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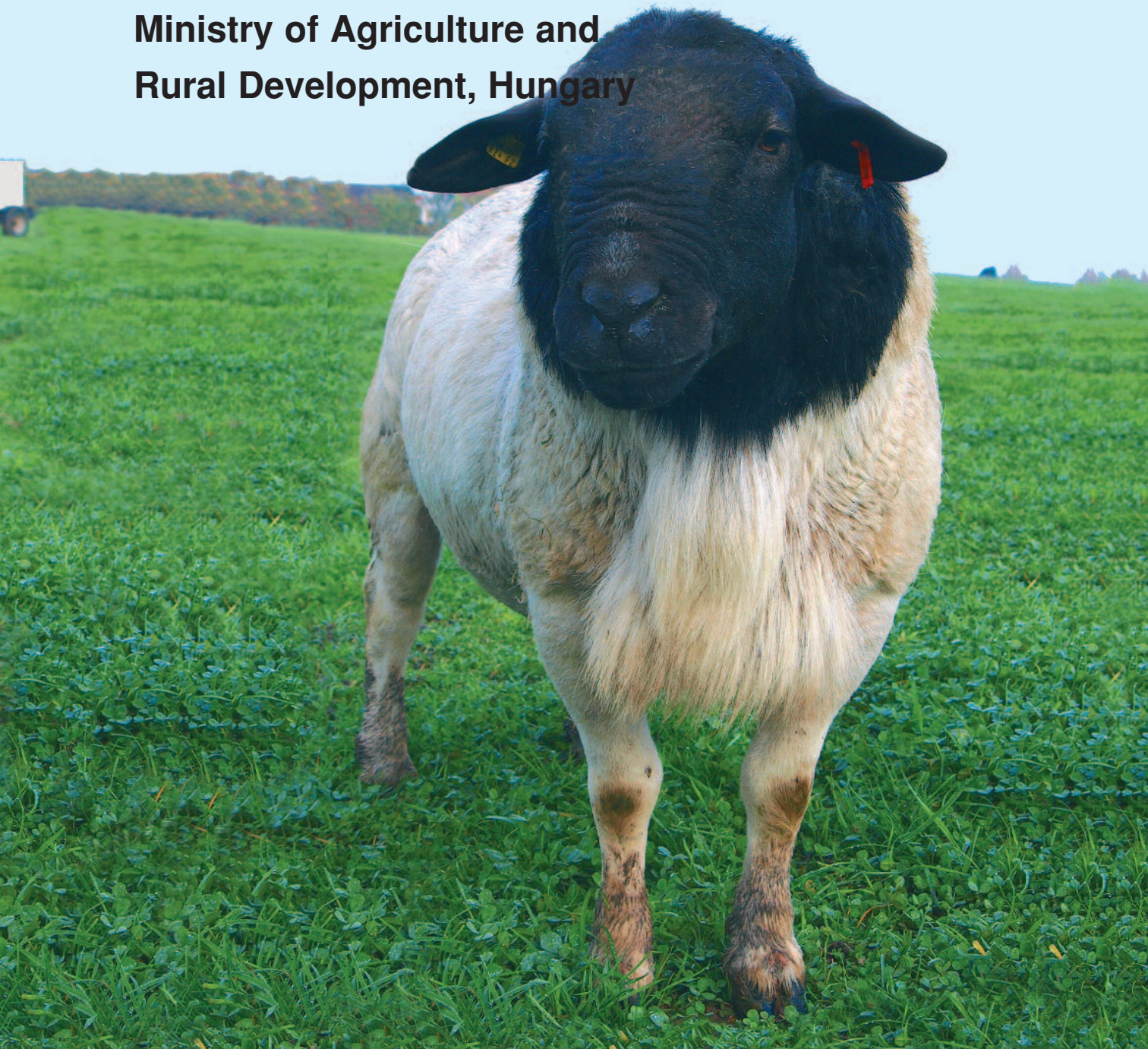

In Memoriam György P. Rédei
(1921–2008)

György P. Rédei, the famous professor of genetics and leading scientist of the University of Missouri passed away at the age of 87 on 10th November, 2008 in Nashville, Tennessee.

Although he often faced difficulties in his life, he succeeded in forming a scientific carreer and was recognized as a significant, internationally known scientist. He graduated as an agricultural engineer in Magyaróvár, Hungary in 1949 and he received a Ph.D. degree in genetics in 1955. He started to work at the Agricultural Research Institute of the Hungarian Academy of Sciences in 1956. Because of the political disturbances in Hungary at that time, he and his wife Magdolna emigrated to the USA and settled in Columbia in 1957.

He became affiliated with the University of Missouri that year. During the period of 1957 to 1991 he was active at the University of Missouri first as an assistant lecturer, then as an assistant professor and as a professor, respectively. He remained at the University of Missouri until his retirement in 1991 and continued working as a professor emeritus.

All the time of his scientific activity in Missouri, he was engaged in researching and elaborating methods to research the genetics and biology of *Arabidopsis*. He was the only person in the USA to work with this plant for 20 years. Today, *Arabidopsis* is the model organism for research in plant biology. As of 2008, about 16,000 laboratories worldwide are pursuing researches with *Arabidopsis* by using his methods.

He was a visiting professor at the Max-Planck-Institute in Cologne, Germany, and he taught for years at the Eötvös Loránd University of Basic Sciences in Budapest, Hungary. While working in Europe, he contributed to the development of certain research and teaching programmes in a significant way. The Hungarian Academy of Sciences offered him a membership in 1990.

He published approximately 250 papers, notes, book chapters and books. His publications appeared in prestigious journals such as: Genetics, Science, Nature, Proceedings of the National Academy of Sciences USA, Cell EMBO Journal, Genes and Development, Molecular and General Genetics, Annual Review of Genetics and others. Considering the above-mentioned list, we may be proud that our periodical also published one of his articles in 1982.

He was plant biologist, professor and author of Hungarian origin, and remained a patriot during his whole life. He was enthusiastic about enhancing the Hungarian education and agricultural research.

In his home and laboratory in Curtis Hall, he welcomed a great number of senior and junior research workers (me as well, as a junior one) from Hungary. Each of them enjoyed his kind hospitality, support and friendship.

George Rédei was an outstanding scientist, a really good teacher, and a warm-hearted MAN.

Peace to his memory, God rest his soul in peace.

On part of the Editorial Board of Cereal Research Communications (**János Pauk**, Editor-in-Chief, **Júlia Mesterházy Scholz** and **Elizabeth Buza** Technical Editors)

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Dorper ram
(Photo by István Egerszegi)

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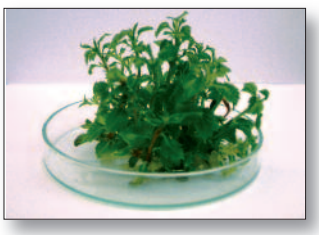

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András Kovács, András Jávor, János Oláh, Gergely Gyimóthy, Nóra Vass, Borbála Stefanovicz, Sándor Harangi[1], István Egerszegi, Sándor Kukovics[2]

Woolless Sheep

Details from sheep history

The earliest findings of domesticated sheep found in the territory of North-Iraq are c.12000 years-old (BRENTJES 1975). As all of the wild sheep fur (*Picture 1*), the first domesticated ones surely had a similar coat. Woolly mutant sheep were probably already being bred 8000 years ago (BRENTJES 1975). As the wool became important for people living in colder climates, the territory of the original woolless domestic sheep became restricted to the tropical areas of Africa and South-Asia. The first sheep taken to the New World by CHRISTOPHER COLUMBUS from the Canary Islands were woolless (DELGADO et al. 1998), and later slave traders carried more similar sheep from the mainland of Africa to Central- and South-America (MASON 1980).

Picture 1: *Argali sheep (George Yu. Maksudov, Russia)*

About 10% of the domestic sheep population of the world is hairy, but their number is growing and in the last decades they started to spread also in North-America, Australia, New Zealand and Europe. The tropical hair sheep are aseasonal breeders with continuous sexual activity and lambing throughout the year, their meat is delicious and their skin is of unique quality (MASON 1980).

Picture 2: *Cameroon ram in Debrecen (István Egerszegi)*

The shedding wool breeds originated from spontaneous or planned hair- x woolsheep crossings. They are larger, have better conformation, easier to handle than the original African hair sheep (*Pictures 2 and 3*) and there are also good disease resistant genotypes among them (ANTON et al. 2007). The hairiness/woolliness are characters of intermedier inheritance determined by the proportion and length of the cover- and underhairs. Transitional types and

[1]The University of Debrecen, Centre of Agricultural Sciences and Engineering
[2]Research Institute for Animal Breeding and Nutrition, Herceghalom

individual differences occur, most of the Barbados Blackbelly (BBB) sheep have an ideal winter coat (*Picture 4*), while on the back of a part of the South- African Dorper sheep wool remains also in summer (*Picture 5).*

The Hungarian sheep industry and the value of wool

According to the teaching of the famous Hungarian professor ARTÚR HORN "the unnecessary things are harmful in animal breeding". Sheep bred in Hungary produce unprofitable wool. Omitting the physiological lasts connected to the growing and wearing the wool, improvement of meat and milk production and the reproductive performance may be expected. Nowadays, some 85–90% of our lambs are exported (mainly to the EU, and predominantly to Italy), but as the consequence of low fertility and seasonality of the production the market possibilities could not be met, and body conformation of lambs also needs some improvements.

At present, about 85% of the Hungarian sheep stock belongs to the seasonal breeder Merino group (*Picture 6*). Wool was its main product for centuries, but the demand has been persistently low for decades and even the biggest exporter Australian warehouses have reached their capacity. Almost all of the raw wool produced in Hungary is exported (about three thousand tonnes) – as there is no wool processing factory left after the economical changes at the beginning of 1990, however, significant quantity of processed wool is imported.

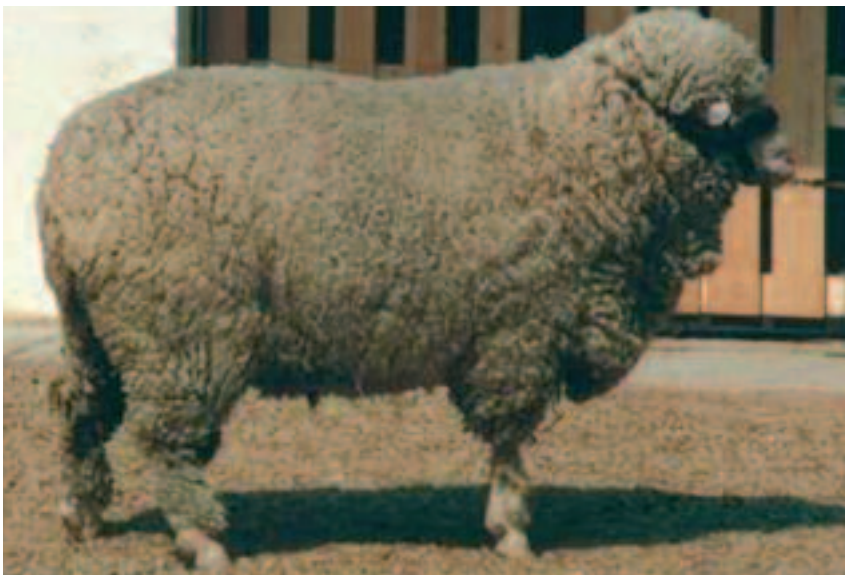
Today, more than 95% of the earnings of the Hungarian Merinos originate from mutton (predominantly lamb), and perhaps even the manure is worth more than their wool. Shearing the sheep is also a duty regarding animal protection, since the annual quantity of the continually growing wool can reach even 10% of the body weight, hinders the thermoregulation and serves as a hotbed for parasites. About 92% of the dry matter content of the wool is protein, which could be also utilized in the meat or milk. Shearing means significant stress for the animals causing cutting injuries which are frequently infected, reducing milk and meat production, moreover the organic phosphoric acid esters applied for dipping are equally toxic for humans, sheep and the environment (e.g. a year ago 700 breeding geese were lost in Northern-Hungary due to such ingesting such toxic material).

Picture 3: *Somali sheep on the Debrecen Farmer Expo (István Egerszegi)*

The dairy breeds present in Hungary: the local Tsigai, the Israeli Awassi, the French Lacaune and the British Milk-sheep (*Pictures 7–10*) are also seasonal breeders. Hormonal manipulations of limited efficacy are expensive and criticized from the aspects of human consumption and animal welfare, as well as from the bio-eco production point of view and the classification of the products. The lambing and milking of seasonal breeder ewes

Picture 4: *Barbados Blackbelly ewes in Debrecen (István Egerszegi)*

Picture 5: *Dorper and White Dorper sheep (Ina Eriksson/Campbell, Canada)*



Picture 6: *Hungarian Merino (Nándor Hajba)*

Picture 7: *Tsigai sheep (Sándor Kukovics)*

are also seasonal, while the national and export demand for sheep products (cheeses, kefir, yoghurt, lamb, etc.) would be unrestricted in winter, too. Due to seasonality, the milking parlours and milking machines are unutilized for about 4–6 months and the employment of milkers is also not continuous. In this period, the processing plants can produce cheese, kefir and yoghurt from cow milk, but their market is flooded and the prices are lower. Relating to wool, everything mentioned regarding Merino is increasingly valid for the wool of dairy breeds, which cannot even be called a by-product, but rather just waste.

The mutton sheep in Hungary, like the American Suffolk, the Dutch Texel, the German Mutton Merino are also seasonal breeders and the value of their wool is so low, that the shearing and handling cost more than the income from selling it.

Changing of breeding aims

Global warming might result in further decrease of wool demand, simultaneously greatly increasing the physiological last of the animals growing and bearing it. Our climate is getting more and more extreme having detrimental effects on agriculture, including animal health (HARNOS 2007). In the case of sheep kept extensively on meadows (it is cheap and important for environment protection), only hair and shedding wool (woolly in winter, hairy in summer) sheep are able to adapt to the rhapsodic changes of cold and warm effects.

As a result of genotype/environment interaction, breeds hairy in the tropics all year round, on intermediate climate grow less undercoat in mild and more in severe winters. In the case of shedding wool sheep, in winter the length of the undercoat is

longer than that of the cover hair. The woolly x hairy cross breds show significant positive heterosis effects, like the outstanding lamb viability.

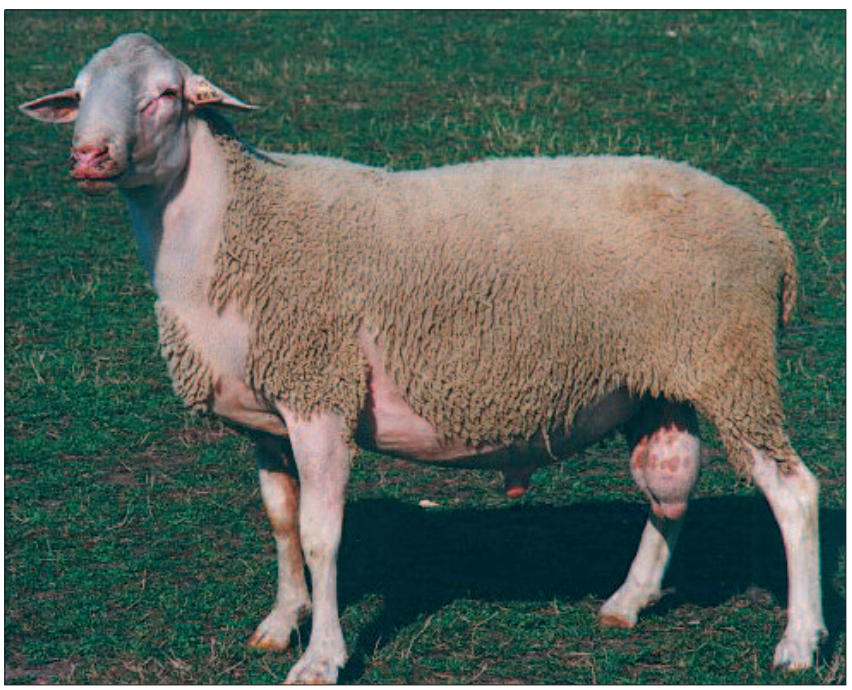
Dewoolling programmes have started world-wide over the last decades by crossing and repeated back crossing the traditional breeds with hairy or shedding wool type rams. Besides the shedding wool Dorper and Wiltshire Horn breeds, there are already also 250 000 heads of Damara hairsheep in Australia. The "Nolana Program" is continued in Germany by Wiltshire Horn, Dorper and Barbados Blackbelly (BBB) rams. The number of such cross breeds is also growing in the United States of America, where two new shedding wool breeds, the Katahdin and the Royal White, were registered in the last decades (KOVÁCS et al. 2006, 2008).

Trying to find our way in creating a new sheep breed of shedding wool or hairy kind, British Milksheep ewes of high fertility have been crossed with European Mouflon (KOVÁCS et al. 2005), but because of the wild and hardly handled behaviour of the progenies this experiments had to be ended. In the second stage of the programme Somali, BBB and Dorper breeding stock were brought to Hungary. The importation of frozen embryos and semen are on the way now, and their efficiency will be increased by the application of modern methods of genetics (DNA-investigations, ANTON et al. 2007, ÁRNYASI et al. 2007) and biotechnics (semen collection by different methods, KOVÁCS et al. 2005, 2007), artificial insemination and embryo transfer.

The objective of the programme is complex: crossing the traditional breeds with hair and shedding wool rams resulting in the reduction of the wools quantity, its becoming shedding, later disappearing, as well as the introduction of aseasonality, twinning, tail shortening and polledness simultaneously. These factors will help to serve our market with continuous lamb output, and increase the profitability of the production. The tail shortening has a significant importance from an animal welfare point of view. Docking is already forbidden in Hungary in the case of dog puppies, but it is an every day practice with sheep concentrating on better body conformation and fertility, as well as easier milking (the long woolly tail is disturbing at milking).

Picture 8: *Awassi ewes (Sándor Kukovics)*

The population of the Somali *(Picture 3),* Somali x BBB *(Pictures 11 and 12),* BBB *(Picture 4) and* BBB x Dorper hair sheep, as well as the Dorper and White Dorper (*Picture 5)*



Picture 9: *Lacaune ram (Nándor Hajba)*

Picture 10: *British Milksheep (András Molnár)*

Picture 11: *"Goldie", our 1st Somali x BBB lamb in Debrecen (János Oláh)*

shedding wool sheep, already present at the Experimental Farm of the University of Debrecen, will be augmented by breeding and further imports. More live Dorper breeding animals will be introduced from Switzerland, frozen Dorper and White Dorper semen and embryos from Canada.

In possession of the above mentioned stocks, a well proportioned, perfect shedder sheep of ideal winter- and summer-coat corresponding to our climate will be developed based on our BBB x Dorper hybrids. The good legs and pigmentation, as well as the resistance to internal parasites of the BBB corresponds to the extensive keeping, the larger size, better body conformation and the introduction of the scrapie-resistant genotypes will be ensured by the Dorper.

Dewoolling programmes will start by the repeated crossing of Hungarian Merino, British Milksheep, Lacaune and Tsigai sheep with Somali, BBB and Dorper rams resulting in longer breeding seasons, good milking ability, higher prolificness, tail-shortening (intermedier inheritance) and polledness (dominant inheritance); the final goal is easy care sheep with no docking and no shearing.

The following up-to-date genetical and biotechnical methods are/will be applied for the improvement and growing of our stocks existing and to be acquired, as well as in the crossing experiments:

- Molecular genetic investigations for the identification and tracing of disease resistant genotypes and other important genes (disposition to twinning and aseasonal reproduction).
- Biochemical investigations concerning aseasonality (melatonin receptors, hormones).
- Semen collection and artificial insemination, semen cryopreservation and laparascopic insemination with self-made and imported frozen-thawed semen.
- Oestrus synchronization, superovulation and embryo transfer. Embryo cryopreservation and transfer of self-made and imported embryos into Merino recipients.
- Ultrasound investigations for early pregnancy testing and body composition measurements.

Summary of the advantages of hair- and shedding wool sheep:

- No shearing and dipping. No growing and wearing the wool, no stress connected to shearing, no cutting injuries and their infection, no work and costs with the profitless wool, and no toxic chemicals applied for dipping.
- Due to their winter/summer coat similar to wild sheep, they can be kept afield or without

Picture 12: *Somali x BBB ewes in Debrecen (István Egerszegi)*

heating all year, except the lambing timed to winter.

- Having aseasonal oestrus ewes can lamb three times within two years, or to the special lamb markets. By transduction of the aseasonality into dairy breeds, they could be milked in different seasons of the year, including winter, providing the continual operation of the milk industry and the continual supply of the market.
- Several breeds (Dorper, BBB) have a high twinning rate.
- Their tail is short and hairy, docking is unnecessary.
- The ectoparasites are less tend to settle down on hair sheep, and several breeds (e.g. Cameroon and BBB) show increased resistance against gastrointestinal helminths.
- The judgement of constitution can be performed realistically.
- The milking is easier and more hygienic.
- The veterinary examinations, like palpation, auscultation and blood taking can be performed easier and more solidly.
- They need less place at transport.
- The slaughtering is easier. Their dressing percentage is better, since their skin and bones are thin and have no wool. Their meat is appropriate for the production of special products, like mutton ham and sausage. These products can be sold also on Islamic and Jewish markets, moreover in case of sufficient demand and appropriate organizing they might even be declared kosher.
- Their leather is of unique quality: thinner than that of the woolly sheep, but thicker than the goat skin, impermeable and the most abrasion resistant among all domestic species, therefore it is the most suitable for the production of special gloves and protective clothing (e.g. for military use and motorcycle racing).
- Their crossing with woolsheep results in significant positive heterosis effects in the offspring, like the outstanding lamb viability.
- Hairsheep are able to adapt to the climate change, which has already been started and is intensifying – they hold on well also under semi-desert conditions in Africa and Australia. These sheep tolerate well the cold and warm, rain, aridity and their sudden changes. In case of floods they can even swim.

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Breeding and improving sheep corresponding to the market demands and climate conditions 2008–2010

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NKTH
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Katalin Magyar-Tábori, Judit Dobránszki, Ildikó Hudák[1]

Factors affecting the rooting ability of in vitro apple shoots

Micropropagation can be used for rapid production of pathogen-free propagation material of apple in a large quantity as well as for multiplication of transgenic apple lines. Micropropagation procedure of apple involves the culture of explants and multiplication of shoots by adventitious or axillary shoot proliferation and then induction of these shoots to form adventitious roots. The last step and subsequently the successful acclimatisation of the rooted shoots are very important in micropropagation. Although successful rooting and large-scale survival could be achieved for several rootstocks and scions, the majority of apple cultivars especially the scions are reluctant to induce root both *in vitro* and *in vivo*. Many factors can influence the rooting ability of *in vitro* apple shoots including genotype, physiological age of the shoots and the composition of root induction media, especially auxins and sucrose. Rooting procedure of apple shoots involves a root-induction phase followed by a root-elongation phase. Dark ambience during induction phase can also play an important role in rooting capacity of microcuttings. An increased number of sub-cultures can improve the rooting ability of the recalcitrant genotypes. Presence of ammonium-nitrate in the root induction media can inhibit rooting, while activated charcoal added to the root elongation media can be favourable. Environmental conditions (photoperiod and light intensity) during the last proliferation phase can also affect the rooting ability of shoots. Post-effect of growth regulators (especially cytokinins) in the last proliferation media on rooting capacity can also be detected. Since different cultivars do not respond in the same way to the *in vitro* conditions these factors should be optimized for the given genotypes.

In our experiments several factors and their interactions were studied on rooting capacity of apple shoots in order to develop the most efficient micropropagation methods for different genotypes.

Effect of auxin levels

For rooting experiments *in vitro* shoots were collected from the best proliferation media (based on Murashige-Skoog, 1962), since different hormone combinations were tested for genotypes in an earlier work (Dobránszki *et al.*, 2000). Four-week-old shoots were placed vertically on root induction media. Indole-3-butyric acid (IBA) was used as auxin and three IBA levels were tested: 1.0; 2.0 and 3.0 mg l^{-1}. Cultures were incubated at 26 °C in total darkness for a week

[1]Research Centre of University of Debrecen CASE, H-4400, Nyíregyháza, Hungary

before transferring to hormone-free root elongation medium *(Figure 1)*. Environmental conditions were the same as for proliferation. Rooting characteristics were observed after two weeks and rooted shoots were planted in Jiffy-7 pellets *(Figure 2)*. Acclimatisation was carried out according to Bolar *et al.* (1998).

Responses of microcuttings were genotype dependent *(Table 1)*. The rootstock 'JTE-H' showed very high rooting capacity, while very low rooting rate could be obtained in 'MM 106' and 'Jonagold'. The concentration of IBA significantly affected the rate of rooting. The lowest level of IBA was favourable for 'McIntosh' and 'Red Fuji', while the cultivar 'Prima' showed the best results at the highest level of IBA. In the remainders the best results were achieved by applying IBA at 2.0 mgl^{-1} level. The number of roots was mainly affected by genotype, but it was also significantly increased by high level of IBA for 'Galaxy', 'Jonagold' and 'Prima'. In general, the length of roots was not affected by the concentration of IBA, since higher than 1.0 mgl^{-1} IBA level only decreased the length of roots for 'JTE-H'. Large differences could be detected between genotypes: the longest roots were obtained for 'Jonagold', while 'MM 106' formed the shortest roots. During acclimatisation the rooted microcuttings showed survival in a very high rate (80–100%) and no post-effect of IBA level could be detected *(Figure 3)*.

Figure 1. *Root system in the root elongation media*

Effect of activated charcoal (AC)

Studies were conducted with three rootstocks ('JTE-H', 'MM 106' and

Figure 2. *Rooted shoot in Jiffy-7 pellet*

Figure 3. *Potted plant after acclimatisation*

Table 1. *Effect of IBA levels on rooting characteristics of in vitro apple shoots*

Cultivar	IBA concentration mg l^{-1}								
	1.0	2.0	3.0	1.0	2.0	3.0	1.0	2.0	3.0
	Rooting rate (%)			Root number per shoot			Length of roots (mm)		
Galaxy	96.9	97.1	88.6	5.2 a	6.1 ab	7.5 b	22 a	18 a	2 a
Jonagold	28.6	48.6	42.9	1.4 a	1.5 a	2.5 b	35 a	28 a	15 a
Red F.	82.9	65.7	51.1	2.5 a	3.5 a	2.5 a	11 a	9 a	11 a
McIntosh	100.0	97.1	88.6	9.7 a	9.6 a	9.0 a	15 a	16 a	16 a
Prima	77.1	91.4	94.3	3.4 a	7.7 b	9.0 b	17 a	18 a	15 a
Royal G.	85.7	94.3	85.7	5.3 a	8.0 a	6.8 a	15 a	15 a	12 a
JTE-H	100.0	100.0	100.0	11.5 a	12.3 a	9.6 a	15 a	11 b	12 b
MM 106	40.0	45.7	37.1	5.1 a	4.4 a	4.9 a	9 a	6 a	7 a

The same letters in rows indicate statistically homogenous groups (Tukey-groups).

'M 26') and two scions ('McIntosh' and 'Red Fuji') to test the effect of the AC in the root elongation media. Root induction was also made on three IBA levels and then the shoots were cultured on elongation media with or without AC.

Responses of the cultivars to IBA levels were the same as described above, but the most significant effect of treatments could be observed in 'M 26', which had not been tested before. Its rooting ability varied from 40 to 94.3% between treatments combination, the lowest IBA level was favourable for root induction *(Table 2)*. Even though we expected that AC will improve the rooting ability of *in vitro* apple shoots, we found, that presence of AC in hormone-free root elongation media can decrease the rooting rate. When root induction media contained 1.0 or 2.0 mg l^{-1} IBA, the rooting percentage of 'JTE-H' was slightly decreased by

Table 2. *Effect of activated charcoal on rooting characteristics of in vitro apple shoots*

Cultivars	Media with activated charcoal			Media without activated charcoal		
	IBA concentration mg l^{-1}					
	1.0	2.0	3.0	1.0	2.0	3.0
	Rooting percentage (%)					
JTE-H	96.7	91.4	100.0	100.0	100.0	100.0
M 26	65.7	57.1	40.0	94.3	74.3	62.9
MM106	40.0	33.0	46.0	40.0	46.0	37.0
McIntosh	97.0	97.0	94.0	100.0	97.0	89.0
Red Fuji	60.0	44.0	45.0	82.9	65.7	51.4
	Number of roots					
JTE-H	6.1 a	8.3 ab	8.8 ab	11.5 bc	12.3 c	9.6 bc
M 26	2.0 a	4.9 b	5.8 b	4.5 b	6.0 b	4.8 b
MM106	4.7 a	5.1 a	4.4 a	5.1 a	4.4 a	4.4 a
McIntosh	9.2 a	8.7 a	8.4 a	9.7 a	9.6 a	8.9 a
Red Fuji	2.5 a	2.2 a	2.0 a	2.5 a	3.5 a	2.5 a
	Length of roots (mm)					
JTE-H	28 cd	30 d	21 c	15 b	11 a	12 a
M 26	17 b	13 b	11 ab	7 a	8 ab	7 a
MM106	7 a	7 a	6 a	9 a	7 a	6 a
McIntosh	28 c	19 ab	21 b	15 a	16 ab	16 ab
Red Fuji	13 ab	12 ab	17 b	11 ab	9 a	11 ab

The same letters in rows indicate statistically homogenous groups (Tukey-groups).

AC. The strong negative effect of AC could be observed in the case of 'M 26' and 'Red Fuji' after each IBA level. Aromatic compounds such as auxins could have great adsorption affinity for AC. In our preliminary experiments we found that the favourable effect of AC was mainly due to the adsorption of naphthalane acetic acid (NAA). Consequently, AC was unfavourable in a hormone free media, but the cause of its negative effects has not been clear yet.

The number of roots increased with an increase in IBA only in the presence of activated charcoal in root stocks 'JTE-H' and 'M 26'. The AC decreased significantly the number of roots for these root stocks, especially when lower IBA levels were applied. Activated charcoal increased significantly the length of roots in the case of 'JTE-H' and 'M 26'. Neither the IBA nor the activated charcoal had any influence on the number and the length of roots, which is true for both scions and for 'MM 106'. Although in this study we could not find any favourable effect of activated charcoal on rooting characteristics, the plants originated from media with activated charcoal grew more vigorously during rooting and acclimatisation. Every rooted plantlet survived in pots independent of the rooting treatments.

Table 3. *Effect of the cytokinin content of the last proliferation media on rooting of in vitro apple shots*

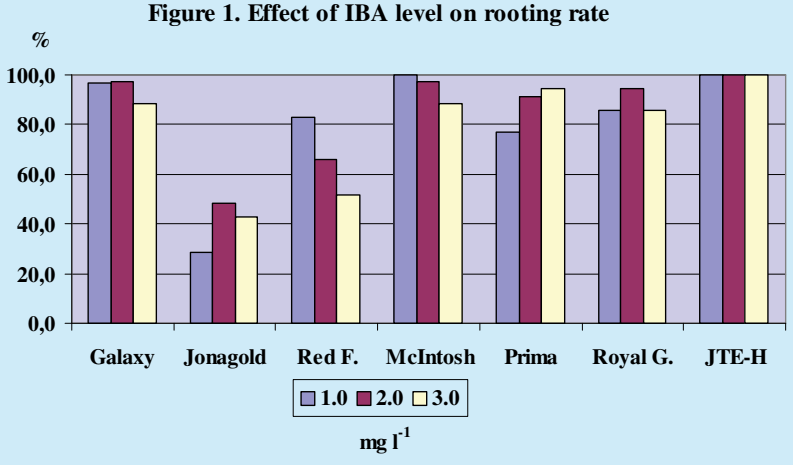
Cultivars	Cytokinin content of media 1.0 mg l^{-1}			
	BA	BAR	TOP	BA+KIN 1.5
	Rooting rate (%)			
Royal Gala	69.0	80.0	100.0	97.0
Red Fuji	63.0	77.0	95.0	95.0
	Number of roots			
Royal Gala	7.5 a	6.0 a	5.8 a	7.1 a
Red Fuji	2.3 ab	3.5 b	2.0 a	1.7 a
	Length of roots (mm)			
Royal Gala	20 a	23 a	20 a	23 a
Red Fuji	16 b	18 b	8 a	8 a

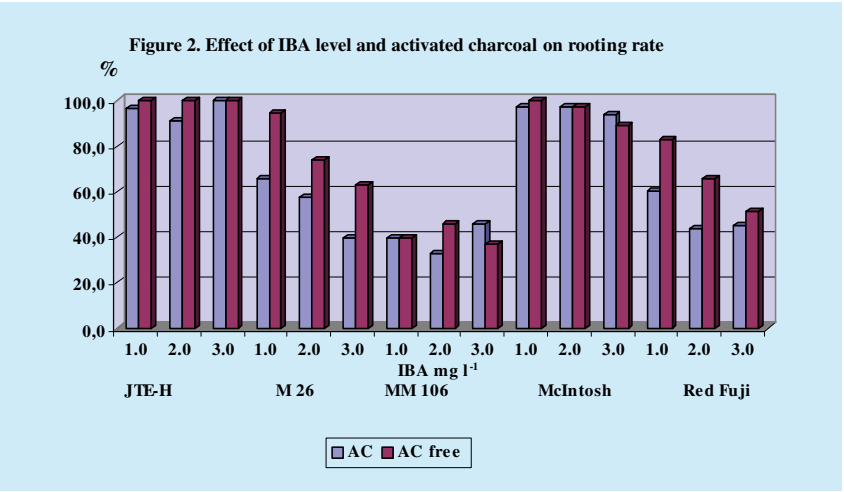
The same letters in rows indicate statistically homogenous groups (Tukey-groups).

Post-effect of cytokinins

Microcuttings of 'Royal Gala' and 'Red Fuji' were collected from proliferation media with different cytokinin contents: 1.0 mgl^{-1} benzyladenin (BA), or 1.0 mgl^{-1} benzyladenin-ribosid (BAR) , or 1.0 mgl^{-1} meta-topolin (TOP), or 1.0 mgl^{-1} BA combined with 1.5 mgl^{-1} kinetin (KIN). The type of cytokinin in the proliferation media influenced the rooting ability of *in vitro* shoots in both cultivars *(Table 3)*. Microcuttings of 'Royal Gala' and 'Red Fuji' showed the lowest rooting percentage when shoots were grown on proliferation media containing BA. When TOP was applied, a very high rooting rate could be obtained for both scions. Addition of KIN beside BA into medium can result shoots with large leaves, which are suitable for rooting. Accordingly, microcuttings of both scions showed high rooting ability when proliferation media contained BA+KIN. Although BA is the most common cytokinin in apple micropropagation there are some scions including 'Royal Gala', which showed very high multiplication rate on media containing BAR. Beside the high multiplication rate, this cytokinin resulted in the longest shoots for 'Royal Gala' (Magyar-Tábori *et al.*, 2000) thus BAR could be very effective for multiplication of this scion, especially if it does not show any harmful carry-over effect on rooting. *In vitro* shoots of 'Royal Gala' and 'Red Fuji' grown on proliferation media containing BAR reached higher rooting percentage than shoots from media with BA, although results were lower than for shoots from media with TOP and BA+KIN. No carry-over effect of cytokinins on root number for

Figure 1. Effect of IBA level on rooting rate

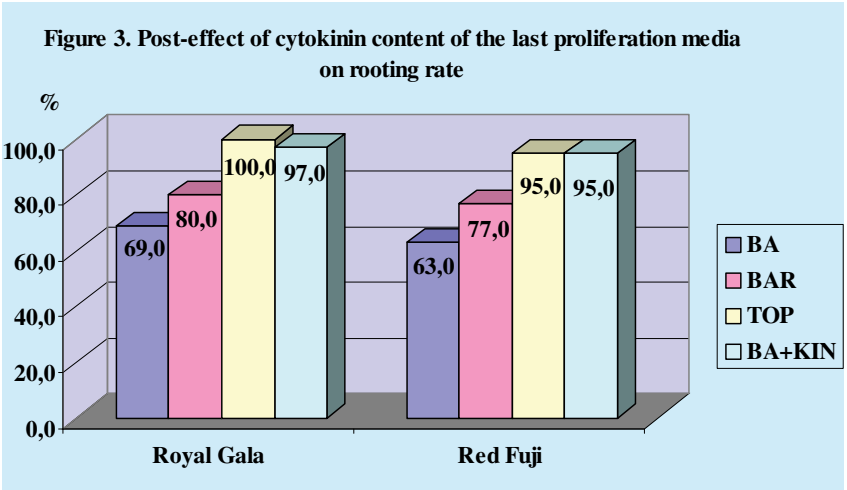




'Royal Gala' could be detected, while shoots of 'Red Fuji' grown on media containing BAR formed significantly more roots than shoots from media with TOP or BA+KIN. Although both scions seemed to form the longest roots after proliferation media with BAR, the length of roots was not affected by the cytokinin content of proliferation media in 'Royal Gala'. In 'Red Fuji' the length of roots was significantly shorter when shoots were grown on media with TOP or BA+KIN compared to microcuttings from media with BA and BAR. Our results suggest that the cytokinin content of the last proliferation media can play an important role in the rooting ability of *in vitro* apple shoots. In our micropropagation experiments BAR was proved to be more effective during shoot proliferation of 'Royal Gala' than BA and shoots showed an increased rooting ability after proliferation on medium with BAR. A favourable post-effect of TOP was also detected on the rooting process.

Other factors

Raising the temperature from 22 to 26 °C during the dark period increased the rooting rate in 'Royal Gala', other characters were not affected. Use of liquid media for root induction also improved the rooting capacity when subsequently the root elongation media contained no AC and the root number was significantly higher than on shoots induced on solid media. The rooting percentage could be raised from 46 to 67% in the case of the recalcitrant rootstock 'MM 106' on elongation media without ammonium nitrate, while its lack in the root induction media did not affect the rooting capacity of shoots. The number of roots was not influenced by ammonium nitrate content of media, while the longest roots developed when it did not exist in either root induction or elongation media. When microcuttings of 'Húsvéti rozmaring' were tested after pretreatments, in which shoots were vertically or horizontally placed on media with different cytokinin content, the rooting percentage was affected only by the position of shoots: a vertical position of the shoots prior to root induction treatment inhibited the rooting considerably. These shoots formed calli on the base of shoots without any roots or with weak root development.



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Árpád Hegyi, Katalin Kinga Lefler, Erika Mészáros, Kata Dankó, Zsolt Csenki, Béla Urbányi[1]

Examination of stress appearing in the process of propagation on four economically important fish species

Propagation of fish is a most important and most critical process of fish industry (Hegyi et al. 2006). Propagation happens in many farms of Hungary and they are able to satisfy the needs of both Hungarian and foreign farms. However carefully and professionally certain work stages of fish propagation in hatcheries are done still the potential parent individuals are hit by stress (Hegyi and Váradi 2002).

In the process of artificial propagation fish often find themselves in an environment different from the accustomed one. However short the distance is between a pond and a hatchery fish must be transported in water. After catching and selection transportation can one be of two kinds: manual and automatic. In the hatchery for the purpose of easier handling fish must be anesthetized. In most cases we use clove oil as a narcotic. After being anesthetized fish must be measured. When weight data are known the amount of hormone/hypophysis can be calculated for female fish. On the basis of our recent knowledge 3.5–4.5 mg dry hypophysis/kg of body weight is required for egg maturation about 10 % of which is introduced as a starter amount. After 12 hours before the ingestion of the main hormone dose an important task has to be finished: the stitching of the genital opening. It has to be done since during the ovulation process eggs become fluid and carp could loose a great amount of them. On the other hand in case of welsh the mouth has to be stitched so that they will not be able to harm each other and thus endanger successful ovulation. These technical solutions applied in farming

Grass carp (Ctenopharyngodon idella) photo by Zsolt Gózon

Carp (Cyprinus carpio) photo by Zsolt Gózon

[1]Szent István University Department of Fish Culture, Gödöllő, H-2103 Páter K. u. 1. (Hegyi.Arpad@mkk.szie.hu)

Silver carp (Hypophthalmichthys molitrix) photo by Zsolt Gózon

Welsh (Silurus glanis) photo by Zsolt Gózon

Picture 1. *Selecting fish (photo by Zsolt Gózon)*

influence individuals as special stressors. As an effect of hormonal induction some physiological processes are started and after some hours they result in ovulation so eggs can be stripped. For stripping the once again anesthetized fish are wiped dry. Next sutures are opened and with a light pressure on the abdominal wall eggs are stripped out from the ovary to a plastic bowl (Horváth and Urbányi 2000).

In our experiments done in the hatchery of Aranykárász Partnership in Ördöngös the level of stress was examined at the propagation part of the production system through the glucose concentration of blood plasma in the following species: carp (*Cyprinus carpio* L. 1758), grass carp (*Ctenopharyngodon idella* Valenciennes, 1844), silver carp (*Hypophthalmichtys molitrix* Valenciennes, 1844) and welsh (*Silurus glanis* L. 1758).

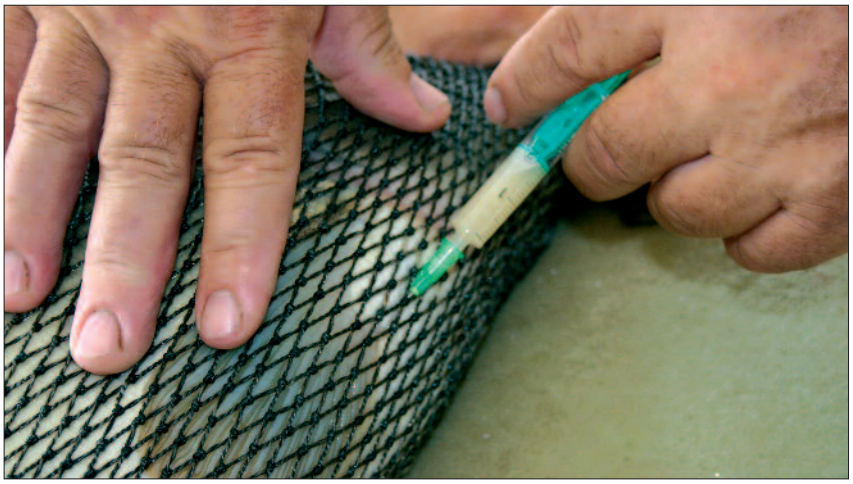
From examined individuals blood samples were taken at different times. Fish were selected (*Picture 1.*) during fishing (1st blood sampling) and then parent fish were transported to the hatchery. They were marked with a colour thread on their dorsal fin so this way blood could always be taken from the same fish. In each species blood was taken from 5–5 individuals. After weighting a starter dose of hormone (carp hypophysis) was given to them (2nd blood sampling). 12 hours after the first dosage (*Picture 2.*) selected parent fish got the main dose of hypophysis (3rd blood sampling), too. Another 12 hours later stripping started (*Picture 3., 4.*) and right after stripping the last sampling of blood also happened.

At blood sampling 1000–1500 µl blood was removed. Fish were turned to their sides and the syringe was prod between the ventral fin and the lateral line. Blood was taken from the vena caudalis of fish and the coagulation of samples was prevented by Heparin (1 drop) (Hegyi et al. 2004). For blood sampling sterile, disposable 23 G sized needles were used with 2 ml syringes in all cases. Samples were transported in a freezer bag (+ 4 °C) to the place of inspection.

Determination of the glucose level of blood plasma happened by the help of enzymatic (GOD-POD) colorimetric method (Reanal, Budapest No:. 36116-2-99–80). The main point of this method was that to the reagent (1,0 ml) made up of phosphate buffer (9.5 mmol/l (pH 7.5)), phenol (9.5 mmol/l) and 4-amino-antipirin (0.7 mmol/l) 0.01 ml of blood plasma was pipetted and then this mixture was incubated on 37 °C for 10 minutes. After the incubation results were read from an automatic photometer (UV mini-1240) in mmol/l (on 50 nm of wavelength).

When evaluating these results it was studied how a continuous imposition (certain tasks) affects the level of examined components of blood plasma. Evaluation was done by the help of one-way ANOVA (Tukey's test) at a significance level of P″0.05.

Glucose concentrations measured at the propagation of carp are shown in *Figure 1*. A continuous growth of glucose in the blood plasma of fish could be detected. At the first hormonal treatment no statistical difference (P>0.05) could be observed compared to the glucose concentration measured at selection. Differences were significant (P<0.05) between the data of fishing, the main dose and stripping which were detected by a one-way variance analysis. There was no statistical difference (P>0.05). between the first and the second hormonal induction and the glucose concentration of blood samples taken after stripping.



Picture 2. *Blood sampling (photo by Zsolt Gózon)*

Picture 3. *Stripping (photo by Zsolt Gózon)*

Picture 4. *Stripping (photo by Zsolt Gózon)*

Results of blood samples taken at the propagation of grass carp fish species showed a similar pattern as in case of carp (*Figure 2*.). Glucose concentration permanently increased in the blood plasma of fish though at stripping somewhat lower values were gained than at the time of the second hormonal injection. Statistical analysis of glucose concentrations showed the same result as in case of carp so no differences (P>0.05) could be observed between the glucose concentrations of fishing and the injection of the starter dose or the starter dose, the main dose and the concentration measured after stripping. Statistical difference (P<0.05) could be detected between fishing and the injection of the main dose and stripping.

Results of blood samples gained from silver carp are shown in Figure 3. (*Figure 3*.).

In case of silver carp the average concentration of blood plasma glucose did not show a significant increase (P>0.05) at the second sampling (first hormonal induction). However, after the second hormonal induction and stripping a significant increase in glucose level was observed (P<0.001), the glucose concentration gained at

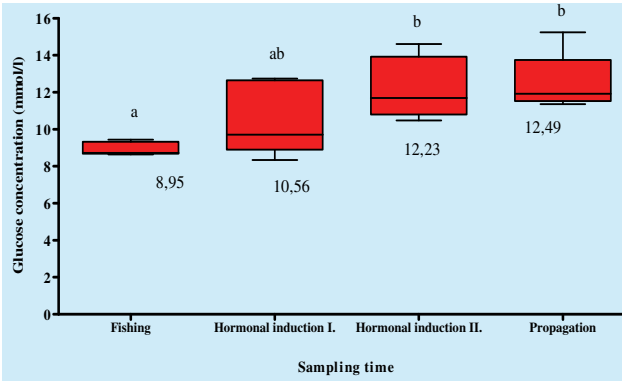


Figure 1. *Blood plasma glucose results of samples taken during the propagation process of carp*

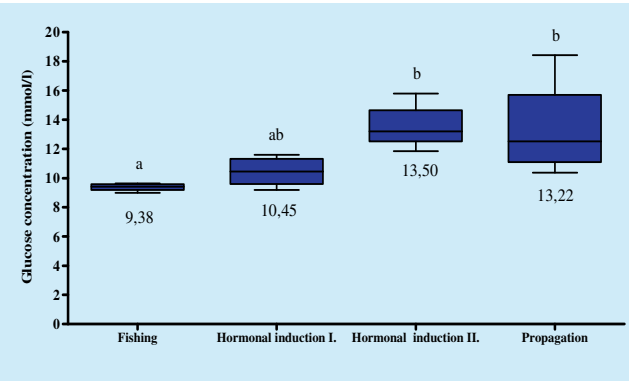


Figure 2. *Blood plasma glucose results of samples taken during the propagation process of grass carp*

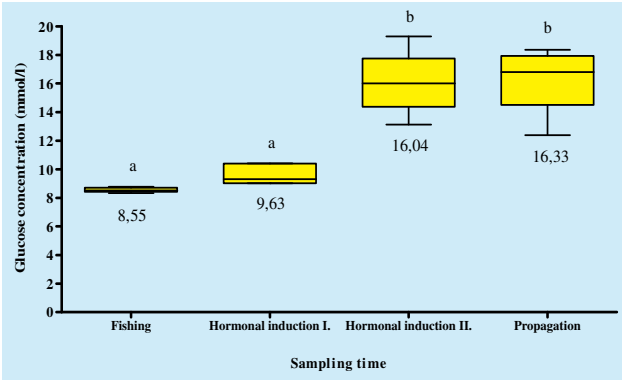


Figure 3. *Blood plasma glucose results of samples taken during the propagation process of silver carp*

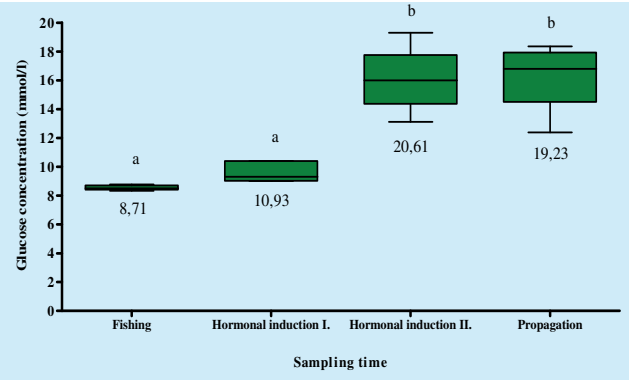


Figure 4. *Blood plasma glucose results of samples taken during the propagation process of welsh*

fishing (8.55 mmol/l) had doubled (16.04 mmol/l, 16.33 mmol/l).

Changes observed at welsh were the same as at silver carp (*Figure 4.*).

Exceedingly high glucose concentration was gained after the injection of the second hormonal dose after the third sampling. Compared to the initial value (8.71 mmol/l) glucose level has nearly tripled after the exhibition of the main dose (20.61 mmol/l) and stripping (19.23 mmol/l) ($P<0.001$).

As a result of these experiments it can be concluded that considering blood plasma glucose concentration in none of the four fish species did a significant change appear from catching and selection till the first hormonal induction ($P>0.05$) though it has to be noted that these tasks only take about half an hour to complete. 12 hours after the first hormonal dose exhibition of the main one happened. Blood plasma glucose concentration of samples gathered at this time did significantly increase in all four species though in a different degree. This ascent was smaller ($P<0.05$) in carp and grass carp and larger ($P<0.001$) in silver carp and welsh. The increased level of blood plasma glucose concentration remained after stripping, too, in all examined species.

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József Popp[1], Andrea Somogyi[2]

Sustainable biofuel production

With the exception of Brazil, the world uses ethanol as fuel exclusively in blends with gasoline – therefore in its anhydrous form. Even the other countries that already have a flex-fuel car fleet, such as the U.S. and Sweden, necessarily use a percentage of gasoline into their ethanol fuel: usually the so called E-85 (85% ethanol and 15% gasoline). In any other blending percentage, ethanol acts as an oxygenating additive, reducing the amount of hydrocarbons, carbon monoxide and nitrogen oxides in vehicular emissions (OECD, 2008).

The economics of first generation biofuels is location specific, as are environmental benefits. With the government's fostering of new industries, positive and negative externalities often occur. Policy makers need to review and assess these unintended consequences with respect to their original intentions. Both the EU and the U.S. have many of the same players supporting and opposing a biofuel boom. Although the EU appears to be further along with regard to raising issues of sustainability – including mitigating the threat to biodiversity; the threat of global warming; and the threat of increasing hunger, especially in less developed countries from bioenergy production displacing food production – all these issues are escalating in importance on both sides of the Atlantic.

The three traditional biofuel options – bioethanol, biodiesel and biogas – differ in the choice of feedstock, in the net energy yield per hectar, and in the investment costs. The net energy yield per ha with biogas can be much higher than with bioethanol production, provided the whole crop is fermented in the biogas plant. However, bioethanol would come closer to the net energy yield of biogas, when in the future the cellulose is fermented to alcohol as well. The investment costs of the conversion technology – based on the output of net energy – are very important. These investment costs are much higher for biogas than for bioethanol. These differences of the biofuel options explain why bioethanol is predominantly produced in countries with an abundance of agricultural area like the USA or Brazil. In these countries the present low net energy yield per ha of bioethanol can be offset by using larger areas. In more densely populated regions like the EU farmland is more expensive. Therefore, here the net energy yield per unit area is more important and so is biogas production as well. In addition, as a consequence of the population density there is much waste from food use and much livestock production, which also means much manure. The more expensive the farmland is and the more waste from food use or manure is available, the more biogas production is the choice. However, subsidies have their effect too.

The development and evolution of trade rules regarding biofuels is becoming a pivotal issue in both the EU and the U.S.. Europe is questioning biofuel production on agricultural lands. In large part, this has much to do with the fact that the U.S. has more land. U.S. farmers have benefited from the high price of commodities and have tended to support biofuels growth. Although Europe does not have the land available for biofuel production that exists in the U.S., it does appear, nevertheless, that substantial farmland could be made available in new member states. Otherwise, biofuels will need to be supplied by countries outside of the EU. Civil society groups in the EU have been more focused on sustainability criteria for biofuels production. This is hardly discussed in the U.S. but is getting more attention in Brazil as well.

The analysis of the ethanol production from corn in the U.S. is completely different from the production of ethanol from sugar cane in Brazil due to the availability of land, energy conversion rates and technologies used. The feasibility of the production of biofuels and of food in Brazil has been discussed frequently. There is a challenge for the Brazilian agribusiness, which is to supply the demand for biofuel without compromising food production, equally for the domestic market and for the international market. Currently Brazil exports a significant part of food production, supplying not only domestic demand, but part of the global demand as well. Besides this, the sugar cane bagasse can be used as forage for cattle feed and as biomass for electricity production.

Subsidies and mandatory blending targets

Reasons for supporting biofuels are attractive: reducing global warming, enhancing energy security and rural development. Fixed

[1]Research Institute for Agricultural Economics, Budapest, Hungary
[2]The Mayors's Office, Department of European Integration, Budapest

subsidies lead to high government costs and inefficiency (Steenblik, 2007). With mandates and targets for biofuel use, combined with government incentives to produce biofuel transport policy will continue to be supply-side and internal-combustion engine oriented, not demand driven. Biofuels are critically dependent on policies in the consuming countries which have proved to be a block to a faster development of markets in the developing countries. If all subsidies and other support for biofuels were removed entirel there would be a reduction inthe capacity of the industry to respond to the challenges of transforming its supply chain and investing in advanced technologies. However, the rate of introduction of biofuels should be slowed until adequate controls are established.

Advanced technologies are immature, currently expensive and require specific incentives to achieve significant market penetration before 2020. However, industry promises future technologies that will yield cheap abundant biofuels from all plant material and plant waste. GM technologies are being promoted to streamline processes and reduce costs. Research is being carried out into GM microbes that could improve breakdown and fermentation processes and methods to streamline cellulose and reduce lignin or even change its nature. Synthetic biology is a new approach that involves using genetic information to build completely new organisms with unknown impacts.

The construction and development of scenarios for biofuels' mandatory blending targets is essential to the production chains of biofuels. A review of increases in and dissemination of mandatory blending targets is necessary to get answers to the following questions. What will decision makers think about biofuels in the near future? What are the decisions on mandatory blending targets that will have to be made? What is the long-term influence of these decisions on the competitiveness of the country? At the same time, this review will be relevant to verify the expected size of the biofuels market in near future. The most important and uncertain key forces to mandatory blending targets have to be listed as well. The main "uncontrollable" factors to be considered in the analysis of the energy sector in the world today are:

a) *Political-legal factors*: the ratification of the Kyoto Protocol in March 1999 was a turn-point for the market of biofuels. In this context, ethanol appears as a renewable energy source which has the potential of complementing or even substituting part of the fossil fuels of the world's energy matrix, in special in the transportation sector.
b) *Economic-natural factors*: evolution of oil price; strong competition among producers of renewable energy; growth in sales of flex fuel and hybrid cars; opening of new markets for ethanol fuel, and competition for biomass; chains of sustainable production (conditions and characteristics of agricultural production, respect to human resources involved, profits and distribution of results).
c) *Socio-cultural factors*: growth in the segment of green consumers; biofuels: affirmation of the image of clean fuel; requirement of corporate social responsibility (charity social projects); growing concern with human health (level of pollution in big cities); search for better quality of life (better public transportation); defense of the national product: the ethanol produced locally; enhancement of the fair trade in purchasing decisions.
d) *Technological factors:* improvement in the efficiency of flex-fuel cars and trucks; patenting of technology for the production of ethanol; technology for burning biomass; major investments in search of cellulose ethanol; diversification of sources and energy production. The amounts of investment in R&D are so expressive that the technical-scientific development in biofuels should still be very significant.

Land for food, feed and biofuels

At present, feedstock for biofuel occupies just 1% of cropland but the rising world population, changing diets and demand for biofuels are estimated to increase demand for cropland by between 17% and 44% by 2020 (IEA, 2007). However, the balance of evidence indicates there will probably be sufficient appropriate land available to meet this demand to 2020, but this needs to be confirmed before the global supply of biofuel increases significantly. Current policies do not ensure that additional production moves exclusively to suitable areas. Attempts to direct agricultural expansion to particular areas face significant implementation and enforcement challenges. Limited land is available globally to grow food and fuel and there are direct and indirect pressures on forests and other lands to be converted. There is a future for a sustainable biofuels industry but feedstock production must avoid agricultural land that would otherwise be used for food production. Advanced technologies have significant potential, but may only produce biofuels with higher GHG savings if feedstock production avoids use of existing agricultural land that leads to indirect land-use change. This can be achieved using feedstock grown on marginal land or that does not use land, such as wastes and residues (although this may compete with other uses of these materials).

When evaluating new production systems, producers are faced with numerous production and marketing uncertainties – in short, there are risks associated with change. Their

ultimate choice of cropping systems will likely be driven by the expected economic returns from various potential markets for agricultural products, bio-fuels, and bio-products; land resource characte-ristics; and related policy incentives (Daberkow, 2008). Cellulosic feedstock production and marketing risks must be weighed against the risks of current production systems and these risks differ between the feedstock sources (i.e., crop residue versus a dedicated energy crop). Weather is the major source of production risks, both during planting and harvesting, for all types of cropping systems, but the lengthy establishment period of perennials may make these crops especially vulnerable. Farmers are concerned that dedicated energy crop markets are not sufficiently developed and remain limited, especially relative to traditional commodity markets. Especially in light of the dramatic decline in oil prices over the last several weeks –the opportunity costs for subsidizing alternative fuels has increased significantly which creates even more uncertainty for this emerging industry. Biofuels can only contribute GHG savings from transport if significant emissions from land-use change are avoided and appropriate production technologies are employed. Governments should amend but not abandon their biofuel policy in recognition of the indirect effects to ensure its biofuels policy delivers net GHG benefits. Mechanisms do not yet exist to accurately measure, or to avoid, the effects of indirect land-use change from biofuels. Current lifecycle analyses of GHG-effects fail to take account of indirect land-use change and avoided land use from co-products (DGs: distillers' grains). Ethanol production has structurally changed the economics of the feedgrain-livestock sector. It is expected that the structural changes taking place in the biofuels and feedgrain-livestock sectors will significantly alter traditional sources of feed grain (mainly corn and wheat) and compel the adoption of distiller's grain (DGs) for feed use. The implications for managers are that they will need to consider strategic adjustments in the marketing of feed grain and how feed grain will be replaced by DGs. Basically, the questions to be answered are:

a) Can the ethanol co-product of DGs alleviate the projected shortages of grain for feed use by the livestock sector?
b) Is it possible to create an international market for DGs (standards, GMO ect.)
b) What will be the global geographic pattern of DGs distribution from surplus regions to deficit regions?

Consequently, the net GHG emissions from current biofuel targets cannot be assessed with certainty, and there is a risk that any biofuel target could lead to a net increase in GHG emissions. GHG-based targets may result in a greater land requirement, and land-use change, than a volume or energy-based target; and second generation biofuels using feedstock grown on existing agricultural land may cause greater net land-use change than first generation biofuels that also produce co-products that avoid land use. We have to take in to consideration that with the market introduction of cellulose ethanol no DGs will be produced and byproducts (for example lignin) can be used for heat generation. However, support of carbon taxes and broad-based oil taxes is currently limited. Large areas of uncertainty remain in the overall impacts and benefits of biofuels. International action is needed to improve data, models and controls to understand and to manage effects.

Conclusion and consequences

Recently, a growing number of countries have been engaged in the production and use of ethanol as fuel for transportation, allowing world's production and exports to double in a short period of time. For the existence of a global market of food and biofuel, it is necessary to develop expertise in the building of agribusiness systems that will be increasingly transnational and must be sustainable. The main factors for the existence of a global ethanol market are: more production, compulsory legislation and standardization and certification of the product.

Strategic alliances have also been widely used at the research and development stage, mainly for seeking new sources for production. Oil companies have played a significant role in the production and marketing of bio-fuels worldwide. They have had different levels of participation in the production section, either through vertical integrations, joint ventures or strategic alliances with successful cases like those of Brazil's Petrobras, Finland's Neste Oil, or Total from France. Large scale biofuel production can be taken up mainly by large feedstock producers as well, with a minimal presence of oil companies. Petrol companies get more and more involved either through vertical integration, joint ventures or strategic alliances in bioethanol production. In the future energy companies will enter more rapidly agriculture leading to structural changes. The restructuring of the energy industry to include agri-business including more vertical integration may be hastened with the advent of mandates. Strategic alliances between agribusiness and energy sector by merger and acquisition of agribusiness will increase reliance on contracting and vertical integration. Market structure has been influenced by policy so strengthening the market is essential because stakeholders focus on their local markets first ("home grown" is attractive) and international investments in biofuels have been so far relatively limited. Oil prices are largely demand driven but global recession has led to significant oil price drops. Invest-

ments in alternative energy sources are risky in the face of future potential price falls without policy measures that insure against major price drops. Potential for trade is given by increased demand, but rules need to be clarified. Policy is a key to promote sustainable fuel ethanol trade. At present uncertain classification, a wide range of government measures (tax incentives, high tariffs, subsidies) and a web of separate technical and environmental standards do not facilitate trade.

It should be possible to establish a genuinely sustainable industry provided that robust, comprehensive and mandatory sustainability standards are developed and implemented (RFA, 2008). The risks of indirect effects can be significantly reduced by ensuring that the production of feedstock for biofuels takes place mainly on idle and marginal land and by encouraging technologies that utilize appropriate wastes and residues. Sustainable production is being increasingly regarded as a prerequisite for market access. A sustainability certification scheme follows the principles of sustainability into its three dimensions: environmental, economic and social. However, aspirations, principles are difficult to be measured and verified. To make them achievable, the scheme must count on an institutional environment to create requirements that can be implemented and thereafter monitored and evaluated by an organizational environment. The main initiatives for certification of biofuels produced so far have come from national governments, private companies, non-governmental organizations and international organizations. Most of them are in early stages of studies and planning, while others may already come into force very soon. Their main differences come about on the principles that they include and on their procedures and organizational processes. Most of them are based on existing systems for the agriculture, forestry or energy sectors.

Only a global approach is effective as market-relevant biomass and bioenergy sources are commodities which are traded internationally. Schemes which simply focus on national or EU-wide implementation will not help solve major issues of sustainability. The certification system must cover all biomass (regardless of the end-use) and all relevant bioenergy. If issues relating to leakage are not addressed, the entire system will forfeit all relevance, as would be the case, for example, of palm oil production, most of which is currently used in the food sector. If the relatively small quantities of palm oil used for biodiesel manufacture are produced in a sustainable manner but the large volumes consumed by the food sectors are still being processed in an unsustainable manner, all the effort expended would be invalid. In this process, the planning is essential to the understanding of the production systems, international environmental monitoring and adjustment of deals to the changes underway. The construction and elaboration of strategic planning and management of productive chains should be the objective of each country. This process should prioritize the areas of coordination and institutional adequation (laws), production and products, communications, distribution and logistics, and human resources. Progress to higher targets for current technologies should be implemented carefully if biofuels are not yet demonstrably sustainable. However, any sustainability criterion related to competition and demanding more than just a reporting obligation could potentially lead to an infringement of WTO rules. A certification system is not the most appropriate tool to avoid indirect adverse effects on land use and other solutions like bilateral agreements, exclusion of certain biomass types.

Ethanol producers are price-takers . Petroleum companies dictate the ethanol price to ethanol producers because there are only a small number of oil refinery companies/blender and many ethanol producers. Most ethanol production is sold under contracts the rest is sold on a cash market. There is little information about how the contracts are written and only a few organizations report cash prices. On the other hand, the CBOT (Chicago Board of Trade) has established a future market for ethanol which may give some transparency to price setting. High oil prices lead to higher biofuel production and delivery costs. If biofuel production significantly increases demand for feedstock, the prices will be driven up. The opportunity cost for farmers for raw materials will be equivalent to the higher-valued market (food or fuel) thus creating the linkage of food and fuel markets.

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Climate change – a challenge for plant scientists and breeders

Agriculture is one of the economic sectors that will be most affected by the unfavourable aspects of climate change. The success of crop production has a fundamental influence on food security, so the elimination or mitigation of losses due to these unfavourable effects is a strategic aim. **For almost two decades basic and applied research has been underway in one of the biggest phytotrons in Europe, at the Agricultural Research Institute of the Hungarian Academy of Sciences (ARI HAS), to determine the likely effects of climate change. In acknowledgement of the value of this work, the institute was the first in Hungary to win a grant within the framework of the EU FP7-REGPOT-2007-1 project, aimed at transforming the institute into a regional training and research centre for the whole of Central Europe.** The purpose of this centre will be to enhance our ability to cope with the consequences of climate change by providing training for agricultural scientists, breeders, innovation experts and farmers from Hungary and abroad (especially from other EU countries).

General aims of the programme:

Based on its international recognition and accumulated know-how, the institute aims to create a regional research centre capable of providing practical assistance to farmers in Central and Eastern Europe in overcoming the unfavourable effects of the expected climate change. By means of strategic partnerships based on existing international cooperation, it is planned to expand the research potential by sending young research staff to gain experience abroad, while inviting colleagues with special methodological knowledge to work in ARI HAS. As the institute is situated in the middle of the Carpathian Basin, it is ideally placed to become a Research, Training and Service Centre, charged primarily with the elimination or mitigation of the losses caused by unfavourable climate change.

The institute was one of the first in the country to establish spin-off companies for the utilisation of the research results. It maintains regular contact with numerous knowledge-centred agricultural concerns, helping to satisfy the constant demands of growers for adaptable varieties and for production technologies better suited to changed environmental conditions.

It is hoped that by **advertising the training sessions and publishing new research results** throughout Europe and by making use of research contacts (including twinning) the research teams at ARI HAS will become better integrated in European research, thus strengthening international cooperation.

Expected results of the programme:

The continuation and expansion of existing bilateral agreements with various research centres and universities in Europe will make a great contribution to the development of ARI HAS into a research and training centre serving the whole of the Central and Eastern European region, while the training courses organised for young scientists from research institutes and universities from throughout this region will make ARI HAS even more open to cooperation in research fields related to the interaction between crops and the environment. The results achieved in all five work programmes will be of decisive importance for the countries in the region. The breeding of basic biological material adapted to the climatic conditions in Central and Eastern Europe can only be carried out in the region itself, necessitating the existence and active participation of well-trained plant specialists. Within the framework of the present project ARI HAS plans to carry out developments that will help experts working in the region to overcome the unfavourable effects of global climate change.

The cooperation agreements already signed with a number of Central and Eastern European countries (Romania, Slovakia, Slovenia, Serbia, Croatia), regular contacts with seed companies and farmers in neighbouring countries, and cooperation with officials from the Ministry of Agriculture and Rural Development will provide a firm basis for facing up to global climate change.

Thanks to these contacts, the varieties bred at ARI HAS have entered cultivation extremely rapidly over the past decade, and the institute has held a leading position in the Hungarian seed market for over ten years. Based on these contacts and due to the popularity of events organised in the institute, ARI HAS is in an ideal position to hold practical sessions (in the field and phytotron) demonstrating the unfavourable effects of climate change and to provide information on how it is possible to adapt to these changes and to reduce predicted losses.

Ottó Veisz, DSc, Programme Coordinator
Agricultural Research Institute of the Hungarian
Academy of Sciences

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