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Digital database and mapping of pulse crops in the temperate areas of Jammu region

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Abstract

Pulses are environment-friendly, low in fat, calories, salt, and rich in resistant starch, dietary fibre, minerals, and vitamins. They can thrive under stressful conditions and are often referred to as the "poor man's meat". With their low glycemic index, pulses help manage blood sugar levels, making them beneficial for diabetes management. Additionally, they contribute to environmental sustainability by requiring less water and synthetic fertilizers, unlike other crops, while enhancing soil fertility through nitrogen fixation. Incorporating pulses into diets not only supports human health but also promotes environmental sustainability, highlighting their importance in addressing food security and promoting sustainable agricultural practices. India leads global pulse production, contributing 25% to the total pulse production. In the Jammu and Kashmir (J&K) region, 12955 hectares and 5938 hectares are reportedly dedicated to pulse cultivation, respectively. According to digital database mapping, 98% of respondents in the study area cultivated Rajma, followed by Black gram (79%), Green gram (76%), Horse gram (21%), French bean (19%), and Red lentil (15%). The study revealed that all respondents used Farm Yard Manure as a nutrient source, through application rates varied across regions and crop types. Hand weeding was the preferred weed control method across all farms. The findings also highlight a strong preference among farmers for organic farming over conventional methods, with many advocating for the promotion of organic practices. This research examines the current state of pulse production technologies, the limitations affecting their cultivation, and strategies to enhance productivity.

Keywords

digital database; diversity; mapping; production; pulses

Introduction

Indian agriculture is among the most robust and extensive in the world. Over the past few decades, the growth of Indian agriculture has played a vital role in establishing national food security (1). Pulses, known for being environment-friendly, complement cereals in both production and consumption. They enhance soil health, require less water, and facilitate crop rotation with cereals, which aids in controlling disease and pest (2). Moreover, pulses are an essential component of the Indian diet, being affordable and fulfilling the protein needs of all socio-economic classes. Referred to as the "poor man's meat," pulses are rich in carbohydrates,

calcium, and iron (3) and offer consistent yields even under stressful growing conditions. They also help regulate cholesterol levels and contain bioactive compounds such as phytochemicals and antioxidants, which possess anti-cancer and anti-diabetic properties, among other health benefits (4).

Pulse have been a significant part of agriculture since ancient times. Countries like India, Canada, China, Myanmar, and Brazil collectively contribute to half of the global pulse production. India, with 25% of the worldwide production, is the leading producer. Chickpea, pigeon pea, green gram, black gram, and lentil are among the most prominent pulses cultivated in the country (5). Chickpea leads the category, accounting for over 40% of production, followed by pigeon pea (18–20%), green gram (11%), black gram (10–12%), lentil (8–9%), and other legumes (20%) (6). India also imports pulses to meet domestic demand. Key import sources include Australia, Burma, China, Tanzania, and the UAE for small chickpeas; Australia, Burma, Canada, Iran, and Turkey for large chickpeas (Kabuli); Burma, China, and Tanzania for pigeon peas; Australia, Burma, China, and Singapore for green gram; Burma, Singapore, and Thailand for black gram; and Canada, China, the Netherlands, Syria, and Turkey for lentils (7).

According to World Bank indicators, the global geographical area under pulse cultivation is 81.61 million hectares (Mha), with a production of 55.10 million metric tonnes (MMT). In India, pulses are cultivated on 23.63 Mha, yielding 14.76 million tonnes (Mt) (8). However, to meet the nation's consumption demand, approximately 2–3 Mt of pulses are imported annually. India is the world's largest producer and consumer of pulses, accounting for around 25% of global production, 27% of global consumption, and 34% of food use (9). Currently, pulse output in India is projected at 24.42 Mt. Between 2017 and 2019, pulse production in India increased by 23%, and the country aims to achieve a target output of 32 Mt by 2030. Known as "Smart Food," pulses are integral to staple diets like dal-chawal and dal-roti, serving as a vital plant protein source (10). India contributes significantly to global pulse production, producing over 80% of the world's pigeon peas (*Cajanus cajan*), 65% of chickpeas (*Cicer arietinum*), 37% of lentils (*Lens culinaris*), and more than 65% of green gram (*Vigna radiata*) and black gram (*Vigna mungo*) (11). Pulse production in India has risen by 36.5% over the last decade. However, to bridge the supply-demand gap, pulse production needs to increase from 19 Mt to a range of 25.4 –36.9 Mt. India's pulse output has shown consistent growth, rising from 14.7 Mt in 2009–10 to 18.2 Mt in 2010–11 and reaching an all-time high of 19.8 Mt in 2013–14, with chickpea production alone peaking at 9.53 Mt (12).

In the Union Territory (UT) of Jammu and Kashmir (J&K), the total cropped area under pulse cultivation is 18,893 hectares (ha). Of this, 12,955 ha are in the Jammu region, while 5,938 ha are in the Kashmir region. Key pulses cultivated in J&K include Rajma, Black gram, Green gram, French bean, Horse gram, and Red lentil (13). Although advancements from the Green Revolution (1961–2015) led to substantial increases in the production of maize, wheat, rice, and soybeans, pulse yields only increased by 59%. Globally, per capita pulse consumption is approximately 7 kg per year. India's total pulse consumption is projected to reach 39 Mt by 2050, requiring an annual growth rate of 2.2% to close the supply-demand gap (14).

Many farmers in J&K practice minimal-input agriculture, which, while initially seen as a limitation, has become an advantage due to the adverse effects of synthetic chemical -based agriculture. The soil in these regions remains uncontaminated, and the environment is clean and green. J&K holds immense potential for organic farming due to the limited availability of chemical fertilizers. Large swaths of arable land, particularly in the higher altitudes of Kishtwar, Udhampur, Doda, Kathua, Reasi, Ramban, Poonch, and Rajouri districts, are already semi-organically farmed. The region's moderate climate supports the cultivation of crops with minimal chemical inputs, though certification is needed to market these as organic or semi-organic products. Farmers in J&K can leverage the growing demand for organic produce to enhance soil quality and biodiversity. Many farmers in the region are already practicing organic cultivation of pulses, spices, basmati rice, walnuts, and other crops, ensuring sustainable agricultural practices and tapping into expanding organic markets.

Materials and Methods

The methods employed in this study are described under the following headings:

Research design

The study employs a non-experimental research design, wherein the independent variables are not manipulated by the researchers. Instead, the study examines phenomena as they naturally occurs or has previously occurred. The primary focus is to analyze the relationships between variables, emphasizing field-based observations of specific situations.

Locale of the study

The Jammu division comprises 10 districts. For this study, four districts were purposively selected: Kathua, Udhampur, Doda and Kishtwar in the temperate areas of the Jammu region.

Profile of the study area

Jammu is geographically situated between 32°50′ and 33° 30′ North latitude and 74°24′ and 75°18′ East longitude. The region's elevation ranges from less than 300 meters to approximately 9400 meters above sea level. Out of the total geographical area of Jammu and Kashmir [101,387 square kilometers (km^2)], the net sown area constitutes 0.658 million hectares (Mha) (27.24%), the non-agricultural area accounts for 0.293 Mha (12.13%), and the cultivable wasteland covers 0.361 Mha (14.94%), among other land-use categories (15).

Kathua district

The district is situated between 32° 17′ and 32° 55′ North latitude, covering an area of 2502 Km^2. It is bordered by

Punjab in the Southeast, Udhampur in the north and northwest, Himachal Pradesh in the northeast, Doda in the West, and Pakistan in the southwest. The district encompasses approximately 512 villages (16).

Udhampur district

The Udhampur district lies in the southern part of the Jammu and Kashmir Union Territory and comprises four tehsils. It includes 331 villages, with a rural area spanning 2593.28 km^2 and an urban area of 43.72 km^2 (17).

Doda district

Doda district is located in the outer Himalayan range of Jammu and Kashmir, approximately 175 kilometers from Jammu. It comprises four tehsils, with Doda being the largest. The rural sector of the district includes 406 villages, covering an area of 8892.25 km^2, while the urban sector covers an area of 19.75 km^2 (18).

Kishtwar district

The Kishtwar district derives its name from its district headquarters, the town of Kishtwar. The district is divided into four tehsils and consists of 157 villages in its rural sector, covering an area of 1643.65 km^2. The urban sector occupies a smaller area of 0.63 km^2 (19).

Sampling techniques

A multistage random sampling technique was employed for this study, following the guidelines provided by (20). Data collection was conducted through personal interviews, adhering to the methodology (21).

Selection of districts

The research was carried out in 4 districts of Jammu division, selected purposively due to their extensive area under pulse crop cultivation, as given in (Table 1) (22).

Table 1. District-wise area sown under pulse crop in the temperate region of Jammu 2016-17

Sl. No.	District	Pulses Area (in hectares)
1	Doda	1488
2	Kishtwar	1170
3	Kathua	2403
4	Udhampur	1576

Selection of respondents

A list of temperate sub-divisions with areas under pulse cultivation was prepared for each selected district. One sub-division from each district was randomly selected, resulting in four sub-divisions. A list of villages where pulses are grown was then compiled for each sub-division. Using a random sampling technique, six villages were selected from each sub-division, amounting to a total of 24 villages across the four sub-divisions. Subsequently, a list of pulse-growing farmers was created for each village, and 10 farmers from each village were randomly chosen as respondents for the study. Thus, the final sample size comprised 240 farmers actively engaged in pulse crop production, as detailed in Table 2.

Table 2. Sampling plan of pulse crop growers in the selected districts

Sl. No.	District	Sub-division	Villages covered	Number of respondents from each village	Number of respondents from selected villages
1	Doda	Pranoo	Bigota Masari Shekpura Bathoh Tantla Thilroo	10	60
2	Kishtwar	Mughal Maidan	Bhata Moolchatar Seeri Sigdi Markhar Bankari Dahayan	10	60
3	Kathua	Machedi	Machedi Badnota Nangala Dull Bijohi Najot Kindli	10	60
4	Udhampur	Pancheri	Kultyar Upper Meer Lower Meer Gailote Sadhota Suman	10	60
Total number of respondents from selected villages					240

Construction of research tool

A structured interview schedule was designed using a personal interview technique (21) to facilitate data collection while aligning with the objectives of digital mapping.

Data collection

Data were collected from the selected respondents through the personal interview approach, utilizing the structured interview schedule. Secondary data were also sourced from the Department of Agriculture, Jammu, Government of Jammu and Kashmir (22).

Creation of maps

District maps were digitized and georeferenced using QGIS 3.40.0 'Bratislava. Locations within individual districts were tagged, and sampling points were zoomed out for better visibility.

Statistical Analysis

The collected data were systematically classified, quantified, and tabulated. Relevant information is extracted using statistical tools, including Sampling technique, percentages, mean, and standard deviation.

Percentage

Simple comparisons were performed using percentage calculations to analyze the data.

Arithmetic mean

The arithmetic mean is calculated by dividing the sum of all observed values by the total number of observations.

$X = \Sigma fX / n$

Where,

X = Arithmetic mean

ΣX = sum of all observed values ($X_1 + X_2 + X_3 + \ldots + X_n$)

f = Frequency in each class

n = Total number of observations

Standard deviation

It is denoted by σ, measures the dispersion of a dataset relative to its mean. It is calculated as the square root of the variance.

$$\sigma = \sqrt{\left\{\left\{\sum_{\{i=1\}}^{n}\left(x_i - \overline{\{x\}}\right)^2\right\}/\{n\ -\ 1\}\right\}}$$

Where,

σ = standard deviation, quantifying the spread of data relative to the mean

Σ (Sigma) = Summation symbol, indicating the sum of all terms in the series.

x_i = each individual observation or data point in the dataset.

$\bar{x}$ = Denotes the arithmetic mean of the data (average value).

n = Total number of observations in the dataset

n − 1 = degrees of freedom, used in the denominator for sample standard deviation to adjust for bias.

Results and Discussion

The data collected from respondents (Table 3) revealed the following observations regarding the six selected villages in each of the studied districts:

In the Doda district, the selected villages were Bigota, Masari, Shekpura, Bathoh, Tantla, and Thilroo. The pulses cultivated in these villages included Rajma, Black gram, Green gram, French bean, and Horse gram.

In the Kishtwar district, the selected villages were Bhata, Moolchatar, Seeri, Sigdi, Markhar, Bankari, and Dahayan. The pulses grown included Rajma, Black gram, Green gram, and Red lentil.

Table 3. Areas of J&K with specific pulse crop

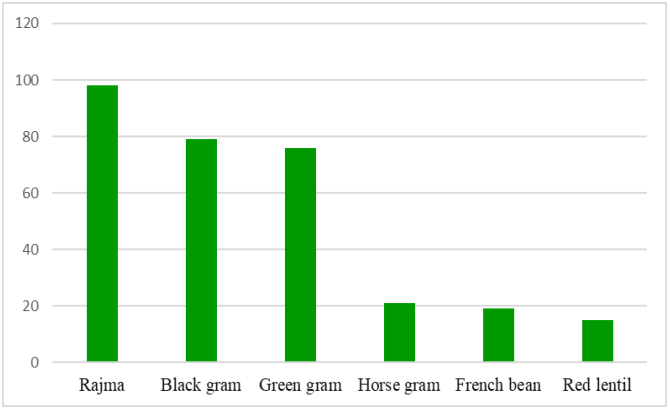
District	Village	Latitude	Longitude	Pulse Crops grown
Doda	Bigota	75.58155	33.10446	Rajma, Black gram, Green gram, French bean, Horse gram
	Masari	75.56686	33.09446	Rajma, Black gram, Green gram, French bean, Horse gram
	Shekpura	75.57873	33.08548	Rajma, Black gram, Green gram, French bean, Horse gram
	Bathoh	75.57112	33.10303	Rajma, Black gram, Green gram, French bean, Horse gram
	Tantla	75.57726	33.09207	Rajma, Black gram, Green gram, French bean, Horse gram
	Thilroo	75.58457	33.08723	Rajma, Black gram, Green gram
Kishtwar	Bhata	75.63105	33.52031	Rajma, Black gram, Green gram, Red lentil
	Moolchatar	75.63695	33.45965	Rajma, Black gram, Green gram, Red lentil
	Seeri Sigdi	75.60092	33.47102	Rajma, Black gram, Green gram, Red lentil
	Markhar	75.59178	33.47733	Rajma, Black gram, Green gram, Red lentil
	Bankari	75.61303	33.43984	Rajma, Black gram, Green gram, Red lentil
	Dahayan	75.60114	33.43124	Rajma, Black gram, Green gram, Red lentil
Kathua	Machedi	75.59816	32.70123	Rajma, Black gram, Green gram, French bean, Horse gram
	Badnota	75.63113	32.73562	Rajma, Black gram, Green gram, Horse gram
	Nangala	75.60651	32.68819	Rajma, Black gram, Green gram, French bean
	Dull Bijohi	75.59886	32.70803	Rajma, Black gram, Green gram
	Najot	75.59189	32.66653	Rajma, Black gram, Green gram
	Kindli	75.60441	32.73522	Rajma, Black gram, Green gram
Udhampur	Kultyar	75.16333	33.07143	Rajma, Black gram, Green gram, French bean
	Upper Meer	75.12999	33.03086	Rajma, Black gram, Green gram
	Lower Meer	75.12705	33.04711	Rajma, Black gram, Green gram, French bean
	Gailote	75.14129	33.07402	Rajma, Black gram, Green gram, French bean
	Sadhota	75.09844	33.09973	Rajma, Black gram, Green gram
	Suman	75.12337	33.07776	Rajma, Black gram, Green gram, French bean

In the Kathua district, the selected villages were Machedi, Badnota, Nangla, Dull Bijohi, Najot, and Kindli. These villages cultivated Rajma, Black gram, Green gram, French bean, and Horse gram.

In the Udhampur district, the selected villages were Kultyar, Upper Meer, Lower Meer, Gailote, Sadhota, and Suman. The pulses cultivated here included Rajma, Black gram, Green gram, and French bean.

The results demonstrated that the mapping of pulse crops using GPS coordinates effectively identified the primary pulses grown in the study area. Figures 1, 2, and 3 indicated that Rajma (*Phaseolus vulgaris*), Black gram (*Vigna mungo*), and Green gram (*Vigna radiata*) were cultivated across all four selected districts of Jammu & Kashmir Union Territory: Doda, Kishtwar, Kathua, and Udhampur. Figures 4, 5, and 6 revealed that the French bean (*Phaseolus vulgaris*) was cultivated in Doda, Kathua, and Udhampur districts, Horse gram (*Macrotyloma uniflorum*) in Kathua, and Red lentil (*Lens culinaris*) in Kishtwar.

According to the mean and percentage derived from the digital database and mapping, the majority of respondents (98%) in the study area cultivated Rajma, followed by Black gram (79%), Green gram (76%), Horse gram (21%), French bean (19%), and Red lentil (15%), as illustrated in Graph 1.The field survey identified six pulse crops grown in the study area: Rajma, Black gram, Green gram, French bean, Horse gram, and Red lentil. The highest diversity of pulses was observed in the Doda district. Mapping pulse crops using GPS coordinates is an efficient method for identifying the major pulses grown in a region, as it provides a temporal overview of the number of pulse crops cultivated in a particular area over the course of a year. Pulses were predominantly grown during the kharif season, with some cultivated during the rabi season. This trend may be attributed to the rainfed nature of the study area, as pulse crops require minimal water for growth.



Graph 1. Percentage of pulse growers in the temperate areas of Jammu region.

Additionally, many farmers refrained from using chemical fertilizers and pesticides, opting instead to grow pulses organically. Organic farming is particularly suitable for rainfed areas where low yields are a common challenge. This approach plays a significant role in ensuring a sustainable and nutritious food supply while offering substantial economic returns to farmers. Moreover, organic farming can enhance the socio-economic status of rural communities and promote environmental sustainability (23). Organic farming is the most effective approach to improving soil quality and supporting the welfare of living organisms. The importance of high-quality food free from industrial inputs is increasingly recognized. Synthetic fertilizers and pesticides, though not essential for ensuring an adequate supply of nutrient-dense food for the growing global population, often result in practices detrimental to soil health and the environment (24). Incorporating pulses into cereal-based

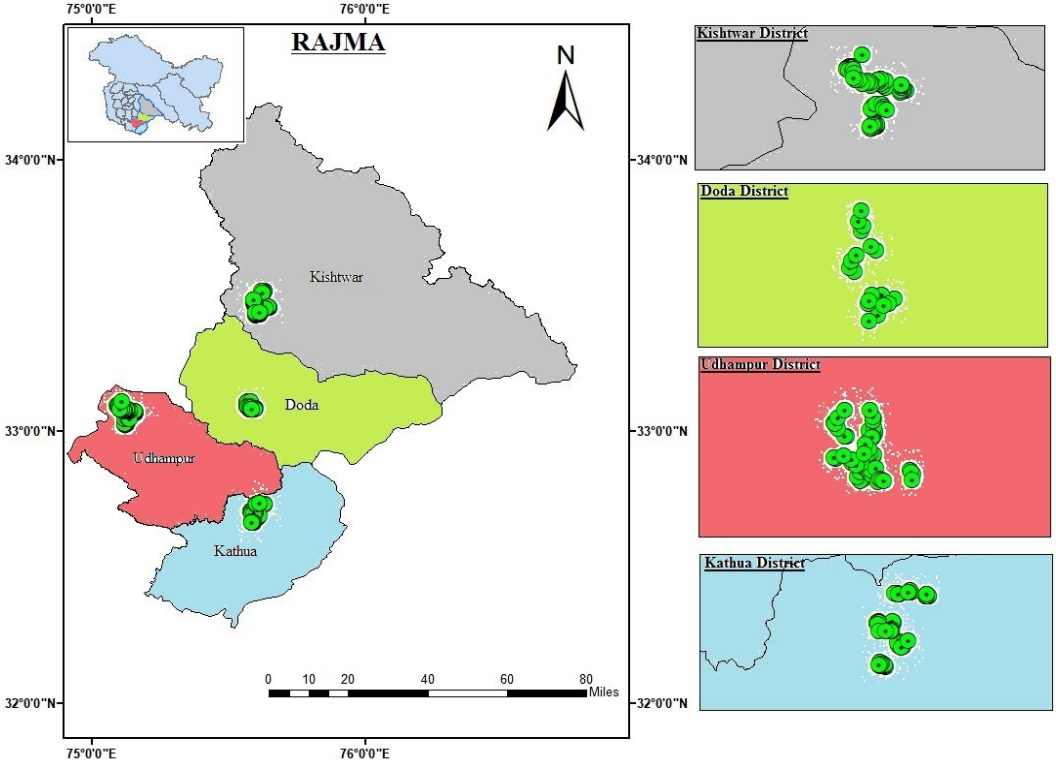


Fig. 1. Map of rajma cultivation (Source: QGIS 3.40.0 'Bratislava).

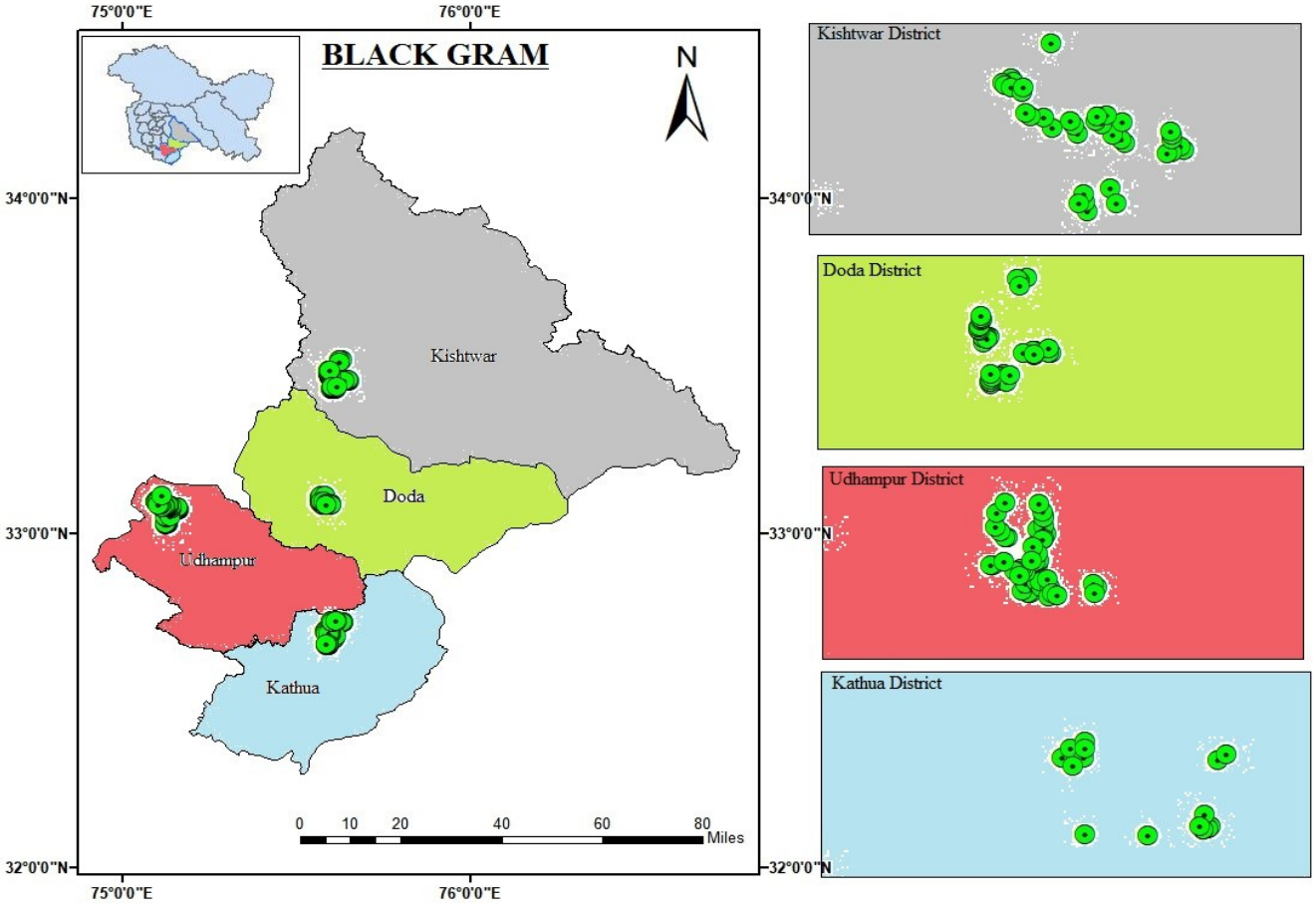


Fig. 2. Map of black gram cultivation (Source: QGIS 3.40.0 'Bratislava).

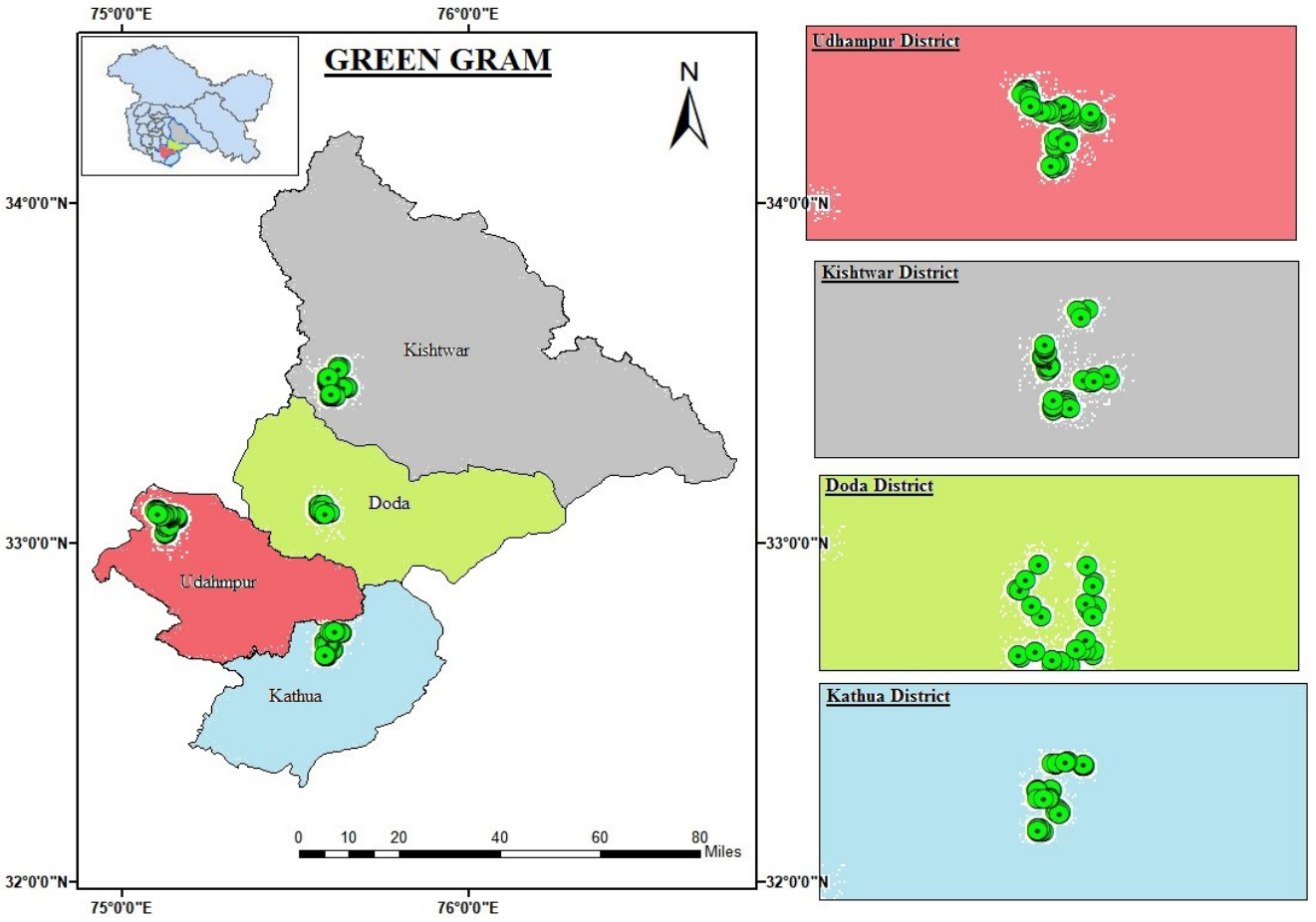


Fig. 3. Map of green gram cultivation (Source: QGIS 3.40.0 'Bratislava).

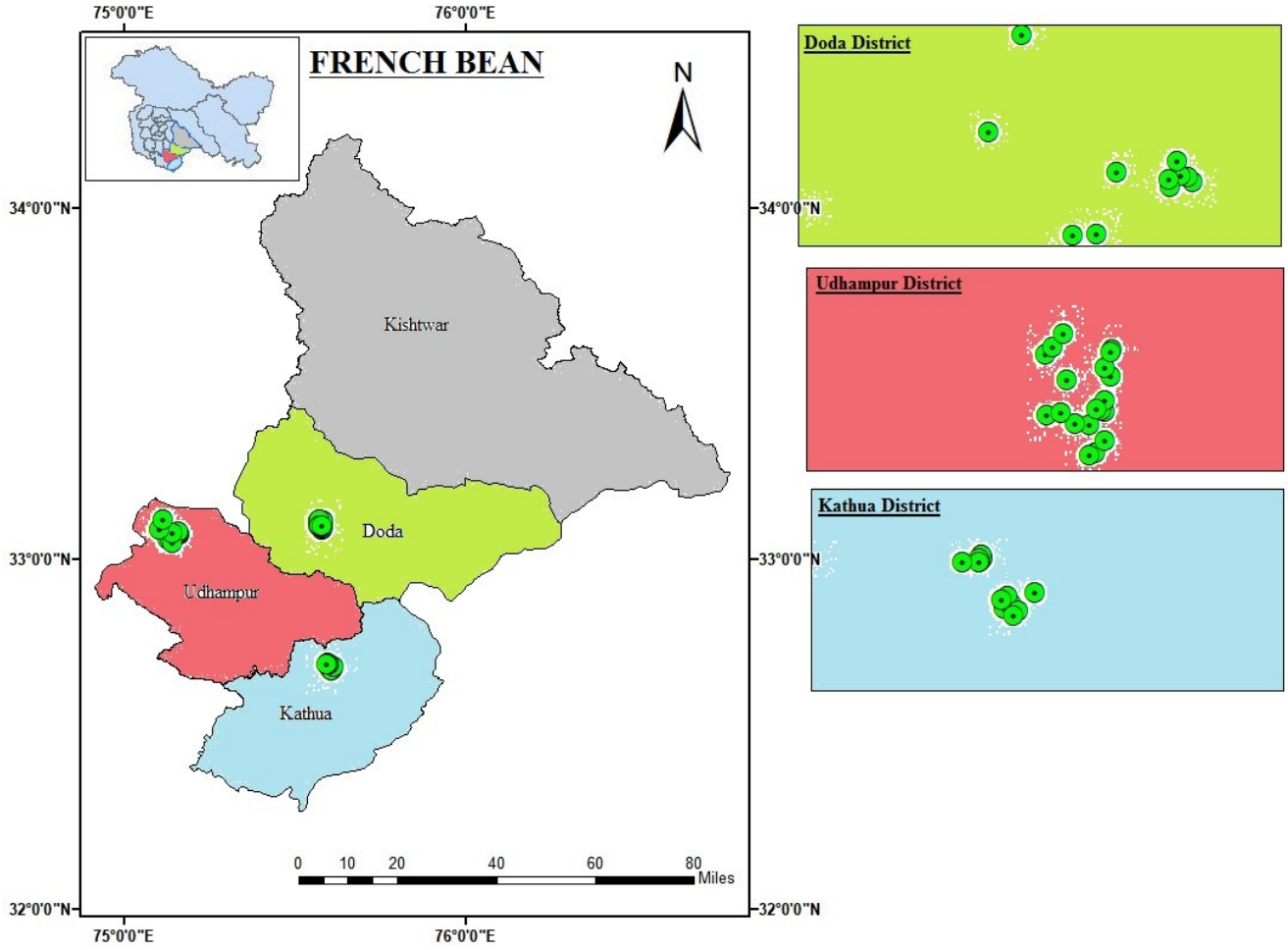


Fig. 4. Map of french bean cultivation (Source: QGIS 3.40.0 'Bratislava).

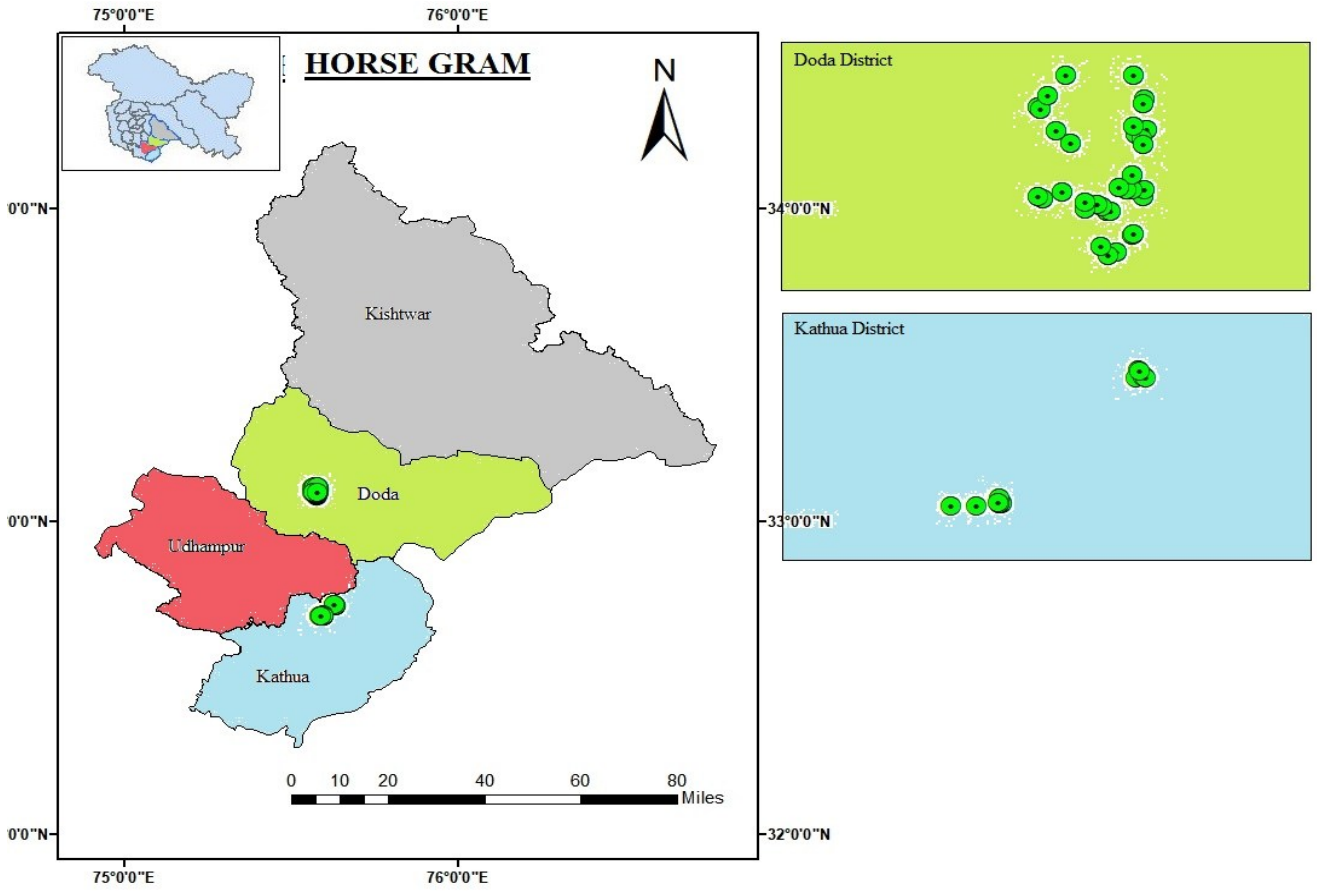


Fig. 5. Map of horse gram cultivation (Source: QGIS 3.40.0 'Bratislava).

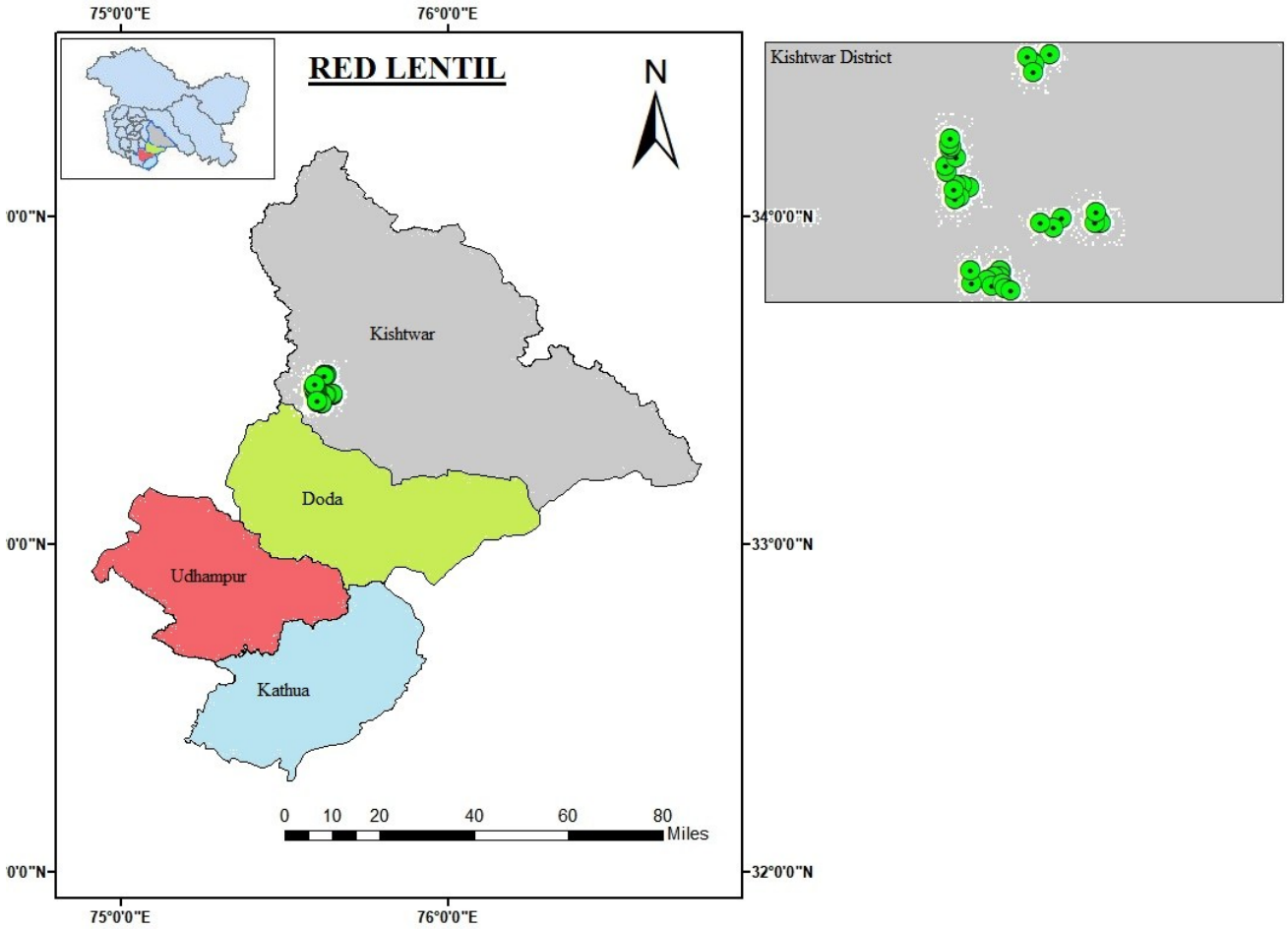


Fig. 6. Map of red lentil cultivation (Source: QGIS 3.40.0 'Bratislava).

cropping systems can enhance the sustainability of such systems by improving soil health (2).

There is an urgent need to educate farmers about the benefits of pulse cultivation, as pulses are a rich source of protein. Farmers can also increase their income by growing pulses, especially organic ones, given their high demand in the market (11).

Conclusion

The study was undertaken with the primary objectives of generating a digital database and mapping pulse crops in the temperature of Jammu. GPS coordinates were used in various sites within the research areas to create a digital map, facilitating the identification of pulse-growing areas for future reference. A digital database was also developed to provide detailed information about the status and characteristics of pulse crops cultivated in the research sites.

The findings revealed that most farmers in the region are marginal farmers with limited access to advanced production technologies. Due to resource constraints, these farmers primarily engage in organic farming practices. Pulses not only offer a promising source of income but also contribute to improving soil health. Farmers in the temperate region of Jammu demonstrated exemplary practices in organic farming, serving as potential role models for other farmers in the state. The study concludes that the cultivation of pulses through organic farming, when combined with proper guidance and support from agricultural extension workers regarding modern production technologies, has the potential to significantly enhance the livelihoods of farmers in the temperate regions of Jammu.

This approach could prove transformative for farmers in this region, encouraging others to adopt organic farming methods while simultaneously addressing sustainability and economic viability.

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Authors' Contributions

GS conceptualized, participated in the data collection and drafted the manuscript. LKS designed the study, analyzed the formal data and performed the statistical analysis. SO participated in the data collection and drafted and edited the manuscript. All the authors read and approved the final manuscript.

Compliance with Ethical Standards

Conflict of interest: Authors do not have any conflict of interests to declare.

Declaration: The authors confirm that they obtained prior informed consent from all the participants before collecting data for the current research study, reviewed and edited the content as needed and take full responsibility for the content of the publication.

Ethical issues: None

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