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DRONE TECHNOLOGY: APPLICATION IN AGRICULTURE

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ABSTRACT

The mechanization of agriculture has increased farm efficiency and productivity enormously. Drone technology can help meet the feeding needs of the rapidly increasing population by producing quality food with efficient manpower and resources. Drone technology can help reduce farmers' work to a large extent. Drones can help farmers optimize inputs, react more quickly to pests and diseases, save time from crop scouting, and also helps in yield prediction. Drones can monitor any crop in any geographical area. The use of drone technology is expected to be increased in future, which will help improve crop yields and productivity.

INTRODUCTION

Agriculture is the main occupation for the majority of people in India. The mechanization of agriculture has increased farm efficiency and productivity enormously. To meet the feeding needs of the rapidly increasing population, we need to use special instruments designed by engineers to serve the agriculture sector. One such example of the modern-day technologies used nowadays is drones in almost every sector, as the economy is growing very fast due to limited environmental resources. According to the reports use of drones will increase quickly in the upcoming few years. From scouting to security, drone use will become ubiquitous on small- and large-scale farms. For large-scale farming, drones in precision farming have already become an essential part of the farming operation.

DRONE

An agricultural drone is an unmanned aerial vehicle to help optimize agricultural operations, increase crop production, and monitor crop growth. Sensors and digital imaging capabilities can give farmers a richer picture of their fields. Adopting drones in agriculture would help farmers in early preparation and quick response in disaster, enhancing food security. External factors such as weather, soil conditions and temperature play an essential role in agriculture. Agricultural drones enable farmers to adapt to specific environments to make conscious decisions. The data will help regulate plant health, crop processing, crop discovery, irrigation, field soil analysis and crop damage assessments. Drone surveys help increase crop yields and minimize time and cost. The government of India has determined the significance of unmanned aerial vehicles, machine learning and artificial intelligence with its Digital Sky Online platform. The demand for drone technology, equipped with artificial intelligence (AI), machine learning (ML) and remote sensing, has increased daily due to its advantages.

ADVANTAGES OF USING DRONES IN AGRICULTURE

USEFUL IN SPRAYING: Drones apply fertilizers, pesticides, fungicides, and seeds more efficiently than traditional methods. Spraying all these can be done easily and faster, saving time. Drones can also be used in uneven areas, steep or when there is no access for spraying; drones can be the best option. Farmers can also easily tackle the issues of pest and disease attacks.

GEO-FENCING: The geo-fencing feature helps where the drone is flying, and the GPS in drones automatically receives restrictions and warnings. For mapping in the agricultural field, geofencing can be used. Geofencing can be used to fence off a restricted area, and it is the best modern technology that helps the farmer protect his crop.

MONITORING OF CROPS: The multispectral camera sensors help identify the stress in the initial stages of the crop and encourage farmers to plan proper crop treatments. For monitoring the health of the crop where the light is poor, clouds cover, and closed fields, drones help in monitoring using satellite imaging.

SEED SOWING AND PLANTATION: For plantation purposes, drones are widely used in agriculture. In the forestry industry, automated drone seeders are mostly used. Planting can be done easily using drones rather than traditional methods. Drones help in sowing in large areas with greater accuracy in less time. In the targeted areas, drones help drop seed balls for more trees.

ANALYSIS OF SOIL AND FIELD: Drones produce precise 3D maps for soil analysis, which can be useful in planning seed planting patterns. With the help of drones, a soil analysis can be done as they provide nutrient management and irrigation data. For landform identification, the advanced use of GIS mapping techniques helps to understand ground conditions in the field within a shorter duration.

MANAGEMENT OF LIVESTOCK: Monitoring of hundreds of animals is challenging, but drones equipped with cameras and thermal imaging scanners can help quickly inform farmers' health conditions. Managing livestock's fundamental activity is to feed animals and take proper care. Thus, UAVs help to monitor animals' health, welfare, and production.

CHECK CROP HEALTH: Recently, drone technology has utilized the automated crop monitoring service for checking crop health. Crop health is important for good crop production and improved quality in yield. For crop health inspection, drones play a major role and are the best solution for farmers.

AVOID OVERUSE OF CHEMICALS: Chemicals will result in health risks to humans and negatively impact the environment; thus, using drones can reduce the overuse of chemical fertilizers. When the crop needs fertilizers, farmers can easily spray them without difficulty in less time.

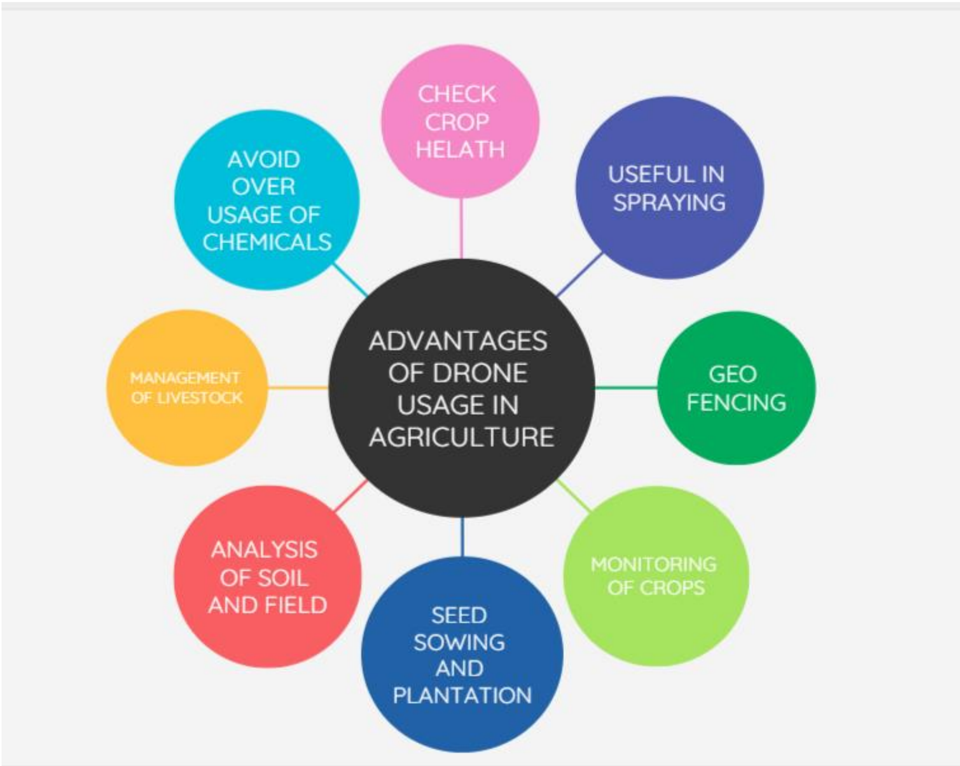

Figure:1 Advantages of using the drone in Agriculture

THE DATA CAPTURED USING AGRICULTURE DRONES TAKES PLACE IN THE FOLLOWING STAGES

ANALYZING THE AREA: Establishing the boundary is the first step in analyzing the area. This identifies the area that needs to be tested. After analyzing the area, the GPS information should be uploaded into the drone's navigation system.

USING AUTONOMOUS DRONES: For collecting the required information or data, drones can fly directly to gather the information required for the farmer.

UPLOADING THE DATA: The uploaded data in the drone will help farmers know the farm management system throughout the season and the required information needed for profitable crop production.

OUTPUT: The data which is collected is formatted in such a way that farmers will understand that data without any hassle. The extensive collected data can be displayed by popular methods like 3D mapping or photogrammetry.

APPLICATION OF DRONES IN AGRICULTURE

MONITORING OF CROP HEALTH: Drones help monitor crop health and timely action required throughout the season. Before the appearance of visual symptoms, the sensors present in the drones will help detect deficiencies or diseases of the crop. Based on the detected stress of the crop, the early decision can be taken as a warning for taking required measures. In a single flight, UAVs can cover hectares of land. Drones help monitor crop health in tall trees and crops, which is challenging for farmers. Thus, it can help reduce yield loss to a maximum extent by easily identifying the field conditions and spraying pesticides.

MONITORING OF WATER STRESS: In agriculture, irrigation plays a vital role. Unmanned aerial vehicles help monitor crop fields to improve water stress management in agriculture. When irrigation is not given at the optimum level, the crop suffers from water stress at different stages of crop growth. Using a remote-sensing drone helps to address the water stress efficiently and helps the farmer decrease his burden to a large extent.

CONTROL OF DISEASES: The occurrence of diseases causes a significant reduction in crop yield. Using drones equipped with infrared cameras can also see the inside plants, providing a clear image of crop conditions. Various preventive measures can be taken only if the farmer can detect the infection before it spreads. Thus when human assessment is unavailable, image-based tools will play an essential role in detecting the diseases.

NUTRIENT STATUS AND DEFICIENCIES MONITORING: Plants must be given the required nutrients to produce a good yield. Nutrients like nitrogen, phosphorous, potassium etc., are required for crop quality production and disease resistance. The crop becomes stressed if the soil does not contain appropriate nutrients. Thus drones help in monitoring the deficiency of nutrients in the soil.

CONTROL OF WEEDS: Weeds cause severe problems by competing with crops for light, moisture, nutrients, etc., resulting in losses to crop yield and growth. The use of herbicide more will also result in herbicide-resistant weeds evolution. Spraying herbicides all over the field is also difficult for farmers. Thus, using drones for weedicide application helps minimize weeds effectively. Spraying can be possible in any field even during sunny and drizzling conditions. It is also the safest method to reduce health hazards while spraying weedicides.

ESTIMATION OF EVAPOTRANSPIRATION: Evapotranspiration is the process of water evaporation from land to the atmosphere and through transpiration by living plants. The drones can help in the estimation of evapotranspiration losses.

SPRAYING: For higher productivity, drone technology can spray chemicals and fertilizers that can make work easier and faster for the farmers. For spraying large areas, UAVs are required. The quadcopter is a small device that can spray indoor and outdoor crops.

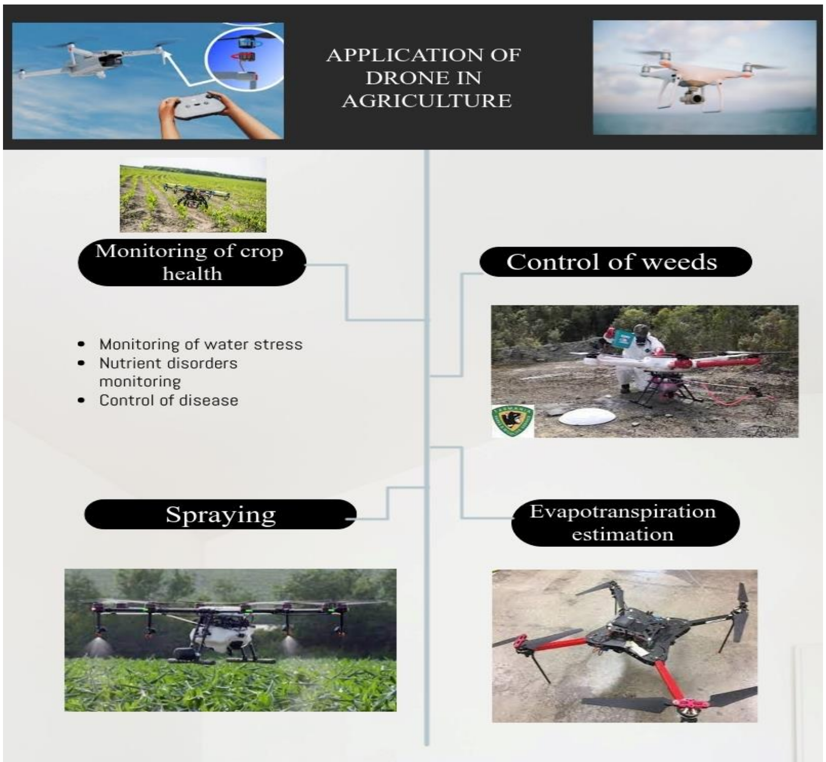

Figure 2: Application of drones in agriculture

BENEFITS OF DRONE TECHNOLOGY

ENHANCED PRODUCTION: Crop production can be increased through drones as it helps the farmers with irrigation planning, and updates to farmers are regular about their crops. Detection of diseases and pests attack with the help of drones can minimize the yield losses.

GREATER SAFETY FOR FARMERS: For spraying pesticides in terrain areas, taller crops, hilly areas, and infected areas, using drones is convenient and safer for farmers. Using drones can also help prevent pollution by using fewer chemicals and greater safety for farmers.

USEFUL FOR INSURANCE CLAIMS: In case of crop damages, farmers use the data captured through drones to claim crop insurance. The captured data can be used and insured to calculate risks and losses.

10X FASTER DATA FOR QUICK DECISION MAKING: Drones help make quick decisions and allow the farmer to save time. Sensors present in drones help in capturing and analyzing data. Diverse crop management can be made as sensors can be fixed for obtaining accurate information.

USE OF DRONES

SCOUTING/ MONITORING PLANT HEALTH: In monitoring plant health, drone plays an important role. Drones equipped with imaginary equipment known as Normalized difference vegetation index (NDVI) give detailed colour information on the plants' health. Thus, it helps the farmers to deal with the problems quickly.

MONITORING FIELD CONDITIONS: For monitoring the soil health and the field condition, drone field monitoring is used. Accurate mapping can be done with the help of drones which help the growers to find any irregularities in the field. Drones help monitor the current status of crops, vegetation, and soil fertility status throughout the crop season and help reduce yield losses.

PLANTING AND SEEDING: Drones help planting seeds within less time. At present automated drone seeders are used mostly in forestry industries for sowing. Around ten drones can plant 4,00,000 trees a day. Planting seeds through drones is easy and time-saving. The UAV help in spraying seeds to reforest lands.

SPRAY APPLICATION: Drone technology helps farmers to spray fertilizers easily. Drone sprayers save workers from chemical hazards occurs while spraying chemical through backpack sprayers. Drones help deliver the fine spray application only to the targeted site areas to maximize efficiency and save chemical costs.

SECURITY: For farm management, drone security is fast growing in agriculture. It helps monitor the far areas and saves valuable time for frequent monitoring. Monitoring remote areas, which is used to take hours of walking, can be completed in a few minutes.

Figure 3: Use of drones in agriculture

CONCLUSION

The mechanization of agriculture has increased farm efficiency and productivity enormously. Drone technology can help meet the feeding needs of the rapidly increasing population by producing quality food with efficient manpower and resources. Drone technology can help reduce farmers' work to a large extent. Drones can help farmers optimize the use of inputs, react more quickly to pests and diseases, save time from crop scouting, and also helps in yield prediction. Drones can monitor any crop in any geographical area. Being a modern agriculture technology, its uses are expected to grow significantly in the coming years.

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BIOFORTIFICATION: AN APPROACH TO BOOST MICRONUTRIENTS IN CROPS

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ABSTRACT

With intensive cultivation, the soil nutrient content is depleting, resulting in micronutrient deficiency in the crops. Biofortification is extra profitable compared to supplementation or fortification in lowering the burden of micronutrient deficiency. Biofortification is vital to increase crop plants' iron, zinc, copper and manganese content. Biofortification can be done through different pathways, *viz.*, selective breeding, genetic alteration or the enriched fertilizer application in various crops. Biofortification is recognized as a good approach to boost nutrient content, thereby increasing food crops' quality and meeting the increasing population's demands for quality food.

INTRODUCTION

In the present scenario, a quality diet is vital to maintain good health. A quality diet provides all the essential nutrients to humans and animals. Any scheme or distribution of micronutrient and vitamin tablets can not compete for the level of undernourishment without providing an adequate enriched diet. But continued mining of nutrients from the soils due to intensive agriculture and lack of ability to extract the nutrient from the deeper layers by the plants results in poor quality food crops (Kumar et al., 2015). Hence, it is important to take an alternative approach to expand the superiority of the produce. Biofortification is one such concept where we enhance a food crop's micronutrient content through various methods like selective breeding, genetic manipulation or the application of enriched fertilizer (Bouis *et al.*, 2011). Biofortification improves the nutritive value of crops during the plant growth stage by incorporating dietary micronutrient content (iron, zinc, copper and manganese) in the crop or by developing the ideal plant types capable of extracting the micronutrient from the soils.

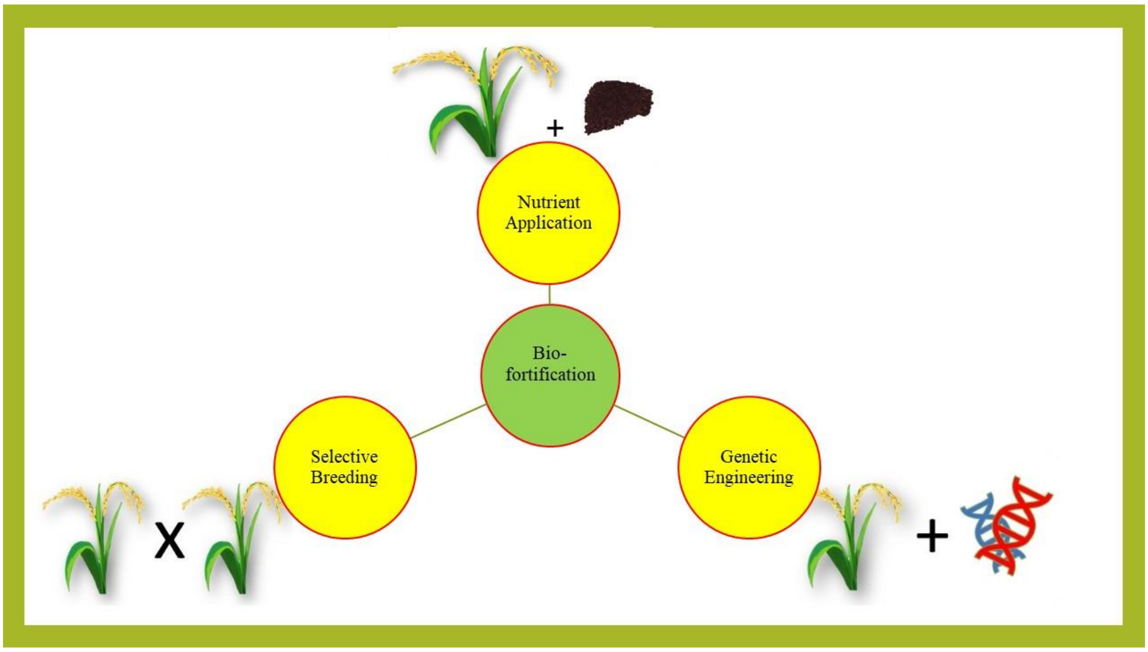
IMPORTANCE AND NEED

Biofortified crops may be able to provide different micronutrients and vitamins to populations who do not have access to commercial markets. The most noticeable advantage of biofortification is its suitability for the poor, who primarily consume basic food. Thus, biofortification can decrease the majority of micronutrient deficiencies and lower the number of people requiring mediation such as fortification and supplementation to augment nutritive value in foods.

DIFFERENT TYPES OF APPROACHES FOR BIOFORTIFICATION

The major approaches for biofortification are:

1. **AGRONOMIC APPROACH:** This includes the application of fertilizers to the soils deficient in the micronutrients so that the plants can access the nutrients for their growth and development and yield nutrient ricg grain and fodder.
2. **CONVENTIONAL PLANT BREEDING:** This involves using traditional breeding approaches to generate enough genetic variants for the desired feature in crops, such as high vitamin content. It entails crossing types over several generations to produce a plant with high nutritional content and other desirable characteristics.
3. **GENETIC ENGINEERING OR MODIFICATION:** This includes integrating DNA into an organism's genome to introduce new or different attributes, such as disease resistance or micronutrient.



PATHWAY FOR BIOFORTIFICATION:

It is divided into 3 steps as follows:

1. **DISCOVERY:** The first stage involves identifying target populations for which a biofortified crop needs to be produced. The selection should be made concerning the micronutrient deficiencies, the targeted crop's production and consumption, and the amount and importance of self and locally produced plants (Ortiz-Monasterio *et al*., 2007).
2. **DEVELOPMENT:** The development stage is primarily concerned with creating and testing biofortified crops. Following the identification of potential lines by breeders and the mapping of genotypic variations, an overview of crops immediately through the biofortification process needs to be done. The performance of the newly produced biofortified cultivars is then evaluated in various situations to assess genetic and environmental factors (Khoshgoftarmanesh *et al*., 2010).
3. **DISSEMINATION:** The new variety's performance in terms of micronutrient retentivity is evaluated in the dissemination stage, followed by a review of micronutrient bioavailability in humans. If the findings of these preliminary tests are favourable, the new variety's performance is studied in a human efficacy trial, which is normally conducted as a follow-up to an absorption study. Efficacy trials are designed to see if a treatment generates the desired results under ideal circumstances. An effectiveness trial should be conducted to ensure that a crop is ready for distribution as the conclusion may differ from the efficacy trial, and hidden obstacles, such as improper implementation or low acceptance may be revealed (Gartlehner *et al*., 2006).

CONCLUSIONS

Biofortification is more profitable compared to supplementation or fortification in lowering the burden of micronutrient deficiency. Biofortification is vital to increase crop plants' iron, zinc, copper and manganese content. Biofortification can be done through different pathways, *viz.*, selective breeding, genetic alteration or the enriched fertilizer application in various crops. Biofortification is recognized as a good approach to boost nutrient content, thereby increasing food crops' quality and meeting the increasing population's demands for quality food.

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HEALTH BENEFITS OF DIETARY FIBRE

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ABSTRACT

In recent times, people are more prone to diseases and other health disorders due to hectic lifestyles. The diet plays a vital role in maintaining the individual's good health. Fruits and vegetables contain a high amount of dietary fibre has many health benefits. It is the principal constituent of all plants, and plant foods are the only source of dietary fibre for humans. Intake of dietary fibre has many health benefits and protects from several diseases by reducing risk factors. A persons needs enough quantity of dietary fibre to prevent the obesity, gastrointestinal diseases, diabetes, heart diseases, stroke, and hypertension coronary. Increasing the intake of high-fibre foods improves serum lipoprotein values, lowers blood pressure, improves blood glucose control for people with diabetes, helps in losing weight, maintains a healthy gut and enhances human immune function. Hence, always one should include fibre-rich foods in the daily diet.

INTRODUCTION

In today's life, a human wants to do everything fast to achieve his goal; at the same time, he cannot manage good health. Many people at an early age suffer from diseases like cardiovascular diseases, diabetes mellitus, obesity, hypertension, etc., because of an unhealthy lifestyle, work pressure, or anxiety. It is very much likely that one day we may also become the victims of such diseases or disorders. From time immemorial and many scientific studies have shown that food is one of the significant factors which plays a role in keeping a human healthy. Several studies have demonstrated the benefits of eating fruits and vegetables to prevent or alleviate diseases such as cancer, hypertension, cardiovascular diseases, diabetes mellitus and others. In recent decades, interest in the role of dietary fibres in health and nutrition has prompted a wide range of research. The addition of dietary fibre in our daily diet has many health benefits.

WHAT IS DIETARY FIBRE?

Dietary fibre (DF) is a polysaccharide which is not digested by the secretion of the human gastrointestinal tract. However, it is the major constituent of all plants, and plant foods are the only source of dietary fibre for humans. Dietary fibre is classified into two types, soluble and insoluble dietary fibre.

Insoluble DF will not form a gel in water and ferment very slowly in the gut, whereas soluble fibre forms a gel in water and ferment quickly in the gut. Total dietary fibre is the sum of soluble and insoluble DF (Barber *et al.*, 2020). Dietary fibre has many health benefits by decreasing the risks of many diseases and disorders.

SOURCES OF DIETARY FIBRE

Dietary fibre's major sources consist of plant foods such as fruits, green leafy vegetables, whole cereals, pulses, nuts, oil seeds and spices (Table 1). In addition to dietary fibre, fruits are rich in micronutrients such as vitamins, minerals and many phytochemicals such as polyphenols and pigments, less caloric content, stronger antioxidant capacity and greater grade of fermentability and water retention capacity. As per ICMR, the suggested intake of total DF is between 25-40 grams/day.

Table 1: Dietary fibre content of some of the commonly consumed foods (values are per 100 g of edible portion)

Sl.No	Name of the foodstuff	Total dietary fibre (g)	Insoluble dietary fibre (g)	Soluble dietary fibre (g)
1	Wheat	12.5	9.6	2.9
2	Rice	4.1	3.2	0.9
3	Jowar	9.7	8.0	1.7
4	Bengal gram, dhal	15.3	12.7	2.6
5	Green gram, dhal	8.2	6.5	1.7
6	Cabbage	2.8	2.0	0.8
7	Coriander	4.3	3.0	1.3
8	Curry leaves	16.3	13.4	2.9
10	Fenugreek	4.7	3.2	1.5
11	Spinach	2.5	1.8	0.7
12	Carrot	4.4	3.0	1.4
13	Potato	1.7	1.1	0.6
14	Radish	2.3	1.8	0.5
15	Bitter gourd	4.3	3.2	1.1
16	Brinjal	6.3	4.6	1.7
17	Cauliflower	3.7	2.6	1.1
18	Cucumber	2.6	2.0	0.6

19	Peas, green	8.6	7.2	1.4
20	Soya bean	23.0	17.9	5.1
21	Coconut, fresh	13.6	12.7	0.9
22	Groundnut	11.0	8.5	2.5
23	Onion	2.5	1.7	0.8
24	Cardamom	23.0	20.4	2.6
25	Cloves	35.1	28.9	6.2
26	Cumin seeds	30.0	25.2	4.8
27	Fenugreek	48.6	28.6	20.0
28	Garlic	5.1	2.6	2.5
29	Turmeric	20.0	17.6	2.4
30	Aonla	7.3	5.8	1.5
31	Apple	3.2	2.3	0.9
32	Banana	1.8	1.1	0.7
33	Dates, dry	8.3	6.9	1.4
34	Dates, fresh	7.7	6.9	0.8
35	Grapes, green	1.2	0.8	0.4
36	Guava	8.5	7.1	1.4
37	Mango	2.0	1.0	1.0
38	Musk melon	0.8	0.5	0.3
39	Water melon	0.6	0.3	0.3
40	Orange	1.1	0.6	0.5
41	Pineapple	2.8	2.3	0.5
42	Pomegranate	2.8	2.3	0.5
43	Custard apple	5.5	4.0	1.5
44	Strawberry	2.3	1.6	0.7

Adapted from: Gopalan *et al*. (2009)

HEALTH BENEFITS OF DIETARY FIBRE

There are many studies which show several health benefits of consumption of DF. High fibre intakes are linked with lesser serum cholesterol concentrations, lesser menace of coronary heart disease, reduced blood pressure, improved weight control, improved glycemic control, low risk of different types of cancer, improved gastrointestinal function and improved immune function. Several clinical studies have shown that

DF helps reduce total cholesterol and low-density lipoproteins (which is considered bad cholesterol), as these are the main culprit for cardiovascular disease development. Soluble fibre delays the digestion of food in the stomach, which in turn delays cholesterol absorption. Soluble fibres also bind to bile acids in the intestine and increase its excretion, which in turn, the liver absorbs more cholesterol from the blood to synthesize bile acids; thus, cholesterol levels decrease in the blood. Inclusion of DF in our diet also helps maintain the glucose level in type 2 diabetic patients as fibres slow down the digestion of starch in the small intestine and decrease the postprandial glucose uptake rate. Many clinical studies have also proved that intake of DF help to reduce obesity or body weight as consumption of fibre-rich food gives high satiety due to its bulking effect and thus lowers the intake of calories. The positive effect of DF on obesity and type 2 diabetes is mainly attributed to greater satiety due to increased chewing and decreased absorption of macronutrients such as carbohydrates, proteins and fats. These mechanisms are believed to be due to the ability of soluble DF to form viscous solutions that prolong gastric emptying, consequently inhibiting the transport of glucose, triglycerides and cholesterol across the intestine. The presence of insoluble DF, which is nondegraded fibre in our food, helps reduce constipation by increasing faecal water and delaying gastric emptying also benefits by adsorbing carcinogenic agents in the intestine (Kendall *et al*, 2010).

CONCLUSION

Intake of dietary fibre has many health benefits and protects from several diseases by reducing risk factors. A persons needs enough quantity of dietary fibre to prevent the obesity, gastrointestinal diseases, diabetes, heart diseases, stroke, and hypertension coronary. Increasing the intake of high-fibre foods improves serum lipoprotein values, lowers blood pressure, improves blood glucose control for people with diabetes, helps in losing weight, maintains a healthy gut and enhances human immune function. Hence, always one should include fibre-rich foods in the daily diet.

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SCIENTIFIC CULTIVATION OF MOTH BEAN (*VIGNA ACONITIFOLIA*)

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ABSTRACT

Moth bean is a drought-hardy annual legume crop grown in dry and warm habitats in arid regions. Its fast and deep penetrating root system can withstand 30–40 days of moisture depletion and temperatures above 35°C in open fields and contain 20–25% protein. It is an excellent sources of vitamins and minerals. They are also excellent sources of vitamins and minerals. The moth bean can be used for multiple recipes and could be good source of income for the farmers in dryland areas. The appropriate production technology can help in improving the yield and quality of the moth bean and improve the livelihood security of the dryland farmers.

INTRODUCTION

Moth bean (*Vigna aconitifolia* (Jacq.) Marechal) belongs to the Fabaceae family (Leguminosae subfamily Papilionoideae) and has 2n=22 chromosomes. It is an annual bushy herb (15–40 cm) of semi-erect hairy nature and short internodes with creeping primary branches (1.5 m) resembling a mat. The long branches grow horizontally and have deeply notched leaflets. The yellow flowers are papilionaceous (2–6 cm long), developing into short pods that contain 4–9 small, rectangular seeds with light green, whitish-green, or yellow-brown seed coats. The pods appear to be glabrous, and the stipules are small. The deep and fast-penetrating root system is covered with spherical nitrifying nodules (Janoria et al., 1984).

A picture of moth bean seed

Moth bean is a drought-hardy annual legume crop grown in dry and warm habitats in arid regions. Its fast and deep penetrating root system can withstand 30–40 days of moisture depletion and temperatures above 35°C in open fields. Moth bean's expansive canopy, viny nature, and semi-trailing growth habit help keep the soil moist and reduce soil erosion and soil temperature (Sharma et al., 2014). Thus, it could act as a biological means for soil and moisture conservation by behaving as an *in situ* shelterbelt. These adjusting and multi-adaptive features make moth bean a beneficial and alternative crop for sand dunes with low or negligible inputs and agronomic aftercare. Moth bean's features and characteristics have made it an essential component of agroforestry, agri-horticulture, silvopastoral, mix cropping, and intercropping systems prevalent in arid regions.

PRODUCTION TECHNOLOGY

Due to the harsh weather conditions in arid and semiarid climatic regions, management strategies enhance legume productivity, especially when grown on resource-poor and low-productive soils (Kumar, 2002). Therefore, decisions pertaining to crop production must incorporate climatic conditions, technological interventions, and socioeconomic conditions. Adoption technologies must be easy to understand and adopt, and be results-oriented.

***CLIMATIC CONDITIONS*:** Moth bean is grown in arid and semiarid regions and can withstand high temperatures without any adverse effect on flowering or fruit development. Optimum growth and development occur at 25–37°C and 250–500 mm rainfall in soils with good drainage.

***SOIL*:** Moth bean can be grown on various soil types but prefer a well-drained sandy loam due to its sensitivity to waterlogging. In India, farmers grow moth bean on poor, light-textured soils with low organic matter, including sand dunes.

SOIL PREPARATION: Soil preparation is an important step in moth bean cultivation. It can be sown as a sole crop, mixed crop and/or intercrop on light or sandy loam soils. Generally, one or two plowings is sufficient for growing sole crops, whereas intercropping with crops such as bajra, the soil may be prepared by keeping in view pearl millet cultivation which requires a mold board plowing followed by cross harrowing. It is important to consider soil moisture conservation and complete weed removal when preparing the soil. The crop must be sown just after the rains on light soils and sand dunes to prevent soil moisture losses. To avoid wind erosion in areas with light soils or sand dunes, repeated or extra plowing (more than one or two) should be avoided due to the high wind velocity.

SEEDING RATE AND SOWING METHODS: Line sowing is the preferred sowing method for moth bean. Moth bean varieties differ in their growth characteristics, such as a profuse canopy or erect growth type. Hence the seeding rate varies according to the plant characteristics and planting pattern. When moth bean is sown as a sole crop for grain at the optimum sowing time, a seeding rate of 8–10 kg/ha is recommended. For fodder, a seeding rate of 20–22 kg/ha is recommended. In mixed cropping with pearl millet, cluster bean, or sesamum, 2–5 kg/ha is recommended, or more with delayed sowing. For closely planted sole crops, early maturing, erect type varieties of moth bean (e.g., RMO-225, RMO-40) should be sown at 12–15 kg/ha. For spreading and semi-spreading type varieties (Jadia, Jwala, CAZRI Moth-1, IPCMO-880), a 10 kg/ha seeding rate is recommended.

Since the crop is rainfed, it must be planted the day after 300–400 cm of rainfall; otherwise, seed germination can be hampered due to rapid soil moisture depletion and seed cover by sand due to fast blowing winds in dryland areas. Line sowing using a planter is the preferred method for sowing moth bean. For spreading and semi-spreading types of varieties planting may be done at 50–60 cm whereas, for erect type varieties sowing at 30-35 cm is optimum with a plant-to-plant distance of 5-10 cm. After sowing, proper planking is needed to avoid soil moisture losses and prevent losses from the open furrows by birds and mites. In the event of delayed rainfall, closer planting with an increased seeding rate is recommended for all moth bean varieties.

SOWING TIME: In arid situations, sowing time is critical for optimum moth bean production. Early planting (1st week of July) leads to vigorous and luxuriant growth, with plants growing up to 50–60 cm tall resulting in poor pod bearing. Late planting can stunt growth, resulting in a reduced crop canopy with profuse pod bearing. The optimum time of sowing moth bean varies with monsoon conditions in a particular region. For example, the optimum sowing time in the western part of Rajasthan is 15–25 July, Maharashtra is the last week of June, and Haryana and Gujarat is the first week of July.

SEED TREATMENT: Seed treatments before sowing may play a significant role in faster seed germination and prevention of soil borne disease. Treating seeds with fungicides like Captan, Thiram, or Agroson GN (1–3 g/kg seed) protects them from soil-borne diseases. It has been well-established that growing legumes in crop rotation/sequences has additional benefits. Moth bean has an inherent capacity to fix atmospheric nitrogen in the soil, making it available for companion/subsequent crops. However, treatment with an appropriate rhizobium culture under favorable conditions may help develop more effective nodulation. Nodulation counts reach their maximum in moth bean by flowering, ceasing by pod formation. Rhizobium treatment of moth bean seeds involves mixing a cooled jaggery slurry (250 g jaggery dissolved in 1 L hot water) is added to 625 g rhizobium culture and sufficient water, mixed thoroughly, and slowly poured over the seed lot (~8–10 kg) before briskly stirring to ensure that all seeds contact the jaggery–culture slurry.

FERTILIZER MANAGEMENT: Moth bean is generally grown in arid regions where the soils are deficient in organic carbon, have poor physical properties, and are poorly managed. Application of 20–25 t/ha of fully decomposed farmyard manure is recommended to improve soil organic carbon and physical properties; a starter dose of 10–20 kg/ha helps with nodule development. Moth bean also responds to phosphorus application, with 40–60 kg /ha improving root development, plant growth, and grain yield.

IRRIGATION: Moth bean is primarily grown as a rainfed crop but, during continuous long dry spells, one life-saving irrigation at the pod formation stage will prevent total crop failure.

WEED MANAGEMENT: In rainfed moth bean crop, weed infestations compete with crops for soil moisture, nutrient, and sunlight, reducing yields. Hence, eradicating weeds before the critical growth stage (20–25 days after sowing) may help crop growth and development for yield realization. Weed infestations after the crucial crop–weed competition stage may not cause tangible yield losses as the crop canopy can suppress the weeds. Therefore, pre-emergent herbicide application of Pendimethalin 30% EC (0.75–1.0 kg a.i./ha) followed by hand weeding 25–30 days after sowing is recommended for moth bean.

HARVEST AND STORAGE: Moth bean has estimated shattering, transport, and storage losses of 8–20% or more. To prevent such losses, when the leaves dry and pods turn light yellow, the plants should be uprooted from the field and sun-dried for 3–5 days. Bullocks, threshers, or hand sticks can be used to thresh the grain. After threshing, the seeds are separated from the stover and sun-dried until the moisture level reaches 8–10%. Later, dried seeds are stored in air-tight earthen pots using gunny bags or cloth bags. With improved technologies, moth bean yields 6–8 q/ha (grain) or 12–25 q/ha (fodder).

USES OF MOTH BEAN

Moth bean is a rich and cheap source of protein that can be used to prepare papad, bhujia, dal, Mangori, vada, kheechdi, roti, sproutings, rabri etc. Apart from that being a leguminous crop it can fix atmospheric nitrogen in soil and can also acts as soil binder

CONCLUSION

Moth bean is a drought-hardy annual legume crop grown in dry and warm habitats in arid regions. Its fast and deep penetrating root system can withstand 30–40 days of moisture depletion and temperatures above 35°C in open fields and contain 20–25% protein. It is an excellent sources of vitamins and minerals.

The moth bean can be used for multiple recipes and could be good source of income for the farmers in dryland areas. The appropriate production technology can help in improving the yield and quality of the moth bean and improve the livelihood security of the dryland farmers.

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SCIENTIFIC CULTIVATION OF BABY CORN

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ABSTRACT

Maize productivity in India is inferior compared to the world maize productivity. More than 80% of maize is cultivated under rainfed conditions. It is available in different types like sweet corn, flint corn, popcorn, pod corn, and baby corn. Baby corn has gained popularity among the farmers owing to its profitability and export potential. It can provide avenues for crop diversification and increased income generation. The scientific management practices, which include optimum spacing, seed rate, time of sowing, nutrient management, irrigation management, weed control, and timely harvesting, results in better yield and economic return.

INTRODUCTION

Maize (*Zea mays* L.) is one of the important staple foods of India. It is available in different types like sweet corn, flint corn, popcorn, pod corn, and baby corn. Baby corn nowadays has gained popularity among farmers owing to its profitability and export potential. It is believed to be originated from Thailand and developed as a crop in 1976. It is a type of corn or maize grown exclusively for vegetable soup and salad purposes. The young, fresh, finger-like green ears are harvested before or just after the emergence of silk. It is most delicate, sweet and tender, having a pleasant flavour. It is more profitably and most successfully grown in countries like Taiwan, Thailand, Sri Lanka, China, USA and South Africa. It is being recently introduced in India and becoming popular in states like Meghalaya, UP, Haryana, Maharashtra, Karnataka, Andhra Pradesh and Punjab. It becomes ready for harvesting within 50-60 days after sowing, which makes it easier to grow 4-6 crops in a year, and its fodder is also consumed by the cattle, which is quite green, succulent, nutritious and palatable with higher digestibility.

METHOD OF PRODUCTION

Baby corn requires well-drained land with good sandy loam soil as corn growth is highly affected by standing water in the field. It is normally grown in kharif, rabi, and spring season like corn. The seed rate for the crop varies from variety to variety but generally sown @ 35-40 kg ha^{-1} is under a spacing of 45-

50 cm x 15-20 cm and maintains two plants per hill. The crop also requires N: P: K in the proportion of 150:75:40 kg ha^{-1} depending upon the soil type and agro-climatic factors, along with 10 tons of well-decomposed FYM. Constant weeding and earthing up after three weeks of sowing or at the 8^{th} leaf stage is essential. The detasseling operation should be continued till no tessel left in any plant.

VARIETY SELECTION

While selecting a variety, the primary objective should be good ear quality than the yield. Small kernel size, straight row kernel alignment and tapered tips are preferred characteristics for high-quality baby corn. Varieties of baby corn grown commercially in India are Golden midget, Praksh, VL-42, HM-4, HIM-129, Keshari, PAC-792, and Shakti (composite).

AVAILABLE NUTRIENTS IN BABY CORN

Baby corn is considered a more nutritious vegetable with low calories and high fibre content compared to other non-legume vegetables. It is a enjoyable, ornamental and nourishing vegetable without cholesterol. The baby corn contains comparable mineral nutrient to egg. It has been reported that 100 g of baby corn contains 11.0 mg of ascorbic acid, 8.2 mg of carbohydrate, 0.2 g of fat, 1.9 g of protein, 0.06 g of ash, and 86.0 mg of phosphorus, 28.0 mg calcium and 89.1 % moisture. This vegetable has all the potential for cooking purposes, and processed value-added products are exported to Thailand, Japan and Europe as canned food.

A picture of baby corn

PLANT PROTECTION MEASURES

Stem borer can be controlled by spraying profenophos @ 2 ml per litre applied at 35 DAS. Stem borer can also be controlled by spraying carbaryl 1 to 2 times at an interval of 10 and 20 days after germination. Diseases in baby corn mostly include stewart's wilt, leaf blight, rust and viruses. However, stem borer (*Chilo partellus*), pink borer (*Sesamia inferens*) and sorghum shoot fly (*Atherigona spp*.) are serious pest observed in baby corn.

DETASSELING

Baby corn is a small unfertilized cob. To prevent the fertilization of this cob detesseling is required so pollination do not take splace. The tessel must be removed from the plants just after its appearance. In general detesselling process starts from 47 days after emergence of the crop.

CONCLUSION

Baby corn has gained popularity among the farmers owing to its profitability and export potential. Following the scientific management practices, which include optimum spacing, seed rate, time of sowing, nutrient management, irrigation management, weed control, and timely harvesting, give better yield and economic returns.

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