



LITHUANIAN
RESEARCH CENTRE
FOR AGRICULTURE
AND FORESTRY



Breeding of Horticultural Plants in Lithuania: an overview

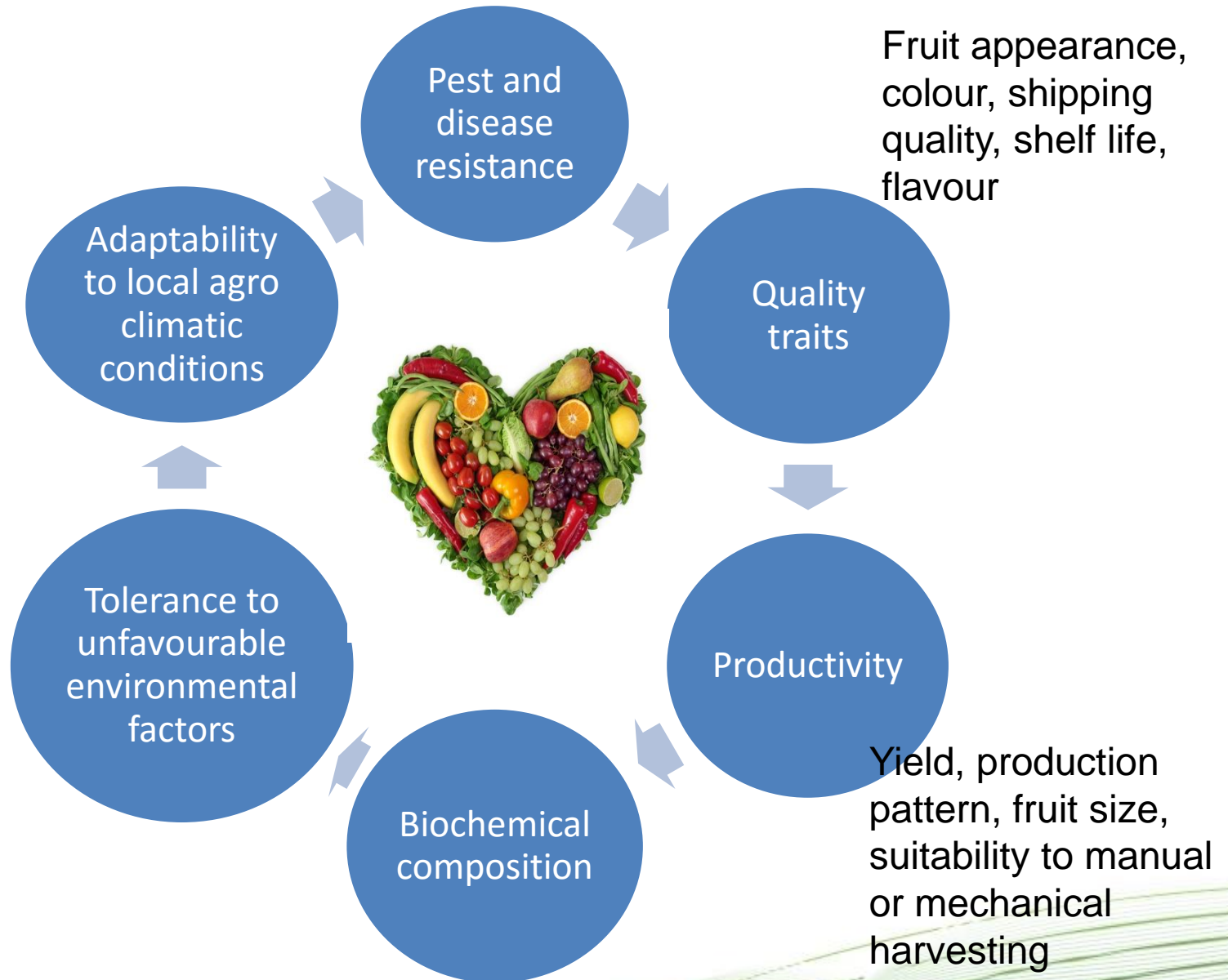
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Plan of presentation

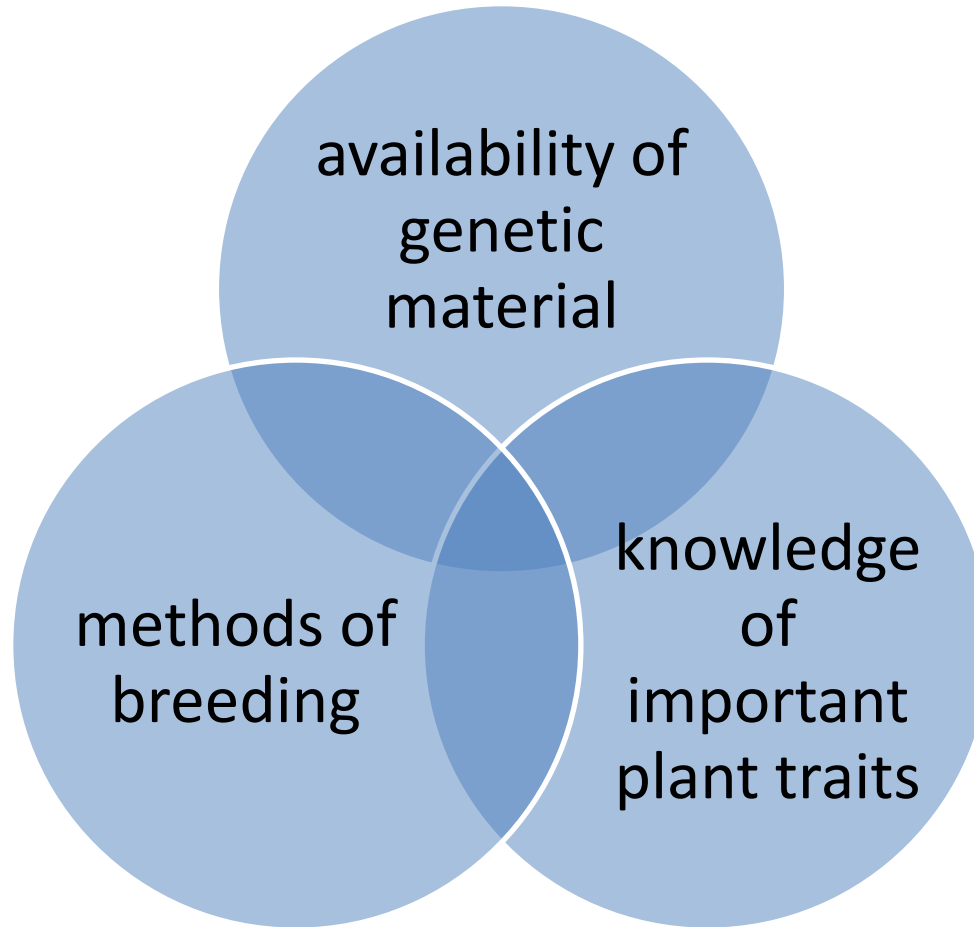
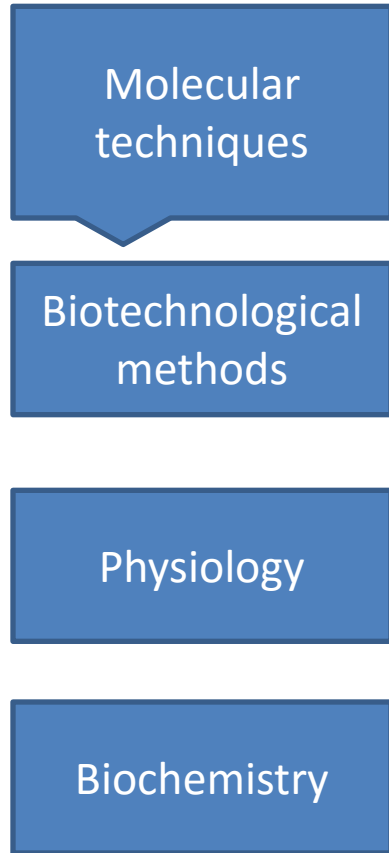
- **Orchard plant research**
 - ➔ *Pome fruits*
 - ➔ *Stone fruits*
 - ➔ *Small fruits*
- **Vegetable research**
 - ➔ *Root crop*
 - ➔ *Fruit crop*
 - ➔ *Onion crop*
 - ➔ *Leaf and legume crop*
- **Conclusions**
- **Acknowledgements**



Breeding program



Successful cultivar development



Orchard plant gene pool at IH-LRCAF

- Over 790 apple cultivars (+8 rootstocks)
- 336 pear cultivars (+5 rootstocks)
- 163 plum cultivars (+2 rootstocks)
- 268 sweet and sour cherry cultivars (+5 rootstocks)
- 184 currant and gooseberry cultivars
- 113 strawberry cultivars
- 52 raspberry cultivars
- 8 sea-buckthorn cultivars





Apple breeding



- The genetic origin of resistance to apple scab (*Venturia inaequalis*) was tested at the embryonic apple development stage using isolated cotyledons. Application of the method allows a 92-100% recovery of progeny and provides a valuable tool for efficient assessment of the disease resistance.
- Screening methods of scab resistant genotypes by using cotyledons *in vitro* can be employed for estimation of donor characteristics and its potentiality in breeding and preliminary estimation of interaction of nucleus and cytoplasm genes.
- Marker-assisted selection (MAS) has been extensively used in apple breeding to identify inherited resistance genes and to reduce the time required for selection of resistant seedlings.



Apple breeding



- The cultivars 'Aldas', 'Skaistis' and 'Rudenis' are immune to *Venturia inaequalis* races 1 to 5 and have a DNA fragment of 500 bp specific for the *Rvi6* gene.



'Aldas'



'Rudenis'



'Skaistis'



Apple breeding



- The evolving virulence of the apple scab pathogen stimulated efforts to adapt new resistance breeding approaches, such **pyramidization** of resistance genes. A total of 159 apple hybrids of pyramidic resistance were obtained: 133 seedlings carried *Rvi5* and *Rvi6* genes, and 26 hybrids inherited *Rvi5* and *Rvi10* genes (Sikorskaite et al., 2012; Sikorskaite et al., 2013).



Apple resistance to canker



Pear breeding

- Crossing of local with introduced cultivars resulted new pear cultivars, such as 'Lukna', 'Gaisra' and 'Liepona'.



'Lukna'

Sweet cherry and sour cherry breeding

- Crossing the local cold resistant cultivars and disease resistant cultivars developed abroad led to create sweet cherry cultivars 'Jurgita', 'Mindaugė', 'Jurga', 'Meda', 'Germa', 'Irema', 'Luke' and sour cherry cultivars 'Vytėnų žvaigždė' and 'Notė'.



'Jurgita'



'Vytėnų žvaigždė'

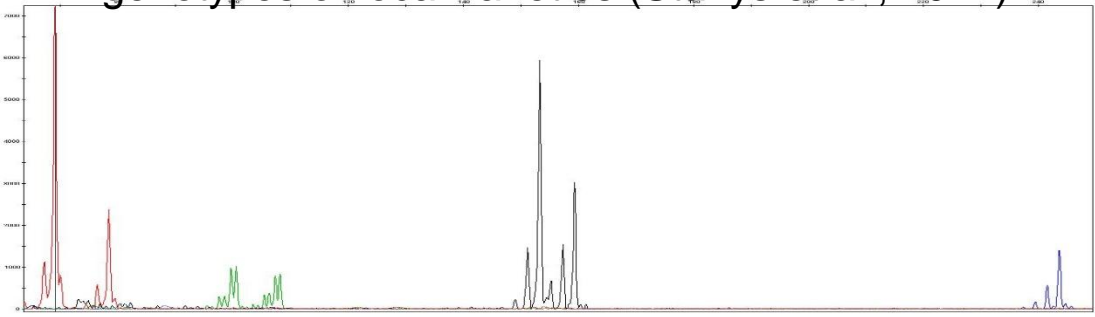


'Notė'

Controlled testing system for differentiation of resistant to brown rot (*Monilinia fructicola*) sweet and sour cherry genotypes with respect to resistance to brown rot was developed. This system can be applied for development of new sweet and sour cherry cultivars resistant to brown rot.

Genotyping wild sweet cherry

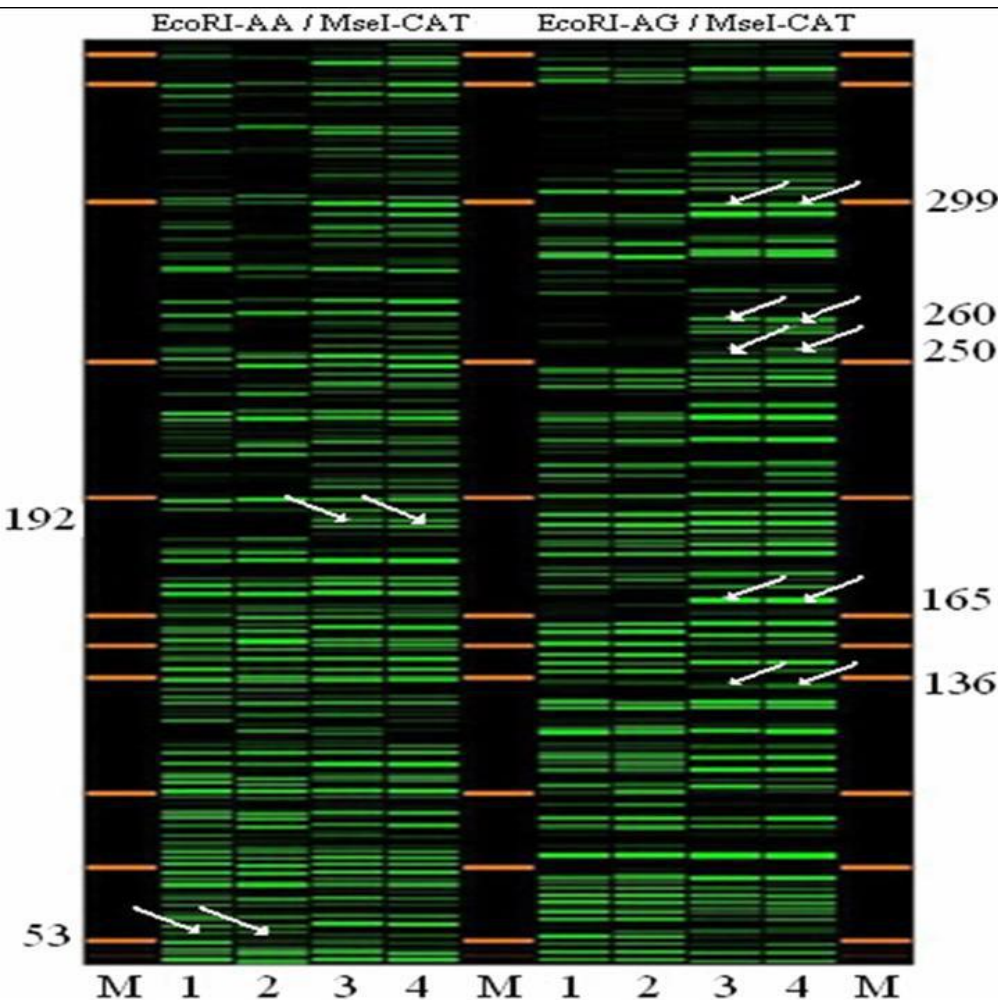
An analysis of polymorphism of microsatellite sequences revealed the genetic diversity of wild populations of the cherry in the region and genotypes of local varieties (Stanys et al., 2012).



The study identified ten different self-incompatibility groups among the genotypes in addition to new unique combinations of S alleles

Self-incompatibility group	Allele	Cultivar
II	S1S3	‘Žemaičių rožinė’
III	S3S4	Seda’
VI	S3S6	‘Vytėnų rožinė’,
VII	S3S5	‘Meda’
X	S6S9	‘Jurgita’
XVIII	S1S9	‘Vytėnų juodoji’
XXI	S4S9	‘Agila’, ‘Vasarė’, ‘Germa’
XXIII	S3S16	‘Žemaičių geltonoji’
XXV	S2S6	‘Lukė’
XXXVII*	S6S16	‘Jurga’, ‘Anta’
Universal donors for groups I-XXXVII	S2S9	‘Irema BS’
	S1S13	‘Žemaičių juodoji’
	S12S16	‘Hrebnickio1’

Sweet cherry flower resistance to frosts



Usage of AFLP methods resulted in 5 markers, identified only spring frost resistant cultivars, and 2 markers specific to spring frost susceptible cultivars of sour cherry.

Cold tolerance traits

It was demonstrated that cold tolerance of **plum** in winter is highly affected by temperature fluctuations, and autumn and the beginning of winter are the most important periods for plum cold hardening.



It was showed that generative organs of **blackcurrants** were the most sensitive to spring frost at **organogenesis stage VII**. The critical temperature for flower tissues is **-3 °C** for most investigated blackcurrant cultivars (Gelvonauskis et al., 2004).



Formation of cold hardiness in **strawberry** during early plant development stage has been investigated, and an *in vitro* system for the screening of strawberry seedlings for cold resistance has been developed (Rugienius, Stanys, 1997; Rugienius, Stanys, 2001).



Developmental biology and biotechnology applications

A wide range of biotechnology applications are based on advances in the developmental biology of plant tissue culture. Adaptation and development of **lingonberry** (*Vaccinium vitis-idaea* L. cv., Sanna) was assessed for plants produced by tissue culture vs. stem cuttings in a collaborative research effort (Gustavsson, Stanys, 2000). Further research led to development of *in vitro* technology for the propagation of **lingonberry** (Stanienė et al., 2002) and methods for the propagation of ornamental plants were also established.

Molecular marker technology was employed to assess genetic and epigenetic stability of **pear shoots** grown under *in vitro* conditions and during long-term storage at low temperature (Rugienius et al., 2011).

Methods of *in vitro* embryo rescue were developed for **sweet cherry, sour cherry and blackcurrant** (Stanys et al., 1995; Stanys, 1998).

As an alternative to the embryo rescue technique, **polyploidisation of *R. nigrum*** was used to overcome the reduced fertility during interspecific hybridization (Sasnauskas, 2007). In another study, polyploid lines of Japanese quince (*Chaenomeles japonica*) were developed using *in vitro* culture technique (Stanys et al., 2006).

Plum breeding

- plum cultivars – ‘Gynė’, ‘Jūrė’, ‘Rausvė’, ‘Kauno vengrinė’ and ‘Aleksona’.





‘Rausvė’




‘Aleksona’

Blackcurrant breeding

 *R. nigrum* ssp. *sibiricum* Pavl. and *R. dikusha* Fisch. – resistance to frost, anthracnose (*Pseudopeziza ribis* Kleb.) and gall mite (*Cecidophyopsis ribis* Westw.)

 Cultivars from Scandinavian countries – resistance to powdery mildew (*Sphaerotheca mors – uvae* Berk.)

 Breeding with this line for resistance to fungal diseases led to the development and release of a number of powdery mildew resistant blackcurrant cultivars – ‘Gagatai’, ‘Pilėnai’, ‘Tauriai’, ‘Blizgiai’ and others.



‘Gagatai’



‘Pilėnai’



‘Tauriai’



‘Blizgiai’

Future perspectives in blackcurrant breeding

- Use of wild germplasm
- Interspecific hybridization
- Use molecular markers
- Phenotyping value
- International cooperation

Blackcurrant breeding

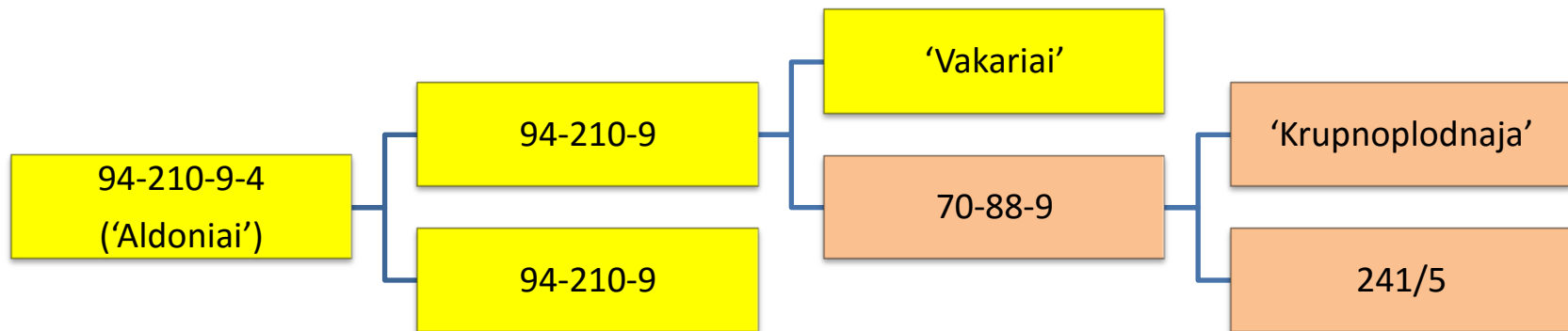
- *R. nigrum* and *R. americanum* hybrids in F2 - F3 progenies and *R. janczewskii*, *R. pauciflorum*, *R. ussuriensis*, *R. petiolare* hybrids in F1 are winterhardy.





Blackcurrant breeding

New pedigree of cultivar 'Aldoniai'

Now at trial evaluation



-  With resistant to gall mite gene P
-  Without gene P

Mazeikiene I., Bendokas V., Stanys V., Siksniunas T. 2012. Molecular markers linked to resistance to the gall mite in blackcurrant. *Plant Breeding*. 131(6): 762—766.

Blackcurrant breeding



'Karina' (BRi 9502-1A)

CHARACTERISTICS	'Gagatai' (Standard)	'Karina'
Ripeness of berries (month, day)	06.30	07.02
Average yield, t/ha	3.55	3.91
Powdery mildew, scores	0	0
Anthraxnose, scores	2.03	2.93
Septoria leaf spot, scores	2.40	2.73
Gall mite, scores	0.36	0.36
Average weight of 100 berry, g	113.6	165.9
Max size of berries, g	1.84	2.63
Sugars, %	5.86	6.55
Ascorbic acid, mg100g ⁻¹	111	115
Anthocyanins, mg100g ⁻¹	442.2	204.8



JUODIEJI SERBENTAI 'KARINA'

Nauja vidutinio ankstyvumo juodųjų serbentų veislė, gauta sukryžminus veisles 'Lentia' ir 'Intercontinental', dirbant pagal bendrą švedų–latvių–lietuvių juodųjų serbentų selekcinę programą, 2008 metais veislė įregistruota Lietuvos Vaislybos augalų sąjungos sąraše.

Keniamai tvirti, vidutinio aukščio, nedaug žiedkankių, formuoja vieningą kerdą skelbtinai laiku. Uogų labai mažomis vidutinė masė – 1,48 g, kerdos sudaro vienodą dydžio uogas. Šioms saldiaragūstoms, labai geroms. Uogose nustatyta 115 mg 100g⁻¹ vitamino C, 271 mg 100g⁻¹ fenolių ir 149,5 mg 100g⁻¹ antocianų.

Derlingumas geras, 2,6 – 4 kg nuo krūmo. Atsparumas ligoms: labai atsparūs miltligėi, atsparūs deguliams, pakankamai atsparūs serbentiniams vikšrams. Išvertinumas žemą gerą.



'Domino', 'Ritmo' and 'Viktor'

Strawberry breeding

- PCR based markers for *Rpf1* gene were developed and used for screening strawberries for red stele resistance.

- **‘Saulene’** (‘Shuksan’ x ‘Senga Sengana’)

Harvesting of the early cultivar ‘Saulene’ starts 5-6 days prior to standard ‘Venta’. Concentrated and high yield with excellent tasting fruits are characteristic of ‘Saulene’. High quality fruits of this cultivar are suitable for fresh use.

- **‘Dange’** (‘Venta’ x ‘Redgauntlet’).

Middle late cultivar ‘Dange’ distinguishes itself by good size, attractiveness of fruits and stable, high yield every year.



Wild strawberry breeding



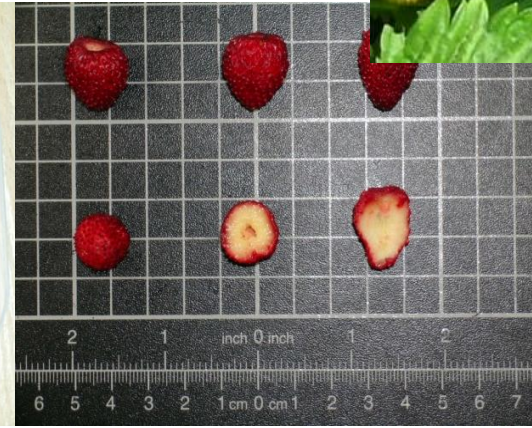
'Dena' (IHFV10)



'Elina' (IHFV12)



'Meda' (IHFV12)



'Redita' (IHFV15)

Four wild strawberry *Fragaria vesca* cultivars 'Dena', 'Meda', 'Redita' and 'Elina' were realized recently. All of them are remontant - producing berries from June to October, with production peaking in mid-summer. They produce high yields of rather big berries with excellent aroma of wild strawberry. 'Dena' distinguished by early fruiting, 'Meda' – by high yield (up to 4 t/ha), 'Redita' by big size (over 3 g), berries of oblong shape and easy picking, 'Elina' by nice white aromatic berries. All of them are tolerant to drought and cold. Propagated by seeds.

Japanese quince

- 'Darius'
- 'Rondo'



Raspberry

- ‘Vizija’
- ‘Mistika’



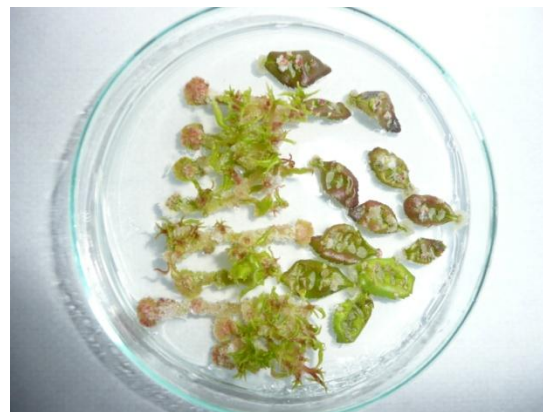
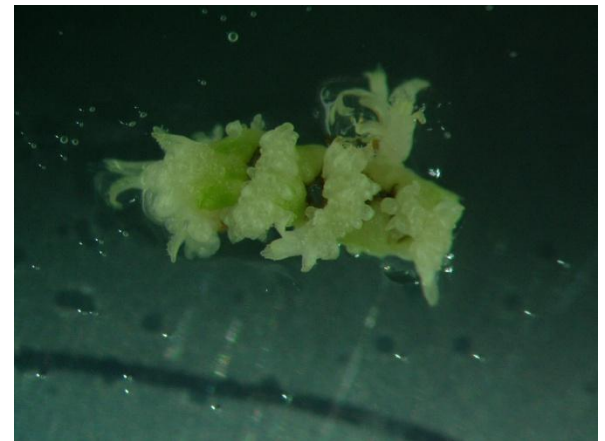
Orchard plant studies *in vitro*

Regeneration systems for over 80 species were prepared,
Plant transformation systems were optimized.

Plant virus eradication

Dependence of organogenesis on:

- cultivar;
- composition of nutritional medium;
- phytohormone quantity and ratio;
- antibiotics;
- light and temperature



Carrot breeding

Carrot cultivars of *Nantes* type are the most popular

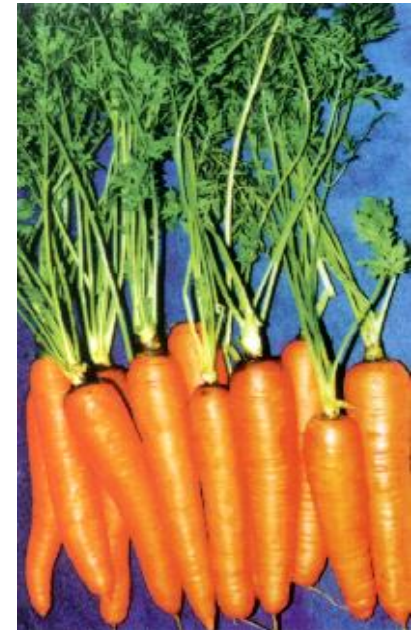
'Ieva' H distinguishes according productivity (from 65.5 to 70.0 t/ha).



'Rokita' H is suitable for growing in a heavier soil.



'Svalia' H is typical for early production.



Red beet breeding

Joniai - small foliage, round and oval round shape of root.



Ilgiai - medium size foliage. Medium cylindrical roots are typical for cultivar.



Rikiai – two seedy, tolerance to drought cultivar.



Radish breeding

Babtu žara - extra earliness maturity. The shape of root is round or oval round and colour is brightly red.



Liliai represents of medium earliness maturity. Rotos are round, massive, red colour with purple tone.



Onion and chives breeding

Babtų didieji is middle earliness, homogenous. Suitable for fresh using, storing and processing.



Chives **Aliai** distinguishes with early production of leaves.



Garlic breeding

Žiemiai is a winter cultivar. Flat round shape of bulb is typical for Žiemiai cultivar.

Vasariai is a middle earliness cultivar and suitable for planting in spring.



'DANGIAI'

White cabbage and bean breeding

White cabbage **Bagočiai** is a middle late cultivar. Bagočiai distinguish with good biochemical composition.



Bean **Baltija** belongs to the bush pod group. Cultivar is a middle earliness.



Cucumber breeding

Hybrids of cucumber Gintai, Daugiai and Krukiai BS originated in Lithuania are suitable for growing in the open field and in the greenhouses.

Gintai is a middle earliness heterotic hybrid with intensity of yielding.



Krukiai BS is middle late hybrid of first generation.



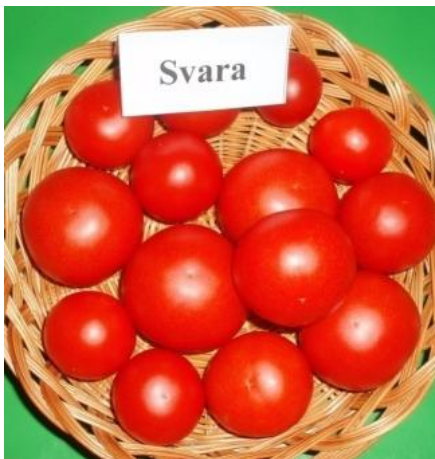
Daugiai distinguishes with early ripening and intensity of yielding.



Tomatoes breeding

Cultivars of tomato Svara, Viltis, Balčiai are suitable for growing in the unheated greenhouses and in the open field.

Svara is late cultivar distinguishes with high yield and fungal disease resistance.



Viltis is early cultivar. Fruit weight of during first harvesting reach 120 – 150 g.



Balčiai is middle earliness cultivar. Fruits are with red colour, good taste, medium size (75 – 95g).



Tomatoes breeding

'Skariai' – middle earliness cultivar. The shape of fruit is flat round.



'Rutuliai' is middle earliness cultivar. Fruits are red, round, middle size.



'Adas' H



'Auksiai'



'Ainiai' H is middle earliness cultivar.



Sweet pepper breeding

Cultivars of sweet pepper Alanta and Reda are middle earliness.

Cylindrical fruits of Alanta distinguish with massive, orange, tasty fruits.



The shape of cultivar Reda is cut cylinder. Fruits have external attractiveness and dark red colour.



Jerusalem artichoke or topinambour



‘Sauliai’

CONCLUSIONS

- Over 90 fruit cultivars and 49 vegetable cultivars and hybrids is developed in IH-LRCAF.
- Research is focused on improving cold hardiness, resistance to diseases and insects, and yield as well as shipping and shelf life qualities; as well as on fruit quality, plant development and biotechnology applications.
- The preservation of genetic resources is also the primary goal.
- More than 60 species are grown in the collection of rare vegetable and spice plants.

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Thank you for you attention!