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Cluster Bean Production Technology: A Guide to Sustainable Farming

(*Astha Verma[1] and Ajit Tippannavar[2])
[1]Department of Vegetable Science, Swami Keshwanand Rajasthan Agriculture University. Bikaner- 334006, Rajasthan
[2]Department of Fruit Science, College of Horticulture and Forestry, Jhalawar Agriculture University, Kota-326023, Rajasthan
*Corresponding Author's email: asthaverma737@gmail.com

Abstract
An important legume, cluster beans are mostly grown on marginal and sub-marginal areas in dry and semi-arid climates. Approximately 80% of the world's cluster bean crop is produced in India. In India, it is grown on over 4 million hectares; Rajasthan alone accounts for around 80% of the total acreage and yield. It has been launched in non-traditional growth regions including Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra, and Chhattisgarh due to its demand in the global market. Additionally, during the summer, its cultivation is being undertaken with irrigation. The endosperm of cluster beans is a natural source of galactomannan, sometimes known as "guar gum (28%-32%)" (Kherawat *et al*., 2013). With several commercial applications in the textile, printing paper, cosmetics, mining, pharmaceutical, petroleum, natural gas, well drilling, and oil industries, the gum possesses special qualities. Due to its high nutritional content, green pods are frequently eaten as a vegetable, particularly in northern and western India. Furthermore, growing cluster beans as an intercrop has reportedly shown positive results. Animals with a monogastric stomach benefit greatly from the high protein content of cluster bean meal, which is derived from seed coat and germ cells. Exporters tend to favour cluster bean varieties with higher gum content (>32%).

Introduction
Cluster bean, scientifically known as *Cyamopsis tetragonoloba* L, is a popular leguminous crop cultivated for its pods and seeds. It is commonly grown in arid and semi-arid regions, making it an essential crop for many farmers around the world. It is also known as guar, is not only a vital food source but also has various industrial applications. Cluster bean is used in diabetes therapy because of its effects on carbohydrate and lipid metabolism. The action of cluster bean on carbohydrates and lipid metabolism is explained by its marked gel - forming capacity and the resulting delayed emptying of the stomach and delayed intestinal absorption of nutrients. Guar gum is a direct fibre advocated for use in lowering serum total cholesterol levels in patients with hypercholesterolemia (Pande *et al*., 2012). Traditionally, the main use of guar plant was as a green manure and soil conserving cover crop. It is consumed as a vegetable and snacks by human beings (Saini, 2014). Rajasthan, in India, is the principal guar growing state accounting for about 87.7% of the production and 91.5% of the acreage during 2020–21 (Anonymous, 2023). In this article, we will explore the production technology of cluster beans, from seed selection to harvest, and discuss the factors that contribute to a successful and sustainable cultivation process.

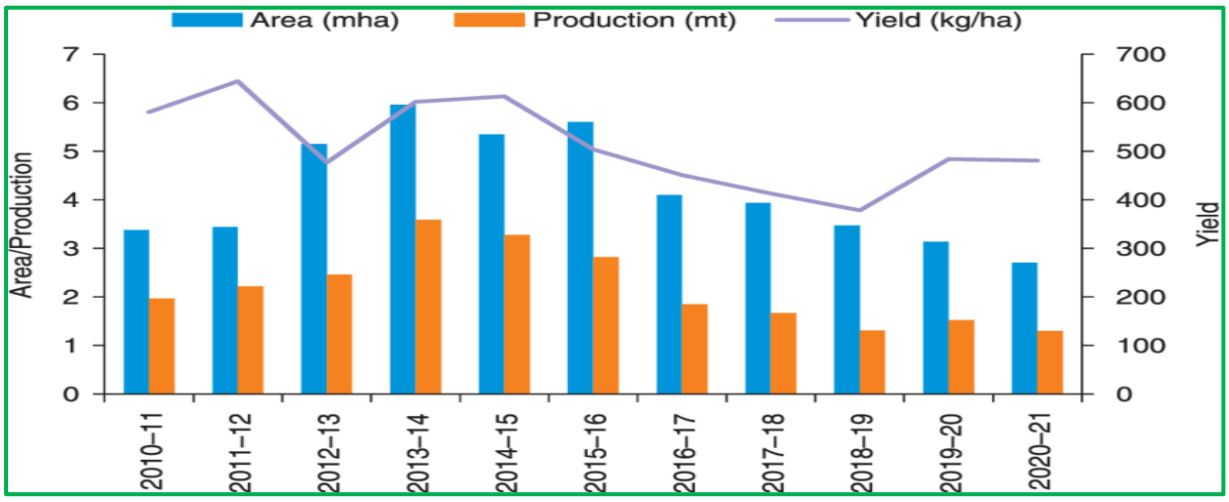
Botany

- Cluster bean common names- gavar, gawar, or guvar bean
- Botanical name - *Cyamopsis tetragonoloba* (L.) taubert
- Family – fabaceae
- Chromosome no. (2n) = 14
- Origin - India
- Types of fruit – pod
- Edible part – seed
- Stem – angled
- Leaves – trifoliate
- Flowers – small white or purple
- Androecium – monodelphus 10 stamens
- Inflorescence – axillary racemes
- Root system – deep roots
- Fruits – compressed, erect and 4-10 cm long double ridge on dorsal side and single ridge below and beaked
- Seed - 5 to 12 white to grey or black coloured seeds per fruit.
- Economic part - green pods used as vegetable and dry seeds.
- It is also grown as a forage and green manure crop.
- Some of the varieties are used for extraction of gum (guar gum).
- The pods are small, double ridged on the dorsal side and borne in clusters.
- It is drought tolerant and is also grown in arid zones as a fodder crop.

Distribution and uses

- Cluster bean is grown in Myanmar, Srilanka, Pakistan and arid regions of the United States like Arizona and Texas.
- In India, cluster bean is cultivated in Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka, Haryana, Uttar Pradesh, Rajasthan and Gujarat (Pabal, 2013).
- Green pods of cluster bean are used as a vegetable and the dry seeds as pulses.
- It is also used as green manure and fodder crop.
- Some of the varieties are suitable for the extraction of gum (20% on dry weight basis).

Area and Production of Cluster Bean



Nutritional value in cluster bean

- Cluster bean is an important source of protein and minerals.
- Its seeds are used as a chemotherapeutic agent against small pox and as a laxative.

- Per 100 g edible pods it contains 81.0 g moisture, 10.8 g carbohydrates, 3.2 g protein, 1.4 g minerals, 0.4 g fat, 2.3 g fiber, 330 IU vitamin A and 49 mg vitamin C (Parthasarathy, 2003).

Climate

- Cluster bean is a warm season, hardy and drought tolerant vegetable adapted to arid and semi arid regions of the world.
- The plant does not tolerate heavy rainfall during flowering and pod formation.
- The average temperature range is 23-33^{0}C.

Soil

- Cluster bean grown in various soils but well drained sandy loam soil with pH 7.0- 7.5 is best suited.

Improved varieties

- **Selection of Suitable Varieties:** The first step in cluster bean production is selecting the right variety. When choosing a variety, consider factors such as local climate conditions, soil type, and market demand. It's essential to choose a variety that is well-suited to your specific region and cultivation objectives.
- ✓ **Pusa Sadabahar (IARI, New Delhi):** The plants for growing in both summer and rainy seasons the pods are green, tender, fibreless and 12-13 cm long. First harvesting is possible in 45 days after sowing in summer season and 55 days in rainy season.
- ✓ **Pusa Mausami (IARI, New Delhi):** The plants suitable for sowing in rainy season .the pods are bright green, smooth and 10-13 cm long. It is late maturing variety and first picking is possible in 65-80 days after sowing.
- ✓ **Pusa Navbahar (IARI, New Delhi) :** It was developed by selection from the cross Pusa Sadabahar and Pusa Mausami. The variety is suitable for sowing in both summer and rainy seasons. The pods are attractive green and 10-12 cm long. First picking is possible by 40 days after sowing.
- ✓ **Sharad Bahar (NBPGR, New Delhi):** It is also suitable for sowing in both summer and rainy seasons. The pods are attractive green, succulent and long.

Land preparation

Cluster beans thrive in well-drained, sandy loam or sandy clay loam soils. Before sowing, the land should be prepared by ploughing and harrowing to ensure proper soil tilt and aeration. The ideal soil pH for cluster bean cultivation is between 6.5 and 7.5. Soil testing can help determine whether any amendments are needed to adjust the pH and nutrient levels.

Sowing of seeds

Cluster bean seeds are usually sown directly in the field, although transplanting can also be done in some cases. The best time to sow cluster bean seeds is during the monsoon season when there is enough moisture in the soil. For direct sowing, seeds are typically sown at a depth of 2-3 cm and spaced at intervals of 10-15 cm between rows and 5-10 cm between plants.

Seed rate

- The seed rate for cluster bean is 25-30 kg /ha.
- Spacing is maintained at 45-60 cm between rows and 15 – 20 cm between plants.
- Sowing is done at a depth of 3-5 cm.

Seed treatments

To facilitate nodulation on roots, inoculate the seed with *rhizobium japonicum* culture where the bean sown for the first time.

Irrigation

Cluster beans require adequate moisture for germination and early growth. Depending on the climate and soil moisture retention, a suitable irrigation schedule should be followed. Drip irrigation is highly efficient in conserving water and preventing waterlogging, which can be detrimental to cluster bean plants.

Nutrient Management

Rajput (2002) and Priyadarshini *et al*., (2017) have reported higher yield with recommended dose of fertilizers (RDF) @ 20: 40: 20 kg ha^{-1} of N: P_2 O_5: K_2O. Proper nutrient management is crucial for maximizing cluster bean yield. Before sowing, apply well-rotted organic manure or compost to improve soil fertility. Nitrogen, phosphorus, and potassium are essential nutrients for cluster bean plants. Based on soil test results, apply fertilizers at the recommended rates. Cluster beans are often sensitive to excessive nitrogen, so it's crucial not to over-fertilize.

Weed Control

Weed competition can significantly reduce cluster bean yields. Manual weeding, mulching, or the use of pre-emergence and post-emergence herbicides can help control weeds in the field. Care should be taken to avoid damaging the cluster bean plants during weeding operations.

Training and Staking

Cluster bean plants tend to grow as sprawling bushes. To prevent pod damage and facilitate harvesting, it is advisable to provide support by staking the plants. This practice also helps in maintaining good aeration, which reduces the risk of disease.

Harvesting

The yield of about 3-4 tonnes of green pods are expected form a hectare. Despite of the maximum area of cluster bean in Rajasthan, the average productivity is only 0.25 tonnes/ha as compared to 0.37, 0.70 and 1.20 tonnes/ha in Gujarat, Haryana and Punjab, respectively (Henry 2003). Cluster beans are typically ready for harvest 60-75 days after sowing (Suliman *et al*., 2017). Harvesting should be done when the pods are still tender and before they become fibrous. Using a sharp knife or shears, cut the pods from the plant. Cluster beans are generally harvested every 3-4 days to ensure a continuous supply of fresh pods. Dry seeds are harvested when a large % of pods are full and most of the remaining will turn yellow. It is to be harvested before the lower pods dry enough to start shattering.

Post-Harvest Management

After harvesting, the pods should be sorted, cleaned, and graded. Cluster beans can be consumed fresh, or they can be dried for storage and later use. Proper storage in cool, dry conditions is necessary to prevent spoilage. Cluster bean seeds are also valuable for industrial purposes, as they are a source of guar gum, which has various applications in the food, pharmaceutical, and oil drilling industries.

Pest and Disease Management

Plant protection: Cluster beans can be susceptible to various pests and diseases, including aphids, whiteflies, powdery mildew, and bacterial blight. Regular scouting of the crop is essential to detect any pest or disease infestations early. Integrated pest management (IPM) practices, which may include using natural predators, biopesticides and resistant varieties which can help to manage these issues effectively.

Insects: pod borer, aphid and plant hoppers.

Diseases: powdery mildew, phytophthora pod rot and rust.

Schedule

Spray the crop with phosphomidon (0.5 ml/litre) or monocrotophos (1.25 ml/litre) on appearance of aphids.

Spray the crop with wettable sulphur (3g/ litre) or dinocap (1ml/litre) when powdery mildew is noticed.

Conclusion

Cluster bean production technology involves a series of steps that, when followed meticulously, can lead to a successful and sustainable cultivation process. From selecting the right variety to implementing best practices in land preparation, irrigation, nutrient management, pest and disease control, and harvesting, every aspect of cluster bean cultivation requires attention and care. By adhering to these guidelines, farmers can enhance their crop yields, reduce losses, and contribute to the sustainable production of this important leguminous crop, benefiting both local food security and industrial applications.

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