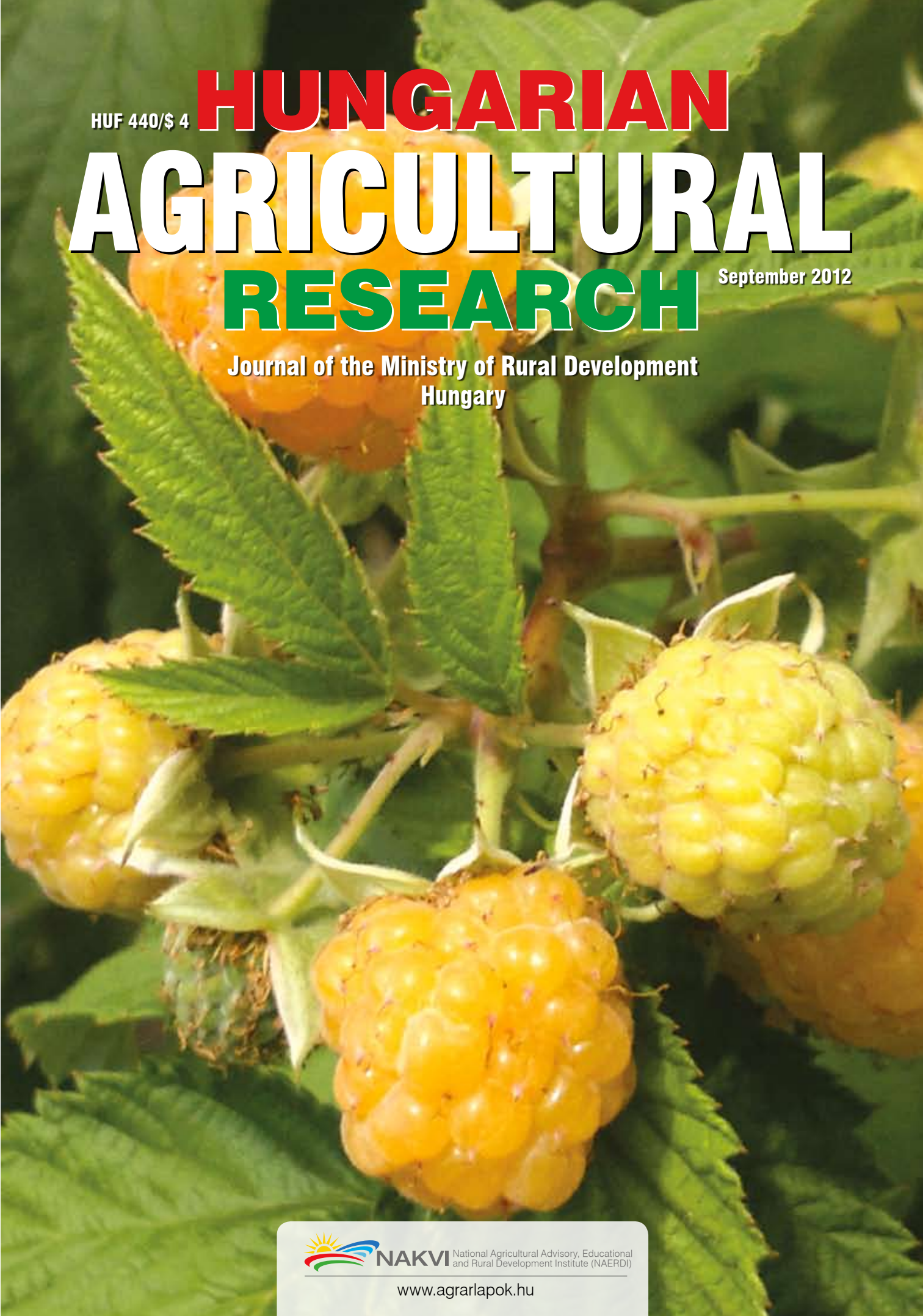

HUF 440/$ 4

HUNGARIAN AGRICULTURAL RESEARCH

September 2012

Journal of the Ministry of Rural Development
Hungary

NAKVI National Agricultural Advisory, Educational and Rural Development Institute (NAERDI)

www.agrarlapok.hu

Péter Sótonyi, Dean of the Veterinary Sciences, Szent István University

Professor Péter Tamás Sótonyi, DVM head of the Department of Anatomy, Faculty of Veterinary Science, Szent István University has been elected dean of the Faculty of Veterinary Science both by the senate of the faculty and that of the university. The new dean was appointed by the rector of Szent István University on 1st July 2012.

Professor Sótonyi was born in 1954 in Mosonmagyaróvár. He graduated as a veterinarian at the Budapest University of Veterinary Science in 1979. In 1989 he became CVS, in 1994 doctor habilitus, and has been awarded the Széchenyi Professors' Scholarship since 1997. He became professor in 2001 and has been the head of the Department of Anatomy and Histology since this year as well. Professor Péter Sótonyi is an acknowledged and influential personality of academic and scientific life in Hungary. He has been teaching several subjects of animal anatomy both in Hungarian and in German. He was given the Apáczai Csere János Award (2001), the Nagyváthy János Prize (2002), the honour of Master Professor (2003) for his work as a teacher and he became "Veterinarian of the Year" in 2006. He became Doctor Honoris Causa of the Semmelweis University in 2009 and that of the Kaposvár University in 2011.

He is engaged in research in neurobiology, developmental anatomy, and macroscopic anatomy. In the last field the application of modern imaging techniques in veterinary anatomy is outstanding including the CT and MRI anatomy of the dog, swine, sheep and horse.

Based upon his over 30-year experience in graduate and post-graduate veterinary training, he introduced a new approach to the teaching of veterinary anatomy by elaborating internationally acknowledged educational materials, CDs and videos. Since 1991 he has gained the honorary title of best lecturer 44 times. He received the "Best Teacher of the Year" award from *Diákinfo* (the journal of students) in 1999. Since the introduction of PhD training eight students have been successful in achieving the PhD degree under his guidance.

He is an author or co-author of 17 books in Hungarian, English, German, and Slovakian. His CD ROM entitled "*Anatomia Canis*" was issued in Hungarian, English, German and Japanese. His cumulative impact factor is 71.11 and 978 independent citations were made for his works. He held nearly 100 lectures at Hungarian and international conferences, and in 2005 he gave a very popular presentation in the framework of a scientific television series (*ENCOMPASS*) about "*An analysis of animal movement*". Having established significant international cooperation in education and research, he has been lecturing regularly at the University of Timisoara, and has been a visiting professor at Yale University since 2004. He participates in research collaborations with the universities of Cologne, Timisoara, Kosice and the Yale University.

He is actively engaged also in professional life as a member of the Hungarian and European Association of Anatomists, as the vice president of the World Association of Veterinary Anatomists, that of the World Organization of Hungarian Veterinarians, president of the Hungarian Society of Veterinary History, vice president of the Hungarian Equestrian Sport Federation, and as a member of the Hungarian Olympic Committee. He was a pioneer in the establishment of a consortium of institutions involved in the training of equestrian specialists at the academic level in 2009 in order to unify equestrian training and equestrian culture, to develop Hungarian horse breeding and horse sport, and by all these to enhance innovative projects, and the transformation of horse riding, husbandry, and the horse-related industries into an economic factor.

As the head of the faculty, Péter Sótonyi intends to increase the role and level of practical training according to the present-day requirements taking into account the opinion of students as well. The significance of food hygiene, domestic animal health, and epidemiology should also be increased, never forgetting the veterinary approach. For all this, the possibilities offered by the Üllő university farm should be utilized better, it should be turned into a model farm, equestrian life should be revitalized, and an Equestrian Recreational Centre should be established.

Yellow-fruited hybrid.

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Published by
NAKVI National Agricultural Advisory, Educational and Rural Development Institute (NAERDI)
H-1223 Budapest, Park u. 2. Hungary
www.agrarlapok.hu | info@agrarlapok.hu

Owner
Ministry of Rural Development

Editorial Office
Deparment of Mechanics and Engineering Design
Szent István University, Gödöllő | H-2103 Gödöllő, Hungary

Subscription request should be placed with the Publisher (see above)
Subscription are HUF 1200 (only in Hungary) or
$16 early plus $5 (p & p) outside Hungary

HU ISSN 1216-4526

Gábor Kollányi[1] *– Pál Kleizer*[1]

Use of some rubus species in raspberry breeding

The production of raspberry – one of the most favourite fruits in Hungary – started an upward trend in the first decades of the last century when the first commodity producing raspberry fields were established to supply fresh fruit for citizens and raw material for the canning industry. The first plantations were planted with the cultivars 'Lloyd George' and 'Nagymarosi' (the local variant of 'Knewett giant'). The aim of Hungarian raspberry breeding started in the 1930's was to develop high-yielding cultivars with large fruit. The cultivar 'E. 401' with good yielding ability was the result of the early crossings. Large scale plantations were founded as of the mid-1950's. In the beginning tried and tested cultivars were planted. The prevailing cultivar 'Nagymarosi' with good fruit quality but with small berries was superseded in the 1960's by the high-yielding cultivars 'Malling Promise' and 'Malling Exploit' with large berries. By the spreading of new cultivars, yield average increased by 30-40% while fruit quality and yield stability reduced. The increase in cold-store industry processing resulted in a greater demand for fruit with firm pulp, and the changes in the requirements called for the replacement of cultivars. By the beginning of the 1990's, the share of the cultivar 'Fertődi zamatos' with fruits perfect for deep freezing increased to 80-85%, which is maintained even today. In addition to late maturing raspberries, the very early maturing cultivar 'Fertődi Vénusz' is planted most often to extend the season of consumption.

Raspberry production is expected to grow due to the more and more considerable fresh consumption, which requires an increase in the selection of cultivars. Beside being able to give high yield, modern cultivars should also guarantee yield stability and excellent fruit quality. At continental climate in Hungary, proper yield and yield stability can only be provided by cultivars with great ecological adaptability and high yield potential that are resistant to pathogens and pests damaging the shoots and roots. The using of resistant wild species as gene sources may advance the breeding of vital resistant cultivars. Fruit quality can be increased by involving European and American red raspberries as well as black raspberries in the breeding procedure.

Interspecific crossing has been commonly applied at the Fertőd Research Institute during which fertile interspecific hybrids were successfully created by crossing cultivated raspberry with various *Rubus* species (*Rubus parvifolius* L., *Rubus phoenicolasius* Maxim., *Rubus occidentalis* L., *Rubus caesius* L., *Rubus flosculosus* Focke, *Rubus coreanus* Miq.) having favourable traits. At the start, the inherited resistance of these interspecific hybrids was not complex and the important quality traits were often similar to those of the wild species. The greatest problem with them was the poor fruit quality. The two main preferences in raspberry breeding today are the development of complex interspecific hybrid lines that are totally resistant to the major diseases and pests and the improvement of fruit quality. This is done by inbreeding the complex interspecific hybrid plants carrying the resistance genes to genetically fix the favourable traits, then they are back-crossed several times with the cultivars derived from European (*R. idaeus* ssp. *vulgatus* Arrhen.) and American (*Rubus idaeus* ssp. *strigosus* Michx) red raspberries with first-rate fruit quality. Then self-pollination is carried out to enable the manifestation of the complex trait.

Species used in raspberry breeding and their traits

The genus *Rubus* is very variegated. Focke distinguished 12 subgenera from which only two are important in terms of raspberry breeding. Except for the European dewberry (*Rubus caesius* L.), all the species used belong to the subgenus *Ideobatus* Focke, just like the cultivated raspberry. The raspberry-like species belonging to the same subgenus can be successfully crossed with each other. Their basic chromosome number is 7, most of them are diploid, however a few are triploid or spontaneous tetraploid, which are generally become ripe in

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the autumn. When crossed with European raspberry, they have fertile progenies. The majority of the members in the subgenus *Ideobatus* are indigenous to South-East Asia (Japan, Chine, Korea). There are much less raspberry-like species in the American centre of origin, while in Europe only the species *Rubus idaeus* L. is native. The common traits of raspberry-like species are the biennial stem (cane) system and the usually edible fruit that comes off of the core. The species in the group *Orientales* can be characterized by long thick very prickly branched canes and small or medium-sized fruits. The best-known and most important species of the group *Occidentales* is the black-fruited raspberry (*R. occidentalis* L.).

The widespread European dewberry belonging to the section *Caesii* of the subgenus *Eubatus* Focke is a natural tetraploid plant (2n = 28) and, concerning pollination, is almost completely pseudogamic. It is difficult to be crossed with raspberry and the progenies are infertile. In some exceptional cases fertile amphidiploid progenies might be produced by doubling the chromosome segment of the hybrids. *R. caesius* L. easily crosses with other wild blackberry species in nature.

The species *Rubus parvifolius* L. is indigenous to Eastern Asia. It can be found both in the mountains and on warmer flatlands. Growing as a small bush, it has excellent adaptability and can tolerate dry weather conditions. The berries are small, shiny, red or orange. It gives low yield but is relatively resistant to fungal diseases.

The F_1 hybrid generation resulting from the crossing of raspberry and *R. parvifolius* L. grows more vigorously than the parents. The plants are semi-climbers and the canes grow late. These traits are maintained in a part of the second back-crossed generation as well. Pollination of the hybrids is good both in F_1 generations and after the second back-crossing with raspberry.

The berries of the F_1 generation are small and crumbling. Fruit size could only be increased by several back-crossings. The fruit colour of the plants generated by crossing the red-fruited raspberry and the wild species with light red berries is very diverse, changing from yellow through orange to various shades of red. As the raspberry parent is homozygous to the red colour, the yellow berry colour can only be originated from the wild species. These new shades can be explained by intermediate inheritance. The majority of the plants in the second generation back-crossed with raspberry maintained the shininess of the fruit characteristic to the wild species. Most of the interspecific hybrids of *R. parvifolius* L. become ripe early and has short maturity period.

The resistance of the wild parent to the three most important cane diseases can be more or less demonstrated in the progeny generations back-crossed several times. The partial resistance to the fungi *Botrytis cinerea* Pers., *Didymella applanatáta* Niessl. (Sacc.) and *Sphaerulina rubi* Demaree *et* Wilcox was transmitted jointly, while the resistance to the stem-damaging fungus *Leptosphaeria coniothyrium* (Fuck.) Sacc. was transmitted independently (Kollányi, 1995). The infestation of the bronze cane girdler (*Agrilus aurichalceus* Redt.) was insignificant in the back-crossed hybrid generations, therefore a genetically based resistance might occur.

The resistance to frost and fungal diseases is better in the tetraploid interspecific hybrids than in the diploid ones.

The species *Rubus phoenicolasius* Maxim. is native to Northern China, Japan and Korea. It has long, vigorously growing canes with glandular hair that are covered evenly with straight prickles. The shiny fruits are smaller than those of the raspberry and taste good. It has large bunches and is high-yielding. *R. phoenicolasius* is more tolerant to some diseases than raspberry and is resistant to raspberry fruit worm (*Byturus tomentosus* Fabr.). No cracks are formed on the bark during the egg-laying period of raspberry cane midge (*Resseliella theobaldi* Barnes), as a result no larva colonies can be found in the cracks appearing only at the end of September (Kollányi, 1977).

As it can be easily crossed with raspberry, it was started to be used as breeding resource material early. The F_1 generation grows more vigorously than *R. phoenicolasius*. The vitality and appearance of the bushes are similar to those of the wild parent. They are liable to produce lateral branches and can take roots on the tips. When back-crossed with raspberry, the overall vigour of the population decreased, while the individual variance increased. The distribution of prickles in the F_1 generation shows an intermediate character, while the number of prickles exceeds those of the parents. The size of fruit is influenced adversely mainly by the insufficient pollination (20%). The mean fruit weight was even below that of the parent *R. phoenicolasius* Maxim. with smaller fruits. After several back-crossings with raspberry (B_3), pollination, fruit size, fruit quality and taste were restored, and cracks in the bark have not appeared either. The hybrids of *R. phoenicolasius* x *R. idaeus* combine the vitality and resistance of the wild species with the fruit size and fruit quality of the cultivated raspberry species. However, yielding ability has to be further improved. Plants

resistant to raspberry cane midge can also be found in the seedling population derived from several back-crossings.

Black raspberry (*Rubus occidentalis* L.) is native to North America and is closely related to the raspberry cultivated in Europe. It has downy, branching, prickly canes and can take roots on the tip. The prickles are flat, straight or curved. No root suckers are formed. The semi-spherical fruit is black and hard. The genetic diversity of the species is low in its entire geographical range. It was demonstrated in foreign experiments that its resistance gene A10 provides resistance to all four European large raspberry aphid (*Amphorophora idaei* Börner) strains (Keep *et al*, 1967). It is resistant to the fungal infections caused by *Botrytis cinerea* Pers. and *Didymella applanatáta* Niessl. (Sacc.) (Jennings, 1982; Jennings *et al* 1989). It is susceptible to cane and leaf spot disease (*Elsinoe veneta* Speg.).

Red and black raspberry cultivars easily cross with each other spontaneously as well, giving the hybrid species *Rubus neglectus* Peck. from which the purple-cane raspberry cultivars originate. Their favourable traits make them suitable to be used as donor parent. When the wild species is used as mother, the F_1 generation is fertile, its main characteristics are of intermediate nature and show little variance within the population. Similarly to the wild parents, it grows very prickly and branching shoots from the buds of the root collar. The thick wax layer makes them look downy white, however, their base colour is purple red. The F_1 generation showed modest resistance to Didymella cane spot disease. Fruit size is small, and fruit weight is closer to that of the wild species. The base colour of the berries is dark red, but they seem purple-blue due to their hairiness. The fruit is juicy, the pulp is firm. It gives higher yield than the black raspberry. The fruit quality of the hybrids could be increased by several back-crossings with large-fruited raspberry. The number of aggregate fruits reached the value of the raspberry parent in the second back-crossed generation (B_2), and their weight reached that of the raspberry parent in the B_3 generation while the fruit hardness characteristic to the wild species was maintained. Genetic segregation in fruit colour was considerable even after the first back-crossing. Dark-fruited plants could still be found in the second back-crossed generation. The third back-crossing resulted in valuable raspberry-like plants the fruits of which could resist to grey mould long after picking. Generally, the hybrids generated using the species *R. occidentalis* L. can well tolerate summer heat and temperature fluctuation at the end of winter.

The F_1 generation is fertile even at tetraploid level, grows vigorously and is less liable to form twin berries as a result of cold during flowering. The fruit size of tetraploid purple raspberry exceeds those of the diploid ones.

European dewberry *(Rubus caesius* L.) is a tetraploid (2n = 28) bramble native to Europe. It is tolerant to different weather and soil conditions. Unlike raspberry, *Rubus caesius* L. have a preference over calcareous soil, this is why it was used even in the initial period of Hungarian raspberry breeding. Raspberry x European dewberry hybrids can be produced spontaneously in nature.

The combination of dissimilar genomes and the maintenance of fertility can only be carried out at poliploid level. The first *R. idaeus* x *R. caesius* interspecific hybrids (Picture 1) were developed by Aladár Porpáczy, then the plants selected from the F_3 generation were crossed with loganberry (*Rubus* × *loganobaccus*). The majority of the progeny generations are genetically unstable, partially or completely sterile and has poor frost resistance (Porpáczy *et al*., 1963). The hybrid vigour manifested in somatic traits after the crossing of genetically distant species reduced significantly after back-crossings. In the second and third progeny generations some valuable blackberry-raspberry types and one raspberry type were generated.

The wild species *Rubus flosculosus* Focke is native to China. From the aspects of taxonomy and morphology, it is farther from raspberry than the other examined species in the subgenus *Ideobatus*. Its fruit is black, bad-tasting and very small. The ripening period is short (Finn, 2008).

Showing great incompatibility with raspberry, seeds could only be obtained by treating the flowers with gibberellin hormone. The canes have the highest resistance to the main pathogens and pests of raspberry. Its disadvantage is poor frost resistance. Even the progenies originating from open pollination are resistant to the major fungal diseases (*Didymella applanata* (Niessl.) Sacc.), *Leptosphaeria coniothyrium* (Fuck.) Sacc., *Botrytis cinerea* Pers) and pests (*Resseliella theobaldi* Barnes). The *R. flosculosus* Focke hybrids grow very vigorously. The thickness of canes can be as many as 30-35 mm. The F_1 hybrids produce uniformly tiny berries, but the number of berries on a bunch is large and the berries ripen relatively simultaneously. Average berry size has not increased significantly in the second back-crossed generation either. The pollination of aggregate fruits was good. The strange taste of the fruit was maintained even after a second back-crossing with raspberry. Wide-ranging

Picture 1: *R. idaeus L. x R. caesius L. interspecific hybrid*

resistance was transmitted also to the population back-crossed several times with raspberry. Fine raspberry taste and frost resistance have to be improved by further back-crossings.

The canes of *Rubus coreanus* Miq. bend down in an arched way, the offshoots are waxed. The shoots are covered with large straight or curved prickles. The fruits are small and their colours range from purple to black. It provides an excellent source of resistance as it is resistant to the major fungal pathogens of raspberry (Keep *et al*, 1977; Kollányi, 1974).

The chromosome structure of raspberry and *R. coreanus* Miq. differs significantly, still, they can be crossed easily. The F_1 generation is only partially fertile. The resistance of the wild species to the introduction and spreading of the fungal pathogens *Botrytis*, *powdery mildew*, *Sphaerulina and Didymella* can be shown in the second back-crossed generation of the interspecific hybrid. The resistance to the fungus *Leptosphaeria coniothyrium* (Fuck.) Sacc. was found to be transmitted independently of the former ones, there were no resistant plants in the F_1 generation. No plants uniting the resistances could be selected up to the present.

Promising complex interspecific hybrids

The species *R. idaeus* L., *R. caesius* L., *R. occidentalis* L. and

Picture 2: *F. 6755/II/13*

Rubus phoenicolasius Maxim. were used to develop this hybrid.

The medium-sized bright red berries are roundish, and they easily come off of the core. They have a pleasant sweet raspberry taste. The plants grow vigorously, producing long canes. Cracks appear on the canes only in late autumn. The resistance to the fungus *Elzinoe veneta* (Speg.) Jenkins is not complete. It is not infested by raspberry fruit worm and large raspberry aphid.

The species *R. idaeus* L., *R. caesius* L., *R. occidentalis* L., and *Rubus parvifolius* L. were used to generate this hybrid. The canes have a medium growing vigour and they are moderately prickly. Pollination is incomplete. The fruits are medium red, and are moderately hairy. The berries are small and start ripening late. The maturity period is prolonged. This hybrid gives high yield and can tolerate dry weather. The resistance

It originated from *R. idaeus* L., *Rubus flosculosus* Focke, *Rubus coreanus* Miq. and *Rubus parvifolius* L..

The growing vigour is medium. Its canes are reddish brown and are slightly prickly. Yield and fruit quality does not reach those of the cultivated raspberry yet. The berries are small, shiny and do not taste like raspberry. This hybrid shows complete resistance to cane diseases.

The parents include the species

Picture 4: F. 6255/III/3

Picture 3: *F. 6894/I*

R. idaeus L., *Rubus flosculosus* Focke, *Rubus coreanus* Miq., *Rubus parvifolius* L. and *R. occidentalis* L..

It grows medium tall, upright, reddish brown canes. The plants are very vital and moderately prickly. The berries are shiny yellow and soft. The bunches have anthocyanic pigmentation. Ripening occurs in a concentrated way.

It is resistant to all the pathogens and pests endangering yield stability.

Consequences

The demand for Hungarian raspberry with excellent fruit quality is great. At present we do not have the commodity supply required to meet the market demand, therefore, an upward trend is expected in production in the near future, which can be

Picture 5. *Yellow-fruited resistant hybrid*

Picture 6*: Fertődi Vénusz*

Picture 7.: *F. 6737/31*

based on the tried and tested cultivar 'Fertődi zamatos' with fruits suitable also for deep freezing, the cultivar 'Fertődi Vénusz' (Picture 6) based on interspecific hybridization and supplying the market with early raspberry, as well as the late-maturing hybrid 6736/31 (Picture 7) under testing.

At present, no high-yielding cultivar that meets all the demands of both the producers and the users and has good fruit quality is available. Wide-ranging resistance could be developed in complex interspecific hybrids, however, fruit quality and yield have to be further improved.

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Csaba Gyuricza, Nikolett Junek, Szabolcs Csuzi[1]

Landscape remediation after the red mud disaster in Hungary with short rotation coppice

On 4th October 2010 the most serious industrial disaster of the Hungarian history took place: the Veszprém county settlements of Kolontár, Devecser and Somlóvásárhely were flooded by heavily polluting alkaline red sludge. A few days after the disaster members of the Szent István University Faculty for Agriculture and Environmental Studies and of the Research Institute for Soil Science and Agricultural Chemistry of the Hungarian Academy of Sciences supported by a number of enterprises arrived in the area to carry out surveys and examinations related to the rehabilitation of non-residential areas. The measurements carried out on-site as well as the laboratory analysis results of soil samples clearly prove earlier assumptions, that is, the heavy metal content of the soil does not reach the pollution limit value of soils and the pH level did not increase significantly in the examined 90 cm deep soil layer. It can be concluded that the damages in non-residential areas are less significant than it had been assumed based on the damage witnessed in residential areas. The area can be made suitable even for food raw material production in a short time (1-2 years). In spite of this it is necessary to alter soil use completely due not so much to habitat damage but to market conditions and psychological impacts. For this, a three-step remediation plan was developed. The present article discusses the main conclusions of the research drawn so far as well as recommendations for arable land rehabilitation.

Red sludge

Red sludge is the by-product of bauxite based aluminium production. Bauxite is a mineral raw material that consists of minerals with aluminium content and other components like iron and silicon compounds. When bauxite is processed with the so-called Bayer technology (this technology is used in Ajka) its aluminium content is separated from the other components with sodium hydroxide in strongly alkaline conditions. The produced main product is called alum earth from which metal aluminium is produced using electrolysis. The by-product of alum earth production is red sludge with high iron content and a characteristic colour. As the name suggests, it is a mud-like material with liquid as well as dry matter content. Its further characteristic feature is that it flows easily in its original form, and its flow features change depending on its moisture content and the pressure it is subjected to. Just like in Ajka, red sludge is stored in reservoirs worldwide. Due to the technology applied, a certain proportion of sodium hydroxide used in the separation process remains in the red sludge and causes it to be strongly alkaline. Its pH is typically between 12 and 14 (MTA KK AKI – Hungarian Academy of Sciences Chemical Research Centre, 2010).

According to effective EU regulations (94/904/EC directive) red sludge is not considered to be hazardous waste. When it gets into the environment, however, it becomes a potential source of danger threatening the human population, animals and plants as well as the environment (air, water and soil) that comes into direct contact with it. Red sludge threatens the man-made as well as the natural environment due to its strongly alkaline nature (MTA TAKI 2010).

A disaster similar to the one that occurred in October 2010 has not yet happened anywhere so there is no previous experience that could be applied for the recultivation of arable land (Gyuricza et al., 2011, László 2011, Alexa 2011). In the present study the first soil examination results and the three-step remediation process developed are introduced.

Examinations in the contaminated area

The region affected by the disaster is situated on the upper watershed area of Marcal in

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the valley of the Torna stream. Most of the area is covered by loess, muddy, sandy river and slope deposits. The surface soil has a typical light mechanical composition (pebbly sand, sand or loam sand) with occasional muddy, clayey inter layers. On the older and higher areas brown forest soils have formed on the loess deposits while the lower-lying areas have hydromorphic humic gley or river valley soils. The higher territories have pebbly brown soils with thin fertile layers and in smaller patches humic gley chernozem soils. The depth of underground water is generally 2 to 4 meters while in the lower-lying areas 0.5 to 1.0 m with seasonal changes. The groundwater normally has calcium-magnesium hydro-carbonate content.

During the survey soil samples were collected from the upper 90 cm of the soil (0-30, 30-60, and 60-90 cm). Sample taking spots were selected so that areas covered by vegetation (clover and corn) and cultivated are both included. Samples were taken three times based on which an average sample was prepared. Basic and nutrient examinations were conducted and the amounts of the most important toxic elements were measured. The elements of the three-step remediation were elaborated on the basis of site specifics, site surveys and laboratory examinations.

Three-step remediation

As a result of the disaster the alkaline red sludge covered about 1000 ha of arable land. On site examinations show that the sludge layer stayed on the surface of the soil. It only flowed into occasional cracks and did not mix with the arable soil. The surface pollution of the soils varied depending on the thickness of plant growth, angle of slope, the distance from the place of burst and the speed of the mud current. On already cultivated land surface free from plants the depth of the sludge left behind was a maximum of 1 to 2 cm (*Figure 1-2*). Due to the fast flow and in some areas to the high moisture content of the soil the alkaline fraction reached the deeper layers to a very small extent or not at all. We concluded that the heavy metal content of the soil does not reach the pollution limit value of soils and the pH level did not increase significantly in the examined 90 cm deep soil layer (with the exception of the top 10-20 cm) (*Tables 1-2.*). These areas (about 40 to 45 per cent of the total arable land) could be used again without the removal of the red sludge. The most serious damage occurred in the areas farthest from the site of burst. In these areas the flow of the sludge slowed down and collected in the deeper parts of the surface (*Figure 3*). It is in these areas that the largest amount of sludge and soil layer had to be removed, and it is also in these areas that the pH level increased.

For the revitalization of the arable land area affected by the disaster it is necessary to elaborate processes that are capable of restoring the cultivation area to its original state. The three-step remediation (3R)

Figure 1 *Over the largest part of the previously-cultivated area the red sludge flowed along without anything to hold it back*

Figure 2 *Red sludge stayed on the surface, it did not enter deeper layers*

Table 1. *Results of basic pedological and nutrient examinations based on soil samples taken in arable land areas affected by the red sludge disaster (Kolontár, 16 October 2010)*

Plant	Depth (cm)	K_A	pH_{KCl}	$CaCO_3$ %	Total salt %	Humus %	NO_2+NO_3-N mg kg^{-1}	P_2O_5 mg kg^{-1}	K_2O mg kg^{-1}
Corn	0-20	60	7.3	12	0.05	3.4	3.92	46.4	83.8
	20-40	43	7.2	11	0.07	3.5	4.93	37	63.3
Clover	0-30	47	7.3	9	0.07	2.0	27.1	93.3	97.1
	30-60	45	7.3	11	0.05	1.6	6.0	45	73.1
	60-90	44	7.2	6	0.07	2.2	3.6	80.8	45.5
Ploughed surface	0-30	36	7.8	7	0.13	2.0	27.7	112	83.8
	30-60	43	7.2	5	0.07	2.0	1.1	33	88
	60-90	38	7.4	9	0.02	1.2	2.9	181	40.9

Table 2. *Results of soluble toxic element content based on soil samples taken in arable land areas affected by the red sludge disaster (Kolontár, 16 October 2010)*

Plant	Depth (cm)	As	Cd	Cr	Cu mg	Hg kg^{-1}	Ni	Pb	Zn
Corn	0-20	9.8	<0.02	28.9	12.4	<0.05	28.2	7.5	63.1
	20-40	20.2	<0.02	36	14.1	<0.05	36.6	7.2	78
Clover	0-30	8.3	<0.02	25.5	10.5	<0.05	26.3	8.5	59.1
	30-60	8.9	0.087	26.9	10.8	<0.05	27.8	5.4	57.8
	60-90	9.9	<0.02	29	9.9	<0.05	27.8	3.8	55.5
Ploughed surface	0-30	8.8	0.039	25.9	8.5	<0.05	23.9	6.5	50.4
	30-60	12.8	<0.02	41.2	12.3	<0.05	37.7	4.8	77.1
	60-90	6.1	<0.02	14.8	6.5	<0.05	19.2	3.8	39.7
***Pollution limit value**		***15***	***1***	***75***	***75***	***0.5***	***40***	***100***	***200***

**in accordance with 10/2000.(VI.2.) KöM-EüM-FVM-KHVM (Ministry of the Environment, Health Ministry, Ministry of Agriculture and Rural Development, Ministry of Transport, Communication and Water) Common Decree*

was developed for this purpose (*Figure 4.*)

Step 1: The key element of habitat revitalization is the recovery of soil biological activity and the prevention of the dusting out of the red sludge. In order for these to happen, a special soil improving and yield enhancing product (compost-turf mixtures) was used (1st remediation step). This step increased the biological activity of the soils as well as their nutrient storage capacity thanks to the high adsorption capacity, increased the immunity of energy plants (willow and poplar) against germs and pests, established a stable soil structure and improved the water, heat and air management of soils. After spreading the material, it needs to be turned into the soil with a disc (to a depth of max. 10 cm).

Step 2: Right after the compost-turf mixture was spread annual plants were sown on the area (2nd remediation step), which ensures

Figure 3 *The thick layer of red sludge must be removed before the area is reused*

the quick cover of the soil with vegetation and organic matter replacement. For this purpose, undemanding plants with fast growth rate (e.g. triticale and rye) were used. In spring the green plant mass will be crushed with stem shredder, which will result in a high volume of mulch cover.

Step 3: Creating an SRC plantation (3rd remediation step). Planting is possible with 150-200 cm long poles or 20-22 cm cuttings (*Figure 5*). A pole is a one-year-old unrooted pole planted 40-50 cm deep. The foliage that falls in the autumn protects the soil surface and provides organic matter. The plants can be first harvested in 2 years and then for the next 10 to 16 years the biomass can be cut with the same cutting cycle.

Figure 5 *With short rotation coppice (SRC) energy plants the habitat can recover in a short time*

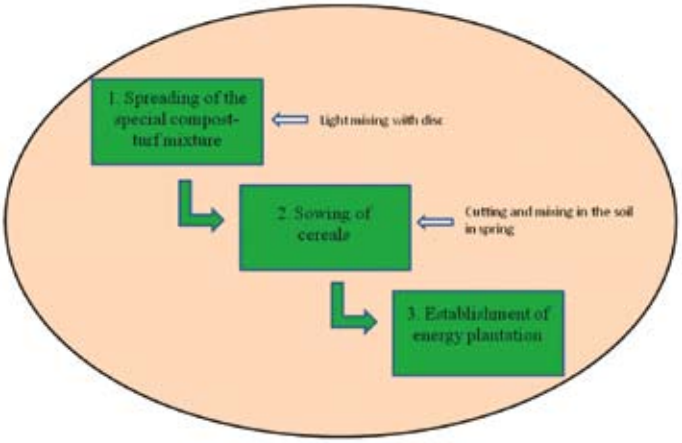

Figure 4 *The schematic of the three-step remediation (3R)*

Conclusions

In summary, it can be concluded that the disaster caused less damage in non-residential areas then it could have been expected based on the damage caused in residential areas. The area can be made suitable even for food raw material production in a short time (1-2 years). In spite of this it is necessary to alter soil use completely (through growing energy plants with the role of landscape rehabilitation and regeneration) due not so much to habitat damage but to market conditions and psychological impacts. For selecting the most suitable energy crop various aspects need to be considered (ecological, market, social and socio-economic). Based on these, the cultivation of ligneous energy crops with a systemic approach is the most efficient and secure solution. The specifics of the site make the area absolutely suitable for growing willow, poplar, black locust and various other energy crops. The buying up of the biomass can be done by the nearby power plant. At the same time, the heat energy needs of the rebuilt settlement districts could thus be supplied from renewable energy sources.

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Clonal approaches to growing Leuce poplars and their hybrids in Hungary

Introduction

Leuce-poplars, first of all white poplar (*Populus alba* L.) and its most important natural hybrid, the grey poplar (*Populus x canescens*) are native poplar species in Hungary. The area of poplar stands and plantations in the country was 63 thousand ha in 2010 (3.2 per cent of the total forested land), with a standing volume of 9.7 million m^3 (163 m^3 ha^{-1}).

More than 70% of the white poplar stands can be found on calcareous sandy sites on the Danube–Tisza region. Native poplars have been regarded for several decades as weed tree species without any value for timber market. In spite of this fact about 35% of the new afforestation and artificial regenerations is carried out presently with white poplar in the mentioned region. White poplar has a rich gene pool on the sand dune region in the middle of the Great Hungarian Plain and on the bottomland of big rivers. In the near future, due to the establishment of national parks in these regions, considerable increases can be expected in the area of native poplars. At the same time their importance will be increasing in the large areas of marginal sites which are not suitable for hybrid poplars but can accommodate native ones (*Figure 1*).

Photo 1. *Leuce-poplars' plantation (Danube-Tisza Interflue)*

In the Danube–Tisza region some very important ecological factors have become unfavourable for poplar growing in the last two decades. There is no sufficient precipitation during the growing season (appr.150–200 mm), and the rivers' control and canalisation have caused a drastic lowering of the ground-water table in many places. In such spots the water supply for poplars depends on the moisture content of soils, accumulating waters on the surface and on the water-storing capacity of soils. Therefore, the main aim of the selection work is to find and improve *Leuce* (white) poplar clones and cultivars that have good shape for ornamental purposes, provide

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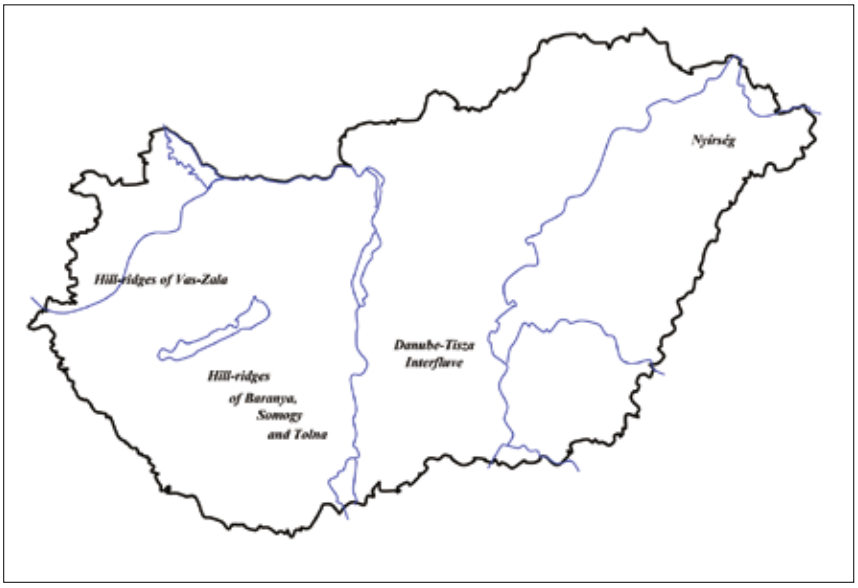

Figure 1. *The main growing regions of black locust (Robinia pseudoacacia L.) stands in Hungary*

good-quality wood material for industrial purposes (without false heartwood), and that can adapt to the changed ecological conditions (Rédei, 1994).

Taxonomy and distribution of poplars

The genus *Populus* is widespread through the north temperate zone and has about 35 species inhabiting vast areas from the boreal tree line down to Mexico, North Africa, Himalayas, Japan and China. The genus is divided into 5 sections: *Turanga, Leuce, Aigeiros, Tacamahaca* and *Leucoides*. The *Leuce* section consists of the following tree species: European aspen (*P. tremula*), Quaking aspen (*P. tremuloides*), Bigtooth aspen (*P. grandidentata*), white poplar (*P.alba*) and grey poplar (*P.canescens*).

Species crosses have yielded up to now the best results. It has to be mentioned, that the direction of crossing has importance in poplars, i.e. reciprocal crosses are genetically different. Hybrid vigour was observed in the crosses *P.alba x P. grandidentata* and *P. tremula x P. tremuloides,* which means that genetically close species, originating from different continents (usually Europe – N. America), are the most suitable partners. Such crosses may happen in nature, when the species are planted by accident, close to each other *(*Mátyás, 1983*)*.

Brief summary on breeding and improvement of poplars in Hungary

The basis for the breeding and improvement programme was a series of clones given in the frame of co-operation, during the 1950's by the Poplar Research Institute of Italy, Belgium, the Netherlands, France, Germany and Yugoslavia, combined with the genetic heritance of Hungarian forests (*Populus nigra and Populus alba*). This research programme started by the prominent scientists of the Hungarian Forest Research Institute (ERTI), Gy. Koltay and F. Kopecky. In Hungary ERTI is the most important national institution for poplar breeding and improvement. It took part in provenance testing experiments of *Populus trichocarpa*, *Populus deltoides* and *Populus nigra,* which were launched by FAO and IUFRO. In the course of breeding activities over four decades, about 80 000 seedlings were produced and tested by ERTI, of which 50% were among interspecific and intraspecific hybrids of the *Aigeiros* section, 15% of the *Leuce* section and 35% of the *Tacamahaca* section.

The number of clones selected out of progenies amounts to more than 1000. These clones, screened by early testing methods, make up a considerable part of the collection of ERTI and at the same time primary materials for clonal testing experiments. This poplar cross-breeding resulted in several excellently growing euramerican poplar clones, of which *Populus x euramericana 'Pannonia', 'Kopecky' and 'Koltay'* have been admitted to the official national poplar clone-choice and are integral parts of the state approved and tested varieties.

Selection breeding was mostly directed to native poplars (Kopecky, 1962, 1978). According to his research on native poplar hybrids, the *P. alba x P. grandidentata 'H 422-1',* the *'H 422-6'*, the *P. alba x P. alba 'H 425-4'* and the *'H 325-10'* clones could have some growing-importance. The *P. alba cv. 'Bolleana' 'H 427-3'*, the *P. alba x P. grandidentata 'H 422-1'* and the *'H 422-6'* clones can be planted in roadside plantations and parks for their decorative value on the whole range of suitable sites. On the calcareous sites of the Great Plain only the *P. canescens x cv. 'Bolleana'*, the *'H 372-1'* and the *'H 372-2'* can be planted.

Selection investigations on marked individuals and populations of native poplars laid the foundation for their possible *in situ* and *ex situ* conservation. Marked gene-reserves extend to roughly 100 ha and the number of registered plus-trees is about 200 (*in situ* gene preservation). In Hungary the area of native and hybrid poplar experiments amounts to 800 ha.

Geographically they are dispersed in the poplar growing regions, and therefore are suitable for drawing conclusions on clone-site relations under the typical conditions of the country.

Methods of vegetative propagation used for Leuce poplars

Clonal selection is a variant of individual selection, a very effective one, as both additive and non-additive genetic components are utilized. Asexual propagation is very important for archivation and conservation of selected genotypes. The ease of vegetative sustenance of individuals is maybe the greatest advantage of forest tree breeding as compared with perennial plant breeding.

The vegetative reproduction of *Leuce* poplars can be solved by autovegetative propagation. Cutting propagation has been practiced for centuries in horticulture and to some extent in forestry as well. Root cuttings have been proved to be the best method. Root cuttings are detached portions of root systems, generally 0.5 cm in diameter and about 5-10 cm in length. They are planted horizontally at a depth of 2 to 3 cm in a well-watered rooting medium. Good results can be achieved by simple sowing of root cuttings in the nursery.

Green cuttings are much more difficult to handle, as they are sensitive to drying-out. Greenwood cuttings of *Leuce* poplars are rooted under shaded foil cover, they have to be carefully watered. The time required for root formation varies from two weeks to twelve weeks. Clones which root the best in early summer are usually overwintered in a greenhouse because their root systems are not adequate to support the young ramets under outdoor winter conditions.

Almost 10 *Leuce* poplar selected clones were micro-propagated during the last few years in the Micropropagation Laboratory of Research Institute for Fruit growing and Ornamentals, Budapest–Érd in collaboration with the Hungarian Forest Research Institute. Plant tissue culture methods provide us with new means to speed up vegetative propagation of the selected clones and give us the opportunity to establish new clone trials and seed orchards with them. (Rédei, Balla, 2007). In spite of the numerous advantages of this method it has to be underlined that tissue culture plants must not be brought into cultivation before risks and costs are carefully considered.

Evaluation of Leuce poplars' clone trial

Suitable observation techniques make it possible to observe some characteristics important for breeding already at an early stage of development of trees, while other characteristics are manifested at a later age. The responses of clones under different environmental conditions is a result of their greater or smaller adaptability in regard to survival, rate of growth, resistance to damages, etc.

In the past 20 years the Hungarian Forest Research Institute established several comparative trials with white poplar clones for investigating their site requirements, growing patterns and yield. The trials demonstrated in this paper are allocated in different poplar growing districts in Hungary.

According to the Hungarian classification of forest site types, the main ecological characteristics of the studied areas are the following: forest steppe climate zone; humidity is less than 50% in July at 2pm; the annual precipitation is less than 600 mm; genetic soil type: humic sand as well as alluvial soil with shallow rootable depth.

The following stand parameters were measured and calculated at the age of 5, 10, 15 and 20 years: stem number, dbh.(diameter at breast height), basal area, tree height, stem volume, stand volume and mean tree volume. Stem volume was estimated by the following volume function (Sopp, 1974):

$$v=d^2*(h^{(po+1)})*(p_1*d*h+p_2*d+p_3*h+p_4)/(((h-1.3)^{po})*10^8),$$

where d is diameter at breast height ($d_{1.3}$, cm), h is tree height (m), $p_o= 2$, $p_1= - 4236$, $p_2=12.43$, $p_3=4.6$, $p_4=3298$.

To characterize tree quality, the *stem quality index* at the age of 20 was defined, by using the following stem quality classes:

- *Class 1* - The stem is straight, cylindrical, healthy and reaching the top of the crown. Crooks are tolerated in one dimension only, up to a bend of less than twice the stem diameter. The lower two-third of the bole is free of live branches.
- *Class 2* - The stem is straight and healthy, forks are tolerated, but only if they are in the uppermost third of the tree. Crooks are tolerated in one dimension only, up to less than four times the stem diameter.
- *Class 3* - The stem is crooked, leaning and more or less damaged. Crooks may reach six times the stem diameter in one dimension and minor crookedness in a second dimension is tolerated.
- *Class 4* - The stem is very crooked in more than one dimension and heavy damaged. Low branching, forked trees sometimes with broken crown.

The stem quality index was calculated as the average of the stem classes weighted by stem number.

In the trial established in Danube-Tisza Interflue at Szentkirály the clones *'H 422-9'* (*Populus alba x Populus grandidentata*), *'H 425-4'* (*Populus alba x Populus alba*), *'H 427-3'* (*Populus alba x Populus*

Table 1. *Yield data of white poplar clones at the age of 20 at Szentkirály (replications' means)*

Name of clones	Mean height m	(%)	Mean DBH cm	(%)	Mean tree volume m^3	(%)	Stern quality index
'H 427-3'	19.6	92	18.1	74	0.259	52	1.6
'H 758'	20.3	95	22.2	99	0.402	80	1.5
'H 425-4'	22.6	106	25.6	104	0.542	108	1.3
'H 422-9'	18.8	88	17.9	73	0.244	49	1.8
Control*	21.4	100	24.5	100	0.501	100	-

** data derived from yield table (Rédei, 1991)*

alba cv. Bolleana), and *'H 758'* (*Populus alba Mosonmagyaróvár 124*) can be found. The experiment was set up in a randomised block system with three replications. The initial spacing was 2.0 x 2.0 m. The control white poplar and the third replication of the clones, due to the unfavourable site conditions, died out at the age of 2. Because of this the characteristics of the main part of a white poplar stand of Yield Class I (Yield table: Rédei, 1991) was considered as control with the following values: mean height = 21.4 m; mean DBH = 24.5 cm; mean tree volume (according to the volume table for white poplar) = 0.501 m^3/tree at the age of 20.

Some yield data and the relevant percentage-values compared to the control calculated on the basis of replications' means at the age of 20 can be found in *Table1.*

On the basis of the data, considering the growth in height,the clone *'H 425-4'* provided the best result. It overpassed the control by 6 and 4 per cent, respectively. The tendency is the same with regard to the mean tree volume. The effect of differences in dbh. on the mean tree values seems to be considerable (additional 8 per cent for the above-mentioned clone). As for the tree quality index is concerned, the order from best to worst is: '*H 425-4*', *'H 758'* '*H 427-3'* and '*H 422-9*'. According to the significance test at P=5% level, significant differences were found in dbh ($SD_{5\%}$=7cm) and in the mean tree volume values ($SD_{5\%}$=0.144 m^3).

The trees in the clone trials thrive under site conditions that are only partly favourable for poplar growing. Considering this fact, the preliminary evaluation showed that all the examined *Leuce* poplar clones are promising for growing on the above-described sites. The clones *'H 422-1', 'H 422-6', 'H 425-4'* and *'H 758'* seem to be suitable for wood production, while the '*H 422-9'* and '*H 427-3'* clones (with decorative stem form) could be better used for tree lines and decorative plantations.

Conclusions

Hungary has got relatively much experience in *Leuce* poplar growing. As the results suggest, systematic testing is essential in poplar breeding. The systematic evaluations of clone trials set up in the past decades in the country will make it possible to select more reliably the *Leuce* poplar clones which can meet all the requirements drafted in the introduction of this paper.

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The methodological and practical issues of lifestyle segmentation in Hungary

1. Introduction

As a response to global challenges, the importance of sustainable development and, at individual level, sustainable consumption is increasing more and more. The group that could be regarded as the most committed one to sustainable consumption is LOHAS (Lifestyle of health and sustainability), since – based on international literature – these are those consumers who consider all three pillars (economic, social and ecological) of sustainable development when making purchase decisions.

It is important that the motivations of new-type consumers are manifested also in concrete purchase situations to express their need for change. This statement brings new challenges to food industry companies as well partly because the supply of foodstuffs with unique added value satisfying special consumer needs could provide competitive advantage in the market of undifferentiated products and partly because the appearance of the new consumer behaviour trend draws the attention to the requirement that the activities of corporations have to be reorganised in accordance with the principles of sustainability to avoid losing further market share.

2. Review of literature

According to the segmentation model of the NMI (Natural Marketing Institute), LOHAS consumers possess the following characteristics: the most significant elements of their attitudes are environment, society and socially responsible business. They are early accepters, able to influence the opinion and purchasing decisions of their families and friends, are less price-sensitive and show brand loyalty (French-Rogers, 2006). Although the examined consumer group is committed to sustainability, style and aestheticism are similarly important purchase criteria for them, and it means that they do not refuse hedonism (Kreeb et al., 2008). The Zukunftistitute, based on its researches, defines the characteristics of group LOHAS as follows: for them quality has an increased value, and they prefer authentic values rather than experience. Stockpiling of material goods is substituted by the importance of being and soul. LOHAS consumers are health-conscious and they pay extraordinary attention to the impacts of certain products on nature and social justice. They do not aim boycotting the consumption of products produced by non-sustainable methods. Their goal is to reach a global ecological and social-centred change in the attitude (Kreeb et al., 2008). Based on the above, LOHAS consumers developed a hybrid lifestyle which contains diverse characteristics (for instance health, search for experiences, individual but not egocentric behaviour). These partly controversial characteristics define the new post-modern consumer strongly value-oriented lifestyle (Schulz, 2008). Moreover, Paul Ray (1996) found in the American LOHAS group that followers are mainly women and they are from high/medium social classes.

As LOHAS consumers are aware of the risks of purchasing, they attach great importance to reliable information, and they only make decisions after thorough gathering and assessment of information. They expect that food producing and trading companies ensure the transparency of the entire process (verticum). They pay special attention to the following: food labelling (such as the list of ingredients, nutritional value label, trademarks) and the CSR activity of companies proving ethical behaviour for them (French-Rogers, 2005).

No paper has been published in Hungary defining the share of LOHAS segment within the population and identifying its behavioural characteristics. However, several Hungarian papers have demonstrated that health-conscious, environment-

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conscious and ethical consumption characterising the so-called 'hybrid lifestyle' have appeared in Hungary (Horváth et al., 2005; Hofmeister Tóth et al. 2010; Gulyás, 2008).

3. Materials and methods

A qualitative research was performed in 2010 to examine the general women's magazines published also in Hungary using the method of content analysis. The aim of the research was to define the extent to which the Hungarian opinion leader media targeted the LOHAS consumers. The statements included in Table 1 were specified on the basis of the results of this research. From logical aspect, the statements can be categorized in five groups (dimensions): *environmental consciousness, health consciousness, ethical behaviour, authentic values and individualism.*

Data was collected in September 2011 in the frame of the Omnibus-survey performed by the market research company Cognative Piackutató Kft. by querying 1015 people. Sampling was carried out using the method of random walk with the help of stratified sampling based on settlements and counties using 111 sampling points. The data entered and cleaned after data collection were processed using the statistic software SPSS 16.0.

4. Results

4.1 Sustainability values appreciated by Hungarian consumers

Factor analysis was performed on the statements representing the five lifestyle dimensions and the results prove that the value structure describing the hybrid lifestyle, including values of sustainability, can be observed among Hungarian consumers as well. The results of factor analysis demonstrate that the value structure characterizing Hungarian consumers differs in several ways from the original concept. One of these surprising features is that values representing health and environment conscious behaviour got in the same factor, indicating that these two behavioural forms are closely related in the scale of values of Hungarian consumers. The other feature that is worth mentioning is that the arrangement of ethical values into factors within the lifestyle patterns of Hungarian consumers was based on whether the customers consider themselves competent from the aspect of the given statement (Table 1).

Factor 1 – Individualist values (explained variance: 19.918%): Values 19-25 in the list of statements.

Factor 2 – Values of health and environment consciousness (explained variance: 19.554%): Values 1-9 in the list of statements. We would like to emphasize that all the values of environmental consciousness (except one) have lower importance than the statements representing health consciousness, which indicates that greater weight is attached to health consciousness in the scale of values of Hungarian consumers.

Factor 3 – Authentic values (explained variance: 4.836%): Values 15-18 in the list of statements. Factor 3 includes authentic values that describe the national commitment and need for safety of consumers.

Factor 4 – Ethical (competence) values (explained variance: 3.119%): Values 10, 11 and 14 in the list of statements. Factor 4 indicates that Hungarian consumers do not feel that the values of ethical competence apply to them, i.e. ethical behaviour is not or just partly typical of them in their concrete actions.

Factor 5 – Ethical values (relating to corporate behaviour) (explained variance: 3.069%): Values 12-13 in the list of statements. In this dimension two factors appear that relates to the judgement of corporate behaviour, which are considered by consumers as beyond their competence.

4.2 Lifestyle segments based on the values of sustainability

After the factor analysis was performed, a cluster analyses was carried out to create the value-based lifestyle segmentation of Hungarian consumers. With regard to the large number of samples (N=1015), k-means method was used for the analysis. The following groups were specified by the k-means procedure: *Cluster 1: Conscious elderly; cluster 2: trend followers; cluster 3: health and environment conscious consumers with national commitment; cluster 4: uninterested consumers; cluster 5: disappointed pessimists* (Table 1).

Among the above groups, the scale of values of 'Trend followers' conforms most to the hybrid lifestyle characteristic to the LOHAS consumer. They are health and environment conscious and in the case of ethical values they attach importance not only to social-centred corporate behaviour but also to competence values (such as volunteering, purchasing of products not tested on animals). Another feature of this consumer group is that they can be regarded as the most individualist segment of all, while they also consider authentic values as important.

It should be noted that the segment of 'Trend followers' cannot be regarded as fully committed LOHAS consumers yet, as the judgement of ethical (competence) values indicates a critical issue in their case. The results of detailed

analyses show that they are rather indifferent than committed to the factors (statements) of this dimension. Therefore, the opinions of the consumers in the 'Trend followers' group were examined more thoroughly in the frame of further segmentation within the given sub-sample. (Clusters were formed using k-means method again, the level of significance of F-test was below 0.05, as expected, proving the formation of homogenous groups).

Six consumer sub-groups could be distinguished within the segment of 'Trend followers', two of which are sub-clusters that considerably overvalued the ethical (competence) values in comparison to the group average. These two sub-clusters considered the groups of values representing the hybrid lifestyle characteristic to the LOHAS consumer as true to themselves, and their share in comparison to the entire sample was 4.0% and 3.6%. The two sub-clusters differed slightly in the judgement of the values representing each lifestyle dimensions, however, this difference was not considerable. It can be also stated that the rate of consumers keeping the criteria of sustainable consumption more or less in mind in Hungary today is 21% (the potential market) which is represented by the group of 'Trend followers'. The LOHAS segment can be identified within this group, which can be distinguished most clearly on the basis of ethical (competence) values and whose rate within the entire population of Hungary is 4-8%.

Factors
1. The packaging of the purchased product should be reusable.
2. Energy efficient household appliances contribute to sustainable development.
3. Children should be raised in an environmentally conscious manner.
4. I prefer foodstuffs that help maintain my health.
5. When I plan my daily meals I pay attention to obtain the essential nutrients in a proper quantity.
6. Sport is indispensable to maintain health.
7. I usually buy seasonal products (e.g. watermelon in August).
8. Additives in foodstuffs are harmful to my health.
9. For healthy nutrition, people should be aware of the physiological effects of food ingredients (e.g. vitamins, sugar, saturated fatty acids, etc).
10. I usually support the work of civilian bodies with donations.
11. I perform voluntary work every year.
12. I appreciate companies supporting charity programmes.
13. I appreciate companies ensuring suitable working conditions for their employees.
14. I only buy products not tested on animals.
15. If I buy foodstuff at the local markets, I support Hungarian producers.
16. Traditionalism is important to me.
17. Through buying Hungarian products, I contribute to the economic development of the country.
18. Trademarks (e.g. 'Hungarian product') placed on products reduce my uncertainty during shopping.
19. Career is important to me.
20. I prefer branded products.
21. I like unique products.
22. Style is important to me.
23. I form my lifestyle in accordance with the latest trends.
24. I buy products that reflect my personality.
25. I like high quality products.

5. *Consequences, recommendations*

The results of our research show that health and environment consciousness are major factors in the scale of values of Hungarian consumers. The consumers attach special importance to the reliable information on the physiological effects of foodstuff ingredients and try to avoid products containing additives as much as possible. During shopping, they prefer foodstuffs that they consider as healthy but they also find it important that the product does not pollute the environment. Hungarian consumers tend more and more to express their national commitment (ethical values) by having a preference for Hungarian products. These results demonstrate that healthy and environmentally friendly Hungarian products that also represent individualist values, for instance they are unique in some way (local products) or can be distinguished from other brands due to a special feature, have competitive advantage in the Hungarian market.

On the basis of international consumer behaviour trends and the results of our research, it can be predicted that a new group of customers will soon appear that prefer products that are proved to be produced in accordance with ethical corporate behaviour. Ethical values will, of course, be truly realized in consumer expectations only when consumers will be provided with not only wide-ranging but also verified and reliable information on market processes.

Value-based consumer groups								
	F	sig	Sample average N=1015	Cluster 1 N=176 17%	Cluster 2 N=212 21%	Cluster 3 N=275 27%	Cluster 4 N=192 19%	Cluster 5 N=160 16%
	74.724	0.000000	3.992	4.488	4.439	4.136	3.352	3.374
	73.003	0.000000	4.045	4.566	4.340	4.194	3.445	3.544
	128.117	0.000000	4.334	4.864	4.597	4.650	3.506	3.853
	108.108	0.000000	3.930	4.466	4.473	4.133	3.185	3.163
	74.328	0.000000	3.739	3.967	4.414	3.898	3.116	3.055
	88.088	0.000000	3.846	4.146	4.439	4.093	3.173	3.112
	70.038	0.000000	3.845	4.240	4.415	3.983	3.137	3.267
	116.212	0.000000	3.956	4.496	4.431	4.137	3.169	3.367
	118.298	0.000000	3.944	4.536	4.356	4.151	3.230	3.247
	76.77	0.000000	2.157	1.924	2.784	1.647	2.964	1.488
	109.083	0.000000	2.072	1.385	2.833	1.613	2.997	1.492
	79.259	0.000000	3.440	3.932	4.170	3.333	3.196	2.41
	92.013	0.000000	3.832	4.498	4.345	3.918	3.240	2.981
	57.23	0.000000	3.107	3.113	4.003	2.751	3.166	2.458
	101.188	0.000000	3.815	4.461	4.404	3.762	3.157	3.204
	97.06	0.000000	3.870	4.688	4.263	3.888	3.155	3.280
	90.879	0.000000	3.927	4.508	4.318	4.125	3.172	3.337
	76.718	0.000000	3.724	4.275	4.226	3.810	3.088	3.068
	235.553	0.000000	2.940	1.520	4.104	3.275	3.224	2.039
	282.463	0.000000	2.826	1.493	3.952	2.948	3.463	1.824
	361.051	0.000000	2.859	1.497	4.258	2.940	3.349	1.772
	314.94	0.000000	3.074	1.732	4.338	3.312	3.498	1.962
	340.52	0.000000	2.599	1.203	3.876	2.469	3.422	1.677
	219.964	0.000000	3.097	2.022	4.275	3.278	3.405	2.035
	132.702	0.000000	3.175	2.414	4.188	3.291	3.333	2.278

5-level interval scale (1 – not true at all, 5 – absolutely true), One-Way ANOVA sig<0,05, Test of Homogeneity of Variances sig<0,05 - Post Hoc Tests Tamhane (sig<0,05), sig>0,05 - Post Hoc Tests LSD (sig<0,05), Classify=K-Means Cluster, Number of Clusters=5, Maximum Iteration=20, Convergence Criterion=0, Missing Values=Exclude Cases Listwise; Source: own research, 2011, N=1015;

The results of our research involving a large representative sample prove that the group of 'Trend followers' as potential LOHAS consumers may represent new market opportunities for food industry companies. Although the rate of genuine LOHAS consumers within the entire population of Hungary is low, their presence is already worthy of note. Assuming that the trend of commitment to sustainability will further spread, food producers and traders should be prepared for the critical attitude characteristic to the LOHAS group and should adjust corporate processes in accordance with the expectations.

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Abstract

Sustainable development, and - at individual level - sustainable consumption is becoming more and more important today, which predicts the development of conscious consumer groups. Supported by international literature, our study introduces the features of the hybrid lifestyle characteristic to LOHAS consumers, and the relevance of the LOHAS concept in Hungary is examined on the basis of national research.

Then the results of the research involving representative data collected in September 2011 in the frame of the national Omnibus-survey performed by the market research company Cognative Piackutató Kft. are presented. Beside descriptive statistics, bivariate and multivariate correlation assessments were also performed, and the methods of cross table, variance, factor and cluster analysis were also applied.

The results demonstrate that a consumer scale of values appreciating sustainability started to emerge in Hungary as well, on the basis of which a conscious segment representing the hybrid lifestyle characteristic to LOHAS consumers can be defined.

The summary of our study points to the fact that the new consumer segments following this hybrid lifestyle bring completely new market opportunities and threats to food industry companies.

Keywords: representative data collection, sustainable consumption, LOHAS, value-based lifestyle segmentation

"Research was supported/ subsidized by the TÁMOP-4.2.2/B-10/1-2010-0011 „Development of a complex educational assistance/ support system for talented students and prospective researchers at the Szent István University" project.

Béla M. Csizmadia was awarded with Knight's Cross from the Order of Merit of the Hungarian Republic

Béla M. Csizmadia was born in 1942 in Budapest. He attended the Technical University for Heavy Industry in Miskolc and graduated with honours in 1965.

He started work at Ganz Electric Works, then – as of August 1972 – he worked at the Department of Mechanics and Metal Structures of the College Faculty of Metallurgy of the Technical University for Heavy Industry in Dunaújváros as an assistant lecturer and an appointed deputy head of department.

In 1978, he moved to his present workplace, the Institute of Mechanics and Machinery of the Faculty of Mechanical Engineering of the Szent István University, where he first worked as a university senior lecturer and from 1984 as an associate professor. Meanwhile, he obtained the title of university doctor in 1981 and the candidate in engineering in 1982. He was appointed in 1992 to university professor to teach the subject of Mechanics and to direct the connected research activities. He performed this work until June 2012, since then he has been teaching there as a professor emeritus.

After seven years in industry, he spent his whole life working in higher education, yet, he kept and still keeps close and continuous contact with engineering practice. His research activity has always been connected with the solving of practical problems. He has prepared over fifty research reports to solve mechanical issues in the fields of industry, mining, chemical industry, metallurgy and agriculture, which were manifested in real products and developments. These research activities involved, among others, the development of mining safety mechanisms, the dimensioning of various agricultural appliances and certain areas of biomechanics.

Within agricultural engineering, his research topic is the transportation and warehousing of grain crops. His research results assist the improvement of energy-efficient environmentally friendly screens, straw choppers, and he also performs investigations to reveal the mechanical processes in a silo. He founded an internationally known research base for the examination of the mechanics of granular materials.

In 2005 he was awarded with the Imre Botka Prize by the Hungarian Chamber of Engineers for his scientifically justified constructive engineering activity.

He has been improving the subject Mechanics in Gödöllő for twenty years since he was appointed to a professor, obtaining several coordinated methodological results and uniting the teaching of Mechanics in a unified system. The conference series 'Meeting of Hungarian Teachers of Mechanics' organized every two years since 1993 is connected with the improvements in teaching methodology. In cooperation with other higher education institutes, a Mechanics textbook in four volumes was published on his initiative, based on his concept and was edited by him. The volumes of this textbook series, awarded with the honour 'Textbook written in nice Hungarian language' and the Award of 2004 of the Hungarian Academy of Engineering, were published altogether in more than twenty thousand copies.

The editing of the multilingual glossary series prepared with the aim to improve the Hungarian professional terminology is connected to the teaching of Mechanics, the first volume of which was published with the title 'Technical Mechanics'. The World Council of Hungarian University Professors conferred the honour „Pro Universitatae et Scientia" on this book in 2003.

He was a guest professor at the Technical University of Temesvár and the University of Nagybánya where he taught the subject 'Designing of experiments'. He is the honorary professor of these two universities.

Beside basic education, he actively participates in talent management as well. At present, he directs the Educational Committee of the Doctoral School of Engineering Sciences of the Szent István University.

In 1997 he was granted with Széchenyi scholarship. He works in numerous faculty, university and state professional committees, the organizing board of journals and conferences, the Committee for the Mechanics of Solids of the Hungarian Academy of Sciences, and the Academic Committee for Mechanics.

He joined the work of the Chamber of Engineering in 1989 by establishing the Gödöllő Group. At present, he is the chairman of the Department of Mechanics of the Hungarian Chamber of Engineering. His activity was acknowledged by the Chamber of Engineering by granting him the Prize Szilárd Zielinski in 2012.

On 20 August 2012, the President of the Hungarian Republic awarded him the Knight's Cross from the Order of Merit of the Hungarian Republic for his research of over three decades in engineering mechanics and as an acknowledgement of his teaching work performed to educate highly qualified engineers.

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