

PERSPECTIVE



Better research for better tea

Studies that aim to improve tea's quality are limited by the research cultures of countries that dominate tea production, says **Jeff Bennetzen**.

As the source of the world's most consumed beverage after water, the infusion from the leaves of the tea plant, *Camellia sinensis*, should be a leading target for improvement. For most cereal or legume crops, including maize and soya beans, the top three research targets are yield, yield and yield. Tea, by contrast, is esteemed for its palatability and, like wine, is known for several order-of-magnitude differences in cost per quaff, based on variation in quality. Research efforts to further enhance the quality of tea are, however, falling short of their potential for intrinsic and cultural reasons — mainly the way that science is conducted in countries that lead tea production.

The palatability of tea is derived from a combination of plant genetics and tea's growth environment, such that the same variety will produce teas with different tastes when grown in different locations. The manner in which tea leaves are processed is crucial. There are six main techniques, which range from little more than drying and heating the leaves to yield green tea to the extensive fermentation that is required to produce dark tea. Leaf size is also important: the highest-quality green teas are created from the smallest leaves, or leaf buds, which must be gathered by hand at considerable cost. Mature leaves are never harvested for green tea, although oolong tea, yellow tea, dark tea and black tea can come from older leaves that are then highly processed.

The tea plant originates from a region that is centred on the border between Yunnan in south-western China, Assam in northeastern India and northern Myanmar. It has been consumed in China for more than 4,500 years. Since then, *C. sinensis* has diversified into hundreds of varieties that are grown in more than 60 countries, with China and India vying for the position of the world's largest tea producer. The next most productive tea-growing nations — Kenya, Sri Lanka, Turkey and Indonesia — produce less tea combined than does China alone.

China also dominates research on tea. It publishes more than twice as many papers in the field each year as does the second most active research community, in India. Unfortunately, China has a research reward system that tends to inhibit cooperation and stifle creativity, and that focuses on short-term goals. Researchers are not rewarded fully for their work if credit for it is shared; senior scientists so monopolize funding that the creativity of more junior scientists is stifled; and the focus is always on producing the next publication rather than moving a body of science forwards.

These problems stem from the research culture of China rather than the country's scientists as individuals, who often tell me of their displeasure with the hierarchical system and cash-for-publication mandate. Nor are these problems limited to China: tea researchers, in general, do not have a history of sharing materials or data within or between countries. Such issues are not unique to tea research, either. But they are problematic for tea, in particular, because the field has no international institute or large research community outside

Asia that can provide shared resources. As tea is predominantly an Asian crop, it is the countries of Asia that must deal with these tea-research issues.

A key to productive crop research is the ability to associate heritable plant traits with genotypes. In tea plants, this presents a challenge because the plants reproduce slowly: the seed-to-seed generation time for tea is typically 3–6 years. That time span makes the creation of successive generations of crossbred populations of tea plants a lengthy process (Y. Xiao, H. Liu, L. Wu, M. Warburton & J. Yan, *Mol. Plant.* **10**, 359–374; 2017).

Moreover, no world-sourced collections of tea exist, and the local collections and crossbred populations that have been described in the literature so far have not, in general, been made available to the wider research community. My colleagues at Anhui Agricultural University in Hefei, China, are beginning to construct universally available collections and crossbred populations, but they do so at personal sacrifice. This is because the many-year effort will not yield them the numerous, immediate publications on which China's research reward system is based.

Although tea research could be advanced by a more open community, that alone would not be sufficient. Changes in the ways in which research is funded and rewarded are also required. Joint resources such as plant-stock centres, crossbred populations and replicated nurseries at multiple locations, to test for the effects of the environment, need to be funded by the main players in tea research.

Institutions that choose to provide shared resources will find that the wider research community converges on them, bringing fresh ideas,

scientific advances and their admiration. Some funding panels for tea research should make multi-institutional participation a requirement for grants to be awarded, and the research reward system should recognize scientists' accomplishments, even when such work does not lead to publications. Credit should be shared without a rigid focus on a paper's first and last authorship. Research to improve tea's quality will require deep collaboration between biochemists, geneticists and agronomists, as well as the specialists who serve on tea-tasting panels.

Tea research has huge potential for success, with fascinating targets and a community of talented scientists. The countries that lead tea production worldwide must let their researchers show the way. Once the genes responsible for palatability traits have been identified, and their allelic variants distinguished and associated with environmental modifications, one can foresee an improvement community that can pursue crosses for predictive breeding.

Tea growers could then have quality so under control that the new focus can be yield, yield, yield. ■

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