PROCEEDINGS OF THE LATVIAN ACADEMY OF SCIENCES. Section B, Vol. 71 (2017), No. 3 (708), pp. 237–247.
DOI: 10.1515/prolas-2017-0040

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Science Life

FRUIT-GROWING IN LATVIA — INDUSTRY AND SCIENCE

Edīte Kaufmane, Māra Skrīvele, and Laila Ikase

Institute of Horticulture, Latvia University of Agriculture, Graudu 1, Ceriņi, Krimūnu pag., Dobeles nov., LV-3701, LATVIA
edite.kaufmane@llu.lv

In all times, fruit trees for family use have been grown at Latvian farms. Yet these fruits obtained market value only after the land ownership reform in 19th century. This facilitated rapid area increase of different fruit crops, allowing supply with fruits not only the local market, but also for export to the largest cities of Russia. Especially fast development of fruit-growing was observed during the first independent republic (1919–1940). The demand for planting material increased, and plants were imported from Western Europe. Choice of unsuitable cultivars and rootstocks was the main reason of the massive orchard area loss during the following severe winters. After the Second World War, the Soviet powers supported only the establishment of large orchards for processing needs, 200–300 ha, which were unsuitable for the Latvian climate and terrain. At the same time, numbers of allotment gardens rapidly increased and part of their produce was sold also on the market. After regaining of independence and private property, interest in fresh fruit and berry production for market, as well as processing, renewed. It was hindered by lack of continuity in experience and knowledge. Diversity of terrain, soils and climate all demand considerate choice of suitable orchard location and cultivars. Direct use of foreign experience often led to failure.

At present, development of the fruit industry is most of all hindered by lack of qualified specialists of different levels, which does not allow to establish an appropriate consulting system. Cooperation of growers for easier marketing also is developing too slowly. Insufficient economic and market research does not allow to balance the demand with increase of plantation area, especially for large-scale processing and export, so strategic guidance of the fruit industry is not possible.

Development of fruit-growing is hindered also by a lack of continuous long-term support to horticultural science. As a result of research by the Institute of Horticulture: 1) new local breeding fruit crop cultivars were obtained and recommended for commercial orchards; variety testing including growing technologies was initiated in different regions of Latvia; 2) monitoring of harmful and favourable organisms was conducted in plantations, with development of a system for prognosis and control; and 3) research results were transferred to growers through practical recommendations, publications, seminars and demonstrations.

Key words: *fruit-growing history, fruit production, technology transfer.*

INTRODUCTION

History has shown that perennial crops may be grown successfully only when farmers own their land, and for this reason in Latvia larger orchards were planted on farms only after the end of serfdom in the 19th century. Farmers obtained knowledge about orchard management and cultivars from manor orchards and nurseries. After the founding of the independent Latvia state, fruit-growing developed rapidly. In 1929, there were 29 state-funded bodies carrying out extension service for the growers. Orchard areas increased, processing of fruits and berries started, and export of fruits and their products to Western Europe developed. This created the necessity and opportunity to establish a State Research Station in Pūre. As evaluation of cultivars was just started, each nursery propagated cultivars and rootstocks mostly from Western Europe. This was one of the reasons why in the following severe winters of 1940s the greatest part of orchards perished — about 6 million trees.

Development of fruit-growing after the Second World War was greatly hindered by the abolishment of private land property, as well as loss of generation succession. Yet scientific research continued. A new Experimental Station was founded in Ogre, along with several support sites. Research was targeted more to yield quantity, not quality, as a significant processing industry had developed in Latvia. There were no possibilities to become acquainted with Western experience, and instead wide cooperation with other Soviet researchers developed. Studies of growing technologies were carried out both for the needs of large state farms and home gardens. Variety evaluation focused on the needs of home gardens.

After restoration of the independent Latvian state, interest in commercial orchards increased rapidly. Western European cultivars and technologies were the main interest. Yet, as shown by experience of the last years, their introduction without preliminary trials may cause substantial financial loss.

This paper reviews information about fruit-growing in Latvia — industry, possibility for farmers to obtain knowledge about orchard management and cultivars and horticultural science since the beginning of the 19th century till today.

FRUIT-GROWING, RESEARCH AND SPREAD OF KNOWLEDGE IN THE 19TH CENTURY AND THE FIRST HALF OF 20TH CENTURY

Development of fruit and berry production. Although various fruit crops have been cultivated for thousands of years, as shown by archeological excavations, fruits in Latvia were known already in the Neolithic era. Folk songs and tales often mention the fruiting apple-tree. Cherries, plums, and pears appeared later.

In the 18th century, farmers of Vidzeme (Livland) mostly cultivated various vegetables, only at some farms a cherry-tree or crabapple could be seen. Some owners of manors or bigger land plots has established high-class orchards, as well as nurseries, only near larger towns. Already at that time low-crown and dwarf trees were planted in some locations. Imported trees perished after a few years, especially plum-trees. Apricots and other exotic fruits were grown in greenhouses or as espaliers on walls. Orchards were managed not only by educated foreign gardeners, but also local gardeners — serfs trained by experts (Apinis, 1935).

In the middle of 19th century, with industrialisation and increase of population in large towns, demand for fruits also increased. Manor orchards could not satisfy this demand, and therefore the government and gentry facilitated planting of orchards on farms, which at the time already could be bought out by peasants.

The manor was a school for Latvian farmers in planting and managing orchards. As the gardeners mainly were German, Western European cultivars were planted, which lacked hardiness in Latvia. The most tender cultivars and crops were covered in winter, or top-grafted on local wild apples at 2–2.5 m height. This was the reason why in some places vigorous, healthy 40–50-year-old trees of these cultivars could be found.

In the end of 19th century, large nurseries developed in Riga region, which sold their fruit, berry, and ornamental plants mostly to Russia — to more than 100 of its provinces. In the countryside, many small nurseries formed, which propagated various landraces of local origin and cultivars obtained from manor orchards. Rootstocks were mostly sedlings of native wild apples (*Malus sylvestris*) and pears (*Pyrus pyraster*).

After the First World War, as the result of land reform, different types of small farms arose. Especially many small farms with 4–7 ha land occurred in Latgale (Eastern Latvia). As wrote K. Reņģe (Reņģe, 1933), in small farms horticulture is the activity on which to lean. Orchards of Latgale produced relatively large amount of fruits both for cities and export.

The importance of fruit-growing in the national economy and the ways of its development were understood by the Ministry of Agriculture and the Central Society for Horticulture; the tasks of the latter afterwards were taken over by the Latvia Chamber of Agriculture (LCA). These had significant roles in the development of horticulture. LCA at the end of 1930s had nine top employees dealing with horticulture and 21 paid horticulture instructors in regions. LCA in its work was based mostly on Horticulture Supervision societies (HSS) and Horticulture sections of Agricultural societies. In August 1938, there were already 58 HSS and 92 Horticulture sections of Agricultural societies. There were 48 employed supervisors in horticulture (44 of these with support of LCA) among the HSS. Instructors of LCA also regularly carried out yield evaluation of various crops (Kļaviņš, 1935; Ķīsis, 1938).

For marketing of fruits, their quality should be controlled, and larger lots of uniform fruits need to be established for export needs. Already in 1927, the Law for control of export fruits and berries was adopted, and in 1936, the Law for inland marketing of fruits and berries, with guidelines published in 1937. To reduce price fluctuations, joint-stock companies were organised for purchase of fruits, and plans of common storage facilities emerged.

Strict observation of these laws and control of their application can facilitate fruit export and stimulate the growers to manage their orchards better. Fruitlet thinning was recommended and also done at more progressive farms, although it was not easy, as there were only large trees in orchards. Yet the conclusion was unanimous — its pays (Šterns, 1936).

Production of juices was significantly supported. More than 100 units producing juice worked in the countryside, 50 of them were established with government support.

Export of fruits started already in 1921, when 975 tons of fruits and berries were shipped to Finland and Sweden. In the 1930s, the biggest amount was exported to Germany. In 1937, already seven companies were exporting fruits, including 80 wagonloads of ‘Antonovka’ from Latgale, as well as some fruits of ‘Rudens Svītrainais ’ (‘Streifling Herbst’) and ‘Aport’. Export of blackcurrant preserves increased, causing an exponential rise in wholesale prices, from 0.25–0.30 to 0.90–1.30 lats. In 1936, 110 t preserves were exported, in 1937 — 180 t.

Regulations were adopted also for nursery registration and marketing of plants, as well as about the Latvian stock register for fruit crops.

Knowledge transfer and education. In late 18th century and 19th century, farmers obtained know-how in orchard management from many various calendars and newspapers. For the development of fruit-growing, the most important was the Baltic Gardener's Calendar published by J. Penģerots-Svešais and S. Klēvers in 1898. The calendar not only introduced readers to fruit-growing, but also gave the associated scientific background. The introduction said that its aim is to give to Latvian gardeners new konwledge about development of horticulture, using foreign experience. Many articles on gardening were found in newspapers. The first book in Latvian about fruit-growing was published in 1796 by Samuel Holst (Ozols, 1941). In the 2nd half of the 19th century, also Latvians improved their knowledge in gardening abroad — S. Klēvers, J. Penģerots-Svešais, J. Plaudis, F. Lasmanis, T. Bētiņš, P. Peltcs, P. Veinberģis etc. In 1899, the Riga department of the Russia Imperial Horticulture Society was registered, which started to publish its Annual almanac (Fig. 1).

Fig. 1. Fricis Lasmanis (1862–1941), founder and chairman of the Riga department at Russian Imperial Society for Horticulture.

A great contribution to development of horticulture and training of Latvian gardeners came from Count von Sievers, who already in 1870 founded the Pomological garden and a large nursery near Cēsis, in Kārļi. He established 2-year courses for 30–40 students, which prepared gardeners for the estates of the Russian aristocracy and and also for German nurseries (Gailītis, 1939). Part of these qualified horticulturists sooner or later returned to Latvia, established their own nurseries or farms, and published their experience obtained in Russia or Germany in Latvian journals and books.

The possiblities to gain know-how increased during the independent Latvian Republic. In 1930–1932, the journal *Latvijas dārzkopis* (Latvian Horticulturist) was published. The Monthly of the Central Society for Horticulture *Dārzkopības žurnāls* (Journal of Horticulture) was published since 1933. In 1936, LCA started editing a second journal *Dārzkopības un biškopības žurnāls* (Journal of Horticulture and Apiculture). Articles were also published in magazines and newspapers, including in Latgalian and Russian.

The first and only horticultural school in Latvia before the First World War was founded in 1911 in Bulduri (near Riga). Its founders were the Riga Department of Imperial Horticultural Society with the support of Russian government and 20 00 golden rouble donation from Alvina Schoch. The school accepted experienced gardeners with three-year or longer practice for 6-month theoretical studies, and youth without experience for three-year pactical studies, including six months of theory winter classes. After the war, the board of the Imperial Horticultural Society disclamed its property rights, and on 6 May 1920, the work of the school was renewed by the Ministry of Agriculture. In 1922, a school of apiculture and horticulture was founded in Vecberi, and in 1927, a horticulture school in Ziedoņi. The Latgale region also wanted educated horticulturists, and in 1931 a similar school was founded in Višķi.

In the period of 1929–1938, 886 horticulturists graduated from these schools, and during the whole 20-year period of independence — 1132. A new two-year horticultural school for girls also was founded, along with a school for garden workers**.**

As two-year schools were not sufficient for education of leading horticulturists, ways were seeked to extend education. The Horticulture College in Bulduri was officially opened in May, 1930. In 1932, the school had 20 graduates — first-degree horticulture instructors (Robiņš, 1938).

The 9th Latvian Scientific Congress of Agronomists concluded that horticulturists need also academical education, and a Chair of Horticulture was founded at the University of Agriculture.

Research in horticulture. Horticultural science is one of the youngest and also most complex sciences. For example, research at Geisemhem, Germany, started in 1875, at East Malling, UK, in 1918 (Ķišķis, 1940). In Latvia, the first research institution — Pūre Horticulture Experimental Station (HES) — was founded in 1930 (Fig. 2).

Long-term investigations in the 2nd half of the 19th century and the 1st half of the 20th century were carried out by fruit growers in different regions of Latvia, the results were regularly published in horticultural journals. The many-year experience of these people, their level of knowledge, interest in novelties and their ability to evaluate the effect of soil, climate and growing technologies on the performance of cultivars in various locations is admirable and noteworthy.

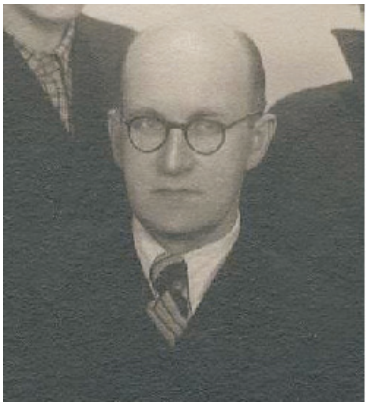

Fig. 2. Pauls Gailītis (1900–1992), first director of Pūre Horticultural Research Station and an outstanding expert in horticulture.

Fig. 3. Professor Jānis Sudrabs (1884–1972), the founder of scientific horticulture in Latvia.

Long-term data were obtained about the profitability of individual cultivars (Siliņš, 1940). In 1939, the profitability of orchards was evaluated also at two support farms. In both, the expenses of production were two times lower than expenses of marketing. Calculations showed that fruit-growing can be profitable even with irrational management (Teteris, 1940).

Before the founding of Pūre HES, some horticultural research was done by the Faculty of Agriculture of Latvian University, Department of Horticulture at the Ministry of Agriculture and by individual horticulturists, as well as university teachers. A significant contribution was given by Professor Jānis Sudrabs, who is considered the founder of scientific fruit-growing in Latvia (Fig. 3). For example, associate Professor P. Delle published the results of a three-year evaluation of 13 plum cultivars for their fruit maturing time and market evaluation (Delle, 1938).

Not only teaching, but also scientific research during that time was overseen by the Ministry of Agriculture and Chamber of Agriculture. Through horticulture instructors, these institutions had good insight into needs of the industry and could support research necessary for growers.

As Pūre HES had just started its activities, journals published articles about research results obtained abroad, about new cultivars. Possibilities to participate in international congresses and exhibitions were exploited. For example, in the 12th International Horticulture Congress in Berlin there were 21 participants from Latvia, 22 from Estonia, 8 from Lithuania, compared to 54 from Great Britain etc. The *Journal of Horticulture* afterwards published an extensive report about the Congress.

The head of the Horticulture Department of the Ministry of Agriculture A. Ķišķis admitted that findings in research still were rarely used in horticulture. Results of studies from abroad gave little to praxis in Latvia; they could serve only as guidelines for scientists (Ķišķis, 1940). He wrote that, to become an expert in horticulture overseeing, a year was needed in England to perfect one's knowledge. P. Gailītis admits that "we cannot completely take over the rich practical experience by generations of our own gardeners. In search of new roads, we risk to lose contact with real possibilities of our land, carried away by illusory quests" (Gailītis, 1939).

After the founding of the Pūre Horticulture Experimental Station, the directions and tasks of research broadened, and therefore in 1938, with an order by the Minister of Agriculture, five support points for Pūre HRS were founded at Mežotne, Bulduri, Priekule, Stāmeriena, and Liguti.

There was also a sceptical attitude to scientists, so the new methods often were not introduced. To prevent this, large agronomical assistance organisations were formed, to teach the farmers the findings in science and convince them to use these in practice. Support farms of the LCA were useful, providing a working base for horticulture instructors and possibilities of book accounting.

Development of fruit-growing and winterhardiness of fruit crops. Extremely cold winters occur in Latvia more or less periodically. During the last 150 years, such were the winters of 1867/1868, 1902/1903, 1916/1917, 1928/1929, 1939/1940, 1941/1942, 1949/1950, 1956/1957, 1978/1979. There are no published data in horticulture literature about fruit tree injuries in the first severe winters. Publications appear after the winter of 1928/1929, when soil froze to the depth of 1.5 metres. In February the minimal temperature was –28 to –34 °C. The spring arrived rapidly, when the tree parts above soil started vegetation, with increased evaporation, while the roots in the frozen soil did not uptake moisture. Orchards were inspected in whole country. The average damage was 30% of the orchard area. The Zemgale region (southern plains) had suffered the most: 26% of apple-trees had perished. Slightly less injuries to apple-trees occurred in Kurzeme region (Western Latvia), with 20.64% apple trees damaged. In Latgale (Eastern Latvia) only 12.9% trees had died. In some locations winter-hardy cultivars had perished, while less hardy survived. Not only were 'Antonovka' and similar cultivars ranked as fully hardy, but also 'Dronning Louise', 'Filippa' etc. Sweet cherries and the most valuable plum cultivars were completely lost (Sudrabs, 1931; Dindonis, 1929).

Already after the winter damage of 1928/1929, the central organisations of agriculture tried to limit the number of cultivars in commercial orchards. The resulting variety list was much criticised, tree nurseries continued to propagate many Western European cultivars and, although this was prohibited, to import rootstocks without testing in Latvia.

In the 1930s, there were several cold snowless winters. In 1936/1937, the heaviest cold damage was suffered at nurseries and orchards in Kurzeme coastal areas. In contrast, in 1937/1938 the most damage was observed in Vidzeme (Northern Latvia) and Zemgale while in the southwestern region around Liepāja the damage was lower. (Šterns, 1939). The highlands of Alūksne-ape theoretically are poorly suitable for fruit-growing, as winter starts a week earlier and lasts two weeks longer; yet in the winter of

1936/1937, of 18 plum cultivars, only 'Victoria' grafted on St. Julien had damaged roots. Trees budded on local seedling rootstocks did not suffer (Timans, 1939).

In the winter of 1938/1939, neither winter cold, nor drought of the previous summer were at fault for the damage, but the warm, moist autumn. Young trees in nurseries and orchards had completed vegetation, but it renewed in autumn. And then frost came suddenly. Afterwards there were sharp temperature fluctuations, when cold alternated with thaws (Kārkliņš, 1940). Observations showed that plum-trees on the local Priekuļi population of myrobalan (*Prunus cerasifera ssp. divaricata*) or on seedlings of landrace 'Latvijas Dzeltenā Olplūme' showed no injury, while trees on St. Julien in several nurseries had severe damage (Šterns, 1939).

The experienced horticulturist J. Šterns in 1939 wrote that the snowless winters of the last two years had shown mistakes in choice of rootstocks and cultivars. One cannot expect that German or French cultivars will possess winterhardiness.

The greatest harm was done by the winters from 1939 till 1942, when 3/4 of fruit-trees in Latvia perished. The yield in 1939 was abundant. The end of summer and autumn were dry. The soil lacked moisture and froze to great depth. On January 16, air temperature rapidly fell to –40, –46 °C above deep snow. In spring the temperature increased rapidly, the snow melted, but the water could not penetrate the frozen soil. Trees burst into leaf while the roots still did not function, so regeneration of winter-injured trees was difficult.

The superior winterhardiness of local cultivars and cultivars from more severe regions became evident. Apple-trees on hill-tops survived close to wider lower land and slopes. Orchards with windbreak protection from the north and east suffered less.

And yet, although the winters were so various, what was the reason why orchards suffered such severe damages in the end of 1930s? It must be acknowledged that such rapid growth in horticultutre as occurred in 1930s met both nurseries and growers unprepared. After the land reform, planting of orchards and with it demand for plants increased too fast. As there were not enough seeds of local wild apples and pears and their seedlings grew slowly, much cheaper seeds were imported in great quantities from Western Europe, resulting in seedling rootstocks with low winterhardiness.

Also, the number of cultivars propagated by larger nurseries was large: about 200 apple, 90 pear and plum, 70 sweet cherry cultivars. Most of these were tender Western European cultivars, which in Latvian climate are not winterhardy if not top-grafted.

Previous knowledge about suitable rootstocks and cultivars was lacking, as the Pure Horticulture Experimental Station was founded only in 1930 and had just started to operate. There were many experienced horticulturists in different regions who shared their knowledge about cultivars and technologies, but the numerous horticulture instructors lacked experience.

Great changes came in 1940. Fruit-growers did not lose heart after the severe winters. The first year of Soviet occupation even seemed promising to several leading workers of horticulture. There were plans to organise mobile groups of orchard workers with fixed rates of pay, and plant 150 ha new orchards and 150 ha berry plantations.

Professor J. Sudrabs (Sudrabs, 1940), after the arrival of Soviet power very optimistically wrote that: in the next years 8 million different fruit-tree plants should be grown for the renovation of winter-injured orchards. After a land reform, about 40 000 new farms may be formed who will need to plant orchards. Thus, the demand for plants may be very high. All nurseries should be supervised centrally, to provide plants suitable for local conditions. There should be just a few nurseries in the country, managed by experts. The larger the nursery, the more rationally it operates, plants are cheaper, mechanisation of work is possible.

DEVELOPMENT OF FRUIT-GROWING AND SCIENCE DURING THE SOVIET PERIOD (1945–1991)

Both the political situation and the Second World War greatly damaged hopes about development of horticulture. Most orchards were destroyed.

A group of horticulturists carried out expeditions during the 1950s and found that the local cultivars have survived the severe winters best. Various genotypes of unknown origin also were selected and named as landraces (Spolītis *et al.*, 1955). Some of these have not lost their importance today.

The assortment of cultivars that had survived the severe winters was considered suitable only for fruit processing. This was the reason why in the beginning of 1950s, for the needs of the Trust of Preserve Production and following the model used in Soviet Union, large orchards of 150–300 ha were planted with cultivars suitable for processing. The severe winters of 1955/1956 and 1978/1979 showed that the Latvian terrain is not suitable for such orchards. Most injuries after these winters were observed in Vidzeme and Latgale hilly regions, where apple-trees in these large plantations perished in the lower part of hill slopes and survived only on hilltops.

Apple-trees were planted on vigorous rootstocks with large planting distances. (Fig. 4). In orchards which were established in suitable locations and managed by qualified specialists, the yields were quite good, 20–40 t/ha. Profitability of orchards exceeded 100%. Yet most collective and state farm orchards were poorly managed and produced only 1–2 t/ha.

Sweet cherries and pears, which in 1930s were among the most profitable crops, were rare in this period. Larger plum plantations were more common in suitable locations.

Fig. 4. Planting of an orchard at "Saules dārzs", 1950s.

Nobody thought that fruit-growing is an important field of agriculture, although the orchard areas were several times larger than today. In many places pre-war family orchards still survived, but were not cared for. Quality fruits and berries were a rarity in shops; fruits for consumption were grown in home gardens or obtained from family orchards of rural relatives. It was very profitable to sell fruits in large Russian cities — Pskov and |Leningrad. Fruits in poorly maintained orchards were also harvested for winemaking and selling the product in Northern Russia or more distant regions.

Deportations and emigration significantly reduced the number of experienced fruit growers in Latvia, yet investigations continued in the Department of Fruit-growing of the Institute of Agriculture which supervised experimental stations in Pūre and Ogre, and at several support sites. Research in plant protection was done at the Baltic branch of All-Union Plant Protection Institute (Kaufmane *et al*., 2013). Fruit breeding was done by several horticulture enthusiasts at support sites of the experimental stations. Final evaluation of the elite hybrids and their handing in for State variety trials was done at Pūre and Ogre experimental stations. In the end of the 1980s, evaluation of fruit and berry cultivars was started at Dobele Laboratory of Pomology (Skrīvele *et al.,* 1995).

A few larger new orchards were planted. The main audience interested in scientific research results, especially in breeding and variety testing, were owners of small gardens. This was facilitated by the work of gardening societies, who organised training of allotment gardeners in Riga and the whole country, through People's Universities, lectures, practical works and exhibitions. All these events were widely attended and increased the popularity of horticultural research. During this period, an important contribution to the training has given by the long-term teacher at Bulduri Horticulture School, Jānis Kārkliņš, who published (wrote) many textbooks on fruit-growing (Fig. 5).

New cultivars were obtained by enthusiasts from experimental stations in Latvia, as well as from the whole Soviet Union. Some severe winters in the 1980s–1990s caused damage to introduced cultivars of apple and pear trees only

Fig. 5. Jānis Kārkliņš (1918–2014), long-term teacher at Bulduri Horticulture School, author of many textbooks and pomology books, an outstanding horticulturist.

at experimental stations, while plantations of stone fruits suffered significant losses.

DEVELOPMENT OF FRUIT-GROWING AND SCIENCE IN THE TRANSITION PERIOD (1990–2000)

The first years after regaining independence were very challenging for fruit-growing and science in Latvia. After private land property rights were restored, interest for intensive orchard establishment and growing technologies increased rapidly, especially after 1998, when state subsidies were paid for establishment of new orchards. However, funding was not sufficient for purchase of machinery and equipment for large orchard maintenace, and therefore the new orchards were small, 1–3 ha and not always properly maintained. The largest new plantations were established for blackcurrants and apples on 'Antonovka' seedling rootstocks, as shortage of size reducing clonal rootstocks and lack of knowledge about growing technologies hindered the planting of intensive orchards. In 1998, 57.1 ha blackcurrants and 39.7 ha apples were planted, while in 2000 already 60.8 ha and 97.6 ha were planted, respectively. Interest increased in non-traditional crops — seabuckthorn, cranberries and blueberries (Skrīvele, 2004).

In order to evaluate suitability of foreign experience of intensive fruit-growing to local conditions, similar research had to be started in Latvia. Problems of the new commercial fruit growers had to be solved as soon as possible, and involvement and collaboration between scientists from several institutions was needed. In 1995, the Laboratory of Pomology of the Research Institute of Agriculture separated from a 6000 ha state farm, and became Dobele Horticultural Plant Breeding Experimental Station (Dobele HPBES). Since the beginning of 21st century, a new system of commercial fruit-growing was introduced (transfer to intensive western-type orchard management).

Dobele HPBES became a centre of horticultural science, and, uniting the efforts of researchers from several institu-

tions in the framework of a State Research Programme, started resaerch in areas essential for the development of commercial fruit-growing: (1) new growing technologies, (2) choice of cultivars, (3) transfer of best available knowledge and technologies in the world, and (4) testing and adaptation of knowledge and technologies to Latvian conditions (Skrīvele and Kaufmane, 1999; Skrivele *et al.,* 2000, Kaufmane *et al.*, 2013). Dobele HPBES was the initiator of the Latvian Fruit Growers' Association founded in 1997 and uniting the majoroty of commercial growers. All newest information obtained by scientific research, which can become useful for commercial growers, was passed on to the farmers with the help of the Association.

FRUIT SCIENCE AND DEVELOPMENT OF INDUSTRY IN THE BEGINNING OF 21ST CENTURY

After the turn of the millennium, more reorganisation of fruit science in Latvia took place in order to make the Latvian fruit and berry sector capable to meet future challenges. The leading research institution of fruit-growing was the Latvia State Institute of Fruit-Growing (LSIFG), which was founded in 2006 after re-organisation of Dobele HPBES. There were five more institutions carrying out research in fruit-growing science in Latvia (Kaufmane *et al.*, 2013). Research was carried out in the following directions: a) breeding of disease resistant, climate adapted cultivars, using Latvian and introduced genetic resources, and cultivar evaluation; b) development of effective breeding methods applying molecular markers and propagation technologies; c) study of fruit crop harmful organisms in Latvia, their distribution, development biology and control; d) orchard management through development of environment friendly, sustainable technologies for the most important crops under different conditions; e) development of innovative fruit storage and processing methods, new products from traditional and novel crops, and waste-free technologies preserving functionally active compounds.

A strong incentive for the development of knowledge and, as a result, better maintained orchards, was introducton of the integrated growing system. In 2004, preparation of background data and substantiation for the EU was started. Researchers working of fruit-growing a dapted the EU guidelines[1] to Latvian conditions[2], based on their former experience.

A Programme for the development of integrated fruit and berry growing was developed along with a training programme and publications about integrated fruit crop growing technologies in various journals. Training of growers in integrated growing was started in 2006. Knowledge about the aims, methods and national guidelines of this system had to be obtained in special courses. Theoretical and practical training was carried out in the whole country. Certificates of attendenace were handed out to 282 farms. This allowed these farms to obtain state subsidies (Skrīvele, 2005).

The first three years of monitoring and evaluation of farms submitted for registration as integrated growers was done by researchers and other specialists, who had signed an agreement with Latvian Fruit Growers Association (LFGA). During visits to orchards the growers were also consulted and trained. At the same time, the real situation in fruit-growing was evaluated, along with the level of knowledge of growers and the areas needing scientific research.

In the beginning of 21st century, the area of commercial orchards continued to increase. In Latvia, the climate, terrain and soils are very variable, which does not allow to establish large monocultural plantations in the largest part of the country, yet allows to choose crops most suitable for each specific location. As during the last 100 years, the purposes and systems of orchard planting have radically changed, and it is not possible to compare plantation areas and tree numbers in different periods.

The most important fruit crop is apple. According to statistics from the year 2012 Central Statistical Bureau on area of commercial apple orchards, tree age and cultivars (Fig. 6), in apple orchards planted during the last 15 years there were 500–1666 trees per hectare, while in orchards older than 25 years only 200–420 trees. Small farms with apple orchard area up to 3 ha were most dominant and about 10% were larger farms with size 15 ha. The most popular 18 apple cultivars form 48% of total orchard area and 62% of total apple-tree number (Table 1). The variety list in orchards significantly differs from those in Western Europe and Scandinavia. The most popular among both consumers and growers has become a cultivar of Lithuanian breeding 'Auksis', which is still inceasing in area. Belarusian and Russian advanced cultivars and old local varieties are also common.

As shown by data from individual farms, by choosing cultivars and technologies suitable to the orchard location, the annual yield of apple trees may be 20–40 t/ha (Fig. 7). Almost all farms insufficiently use technologies for fruit quality improvement.

The total areas of all fruit crops can be estimated by orchard areas larger than 0.3 ha submitted for united area payment. Corresponding data of the Rural Support Service as of

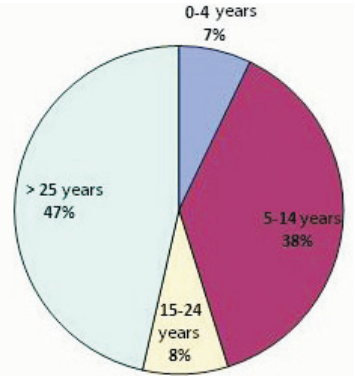

Fig. 6. Apple commercial orchard areas by tree age.

[1] http://www.iobc-wprs.org/ip_ipm/IOBC_IP_principles.html

[2] http://www.lvai.lv/pdf/IAR_VadlinLatvSeklen.pdf; http://www.lvai.lv/pdf/IAR_VadlinLatvKaulen.pdf; http://www.lvai.lv/pdf/IAR_VadlinLatvOgul.pdf

Table 1

TREE NUMBER AND AREA OF THE MOST POPULAR APPLE CULTIVARS, 01.01.2012*

Cultivar	Tree number, thousands	% of total tree number	Area, ha	% of total area
TOTAL	1335.0	100	2390.5	100
Auksis	200.8	15.0	177.5	7.4
Antej	88.6	6.6	101.9	4.3
Belorusskoje Maļinovoje	65.5	4.9	90.0	3.8
Sinap Orlovskij	63.1	4.7	78.8	3.3
Lobo	61.3	4.6	55.9	2.3
Antonovka	51.3	3.8	232.2	9.7
Rubin	46.8	3.5	51.9	2.2
Zarja Alatau	44.2	3.3	52.4	2.2
Kovaļenkovskoje	37.1	2.8	45.4	1.9
Saltanat	37.0	2.8	40.2	1.7
Oļesja	25.2	1.9	19.8	0.8
Tellissare	20.9	1.6	36.5	1.5
Konfetnoje	18.1	1.4	23.0	1.0
Tiina	17.1	1.3	22.6	0.9
Ligol	16.7	1.3	16.1	0.7
Baltais dzidrais	15.4	1.2	74.4	3.1
Orļik	13.9	1.0	16.0	0.7
Delikatese	9.4	0.7	10.0	0.4

* data of Central Statistical Bureau

Fig. 7. A modern commercial apple plantation.

1 January 2017 are presented in Table 2. There are also growers near large cities who cultivate some crops, especially strawberries and rare crops using organic or integrated technologies in areas below 0.3 ha. Area of self-support orchards is difficult to estimates, as they exist at every farm.

As climatic factors facilitate development of high aroma in fruits and berries, Latvian-grown strawberries and raspberries are beyond competition on the local market during their season. Only a few growers have larger areas of strawberries. Plantations of raspberries, especially primocane cultivars, as well as red and black currants have increased rapidly. This is linked not only with the demand of the fresh

Table 2

AREA OF COMMERCIALLY GROWN FRUIT CROPS IN LATVIA, 01.01.2017*

Crop	Total area (ha)	including organic (ha)
Apples	2792	335
Pears	157	10
Plums	85	8
Cherries	128	24
Strawberries	423	26
Red and white currants	78	10
Raspberries	191	15
Black currants	70	213
Blueberries	283	35
Cranberries	141	5
Seabuckthorn	775	177
Japanese quince	221	65
Grapes	19	9
Blackberries	8	8
Gooseberries	6	2
Aronia	79	27
Rowan (*Sorbus*)	8	4

* data of the Rural Support Service

berry market, but even more with the development of wine-making.

Recently, there has been significant increase in area of Japanese quince and seabuckthorn, which still can not meet the growing demand of the procesing industry as product export increases. The plantations of blueberries and cranberries also have expanded, and for the harvest season, labour is imported from Eastern neighbouring countries. Similar solutions are used also by some larger strawberry growers. Fruit tree growers do not need labour import if they have cultivars with different season of maturity. Bush fruits, if the areas are large, are machine harvested.

Along with rising competence in organic growing methods, gradual increase of organic orchard area has occurred. This is facilitated especially by the demand for organic raw material from several processing enterprises. Examples are the producer of baby food “LatEkoFood” and candied fruit and bery producer “Rāmkalni” who have started large-scale export to various countries worldwide.

Credible data about the productivity and total yield of each crop are not available presently. Statistics covers only the fresh fruits sold at supermarkets and supplied for the programme “Skolas auglis” (School Fruit), and fruits and berries sold to the largest processing enterprises. A large part of fresh fruits and berries are sold on farm or at farmers markets, and also home processed into products of large diversity.

The main problems for the development of fruit industry in Latvia are: a) lack of qualified horticulture specialists; b) lack of training and consulting system for fruit growers;

c) slow development of fruit grower cooperation (only four producer groups and cooperatives have been formed); d) no economic and marketing research of fruit-growing, which does not allow to balance the demands for the produce with the increase of growing area, especialy for large-scale export and processsing, making development of a strategy for horticulture difficult, e) diversity of soils and climate, and severe winters, all create a need for careful choice of suitable locations and cultivars. The crops and cultivation methods are highly diverse. This does not allow direct application of experience from other European countries; f) continuous lack of support for long-term research hinders development of horticulture and is one of the main problems in horticultural science.

During this period, in the framework of several projects (the largest of these —"Development of sustainable fruit growing, using integrated growing technologies friendly to environment and water resources and preserving the countryside landscape, for reducing climate change and providing for biological diversity", funded by Latvia Ministry of Agriculture), large-scale applied research was done, which had positive influence on the development of fruit-growing and processing industries. The most important lines of research were: a) new local fruit crop cultivars were bred and local and introduced cultivars were recommended for commercial orchards, including scab-resistant apple cultivars (Ikase and Lācis, 2013), winterhardy cherry cultivars (Ruisa and Krasnova, 2013), high-quality and winte hardy pear cultivars (Lāce and Lācis, 2015), high-quality plum cultivars (Kaufmane *et al.,*2010) and black currant and raspberry cultivars (Strautina *et al.,* 2012a; 2012b); b) monitoring of harmful and favourable organisms in plantations along with studies of their development and prognosis, improvement of control methods, together with Latvian Plant Protection Research Centre (Gospodaryk *et al.,* 2013; Konavko *et al.,*2014; Moročko-Bičevska and Maldute, 2014; Rupais *et al.,* 2014; Lācis *et al.,* 2015); c) recommendations developed on apple rootstocks suitable for Latvian conditions (Skrivele *et al.,* 2011), their compatibility with cultivars (Rubauskis *et al.,* 2012), growing technologies for promising new Latvian and introduced cultivars — planting distances, tree training specifics, winterhardiness in different growing conditions (Laugale *et al.,* 2012; Rubauskis *et al.,* 2013; 2014), and testing of these cultivars, including studies on their growing technologies, initiated in different regions of Latvia (Ikase, 2015); d) investigations about the possibilities of using risk reducing technologies for sweet cherries, raspberries and strawberries in Latvian conditions (Rubauskis *et al.,* 2013; Strautina *et al.,* 2013; Kalnina *et al.,* 2014.; Laugale *et al.,* 2014); e) research on unconventional plant material as a source of bio-components for food and pharmaceutical industries (Górnaś *et al.,* 2013;2014; Šnē *et al.,* 2013); g) research on apple storage under various environmental conditions suitable for commercial production, starting studies also with CA and 1-MCP storage (Juhnevica *et al,* 2013a; 2013b; Juhnevica-Radenkova *et al.,* 2014); and h) development of innovative technologies and products for small and medium food processing enterprises, and development of five products within a year for market diversification in collaboration with entrepreneurs.

Fundamental research also was conducted on fruits and berries in the area of genetics and molecular biology and plant pathology and entomology, including a platform for nuclear stock material (Kota and Lācis, 2013; Lācis, 2013; Lācis and Kota, 2013; Samsone *et al.*, 2014).

On 1 January 2016, by reorganising of Latvian State Institute of Fruit-Growing and incorporating scientists from Pūre Horticultural Research Centre and "Vīnkoki", Ltd, the Institute of Horticulture, which is supervised by the Latvian University of Agriculture, was founded. Now the Institute is the leading institution in horticultural research, carried out in four priority directions: 1) diversification and breeding of cultivars suitable for the Baltic Sea region; 2) environment-friendly production systems; 3) storage and processing technologies for horticultural crops; and 4) fundamental biological research for horticultural science. Research is aimed at development of horticulture taking into account international tendencies in science.

Research will be continued in directions that are closely linked with the needs of the industry, accenting: 1) breeding of priority fruit crops, immune or highly resistant against most important diseases and pests conducted wider cultivar testing under differing conditions, 2) development of technologies reducing hand labour in fruit and berry growing; 3) development of growing technologies for new crops and risk-reducing technologies by using precision farming methods (including techniques for weed control and precise fertilisation), 4) development of new processing technologies for innovative food products using by-products of the horticultural plant growing and processing, including bark of trees, etc; development of possiblities of untraditional crop processing, 5) economics and marketing research for the analysis on fruit-growing development possibilities.

Considering the modern laboratory research framework created in the Institute during the latest years, basic research on horticultural crop also will evolve, which will contribute to the development of horticulture in more distant future: a) characterisation of germplasm genetic diversity — selection of new, valuable material for future breeding or raw material for specific purposes, b) research on genetic mechanisms of plant and environmental interactions — development of methods and tools for breeding, accelerated selection, c) research on plant biology — development of propagation technologies (e.g., *in vitro*) and healthy planting material, ensuring its genetic stability, d) identification and monitoring of diseases and pests of horticultural crops, e) characterisation of diversity of plant pathogens and pests in relation to their hosts, f) research on host-pathogen interactions — virulence of pathogens and host resistance, development of methods, and g) establishment of virus free nuclear stock collections for fruit crops, development of virus elimination methods.

Through development of small and medium enterprises, cooperatives and their collaboration with science, establishing a system for training and consulting, the fruit industry will

be able to provide fruits and products filling the local market and increasing their export capacity.

REFERENCES

Apinis, K. (1935). Dārzkopības stāvoklis 18.g.s. Vidzemē [Situation in horticulture in Vidzeme in the 18th century]. *Dārzkopības Žurnāls*, **10**, 427–428 (in Latvian).

Birzaka, J. (1940). Vērojumi augļu dārzos Mālpils rajonā 1940. gada vasarā [Observations in orchards in Mālpils region in the summer of 1940]. *Dārzkopības un Biškopības Žurnāls*, **10,** 531 (in Latvian).

Delle, P. (1938). Materiāli un ierosinājumi vietējās augļkopības, augļu vērtēšanas un izvērtēšanas jautājumos [Materials and suggestions about the problems of local fruit-growing and fruit evaluation]. *Dārzkopības un Biškopības Žurnāls*, Nr. 3, 93–101, Nr. 6, 225–233, Nr. 9, 362–365 (in Latvian).

Dindons, P. (1929). Kas jāievēro turpmāk pie augļu dārzu ierīkošanas [What should be observed at establishment of orchards in future]. *Rīgas dārzkopības biedrības gada grāmata,* 75–78 (in Latvian).

Gailītis, P. (1940). Kārļos atrodamais potcelmu materiāls [Rootstock material found at Kārļi]. *Dārzkopības un Biškopības Žurnāls*, Nr. 9, 467–473 (in Latvian).

Gailītis, P. (1940). Kārļu vecais pomoloģiskais dārzs [The old pomological orchard at Kārļi]. *Dārzkopības un Biškopības Žurnāls*, Nr. 5, 225–230 (in Latvian).

Górnaś, P., Rudzińska, M. and Segliņa, D. (2014). Lipophilic composition of eleven apple seed oils: A promising source of unconventional oil from industry by-products. *Industr. Crops Prod.*, **60**, 86–91.

Górnaś, P., Siger, A., Segliņa, D. (2013). Physicochemical characteristics of the cold-pressed Japanese quince seed oil: New promising unconventional bio-oil from by-products for the pharmaceutical and cosmetic industry. *Industr. Crops Prod.,* **48**, 178–182.

Gospodaryk, A., Moročko-Bičevska, I., Pūpola, N., Kāle, A. (2013). Occurrence of stone fruit viruses in plum orchards in Latvia. *Proc. Latvian Acad. Sci.*, Section B, **67** (2), 116–123.

Ikase, L., Lācis, G. (2013). Apple breeding and genetic resources in Latvia. *Acta Hortic.,* **976**, 69–74.

Ikase, L. (Ed.) (2015). *Augļkopība* [Fruit-growing]. Latvijas Valsts Augļkopības institūts. 545 pp. (in Latvian).

Juhnevica-Radenkova, K., Skudra, L., Skrivele, M., Radenkovs, V., Seglina, D. (2014). Impact of the degree of maturity on apple quality during the shelf life. In: *Proceedings of 9th Baltic Conference on Food Science and Technology "Food for Consumer Well-Being" FOODBALT 2014,* pp. 161–166.

Juhnevica, K., Aboltins, A., Skudra, L., Krasnova, I. (2013). The assessment of apple shelf life after storage at modified atmosphere. *Acta Hortic*., **981**, 597–606.

Juhnevica, K., Skudra, L., Skrivele, M., Radenkovs, V., Seglina, D., Stepanovs, A. (2013). Effect of 1-methylcyclopropene treatment on sensory characteristics of apple fruit. *Environ. Exper. Biol.,* **11**, pp. 99–105.

Kalnina, I., Strautina, S., Silina, L., Laugale, V. (2014). The possibilities of strawberry growing under high tunnels in Latvia. *Acta Hortic.,* **1049**, 535–540.

Kaufmane, E., Grāvīte, I., Trajkovski, V. (2012). Results of Latvian plum breeding programme. *Acta Hort.,* **968,** 55–60.

Kaufmane, E., Skrīvele, M**.,** Rubauskis, E., Strautiņa, S., Ikase, L., Lācis, G., Segliņa, D., Moročko-Bičevska, I., Ruisa, S., Priekule, I. (2013). *Development of Fruit Science in Latvia. Proceedings of the Latvian Academy of Sciences*, Section B, **67** (2), 71–83.

Kārkliņš, J. (1940). 1938.–39. gada ziemas sala postījumi Vidzemes vidienā [Damages of the winter of 1938–39 in the central region of Vidzeme]. *Dārzkopības un Biškopības Žurnāls*, **3**, 129–134 (in Latvian).

Konavko, D., Moročko-Bičevska, I., Bankina, B. (2014). *Pseudomonas syringae* as important pathogen of fruit trees with emphasis on plum and cherry. *Res. Rural Devel.*, 19–25.

Kota, I., Lācis, G. (2013). Evaluation of genetic diversity in plum germplasm collection using DNA-based S-genotyping. *Acta Hortic.,* **985**, 35–42.

Ķišķis, A. (1940). Vairāk zinātniski pamatota darba arī dārzkopībā [Need for more scientific background also in horticulture]. *Dārzkopības un Biškopības Žurnāls*, **1**, 2–8, Nr. 2 62–65 (in Latvian).

Ķīsis, O. (1938). Latvijas dārzkopība valsts 20 pastāvēšanas gados [Latvian horticulture during the 20 years of independent state]. *Dārzkopības un Biškopības Žurnāls*, **11**, 449–452 (in Latvian).

Laugale, V., Strautina, S., Krasnova, I., Seglina, D., Kampuss, K. (2014). The influence of cultivation system on biochemical content of strawberry fruits. *J. Hortic. Res.*, **22** (2), 85–92.

Laugale, V., Lepse, L., Strautina, S., Krasnova, I., Seglina, D. (2012). Effect of planting density and plastic soil mulch on strawberry plant development, yield and fruit quality. *Acta Hortic.,* **926,** 517–525.

Lāce, B., Lācis, G. (2015). Evaluation of pear (*Pyrus communis* L.) cultivars in Latvia. *Hortic. Sci. (Prague*), **42,** 107–113.

Lācis, G. (2013). Characterisation of Latvian fruit crop genetic resources by application of molecular genetics methods. *Proc. Latvian Acad. Sci.*, Section B: Natural, Exact and Applied Sciences, **67** (2), 84–93.

Lācis, G., Kota, I. (2013). SSR marker based fingerprinting for sour cherry (*Prunus cerasus*) genetic resources identification and management. *Acta Hortic*., **976,** 251–256.

Lācis, G., Lāce, B., Blukmanis, M. (2015). Evaluation of the susceptibility of pear cultivars to scab (*Venturia pirina* Aderh.). *Acta Hort.,* **1099**, 741–747

Moročko-Bičevska, I., Maldute, S. (2014). Fire blight in Latvia: Occurrence, management and problems. *Acta Hort.,* **1056**, 133–136.

Ozols, K. (1941). Latvian agricultural literature in 18th century. Lauksaimniecības. Trials and research in agriculture, II LPSR Z.T.K. Lauksaimniecības literatūras apgāda izdevums, 194–205 (in Latvian).

Porietis, K. (1940). Augļu dārzu izsalšanas cēloņi un to novēršana [Reason of winter damages in orchards and their prevention]. *Dārzkopības un Biškopības Žurnāls*, **8**, 411–413 (in Latvian).

Robiņš, E. (1938). Dārzkopības izglītība Latvijas 20 gados [Horticultural education in the 20 years of Latvian state]. *Dārzkopības un Biškopības žurnāls*, **11,** 445–449 (in Latvian).

Rubauskis, E., Skrīvele, M., Ruisa, S., Feldmane, D. (2013). Effect of crown restriction on the growth and productivity of sweet cherries. *Proc. Latvian Academy of Sciences,* Section B, **67** (2) (683), 151–156.

Rubauskis, E., Skrīvele, M., Ruisa, S., Feldmane, D. (2013). Effect of VOEN cover on the growth and productivity of two sweet cherry cultivars. *Proc.Latvian Acad. Sci.*, Section B, **67** (2), 157–161.

Rubauskis, E., Skrivele, M., Ikase, L. (2012). Growth and yielding of apple cultivars on the rootstock M 26 in Latvia. *Acta Hortic.,* **940**, 507–513.

Rubauskis, E., Skrivele, M., Ruisa, S., Feldmane, D. (2014). Growth and yielding of two sweet cherry cultivars on vegetatively propagated rootstocks. *Acta Hortic.*, **1058**, 657–661.

Ruisa, S.,Krasnova, I. (2013). Assessment of cherry cultivars and selections in Latvia. *Acta Hortic.,* **976,** 161–166.

Rupais, A., Stalažs, A., Strelčūns, R. (2014). Kokaugu kaitēkļu noteicējs pēc bojājumiem augļdārzos un apstādījumos [A key to tree pests by their damages in orchards and ornamental gardens]. *Scripta Letonica,* **1** (1), 5–221 (in Latvian).

Samsone, I., Moročko-Bičevska, I., Sokolova, O., Lācis, G. (2014). Resistance of strawberry to root rot and petiole blight caused by *Gnomonia fragariae*. *Acta Hortic.,* **1049**, 661–668.

Siliņš, T. (1940). Vai augļkopība atmaksājas? [Does fruit-growing pay?]. *Dārzkopības un Biškopības Žurnāls,* **8**, 407–409 (in Latvian).

Skrivele, M., Ikase, L., Kaufmane, E., Ruisa, S., Blukmanis, M., Strautiņa, S., Laugale, V., Brūvelis, A., Āboliņš, M., Rubauskis, E., Segliņa, D., Eihe, M., Berlands, V., Epro, V., Drudze, I., Gertnere, D. (2000). *Intensīvas augļkopības rokasgrāmata* [Handbook of Intensive Fruit-Growing]. Valsts Dobeles DSIS, Dobele. 281 lpp. (in Latvian).

Skrivele, M., Rubauskis, E., Ikase, L. (2011). Apple rootstocks in Latvian orchards — situation and tendencies. *Acta Hortic.,* **903**, 363–370.

Skrīvele, M. (2005). Integrētās augļu un ogu ražošanas pamatprasības [Basic demands in integrated fruit and bery growing]. *Agrotops tematiskais pielikums: Augļu Dārzi*, Nr. 3. SIA Mēdiju grupa „Tops", Rīga, 5–7 (in Latvian).

Skrīvele, M. (2004). Cik dārzu iestādīts? [How many orchards have been planted?]. *Agrotops,* **1**, 34–35 (in Latvian).

Skrīvele, M., Kaufmane, E. (1999). Augļkopība [Fruit-Growing]. In: *Latvijas lauksaimniecības zinātniskie pamati* (Chapters 4.36–4.38, 5.42–5.47, 11.33–11.34, 17.17–17.1), LLU (in Latvian).

Spolītis, A., Romanovska, O., Kārkliņš, J. (1955). *Latvijas PSR tautas selekcijas augļu koku šķirnes* [Latvian fruit tree landraces]. LPSR ZA izdevniecība, Rīga, 12–49 (in Latvian).

Strautina, S., Krasnova, I., Kalnina, I., Kampuss, K. (2012). Results of red raspberry breeding in Latvia. *Acta Hortic.,* **946**, 171–176.

Strautina, S., Krasnova, I., Kalnina, I., Sasnauskas, A., Trajkovski, V., Tikhonova, O., (2012). Results of the coomon international breeding programm for blackcurrants. *Acta Hortic.,* **926,** 53–59.

Strautina, S., Kalnina, I., Lusens, R. (2013). Raspberry cultivar 'Glen Ample' growing under high tunnels in Latvia. *Proc. Latvian Acad. Sci., Section B*, **67** (2), 162–166.

Sudrabs, J. (1931). Augļu koku izsalšana 1928.–29. g. un tās varbūtējie cēloņi [Winter damages of fruit trees in 1928–29 and their possible causes]. *Lauksaimniecības mēnešraksts*, **9**, 577–603 (in Latvian).

Sudrabs, J. (1940). Kā būtu organizējamas Padomju Latvijas kokaudzētavas [How tree nurseries should be organized on Soviet Latvia]. *Dārzkopības un Biškopības Žurnāls*, **8**, 399–401 (in Latvian).

Šnē, E., Segliņa, D., Galoburda, R., Krasnova, I. (2013). Phenol content and antioxidant activity of the ethanolic and aqueous extracts from sea buckthorn (*Hippophae rhamnoides* L.) vegetative parts. In: *Seabuckthorn (Hippophae L.) A Multipurpose Wonder Plant. Vol. IV: Emerging Trends in Research and Technologies*, Daya Publishing House, Delhi, 442–453.

Šterns, J. (1940). Kāds sagaidāms pavasaris mūsu augļu dārzos [What to expect in the spring in our orchards]. *Dārzkopības žurnāls*, **1**, 55–57 (in Latvian).

Šterns, V. (1936). Augļu retināšana [Fruit thinning]. *Dārzkopības Žurnāls*, **6**, 199–201 (in Latvian).

Šterns, V. (1939). Daži vērojumi no pagājušās ziemas sala postījumiem Liepājas apkārtnē [Some observations about last winter damages in the region of Liepāja]. *Dārzkopības Žurnāls*, **7**, 278–280 (in Latvian).

Teteris, E. (1940). Augļu dārzu ienesība 1939. gadā [Profitability of orchards in 1939]. *Dārzkopības un Biškopības Žurnāls*, **8,** 403–407 (in Latvian).

Timans, O. (1938). Augļkopība Alūksnes-Apes augstienē [Fruit-growing in the Alūksne-Ape highlands]. *Dārzkopības Žurnāls*, **8,** 352 (in Latvian).

Timans, O. (1939). Pagājušās 1938/39. g. ziemas sals [The cold of the last winter of 1938/39]. *Dārzkopības Žurnāls*, **10,** 407. lpp. (in Latvian).

Tumšs, V. (1986). Augļkopības perspektīvā attīstība [Perspective development of fruit-growing]. *Padomju Latvijas lauksaimniecība.* **7**, 6.–8. lpp. (in Latvian).

Villerts, A. (1940). Par sala drošiem potcelmiem [About winter-hardy rootstocks]. *Dārzkopības un Biškopības Žurnāls*, **8**, 409–411 (in Latvian).

Zirnītis, J. (1940). Būsim atklāti [Let's be honest]. *Dārzkopības un Biškopības Žurnāls*, **5**, 237–239 (in Latvian).

AUGĻKOPĪBA LATVIJĀ — RAŽOŠANA UN ZINĀTNE

Visos laikos Latvijas lauku sētās ir augušas ābeles savas ģimenes vajadzībām. Taču tikai pēc zemes iegūšanas īpašumā 19. gs. beigās izaudzētais ieguva arī tirgus vērtību. Tas veicināja strauju dažādu augļaugu kultūru platību pieaugumu, kas ļāva ar izaudzēto pildīt ne tikai vietējo tirgu, bet apgādāt arī Krievijas lielākās pilsētas. Īpaši strauji augļkopība sāka attīstīties Latvijas brīvvalsts laikā (1919–1940). Pieauga stādu pieprasījums, tos ieveda no Rietumeiropas valstīm. Nepiemērotu šķirņu un potcelmu sortiments bija noteicošie faktori, kuri veicināja dārzu izsalšanu sekojošās bargās ziemās. Pēc kara padomju vara tikai veicināja Latvijas klimatam un reljefam nepiemērotu 200–300 ha lielu dārzu stādīšanu galvenokārt pārstrādes vajadzībām. Tajā pašā laikā strauji pieauga mazdārziņu daudzums, kuros daļu no izaudzētā realizēja arī tirgū. Pēc valsts neatkarības atgūšanas, interese par ražošanu svaigo augļu un ogu tirgu kā arī pārstrādi strauji pieauga. To kavēja iepriekšējo paaudžu pieredzes un arī zināšanu trūkums. Reljefa, augsnes un klimata daudzveidība prasa rūpīgu piemērotas vietas un šķirņu izvēli. Tieša citu valstu pieredzes pārņemšana bieži noveda pie neveiksmēm.

Pašlaik nozares attīstību visvairāk kavē kvalificētu dažāda līmeņa speciālistu trūkums, kas neļauj izveidot atbilstošu konsultāciju sistēmu. Pārāk lēni veidojas arī audzētāju kooperācija produkcijas realizācijai. Ekonomisko un tirgus pētījumu trūkums neļauj sabalansēt pieprasījumu ar stādījumu platību pieaugumu, jo sevišķi liela apjoma pārstrādei vai eksportam, tāpēc nav iespējama arī augļkopības nozares attīstības stratēģiska vadība.

Dārzkopības attīstību kavē arī pastāvīga ilgtermiņa atbalsta trūkums zinātnei. Dārzkopības institūta pētījumu rezultātā: 1) ir izveidotas jaunas vietējās selekcijas šķirnes, kas tiek rekomendētas komercdārziem; uzsākta šķirņu un to audzēšanas tehnoloģiju pārbaude dažādos Latvijas reģionos; 2) veikts kaitīgo un derīgo organismu monitorings, izveidota nozīmīgāko slimību un kaitēkļu attīstības prognozēšanas un to kontroles sistēma; 3) ražotāji ar pētījumu rezultātiem tiek iepazīstināti semināros, demonstrējumos, kā arī rekomendāciju vai publikāciju veidā.