

Research Article

# Review on Effect of Seed Sources and Sizes on Faba Bean (*Vicia faba* L.) Production in Ethiopia: Review

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## Abstract

A significant legume crop in Ethiopia, the faba bean (*Vicia faba* L.) is essential for food security, nutrition, and the livelihoods of smallholder farmers. While there are a number of factors that affect faba bean output, seed sizes and sources have a big impact. In order to give a thorough understanding of these factors, this study synthesizes research data from other studies to investigate the effects of various seed sources and seed sizes on Ethiopian faba bean yield. The potential for production, disease resistance, and adaptation of the faba bean cultivars is significantly influenced by the seed source. Locally adapted seed variations, which are often generated from farmers' own harvests, are generally more resistant to local environmental variables and pests than imported seed varieties. However, locally sourced seeds might occasionally be of uneven quality, which can have a detrimental effect on crop performance. On the other hand, it has been shown that improved seed types have higher yields and are more resistant to disease, which can increase overall production even if they are typically more expensive. The size of the seeds has a major impact on faba bean yield as well. Larger seeds tend to generate robust seedlings and greater germination rates, both of which are necessary for achieving optimal yields. Tiny seeds may occasionally be more appropriate for specific local growing conditions for farmers who have limited access to larger, superior seed varieties. This review describes how maximizing the production of faba bean types can be achieved by selecting the appropriate seed size while accounting for local environmental considerations. This review examines how selecting the appropriate seed size while accounting for local environmental conditions can optimize faba bean yield variations. To boost Ethiopian faba bean productivity, seed size and seed supply must be adjusted. Further research is required to assess the long-term impacts of varying seed sizes and sources under various agro-ecological zones in order to improve the stability and sustainability of faba bean yields throughout the nation.

## Keywords

Faba Bean (*Vicia faba* L.), Seed Sources, Seed Size, Crop Productivity

## 1. Introduction

The faba bean (*Vicia faba* L.) is the most important legume crop in the world and was one of the first to be domesticated [65]. Faba beans, fava beans, wide beans, Windsor beans, horse beans, tick beans, Bakla (Ethiopia), Fulmaris (Sudan), Fave (French), and Yeshil Bakla (Turkey) are some of the

many common names for the crop [66]. Currently, faba beans are produced in over 66 countries [17]. China, Ethiopia, Australia, the United Kingdom, France, Germany, Sudan, Egypt, Sweden, Italy, Spain, Tunisia, Belgium, Peru, and other nations were among those that produced faba beans [32].

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Faba bean seeds can be consumed in a variety of ways, including dry, roasted, soaking, boiled, frozen, or canned [22]. In some parts of the world, the green, immature beans are eaten as a vegetable after boiling. The bean is also eaten roasted in India, where it is used as a coffee extender. The faba bean has an important role in improving soil fertility by fixing nitrogen from the atmosphere in association with bacteria [76]. It is also used in crop rotation with cereal crops. In 2020, the annual global production of pulses was about 90 million tons. Of this, faba bean accounted for about 5.7 million tons [32]. In Ethiopia, faba bean is cultivated for food and cash income [21]. It is grown on 504,569.99 hectares throughout the majority of the country, including Oromia, Amhara, SNNP, Tigray, Sidama, and Benshangul Gumuz provinces, producing 1,070,636.538 tons annually [19]. It is grown on 504,569.99 hectares throughout the majority of the country, including Oromia, Amhara, SNNP, Tigray, Sidama, and Benshangul Gumuz provinces, producing 1,070,636.538 tons annually [19]. Depending on the cultivar and agro-ecology, faba beans can produce up to 3.9 tons per hectare [48]. Numerous biotic, abiotic, and socioeconomic factors restrict the country's ability to produce faba beans. The primary biotic stressors influencing the country's faba bean production are Ascochyta blight (Ascochyta), chocolate spot (Botrytis fabae), powdery mildew (Microsphaera penicillata var. ludens), faba bean gall (Olpidium viciae Kussno), and soil-borne diseases (Fusarium root rots) [39, 16]. There are over 40 improved faba bean varieties in Ethiopia [24]. A number of improved faba bean varieties were brought to the country due to their exceptional productivity; nevertheless, seeds for these improved varieties are not readily available [12]. Moreover, acidity, fertility, and soil erosion restrict the production of faba beans [3]. Faba bean productivity is below potential due to farmers' dependence on native landraces and ignorance about improved seed [12, 18, 16, 79]. Formal and informal seed sources are the two categories found in Ethiopia [2, 20]. The chain starts with plant breeding or a variety production program that includes a systematic variety release and maintenance system [56, 13]. Because it is largely a government-sponsored system that involves several public bodies, the formal seed system receives its name. The informal seed system, also known as the local system or the "farmers" system, gets its name from the fact that it is not subject to legal regulations and is characterized by farmers trading seeds with one another. The unauthorized approach is used to supply the majority of the seed supply. [79] Indicate that the informal seed market accounts for more than 97% of the demand for faba bean seeds. 42.9 percent of farmers utilize their own seed, according to [12]. Seed processing includes harvesting, packing, and distribution. The best time to harvest, transportation of the seed to processing facilities, cleaning, treatment with recommended chemicals, drying, packing, storage or processing that produces value-added products, etc. are all important factors in reducing post-harvest losses of seed [11]. A quality product is dependent on appropriate postharvest handling. Using best

practices during cultivation, harvest, and particularly post-harvest operations is crucial to producing a safe and high-quality end product [53]. In the [80] survey, about 57.5% of farmers cleaned their seeds to remove small, broken, or damaged seeds, 30% to remove weeds and other crops, and 12.5% to remove inert matter to increase the quality of field peas. Ethiopian farmers use traditional methods such as gotera and polypropylene bags to store their faba beans [25]. Grain safety over long periods of time cannot be guaranteed by conventional storage procedures, which expose grains to several degrading elements [45]. It might be impossible to produce crops in a significant way without viable seeds. It is commonly known that using high-quality seed from improved and adapted varieties is crucial to ensuring increased crop yield and productivity [28]. Selecting high-yielding cultivars that are appropriate for the production region, possess resistance traits to disease, insects, and water, as well as other desirable attributes, is essential to attaining exceptional crop performance and yield. The scarcity of high-quality seed limits the production of faba beans [30]. Because it influences vigor index, field emergency, seedling dry weight, root and shoot length, and germination, seed size is essential for increasing agricultural productivity and production in addition to the input [72]. According to [65], faba bean plants with larger seeds had increased fresh matter and seed output. In addition to seed yield, germination percentages, germination speed, shoot and root length, and seedling dry weight influenced by seed size, [14] other factors include plant height, number of pods per plant, pod weight per pod, pod length, pod weight, and 100-seed weight.

## 2. Literature Review

### 2.1. Origin and Distribution of Faba Bean

The Mediterranean is where faba beans are found. Central Asia is where the faba bean originated, according to [47]. The faba bean is domesticated primarily in the Middle East [52]. It is commonly grown in South America, Africa, Central Asia, China, Canada, and Australia. The faba bean is now found worldwide, particularly in South America and Mexico [67]. Ethiopia is considered to be one of the locations where faba beans underwent secondary diversification [74]. It is believed that the crop was introduced to Ethiopia from the Middle East through Egypt around 5000 B.C. Ethiopian faba beans are mostly grown in mid- and high-altitude areas, with elevations ranging from 1800 to 3000 m.a.s.l. and 700 to 1000 mm of rainfall per year throughout the growing season [60].

It can tolerate water logging and thrive on vertisol, unlike regular beans, lentils, and field peas [52]. The Oromia and Amhara areas have the largest faba bean production area when compared to other regions; the former produced 536,430.1 tons of faba beans on 230,114.95 hectares, while the latter produced 346,352.40 tons on 180,245.56 hectares [19].

## 2.2. Importance of Faba Bean

In addition to being used as animal feed and fodder, faba beans are a source of protein for human diets. The plant is an important vegetable and pulse crop, and its pod, seed, and new shoot are eaten, however this depends on local culture [67]. Agronomically speaking, it absorbs nitrogen from the atmosphere, enhances soil fertility, increases soil organic matter, can be used as a grazing crop [75], and lessens soil erosion [26, 17]. The advantages of faba beans, which are widely utilized in rotation with cereals to improve soil fertility, are well known to Ethiopian farmers [59]. It helps six smallholder farmers use less fertilizer and makes a substantial contribution to the restoration of soil fertility by fixing atmospheric nitrogen [41].

The faba bean is an essential pulse for Ethiopia's exports and nutritional requirements due to its high protein content. There are several ways to eat it [35]. Because of their efficient ability to fix nitrogen in the atmosphere, faba beans are a necessary crop [17]. In Ethiopia, faba beans provide rural households with the much-needed protein boost they require in addition to grain and root crops. Rural dwellers usually boil the seeds and eat them as a snack. Regional dishes like "shiro wot" and "kik wot," which are consumed with "injera" cereal, are also made with them [68]. The crop is consumed as a vegetable when the pods are harvested green. The stalks are utilized for horse and cattle feed, compost, and cooking fuel feed.

## 2.3. Seed System

Formal and informal seed systems are the two categories identified by [2 13]. In Ethiopia's seed industry, there has recently been interest in the concept of an intermediary seed system that blends the formal and informal seed systems [58]. The three categories of Ethiopia's seed system are formal, informal, and intermediate, per [71]. The first to produce and market enhanced seeds was Jimma Agricultural School in 1942. Research and academic institutions in Ethiopia created the institutional seed system for extension activities. For the first time, farmers received seeds from the Haramaya College of Agriculture in 1954. 1966 saw the founding of the Institute of Agricultural Research (IAR).

### 2.3.1. Formal Seed System

Formal seed sources are introduced to farming communities through the operations of contemporary agricultural research centers, including variety development, release and registration, seed processing and multiplication, seed marketing and distribution, and seed quality control and certification. This procedure follows a certain set of stages [57]. The formal sector functions in accordance with national policy and regulatory frameworks that govern the institutional and organizational arrangements as well as a set of laws, rules, protocols, and standards in order to produce seeds of suffi-

cient quality and provide them to farmers at a fair price, at the appropriate time, and at the appropriate location [33]. The EIAR, RARIs, HLIs, EABC, PSCs, Cooperative Unions, RSEs, RBOA, and federal and regional seed banks are the main players in the formal seed system.

### 2.3.2. Informal Seed System

Farmers may buy seeds from the local market or get them from friends, neighbors, and other farms. Informal seed sources are ones that are produced and distributed by many parties without a formal certification [20]. The seed trade between farmers is the primary source of faba bean seeds, according to [27, 12]. Informal seed suppliers are farmers who actively take part in the selection, production, and distribution of seed. [49] claims that farmers save seed for their own use, frequently in connection with regional commerce or sales. Some restrictions on farmers' seed supplies include the use of local seed, lack of certification, and seed quality control inspections. According to [9], continuous seed recycling reduces seed quality and yield. Continuous seed recycling lowers seed yield and quality [9]. [2] State that most Ethiopian farmers use informal seed sources since they are more readily available and less expensive in their community when needed. They are also more sustainable in terms of supply than formal seed sources, and they use them after first adopter farmers have done so. A formal system that focuses on a limited number of crops, a low level of private sector participation in the formal system, ineffective mechanisms for promoting, distributing, and marketing seed, a weak system, insufficient supply of high-quality seed at reasonable costs, and improper connections between various actors in seed systems are the main challenges faced by seedactors for variety release and seed quality assurance [69]. There was no desire to alter it at all among those farmers who preferred local adaption varieties [27] for smallholder farmers to embrace new faba bean cultivars, they need to have a dependable seed infrastructure that can guarantee the transmission of superior varieties and integrated crop management technology.

### 2.3.3. Seed Production

A vital part of crop production, planting materials, or seed, interact with their surroundings to influence the crop's or plant's health. Because low-quality seeds are likely to yield less, farmers must use healthy, high-quality seeds even under the best of conditions [15, 46] As the most economical external input for farmers, it is a crucial component of agricultural output. The most crucial component in crop production has been recognized since the beginning of agriculture: seeds. In sub-Saharan Africa, it is considered the most cost-effective input for farmers in the initial stage and is the most useful resource for farmers, especially smallholders, according to [51]. The other essential component of a working seed system is seed production, which is expected to provide sufficient and high-quality seed in accordance with national regulations, laws, and standards. Breeder, pre-basic, basic and certified

seed are the four seed classifications that Ethiopia has embraced for seed production [2]. The primary duties of EIAR and RARIs are to breed, maintain, and distribute breeder seed and pre-basic seed in sufficient quantity and quality for a variety of crops and crop varieties to Ethiopian Seed firms (ESE) or Regional Seed Enterprises (RSEs) as well as private seed firms [73]. On its farm in the middle, it also produces basic seed, despite its very small capacity. Several actors and many steps are involved in the production and multiplication of seeds. It was controlled by public seed companies, such as the ESE and RSEs in Amhara, Oromia, SNNP, and most recently, Somali [13]. The production, marketing, and distribution of basic and C1 seed of improved agricultural varieties throughout the nation is mandated by the ESE [31].

In order to develop and manufacture pre-basic and basic seeds, seed producer and marketing cooperatives now collaborate closely with academic institutions and research centers. The seed value chain system also includes quality monitoring and certification for seeds. According to national seed laws, early generation seed must meet the highest standards for varietal purity and seed quality traits [63]. To preserve varietal identity and integrity, field standards and seed criteria for physical, physiological, and health quality are given. Compared to the local variety, the improved variety is more productive [34]. Improving the quality of the seeds can enhance the crop's potential yield several times over. It is therefore one of the most economical and efficient inputs for agricultural development, claim [79].

## 2.4. Farmers' Selection Criteria of Variety

Farmers want a variety based on its mature date, disease resistance, pods per plant, seeds per pod, grain production, lodging status, robust crop stand, seed size, and profitability [27, 12, 7, 37]. Farmers used a range of criteria to assess faba bean types at the flowering, maturity, and harvest crop growth stages. The primary selection criteria included stand establishment, plant height, maturity, seed size, leaf shading, appropriateness for intercropping, number of pods, number of branches, stem strength, pest and disease resistance, grain and straw yield, large seed size, and disease tolerance [38, 81, 33].

## 2.5. Effects of Seed Size on the Seed Yield and Quality of Faba Bean

Seed size is one aspect that affects crop establishment and performance [10]. A crucial physical indicator of seed quality, seed size is impacted by variety, environment, and management practices. According to their size, the seeds are categorized as large, medium, small, very small, and very large [10, 62].

Numerous factors related to seed size have been discovered to impact field emergence, seedling growth, seed germination and vigor, crop performance, and seed yield characteristics [1]. It is one of the most important characteristics of seeds that can

affect seed growth and plays a special function in crop production. Most crops grade their seeds based on size and weight since it has been demonstrated to regulate germination and the subsequent growth of seedlings in many plants. A plant with larger seeds can flower earlier, grow taller, develop more branches, have a higher leaf area index, weigh more seeds, and produce more seeds, according to [1]. Seed size affects germination speed, seed vigor index-I, and seedling shoot length [72].

Seed size should either have a positive, neutral, or negative impact on seed output, depending on the connection between seed size and yield. Consequently, if seed size affects productivity, it would be advantageous to sow the seeds that yield the most [54]. Greater seed weight resulted in increased growth and yield. More seeds and fresh materials were produced by faba bean plants cultivated from huge seeds, according to [65]. Germination percentages, germination speed, shoot and root length, and seedling dry weight are all impacted by seed size [14].

## 2.6. Faba Bean Seed Quality

A seed lot's potential performance is characterized by its seed quality. Vitality, disease resistance, germination percentage, inert matter, weed seed, and seed of another crop are important traits of seed quality, and high-quality seed batches should meet minimum requirements for each of these qualities. It is said to be the most important agricultural input that increases crop yield [79], and if high-quality seed is not used, the investment made in inputs like fertilizer, herbicides, and irrigation will not be profitable. The value of seed is determined by its quality; if the seed is of low quality, its value is also low [42].

In order to meet the growing expectations of the populace and boost output and productivity, the farming community benefits from timely access to high-quality seed at a reasonable price. Seed quality standards are the cornerstone of seed production, certification, marketing, and global trade [43]. Seed quality is one factor affecting the possible yield. The concept of seed quality is comprised of several components, including physical purity, physiological quality, genetic quality, and seed health quality. Furthermore, [43] suggested four components of seed quality: genetic purity, physical purity, physiological purity, and seed health.

### 2.6.1. Seed Physical Purity

In order to prevent inert waste or seed from other crop or weed species from reducing the quality of their final product, farmers need seed. Some farmers do not use the proper measures to ensure the quality of their seeds, according to [22]. For analysis, the sample is separated into three sections: pure seed, other crop seed, and inert materials. Weight is used to determine the percentage [28]. Physical purity indicates the proportion of a seed lot that is pure seed of the species in issue. To some extent, each seed lot includes a mix of pure seeds,



inert materials, and additional seeds [44].

Three parts make up the working sample: pure seed, additional seeds, and inert materials. Weight is used to determine the percentage of each component, and every type of seed and inert matter present must be identified as thoroughly as possible [43]. The seed of the designated crop that the producer produces contains all botanical variants and cultivars of that particular species [44, 43]. Seed units, stems, shells, stones, soil particles, and any other material or structure that is not considered pure seed are all considered inert matter. Seed units that are damaged or broken must be at least half as large as they were before. Seed units of any plant species other than pure seed must be present in other seeds [43].

### 2.6.2. Seed Moisture Content

When evaluating the quality of seeds, one of the parameters considered is their moisture content. It provides guidance on when to harvest and when to safely store. A sample's moisture content is the amount of weight lost after it is dried using the proper methods. The weight of the original sample is expressed as a percentage [43]. By drying them to less than 10% or 11.5% grain moisture content before the 12th storage period, faba beans can be stored for a long time without experiencing significant insect (bruchid) difficulties [55, 40]. A 1% drop in seed moisture content doubles the seeds' storage life, according to the "rule of thumbs." Therefore, even if the temperature and humidity are kept constant every 1% reduction in moisture content has an advantage of doubling the seed longevity.

### 2.6.3. Seed Germination

The germination percentage, defined as the percentage of the total number of seeds that are alive [43], is calculated using a controlled test and the actual number of seeds that germinate. The purpose of seed germination is to quantify a seed lot's germination potential in order to assess the quality of different lots and calculate the crop's field planting value. The variance in germination % is explained by a number of factors that affect germination and vigor, including seed size, age and pathogen, mechanical damage, harvest maturity stage, nutrition, environmental and parental factors, and varieties. A crop seeded with high-quality seed may produce more seedlings than one sown with relatively low-quality seed [1]. The purpose of the seed germination test is to determine the maximum germination capability of the seed lot in order to evaluate the quality of different seed lots and estimate the planting value [63]. A seed that develops into a seedling with all of its required structural elements is considered normal. The seedlings listed below are considered typical: A little defective seedling is one that has a few minor flaws in its essential structure; an intact seedling is one that has all of its essential structures fully formed, proportionate, and healthy; and a secondary infection seedling is one that has been affected by bacteria or fungus when the illness is not brought on by seeds. [43]. According to [6], seedlings are deemed normal

if they have a healthy root system, which includes a primary root and an intact hypocotyl or epicotyl with no harm to the conducting tissue. A seed that germinates during the test period but yields a seedling that is discolored, tainted with seed-borne illnesses, or devoid of essential characteristics like cotyledons is considered abnormal. Aberrant seedlings include those with damaged or stunted plumules, inflated shoots, stunted roots, spilled plumules, no primary leaves, excessive development after emergence, or defective or distorted development of key structure [43]. Ungerminated seedlings can be classified as dead seed (seeds that are neither fresh nor hard at the end of the test period and have not produced any part of a seedling), fresh seed (other than hard seed that failed due to dormancy but are still clear and firm and have the potential to develop into the seedling), or hard seed (seeds that remain hard at the end of the test period because they do not absorb the water) [43]. Insect-damaged, embryo-less, and empty seeds are examples of other seeds [43].

### 2.6.4. Seed Vigor Test Seed

A seed lot's vigor is the sum of all the traits that influence how well it performs in unfavorable environmental conditions, how rapidly and reliably the seedlings grow, and how well the seeds perform during germination and seedling emergence following storage [43]. According to [77], it is the physiological trait necessary to ensure the plant's rapid and reliable field emergence. Included in this are the seed's lifespan, its ability to withstand prolonged storage, and the germination's resistance to atmospheric stress. Genetic composition, harvest maturity, seed size and weight, aging, pathogens, and the mother plant's nutrition and environment are all known to have an impact on seed vigor [61].

### 2.6.5. Hundred Seed Weight

The hundred seed weight (HSW) is the weight of 1000 pure seeds from the pure seed sample that was submitted. The two methods that are employed are either counting the percentage of pure seeds or counting 100 seeds that have been replicated.

From the given sample, HSW assisted us in calculating the weight of 1000 pure seeds [43].

### 2.6.6. Faba Bean Seed Health

The presence or absence of animal pests like nematodes and pathogens like bacteria, viruses, and fungi are the primary markers of seed health [43]. Seed health testing is essential for the reasons listed below: (a) A seed-borne inoculum may reduce the crop's commercial value and lead to the development of progressive diseases in the field. (b) A batch of imported seeds may introduce the illness to the new location. (c) The evaluation of seedlings and the causes of poor germination or field establishment can be clarified (explained) by seed health testing. (d) Using a seed lot treatment to eradicate a seed-borne pathogen or reduce the risk of disease transmission may or may not be recommended by

the results of a seed health test. [43]. Over 17 diseases from various regions of the nation have been discovered on faba beans thus far. *Ascochyta fabae* (ascochyta blight), *Fusarium solani* (black rot), *Botrytis fabae* (chocolate spot), *Uromyces vicia fabae* (rust), and Faba Bean Necrotic Yellow Virus (FBNYV) are the primary illnesses that restrict yield. *Rhizoctonia solani* causes seedling damping off, *Ascochyta fabae* causes leaf and pod spot, *Botrytis fabae* causes chocolate spot, and *Fusarium* sp. causes plant wilt. The storage fungus harms the grains in a number of ways, including reducing their ability to germinate, discoloring and odorizing the kernels, lowering their nutritional value, and producing toxins that are harmful to consumers' health [50].

### 3. Conclusion and Outlook

In conclusion, seed size and seed source have a major impact on Ethiopian faba bean (*Vicia faba* L.) yield. The choice of seed source has a significant impact on the crop's potential for overall output, disease resistance, and adaptability. Locally adapted seeds provide advantages in terms of susceptibility to local environmental conditions and pests, but their quality can vary, which impacts the consistency of harvests. The importance of enhanced seed varieties for increasing national production levels is shown by the fact that, despite their higher cost, they usually yield more and are more disease resistant.

Seed size is also crucial for ensuring optimal crop establishment and growth. Generally speaking, larger seeds produce stronger seedlings and higher germination rates, both of which increase yields. However, smaller seeds may also be suitable for particular agro-ecological zones, offering a more affordable option to farmers who lack easy access to larger, superior seeds. Understanding the relationship between seed size and local growing conditions is therefore necessary to make informed decisions that optimize production.

Further research is required to provide a more thorough understanding of the interactions between various agro-ecological characteristics in Ethiopia and seed sources and seed sizes. Future study should concentrate on long-term field testing to assess the efficacy of different seed sizes and kinds under different environmental conditions. Better seed availability and local farmer demands may be reconciled through breeding programs that improve seed quality while maintaining local adaptation. Policies and extension services that promote the adoption of high-quality seeds and suitable seed management techniques will be crucial to increasing faba bean production on a national scale. In the end, improving seed selection techniques has a big chance of increasing faba bean yield and guaranteeing Ethiopia's food security.

### Abbreviations

ESE Ethiopian Seed Enterprises

RSEs Regional Seed Enterprises  
 EIAR Ethiopian Institute of Agricultural Research  
 RARIs Regional Agricultural Research Institutes  
 HLIs Higher Learning Institutions  
 EABC Ethiopian Agricultural Business Corporation  
 PSCs Private Seed Companies, Cooperative Unions  
 RBoA Regional Bureau of Agriculture

### Conflicts of Interest

The authors declare no conflicts of interest.

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