**Challenges for rapid breeding of fruit cultivars for future sustainable production**

Docent lecture in Horticulture with specialization in Plant Breeding by Kimmo Rumpunen

Fruits are healthy food and we are all recommended to increase consumption on daily basis to stay healthy. Further, it is desirable that future fruit production takes place in sustainable production systems, such as integrated pest management systems and organic growing, to avoid residues and reduce pollution. However, most cultivars presently being used were not developed for sustainable growing and should not be used in the future. Therefore, new cultivars are urgently needed and methods that could quickening plant breeding aimed at cultivar development should be given priority.

Plant breeding research is rapidly evolving when it comes to genomic research e.g. methods for genomic analyses, strategies for genomic selection and protocols for genetic engineering aimed at speeding up cultivar development, but phenomics is lagging behind. The lack of accurate, rapid and cost-efficient phenotyping methods and equipment limits our possibility to obtain sufficient data for e.g. association studies and thereby hampers the development of molecular markers, for both juvenile and adult traits, which is very much needed in applied breeding. This is especially a concern for woody perennial fruit crops such as apple and black currants, which must be grown in the field over several years to express their traits of interest, account for seasons and enable separation of genotype and environmental effects.

Phenotyping is often time consuming and methods usually need to be developed for each trait separately. For accurate sampling identifying the stage of maturity can also be difficult, and mistakes could bias data to a large extent. For phenotyping of some traits image analyses have proven useful in achieving a high throughput, whereas for other traits, especially for fruit quality traits, laborious sample preparation in labs are usually necessary. New non-destructive techniques offer interesting possibilities for future use if sufficient specificity can be obtained.

As a researcher I have especially been studying diversity in fruit quality traits, such as content of health promoting compounds like phenols and vitamins, and effects of genotype and environment on these traits. This has resulted in useful information on diversity and its potential use in applied plant breeding for development of cultivars with increased content of specific compounds such as anthocyanins and ascorbic acid. Cultivars with increased content of healthy compounds could contribute to a sufficient daily intake even if total consumption of fruits and vegetables is not increased which seem to be a challenge for many people. A breeding strategy to increase consumption would instead focus taste quality traits which also is a challenge since sensory tests are expensive and need trained panels.

As a plant breeder of apples and black currant I find a holistic perspective necessary in order to be able to develop cultivars that are competitive and can contribute to increased sustainable production, profit for growers, and healthier consumers. Plant adaptation to local climate, tolerance to severe pests and diseases as well as sufficient and stable yield is necessary to target. However, a new cultivar cannot be successfully introduced on the market unless its quality supersedes the quality of available cultivars, and interaction with industry and consumers are therefore necessary. For this purpose, it is also important to realize that unless superior plant material is selected in the same context as the future commercial production systems there is little chance for success. Thus, research on future sustainable management systems for fruit orchards, which could be implemented in the applied breeding programmes, should be undertaken.