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15. Seed Production Techniques in Millets

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Abstract:

Seed production in millets is a critical aspect of agricultural sustainability, with a profound impact on crop yield and food security. This study explores the diverse dimensions of seed production, focusing on millets—a group of resilient and nutritious small-seeded grasses. The context is set within the agricultural landscape of the Union Territory of Jammu and Kashmir, which has witnessed remarkable progress in the last five decades, transitioning from food scarcity to security with exportable surpluses. The vision for the next revolution in seed production emphasizes collaboration between farmers, scientists, and government entities, aiming to transform farmers into successful enterprises. In the specific scenario of millet seed production, key factors influencing crop yield are examined, including agronomic practices, input utilization, and the pivotal role of high-quality seeds. The economic significance of seed quality is underscored, emphasizing that despite being a small component of total production costs, it significantly impacts overall productivity. Traditional practices of using farm-saved seeds are discussed, highlighting the need for a shift towards certified seeds to ensure improved production. The study categorizes four distinct classes of seeds—Nucleus Seed, Breeder Seed, Foundation Seed, and Certified Seed each playing a vital role in maintaining genetic purity and overall seed quality. The importance of continuous development of new and improved varieties is emphasized, aligning with the National Seeds Policy 2002. The study recognizes the appropriate agro climatic conditions in Jammu and Kashmir, presenting an opportunity for quality seed production. By prioritizing seed quality over yield, adopting modern seed technologies, and ensuring continuous development, this research contributes to the broader goal of sustainable millet cultivation and enhanced food security.

Keywords:

Certified seeds, Nucleus Seed, Breeder Seed, Foundation Seed and Certified Seed.

15.1 Introduction:

The availability of high-quality seeds plays a pivotal role in agricultural productivity and the widespread adoption of improved cultivars or varieties. The significance of quality seeds in enhancing productivity has been widely acknowledged, with research indicating that the quality of seeds alone can contribute to a substantial 10-15% increase in overall productivity (ICAR, 1993). Despite this recognized importance, the persistent challenge of inadequate access to quality seeds remains a significant impediment, hindering efforts to bridge the substantial yield gap observed in various agro-climatic conditions.

The cultivation of millets, a group of small-seeded grasses widely grown around the world, presents a unique set of challenges and opportunities in seed production (Vetriventhan et al., 2020). Millets, encompassing diverse varieties such as pearl millet, sorghum, finger millet, and others, have gained attention for their nutritional resilience and adaptability to varied environmental conditions. To fully exploit the potential yield of millet cultivars and ensure their successful adoption across different agro-climatic zones, it becomes imperative to address the critical aspect of seed quality through effective production and distribution mechanisms.

Quality seeds are the foundation of agricultural productivity. The adoption of improved cultivars is contingent upon the availability of seeds with high genetic purity, vigor, and uniformity (Mohan et al., 2021). These attributes not only ensure optimal crop performance but also contribute significantly to increased yields.

The intrinsic link between quality seeds and enhanced productivity underscores the need for focused attention on seed production processes. Despite advancements in agricultural practices, a substantial yield gap persists in various crops, including millets. This gap signifies the difference between the potential yield of a cultivar under ideal conditions and the actual yield realized by farmers. In the context of millets, the yield gap is exacerbated by the inadequate availability of quality seeds. Bridging this gap necessitates a comprehensive approach that prioritizes the production and distribution of seeds meeting stringent quality standards.

The challenges associated with ensuring the availability of quality millet seeds are multifaceted. Factors such as limited access to improved cultivars, inefficient seed production techniques, and inadequate distribution networks contribute to the prevailing scarcity. Additionally, the diverse agro-climatic conditions in which millets are cultivated further complicate seed production efforts, requiring tailored approaches for different regions. Millets, being hardy crops with remarkable adaptability, hold immense promise for addressing global food security challenges.

However, their full potential can only be realized when quality seeds of improved varieties are made accessible to farmers. Effective seed production in millets involves the meticulous management of genetic resources, employing modern breeding techniques, and establishing robust seed systems that cater to the unique needs of diverse millet cultivars. Seed production in millets aligns with the principles of sustainable agriculture by promoting biodiversity, resilience, and resource efficiency.

Millets are known for their low-input requirements, making them suitable for cultivation in resource-constrained environments. A sustainable seed production strategy ensures the continued availability of diverse and resilient millet cultivars, contributing to long-term agricultural and environmental sustainability.

Recognizing the paramount importance of quality seeds in millet cultivation is crucial for unlocking the full potential of these resilient crops. Bridging the yield gap and promoting the widespread adoption of improved cultivars depend significantly on robust seed production and distribution systems. This paper explores the intricate dynamics of seed production in millets, addressing challenges, proposing solutions, and emphasizing the role of quality seeds in fostering sustainable agricultural practices.

15.2 What is Quality Seed:

Quality seeds are the cornerstone of successful agriculture, and several key characteristics define what constitutes good-quality seeds. Ensuring these traits is essential for maximizing crop performance, achieving desired yields, and promoting the overall success of agricultural endeavors. The following are crucial characteristics that exemplify good-quality seeds:

A. Genetic Purity and Uniformity: Good-quality seeds exhibit genetic purity, ensuring that they possess the desired traits of the particular variety (Kameswara Rao et al., 2017). Genetic uniformity is equally important, as it ensures consistency in the crop's characteristics. Seeds should conform to established standards for the specific variety to maintain the desired attributes across successive generations.

B. Disease-Free and Viable Seeds: Disease-free seeds are essential for preventing the transmission of pathogens to the emerging plants. Quality seeds should undergo rigorous testing to ensure their freedom from diseases. Additionally, viability is a critical factor; seeds must be capable of germination under favorable conditions to ensure a robust and healthy crop stand.

C. Free from Admixtures: High-quality seeds should be free from any admixtures of other crop seeds, weeds, or inert matter (Afzal et al., 2019). Admixtures can compromise the purity and performance of the crop, leading to reduced yields and potential contamination of fields. Stringent measures in seed processing and testing are necessary to eliminate unwanted components.

D. Uniformity in Size, Shape, and Color: Acceptable uniformity in seeds with regard to size, shape, and color is essential for consistent planting and optimal crop development. Uniform seeds facilitate mechanized planting and contribute to even emergence, resulting in a more uniform crop stand. This characteristic is particularly important in precision agriculture practices.

15.2.1 Key Points for Seed Production in Millets:

A. Availability of High-Yielding Varieties: Ensure access to high-yielding millet varieties that are well-suited to local agro-climatic conditions. High-yielding varieties form the foundation for achieving enhanced productivity in millet cultivation.

B. Use Authentic Sources for Basic Seed: Obtain basic seed from authentic and reliable sources to maintain genetic purity and the desired characteristics of the selected millet variety. Authentic sources contribute to the success of subsequent seed production stages.

C. Careful Selection of Seed Plot: Choose the seed plot meticulously, considering factors that influence millet performance such as soil quality, drainage, and sunlight exposure. Careful selection contributes to better overall seed production performance.

D. Consideration of Environmental Requirements: Understand and adhere to specific environmental requirements for millet cultivation, including altitude, temperature, and other climatic factors. Adapting to environmental conditions ensures optimal seed development and quality.

E. Isolation from Other Varieties: Isolate millet crops from other varieties, especially in the case of cross-pollinated crops. This isolation prevents unwanted cross-pollination, preserving the genetic purity of the millet variety being cultivated.

F. Technical Skill for Quality Maintenance: Employ technical expertise for the maintenance of seed quality throughout the production process. Technical skills are crucial for managing potential challenges and ensuring the overall success of seed production.

G. Maintenance of Genetic Purity: Vigilantly maintain genetic purity by preventing the introduction of foreign pollen or seeds. Genetic purity is paramount for preserving the unique traits and characteristics of the selected millet variety.

H. Compulsory Roguing Practices: Implement compulsory roguing practices to remove any undesirable plants or off-types from the crop. Roguing is essential for maintaining uniformity and eliminating any deviations from the desired characteristics.

I. Harvesting at Physiological Maturity: Conduct harvesting at the physiological or harvestable maturity stage to ensure that the seeds are fully developed and mature. Harvesting at the right time contributes to the quality and viability of the resultant seeds.

J. Emphasis on Seed Quality over Yield: Place importance on seed quality rather than solely focusing on yield. Prioritizing seed quality ensures the production of vigorous and viable seeds, contributing to the success of subsequent planting seasons.

15.2.2 There Are Two Types (Major) of Seed Production i.e. Varietal and hybrid:

Seed production varies based on the type of seed used for multiplication, and there are distinct differences between varietal and hybrid seed production. These differences encompass aspects such as breeding methods, genetic characteristics, and the goals of seed production.

Below is an exploration of the disparities between varietal and hybrid seed production:

A. Breeding Methods:

- **Varietal Seed Production:** Varietal seeds are produced through the natural process of cross-pollination or self-pollination, maintaining the desired characteristics of a specific variety. The breeding process involves selecting plants with favorable traits for further propagation.

- **Hybrid Seed Production:** Hybrid seeds result from the controlled cross-breeding of two different but genetically compatible parent plants. This process aims to capitalize on the advantageous traits of both parents, producing offspring with enhanced vigor and performance.

B. Genetic Characteristics:

- **Varietal Seed Production:** Varietal seeds exhibit genetic stability, as they are derived from the same variety of parent plants. This stability ensures that the subsequent generations maintain the characteristics of the original variety.
- **Hybrid Seed Production:** Hybrid seeds display hybrid vigor or heterosis, where the offspring inherit superior qualities from both parents. This vigor often leads to enhanced yield, resistance to diseases, and overall improved performance.

C. Goals of Seed Production:

- **Varietal Seed Production:** The primary goal of producing varietal seeds is to maintain the genetic purity and specific traits of a particular plant variety. This is crucial for preserving and disseminating established varieties with desired characteristics.
- **Hybrid Seed Production:** Hybrid seed production aims to capitalize on the heterosis effect, resulting in plants with superior traits. The primary focus is often on achieving high yield, improved quality, and increased resistance to environmental stressors.

D. Seed Availability and Cost:

- **Varietal Seed Production:** Varietal seeds are relatively more stable and can be saved by farmers for subsequent planting seasons. This self-sufficiency reduces the dependency on purchasing seeds each season, potentially lowering costs.
- **Hybrid Seed Production:** Hybrid seeds, being the result of specific cross-breeding, do not consistently produce offspring with the same desired traits. As a result, farmers typically need to purchase new hybrid seeds each planting season, potentially increasing the overall cost of production.

Table 15.1: Difference between Varietal seed production and Hybrid seed production

Varietal seed production	Hybrid seed production
It is single parent multiplication	It needs two to many parents
Isolation distance requirement is less	Isolation distance requirement is more
Production is by open pollination	Production is by managed control pollination (Female)

Varietal seed production	Hybrid seed production
Seed can be used continuously for 3 years (33 percent seed replacement) in self-pollinated crops and only for two (50 % seed replacement) years in cross pollinated crops	Seed has to be changed every time (100 seed replacement)
Production technique is uniform (multiplication)	Technique differs with crop
Seed Production care is less	Seed Production care is more
Yield will be lower	Yield will be higher
Profit is less	Profit is higher

15.3 Scope and Importance of Seed Production in Jammu and Kashmir:

A. Agricultural Progress in Jammu and Kashmir: Over the past 50 years, agriculture in the Union Territory (UT) of Jammu and Kashmir has witnessed remarkable progress. India has transitioned from a state of food scarcity to one of food security with exportable surpluses. This transformation sets the stage for further advancements, particularly in seed production.

B. The Role of Farmers as Successful Enterprises: The next phase of seed production in Jammu and Kashmir envisions farmers as successful enterprises, supported by collaboration with scientists and government initiatives. The success of this endeavor is crucial for achieving the next revolution in agriculture.

C. Achievements in Agriculture in Jammu and Kashmir: Landmark achievements in agriculture in the UT will involve the development of new crop varieties resistant to diseases and insect pests. The success of these varieties is contingent on a holistic approach, incorporating high-yielding varieties, increased fertilizer use, expanded irrigation facilities, extensive extension efforts, improved farm practices, and the integration of farm mechanization and digital agriculture.

D. Seed Production for Food and Nutritional Security: The emphasis on seed production is integral to ensuring the food and nutritional security of Jammu and Kashmir and the country as a whole. As the population in the region increases rapidly and natural resources dwindle, the focus must be on enhancing productivity per unit of cultivated land.

15.3.1 Scenario of Seed Production in Millet Crops in Jammu and Kashmir:

A. Factors Influencing Crop Yield: The substantial increase in yield and quality of millet crops, as well as other crops, depends on various factors, including suitable agronomic practices, inputs such as fertilizers, irrigation, and plant protection measures.

B. Critical Role of High-Quality Seeds: The use of high-quality seeds is pivotal in crop production. Poor-quality seeds can negate the benefits of agronomic practices and other inputs, regardless of how lavishly they are applied.

C. Economic Considerations: Despite being a relatively small component of the total cost of production, the economic significance of using high-quality seeds cannot be understated. The cost of seeds is a critical investment that influences overall productivity.

D. **Prescribed Standards for Seed Quality:** To maximize productivity, it is imperative to use seeds that conform to prescribed standards, ensuring high genetic purity, physical purity, physiological maturity, and health quality.
E. **Transition from Traditional Varieties:** Historically, farmers in the region heavily depended on traditional varieties and farm-saved seeds. However, this practice must evolve to enhance production and quality.

15.4 Quality Seed:

A. **Critical Determinant of Agricultural Production:** Seed quality is a critical determinant of agricultural production, influencing the efficacy of other inputs.
B. **Impact of Agro-climatic Conditions:** Quality seeds are affected by agro-climatic conditions, and ensuring an adequate and affordable supply is essential for raising productivity.
C. **Continuous Development of Varieties:** The availability and use of quality seeds require continuous development of new and improved crop varieties, as well as efficient systems for seed production and supply to farmers.
D. **National Seeds Policy 2002 Emphasis:** The National Seeds Policy 2002 emphasizes the need for a major effort to enhance seed replacement rates, focusing on varietal development, seed production, and the availability of newly developed varieties to farmers.
E. **Appropriate Agro climatic Conditions in Jammu and Kashmir:** The UT of Jammu and Kashmir is endowed with suitable agro climatic conditions, providing a favorable environment for the production of quality seeds when crops are raised on a scientific basis.

15.4.1 Four Different Classes of Seeds:

A. Nucleus Seed:

- **Definition:** Genetically pure seed with 100% purity.
- **Characteristics:** Initial number of pure seed of an improved variety, free from physical impurities.

B. Breeder Seed:

- **Definition:** Progeny of the nucleus seed.
- **Characteristics:** Typically produced in one stage, but can be in two stages (Breeder Stage I and II) if demand is high and seed multiplication ratio is low. It is 99.9% physically and genetically pure. Used for the production of foundation seed.

C. Foundation Seed:

- **Definition:** Progeny of the breeder seed.
- **Characteristics:** Produced in two stages (Stage I and Stage II). Produced by farms of State Agricultural departments, universities, government farms, State Seeds Corporations, and private seed companies. Requires registration for certification with a

state seed certification agency. Inspected jointly by a team including Divisional Seed Certification Officer, crop breeder, and District Seed Certification Officer. Tagged with white-colored tag and label after certification.

D. Certified Seed:

- **Definition:** Progeny of foundation seed produced by progressive farmers or registered seed growers.
- **Characteristics:**

Produced under technical advice and supervision from government-approved agencies like the National Seeds Corporation. Truthfully labelled seeds, ensuring adherence to seed act standards and certified seed stage. The responsibility for the seed lies with the seed producer and seller. Certified seed is also tested for physical purity and germination.

15.4.2 Colour of Tags for Different Classes of Seed:

- Breeder Seed: Golden Yellow
- Foundation Seed: White
- Certified Seed: Blue

These four classes represent a systematic approach to seed production, ensuring genetic and physical purity throughout the process. Each class plays a crucial role in maintaining and enhancing seed quality, ultimately contributing to improved crop yields and agricultural sustainability.

Figure 15.1: Colour of Tags Used for Different Types of Seed

15.4.3 Seed Certification:

Seed certification is indeed a crucial step in seed production and marketing which is generally done to maintain high-quality seeds standards and making them available to farmers for maintaining good and quality yield (Batur et al., 2021). In this system varieties of crops are generally grown aiming checking the purity, viability and physical identity and characteristics of seeds.

A. Objectives of Seed Certification:

Seed Certification process has many objectives but the main aim is ensuring the seed standards like seed purity, vigour, genetic makeup and seed health and quality index.

A good seed certification system should be able to accomplish three objectives which are:

- A systematically increased production and marketing of superior varieties or cultivars.
- Identification and generalization of new released elite varieties and their fast increase under generally accepted and suitable names.
- Through cautious maintenance, providing regular and continuous supply of seed material. Certification agencies Certification of seeds should be done by the Seed Certification Agency which has got registration under year 1966 Section 8 of the Seeds Act.

B. Eligibility Requirement for Seed Certification:

Seeds of only suitable varieties which are already got certification from Seeds Act in year 1966 under Section 8 shall be acceptable for certification process. The variety in question for becoming acceptable for certification should strictly follow certain requirement which are listed below:

- Basic requirements: Variety should be registered variety under Section-5 of the Indian Seed Act in year 1966 strictly. It should come under the chain of production. Pedigree record of the variety should be properly traceable.
- Field Standards: Field standards include good site selection, isolation distance and, spacing should be maintained, planting ratio should be checked.
- Quality Seed standards: Minimum certification of seed standards have been developed crop-wise.

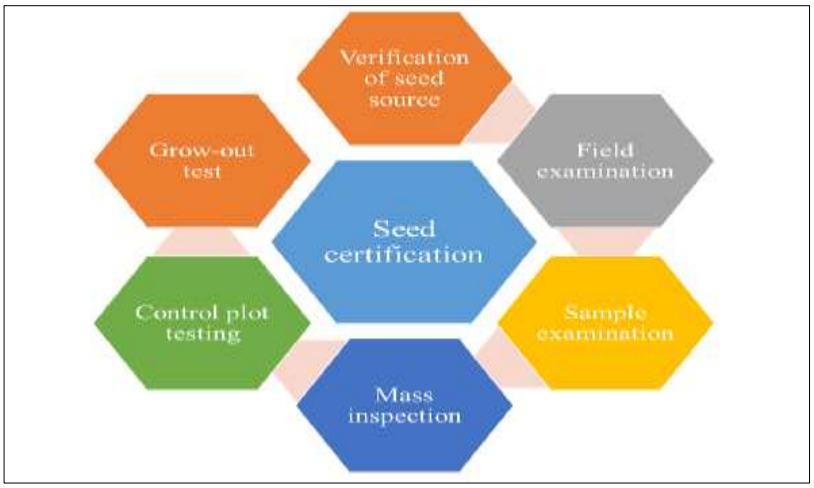

Figure 15.2: Process Followed in Seed Certification

C. Validity of Seed Certification (i.e. Time period):

The validity time period of seed certification is around 9 months from the day of testing when certification is done in initial time. The valid time period of any certification can be further increase for around 6 months giving on re-testing seed conforms to the purity standards like physical purity, inborn/genetic purity, germination percentage.

15.5 Conclusion:

The diverse landscape of seed production, as exemplified by varietal and hybrid seed cultivation, underscores the intricate balance between genetic stability and heterosis-driven vigor. Varietal seed production, emphasizing genetic purity and stability, provides a foundation for preserving specific traits across generations.

This approach grants farmers the autonomy to save seeds, contributing to self-sufficiency and potential cost reduction. On the other hand, hybrid seed production harnesses the power of cross-breeding for superior traits, enhancing yield and resilience. However, the reliance on purchasing hybrid seeds each season introduces economic considerations. As agriculture advances, the choice between varietal and hybrid seed production becomes a strategic decision, navigating the delicate interplay between tradition, innovation, and sustainable agricultural practices. Successful seed production hinges on aligning these approaches with the broader goals of food security, environmental sustainability, and the evolving needs of the agricultural landscape.

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