table 4. Village-wise principal crops and animals

Villages	Altitude (m)	Principal corps	Principal animals
Jhopada	2090	Paddy, Wheat, Barley, Millets, Maize, Pulses, Oilseeds, and Citrus	Cows, Buffaloes, Oxen, Goats
Kweeti	1180	Paddy, Wheat, Citrus, Garlic, Ginger, Caret, Green leaves, Pulses, and mustard	Cows, Buffaloes, Oxen, Goats
Bangapani	1150	Paddy, Wheat, Citrus, Garlic, Ginger, Caret, Green leaves, Pulses, and mustard	Cows, Buffaloes, Oxen, Goats
Sela	2700	Rajma (kidney beans), potatoes, and apple	Goats, Seeps, Lambs, and Horses
Dantu	3220	Rajma (kidney beans), potatoes, and apple	Goats, Seeps, Lambs, Yaks, and Horses

Levels of Area, Production, and Productivity of Principal Crops. The area, production, and productivity of 12 principal crops grown in the five villages were examined (Table 5). The area under paddy and wheat was the largest, followed by mustard and potato, with each of these crops occupying more than 10 hectares of arable land. Pear, apple, maize, Rajma, and barley had substantial areas, ranging from 5 to 10 hectares. The remaining crops occupied less than 5 hectares of arable land. In terms of production, paddy and wheat had the highest yields (>6000 kg), followed by potato, apple, mustard, and Rajma (3000-6000 kg). Other crops produced less than 3000 kg. Regarding productivity, apple and paddy exhibited the highest productivity (>600 kg/ha). Tomato, potato, wheat, citrus, pear, Rajma, onion, and mustard had productivity levels ranging from 300 to 600 kg/ha. Barley and maize had productivity levels below 300 kg/ha.

Descriptive statistics were used to calculate the mean, maximum, and minimum values for area, production, and productivity (Table 6). The total arable land for the 79 households was 93 hectares, and the total production was 43,500 kg. The mean area of arable land was 7.8 hectares, with a maximum of 14 hectares and a minimum of 2.8 hectares. In terms of production (kg), the mean was 3,625 kg, with a maximum of 9,800 kg and a minimum of 1,000 kg. Additionally, the mean productivity was 464 kg/ha, with a maximum of 751 kg/ha and a minimum of 279 kg/ha.

Table 5. Levels of area, production, and productivity of principal crops (n=79 HHs)

Area (ha)		
Indices	Levels	Principal crops
<5	Low	Citrus, tomato, and onion
5-10	Medium	Pear, apple, maize, Rajma, and barley
>10	High	Potato, mustard, wheat, and paddy
Production (kg)		
<3000	Low	Onion, citrus, pear, maize, tomato, and barley
3000-6000	Medium	Rajma, mustard, apple, and potato
>6000	High	Wheat and paddy
Productivity (kg/ha)		
<300	Low	Barley and maize
300-600	Medium	Mustard, onion, Rajma, pear, citrus, wheat, tomato, and potato
>600	High	Paddy and apple

Table 6. Descriptive statistics of the area, production, and productivity

Metric	Area (ha)	Production (kg)	Productivity (kg/ha)
Mean	7.8	3625	464
Minimum	2.8	1000	279
Maximum	14	9800	751
Sum	93.8	43500	-
Standard Deviation	3.6	2463	153

Production and Productivity of Principal Crops. The production (output from the cropland) and productivity (per ha production) of crops were analyzed (Fig. 3), and based on the findings, a suitable livelihood opportunity was proposed. The highest production was observed in paddy, followed by wheat, potato, apple, and mustard. One reason for the high production of these crops is the large area devoted to them. In terms of productivity, apple had the highest yield, followed by paddy, tomato, citrus, potato, and wheat. Other crops exhibited lower production and productivity.

Crop Production and Economic Valuation Figure 4 depicts the production of crops (kg) and their economic value (USD). It shows that paddy had the highest production, followed by wheat, potato, apple, mustard, and Rajma. In terms of economic value, apple had the highest value, followed by paddy, wheat, Rajma, and mustard. The other crops had lower production and economic value. The results indicate that apple has high potential. Although the area and production of apple were comparatively smaller, its economic value was high. Rajma showed a similar trend, with a high economic value. Paddy and wheat, being staple foods, had the largest areas and production. Paddy is grown both as rainfed and irrigated. However, agricultural land has been shrinking, and the output from traditionally grown crops has been decreasing.

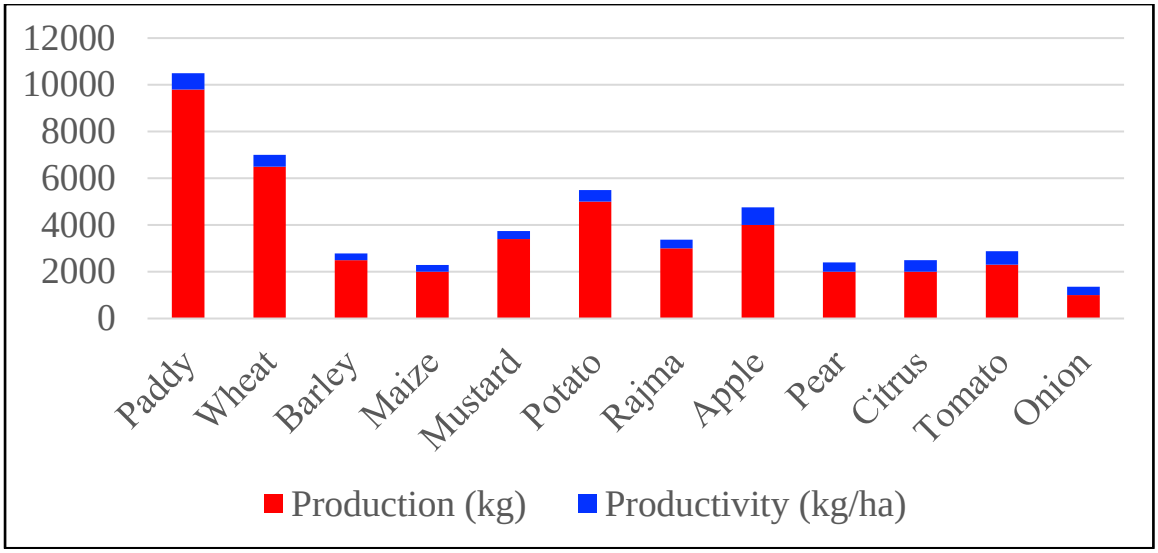

Fig. 3. Production and productivity of principal crops

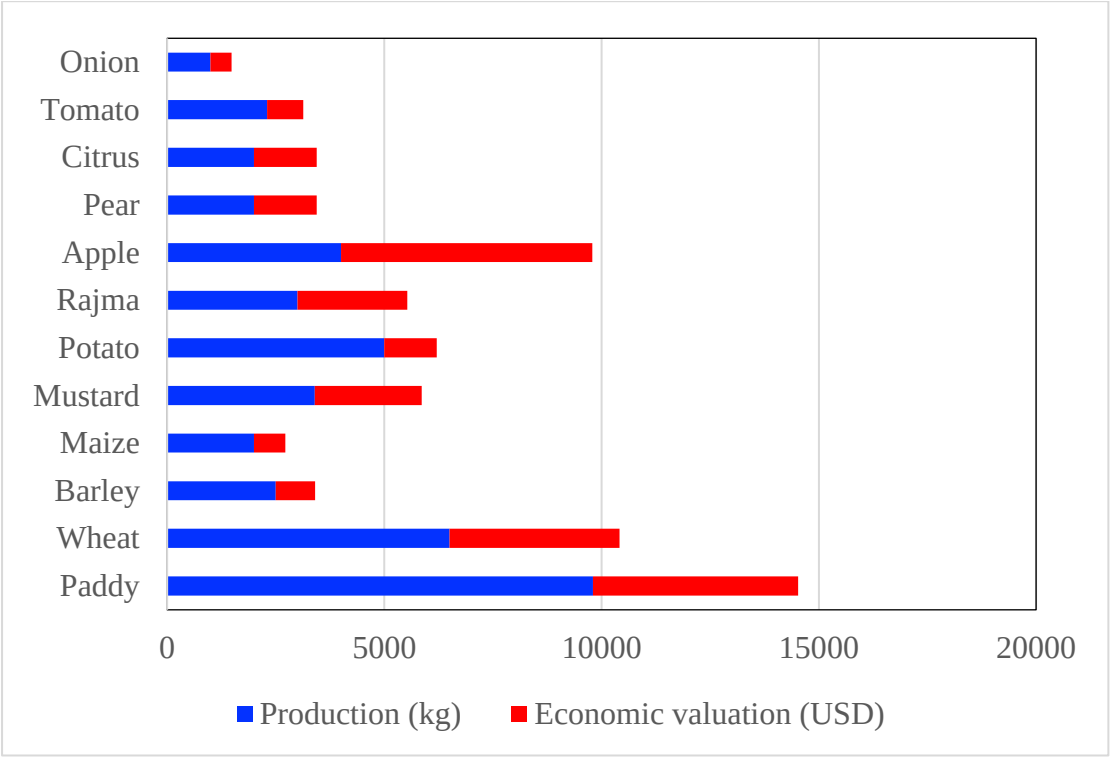

Fig. 4. Crop production and economic valuation

Correlation between Altitude and Occupations. Correlations between altitude and occupational structure were established (Table 7). It was observed that agricultural activities, including livestock farming, are moderate in the higher altitudes due to the snowcapped conditions during the six months of winter. In contrast, agriculture, including horticulture, is more prominent in the lower altitudes. Services, including the tourism sector, are less prevalent in the valley regions but are more common in the high Himalayan villages. Business activities are more concentrated in the lower altitudes and less so in the higher altitudes. Therefore, it can be concluded that the occupational structure changes in response to variations in altitude.

Table 7. Correlation between altitude and occupations

Variables	Altitude	Agriculture	Service	Business	Correlations
Altitude (m)	1.000	-0.979	-0.353	-0.649	Higher altitudes have moderate agricultural activity; services dominate slightly over business.
Agriculture & livestock	-0.979	1.000	0.392	0.573	Agriculture peaks at lower altitudes; business activity is higher compared to services.
Service & tourism	-0.353	0.392	1.000	0.754	Agriculture is the dominant activity; service and business are minimal at lower altitudes.
Business	-0.649	0.573	0.754	1.000	Agriculture and service decrease as altitude increases; business is minimal. At high altitudes, agriculture declines further; services dominate over business.

Note: Values close to 1 or -1 indicate strong positive or negative correlations, respectively. Values near 0 indicate weak or no correlation.

People's Perceptions on Livelihood Opportunities. In recent years, two key activities—agriculture and the interaction between highland and lowland areas—have decreased sharply. Agriculture remains the primary livelihood activity, with many people still engaged in its cultivation. However, the production and productivity of crops have declined, which is insufficient to feed the growing population. Several factors contribute to the decline in agriculture, including wild animals, climate change, and low crop yields. Wild animal populations are increasing, leading to conflicts within the forests, and some animals venture into settlement areas, destroying crops. Erratic rainfall and changing temperatures are also contributing to the decline in agricultural production. Additionally, there has been a significant out-migration of people to the river valleys and plains, leading to the abandonment of agricultural land, which in turn increases the risk of crop damage from wild animals. The heads of 79 households were interviewed to gather their perceptions on the decline of agriculture in the Kali Kumaon region (Table 8).

A total of seven prominent questions were asked to the heads of households. The majority of respondents indicated that agriculture is declining. They also noted that climate change has impacted agricultural production, leading to a decrease in crop yields, and that wild animals are contributing to the decline in agriculture. Additionally, they perceived that the cultivation of fruits and tourism development could enhance rural livelihoods.

Integration of Agriculture and Livestock Farming. Agriculture and livestock farming are the primary occupations and major sources of income and livelihood in the Kali Kumaon region. However, the area, production, and productivity of crops are significantly low. One reason for this is the limited arable land, leading to low production. Additionally, the production of crops has decreased due to the destruction caused by wild animals, such as monkeys, langurs, wild boars, and wild pigs. Traditional farming methods also result in lower productivity, and with the growing population, the output is insufficient to meet the demand. It is suggested that the area of arable land be increased to boost production. The areas, which are cultivable wasteland and the forest fringes, which are fertile, can be used more sustainably for agriculture. Off season vegetables – tomato, onion, cauliflowers, beans, potato, and peach can be grown in the valley regions, fruits – orange and lemon; pulses and oilseeds can be grown according to altitude and changing climate; jersey cows, goats, lamb, and sheep in the highlands (alpine pastureland) can be grown for sustainable livelihoods. Effective wildlife management could also help sustain farming activities. A plan for crop suitability, identifying which

crops are best suited to specific areas under changing climate conditions, should be developed. Livestock farming may play a significant role in livelihood sustainability, as the region's rich agro-climate and abundant fodder trees and grasslands support sustainable livestock farming. Milk production is relatively good. Figure 5 depicts three key options for sustainable livelihoods in the Kali Kumaon region, based on the current climate, availability of natural resources, agriculture, and livestock farming. Additionally, processing food and fruit products through value addition presents another opportunity to enhance livelihoods.

Development of Tourism and Service Sectors. Tourism is a potential sector for sustaining livelihoods in the Kali Kumaon region, which is rich in natural, adventure, and cultural attractions. Three highland valleys—Johar Valley (Munsiyari), Darma Valley (Panchachuli), and Vyas Valley (Adi Kailash and Om Parvat)—are prominent tourism destinations. However, these areas are not well-connected by transportation, which limits their proper development and potential. Moreover, the entire region is highly fragile and vulnerable to natural hazards. Establishing educational and developmental institutions in these valleys could foster the growth of tourism and service sectors.

Table 8. People's perceptions on agriculture and livelihood options (n=79)

Reasons of decreasing agriculture	People's perception (%)		
	Yes	No	Don't know
Is agriculture declined?	65.82	21.52	12.66
Do you know about climate change?	60.76	12.66	26.58
Is climate change the reason for decreasing agriculture?	60.76	12.66	26.58
Is production of crops is decreasing?	65.82	15.19	18.99
Are wild animals causing for decreasing agriculture?	75.95	12.66	11.39
Do you suggest that fruit cultivation will be suitable for sustainable livelihood?	78.48	10.13	11.39
Do you think that tourism development can assist livelihood enhancement?	70.89	20.25	8.86

Sustainable Livelihood Opportunities

Value Addition in Agricultural and Horticultural Products. The region has the potential to grow high-quality and high-quantity crops. However, it has been observed that many crops, particularly fruits and vegetables, are spoiled in the fields before and after harvesting due to the lack of cold storage and market facilities. Additionally, the remoteness of the villages exacerbates these challenges, leading marginal farmers to avoid growing perishable fruits and vegetables. Adding value to agricultural and horticultural crops by processing them into products such as juices, jams, pickles, and chips would enhance the livelihoods of the people and help maximize the potential of their crops.

Village-wise Livelihood Opportunities. Based on the findings of our research, village-wise livelihood opportunities were identified (Table 9). In the lower altitudes, the cultivation of mixed crops—such as traditional crops, cash crops, and livestock farming—would be most suitable. Similarly, in the higher altitudes, the cultivation of specific crops like potato, Rajma, and apple, along with the development of tourism, particularly in natural, adventure, and cultural sectors, can enhance livelihood opportunities

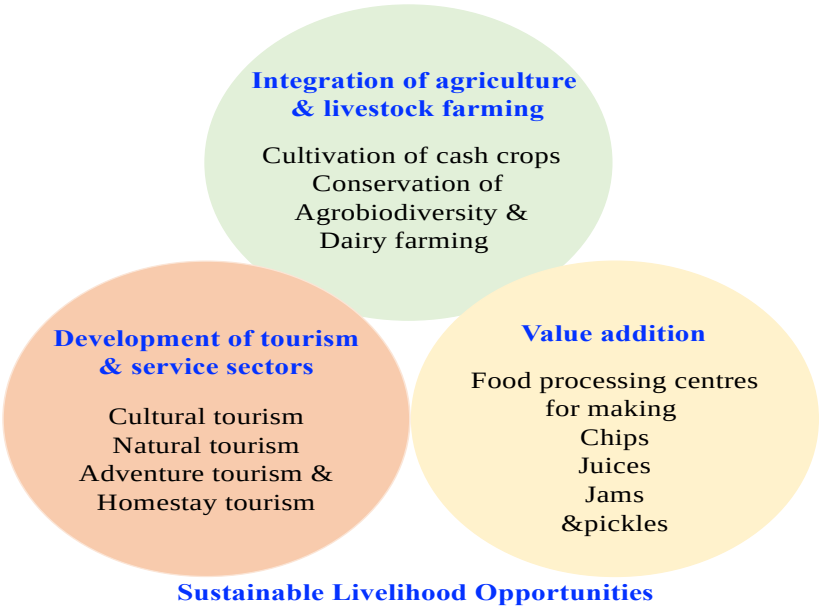

Fig. 5. A sustainable livelihood opportunity model for the Kali Kumaon region

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Table 9. Village-wise livelihood opportunities

River valleys	Altitudes (m)	Suitable livelihood options
Saryu (Danpur)	<1600	Paddy, wheat, citrus, pulses, oilseeds, vegetables, and livestock farming
Ramganga east (Thal)	<1600	Paddy, wheat, citrus, pulses, oilseeds, vegetables, and livestock farming
Gori Ganga (Johar Valley)	>2500	Adventure tourism, potato, Rajma, and livestock farming
Dhauli Ganga (Darma valley)	>2500	Adventure tourism, potato, Rajma, and livestock farming
Kali River (Vyas Valley)	>2500	Cultural tourism, potato, Rajma, and livestock farming

Livelihood opportunities in the Uttarakhand Himalaya, and specifically in the Kali Kumaon region, are vast, thanks to its abundant water, land, forests, rich culture, and attractive tourism destinations. Several glacier-fed rivers originate and flow through this region, with prominent rivers including the Saryu, Ramganga (East), Gori Ganga, Dhauli Ganga (East), and Kali Ganga—all tributaries of the Kali River. These river valleys host notable tourist destinations, such as Johar Valley, Darma Valley, and Vyas Valley, each with its unique socio-economic, spiritual, cultural, and natural significance. Along Vyas Valley runs the famous Kailash-Mansarover route, home to Adi Kailash and Om Parvat. Darma Valley is known for the iconic Panchachuli Mountain peak, and Johar Valley features Munsiyari, often referred to as the "Switzerland of Uttarakhand." These natural assets are key to the region's sustainable tourism development. Additionally, the land features, river topographies, and forest landscapes further enhance the beauty and appeal of the Kali Kumaon region.

The entire region boasts a rich agro-climate and agrobiodiversity, with fertile river valley terraces irrigated by river water. A variety of crop races and cultivars are grown. However, agriculture is traditionally practiced, and the available arable land is limited, resulting in nominal production. The region is also known for its milk production, though most of it is consumed at the household level, with only small portions sold at nearby

service centers. In the middle altitudes, crop diversity is high, but rainfed agriculture and traditional farming methods contribute to low production and productivity. In the high Himalaya, farming is limited to the six months of summer, as the region remains inaccessible during the six months of winter. Recently, the impacts of climate change on agriculture have become more apparent. Local perceptions confirm the significant decline in agriculture due to factors such as low production and productivity of traditional crops, widespread crop damage from wild animals, and the younger generation's decreasing interest in farming. Additionally, the income from the service sector is significantly higher than from agriculture, making the service sector more attractive to the youth.

During discussions with the heads of households in the survey, they identified crop damage by wild animals, particularly monkeys, langurs, wild boars, and wild pigs, as the most significant factor contributing to the decline of agriculture. The number of wild animals continues to increase, forcing rural residents to migrate to other parts of the state, such as Dharchula, Pithoragarh, and Haldwani. Many of these individuals live below the poverty line (BPL), and while they have received BPL cards, the amount of monthly food grains provided is insufficient, leading to malnutrition and food insecurity. Additionally, educational institutions are scarce in the region. In the high Himalayan areas, only a few primary schools exist, resulting in low education levels. Other infrastructure is also minimal, further hindering development.

The Kali Kumaon region holds significant potential for growing fruits and vegetables, along with raising livestock, particularly goats, sheep, lambs, and horses. Its rich agrobiodiversity can be harnessed through multi-crop cultivation across various altitudinal gradients, taking into account the changing climate and shifting agro-climatic zones. A village-specific livelihood opportunity has been proposed, emphasizing the integration of agriculture and livestock, the development of tourism and service sectors, and value addition in agricultural and horticultural products by establishing food and fruit processing centers at the village level. Tourism development, particularly adventure tourism (trekking and mountaineering), as well as cultural and spiritual tourism, holds high potential. The region is home to rich destinations, such as Adi Kailash and Om Parvat, which have recently seen an increase in pilgrim visits. However, road conditions still need improvement, and the area is a restricted zone due to its geo-strategic location on the India-China border. Consequently, visiting the area requires special permission. Since it is located within Indian territory, facilitating free mobility to Adi Kailash should be a priority.

CONCLUSIONS

The findings of the study revealed that the Kali Kumaon region is endowed with rich natural resources, including water, land, forests, biodiversity, and a favourable agro-climate. The natural and cultural landscapes are truly spectacular. Although the area of arable land is limited, the river valley terraces are fertile and well-irrigated. The snow-capped mountain peaks, alpine pastures, middle altitudes, and river valleys all support sustainable tourism development, particularly natural and adventure tourism. The cultural landscape is equally impressive, with its strategic location on the Kailash Mansarover route and the presence of Adi Kailash and Om Parvat. However, despite these advantages, the region remains economically underdeveloped, with limited development activities. Livelihoods are primarily dependent on the cultivation of traditional crops, which are characterized by low production and productivity.

To better harness the region's natural and cultural assets and enhance livelihood opportunities, several measures can be proposed. These include the development of irrigation facilities, utilizing the region's rich crop diversity for multi-crop cultivation, and cultivating cash crops such as fruits and vegetables. Additionally, promoting tourism and preserving cultural heritage, adding value to agricultural and horticultural crops by establishing food and fruit processing centers at the village level, and improving transportation and other infrastructural facilities are essential. These measures would enhance livelihood opportunities in this remote Himalayan region, reduce livelihood vulnerability and malnutrition, and contribute to food security. The active involvement of all stakeholders—government,

development agencies, and local communities—is crucial to achieving these goals.

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DECLARATIONS OF CONFLICT OF INTEREST

The author declares no conflict of interests in this paper

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