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Advances in Seed Science Research

V. Satya Srii
All India Coordinated Research Project on Seed (Crops), Seed Technology Research Unit, Gandhi Krishi Vignana Kendra, University of Agricultural Sciences Bangalore, Bengaluru-560065.

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Introduction

When you hold a seed in your hand, no matter how small it is, you are holding a future plant! The plant's blueprint is encapsulated, waiting for moisture and nutrients to press the "go" button. Seeds are amazing. Seeds make up over 70% of the food that people consume directly. From the wheat in our bread to the oats in our cereal, from corn and rice to beans and peas, seeds nourish humankind. Seeds are also planted to produce the rest of the plant foods we eat. From the leaves of lettuce to the fruits of tomatoes, it all starts with a seed. When we eat meat, dairy, and eggs, we also rely on seeds and their products, as livestock are largely fed on corn, soybean, and other seeds. The fibers that clothe us, such as cotton, linen, and hemp, are grown from seeds.

Need for Advances in Seed Science and Technologies

Food and agricultural seeds are developed, processed, and maintained with high quality through continuous advancements in seed sciences and technologies. Some of the steps scientists take to assure a safe seed supply are:

- Sorting
- Drying
- Testing
- Cleaning
- Packaging
- Storing

Continuous advancements in seed sciences and technologies ensure seeds are developed, processed, and maintained with high quality. If a seed supply is not cared for properly, it will lose its ability to sprout, resulting in empty fields. Seed security is food security.

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"*First the Seed*" is the slogan of the American Seed Trade Association. Progress in our understanding of the physiological, molecular and morphological mechanisms and their interactions that determined the performance of seeds greatly relies on the availability of technologies that allow for the investigation of different aspects of seeds under various conditions. Hence, the progress in seed science is strongly related to technical innovations and their availability for application to seed. In addition, these advancements in technology may result in new methods to evaluate seed quality in seed testing procedures. Both application to seeds of completely new technologies and the adaptation of existing technologies developed earlier for other purposes will contribute to new insights in seed science.

Challenges to overcome

A major challenge in seed research is the fact that we are studying the behavior and development of a complete organism, the embryo, that is in most cases safely hidden inside the seed. The embryo not only is made up of a large number of different cells with different functions but also shows a distinct morphology, developmental status and a (seed) environment that all play a role in the seed performance when favorable conditions for the next step in the life of seed occur: gerÍnination. Therefore, the need for non-invasive technologies that can disclose information about the physiological, molecular, biochemical or morphological status of the interior of the seed is of primary importance. Non-invasive measurements on a seed allow for combining the obtained data with information on the performance of the same seed in germination and plantlet formation. This makes it possible to directly correlate embryo (and whole seed) status to seed performance. In addition, these technologies may provide tools for improved seed quality testing methods and protocols.

Productive crops and healthy plant foods for people and livestock start with good seeds. Seed producers and processors must provide these high-quality seeds to farmers and consumers every year. This is challenging work, as it requires that seeds be clean and free of weed seeds and other contaminants. Seeds for sale must also be certified for their viability and may be treated in preparation for planting. They need to be checked to make sure they have a good germination rate. Seeds conserved as genetic resources that can be used in future plant breeding efforts must be preserved with care so that they are available

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for decades or longer. These high standards require that seed processing and testing are performed both rapidly and with precision.

Areas of rapid advancements

Modern Seed Technology (MST) includes a wide range of technologies and practices to upgrade seed quality, enhance seedling and plant growth, and assess seed quality using imaging technology. Another key topic of MST is Seed Enhancements. First defined as post-harvest methods that improve germination and seedling growth or facilitate the delivery of seeds at the time of sowing. The broader topic of MST includes pre-harvest treatments to hasten seed maturation and post-sowing methods to enhance seed viability and vigor for greenhouse and field production.

New technologies are being developed to test seeds for contaminants. For seeds that will be shipped internationally, high precision testing will help determine the presence of genetically modified organisms. This is a necessary step in the certification of the seeds for shipment. Seed sciences and technologists are working together with gene banks. Cryopreservation–special freezing techniques–may allow us to save seeds for hundreds to thousands of years. Saving the genetic integrity of seeds is important, as many new advancements come from using older plant seeds. These technologies enable conservation processes to be more efficient. For example, precise viability testing techniques might use just a few seeds versus a large amount. This will save time, money, and seeds. The available genetic and genomic resources underpinning seed biology and traits provide valuable resources and knowledge for more efficient management of novel variations for seed traits in gene banks and for the development of improved cultivars with specific seed characteristics. For instance, gene bank curators may assess seed viability by monitoring changes in gene expression of biomarker genes in dry seed samples to decide germplasm regeneration and assess genetic integrity of collections by monitoring changes in diversity and allele frequencies between samples of the same accession stored in gene banks.

Thus the research efforts in various fields of seed science and technology have immensely helped in addressing key problems. However, there are still plenty of opportunities and questions to be addressed in this emerging field.

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