Organic Pulse Production: Exploring Opportunities and Overcoming Challenges

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ABSTRACT

Pulses are an essential part of global human nutrition and sustainable agriculture, consisting of a range of leguminous crops like beans, lentils, and chickpeas. The growing demand for organic food has made organic pulse cultivation a viable means of satisfying this need while also fostering environmental stewardship and strengthening farm resilience. Increased biodiversity on farms, fewer chemical inputs, and better soil health are just a few benefits of growing pulses organically. Furthermore, organic pulses are well known for their high nutritional content, providing the human diet with the necessary fibers, proteins, and minerals. Farmers that grow pulses have a large market opportunity due to consumers’ increased demand for organic products. But growing organic pulses certainly has its share of difficulties. These include probable yield swings, vulnerability to pests and diseases, and restricted availability of seeds with organic certification. Furthermore, farmers may face operational and financial challenges throughout the shift from conventional to organic agricultural methods. Multiple parties must work together in order to overcome these obstacles and take advantage of the potential that comes with producing organic pulses. The development of hardy organic pulse types that are suited to a range of agroecological settings can be greatly aided by research. It is imperative for policymakers to enact laws and incentives that are conducive to the growth of organic pulse production and provide equitable market access for organic growers. Ultimately, organic pulse farming has enormous potential for both food security and sustainable agriculture. Organic pulse growers can play a major role in supplying the increasing demand for nutrient-dense, eco-friendly food while building strong, thriving farming communities by mitigating problems with innovative solutions and teamwork.

Keywords: Nutrition, Organic farming, Pulse, Soil Health, and Sustainability

INTRODUCTION

The world is now aware of the significance of high-quality food that is uncontaminated by artificial inputs, such as chemical fertilizers, herbicides, and insecticides used in crop production, as well as hormones and other chemicals used in the livestock industry (Babu et al. 2022). Synthetic fertilizers and pesticides are not necessary to sustain a sufficient supply of nutrient-rich food to feed the world’s expanding population (Tripathi et al. 2020). Moreover, they may encourage actions that worsen the environment in general and soil quality specifically. Thus, organic farming is a safer alternative since it is founded on the ideas of biological, cultural, and physical techniques to provide crops with appropriate nutrition and to control pests and also to maintain the soil quality and health of the living things. According to recent study, growing crops organically will result in an average yield loss of 20% when compared to conventional farming methods (Seufert et al. 2012). This suggests that if significant increases in food production are required to feed a population of 10 billion people by 2050, widespread substitution of conventional with organic farming is not advised (Knapp et al. 2018). On the other hand, in rainfed regions where low yields are a constant, organic farming could be a feasible option. Organic farmers may achieve high yields and play major role in providing a better future with an adequate and nutritious food supply (Suresh Reddy, 2010). Furthermore, organic farming
may be a more effective approach than conventional farming for advancing the socioeconomic and environmental sustainability of rural life (Gamage et al. 2023). Prior to the invention and application of synthetic fertilizers and pesticides, which started in the 1940s, farming methods were essentially organic. In general, organic farmers still adhere to a lot of the pre-1940s agricultural techniques. Many researchers have highlighted the advantages of carefully planned crop rotations in the cycling of nutrients for the crops in organic farming, as well as the use of varied crop rotations for weed suppression (Volsi et al. 2022).

Contemporary agricultural methods and excessive application of chemical inputs during the last four decades have also led to various risks, destruction of natural habitat equilibrium and soil health besides inducing soil erosion, depletion of groundwater, soil salinization and desertification, pollution due to pesticides and fertilizers, genetic erosion, reducing food quality, and higher cultivation expenses (Suresh Reddy 2010). A numerous number of farmers have committed suicide because they no longer believe that agriculture is a viable endeavor (Deshpande 2002). Similar to the previous example, the current agricultural crisis could be brought about by growing prices for imported inputs, a slowdown in government spending, market intervention, and above all-the shift from subsistence farming, which primarily uses inputs grown locally, to commercial farming, which primarily uses inputs that are purchased (Qiao et al. 2022). On the other hand, conventional farming practices have been replaced by contemporary crop production techniques, resulting in an unproductive and unsustainable agricultural sector. Because organic farming has so many advantages over modern farming techniques, farmers are starting to show interest in it (Misra and Ghosh 2024). It is essentially an agricultural technique that strengthens and promotes biological processes without the use of artificial inputs like pesticides or genetically modified organisms. Many private citizens, non-governmental organizations, and government-sponsored organizations have been experimenting with organic food production methods recently.

PULSES IN ORGANIC AGRICULTURE

Pulses, the edible seeds of legume plants, play a crucial role in sustainable agriculture, particularly in organic farming practices. The fertility of the soil, biodiversity, and general health of agroecosystems are all greatly enhanced by these nutrient-dense crops. There are several financial, health, and environmental advantages to growing pulses in organic farming systems. (i) **Soil Enrichment**: By forming symbiotic partnerships with soil microbes, pulses possess the exceptional capacity to fix atmospheric nitrogen. They aid in the fixation of nitrogen, improving soil fertility and lowering the need for synthetic fertilizers in organic farming. (ii) **Crop Rotation and Diversification**: By adding pulses to crop rotations, pest and disease cycles can be broken, reducing the need for chemical treatments. They also help to improve soil structure and moisture retention with their deep-rooting system. (iii) **Rich in Nutrients**: Pulses are an excellent protein source, vitamins, minerals and dietary fiber. They are an important source of nutrition for organic diets and help maintain sustainable. (iv) **Less Environmental Impact**: Organic farming techniques lessen their environmental impact by emphasizing natural inputs and minimizing the use of chemicals.

ORGANIC PULSE PRODUCTION: CURRENT STATUS

Global and regional production statistics

In 2021, approximately 7.33 lakh hectares accounting for 0.8% of the total global area dedicated to dry pulses, were being cultivated using organic practices. Europe leads in organic pulse cultivation with 5.69 lakh hectares, followed by North America with 1.11 lakh hectares. Asia contributes 30,230 hectares, while Latin America contributes 17,918 hectares and Africa have 3,563 hectares under organic pulse production. Approximately 56.94% of the area of dry pulses and protein crops is allocated to unspecified varieties. Peas occupy about 18.06%, followed by beans at 10.85%, lentils cover 6.56% and chickpeas occupy 2.97%. Vetches cover a smaller portion accounting for only 0.16% of the total area. These statistics highlight the distribution of land among various types of organic pulses and protein crops, indicating the varying degrees of cultivation and significance across these categories (IFOAM 2023). The country with largest area dedicated to organic pulses is France with an area of 156,782 hectares followed by Canada with 80,121 hectares for organic pulses and Germany on third spot with an area of 71,000 hectares. Meanwhile, in terms of the highest percentage of organic area share, Australia ranks first with 81.04% followed by Denmark accounting for 53.37% and France on third number with 42.27% area under organic pulse cultivation (FiBL survey 2023). In India the
production of organic pulses during the year 2021-22 was 73,765.369 MT and conversion production in MT was 24.084 of the organic pulses. The export quantity of organic pulses in the year 2020-21 was 8781.97 MT while in 2021-22 it was only about 5433.505 MT (FiBL survey 2023).

**Major organic pulse crops**

Pulses are an essential part of the diets of majority of the Indian populace. In the form of feed and fodder, it is also crucial component of livestock. Due to their special qualities-namely, biological nitrogen fixation, carbon sequestration, soil amelioration, low water requirement and capacity to endure harsh climate, pulses continue a vital component of sustainable production system, specially under rainfed areas. Given its capacity to adapt to low-input management circumstances, it is a promising option for crop intensification and diversification, particularly in regions where the Green Revolution has left a number of sustainability-related issues in its wake (Singh et al. 2005). Pulses are mostly grown in rain-fed monsoon-dependent regions where soil moisture is a key determinant of productivity; as a result, annual variations in production patterns are inevitable. In addition to socioeconomic issues, the main obstacles to realizing the potential yield of pulses are biotic and abiotic stressors that are common in the places where pulses are grown. By enhancing soil health, adding pulses to a cereal-based cropping system may increase its sustainability (Babu et al. 2016).

**OPPORTUNITIES IN ORGANIC PULSE PRODUCTION**

**Soil health and fertility management**

For a very long time, pulses have been appreciated as “soil building” crops. Benefits of pulse include improved soil quality due to improvements in its biological, chemical, and physical characteristics. Pulses break down the growth of weeds and diseases, increase soil organic matter, increase soil porosity, recycle nutrients, enhance soil structure, and lower pH when they are planted and maintained properly. In addition, there exist numerous other indicators (described subsequently) that are either directly or indirectly associated with soil quality, and RUE can be employed to elucidate the benefits of pulses or pulse-based systems. For pulses to provide high-protein crops, they require substantial levels of nitrogen, which can best be supplied through the biological nitrogen fixation process. Plants need to have a “symbiotic,” or mutually beneficial, relationship with specific bacteria known as rhizobia in order for the fixation process to take place. Because of their innate ability to fix nitrogen, pulse crops can meet a significant percentage of their nitrogen needs and also help save nitrogen for use in subsequent non-pulse crops. The ideal rate of nitrogen fixation for pulses throughout the cropping season is approximately 1.0 kg/ha/day; this is commonly known as the pulses’ potential for nitrogen fixation in a particular setting. A pulse crop fixes nitrogen, and typically the next growing season can use around two thirds of that nitrogen. Depending on the rhizobia population, host crop and variety, soil characteristics, degree of management, and environmental factors, pulses can fix 25-160 kg N/ha. When pulses are planted one after the other, the previous crop may enrich the soil with 20-70 kg N/ha, so preserving a significant amount of N for the next crops. Growing short-duration mungbean in the summer can increase nitrogen economy in the rice crop that follows by 40-60 kg N/ha in a rice-wheat rotation (Prharaj et al. 2021). It is well known that kharif and rabi pulses have comparable effects on the productivity and N-economy of subsequent cereal crops. It was discovered that the nitrogen economy from using pigeon pea instead of sorghum was 51 kg N equivalent/ha. A study on the impact of rabi pulses on productivity and nitrogen economy in rice replacement revealed that lentil, rajmash, and chickpeas had the best results, saving up to 40 kg of nitrogen per hectare. Chickpea-rice was the most productive approach, followed by rajmash-rice. Furthermore, it was observed that the NO_{3}^{-}-N concentration that remained after the harvest of the rabi pulse showed improvement in the soil’s N budget. Regarding their contribution to the residual NO_{3} in the soil profile, field pea and lentil ranked second and third, respectively, while the highest-ranking legume was 20.4 kg/ha. These genotypes that enhanced the amount of nitrate in the soil the greatest were field pea cv. Rachana, lentil cv. ‘DPL-62’, and chickpea cv. ‘BG 1003’ (IIPR 2009).

The taproots of pulses create passageways that delve deeply into the soil, enhancing its physical state. The growth in stable soil aggregates is mostly responsible for the improvements. The “glue” that holds soil particles together into stable aggregates is a protein called glomalin, which is secreted by the roots of pulse plants and other plants. Because of the increased pore space and tilth caused by this aggregate stability, soil erodibility and crusting
are decreased. Comparing the rice-chickpea, rice- 
wheat-mungbean, and maize-chickpea, pigeonpea- 
wheat, and maize-wheat-mungbean systems to the 
rice-wheat and maize-wheat, respectively, two long-
term studies conducted at IIPR, Kanpur revealed 
similar benefits. Furthermore, soil nutrients in 
plant-available forms become unavailable due to 
the production of root exudates by pulses and the 
addition of organic matter to the soil. Rather than 
obtaining their nitrogen from the soil as nitrate, 
pulses obtain their nitrogen from the air as diatomic 
nitrogen, which lowers the pH of the soil overall. Plant 
growth and soil microbial activity both significantly 
increase at a favorable pH. Furthermore, pulses are 
rich in nitrogen due to their high protein content, 
as previously indicated. The nitrogen provided by 
pulses speeds up the breakdown of crop residues in 
the soil and their conversion to soil-building organic 
carbon since most crop residues contain far more 
carbon than nitrogen, and bacteria in the soil require 
both. Similarly, short duration summer pulses can 
be used to reduce C-loss during fallow period and 
enhance C-sequestration of a system.

**Crop rotation and intercropping strategies**

Pulse crops are typically cycled with cereals to 
minimize the usage of nitrogenous fertilizers (Babu 
et al. 2016). Pulse crops are often grown in rotation 
with cereals to optimize the financial gains, reduce 
the requirement for nitrogen fertilizer, and supply a 
higher-grade plant protein (Singh et al. 2021b). Given 
that pulse crops return little residue to the soil, it 
is unknown how they might impact soil quality 
(Singh et al. 2021a). This study evaluated the system 
stability, soil organic carbon, and crop production in 
intensified pulse-wheat (*Triticum aestivum* L.) cycles. Four cycles of research were conducted at two field 
sites on chickpea (*Cicer arietinum* L.)-wheat, lentil 
(*Lens culinaris* Medik.)-wheat, pea (*Pisum sativum* 
L.)-wheat, and wheat monoculture. Over the course 
of four rotation cycles, pea-wheat increased protein-
based system yields by 22–82, 9–26, and 26–66% in 
contrast to chickpea-wheat, lentil-wheat, and wheat 
monoculture. Among the rotations incorporating 
pulse crops, soil mineral N to a depth of 60 cm 
did not change; nonetheless, it was higher than 
what monoculture. After eight years of rotations, 
the baseline soil’s 10.3 g/kg of soil organic carbon 
increased to 11.2 g/kg, but the rotation systems 
remained unchanged. An integrated evaluation of 
yield, soil organic carbon, and system stability, as 
reported by Liu et al. (2020), reveals that pulse crop 
rotations perform better than wheat monocultures, 
and the pea-wheat system provides a model for 
sustainable crop intensification.

**Genetic diversity and seed selection**

Producing organic pulses provides a means of 
preserving genetic variety through the cultivation of 
a range of heirloom and indigenous types. 
Sustainable farming techniques are facilitated by 
the preservation of various genetic resources, which 
guarantee resistance against diseases, pests, and 
environmental changes. Various pulse crops have 
distinct features that could respond to changing 
environmental conditions as a result of shifting 
climatic patterns. A reservoir of genetic features 
essential for crop adaptation may be found in certain 
pulses, which may be more heat-tolerant, drought-
resistant, or suited to particular soil types (Turner et 
al. 2001). Pulses with different genetic backgrounds 
also have different nutritional profiles. Pulses with 
greater nutritional value, such as higher protein 
content or increased micronutrient levels, could be 
produced by experimenting with and promoting 
various types, improving food security and health 
(Singh et al. 2021b). Selective breeding strategies 
focusing on desirable qualities such as disease 
resistance, improved taste, and higher yields are 
made possible by organic pulse farming. Through 
careful seed selection from outstanding plants, 
farmers can progressively raise the crop's quality 
and hardness. The exchange of a variety of pulse 
seeds among farmers is facilitated by initiatives 
that support seed banks and exchange programs. 
By giving farmers access to a range of genetic 
resources and enabling them to test out multiple 
cultivars that are suitable for their particular 
agroecological conditions, this promotes farmer 
collaboration. Farmers are encouraged to save seeds 
from good harvests because it preserves diversity 
and gradually adjusts crops to local conditions. 
Additionally, it lessens reliance on outside seed 
suppliers, empowering farmers and encouraging 
self-sustainability.

**Market demand and economic benefits**

Growing awareness of health, sustainability, 
and environmental issues has led to a steady increase 
in the demand for organic produce worldwide, 
particularly pulses. Due to their high protein, fiber 
content, and other essential components, pulses are 
a valuable component of a balanced diet. Pulses 
include lentils, chickpeas, dry peas, and beans. The 
production of organic pulses has seen significant 
growth due to the increase in demand, which
benefits farmers, local communities, and the market as a whole economically.

**Market demand for organic pulses**

Consumers worldwide are gravitating toward organic pulses due to their perceived health benefits and environmentally friendly production methods (FAO 2020). The growing interest in plant-based diets and the preference for natural, chemical-free foods has amplified the demand for organic pulses. Additionally, the recognition of pulses as sustainable crops that enhance soil fertility through nitrogen fixation further fuels their popularity. The global market for organic pulses has seen remarkable growth, driven by the increasing awareness of their nutritional value and sustainable farming practices. Europe, North America, and Asia-Pacific regions have emerged as significant markets for organic pulses, presenting ample opportunities for producers to cater to this demand (FAO 2020).

**Economic benefits of organic pulse production**

Organic pulses command higher prices in the market compared to conventionally produced ones due to their perceived quality, nutritional value, and environmentally friendly cultivation methods. This premium pricing offers a lucrative opportunity for farmers to enhance their income. Organic farming practices often reduce input costs associated with synthetic fertilizers and pesticides. Implementing sustainable practices like crop rotation and intercropping in organic pulse production can lead to long-term cost savings while maintaining soil health. Engaging in organic pulse production allows farmers to diversify their crop portfolio, reducing dependency on a single crop and mitigating market risks associated with price fluctuations and external factors. Organic pulse production contributes to environmental sustainability by promoting biodiversity, reducing chemical inputs, and fostering soil health and water conservation. This not only benefits the immediate ecosystem but also supports long-term agricultural viability.

**CHALLENGES FACED IN ORGANIC PULSE PRODUCTION**

**Limited access to organic inputs and technologies**

Limited access to organic inputs and technologies presents a critical challenge in organic pulse production, impacting both productivity and sustainability. Organic pulses, including lentils, chickpeas, and beans, are vital sources of protein and essential nutrients, often cultivated under organic practices to meet the growing demand for organic food globally (Panneerselvam and Ravi 2020). However, several factors contribute to the constrained availability of inputs and technologies in this sector. Access to high-quality, certified organic seeds tailored to specific regions remains a significant hurdle. Limited availability and higher costs of organic seeds restrict farmers’ choices and may compromise crop performance. Organic farming relies on natural fertilizers, compost, and bio-based soil amendments. However, the accessibility and affordability of these inputs vary widely across regions, hindering consistent and sustainable soil fertility management (Smith and Johnson 2019). Organic pest control methods often include biopesticides and natural predators. However, accessibility to these solutions might be restricted due to limited local availability or high costs, leading to yield losses. Advanced technologies for precision farming, irrigation, and monitoring systems are less accessible or adapted for organic pulse cultivation. The adoption of such technologies could enhance efficiency and yield but remains limited due to various constraints.

**Weed management and labor-intensive practices**

The biggest challenge in organic farming is managing weeds in an organic manner. Organic pulse production, encompassing crops like lentils, chickpeas, peas, and beans, is an essential component of sustainable agriculture. However, one of the primary challenges faced in organic pulse farming is effective weed management without the use of synthetic herbicides.

**Yield variability and productivity concerns**

Organic pulse production, while lauded for its environmentally friendly practices and health benefits, faces significant challenges regarding yield variability and productivity. Pulses, encompassing crops like lentils, chickpeas, and beans, are pivotal for sustainable agriculture due to their nitrogen-fixing abilities and high protein content. However, several factors contribute to the volatility and concerns surrounding their organic cultivation.

**Certification and regulatory issues**

Organic pulse production faces several challenges due to certification and regulatory issues that impact farmers, processors, and consumers alike. These challenges can impede the growth
and adoption of organic practices in the pulse industry. Obtaining organic certification can be expensive and intricate. Small-scale farmers might find it financially burdensome to comply with the stringent requirements set by certifying bodies. The cost of certification, along with the need for paperwork and record-keeping, can deter farmers from transitioning to organic methods. Meeting the diverse and often changing regulatory standards across different regions or countries poses a significant challenge. Farmers often face difficulties in aligning their practices with varying regulations, especially if they engage in export-oriented production where international standards come into play (FAO 2016). Limited access to knowledge and technical support on organic farming practices can hinder farmers’ ability to comply with certification requirements. Training programs and extension services that offer guidance on organic methods are crucial for successful implementation. Organic pulses face market access challenges due to stringent import regulations in some countries. Additionally, ensuring fair trade practices and obtaining fair prices for organic produce remains a concern, impacting the economic viability of organic farming (FAO 2018). Maintaining buffer zones to prevent contamination from conventional farms using synthetic pesticides or GMOs can be logistically challenging. Ensuring these buffer zones meet certification standards requires constant vigilance and coordination among neighboring farms (Pretty et al. 2003, Pretty et al. 2006). Consumer trust in organic products relies heavily on the integrity of the certification process. Any lapse in maintaining the organic standards or instances of fraud can undermine consumer confidence, affecting market demand for organic pulses (FAO 2016). Addressing these challenges requires collaborative efforts among stakeholders, including policymakers, certifying bodies, farmers, and consumers. Supporting research, education, and policy reforms that simplify certification processes, provide better market access, and ensure fair trade practices are crucial for the sustainable growth of organic pulse production.

Knowledge gap

Organic pulse production faces several challenges primarily due to knowledge gaps in various aspects of cultivation, management, and market dynamics. Pulses are vital sources of protein and nutrients, and their organic cultivation presents unique challenges. Here are some key challenges stemming from knowledge gaps. Small-scale farmers often lack access to comprehensive and updated information on organic pulse production techniques. Without adequate knowledge, farmers may struggle to maximize yields and maintain soil health. Access to quality organic seeds adapted to local conditions remains a challenge. Farmers might lack information on suitable seed varieties that thrive in organic settings, impacting crop yield and resilience (Shukla and Mishra 2020). Additionally, the limited availability of certified organic seeds may hinder production scale-up. Understanding soil health and fertility management practices is crucial for successful organic pulse production. Knowledge gaps in organic fertilization methods, cover cropping, and composting techniques hinder farmers’ abilities to maintain optimal soil conditions (FAO 2019). Organic pest and disease control relies on preventive measures, beneficial insects, crop rotation, and natural pesticides. However, gaps in knowledge regarding identification of pests and diseases, as well as the use of organic control methods, can lead to yield losses and crop damage. Farmers might lack information on market demand, quality standards, and certifications necessary for accessing organic markets. Fluctuating prices and inadequate market linkages exacerbate the challenge of obtaining fair prices for organic pulses.

SUSTAINABLE PRACTISES AND INNOVATIONS

Innovations in organic fertilization and pest control

Pulses, known for their ability to biologically fix atmospheric nitrogen through symbiotic relationships with Rhizobium (Herridge et al. 2008). Biological nitrogen fixation transforms inert N₂ into biologically useful NH₃, reducing pulse dependence on external application of nitrogen. While pulses require less nitrogen due to biological fixation, their demand for adequate phosphorus, sulfur, iron, molybdenum, calcium, zinc, boron and potassium is crucial (Banerjee et al. 2021). Phosphorus is essential for root proliferation; sulfur aids amino acid formation (Choudhary et al. 2014), iron promote chlorophyll synthesis (Majeed et al. 2020), iron and molybdenum facilitate nodulation and nitrogen fixation (Banerjee et al. 2021), zinc and boron nutrition reduce the flower drop and increases the pod setting (Raj and Raj 2019), calcium enhances cell wall structure or pod formation (Bagale 2021), and potassium regulates water uptake, providing stress tolerance in pulses (Subbaramamma et al. 2017). These elements collectively contribute to
robust plant growth, protein synthesis, and overall nutrient balance in pulse crops. While pulses can fix nitrogen through nitrogen fixation, this process begins after nodules’ formation, usually 2-3 weeks after sowing (Hossain et al. 2017), indicating the need for a starter nitrogen dose early on. Therefore, achieving balanced fertilization is pivotal in nutrient management for pulse crops, ensuring successful and sustainable crop production. Dass et al. (2014) have made clear that supplying the proper amount of nutrients at the right time and using the right techniques are crucial components of balanced fertilization.

Table 1. Fixation and release of nitrogen into the soil under various pulses

<table>
<thead>
<tr>
<th>Crop</th>
<th>N fixation (kg/ha)</th>
<th>N release into soil (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chickpea</td>
<td>26-63</td>
<td>-</td>
</tr>
<tr>
<td>Cowpea</td>
<td>53-85</td>
<td>50.3</td>
</tr>
<tr>
<td>Lentil</td>
<td>35-100</td>
<td>32.8</td>
</tr>
<tr>
<td>Mungbean</td>
<td>50-55</td>
<td>34.5</td>
</tr>
<tr>
<td>Pigeon pea</td>
<td>68-100</td>
<td>-</td>
</tr>
<tr>
<td>Field pea</td>
<td>46</td>
<td>59.4</td>
</tr>
<tr>
<td>Urdbean</td>
<td>50-60</td>
<td>38.3</td>
</tr>
<tr>
<td>Green gram</td>
<td>30-60</td>
<td>-</td>
</tr>
<tr>
<td>Soybean</td>
<td>20-260</td>
<td>-</td>
</tr>
<tr>
<td>Black gram</td>
<td>80-140</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Brahmprakash et al. (2004), Gill et al. (2009), NIN, 2004

Organic nutrient sources include all the necessary nutrients that plants need, along with several additional elements that either directly or indirectly promote plant growth. Crop nutrient requirements, however, might not be met by a single organic nutrient source (Singh et al. 2023). By integrating various organic nutrient sources in this manner, one may ensure adequate nutrient supplementation and synchronize nutrient availability with crop demand, taking into account the varying nutrient-release patterns among various organic manures throughout the course of the growing season (Patil et al. 2012).

Compost made from plant and animal wastes is a key component of organic farming. Additionally, vermicompost, produced by earthworms, is rich in nutrients and enhances soil microbial activity, promoting a healthier soil environment for pulses. Ullasa et al. (2018) showed considerably increased dry pod and seed yields when the recommended amount of FYM (7.5 t/ha) was applied coupled with 100% N equivalent through vermicompost (2 t/ha). Black gram yield was considerably higher when goat manure and vermicompost were applied together at a rate of 17 t/ha (Haridha et al. 2020). In organic pulse farming, the use of microbial consortia formulations, which blend different beneficial bacteria, can improve disease suppression, nutrient cycling, and soil health overall. Vesicular-arbuscular mycorrhiza (VAM) fungal application is particularly crucial for phosphorus transformations, P economy, and increased green pea productivity in acid Alfisols (Yadav et al. 2015). Nutrient-rich plant extracts can be added to organic fertilizer as supplements or biostimulants to provide extra micronutrients and growth-promoting agents. Akhila (2017) reported that foliar spraying 2% seaweed sap, followed by 1% enhanced banana pseudo stem sap, greatly improved the quality, yields, and economics of green grams. Leguminous plants, such as fenugreek, vetch, and clover, produce green manure that can be added to soil to improve its organic matter content and nutrient content. This procedure helps to increase the fertility and structure of the soil. When enriched compost (one-third), vermicompost (VC) (one-third), and glyricidia leaf manure (GLM) (one-third) were applied with N equivalent to 100% of the recommended dose, the results showed significantly higher grain yield (2,147 kg/ha), haulm yield (3,172 kg/ha), number of pods/plant (62.65), and 100-seed weight (20.25 g) when compared all other organic manure treatments. Mitra and Datta (2001) found that applying a bio-mulch of Saccharum sp + Gliricidia maculata leaves at 7.5 t/ha in a 1:1 ratio in Tripura produced the best number of pods per plant, seeds per pod, and ultimately grain output in blackgram. Mitra (2001) reported that different study that applying poultry manure at a rate of 5 t/ha produced the highest yield of black gram when compared to other reproductive treatments. Chickpeas’ growth and yield-contributing qualities were improved by applying nitrogen equivalent to
100% of the recommended dose through the use of enriched compost, vermicompost, and gliricidia leaf manure in the soil, as well as by foliar spraying panchagavya at 3% or cow urine at 10% during flower initiation and at 15 days after flowering. By combining a variety of organic sources to meet the nutritional needs of chickpeas, this method lessens the need for artificial fertilizers. Additionally, organic manures alter the physical behavior of the soil, improving the applied nutrient effectiveness (Pandey et al. 2007). In addition to increasing yield, consistent organic treatment that satisfies crop requirements also enhances soil fertility and organic matter content (Ramesh et al. 2008, Singh et al. 2016).

Algal extracts or formulations can function as organic fertilizers by offering vital elements including potassium, phosphorus, and nitrogen. Fertilizers based on algae also help to increase microbial activity and soil structure. The utilization of certain concoctions derived from organic materials, such as cow dung and therapeutic herbs. When growing organic pulses, these preparations improve the soil’s fertility and vitality. Numerous studies have demonstrated that applying a 3% foliar spray of panchagavya increased plant growth rates because the plant contains growth hormones and beneficial micro- and macronutrients. The panchagavya enzyme promoted quick cell division and multiplication, which improved plant development patterns (Kumbar et al. 2016). Panchagavya spray (3%) at 10 days after sowing (DAS) considerably boosted the growth of greengram plants, leading to a better grain production (Kumaravelu and Kadambian 2009). There was a noticeable difference in the amount of lateral roots, nodule count, and fresh and dry plant mass that rose considerably at the 3 and 4% treatment levels. The findings of an additional study showed that the most efficient low-cost technique for increasing the grain production of greengram and other crops was the foliar application of panchagavya @ 3% at 15, 25, 40, and 50 DAS with no inorganic nutrients (Somasundaram et al. 2003, Yadav and Vijayakumari 2003). Application of different organic manures, liquid organic manures, and their mixtures had a notable impact on chickpea yield and yield characteristics. In comparison to the foliar spray of bio-digester slurry @ 10% and vermiwash @ 10% at flower initiation and 15 DAF, the spraying of panchagavya @ 3% at flower initiation and 15 days after flowering (DAF) demonstrated a significantly higher grain yield (2,189 kg/ha), haulm yield (3,190 kg/ha), pods/plant (62.01), and 100-seed weight (20.40 g) among liquid organic manures. It was comparable, nevertheless, to the foliar spray of 10% cow urine at flower initiation and 15 DAF. According to De Britto and Girija (2006), cow urine supplies nitrogen, which is necessary for crop growth, while cow dung serves as a medium for the growth of beneficial bacteria in panchagavya. Kumbar et al. (2016) came to the conclusion that French bean yields were noticeably greater when the maximum dosages of jeevamrutha and panchagavya were applied. In a study on French beans, Amareswari and Sujathamma (2015) found that applying 8 t/ha of vermicompost plus 3 percent panchagavya as a foliar spray had the highest benefit-cost ratio, while applying 10 t/ha of straw mulch plus vermicompost plus panchagavya produced the highest net profit. Other than that, crops grown organically can also be nourished with calcium chloride, limestone, gypsum, and chalk. Rao and Kumar (1990) evaluated various pea varieties in Manipur and found that ‘KPMPR 39‘ was the most tolerant to phosphorus stress of all the types examined. Similar to this, Datta and Laskar (1990) found that “DM 1” and “Pusa 8731” showed a decent tolerance to phosphate stress after screening greengram varieties in Tripura for the disease. By growing several crops in one space, intercropping encourages biodiversity and makes the environment less inviting to pests (Smith and McSorley 2000).

Strip cropping, which involves growing various crops in alternating strips over a field, is a variation of this technique. Both approaches seek to prevent the spread of pests. Bringing in bug predators with a variety of blooming plants (such as celery and fennel from the Umbelliferae family) is a good way to keep pests away from your garden. These helpful insects aid in keeping pest populations below levels that could be detrimental to the economy. The way the soil and foliage are tilled has a significant impact on insect populations. Tillage systems, which are usually carried out in the fall or early spring, target insects that are in the process of overwintering. This disrupts their life cycle and exposes them to predators and unfavorable weather. Sprinkler-based crop irrigation has been shown to decrease pest populations, whereas culvert irrigation upsets soil insect life cycles (Caldwell et al. 2005). Mulching is the process of applying a material layer to the soil’s surface with several benefits, including improved soil fertility, weed control, moisture conservation, and defense against pest infestation (Gill et al. 2009). Compared to bare soil, mulch—which can be organic or non-biodegradable like
plastic sheeting—is more successful in keeping insects at bay. Aphids and whiteflies can be further suppressed by using different colored plastics, such as clear, white, yellow, or reflective metal. However, be cautious when using colors like blue and yellow, since these may attract more pests. In order to ensure conformity with certifier organizations’ standards, farmers who are thinking of mulching should review organic regulations (Brian Caldwell et al. 2013, Linker et al. 2009).

**All-round herbal pesticide**

The following are common plants that can be used to make herbal extracts (Stoleru and Sellitto 2016).

**Agro-ecological approaches for enhancing productivity**

Using sustainable techniques to maximize environmental effect while enhancing the resilience, yield, and soil health of pulse crops—such as

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Common Name</th>
<th>Botanical Name</th>
<th>Useful Plant Parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Neem</td>
<td>Azadirachta indica</td>
<td>Neem Cake</td>
</tr>
<tr>
<td>2.</td>
<td>Pungam</td>
<td>Pongamia glabra, Pongamia pinnata</td>
<td>Leaf and flower</td>
</tr>
<tr>
<td>3.</td>
<td>Notchi</td>
<td>Vitex negundo</td>
<td>Leaf and flower</td>
</tr>
<tr>
<td>4.</td>
<td>Nithyakalyani</td>
<td>Catharanthus roseus</td>
<td>Whole plant</td>
</tr>
<tr>
<td>5.</td>
<td>Unni</td>
<td>Lantana camera</td>
<td>Leaf and flower</td>
</tr>
<tr>
<td>6.</td>
<td>Devils Trumpet</td>
<td>Datura metel</td>
<td>Leaf, fruit, flower</td>
</tr>
<tr>
<td>7.</td>
<td>Yellow Nelliam</td>
<td>Nerium thevetia</td>
<td>Flower, fruit, root</td>
</tr>
<tr>
<td>8.</td>
<td>Aruku</td>
<td>Calotropis gigantea</td>
<td>Leaf, fruit, root</td>
</tr>
<tr>
<td>9.</td>
<td>Siria Nangai</td>
<td>Andrographis paniculata</td>
<td>Whole plant</td>
</tr>
<tr>
<td>10.</td>
<td>Parthenium</td>
<td>Parthenium sp.</td>
<td>Plant before flowering</td>
</tr>
<tr>
<td>11.</td>
<td>Adathoda</td>
<td>Adhatoda vasica</td>
<td>Leaf</td>
</tr>
<tr>
<td>12.</td>
<td>Tobacco</td>
<td>Nicotiana tabacum</td>
<td>Dried leaf, plant waste, stem waste</td>
</tr>
<tr>
<td>13.</td>
<td>Chevanthi</td>
<td>Chrysanthemum cinerariifolium</td>
<td>Flower</td>
</tr>
<tr>
<td>14.</td>
<td>Thumbai</td>
<td>Leucas aspera</td>
<td>Flower, leaf, tender stem</td>
</tr>
<tr>
<td>15.</td>
<td>Tobacco Plant (weed)</td>
<td>Lobelia sp.</td>
<td>Whole plant</td>
</tr>
<tr>
<td>16.</td>
<td>Ginger</td>
<td>Zingiber officinale</td>
<td>Rhizome</td>
</tr>
</tbody>
</table>

Natural plants and their target insect pests (Stoleru and Sellitto 2016)

Table 3. Natural plant associated to control target pests

<table>
<thead>
<tr>
<th>Natural plant</th>
<th>Target pests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yarrow (Achillea millefolium)</td>
<td>Aphids, Mites, Psyllids, Thrips</td>
</tr>
<tr>
<td>Queen of poisons (Aconitum sp.)</td>
<td>Coleopteran larvae</td>
</tr>
<tr>
<td>Sweet flag (Acorus calamus)</td>
<td>White cabbage butterfly</td>
</tr>
<tr>
<td>Onion (Allium cepa)</td>
<td>Mites, ants, storehouse pests</td>
</tr>
<tr>
<td>Garlic (Allium sativum)</td>
<td>Thrips, storehouse pests</td>
</tr>
<tr>
<td>Birthwort (Aristolochia clematitis)</td>
<td>Bed bug</td>
</tr>
<tr>
<td>Absinthium (Artemisia absinthium)</td>
<td>Nematodes, caterpillars, fleas</td>
</tr>
<tr>
<td>Mugwort (Artemisia vulgaris)</td>
<td>Fleas, Colorado beetle</td>
</tr>
<tr>
<td>Lamb’s quarters (Chenopodium album)</td>
<td>Colorado beetle, white butterfly</td>
</tr>
<tr>
<td>Hemlock (Conium maculatum)</td>
<td>Coleopteran larvae</td>
</tr>
<tr>
<td>Coriander (Coriandrum sativum)</td>
<td>Aphids, spiders, Colorado beetle (repellent effect)</td>
</tr>
<tr>
<td>Spurge (Euphorbia.)</td>
<td>Caterpillars, aphids</td>
</tr>
<tr>
<td>White sweet clover (Melilotus albus)</td>
<td>Colorado beetle</td>
</tr>
<tr>
<td>Mint (Mentha sp.)</td>
<td>Colorado beetle</td>
</tr>
<tr>
<td>Tobacco (Nicotiana tabacum)</td>
<td>Aphids, mites, Colorado beetle</td>
</tr>
<tr>
<td>Black nightshade (Solanum nigrum)</td>
<td>Aphids, mites, Colorado beetle, cabbag beetle</td>
</tr>
<tr>
<td>Yew (Taxus bacata)</td>
<td>Various insects</td>
</tr>
<tr>
<td>Field penny-cress (Thlaspi arvense)</td>
<td>Bed bug (repellent)</td>
</tr>
<tr>
<td>Common nettle (Urtica dioica)</td>
<td>Aphids, mites</td>
</tr>
<tr>
<td>Mullein (Verbascum phlomoides)</td>
<td>Colorado beetle</td>
</tr>
</tbody>
</table>
lentils, chickpeas, beans, and peas is known as agroecologically enhanced pulse productivity. These are a few tactics:

### Crop Rotation

Pulses disrupt disease cycles, improve soil structure, and increase fertility when a variety of crop rotations are implemented. Pulses can help promote balanced nutrient intake and lessen pest pressure when they are planted in rotation with other crops, such as grains or oilseeds. To optimize nutrient availability and reduce fertilizer usage, crop sequences might be changed. Leguminous crops, for example, provide a substantial source of easily absorbed nitrogen for crops that follow and aid in fixing atmospheric nitrogen. Certain crop rotations (e.g., by preferring winter crops or the introduction of cover crops) also increase soil conservation and protection by increasing soil cover (Dogliotti et al. 2004) and (Watson et al. 2002). In addition to increasing soil stability, these rotations boost soil fertility and carbon content. The root systems of succeeding crops are important because crop remains, such as roots, increase soil structural stability and promote soil biological activity. Through root turnover and exudates, root systems provide up to 40% of the microbial carbon absorption, according to research by Richardson et al. (2009). Therefore, it could be a good idea to include cover and catch crops in the rotation (Bilbro 1991, Bruce et al. 1991; Nearing et al. 2005). By switching up the crops cultivated in the cropping sequence and avoiding the establishment of following host crops for diseases, crop rotations can also be an efficient way to reduce the incidence of pests and illnesses. Crop management strategies, such as crop residues and fertilizer, are also essential. Fourth, crop rotation is widely acknowledged as an effective method of reducing weed invasion. This results from certain crops’ exceptional ability to cover soil quickly, which puts them in conflict with weeds for resources like light and soil. Additionally, crop management plays a key role in weed control, with several weeding strategies available at various times of the year (Anderson 2007, Bárberi 2002, Koocheki et al. 2009).

### Cover crop/green manure

Cover crops, often known as green manure, are a popular agroecological method to reduce soil or wind erosion, lower the risk of water contamination from leaching, and limit fertilizer inputs (Sanchez et al. 2004, Scholberg et al. 2010). Crop diversity results naturally from the use of cover crops in the rotation. Legumes also boost biological activity in the soil and deliver nitrogen (N) for the crop that follows (Birkhofer et al. 2008, Steenwerth and Belina 2008). Legumes can be a useful source of easily absorbed nitrogen for other crops in the rotation since they can fix atmospheric nitrogen (Birkhofer et al. 2008). Furthermore, they release large amounts of labile carbon molecules that improve soil structure and promote microbial growth (Shepherd et al. 2002). However, there are disadvantages to utilizing cover crops, including the need for more effort and the potential for pest development (e.g. snails growing under cover crops).

### Intercropping

Pulses may naturally manage pests and
enhance soil health when grown in a field with other suitable crops. This optimizes land use and biodiversity as well. It is anticipated that intercropping systems provide potential benefits in productivity, output stability, disturbance resistance, and ecological sustainability, despite the prevalent perception that they are more challenging to manage (Vandermeer 1989). Controlling resource competition among related crops is the main goal in a system such as this (Ozier-Lafontaine et al. 1997, Van Noordwijk et al. 1996, Willey 1990). The main objective of intercropping is to increase land production through the complementarity of related crops. The usage of radiation, in particular, can be improved when a related crop benefits another. Schmidt et al. (2005, Midmore 1993). Facilitation also occurs in enhanced resource use efficiency. It has been demonstrated that the root exudates of several legume species raise the availability of phosphorus in the soil, solubilizing soil organic phosphorus and improving organic fertilization at the same time (Li et al. 2005, Midmore 1993). Facilitation also occurs when a related crop benefits another. Schmidt et al. (2003), for instance, noted that twice as many earthworms were found in the soil when wheat was grown adjacent to clover grass. Another example is that the higher resource use efficiency and increased competitiveness of cereal crops when produced in an intercropped system, as opposed to as a solitary pea crop, may help reduce weed infestation in pea crops (Hauggaard Nielsen et al. 2001, 2006). Intercropping also improves the soil’s physical structure and fertility. These systems exhibit decreased compaction and penetration resistance along with improved structural stability (Carof et al. 2007, Latif et al. 1992). Further, intercropping also usually results in increased soil cover, which lessens soil erosion and crust forming (Le Bissonnais et al. 2004). The interaction of many crops on resources including soil, residual moisture, light, and nutrients occurs in an intercropping system. The crops utilize these materials well because of their modified roots and growth patterns. When green gram and maize are interplanted together, there is less competition because their peak periods for resource requirements are different. As a result, the system as a whole will benefit from reduced disease and pest incidence as well as enhanced weed-smothering effectiveness.

Weeds are effectively choked out by pulses because of their fast ground-vegetative cover. The decrease in the incidence of pests and illnesses is caused by the barrier crop effect, which holds that each companion crop will prevent the spread of pests and diseases of other crops. The reason behind the decline in the occurrence of pests and illnesses is the barrier crop effect, which posits that a companion crop will impede the spread of pests and diseases to other crops. They were also found to reduce the incidence of pests and illnesses (Schoeny et al. 2010, Uzokwe et al. 2016).

**Soil Management**

The cultivation of pulses in an organic production system requires the preservation of soil fertility through techniques like no-till or minimum tillage farming, cover cropping of legume and the crop residues or compost for addition of organic matter. These factors are essential for the growth of pulse crops (Bridgit et al. 1994). No-till practices, which minimize mechanical soil disturbance, can have significant positive effects on the environment and economy (e.g., reduced field operations, reduced erosion, retention of nutrient-rich top soil, improved water capture and retention). However, the yield impacts of no-till are complex, context-dependent, and dependent on management duration (Daigh et al. 2018). When no-till is utilized with some cropping systems, yields decrease over the long and short terms (Giller et al. 2015, Pittelkow et al. 2015a). A recent worldwide meta-analysis comparing yields under no-till and conventional tillage, using over 5,000 paired yield data across crop types, found an overall yield reduction of −9.9% when no-till was applied alone (Pittelkow et al. 2015b). Yield decreases were attenuated when no-till was combined with rotation (−6.2%) or residue retention (−5.2%), and negative yield effects were even avoided when all three approaches were applied concurrently (−2.5%) (Pittelkow et al. 2015a). The near-term (1-2 yr) versus long-term (10+ yr) implications vary depending on whether no-till was employed alone (i.e., near- and long-term yield declines) or in combination with other CA practices (near-term yield declines diminish in the mid- and long-term). Cover crops offer a higher 100-150 g CO₂-e/m²/year reduction in greenhouse gas flux when compared to no-till mitigation. Based on case studies, an estimate of the impact of cover crops on surface albedo changed over a 100-year period, showing mitigation of 12-46 g CO₂-e/m²/year. Cover crop management helps with climate change adaptation by lowering soil erosion from rain, conserving mineralized nitrogen due to warming,
and increasing soil water management options during periods of soil saturation or drought (Kaye and Quemada 2017).

Nitrate leaching losses in conventional grain production systems could represent 10% to 30% of the applied nitrogen. Sharma et al. (2012) state that it’s a complex process that relies on variables related to the climate, soil characteristics, and management practices. Nitrate leaching is a major concern since it directly affects drinking water, eutrophises ocean, and causes atmospheric ammonia pollution. Precision agriculture is one soil management strategy that can help lower nitrogen leaching in agricultural soils, according to Di and Cameron (2002). Tosti et al. (2014) reported that a noteworthy further study demonstrated the efficacy of cover crops and green manures in controlling nitrogen in agricultural soils. With nitrogen being absorbed by roots, nitrate leakage into groundwater is prevented, and downward movement into the soil profile is hindered, cover crops can reduce the amount of nutrients needed, especially nitrogen, for the following crop (Gabriel et al. 2013). Essentially, the purpose of planting cover crops is to lessen soil erosion (Parke 1915). These are the tools and techniques used to control erosion and protect the environment. Cover crops contribute to reducing the quantity of precipitation that reaches the ground by serving as a barrier between the soil’s surface and precipitation, especially rainfall. Water slowly seeps into the ground through soil pores, which are enhanced by the root growth of cover crops and formed by soil macrofauna (Joyce et al. 2002). Consequently, water infiltration rises rather than drains away, replenishing soil water storage (Joyce et al. 2002, Sharma et al. 2011).

In organic and sustainable farming systems, cover crops such as narrow-leaved lupine (Lupine angustifolius L.) mixed with oil radish (Raphanus sativus), white mustard (Sinapis alba L.), and white mustard mixed with common buckwheat (Fagopyrum esculentum Moench) are used to suffocate weeds in soils with low humus (1.90% - 2.01%) and moderate humus content (2.10% - 2.40%). In an organic farming system, white mustard proved to be more effective at suppressing weeds than narrow-leaved lupine cultivated in combination with oil radish, either as a single crop or in conjunction with buckwheat. The study revealed that when field plots without cover crops were compared to those grown with them, the former had a greater amount and biomass of weeds. This applied to soils with low and high humus contents. The application of white mustard and a mixture of white mustard and buckwheat was shown to have the highest effects on volunteer plants and weed biomass in soils with low and high humus content (Masilionyte et al. 2017, Tonitto et al. 2006). Cover crops have the advantage of having a greater SOC without reducing the yield of primary crops when compared to alternative management strategies. At a depth of 22 cm, cover crops rotated for up to 54 years shown a linear connection with annual SOC change at a rate of 0.32 ± 0.08 Mg/ha/yr ($R^2 = 0.19$). The average SOC stock change was modeled with the assumption that the observed linear SOC accumulation will not continue to increase indefinitely. The updated projected steady state data would have a SOC accumulation of 16.7 ± 1.5 Mg/ha/yr after 155 years of using cover crops (Poeplau and Don, 2015). Using cover crops is a common strategy to encourage soil microbial growth in agricultural contexts. The study examined the number of microorganisms and soil enzyme activities in cotton (Gossypium hirsutum L.) grown in conventional tillage and No-tillage (NT) systems that included ryegrass as a cover crop. When ryegrass cover crops were compared to no-cover plots in CT and NT, the former maintained a higher microbial population in the top layer (2 cm), whereas the latter had higher soil depths of 2 to 10 cm with more bacterial and fungal colony-forming units (CFUs). Cover crops under NT retained CFUs 100 times greater than those under other treatments (Zabladowicz et al. 2007). The earthworm population and biomass in cover crop plots increase by 1.2 and 1.4 times, respectively, compared to no cover crop areas when rye (Secale cereale L.) is planted in corn silage-soybean rotation (Roarty et al. 2017). Long-term use of cover crops reduces nutrient and sediment losses from surface runoff by enhancing soil structure and increasing the population of earthworms (Korucu et al. 2018). Enhancing soil quality will increase output and optimize fertilizer use. Pulse crop wastes should be fed to the soil in addition to fertilizer. A significant amount of leaf litter, or falls of leaves, is also seen in various pulses; they give nutrients to the soil as they decompose. (Table 5).

Reducing nutrient losses through leaching, volatilization, or fixation especially in situations with unfavorable soil conditions is another crucial factor in the wise use of agricultural leftovers. Pulse crop residues break down more quickly due to their low C/N ratios, and they also provide a good supply of readily available nutrients, which increases soil fertility. It would be simple to replace
the 25–50% NPK requirements of winter season crops with crop residues from short-duration summer or rainy season pulses. Using crop residue in organic farming and utilizing cellulolytic fungi to accelerate its breakdown can improve the physical, chemical, and biological properties of the soil while preserving 25–50% of the plant nutrients used in fertilizer applications during crop production, according to numerous studies. The addition of chopped residues and watering promotes microbial breakdown and mineralization. In the rice-chickpea sequence, the inclusion of rice residue had a substantial impact on the yield of chickpeas. The treatment that removed rice residue produced the lowest seed yield, while the inclusion of chopped straw with irrigation produced the highest yield. Similarly, compared to the control, the addition of chopped mungbean waste and irrigation increased wheat yield by 38% (Annual Report, 2011–12). Urdbean and mungbean residue addition to the system had a beneficial impact on soil microbial biomass carbon.

Research advancements in organic breeding and genetics

Growing interest has been shown in the genetics and organic breeding of pulse crops (lentils, chickpeas, peas, etc.) with an emphasis on the sustainability, biodiversity, and stress-resilience of organic agriculture. Here are a few noteworthy developments: (i) Genetic Diversity and Adaptation: Scientists are finding genetic markers linked to desired characteristics such as resistance to disease, drought tolerance, and increased yields in pulse crops. This helps create types that work well in organic environments. Maintaining genetic diversity is important for organic systems that face a variety of environmental stresses, and it can be achieved by using diverse populations rather than pure lines. (ii) Breeding Technique: This method saves time and money by using genetic markers to speed up the selection process for desirable qualities rather than depending only on field trials. Precise genome alterations in the pulse can be achieved through methods such as CRISPR-Cas9, which may improve organic yield by enhancing features like insect resistance or nutritional content. (iii) Biofortification: Increasing the content of nutrients in pulses, such as protein or iron levels, to compensate for dietary shortages and encourage better eating, breeding to increase the flavor, texture, and cooking qualities that appeal to consumers. (iv) Pest and Disease Resistance: Our expanding understanding of the genetic basis of resistance to pests and diseases has made it possible to produce cultivars with innate protection against common challenges in organic settings. The managing pests and disease without the use of synthetic pesticides by combining genetic resistance with cultural, biological, and ecological methods. Environmental adaptation, or breeding pulses that can survive in a variety of settings, such as high temperatures or scarce water supplies, is important for organic systems that depend on natural inputs. Creating cultivars that are compatible with various agroecosystems and farming methods while adhering to organic farming principles.

POLICY RECOMMENDATIONS AND FUTURE DIRECTIONS

Policy support for organic pulse farming

India has a long history of agricultural practices, and pulses are a key crop because of their high nutritional content and ability to improve soil fertility. The Indian government has implemented many measures to encourage and support organic pulse production in the nation, acknowledging the significance of sustainable agriculture and the increasing market for organic food.

Policy Initiatives and Support

(i) National Mission on Sustainable Agriculture (NMSA): The Indian government launched the NMSA with the goal of advancing organic farming and other sustainable agricultural methods. It offers farmers both financial and technical support to help them use organic farming practices when growing pulses.

(ii) Paramparagat Krishi Vikas Yojana (PKVY): Through the support of both traditional and organic methods, this initiative fosters organic farming. It encourages farmer groups to form

<table>
<thead>
<tr>
<th>Crop</th>
<th>Leaf litters (t/ha)</th>
<th>N (kg/ha)</th>
<th>P (kg/ha)</th>
<th>K (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chickpea</td>
<td>1.1-1.7</td>
<td>7-14</td>
<td>3.5-5.0</td>
<td>8-20</td>
</tr>
<tr>
<td>Lentil</td>
<td>1.3-1.6</td>
<td>8-10</td>
<td>3.5-4.5</td>
<td>12.5-19</td>
</tr>
<tr>
<td>Pigeonpea</td>
<td>1.3-2.8</td>
<td>8-16</td>
<td>2.5-5.0</td>
<td>13.5-24</td>
</tr>
</tbody>
</table>
and offers financial support to farmers for infrastructure development, training, and certification.

(iii) **National Programme on Organic Production (NPOP):** With certification and quality control, the Ministry of Agriculture’s NPOP seeks to promote the growth of organic agriculture. It sets standards for organic production and accredits certification agencies.

(iv) **Mission Organic Value Chain Development for North Eastern Region (MOVCDNER):** The GoI has initiated a mega programme to promotes third party certified organic farming by involving Farmers Producer Organizations (FPOs) with special emphasis on export in NEH Region of the country in 2015-16. In this scheme farmers are given an assistance of Rs 25,000 per ha basis for three years for organic inputs including organic manure and bio-fertilizers among other inputs. Support for formation of FPOs, capacity building, post-harvest infrastructure up to Rs 2 crore are also provided in the scheme.

(v) **Organic Farming Policy:** Several states in India have formulated their organic farming policies to incentivize farmers to shift from conventional to organic practices. These policies offer subsidies, training, and market linkages to promote organic pulse cultivation.

(vi) **Market Support and Promotion:** The government has taken steps to create a robust market for organic produce. Initiatives include setting up organic markets, providing marketing support, and encouraging public procurement of organic pulses for government programs like the Mid-Day Meal Scheme.

(vii) **Awareness and Consumer Education:** Launch awareness campaigns highlighting the health and environmental benefits of consuming organic pulses. Educate consumers about the importance of supporting local organic produce for the overall well-being of farmers and the environment.

**Future Directions**

(i) **Financial Assistance:** Subsidies and financial aid are provided to farmers for the procurement of organic inputs, certification costs, and infrastructure development for organic farming. (ii) **Capacity Building and Training:** Training programs and workshops are conducted to educate farmers about organic farming practices, certification processes, and market access. (iii) **Market Linkages and Certification:** Facilitating market access and ensuring certification of organic produce to comply with national and international standards. (iv) **Research and Development:** R&D expenditures for the creation of high-yielding organic cultivars, pest control techniques, and enhancing soil health. (v) **Collaboration and Partnerships:** Foster collaborations between government bodies, NGOs, private sectors, and international organizations to leverage expertise, technology, and investments in the organic pulse production sector.

**CONCLUSION**

Exploring the realm of organic pulse production unveils landscape rich in promise and potential, yet not devoid of challenges. The opportunities within this sector are vast, offering avenues for sustainable agriculture, nutritional enhancement, and economic growth. However, to fully harness these benefits, it’s crucial to navigate and address challenges such as market demands, technological advancements, and environmental sustainability. By fostering innovation, encouraging research, and implementing supportive policies, the potential of organic pulse production can be maximized. Collaborative efforts between farmers, researchers, policymakers, and consumers are pivotal in overcoming obstacles and tapping into the myriad opportunities this sector presents. A more robust and healthy agricultural landscape will surely result from embracing these challenges as stepping stones towards a more resilient and sustainable future for the production of organic pulses.

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