[Case Study]

Transforming sorghum breeding with PBS International pollination bags

Introduction to sorghum: A climate-smart grain

Sorghum is a cereal grain that is part of the grass family. It originates from Africa and has been grown in Asia for a long time; however, due to its resistance to hot temperatures and drought, it is increasingly being grown in geographies such as Europe, Australia, and the Americas. As a versatile grain with a wide range of applications, it is used in the production of human food, alcoholic beverages, and animal feed. More recently, sorghum has shown promise as a source of biomass, which can be used in sustainable biofuel production.[1]

Professor Melinda Yerka started working in sorghum in 2012, following receipt of her Ph.D. in plant breeding and plant genetics from the University of Wisconsin-Madison and a postdoctoral researcher position in plant genomics at the University of Georgia-Athens. Her first job in Nebraska focused on a genetic programme for grain quality traits. In her current role, Prof. Yerka runs the Yerka Lab at the University of Nevada, Reno, growing sorghum with collaborators across three states: Texas, California, and Nevada.

In 2023, Prof. Yerka founded 'Yerka Seed Company' to create and market commercial sorghum to producers. It functions by taking publicly available varieties, developed by the Yerka Lab, and finishing their development into commercially competitive inbred lines or hybrids[2]. Yerka Seeds is interested in grain sorghums for the food sciences (including malting and brewing) as well as silage sorghums that act as less water-intensive dairy feeds. It has ongoing pilot studies to assess the viability of its silage hybrids as an alternative to current dairy feeds like corn. The results are promising[3].

Prof. Melinda Yerka started her sorghum career in 2012. Today, she leads both the Yerka Lab at the University of Nevada, Reno, and the Yerka Seed Company.

Sorghum: A promising solution for regenerative agriculture

As a human and animal food/feed source, sorghum offers various functional benefits including improved digestion, blood sugar regulation, gut health support, and more[4].

Sorghum varieties with low amylose starch content in their seeds are often referred to as “waxy” sorghum due to the texture of the endosperm. Waxy corn varieties exist and are widely used in food and beverage applications for their thickening and texturising properties – however, corn requires about 30% more water on average than sorghum to grow. This means that waxy sorghum is emerging as a more sustainable alternative in human foods. However, its low amylose content also makes it particularly well-suited for fermentation applications in ruminant nutrition and ethanol production, where it can replace normal corn varieties.

Sorghum as a food source offers various functional benefits, and is rapidly emerging as a more sustainable alternative to corn.

Prof. Yerka is currently collaborating with a food ingredient company that use waxy corn in its starch portfolio, to examine the suitability of waxy sorghum as a more sustainable alternative. This collaboration focuses on developing a waxy sorghum variety that offers similar functional properties to waxy corn, which would allow the company to offer consumers the same functional performance in their products while promoting reduced agricultural water use.

The core focus of Prof. Yerka’s long-term research is to adapt sorghum to grow in regions where other cereal crops are currently cultivated, providing farmers with a more resilient alternative as temperatures rise and precipitation patterns change. Her sorghum varieties are well-suited to replacing existing grain crops in western US states while maintaining diverse food, feed, and biofuel functionality traits that local communities and food chains rely on. Sorghum also makes an excellent rotational crop with wheat. Many farmers have reported a bump in wheat yield and quality following a sorghum crop, which is likely due to sorghum’s high production of root biomass that improves the soil. The University’s location in Nevada is ideal for this work, as Reno is one of the fastest-warming cities in the US – experiencing a 7.6°F raise in annual average temperature from 1970 to 2023[5].

As the gluten-free industry continues to grow, Prof. Yerka is examining ways that sorghum can replace other grains like wheat, barley, and rice to provide better-tasting options for gluten-free foods and beverages. Recently, she has identified several grain quality classes in her varieties that have different end-use categories. The sorghum grain quality classes she has developed are similar to wheat grain quality classes: hard kernels are best for making pastas, tortillas, yeast breads, and popping, whereas softer kernels with low and high protein contents are best for baked goods like cookies and cakes. This work was recently validated through human sensory analyses conducted with community members from Nevada and California in June 2025.

Building on the promising grain quality profiles, Prof. Yerka has partnered with sorghum breeders at the International Maize and Wheat Improvement Centre (CIMMYT) in Nairobi, Kenya, to develop similar varieties for locations including Kenya, Ethiopia, Tanzania, Uganda, Malawi, Zimbabwe, Zambia and Senegal. The collaboration focuses on improving knowledge about the genetics underlying food quality traits and optimising methods for rapid local adaptation to new environments. Prof. Yerka consulted on two breeding programme reviews in Autumn 2024, organised by the Centre and its international partners. For this project, Prof. Yerka has been traveling between the U.S. and Kenya to conduct inaugural research for integrating her sorghum varieties into local breeding programs[6].

Overcoming pollination challenges in sorghum breeding

Before discovering PBS pollination control bags, Prof. Yerka exclusively used paper bags, known as Canvasback® bags. While these bags are weather-resistant, the non-permeable paper material traps heat. This creates an extra layer of warmth around the developing kernels and negatively impacts seed sets, as sorghum grains become non-viable when exposed to excessively high temperatures at critical points in the growth cycle.

Prof. Yerka discovered PBS International when searching for an alternative bag that could offer both temperature and pollination control. In 2022, she conducted an experiment in three different environments, placing three PBS International bags alongside three paper bags on each variety to compare performance. The results showed that PBS bags maintained more tolerable temperatures inside the bag, caused less grain shrinkage and collapse, and improved seed sets in hotter conditions.

Prof. Yerka's research found that PBS International bags help to reduce grain shrinkage and collapse, and also improve seed sets.

The bags also protect against bird damage, which is a common challenge faced by sorghum breeders. Birds often eat the grains as they're developing, especially when other food resources are low, and have quickly learned that the paper bags can be torn open. Prof. Yerka explains:

"A lot of our work is based in Lubbock, north Texas, as sorghum growing is almost centred in this region. This area, however, also has a lot of birds, who have been known to just decimate the crops. The PBS International bags help to reduce this pressure, as the birds aren't able to tear the fabric like they can with paper."

Furthermore, the PBS International pollination bags can be bleached and reused, offering a more cost-effective approach in the long run as they do not need to be replaced yearly if properly treated and stored. Plant breeders can also write on the bags with a marker pen without affecting the integrity or performance of the bag, which is especially useful in the field.

How PBS International pollination bags support sorghum breeding

The PBS 2D42 SG1 pollination bag has been developed to address common issues sorghum breeders face, including bird damage and mould. The 2D42 SG1 is made from duraweb® Sentinel SG1 material, which offers a number of economic benefits compared to the traditionally-used paper bags in terms of germplasm maintenance, hybridisation processes and generation advance in sorghum.

The advanced breathability of duraweb® Sentinel SG1 compared to paper bags means the environment inside the bag is less humid and less likely to reach high temperatures. This results in increased seed yields, as the panicles are not subject to extremely high temperatures, and there is decreased risk of mould incidence, as the humidity build up inside the bag is reduced.

PBS International identified an opportunity to re-deploy a bespoke machine as a dedicated sorghum bag production line to automate the manufacturing of 2D42 SG1 bags – ideal for both sorghum and other cereals crops.

This production method offers a number of benefits for customers looking to purchase these bags for sorghum and cereals crops, including reduced lead times, dramatic price reduction, and complete traceability through the duratrace™ quality control system. PBS International pollination bags provide plant breeders with an opportunity to get higher quality sorghum grains, a more precise phenotype for starch and protein, and prevent outcrossing.

Market opportunities and next steps

Yerka Seed Company is currently quantifying colour development in sorghum grains for the first time, aiming to assess differences between panicles kept under PBS bags and open-pollinated panicles based on 2024 field trials. This experiment uses a colour metric sensor to scan the grain and compare CIELAB colour values between open-pollinated and PBS bag-covered panicles. The research is ongoing.

Prof. Yerka is also in the process of securing funding to establish regional on-farm variety testing networks across the Western U.S. Her goal is to provide grain samples for the food and brewery industries to develop new products; identify regions that produce stable flavour and quality traits; and assess the impact of organic and regenerative farming systems on sorghum quality[7]. Pollination control tents could be useful to this work where growing seasons are short, as Prof. Yerka explains:

"Using pollination control tents could be an interesting option for sorghum breeders who are working on areas such as grain quality traits. Work is still ongoing to see how grain colour affects flavour and other areas, but I expect the tents will retain heat around the plant, which may make them useful for extending the growing season and preventing frost damage. It's an interesting concept and definitely something worth exploring further."

As Prof. Yerka continues her work in sorghum breeding, she plans to continue using PBS International bags to help support her work in breeding new varieties. She summarises:

"We know that we don't get cross-pollination if we use the PBS International bags, and we know the bags will exclude pollen while allowing airflow. We can see that the grains look more plump and healthy under a nonwoven bag rather than a paper bag, and we get good seed chemistry that isn't outcrossed; it's a no-brainer that we are going to continue using the bags."

To learn more about how PBS International bags and tents can support your cereal breeding efforts, visit:
https://www.pbsinternational.com/key-sectors/cereals/

For more information about the Melinda Yerka and the work of the Yerka Lab, visit:
https://www.unr.edu/avrs/directory/yerka-melinda

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