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ACTA AGRONOMICA ÓVÁRIENSIS VOL. 53. NO. 1.

Disease, pest and weed damage to Hungarian and French garlic varieties in North-West Hungary

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SUMMARY

The cultivation of the 5000 year old garlic (*Allium sativum* L.) is concentrated in two regions in Hungary: Makó and its county area, and in the area of Dusnok in Bács-Kiskun county. In Hungary garlic is known as a plant which is grown in fields; greenhouse cultivation is not common.

Although the plant could be easily cultivated in the whole of the country, in order to produce the correct quantity and quality, it is important to observe the best practices for the plant's propagation.

4 winter varieties (*Makói őszi*, *Sprint*, *Thermidrome*, *Arno*) were involved in this study together with a vernal variety (*GK Lelexír*). The protocol used different methods to identify the occuring pathogens and pests of these garlic varieties, and to determine their damaging effects.

In each of the garlic plots which were examined, a weed survey was undertaken using the Balázs-Újvárosi method together with the help of GPS.

Keywords: *Allium sativum* L., diseases, pests, weeds, evaluation of varieties.

INTRODUCTION

Cultivation of the nearly 5000 year old garlic (*Allium sativum* L.) in Hungary is concentrated in two main areas: the countryside around Makó and Dusnok. In Hungary it is known as a field crop; its' cultivation under glass is not common. Although this plant could be easily grown in the whole country, it is important to follow the rules of plant propagation to ensure good quantity and quality of the crop. The correct choice of field is necessary.

In Hungary there are winter and spring garlic varieties. The spring varieties are planted between the end of February and the beginning of March. These need dense meadow soil since the bulbs will not develop in sandy soil. The winter varieties are planted at the end of September and at the beginning of October. These prefer chernozem fluvic soil (*Budai et al.* 1999).

It is very important to make a 3–4 year crop-rotation. It is necessary to avoid planting in the same plot that has previously been used for root vegetables, because bulb infection and stem nematode can also damage garlic. Also other Allium species should not be planted in the same plot that has previously been used for garlic because of the risk from the same pests and diseases (*Szalay* 1987).

Stem and bulb nematode (*Ditylenchus dipsaci* Kühn) can damage almost 450 host plants: lucerne, bean, peas, various leguminous plants, potato, strawberry, carrot, tobacco etc, and for that reason the planting of garlic after these plants should also be avoided (*Sturhan* 1969, *Eriksson* 1974, *D'Errico* 2007).

During the garlic growing season, the largest amount of damage is caused by stem and bulb nematode, onion carpenter worm (*Dyspessa ululа*), onion thrips (*Thrips tabaci* Lindeman), fusarium (*Fusarium oxysporum, Fusarium cepae*) and diseases during storage (*Table 1.*).

Table 1. Plant protection of the garlic

Proposed Growth	↓		↓	↓	↓	↓		
	III.	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	
Development of the plant								
Weeds								
Soil-borne diseases								
Terricol pests								
Ditylenchus dipsaci								
Thrips species								
Aceria tulipae								
Dyspessa ulula								
Puccinia species								

Source: Budai et al. (1999), *Seprős* (2001)

Diseases

Viral diseases pose potential risks to the garlic. Economically most significant are: *Garlic common latent Carlavirus* (GCLV), *Onion yellow dwarf Potyvirus* (OYDV), *Shallot latent Carlavirus and Leek yellow stripe Potyvirus.* Of these, the most common is the first (GCLV), which is often free of symptoms, infection being passed from plant to plant. Other viruses can also produce serious damage, which are recognisable by mosaic symptoms on leaves. Typically this virus does not infect winter garlic to the same extent (20% infection) as the spring varieties (up to 80% infection) (*Budai et al.* 1999).

The *Onion yellow dwarf virus* is encountered more rarely. It causes about 40% infection. Its' conspicuous symptoms are yellow-green stripes on leaves, the lack of the wax-coating, and deformed, wilted leaves. The plant also displays stunted growth.
The source of virus diseases is the clove. The virus spreads with vegetal fluid from plant to plant with the major help of aphids. However in Hungary it has lesser significance, because accumulation in the bulb only occurs in very rare cases (*Glits* 2000).

The most important diseases caused by fungi are:
Fusarium decay (*Fusarium oxysporum, Fusarium cepae*): This infects the garlic for the whole of the growing season in the soil, and damages the bulb. The roots of infected plants rot, the foliage turns yellow or brown, fades and finally dries. However the infection does not always cause the death of plants (*Jepson* 2006).

Allium root rot (*Sclerotium cepivorum* Berk.): This fungi infects the roots during wet and cool weather. The leaves turn yellow and wilt. The bulbs are covered with white mildew, and rot. The sclerotiums of fungi in the soil are viable for years (*Hagyma Terméktanács* 1996, *Budai et al.* 1999).

Garlic rusts (*Melampsora allii-fragilis* Kleb., *Melampsora allii-populina* Kleb.): The appearance of orange spots on leaves are a sign of disease. Intensively infected plants turn yellow and die. Highly humid, sunny days with less precitipation, and temperatures of 45–55 °F, i.e. ca. 8–13 °C are favourable for the spread of this fungi (*Schwartz* and *Mohan* 2007). In Hungary it causes significant economic damage only in exceptional cases.

Blue-green garlic rot (*Penicillium* spp.): Lesions on the garlic bulb, incorrect storage (high temperature, and high relative humidity), or late planting are causes of this disease. It blocks the rooting of plants, and covers the cloves with black mildew. *Penicillium corymbiferum* species cause particularly heavy damage on garlic (*EPPO* 1994).

Botrytis rot (*Botrytis* spp.): Garlic can be infected by *B. aclada*, *B. byssoidea*, *B. porri* from soil or from planted cloves. This fungi needs heavy dew and precipitation in order to spread. Symptoms rarely appear in the field but it causes problems in storage: in a warm (15–20 °C), wet room if the garlic is stored in thick strata the rot spreads (*Petróczi* 1997, *Glits* 2000).

Pests

Terricol pests (*Elateridae, Melolonthidae*): Damage caused by these species is complex. It gnaws into the cloves and thus the vegetative parts of plants cannot grow adequately, and diseases can enter plants.

Stem and bulb nematode (*Ditylenchus dipsaci* Kühn): This is the highest risk pest for garlic. In favourable weather the damage can be as much as 40–50%. Ordinarily it causes 5–10% damage every year. Wet, cool weather is optimal for this pest, which encourages the fast spread of the nematode especially in adherent soils. A common symptom caused by *D. dipsaci* is swelling of the tissues on the lower stem region aboveground, close to the root crown or bulb. Advanced infections of stem nematode on garlic will cause a discoloration and rotting of the base of the bulb area, and the root plate can be easily separated from the bulb. The leaves turn yellow, wilt, and wither. Both the young and full-grown nematodes move on plant by plant in the soil, and enter through stomas (*Jenser et al.* 1998, *McKenry* and *Roberts* 1985).

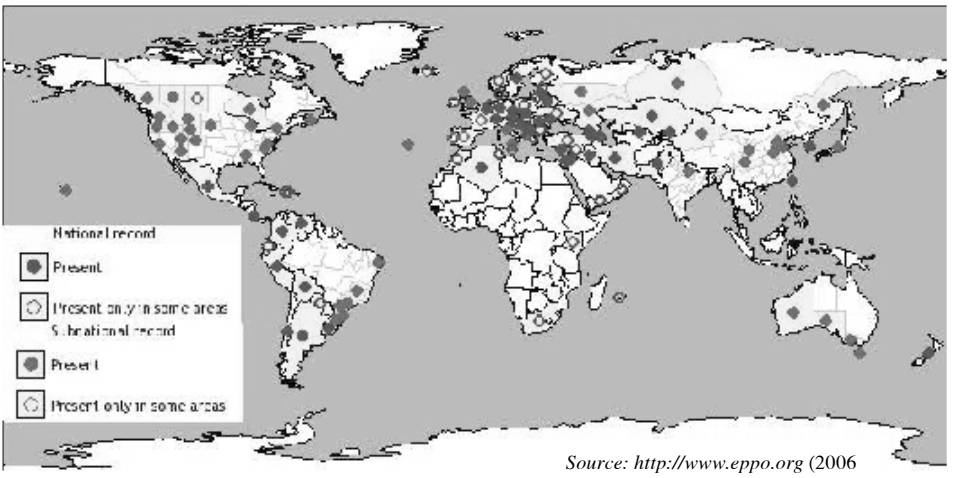

Figure 1. Distribution map of *Ditylenchus dipsaci*)

Wheat curl mite (*Aceria tulipae* Keifer): This winters easily in storage in high temperatures, and damages the garlic. In the field the infection starts from planted cloves. The young plants curve, then foliage withers, turns yellow and is stunted. It is a carrier of several viruses (mosaic viruses) in the field and in storage (*Diekman* 1997, *Budai et al.* 1999).

Bulb mite (*Rhizoglypus echinopus* Fumouze et Robin): In Hungary the infection caused by this pest is about 10–30%. It infects mostly decayed plants, but can damage healthy ones too. Optimal conditions are 23 °C temperature and 85–89% humidity (*Jenser et al.* 1998). It can survive in unfavorable conditions in an inert state (*Erdős* 1982). It lives and chews on the root of the garlic. The plants wilt and foliage becomes violet coloured. Mites can be carriers of many diseases (fusarium per example).

Onion thrips (*Thrips tabaci* Lindemann): These suck on the young leaves. On the auxillary of leaves and on young bulbs silvery spots appear, then spread onto the whole plant. The garlic deforms and its' bulb does not grow adequately. Dry, warm weather helps the propagation of this pest (*Budai et al.* 1999, *Jenser et al.* 1998).

Garlic carpenter worm (*Dyspessa ulula* Borkhausen): Caterpillars damage the inside of the bulb; it is totally caverned by these. It enters the plant from the soil. In the bulb more larvae can also cause damage. In Hungary it rarely appears in large quantities, and only sporadically (*Ubrizsy* 1960).

Weeds

Garlic is an optimal plant for weeds because of its' small foliage. The quantity of weeds can be reduced through the consideration of more factors. Weed coverage depends on the integrity of planted cloves, the choice of variety, the date and method of planting, plant nutrition, on the date of harvest and on chemical and mechanical weed control (*Albrecht* 1995, *Froud-Williams* 1987). Between these factors there is a close interaction which is difficult to separate.

The species of weeds are different for winter and spring garlic varieties. Winter garlic is usually grown in loose soil which has thin weed coverage. Spring garlic is usually grown in hard soils, which is prone to grow weeds because it is more difficult to till and has more weed species seeds (*Hagyma Terméktanács* 1996).

The most common weeds in garlic are follows:
T1: shepherd's purse (*Capsella bursa pastoris*), deadnettle (*Lamium* sp.), ragworts and groundsels (*Senecio* sp.), veronica (*Veronica* sp.),
T2: corn chamomille (*Anthemis arvensis*), stickyweed (*Galium aparine*), chickweed (*Stellaria media*), field penny-cress (*Thlaspi arvense*),
T3: *Fumaria schlecheri*, wild radish (*Raphanus raphanistrum*), wild mustard (*Sinapis arvensis*),
T4: amaranth (*Amaranthus* sp.), scarlet pimpernel (*Anagallis arvensis*), saltbush (*Atriplex* sp.), goosefoot (*Chenopodium* sp.), jimson weed (*Datura stramonium)*, potato weed (*Galinsoga parviflora*), mayweeds (*Matricaria* sp.), mercuries (*Mercurialis* sp.), plantains (*Plantago* sp.), knotweeds (*Polygonum* sp.), purslanes (*Portulaca* sp.), wild mignonette (*Reseda lutea*), annual hedgenettle (*Stachys annua*), small nettle (*Urtica urens*),
G3: creeping thistle (*Cirsium arvense*), field bindweed (*Convolvulus arvensis*), peppercress, peppergrass (*Lepidium* sp.) (*Botos* and *Füstös* 1987).

Material and method

This study took place in Hanságliget where the soil type is peat meadow. Meadow soils which can be found in Hanság are old moorland bottoms, from which peaty stratas were eroded by the wind leaving only the clayey stratas. The high underground water-level ensures a favourable water supply to assist the quick and rich growth of the plants. The humus is black coloured and adheres to the grains of soil to create polyhedron formations.(*Stefanovits* 1956).
The chosen varieties were planted as follows:

– Winter varieties: 7–10 October,
– Spring variety: *GK Lelexír* (*Makói tavaszi*): 10–12 March.

The planting depth of the winter varieties was 7–8 cm, and the spring varieties 4–6 cm. Line width x stem distance = 30 cm x 8–12 cm, depending on whether exterior, interior or central cloves were planted. In the case of cloves from the exterior circle a larger stem distance (12 cm) was used, because these can develop bulbs with a larger mass and greater quantity of cloves. Conversely the central cloves of the bulb were planted with a smaller stem distance (8 cm).
In 2006–2007 super elite classes of *Sprint*, *Arno* and *Thermidrome* varieties were planted. The following year, in 2007–2008, the cloves obtained from the harvest of these, were planted.

Dates of data collection (*Table 2*.):

Table 2. Data collection of garlic varieties in 2007 and 2008

	Date of data collection	
	2007	**2008**
Stem and bulb nematode (*Ditylenchus dipsaci* Kühn)	May 5	May 2
Garlic rusts (*Puccinia allii-fragilis* Kleb., *Puccinia allii-populina* Kleb.)	May 5, June 3	May 2, May 27, June 10
Garlic carpenterworm (*Dyspessa ululа* Borkhausen)	May 5, May 15	May 2, May 15
Onion thrips (*Thrips tabaci* Lindemann)	May 15 – July 15	May 15 – July 15
Weeds	April 2, May 22	
Diseases during the storage	November 15, December 7	January 4, January 31, February 25, March 24

This study used the following methods to determine the degree of damage:
- Stem and bulb nematode: individual plant observation in the field
- Garlic rusts: individual plant observation in the field
- Garlic carpenter worm: light trap
- Onion thrips: yellow water bowl, blue water bowl
- Weeds: Balázs–Újvárosi method to estimate the percentage of weed coverage
- Storage diseases: observation of stored garlic bulbs, wet chamber

Data analysis was completed using a Microsoft Excel spreadsheet. The average values of the gathered results were displayed in a table, and either columns on a bar chart diagram, or in line graphs format.

Results

Infection of stem and bulb nematode

To determine the infection of stem and bulb nematode the individual plants were observed in the field. The research examined 200–200 garlic plants from each species; the characteristic symptoms caused by nematodes, such as dwarfism, curved, stunted leafage were sought. The following were found (*Figure 2*.).

The results suggest that the infection of stem and bulb nematode shows the highest value in the *Sprint* variety, even though super elite cloves had been planted. Examination of the data for the following year reveals that in every variety the infection had doubled except in the case of *Sprint*. For this variety, the infection of stem and bulb nematode was reduced to a minimum.

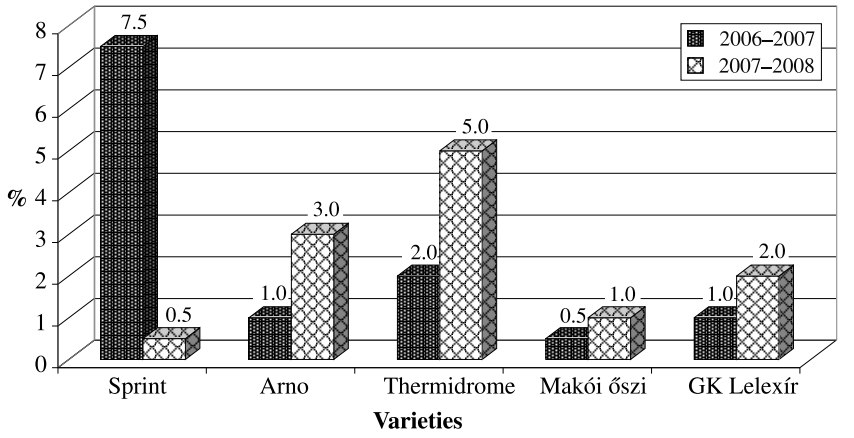

Figure 2. Infection of stem and bulb nematode in different garlic varieties (%)

Infection of garlic rusts

To determine the infection of garlic rusts individual plants in the field were also examined. In 2007 two examinations and in 2008 three examinations were made of the foliage of the garlic varieties.Typical orange coloured uredo spots of *Puccinia allii-fragilis* Kleb., and *Puccinia allii-populina* Kleb were sought on the plants. The following values were noted on different dates (*Figure 3–4*.).

Plants were examined for *garlic carpenterworm infection* (*Dyspessa ulula* Borkhausen) twice in each year. In order to observe the swarming of the garlic carpenterworms a light trap was used. The traps were placed on the field before sunset. However there was no evidence of any garlic carpenterworm during the study.

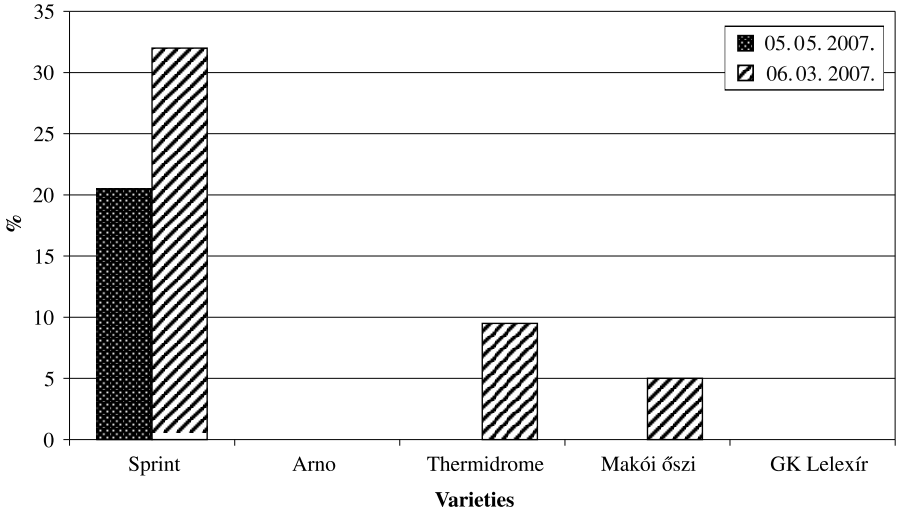

Figure 3. Infection of rusts on the examined garlic varieties in 2007 (%)

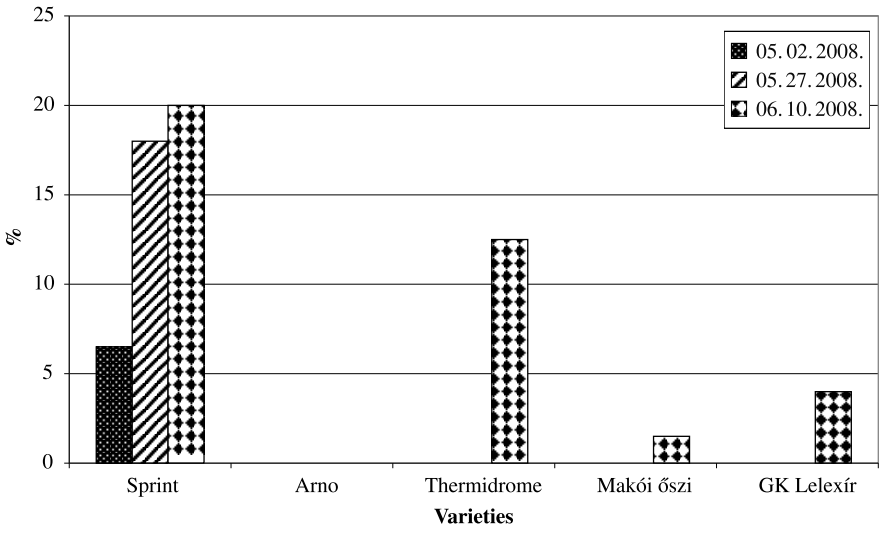

Figure 4. Infection of rusts on the examined garlic varieties in 2008 (%)

In order to observe the number of *onion thrips* (*Thrips tabaci*), a yellow and a light blue water bowl were placed in every 100 m^2 area. These were filled with water, formaline and, to reduce the surface tension, with washing up liquid. The bowls were placed in the upper foliage. The captured insects from a two day period were analysed. Collection was made for two months, but no onion trips were found.

Diseases during storage (*Botrytis* spp.*, Fusarium* spp.*, Penicillium* spp.*, Alternaria* spp.): Examination was undertaken more frequently. In order to determine which fungi species damaged garlic during storage, the fungi were raised in the laboratory using the so-called wet chamber method: garlic cloves were washed with sterile water, two wet wads were placed in the vents of the wet chamber, and these were placed below a sterilised rail. The garlic cloves were then placed on this rail, and the chamber was closed. It was stored at room temperature for five days. A large quantity of flimsy, grey mildew cover of the *Botrytis* species was observed on the cloves. To determine the level of infection of the *Botrytis* species 30–30 pieces of each garlic variety were taken at random. After cutting the bulbs into two parts, the number of cloves infected by mildew were ascertained and the quantity of infected plants was given a percentage value (*Figure 5.*).

Results suggest that winter varieties are less suitable for storage than spring varieties. *Arno* is an exception as it displayed the specific symptoms at the same time as the *GK Lelexír* spring variety. Even in the latest observation, it was found that the healthiest bulbs were from *Arno.* Unfortunately in the case of the Hungarian *Makói őszi* symptoms were presented very early.

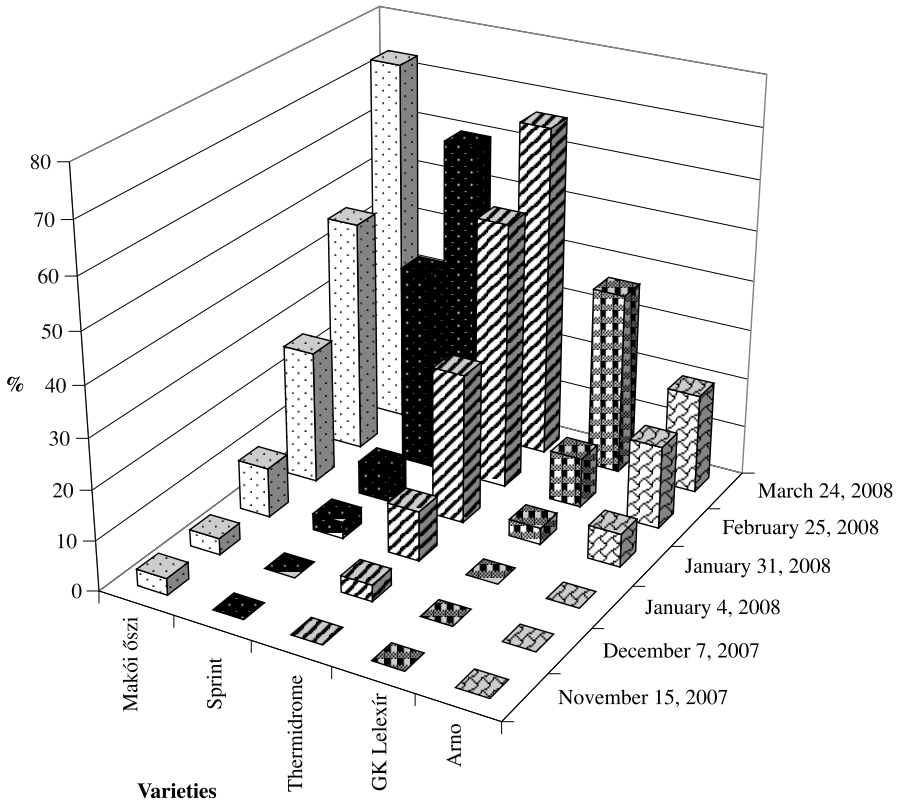

Figure 5. Infection of *Botrytis* species on the examined garlic varieties (%)

Weed-composition of the examined plots

In the examined plots of garlic weed surveys were made twice in 2007. The results of weed species coverage have been evaluated. The first inspection revealed that in winter garlic varieties only perennial weeds that have the T2 life form were found, of all the weed types, these only covered a relatively small surface of the field. In the second inspection, May 20, 2007 numerous other weeds had also appeared (*Table 3.*). From this data weed maps were created (*Figure 6.*).

The slow warming of the soil is the cause of late weed infestation, because of the thermal pocket caused by the lowland soil and by the Hanság-mainchannel that flows at the end of plots. For the plots supporting spring varieties; it was the central part that was more exposed to sunshine which had a large cover of weeds, because this optimal enviroment provided perfect conditions for the weed species seeds to germinate.

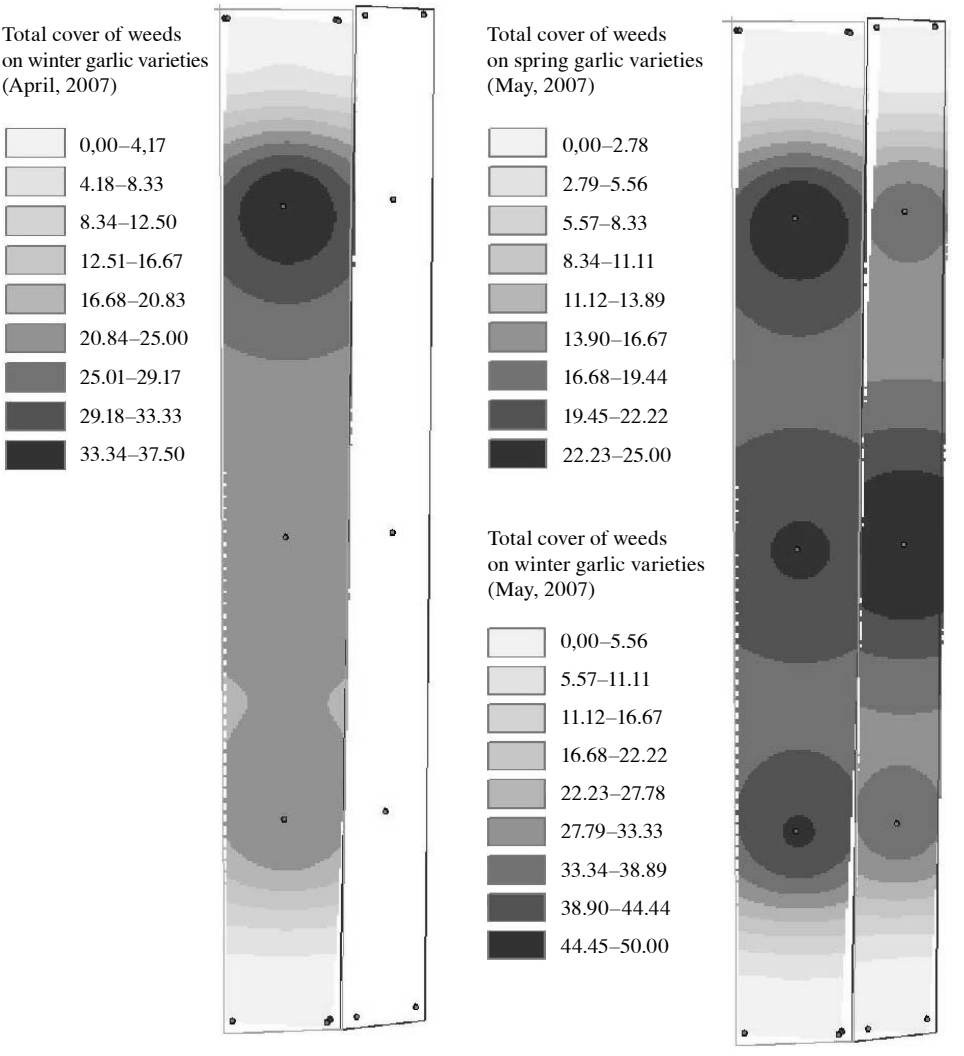

Figure 6. Weed cover on plots of garlic, April–May, 2007 (%) (Hanságliget)

From the results displayed in *Table 3.* it appears that the most significant problem was ragweed (*Ambrosia elatior),* and yellow foxtail *(Setaria glauca)* which appeared in very high number. Their appearence may be expected in May. The results of the Fifth National Weed Survey reveals the severity of the ragweed problem because of its' large range, and its' allelopathical effects for cultivated plants (*Brückner* 1998). The total weed cover including ragweed was larger in the plots of spring garlic varieties.

Table 3. Weed cover on plots of garlic, April–May, 2007 (%) (Hanságliget)

Weed species in winter garlic varieties, April 2, 2007																							
Sample	**X latitude**	**Y longitude**	Total cover	AMBEL	CHEAL	VERHE	RESLU	SETGL	CHEHY	FRACO	MERAN	CONAR	DATST	ECHCR	EQUIAR	STAAN	EUPHE	PANMI	CHIRAR	RUBCE	CAPBU	PLAMA	CONVU	**ALLSA**
1.	508431.320	266105.870	0.620	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.60	0	0	0	0	**38**
2.	508433.680	266062.980	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**25**
3.	508435.260	266026.380	0.820	0	0	0.60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**25**
Weed coverage in spring garlic varieties, May 22, 2007																								
Sample	**X latitude**	**Y longitude**	Total cover	AMBEL	CHEAL	VERHE	RESLU	SETGL	CHEHY	FRACO	MERAN	CONAR	DATST	ECHCR	EQUIAR	STAAN	EUPHE	PANMI	CHIRAR	RUBCE	CAPBU	PLAMA	CONVU	**ALLSA**
1.	508445.490	266107.440	35.680	18.75	3.12	1.87	0.10	3.12	0.62	0	0.62	0	0	3.12	3.12	0	0	0.62	0	0	0	0.62	0	**18**
2.	508447.450	266064.160	31.730	25.00	3.12	0.10	0.1	0.62	0.10	0.62	1.25	0.62	0.10	0.10	0	0	0	0	0	0	0	0	0	**25**
3.	508448.240	266027.960	28.920	18.75	1.87	0	0.62	3.12	0	0	0.62	0.62	0	3.12	0	0.10	0.10	0	0	0	0	0	0	**18**
Weed coverage in winter garlic varieties, May 22, 2007																								
Sample	**X latitude**	**Y longitude**	Total cover	AMBEL	CHEAL	VERHE	RESLU	SETGL	CHEHY	FRACO	MERAN	CONAR	DATST	ECHCR	EQUIAR	STAAN	EUPHE	PANMI	CHIRAR	RUBCE	CAPBU	PLAMA	CONVU	**ALLSA**
1.	508431.320	266105.870	27.170	6.24	0.62	0	0	6.24	0.62	0	1.87	0	0	0	0	3.62	0	0	3.62	3.62	0.10	0	0.62	**50**
2.	508433.680	266062.980	38.310	6.25	3.12	0	0	0	0	0.10	0.62	0	0	25.0	3.12	0.10	0	0	0	0	0	0	0	**45**
3.	508435.260	266026.380	16.510	6.24	1.87	0.62	0.10	3.12	0.10	0	0.10	0.62	0	0	3.12	0.62	0	0	0	0	0	0	0	**45**

Explanation to the Table 3.
AMBEL: *Ambrosia elatior* (common ragweed)
CHEAL: *Chenopodium album* (goosefoot)
VERHE: *Veronica hederifolia* (ivy-leaved speedwel)
RESLU: *Reseda lutea* (wild mignonette)
SETGL: *Setaria glauca* (foxtail grass)
CHEHY: *Chenopodium hybridum* (maple-leaved goosefoot)
FRACO: *Fragmites communis* (giant reed)
MERAN: *Mercurialis annua* (annual mercury)
CONAR: *Convulvulus arvensis* (field bindweed)
DATST: *Datura stramonium* (jimsonweed)
ECHCR: *Echinocloa crus-galli* (cuckspur grass)
EQUIAR: *Equisetum arvense* (field horsetail)
STAAN: *Stachys annua* (annual woundwort)
EUPHE: *Euphorbia helianthus* (spurge)
PANMI:*Panicum miliaceum* (common millet)
CIRAR: *Cirsium arvense* (creeping thistle)
RUBCE: *Rubus caesius* (dewberry)
CAPBU: *Capsella bursa-pastoris* (shepherd's purse)
PLAMA: *Plantago major* (greater plantain)
ALLSA: *Allium sativum* (garlic)

Magyar és francia fokhagymafajtákban előforduló kórokozók, kártevők és gyomok kártétele Nyugat-Magyarországon

GOMBKÖTŐ CSILLA – IVÁNCSICS JÓZSEF – NÉMETH LAJOS – REISINGER PÉTER

Nyugat-magyarországi Egyetem
Mezőgazdaság- és Élelmiszertudományi Kar
Növénytermesztési Intézet
Mosonmagyaróvár

Összefoglalás

Az 5000 éves fokhagyma (*Allium sativum* L.) termesztése Magyarországon két nagy régióban valósul meg: Makó és környékén, illetve a Bács-Kiskun megyei Dusnok és környékén. Hazánkban a fokhagymát szántóföldi növényként tartjuk számon, üvegházi hajtatást nem alkalmazunk.

Bár az ország egész területén biztonsággal termeszthető növény, megfelelő mennyiségű és minőségű terméket csak a növényvédelmi szabályok figyelembevételével kapunk.

Kísérleteinkbe 4 téli fajtát (*Makói őszi*, *Sprint*, *Thermidrome*, *Arno*) és egy tavaszit (*GK Lelexír*) vontunk be. Vizsgálataink során több módszert alkalmaztunk ezen fajokban előforduló betegségek és kártevők meghatározására, és a kártételük mértékének megállapítására.

A vizsgálatba vont területen gyomfelvételezést végeztünk Balázs-Újvárosi módszer segítségével, GPS-es helymeghatározással.

Kulcsszavak: *Allium sativum* L., kórokozók, kártevők, gyomborítottság, fajtaértékelés.

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Fűszenázsalapú takarmányozás és burkolással előállított halolajalapú zsírkészítmény kombinált etetésének hatása a tej zsírsavösszetételére

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Összefoglalás

Holstein-fríz tehenekkel (n = 80) végzett üzemi kísérletben vizsgáltuk a fűszenázsalapú takarmányozás és egy burkolással előállított halolajalapú védett zsírkészítmény (termék neve: Adexgo-1, gyártó: Adexgo Kft., Balatonfüred) kombinált etetésének hatását a tejtermelésre, a tej összetételére és zsírsavtartalmára. A tejmintákat a reggeli és az esti fejésből egyaránt gyűjtöttük és értékeltük. Megállapítottuk, hogy a kidolgozott tartósított fűalapú takarmányozás és az omega-3 zsírkészítmény etetése nem befolyásolta a tehenek tejtermelését, illetve a tej fehérje- és laktóztartalmát. Ezzel ellentétben szignifikáns ($P < 0,05$) mértékben csökkent a reggeli és az esti tejmintákban a szárazanyag- és a zsírtartalom. A telített zsírsavak (SFA) közül a C17:0; C20:0; C22:0 zsírsavak részaránya szignifikáns ($P < 0,05$) mértékben nőtt, míg a C8:0; C10:0; C12:0; C13:0; C16:0; C18:0 zsírsavaké szignifikánsan ($P < 0,05$) csökkent a kísérleti csoport elegytej mintáiban. Az egyszeresen telítetlen zsírsavak (MUFA) mennyisége – az olajsav (C18:1) kivételével – szignifikánsan ($P < 0,05$) nőtt a kísérleti takarmányadag etetésének hatására mind a reggeli, mind pedig az esti tejmintákban. A kísérleti csoportban a transz-zsírsavak (TFA) részaránya 3,40-, illetve 3,64-szeresére növekedett az esti és a reggeli tejmintákban (sorrendben). A kísérleti takarmányadag etetését követően mért kiugróan magas transz-zsírsav mennyiség fokozatosan csökkenő tendenciát mutatott. Az etetett kísérleti takarmányadag a fontosabb n-3

zsírsavak (C18:3, C20:5, C22:5 és C22:6) és a vizsgált CLA izomerek (c9,t11; t10,c12; c9,c11; t9,t11) részarányát szignifikánsan javította. Ez egyben megnövelte a tej PUFA-tartalmát, illetve szűkítette az n-6/n-3 arányt mind a reggeli (7,48:1 *vs.* 3,79:1), mind az esti (8,00:1 *vs.* 3,69:1) elegytej mintákban (kontroll *vs.* kísérleti, sorrendben).
Kulcsszavak: tejelő tehén, halolaj, védett zsírkészítmény, omega-3, CLA, zsírsavösszetétel.

Bevezetés és irodalom

A rendelkezésre álló irodalmi adatok szerint a tejelő tehenek takarmányadagjában alkalmazott zsírforrások és -készítmények (pl. full-fat magvak, Ca-szappanok, hidrogénezett zsírok, olajok stb.) nemcsak a tehenek tejtermelését, hanem a tej táplálóanyag-tartalmát, illetve a tejzsír zsírsavösszetételét is befolyásolják (*Komprda et al.* 2005, *Ribács* és *Schmidt* 2006, *Várhegyi et al.* 2007, *Kudrna* és *Marounek* 2008, *Murphy et al.* 2008). Az olajforrások közül a tej zsírsavösszetételének kedvező irányban történő módosítására alkalmas lehet a halolaj. Ennek oka, hogy a halolajok nagy koncentrációban tartalmaznak olyan n-3 zsírsavakat (pl. eikozapentaénsav, EPA, C20:5; dokozahexaénsav, DHA, C22:6), amelyek pozitív humán-egészségügyi hatásúak. Az n-3 zsírsavak számos élettani folyamatban vesznek részt, mint például a vérplazma zsírsavszintjének szabályozása, hatással vannak a kardiovaszkuláris és immunfolyamatokra, az idegrendszer fejlődésére, a normális látási funkciók kialakulására (*Jump* 2002). A hosszú szénláncú, többszörösen telítetlen zsírsavak másik csoportját az n-6 zsírsavak (pl. linolsav, LA, C18:2) alkotják. Amíg az optimális n-6/n-3 arány 4:1 (vagy kevesebb), addig a mai amerikai és európai típusú étrendben ez 10:1 vagy akár a 30:1 arányt is elérheti. Éppen ezért fontos lehet olyan élelmiszerek fejlesztése, amelyekben az n-3 zsírsavak nagyobb részarányban fordulnak elő. Ennek egyik lehetősége például az n-3 zsírsavakban gazdag tej és tejtermékek előállítása, mivel ezek a szokásos táplálkozás integráns részét képezik.

A halolaj önálló, és egyéb zsír- vagy olajforrásokkal történő kombinált etetése nemcsak a tej zsír- és fehérjetartalmát, de annak zsírsavösszetételét is jelentősen befolyásolhatja (*Jones et al.* 2000, *Palmquist* és *Griinari* 2006, *Shingfield et al.* 2006, *AbuGhazaleh* és *Holmes* 2007, *Cruz-Hernandez et al.* 2007, *Fatahnia et al.* 2008). A tejelő tehenek takarmányadagjának halolajjal történő kiegészítésekor nő a tej EPA- és DHA-tartalma (*Lacasse et al.* 2002, *Kitessa et al.* 2004, *Rego et al.* 2005, *Fatahnia et al.* 2008, *Toral et al.* 2010). Az n-3 zsírsavak mellett elsősorban a tej CLA-tartalmának növekedéséről számolnak be azok a kísérletek, amelyekben halolaj, repceolaj, napraforgóolaj, faggyú kombinált etetését, illetve halolaj önálló etetését vizsgálták (*Donovan et al.* 2000, *Jones et al.* 2000, *Palmquist* és *Griinari* 2006, *AbuGhazaleh* és *Holmes* 2007, *Osiegowski et al.* 2007, *Cruz-Hernandez et al.* 2007, *Potkański et al.* 2009).

Kedvezőtlennek tekinthető, hogy a különböző zsír- és olajforrások hatására megnő a tejben a transz-zsírsavak mennyisége (*Ramaswamy et al.* 2001, *Whitlock et al.* 2006, *AbuGhazaleh* és *Holmes* 2007, *Schmidt et al.* 2008). A transz-zsírsavak negatív hatása, hogy növelik a vérnyomást, elősegítik a szív és érrendszeri betegségek kialakulását, továbbá

rákkeltő hatásúak (*Judd et al*. 1994, *Mihályiné* 1997, *Offer et al*. 1999). Több szerző a tejben megnövekedett transz-zsírsav mennyiséggel hozza összefüggésbe a tej zsírtartalmának csökkenését is (*Kalscheur et al*. 1997, *Offer et al*. 1999, *Petit et al*. 2004).
A legeltetés és a zöldtakarmányozás tej zsírsavösszetételre gyakorolt kedvező hatását számos vizsgálatban igazolták (*Hagemeister* és *Voigt* 2001, *White et al*. 2001, *Rymer et al*. 2003, *Varga-Visi* és *Csapó* 2003, *Wijesundera et al*. 2003, *Addis et al*. 2005, *Scollan et al*. 2005, *Cabiddu et al*. 2006, *Elgersma et al*. 2006, *Mel'uchová et al*. 2008). A tartósított fűfélék és a halolajalapú védett zsírkészítmények kombinált etetésére vonatkozóan ugyanakkor kevesebb irodalmi forrás áll rendelkezésre.
Előzetes vizsgálatainkban (nem publikált adatok) egy olyan omega-3 zsírkészítményt fejlesztettünk ki, amelyet kukoricaszilázs–lucernaszenázs–kukorica alapú takarmányozás mellett etettünk a tejelő tehenekkel. Megállapítottuk, hogy a készítmény naponta és állatonként 0,25 kg mennyiségben adagolva szignifikáns hatású a tejzsír zsírsavösszetételére (C20:0; c-C18:1; t-9 C18:1; C20:1, c9,t11-C18:2, C20:5, C22:2 és C22:5). Jelen kísérletünkben a készítmény továbbfejlesztett változatát használtuk. Az etetett takarmányadag nem a hazai takarmányozásra jellemző kukoricaszilázs–lucernaszenázsra épült, hanem fűszenázs–lucernaszenázs alapú volt. A kísérlet legfontosabb célkitűzése annak vizsgálata, hogy a kidolgozott takarmányadag és a továbbfejlesztett omega-3 zsírkészítmény együttes alkalmazása milyen hatással van a laktáció harmadik szakaszában lévő tehenek tejtermelésére, a tej táplálóanyagainak (fehérje, zsír, cukor) mennyiségére, továbbá a tejzsír zsírsavösszetételére.

Anyag és módszer

Tejtermelési kísérlet

A kísérleteket a Solum Zrt. komáromi tehenészeti telepén végeztük. A kontroll és a kísérleti csoportba 80, többször ellett tehenet vontunk be, amelyek döntően a 2–3. laktációjukat teljesítették, és a laktáció harmadik szakaszában voltak (átlagos napi tejtermelésük a kísérletet megelőző 2 hétben: 21–22 kg volt).
A kontroll csoport kukoricaszilázs–lucernaszenázs–kukoricadara alapú, míg a kísérleti csoport fűszenázs–lucernaszenázs–kukoricadara alapú takarmányadagot kapott. A napi takarmányadag számított táplálóanyag-tartalmát, továbbá vizsgált zsírsavösszetételét az *1. táblázatban* foglaltuk össze. Tekintettel arra, hogy a kidolgozott takarmányadag, továbbá az omega-3 zsírkészítmény PCT szabadalmi bejelentése folyamatban van (bejelentési szám: PCT/IB2011/052014), ezért a pontos összetételt nem kívánjuk közölni. A kísérleti csoport naponta 0,5 kg mennyiségben egy kereskedelmi forgalomban lévő magas EPA- és DHA-tartalmú halolajat tartalmazó saját fejlesztésű burkolási technikával védett omega-3 zsírkészítményt (termék neve: Adexgo-1, gyártó: Adexgo Kft., Balatonfüred) kapott, amelynek halolajtartalma: 50%. Az előzetes adatok alapján a készítmény zsírtartalmának bendőbeli védettsége kb. 70% (nem publikált adatok). A jelen kísérletben használt omega-3 készítmény vizsgált zsírsavösszetétele a *2. táblázatban* található.

1. táblázat A kísérlet során etetett takarmányadag számított táplálóanyag-tartalma és vizsgált fontosabb zsírsavösszetétele (g zsírsav/100 g zsír)

Table 1. The calculated nutrient content and fatty acid profile of the diet in the experiment

Táplálóanyag (1)	**Kontroll** (2)	**Kísérleti** (3)
Szárazanyag (kg) (4)	24,4	24,6
NEl (MJ)	159	159
Nyersfehérje (g) (5)	3921	3964
MFE (g) (6)	2355	2282
MFN (g) (7)	2501	2504
RDP (g)	2239	2223
Nyersrost (g) (8)	3819	4212
NDF (g)	8935	9075
ADF (g)	4570	5334
Nyerszsír (g) (9)	747	1042
Ca (g)	205	262
P (g)	122	122
Zsírsavösszetétel (10)		
$C_{14:0}$: mirisztinsav *(myristic acid)*	0,50	1,08
$C_{16:0}$: palmitinsav *(palmitic acid)*	13,47	24,31
$C_{18:0}$: sztearinsav *(stearic acid)*	4,49	7,60
$C_{20:0}$: arachidsav *(arachidic acid)*	0,30	0,43
$C_{16:1}$: palmitoleinsav *(palmitoleic acid)*	0,35	0,88
$C_{18:1}$: olajsav *(oleic acid)*	45,11	25,22
c-$C_{18:1}$: vakcénsav *(vaccenic acid)*	1,37	1,01
$C_{20:1}$: eikozénsav *(eicosenoic acid)*	0,37	0,66
$C_{18:2}$: linolsav *(linoleic acid)*	29,19	26,88
$C_{18:3}$: linolénsav *(linolenic acid)*	2,71	6,69
$C_{20:5}$: eikozapentaénsav *(eicosapentaenoic acid)*	0,03	1,41
$C_{22:5}$: dokozapentaénsav *(docosapentaenoic acid)*	–	0,15
$C_{22:6}$: dokozahexaénsav *(docosahexaenoic acid)*	–	0,51

(1) nutrient, (2) control, (3) experimental, (4) dry matter, (5) crude protein, (6) energy dependent metabolizable protein, (7) N-dependent metabolizable protein, (8) crude fiber, (9) ether extract, (10) fatty acid profile (g fatty acid/100 g fat)

A tejtermelési kísérlet 6 hétig tartott, amit 3 hét előetetési szakasz előzött meg. Az előetetési szakaszban szoktattuk hozzá a teheneket a fűszenázsalapú takarmányozáshoz és az omega-3 zsírkészítmény etetéséhez. A Solum Zrt. telepén a teheneket naponta kétszer fejik. A tehenészetben számítógéppel összekapcsolt fejési rendszer működik, így az állatok egyedi tejtermelését a kísérlet minden napján fejésenként rögzíteni tudtuk. A tej összetételét az esti és a reggeli fejés tejéből, hetente egy alkalommal egyedileg állapítottuk meg. A vizsgálatokat (zsír-, fehérje-, laktóz-, szárazanyag- és zsírmentes szárazanyag-tartalom) a Magyar Tejgazdasági Kísérleti Intézet Kft. (Mosonmagyaróvár) végezte el, Milkoscan FT 120 (Foss Electric) típusú berendezéssel.

Az egyedi tejminták mellett, a kontroll és a kísérleti szakasz során mintavételi alkalmanként 2 db elegytejet is gyűjtöttünk mind a reggeli (n = 12), mind az esti fejésből (n = 12), melyek zsírsavösszetételét gázkromatográfiás úton értékeltük.

2. táblázat Az omega-3 zsírkészítmény vizsgált zsírsavösszetétele (g zsírsav/100 g zsír)

Table 2. Fatty acid profile of the omega-3 fat supplement (g fatty acid/100 g fat) (gyártó/producer: Adexgo-1; Adexgo Kft.)

Zsírsav (1)	**Omega-3 zsírkészítmény** (2)
$C_{8:0}$: kaprilsav *(caprylic acid)*	0,04
$C_{10:0}$: kaprinsav *(capric acid)*	0,01
$C_{12:0}$: laurinsav *(lauric acid)*	0,11
$C_{13:0}$: tridekánsav *(tridecanoic acid)*	0,04
$C_{14:0}$: mirisztinsav *(myristic acid)*	5,89
$C_{15:0}$: pentadekánsav *(pentadecanoic acid)*	0,54
$C_{16:0}$: palmitinsav *(palmitic acid)*	25,47
$C_{17:0}$: heptadekánsav *(heptadecanoic acid)*	0,45
$C_{18:0}$: sztearinsav *(stearic acid)*	11,26
$C_{20:0}$: arachidsav *(arachidic acid)*	0,39
$C_{22:0}$: behénsav (*behenic acid*)	0,09
SFA: Telített zsírsavak *(Saturated fatty acids)*	44,29
$C_{14:1}$: mirisztoleinsav *(myristoleic acid)*	0,05
$C_{16:1}$: palmitoleinsav *(palmitoleic acid)*	5,88
$C_{17:1}$: heptadecénsav *(heptadecanoic acid)*	0,65
$C_{18:1}$: olajsav *(oleic acid)*	9,85
9t-$C_{18:1}$: elaidinsav *(elaidic acid)*	1,35
11t-$C_{18:1}$: transz-vakcénsav *(trans vaccenic acid)*	0,80
c-$C_{18:1}$: vakcénsav *(vaccenic acid)*	2,54
$C_{22:1}$: erukasav *(erucic acid)*	0,97
MUFA: Egyszeresen telítetlen zsírsavak *(Monounsaturated fatty acids)*	21,29
$C_{18:2}$ (n-6): linolsav *(linoleic acid)*	1,12
CLA (t-10, c-12): konjugált linolsav *(conjugated linoleic acid)*	0,02
CLA (c-9, c-11): konjugált linolsav *(conjugated linoleic acid)*	0,03
CLA (t-9, t-11): konjugált linolsav *(conjugated linoleic acid)*	1,97
$C_{18:3}$ (n-3): linolénsav *(linolenic acid)*	2,10
$C_{18:3}$ (n-6): γ-linolénsav *(γ-linolenic acid)*	0,16
$C_{20:3}$ (n-6): eikozatriénsav *(eicosatrienoic acid)*	0,13
$C_{20:4}$ (n-6): arachidonsav *(arachidonic acid)*	0,60
$C_{20:5}$ (n-3): eikozapentaénsav *(eicosapentaenoic acid)*	11,33
$C_{22:2}$ (n-6): dokozadiénsav *(docosadienoic acid)*	0,03
$C_{22:4}$ (n-6): dokozatetraénsav *(docosatetraenoic acid)*	0,08
$C_{22:5}$ (n-3): dokozapentaénsav *(docosapentaenoic acid)*	1,83
$C_{22:6}$ (n-3): dokozahexaénsav *(docosahexaenoic acid)*	8,05
PUFA: Többszörösen telítetlen zsírsavak *(Polyunsaturated fatty acids)*	27,45
UFA: Telítetlen zsírsavak *(Unsaturated fatty acids)*	48,74
Egyéb zsírsav (3)	6,97
Σn6	2,12
Σn3	23,31

(1) fatty acid, (2) omega-3 fat supplement, (3) non identified fatty acid

Kémiai vizsgálatok

A kísérletek során etetett takarmányok szárazanyag-, nyersfehérje-, nyerszsír-, nyersrost- és nyershamutartalmát a Magyar Takarmánykódexben (2004) javasolt módszerekkel állapítottuk meg. A tejminták zsír-, fehérje-, laktóz-, szárazanyag- és zsírmentes szárazanyag-tartalmát a Magyar Tejgazdasági Kísérleti Intézet Kft. (Mosonmagyaróvár) végezte el, Milkoscan FT 120 (Foss Electric, Dánia) típusú berendezéssel. A takarmányok és a tejminták zsírsavösszetételét Agilent Technologies 6890N (HP, USA) típusú gázkromatográffal, a Magyar Szabványban (MSZ ISO 5508:1992) leírtak szerint határoztuk meg. A kolonna típusa Supelco SP™ 2560 (100 m x 0,25 mm x 0,2 µm) volt. Vivőgázként H_2 szolgált. Nyomás: 176,8 kPa. Detector: FID. Áramlás: 35 ml/perc hidrogén, 30 ml/perc nitrogén, 300 ml/perc levegő. Hőmérséklet: injektor: 250 °C. Mintamennyiség: 1 µl. A zsír elszappanosítását metanolban oldott 1 n NaOH-dal végeztük. Az észterezés 10%-os metanolban oldott bór-trifluoriddal, a minta felvitele pedig hexánnal történt.

Statisztikai eljárások

A kísérleti eredmények statisztikai értékelését a SAS 9.1.3, illetve SPSS for Windows 15.0 programok segítségével (Kolmogorov-Smirnov teszt; t-próba, GLM/repeated measures, Kruskal-Wallis teszt, Mann-Whitney teszt) végeztük.

Eredmények

Tejtermelés, tejösszetétel

Az alkalmazott takarmányozás tehenek tejtermelésére, továbbá a reggeli és esti tejminták összetételére gyakorolt hatását a *3. táblázatban* foglaltuk össze. Az adatokból látható, hogy a kontroll és kísérleti csoport egyedeinek tejtermelése között nem kaptunk szignifikáns különbséget (22,47±0,99 *vs.* 21,46±1,42, sorrendben). A statisztikai analízis során megállapítottuk, hogy a mérési napnak, illetve a kezelés x napnak szignifikáns (min. $P < 0,05$) hatása van a tejmennyiségre vonatkozóan. A mérési nap szignifikáns hatása azzal magyarázható, hogy a tehenek tejtermelése a laktáció végére folyamatosan csökken. A kezelés x nap interakció pedig azt jelzi, hogy egyes tejtermelési napokon szignifikáns (min. $P < 0,05$) különbség volt a kontroll és a kísérleti csoport tejtermelése között. A rendelkezésre álló irodalmi adatokban a halolaj tejelő tehenek tejtermelésére gyakorolt hatásáról meglehetősen ellentmondásos eredmények találhatók. A kapott adatainkkal egyezően *AbuGhazaleh* (2008) 100 g halolaj és 300 g napraforgóolaj kombinált etetésekor, illetve *Bharathan et al.* (2008) 0,5% halolaj önálló etetésekor nem tapasztaltak változást a tejtermelésben. Ugyanakkor *Rego et al.* (2005) vizsgálatában a 160 és a 320 g/nap halolaj-kiegészítés hatására a termelt tej mennyisége csökkent. Ezzel ellentétben *Fatahnia et al.* (2008) eredményei alapján a 3% halolaj-kiegészítés növelte a tejtermelést (32,15 kg/nap) a kontrollcsoporthoz (30,31 kg/nap) viszonyítva. Hasonló eredményeket kapott *Gonzalez* és *Bas* (2002) is, akik a tejtermelés szignifikáns mértékű növekedését (+3,4 l/állat) tapasztalták 3 és 6% halolaj-kiegészítést követően.

3. táblázat A napi átlagos tejtermelés és az elegytej minták összetételének alakulása (n = 12)

Table 3. The daily average milk production and the composition of the morning and the evening milk (n = 12)

	Kontroll (1)	**Kísérleti** (2)
	csoport (3)	
Tejtermelés (kg/nap) (4)	22,47±0,99	21,46±1,42
A tej összetétele, % (m/m) (5)		
Tejzsír% (6)		
Reggel (7)	3,97±0,15[a]	2,98±0,22[b]
Este (8)	4,38±0,23[a]	3,36±0,34[b]
Tejfehérje% (9)		
Reggel	3,51±0,11	3,38±0,15
Este	3,56±0,12	3,47±0,13
Tejcukor% (10)		
Reggel	4,57±0,04	4,60±0,03
Este	4,57±0,07	4,58±0,07
Szárazanyag% (11)		
Reggel	12,70±0,21[a]	11,62±0,28[b]
Este	13,15±0,28[a]	12,08±0,31[b]

a, b: A vízszintes sorokon belül a különböző betűvel jelölt értékek szignifikánsan eltérnek egymástól (P < 0,05)
a, b: different superscripts within a row indicate significant differences (P < 0.05)
(1) control, (2) experimental, (3) group, (4) milk production (kg/day), (5) composition of milk, (6) fat, (7) morning, (8) evening, (9) protein, (10) lactose, (11) dry matter

Az etetett takarmányadag szignifikáns mértékben csökkentette mind a reggeli, mind az esti tejminták esetében a tejzsír%-ot. A reggeli tejmintákban 0,99 százalékponttal, míg az esti tejeknél 1,02 százalékponttal csökkent a kísérleti csoport egyedeinél a tejzsír-koncentráció. A kezelésen kívül a kapott adatokra a mintavétel időpontjának, a napszaknak (reggel, este), illetve a kezelés x mintavételi időpontnak is szignifikáns hatása volt (min. P < 0,05). A tejzsír% jelentős mértékű csökkenése következtében a kísérleti tejmintákban szignifikánsan csökkent a szárazanyag mennyisége. Utóbbi paraméter a reggeli tejminták esetében 1,08 százalékponttal, míg az esti mintákban 1,07 százalékponttal csökkent. Ebben az esetben is igazoltuk a mintavételi időpont, a napszak, illetve a kezelés x mintavételi időpont, továbbá kezelés x mintavételi időpont x napszak szignifikáns hatását (min. P < 0,05). Kapott adatainkkal egyezően *Ramaswamy et al.* (2001) vizsgálatában a 2% halolajetetés hatására szignifikánsan csökkent a tejzsír% (2,58% *vs.* 3,31%), és a szárazanyag-koncentráció (11,47% *vs.* 12,46%). Hasonló eredményeket kaptak más szerzők is (*Donovan et al.* 2000, *Keady et al.* 2000, *Murphy et al.* 2008), míg *Gonzalez* és *Bas* (2002) nem tapasztaltak statisztikailag igazolható mértékű változást a tejzsírtartalomban 3 és 6% halolaj alkalmazása esetén.
A fehérje és a laktóz vonatkozásában nem kaptunk statisztikailag igazolható különbséget a kontroll és a kísérleti csoport között. Hasonló eredményről számolt be *Ramaswamy et al.* (2001), *Gonzalez* és *Bas* (2002), illetve *Bharathan et al.* (2008) is különböző részarányú (2%; 3 és 6%; illetve 0,5%, sorrendben) halolaj-kiegészítést követően. Más vizsgálatokban azonban a halolajetetés hatására a laktóztartalom növekedését (*Murphy et al.* 2008), továbbá a tejfehérje csökkenését tapasztalták (*Rego et al.* 2005, *AbuGhazaleh et al.* 2004).

Zsírsavprofil

A kísérletben etetett takarmányadagok reggeli és esti tejminták zsírsavösszetételére gyakorolt hatását a *4.* és *5. táblázatban* foglaltuk össze. A telített zsírsavak (SFA) esetében a kísérleti csoport teje szignifikánsan nagyobb részarányban tartalmazta a C17:0; C20:0; C22:0 zsírsavakat a kontrollhoz képest mind a reggeli, mind pedig az esti tejmintákban. Ugyanakkor a C8:0; C10:0; C12:0; C13:0; C16:0; C18:0 zsírsavak részaránya szignifikánsan csökkent mindkét mintavételezési időpontban. Ennek következtében a kontroll és a kísérleti tejmintákban a telített zsírsavarány (SFA) vonatkozásában szignifikáns különbséget találtunk a reggeli (65,92% *vs*. 58,95%) és az esti (63,78% *vs*. 58,22%) tejminták között. Az említett telített zsírsavak részarányának szignifikáns mértékű csökkenését más halolajjal végzett vizsgálatok adatai is megerősítik (*Ramaswamy et al*. 2001, *Osiegowski et al*. 2007, *Murphy et al*. 2008). Kapott adatainkkal egyezően a halolaj-kiegészítést követően a hosszú szénláncú telített zsírsavak (pl. C20:0) növekedését *Mozzon et al*. (2002) kísérleti eredményei szintén igazolják. Fűszenázsalapú takarmányadag etetését követően az SFA részarányának csökkenését tapasztalták *Pesek et al*. (2008) is.

A *4.* és az *5. táblázatban* közölt adatokból látható, hogy az egyszeresen telítetlen zsírsavak (MUFA) részaránya – az olajsav (C18:1) kivételével – szignifikánsan nőtt a kísérleti takarmányadag etetésének hatására mind a reggeli, mind pedig az esti tejmintákban. A tejzsírban a t-9 C18:1 (elaidinsav) és a c-C18:1 (vakcénsav) részarányának növekedése táplálkozás-élettani szempontból kedvezőtlen változásnak tekinthető (*Willett et al*. 1993, *Hodgson et al*. 1996, *Mihályiné* 1997, *Hunter* 2005, *Martin et al*. 2005, *Micha* és *Mozzaffarian* 2008, *Wandall* 2008). Eredményeinkhez hasonlóan *Whitlock et al*. (2006) is az említett zsírsavak növekedését tapasztalták halolaj és szója kombinált (0,33; 0,67 és 1%, sorrendben) etetésekor. Vizsgálatukban a t-9 C18:1 zsírsav részaránya 0,25 g/100 g zsírról 0,44 g/100 g zsírra, míg a c-C18:1 zsírsav mennyisége 0,44 g/100 g zsírról 0,51 g/100 g zsírra nőtt. Más szerzők is a transz-zsírsavak (TFA) növekedését tapasztalták 1; 2 és 3% halolaj, illetve 0,5% halolaj és 2% szója kombinált etetésekor (*Donovan et al*. 2000, *AbuGhazaleh et al*. 2004). A vakcénsav részarányának növekedését nemcsak halolaj, hanem legeltetést követően is leírták (*Bauman* és *Griinari* 2001, *Kolver et al*. 2002). Ennek oka, hogy a legelőfű gazdag C18:3 zsírsavban és a bendőbeli biohidrogénezés folyamatában a vakcénsav (c-C18:1) egy köztes termék.

A C18:1 és a vizsgált TFA (t-9 C18:1) adatainak részletesebb értékelésekor megfigyeltük, hogy a 3 hétig tartó előetetési szakaszt követően – a kísérlet 5–7. hete között – a C18:1 zsírsav részaránya jelentősen csökkent, míg a t-9 C18:1 zsírsav részaránya ugrásszerűen megnőtt (*1. ábra*). Ezt követően a vizsgált TFA részaránya mind a reggeli, mind az esti tejmintákban folyamatosan mérséklődött (8–9. hét). Ez a tény egyértelműen felhívja a figyelmet arra, hogy az ilyen típusú kísérletek esetében hosszabb vizsgálati szakaszt kell alkalmazni, mivel a rövid ideig tartó kísérletek félrevezető eredményt adhatnak. Az elvégzett korrelációvizsgálat során megállapítottuk, hogy a C18:1 és a t-9 C18:1 zsírsavak között igen szoros (–0,902; $P < 0,01$) negatív korreláció van. Ez a rendelkezésre álló irodalmi adatokkal összhangban van. Adatainkkal egyezően *Ramaswamy et al*. (2001), *Palmquist* és *Griniiari* (2006),

illetve *Murphy et al.* (2008) szintén a t-9 C18:1 zsírsav növekedését tapasztalták halolaj, és halolaj + napraforgóolaj kombinált kiegészítése során. Más szerzők a c-C18:1 zsírsav nagyobb részarányú növekedését is megfigyelték az említett olajkiegészítések alkalmazását követően (*Ramaswamy et al.* 2001, *Mozzon et al.* 2002, *Palmquist* és *Griniiari* 2006, *AbuGhazaleh* 2008). Meg kell említeni azt is, hogy a kísérleti csoport egyedeinek tejében jelentős mértékben megnőtt a nem azonosított zsírsavak mennyisége. Ez pozitív és negatív élettani hatással rendelkező zsírsavakat egyaránt magába foglalhat.

A *4.* és az *5. táblázat* adatai szerint a kidolgozott fűalapú takarmányadag és az omega-3 zsírkészítmény együttes etetése szignifikánsan megnövelte a többszörösen telítetlen zsírsavak (PUFA) részarányát a tejzsírban. A kontroll egyedek reggeli és esti tejéhez viszonyítva a következő PUFA zsírsavak részarányának szignifikáns növekedését tapasztaltuk: C18:3, C20:5, C22:5, továbbá CLA (c9,t11; t10,c12; c9,c11; t9,t11) izomerek. A kontroll tejben C22:6 zsírsavat nem tudtunk kimutatni, ugyanakkor a dokozahexaénsav a kísérleti tehenek reggeli és esti tejében 0,05 g/100 g zsír mennyiségben megjelent. Az n-3 zsírsavakkal ellentétben számos n-6 zsírsav részaránya szignifikánsan csökkent (C20:3; C20:4; C22:4), miközben a linolsav (C18:2, LA) mennyisége kismértékben nőtt (NS). Az n-6/n-3 arány mind a reggeli (7,48:1 *vs.* 3,79:1), mind az esti (8,00:1 *vs.* 3,69:1) elegytej mintákban jelentős mértékben szűkült (kontroll *vs.* kísérleti, sorrendben). Ez az irodalmi adatok szerint humántáplálkozási szempontból számos betegség (pl. szív- és érrendszeri) megelőzésében előnyös lehet (*Wahrburg* 2004, *Thorsdottir et al.* 2004, *Simopoulos* 2008).

Az n-3 zsírsavak részarányának növekedését különböző dózisú halolaj önálló és kombinált (halolaj–szójaolaj) etetésének hatására más vizsgálatokban is megállapították (*Donovan et al.* 2000, *Ramaswamy et al.* 2001, *Whitlock et al.* 2006). A linolénsav (C18:3, n-3) részarányának növekedése elsősorban a fűalapú takarmányozásra vezethető vissza. A halolaj önálló és napraforgóolajjal történő kombinált etetésekor ugyanis a C18:3 zsírsav részaránya más szerzők kísérletében csökkent (*AbuGhazaleh* és *Holmes* 2007, *Cruz-Hernandez et al.* 2007). *White et al.* (2001) vizsgálatában a kukoricaszilázs-alapú takarmányadaghoz viszonyítva a legelőfű mind a *holstein-fríz*, mind pedig a *jersey* fajta esetében szignifikánsan ($P < 0,01$) növelte a linolénsav részarányát a tejben. A PUFA zsírsavak növekedését fű- és lucernaszilázs-alapú takarmányozás mellett más szerzők adatai is alátámasztják (*Jahreis et al.* 1997).

A CLA-ra vonatkozó pozitív eredményünket a rendelkezésre álló irodalmak adatai szintén megerősítik. Így pl. *Bharathan et al.* (2008) vizsgálatában a takarmányadag 0,5% halolajjal történő kiegészítése esetén a CLA részaránya szignifikánsan nőtt (0,52 g/100 g zsír *vs.* 0,90 g/100 zsír). A tej CLA-tartalmának növekedését a halolaj önálló, illetve szójaolajjal történő kombinált etetésekor ugyancsak igazolták (*Donovan et al.* 2000, *AbuGhazaleh et al.* 2004, *Murphy et al.* 2008). Oka lehet a CLA növekedésének az is, hogy a fűalapú takarmányozás szintén növeli a tejzsír CLA- (különösen a c9, t11-C18:2) tartalmát (*Kelly et al.* 1998, *Dhiman et al.* 1999, *White et al.* 2001). Ismert az is, hogy a tejzsír CLA-tartalmát nemcsak az alkalmazott zsírkiegészítés, hanem a laktációk száma, a takarmányadag típusa és a szezon is befolyásolja (*Lawless et al.* 1998, *Lock* és *Garnsworthy* 2003). Ugyanakkor a hal- és lenolaj alkalmazásakor a CLA-növekedés mellett a transz-zsírsavak emelkedésére is számítani lehet (*Ramaswamy et al.* 2001, *Baer et al.* 2001, *Toral et al.* 2010).

4. táblázat A kontroll és a kísérleti csoport tejének zsírsavösszetétele
(reggeli elegytej minták, n = 12; g zsírsav/100 g zsír)

Table 4. Fatty acid profile of control and experimental group
(in the morning, n = 12; g fatty acid/100 g fat)

Zsírsav (1)	**Kontroll** (2)	**Kísérleti** (3)
$C_{8:0}$: kaprilsav *(caprylic acid)*	0,98±0,07[a]	0,79±0,05[b]
$C_{10:0}$: kaprinsav *(capric acid)*	2,49±0,08[a]	1,98±0,18[b]
$C_{11:0}$: undekánsav *(undecanoic acid)*	0,31±0,00	0,30±0,08
$C_{12:0}$: laurinsav *(lauric acid)*	3,16±0,14[a]	2,66±0,23[b]
$C_{13:0}$: tridekánsav *(tridecanoic acid)*	1,19±0,01[a]	0,16±0,01[b]
$C_{14:0}$: mirisztinsav *(myristic acid)*	10,63±0,39	10,54±0,58
$C_{15:0}$: pentadekánsav *(pentadecanoic acid)*	1,02±0,02	1,16±0,34
$C_{16:0}$: palmitinsav *(palmitic acid)*	35,43±0,52[a]	33,37±0,47[b]
$C_{17:0}$: heptadekánsav *(heptadecanoic acid)*	0,59±0,02[b]	0,77±0,02[a]
$C_{18:0}$: sztearinsav *(stearic acid)*	9,93±0,71[a]	6,95±0,97[b]
$C_{20:0}$: arachidsav *(arachidic acid)*	0,15±0,01[b]	0,22±0,03[a]
$C_{22:0}$: behénsav (*behenic acid*)	0,04±0,00[b]	0,05±0,00[a]
SFA: Telített zsírsavak *(Saturated fatty acids)*	65,92±0,71[a]	58,95±1,68[b]
$C_{14:1}$: mirisztoleinsav *(myristoleic acid)*	0,97±0,05[b]	1,44±0,06[a]
$C_{16:1}$: palmitoleinsav *(palmitoleic acid)*	2,17±0,09[b]	2,95±0,17[a]
$C_{17:1}$: heptadecénsav *(heptadecanoic acid)*	0,19±0,01[b]	0,27±0,02[a]
$C_{18:1}$: olajsav *(oleic acid)*	22,98±0,53[a]	19,50±1,89[b]
c-$C_{18:1}$: vakcénsav *(vaccenic acid)*	0,64±0,05[b]	0,79±0,04[a]
9t-$C_{18:1}$: elaidinsav *(elaidic acid)*	1,54±0,14[b]	5,60±1,54[a]
$C_{20:1}$: eikozénsav *(eicosenoic acid)*	0,13±0,00[b]	0,21±0,02[a]
MUFA: Egyszeresen telítetlen zsírsavak *(Monounsaturated fatty acids)*	28,62±0,67[b]	30,76±1,12[a]
$C_{18:2}$ (n-6): linolsav *(linoleic acid)*	2,50±0,23	2,68±0,39
CLA 1 (c9, t11): konjugált linolsav *(conjugated linoleic acid)*	0,42±0,02[b]	1,44±0,39[a]
CLA 2 (t10, c12): konjugált linolsav *(conjugated linoleic acid)*	0,02±0,00[b]	0,05±0,01[a]
CLA 3 (c9, c11): konjugált linolsav *(conjugated linoleic acid)*	0,02±0,00[b]	0,06±0,00[a]
CLA 4 (t9, t11): konjugált linolsav *(conjugated linoleic acid)*	0,03±0,00[b]	0,05±0,00[a]
$C_{18:3}$ (n-3): linolénsav *(linolenic acid)*	0,32±0,04[b]	0,59±0,05[a]
$C_{18:3}$ (n-6): γ-linolénsav *(γ-linolenic acid)*	0,03±0,00[a]	0,01±0,00[b]
$C_{20:2}$ (n-6): eikozadiénsav *(eicosadienoic acid)*	0,03±0,00	0,04±0,00
$C_{20:3}$ (n-6): eikozatriénsav *(eicosatrienoic acid)*	0,12±0,00[a]	0,09±0,01[b]
$C_{20:4}$ (n-6): arachidonsav *(arachidonic acid)*	0,18±0,00[a]	0,13±0,01[b]
$C_{20:5}$ (n-3): eikozapentaénsav *(eicosapentaenoic acid)*	0,02±0,00[b]	0,06±0,01[a]
$C_{22:2}$ (n-6): dokozadiénsav *(docosadienoic acid)*	0,01±0,00	0,02±0,00
$C_{22:4}$ (n-6): dokozatetraénsav *(docosatetraenoic acid)*	0,05±0,00[a]	0,03±0,00[b]
$C_{22:5}$ (n-3): dokozapentaénsav *(docosapentaenoic acid)*	0,05±0,00[b]	0,09±0,00[a]
$C_{22:6}$ (n-3): dokozahexaénsav *(docosahexaenoic acid)*	–	0,05±0,02
PUFA: Többszörösen telítetlen zsírsavak *(Polyunsaturated fatty acids)*	3,83±0,29[b]	5,45±0,53[a]
UFA: Telítetlen zsírsavak *(Unsaturated fatty acids)*	32,45	36,21
Egyéb zsírsav (4)	1,63	4,84
Σn6	2,92	3,00
Σn3	0,39	0,79
n-6/n3 arány	7,48	3,79

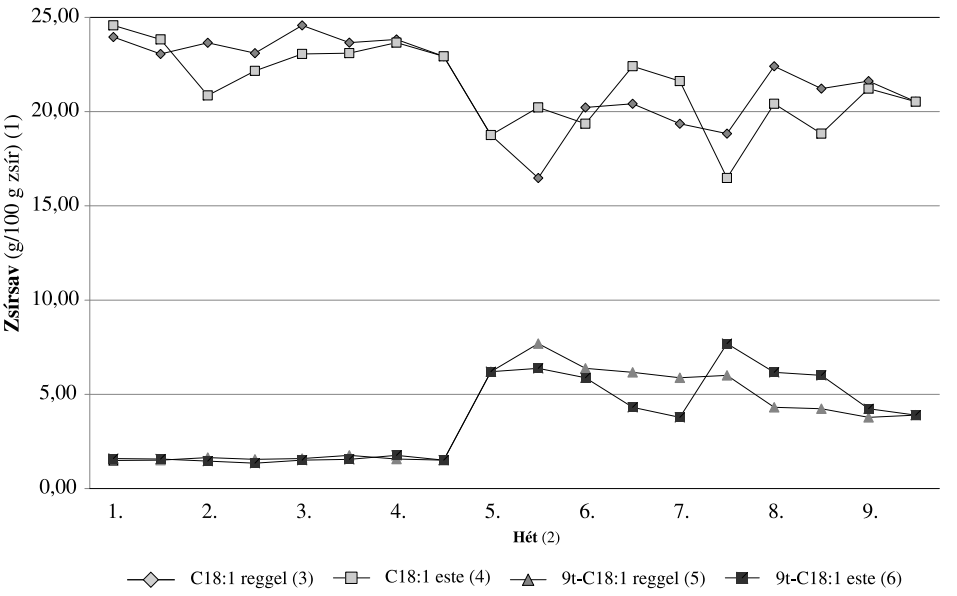
a, b: A vízszintes sorokon belül a különböző betűvel jelölt értékek szignifikánsan eltérnek egymástól (P < 0,05)
a, b: different superscripts within a row indicate significant differences (P < 0.05)
(1) fatty acid, (2) control, (3) experimental, (4) non identified fatty acid

5. táblázat A kontroll és a kísérleti csoport tejének zsírsavösszetétele
(esti elegytej minták, n = 12; g zsírsav/100 g zsír)

Table 5. Fatty acid profile of control and experimental group
(in the evening, n = 12; g fatty acid/100 g fat)

Zsírsav (1)	**Kontroll** (2)	**Kísérleti** (3)
$C_{8:0}$: kaprilsav *(caprylic acid)*	0,94±0,03[a]	0,79±0,07[b]
$C_{10:0}$: kaprinsav *(capric acid)*	2,39±0,12[a]	1,97±0,22[b]
$C_{11:0}$: undekánsav *(undecanoic acid)*	0,34±0,07	0,28±0,02
$C_{12:0}$: laurinsav *(lauric acid)*	3,07±0,17[a]	2,62±0,26[b]
$C_{13:0}$: tridekánsav *(tridecanoic acid)*	0,19±0,00[a]	0,16±0,01[b]
$C_{14:0}$: mirisztinsav *(myristic acid)*	10,48±0,45	10,31±0,50
$C_{15:0}$: pentadekánsav *(pentadecanoic acid)*	1,00±0,03	1,04±0,06
$C_{16:0}$: palmitinsav *(palmitic acid)*	34,73±0,38[a]	32,62±0,31[b]
$C_{17:0}$: heptadekánsav *(heptadecanoic acid)*	0,57±0,00[b]	0,76±0,02[a]
$C_{18:0}$: sztearinsav *(stearic acid)*	9,88±0,54[a]	7,39±0,74[b]
$C_{20:0}$: arachidsav *(arachidic acid)*	0,15±0,01[b]	0,23±0,03[a]
$C_{22:0}$: behénsav (*behenic acid*)	0,04±0,00[b]	0,05±0,00[a]
SFA: Telített zsírsavak *(Saturated fatty acids)*	63,78±0,76[a]	58,22±1,40[b]
$C_{14:1}$: mirisztoleinsav *(myristoleic acid)*	1,00±0,06[b]	1,43±0,10[a]
$C_{16:1}$: palmitoleinsav *(palmitoleic acid)*	2,28±0,06[b]	2,91±0,26[a]
$C_{17:1}$: heptadecénsav *(heptadecanoic acid)*	0,20±0,00[b]	0,28±0,02[a]
$C_{18:1}$: olajsav *(oleic acid)*	23,75±0,66[a]	20,47±0,52[b]
c-$C_{18:1}$: vakcénsav *(vaccenic acid)*	0,69±0,02[b]	0,78±0,03[a]
9t-$C_{18:1}$: elaidinsav *(elaidic acid)*	1,56±0,06[b]	5,31±1,18[a]
$C_{20:1}$: eikozénsav *(eicosenoic acid)*	0,13±0,00[b]	0,23±0,02[a]
MUFA: Egyszeresen telítetlen zsírsavak *(Monounsaturated fatty acids)*	29,61±0,70[b]	31,41±0,99[a]
$C_{18:2}$ (n-6): linolsav *(linoleic acid)*	2,61±0,13	2,73±0,23
CLA 1 (c9, t11): konjugált linolsav *(conjugated linoleic acid)*	0,43±0,02[b]	1,38±0,26[a]
CLA 2 (t10, c12): konjugált linolsav *(conjugated linoleic acid)*	0,03±0,00[b]	0,04±0,01[a]
CLA 3 (c9, c11): konjugált linolsav *(conjugated linoleic acid)*	0,02±0,00[b]	0,06±0,00[a]
CLA 4 (t9, t11): konjugált linolsav *(conjugated linoleic acid)*	0,03±0,00[b]	0,05±0,01[a]
$C_{18:3}$ (n-3): linolénsav *(linolenic acid)*	0,31±0,01[b]	0,62±0,10[a]
$C_{18:3}$ (n-6): γ-linolénsav *(γ-linolenic acid)*	0,03±0,00[a]	0,01±0,00[b]
$C_{20:2}$ (n-6): eikozadiénsav *(eicosadienoic acid)*	0,03±0,00	0,04±0,00
$C_{20:3}$ (n-6): eikozatriénsav *(eicosatrienoic acid)*	0,12±0,00[a]	0,10±0,00[b]
$C_{20:4}$ (n-6): arachidonsav *(arachidonic acid)*	0,19±0,00[a]	0,14±0,02[b]
$C_{20:5}$ (n-3): eikozapentaénsav *(eicosapentaenoic acid)*	0,02±0,00[b]	0,06±0,00[a]
$C_{22:2}$ (n-6): dokozadiénsav *(docosadienoic acid)*	0,01±0,00	0,02±0,00
$C_{22:4}$ (n-6): dokozatetraénsav *(docosatetraenoic acid)*	0,05±0,00[a]	0,03±0,00[b]
$C_{22:5}$ (n-3): dokozapentaénsav *(docosapentaenoic acid)*	0,05±0,00[b]	0,10±0,00[a]
$C_{22:6}$ (n-3): dokozahexaénsav *(docosahexaenoic acid)*	–	0,05±0,02
PUFA: Többszörösen telítetlen zsírsavak *(Polyunsaturated fatty acids)*	3,95±0,15[b]	5,49±0,50[a]
UFA: Telítetlen zsírsavak *(Unsaturated fatty acids)*	33,56	36,90
Egyéb zsírsav (4)	2,66	4,88
Σn6	3,04	3,07
Σn3	0,38	0,83
n-6/n3 arány	8,00	3,69

a, b: A vízszintes sorokon belül a különböző betűvel jelölt értékek szignifikánsan eltérnek egymástól ($P < 0,05$)
a, b: different superscripts within a row indicate significant differences ($P < 0.05$), as in *Table 4.*



1. ábra A C18:1 és a t-9 C:18 (elaidinsav) részarányának változása az előetetés (1–3. hét) és a kísérleti szakasz (4–9. hét) során (g zsírsav/100 g zsír)

Figure 1. Changes in the ratio of C18:1 and t-9 C:18 fatty acid during preliminary (1–3. weeks) and experimental (4–9. weeks) period (g fatty acid/100 g fat)
(1) fatty acid, g/100 g fat, (2) week, (3) C18:1 (morning), (4) C18:1 (evening), (5) 9-t C18:1 (morning), (6) 9-t C18:1 (evening)

Következtetések

Az elvégzett kísérletből összefoglalóan megállapítható, hogy a kidolgozott fűszenázsalapú takarmányozás és a továbbfejlesztett omega-3 zsírkészítmény alkalmazása nem befolyásolta a tehenek tejtermelését, illetve a tej fehérje- és laktóztartalmát. Szignifikáns mértékben csökkent ugyanakkor a reggeli és az esti tejmintákban a zsírtartalom, és ennek következtében a szárazanyag-tartalom is. A zsírsavösszetétel tekintetében pozitív és negatív hatásokat egyaránt tapasztaltunk. Megállapítottuk, hogy az összeállított takarmányadag a fontosabb n-3 zsírsavak (pl. ALA, EPA, DPA és DHA), továbbá a CLA izomerek (pl.c9,t11; t10,c12) részarányát szignifikánsan javította. Ez egyben megnövelte a tej PUFA-tartalmát, illetve szűkítette az n-6/n-3 arányt mind a reggeli, mind az esti elegytej mintákban. A kedvező hatások mellett a transz-zsírsavak (t-9-C18:1) mennyisége szignifikáns mértékben nőtt, ami humántáplálkozási szempontból kedvezőtlen változásnak tekinthető. A kísérleti takarmányadag etetésének megkezdését követően mért kiugróan magas transz-zsírsav mennyiség fokozatosan csökkenő tendenciát mutatott. Ez felhívja a figyelmet arra, hogy az olyan típusú kísérletekben, ahol a tejzsírsav-összetétel módosítása a fő cél, célszerű hosszabb vizsgálati szakaszt beiktatni.

Effect of combined utilisation of grass haylage based diet and fish oil based coated fat supplement on fatty acid profile in milk

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Summary

The effects of combined utilisation of grass haylage based ration and fish oil based coated fat supplement (*Adexgo-1*, produced by Adexgo Ltd., Balatonfüred) feeding on the yield, the composition and the fatty acid content of milk were examined using *Holstein-Friesian* cows (n = 80) in a farm trial. Morning and evening milk samples were collected and tested. It was found that feeding the preserved grass based ration and the omega-3 fat supplement had no influence on milk production, and/or on milk protein and lactose content. In contrast, dry matter and fat content decreased significantly ($P < 0.05$) in the morning and evening milk samples. The rate of C17:0; C20:0; C22:0 fatty acids from the group of saturated fatty acids (SFA) significantly increased ($P < 0.05$), whereas the rate of C8:0; C10:0; C12:0; C13:0; C16:0; C18:0 significantly decreased in the samples collected from the experimental group. Due to feeding experimental diet, the percentage of monounsaturated fatty acids (MUFA) – except oleic acid (C18:1) – increased significantly both in the morning and evening milk samples. The rate of trans fatty acids (TFA) increased up to 3.40 and 3.64-fold in the evening and morning milk samples, respectively. The high quantity of TFAs measured after feeding experimental diet showed a gradually decreasing trend. The experimental diet significantly improved the percentage of the major n-3 fatty acids (C18:3, C20:5, C22:5 and C22:6) and the tested CLA isomers. It also increased the PUFA content of milk and narrowed the n-6/n-3 ratio both in the morning (7.48:1 *vs.* 3.79:1) and evening (8.00:1 *vs.* 3.69:1) milk samples (control *vs.* experimental, respectively).

Keywords: dairy cow, fish oil, bypass fat supplement, omega-3, CLA, fatty acid profile.

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Possibilities of evaluation of energy plant sector in agriculture

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SUMMARY

The importance of energy plant sector – being one of the agricultural sectors – shows a growing tendency in the developed world, at the same time considerable competition exists on the energy market among the different energy sources and basic materials. The competition between the two major groups, the fossil energy sources and the renewable energy sources is present in all the energetic sectors, and the competition is also considerable among the energy sources used for similar energetic purposes. According to the directive of the European Council, Hungary is supposed to reach a 13% share of renewable energy sources by 2020 in the final energy use. The new National Action Program sets the target value of 107 PJ/year concerning the gross utilisation of renewables by 2020.

Agricultural conditions are favourable for energy farming in Hungary, along with its positive effects. Due to its complex and widespread relations, the present situation and future development of energy farming have a considerable effect on the other sectors of the national economy. The macro-economic evaluations of energy farming may highlight those factors that – either in negative or in positive direction – influence the present state of the sector and support the elaboration of the sector strategy.

Keywords: renewable energy, energy plant sector, competitiveness.

INTRODUCTION

The share of renewable energy sources shows an increasing tendency in the world, and energy farming can play an increasingly important role also in the future of the Hungarian agricultural sector. It is indicated both in the mid- and long-term expectations of the European Union concerning the use of renewables and in the Hungarian commitments to increase the share of renewables in energy use.

The increase of share of renewables is both an international and national priority. Besides, energy import dependency could be decreased, and – not at last – the safety of supply could

be increased. All these factors underline that renewable energy sources are emphasized in the energetic development plans from the beginning of the new millennium; among the renewables the utilisation and the analysis of characteristics of biomass play an important role.

Material and methods

Several sources have been included and different viewpoints have been mapped for collecting and evaluating data concerning the research topic. During the research macro-economic evaluation methods have been used to support the elaboration of the strategy for the energy farming sector.
In the first phase of analysis different macro-economic factors – such as political and economic situation, social, technological, environmental and legal background – have been mapped with PESTEL analysis. In order to define further possibilities and limiting factors, the evaluation of the sector and the already established or potential competition factors have been revealed. Finally, the method of SWOT analysis has been applied to collect and structure the collected data and findings, to support the evaluation of the present state and future position of the investigated sector.

Results and conclusions

Analysis of the environment

One possible method for the evaluation of the environment in a wider sense (macro-environment) is the PESTEL analysis. The method refers to the investigation of the significant macro-environmental factors (Political, Economic, Social/Socio-cultural, Technological, Environmental, Legal) and explores the present state and future development possibilities of the energy farming sector (*Bartek-Lesi et al.* 2007). Macro-environment provides a frame that cannot be influenced, what the investigated sector needs to adapt to.
The effect of **policy** on the energy farming sector can primarily be perceived through international and national strategies that aim to improve renewable energy sources.
In 2008 the European Council defined the following objectives: to decrease the emission of greenhouse gas effects by 20%, energy consumption should be decreased by 20% by 2020 compared to the prognosis, the share of renewable energy sources in the total energy consumption of the EU should be increased to 20%, gasoline and diesel use in the traffic should include at least 10% biofuel use (in energy value). According to the directive Hungary is supposed to reach a 13% share of renewable energy sources in final consumption by 2020. The new National Action Plan defines a target value of 107 PJ/year of gross renewable energy use by 2020 (*MET* 2008, *MND* 2010).

From the **economic** factors the current changes in agriculture and energetic considerably influence the situation of energy farming. Energy prices increased significantly in Hungary in the past years, at the same time energy consumption is continuously above 1100 PJ and this value is not expected to decrease in the near future. Almost 70% of energy use in Hungary originates from import; this value well indicates the dependency from the service providers. Development possibilities unambiguously refer to the increase of renewable energy sources; therefore the increasing tendency of biomass-based energy production is a favourable process (between 1997–2008 from 408 toe /tonnes of oil equivalent/ up to 1520 toe).
While the share of agriculture from the GDP reached 6.8% in 1995, by 2008 this rate fell back to 3.7%. Deepening the problem, the proportion of the main sectors in agriculture changed unfavourably: the total gross output reached 1621 million HUF in 2009, of which plant production reached 54%, the share of animal and animal products was 37%, and 9% came out from agricultural services and secondary activities (*HCSO* 2010 a,b).
The main objective is to increase the income-generating ability and competitiveness in agriculture, the production of energy plants can considerably support this objective.
Concerning **social and cultural** relations of the investigated sector it is very unfavourable in Hungary that environment-conscious way of thinking and living is still not popular or widely considered, mainly due to financial reasons. Consumer practices and habits concerning energy supply depend on the established and operating systems, and the influence of ”demand on possibilities” is very limited!
Production **technology** and the technical conditions are mainly available; the available agricultural and forestry machinery base can be used for energy farming purposes. The technical background for the use of energy originating from renewable is also available; moreover, the existing capacities are not totally utilised. As the result of current developments heating units designed for small-scale or family use can be purchased; the efficiency of such heating equipments can reach 90%, but the switch to such technology is very expensive.
The importance of energy plants from **environmental protection** aspects can be primarily described by the rate of decrease of emission of dangerous materials originating from the use of fossil energy sources, whereas the decrease is the resulting from the use of renewables. It should be mentioned that some energy plants also have excellent organic melioration characteristics.
Investigating **legal** aspects it should be emphasised that the explanation of green energy, biomass should be accurately defined when we talk about renewable energy sources. At the moment the inaccurate definition or approach gives floor to processors to free explanations. As a consequence the increasing share of fire wood in heat energy production puts considerable pressure on sylviculture.

Sector analysis

The analysis of different sectors of the national economy highlights certain connecting points of energy farming. Energy gained can be used by almost every sector of the national economy, on the other side these sectors can be connected to the production process in several ways. Just to mention some connecting points: machinery and other equipments

used in the production and processing process, education that provides skilled labour, advisors working in the extension service, or for example banking services that are crucial in business financing, or the shipping industry at sales activities (*Figure 1.*).

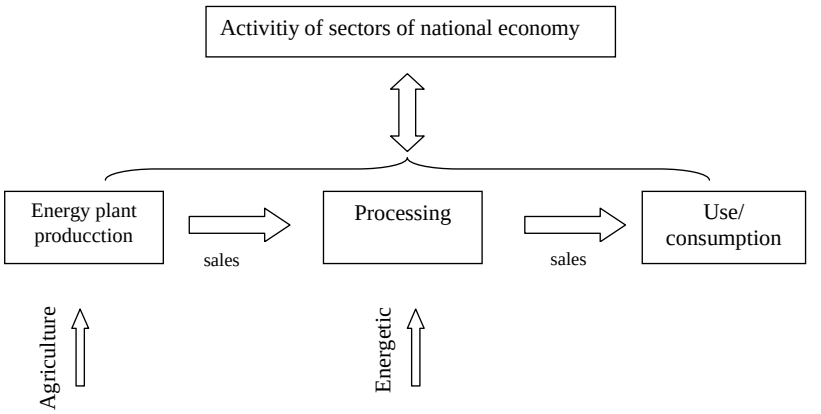

Figure 1. Connection points of energy plants and the uniform sector classification system of economic activities *(Source:* Edited by the authors)

Energy plants are in direct contact with two major national strategic sectors, namely agriculture and energy industry.

The favourable agricultural conditions in Hungary evidently facilitate plant production for energetic purposes, improving profitability, employment in rural areas, and the utilisation of less favoured areas. Besides the positive factors the main conflict of interest between food production and land use for non-food purposes should also be mentioned, this conflict of interest affects producers and national strategy decision-makers as well. It seems indispensible that the balance should be found.

The outstanding development fields in energetic include renewable energy sources, and biomass is one among them. Production potentials – that are not utilised at the moment – should be used primarily for heat energy, in secondary form for "green power". The increase of share of renewables is both an international and national priority, besides environmental aspects, energy import dependency could be decreased, and the safety of supply could be increased.

Competition situations, advantages, strategies

Competition in agriculture is present between the main sectors, within the main sectors and also among products.

Competition between the main sectors primarily is resulted from the use of resources. Plant production produces feed for animal keeping; therefore animal husbandry can affect the structure of plant production, the use of product considerably. Let's think about maize that can be used for energetic, industrial purposes and for feeding animals or straw that is a basic material for both animal keeping and heat production.

Within plant production – as one of the major sectors in agriculture – fierce competition exists for the use of land as a primer resource, but also for the use of further resources (e.g. labour, tools and equipments). On one hand the so-called traditional food and feed producing plant production sectors compete with energy plant production, on the other hand even within the energy farming sector the different plants, species compete. The level and strength of competition within energy farming is primarily defined by the direction of use, purpose of consumption. The competition is less important between oilseed rape produced for biodiesel and energy grass produced for heat energy, than between for example two arboreal energy plantations.

Concerning energy industry the competition is strong for the different energy sources. The two main groups, fossils and renewables compete in every energy sector. The example of electricity could be mentioned, where besides wind energy and connected heat energy, biomass also appeared.

The competition among energy sources used for similar purposes can be significant, as illustrated on *Figure 2*.

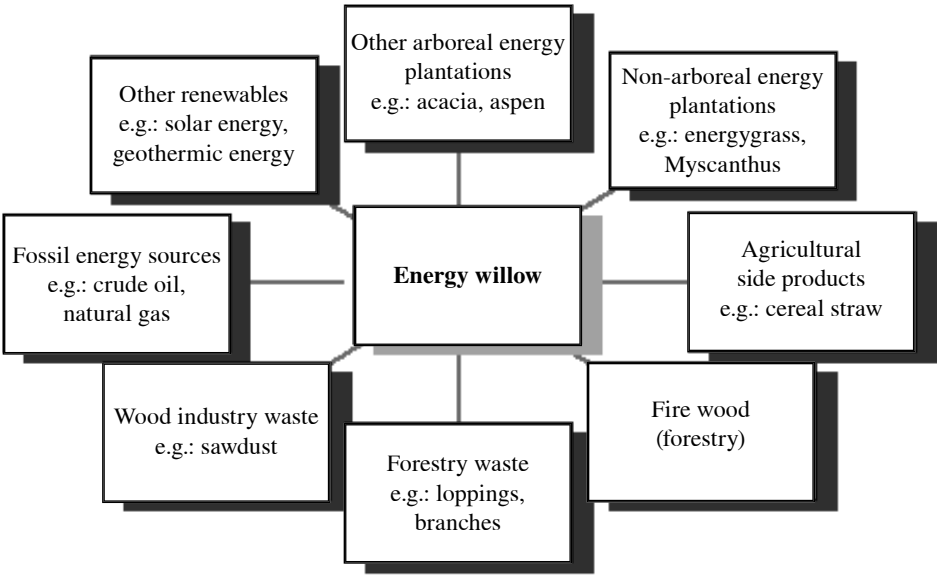

Figure 2. Substitutes to heat energy originating from energy willow
(*Source:* Edited by the authors)

In the drafted competition situation, from energetic aspect the production cost of certain energy unit is the most important factor; production cost is affected by the procurement price of the energy source, further costs of processing, energetic parameters etc. At the moment production cost is an advantage for fossil energy sources, mainly due to the high investment costs of renewables. On the other hand if one considers the limited stocks and the low level of energy-sources in Hungary, another approach comes to focus.

The most important advantage that comes from differentiation is defined by the government strategy. Even if nowadays the processing of renewable energy sources is more expensive than of fossil energy sources, the government ensures the use of renewables with direct and indirect incentive tools in order to reach the long-term objectives. Such tools are for example the obligatory procurement balance circle and development supports; concerning developments in the main thermal power stations the effects of these factors can already be observed.

The problem is that this tempo is slower in the production of the basic material. The strategy exists and defines biomass as the main development field (having the highest potential in this renewable source), and according to statistical data biomass use increases year by year, but the questions is: from what basic material source? Considering the current situation of energy farming fire wood can be a basic raw material, but in this case the sustainability of sylviculture is endangered! Government regulation is needed to avoid similar anomalies in the production of renewables, and to provide advantage for the real "green" energy sources in the competition to encourage the spread in a wider scale. This way the reputation of energy plant production could be improve within the agricultural sector.

SWOT analysis

The method originates from business life and it is mainly used for strategy-making purposes; it is a tool used for the analysis of an organisation with open evaluation of the situation. The method can also be applied for the evaluation of an organisational unit, person, region, sector, project etc. with the main objective to prevail the current state of the subject of investigation, to define strengths or missing or underdeveloped phenomena. Besides, the analysis focuses on the affecting positive and negative external conditions and tendencies – threats and possibilities. Its function is to connect the evaluation of the situation with the definition of objectives and priorities by summarizing the situation in a well-structured form and by helping to select or structure the certain statements.

	Positive factors	**Negative factors**
Internal factors	**S** (Strengths)	**W** (Weaknesses)
External factors	**O** (Opportunities)	**T** (Threats)

Strengths

Resources

– The primer resource of production – land – is available.
– Technological and technical conditions are adequate. The available agricultural and sylviculture machinery base could also be used in plantations; furthermore, machine utilisation efficiency can be increased in case machines are used in dull seasons.

Profitability

– Supports: even 40–60% of planting costs of arboreal or non-arboreal plantations for energetic reasons (*MRD* 2007). Besides, producers are eligible for direct payments, or can apply for LFA support (*Lukács Gergely* 2009).

Risk-decreasing factors

– Demand for biomass increases continuously, purchase (procurement) needs are ensured on the long-term. The obligatory procurement of the secondary product (green current) increases sales safety.
– Appearance of integration systems.

Utilisation

– Production for own needs is encouraged by incentives to use renewables from agricultural sources, to decrease fossil dependency. Furthermore, thanks to technological developments, it is not only the power plants that have suitable equipments for effective use of biomass.
– Certain plantations (energy willow) offer solution to the environment friendly use of liquid manure from animal keeping, or wastewater from industrial or communal sources.

Weaknesses

Factors that detain entrepreneurial activity

– Low level of spread of use, few positive examples.
– Lack of information on producer level.
– Lack of advisory network.
– Transport costs are very high, energy density is low; therefore the distance of location of energetic use is a determining factor.

Risk-increasing factors

– The most important blocking factor of planting is the high investment cost.
– Own share of investments can be reduced with support applications, but only afterwards – such support projects require pre-financing from the investor.
– Concerning land-use aspects it should be noted that energetic plantations ”occupy” the land for 15–20 years.

Agro-technical requirements

– The special production needs of certain plants concerning the production site (e.g. willow needs much water) or other agro-technical needs should be considered.

Possibilities

Agriculture

– Favourable climatic conditions, considerable un-used biomass potential.
– The traditional structure of agriculture widens, competitiveness improves.
– Employment in agriculture increases, in harmony with the rural development strategy.
– Significant sources from EU funds are available for production, processing, use and developments.

Energy policy

– The production of renewables contributes to the decrease of import; therefore the serious energy dependency can be improved.

– Facilitates decentralised energy supply.
– The limits of fossils can be increasingly observed in increasing prices, ensuring more favourable competition positions to the production and use of renewables.
– Highly developed technologies are available, further R&D sources are expected.

Environmental protection

– Undertakings to international and EU regulations should be fulfilled.
– The emission of dangerous agents decreases, in harmony with climate-political ambitions.

Threats

Conflict of interest

– Concerning land use in agriculture for food or non-food purposes might result a conflict of interest. It is hard to define the balance and support level to ensure that energy farming only takes place in fields recommended for this purpose and not for food-production purposes.
– The opposition of salesmen of fossil energy sources is very strong.

Finding the balance

– Lack of balance between production and processing. Energy demand and processing capacities are considerably higher than the available volume; this difference seems to enlarge.
– Dependency on support system. The spread and development of the sector highly depends on financial supports.

Regulations (supports)

– Strict regulations and suitable supports are needed to ensure that biomass reaches processors (agricultural and sylviculture side products, waste from wood industry, energy plants), meeting the defined objectives. (At present the majority of biomass refers to the traditional fire wood, endangering the sustainability of sylviculture.)
– The transformation of the available technology, or new investments are extremely expensive, financing from own sources can be problematic. (For example to change from gas heating with existing gas network to biomass heating.)

Az energianövény-ágazat elemzésének lehetőségei az agráriumban

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Összefoglalás

Az energianövény-szektornak, mint mezőgazdasági ágazatnak a jelentősége a fejlett világban növekvő tendenciát mutat, ugyanakkor az energiaiparon belül jelentős verseny zajlik a különböző alapanyagot biztosító energiahordozók között. Két fő csoport, a fosszilis energiahordozók és a megújuló energiaforrások versenye minden energetikai ágazatnál jelen van, valamint jelentős versenyhelyzet alakulhat ki az azonos felhasználási irányú energiahordozók körében is. Az Európai Tanács irányelve alapján Magyarország felé 2020-ra 13%-os megújuló energiahordozó részarány-elvárást fogalmaztak meg a végfelhasználásban. Az új Nemzeti Cselekvési Tervben foglaltak szerint 2020-ra a bruttó megújuló energiahordózó-felhasználás célértéke 107 PJ/év lesz.

Magyarország kedvező mezőgazdasági adottságai kiváló lehetőséget kínálnak az energetikai növénytermesztésre, annak számos pozitív hatásával együtt. Szerteágazó kapcsolatrendszere révén az energianövény-ágazat helyzete és fejlődése komoly hatást gyakorol a nemzetgazdaság más részeire is. Az energianövény-ágazat makrogazdasági elemzései feltárhatják azokat a tényezőket, amelyek – pozitív, vagy negatív irányban – befolyásolják a szektor helyzetének alakulását és segíthetik az ágazat stratégiájának kidolgozását.

Kulcsszavak: megújuló energia, energianövény-ágazat, versenyképesség.

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Supply response on the Hungarian pork sector

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SUMMARY

Despite of the increasing production and consumption of white meats, swine production is still one of the most important sectors of animal husbandry worldwide as well as in the European Union. In Hungary over recent decades, the swine industry has undergone significant changes. The livestock has decreased sharply from more than 8.5 million in 1989 to 3.3 million currently. After the post 1989 increase of herd size on family farms, their share diminished, and currently two-thirds of output is produced by corporate farms. It appears that small scale pork producers have major difficulties, and must consider all cost reducing alternatives to improve their competitiveness. Considering the pressure on purchase prices from the downstream markets, and the fact that feed represents about 50–60% of total production costs, in this paper we analyze the influence of these two factors on swine producer's supply response. We employ Vector Error Correction Model specification, following the theoretical model of *Hallam* and *Zanoli* (1993). Estimated long-run elasticities highlight farmers' reliance on the slaughter purchase price of live pigs and soybean meal price.

Keywords: error correction model, supply response, pork sector, Hungary.

INTRODUCTION

Swine production was one of the most dramatically affected segments of Hungarian agriculture by the massive changes after 1989. The dismantling of socialist agricultural enterprises and cooperatives, and the shift towards private farming, had a major impact upon the pig stock which was reduced by half in just a couple of years. Newly emerged family farms producing pork are fighting for survival, many being subsistence farms.

There are several reasons for the decreasing Hungarian pig production including the loss of former markets, enhanced competition after joining to EU, inefficient pig production (daily weight gain, feed conversion rate), high price of feedstuff, etc.

The Hungarian meat industry is characterized by a distorted market structure, emphasized by the large number of small, inefficient firms. The dramatic decrease of raw material production left many of the formerly efficient larger size companies struggling with unused processing capacity. *Jansik* (2000) studying the foreign direct investment (FDI) in Hungary, finds that industries characterized by a monopolistic market structure (sugar, vegetable oil, tobacco, soft drinks, starch) were privatized in the early 1990s, having over 70% foreign ownership of their capital. Meat processing is the largest segment of the food industry, accounting for over 18% of the total Hungarian food processing output. The sales of meat industry indicate a slightly growing trend. The number of firms decreased by about 50% between 1996 and 2000, and then it started to grow again. The privatization of the meat industry started late, in the mid 1990s, and was characterized by low FDI. In 2005, approximately 40% of total capital was in foreign ownership. Thus, the concentration process was delayed; the five firm concentration ratios in the meat industry are still rather low with 30.6% in 1992, and 44.1% in 2003. The Hungarian pork sector has experienced numerous structural changes in the past 15 years. From 9.5 million head in September 1990, the pig stock decreased to 4.3 million by December 1994, and it has fluctuated at around 5 million head ever since. One important feature of the Hungarian swine industry is the large number of small-scale farms. Even before privatization, small-scale farms accounted for 50% of the total pig stock, a figure that has not changed significantly since 2005. Many of these small-scale farms do not have commercial activity, i.e. they are subsistence farms. However, a large proportion of them sell their products, forming a two-tier commercial and family pork production system. The average herd size by farm type illustrates unambiguously a dual production structure in the Hungarian pork sector. The average herd size varies between 9–16 pigs. However these numbers hide the significant differences between various types of farms. Private farms on average hold 5 to 7 pigs, while the average herd size for economic organizations is 3.3 to 4.4 thousand pigs. Considering the technology of pig fattening, there is a significant fluctuation concerning the most important feed ingredients (soybean, corn, wheat, barley). At present, soybean meal is the most important feed ingredient. Despite the decreasing animal livestock, Hungary is still a net importer of soybean meal with approximately 600–700 thousand tonnes being imported every year.

The remainder of this manuscript is organized where the second section briefly reviews the existing supply response literature in Central and Eastern European (CEE) countries, followed by the empirical methodology in section 3. Variables are described in section 4, while results are presented in section 5. The last section summarizes and offers some conclusions on the implications for the Hungarian pork producers.

Literature review

There is already a great wealth of literature examining various aspects of the transition period from the transformation in the farm structure to competitiveness and efficiency analysis or vertical price transmission of various sectors. Research into the key determinants, and indeed the estimation of an appropriate agricultural supply response model for transition economies is, however, scarce. One reason for the limited availability of data is that only semi-annual pig stock data exists. Of the papers focusing on supply response in CEE countries, *Hallam* (1998) analyses the supply response in some transition economies, namely Bulgaria, Romania and Slovenia. The author points out the problems of estimating econometric supply models due to the numerous structural breaks that occurred during the transition period, and the lack of sufficiently long time series data. *Mishev et al.* (1998) estimate the price elasticities of supply for Bulgarian crop products, concluding higher own price elasticities than in developed economies, mostly determined by input shortages. *Nyárs* and *Vizvári* (2005) apply linear and non-linear regression equations to estimate the supply response on the Hungarian pork market. The authors estimate that in good market conditions for pork producers (low input, high output prices), the Hungarian pork sector can produce 526,000 tons of live pigs for slaughter, while in unfavourable market environments (high input, low output prices) the capacity is reduced to 411,000 tons.
Contrary to the *Nyárs* and *Vizvári* (2005), the aim of this paper is to estimate a parsimonious Vector Error Correction econometric model, using yearly data from the past 21 years. We follow the methodology outlined in *Hallam* and *Zanoli* (1993) which prove the superiority of error correction specifications to the more common partial adjustment models with regard to agricultural supply response. Earlier studies (e.g. *Ness* and *Colman* 1976, *Holt* and *Johnson* 1988 or *Hallam* and *Zanoli* 1993) demonstrated that the target breeding herd may be modelled as a linear function of own price (pig purchase price) and feed price. Also, the pig production technology excludes the possibility of significant cross-price elasticities with respect to other outputs.

Materials and methods

The long-run supply function may be modelled as:

$$st = c + \beta 1pe + \beta 2fe \qquad (1)$$

where st is the target breeding stock, pe is the expected real purchase price, and fe is the expected feed price. There are several possibilities of defining farmers' price expectations, naive, rational or adaptive. *Hallam* and *Zanoli* 1993 shows, that a VECM model can adequately describe real pig and feed prices through autoregressive lags. Thus, we wish to estimate the long- and short-run pig supply elasticities with respect to slaughter pig and feed price.

The empirical procedure is based on modern time series econometrics, namely Vector Error Correction model estimations. Series are first tested for unit roots, then cointegration, followed by the estimation of a Vector Error Correction Model simultaneously depicting both long and short run response of the breeding stock to changes in pork purchase and soybean meal prices.

Testing for Unit Roots

With time series data, one needs to pay a particular attention to the stationarity of the variables. In the presence of unit roots, classical ordinary least square (OLS) regression yields biased estimates, invalid tests, and ultimately, spurious regressions. Considering the first order autoregressive process, AR(1):

$yt = \rho yt-1+et$ where t =…,-1, 0, 1, 2,…, and et is white noise error stochastic term. (2)

The process is considered as stationary, if $|\rho| < 1$, thus testing for stationarity is equivalent with testing for unit roots ($\rho = 1$). (2) is rewritten to obtain

$$\Delta yt = \delta yt-1+et \quad \text{where } \delta = 1-\rho \tag{3}$$

and thus the test becomes:

null hypothesis H0 : $\delta = 0$ against the alternative hypothesis H1: $\delta < 0$.

There are a large number of unit root testing procedures in the literature, see *Maddala* and *Kim* (1988) for a detailed discussion. Considering the notoriously low size and power properties of unit root tests, in this paper we employ three unit root tests that have alternative null hypotheses. The null hypothesis of the Augmented Dickey-Fuller, ADF (*Dickey* and *Fuller* 1979) and Phillips-Perron, PP (*Phillips* and *Perron* 1988) test is a unit root in the variable against the alternative of stationarity. The KPSS (*Kwiatkowski et al.* 1992) procedure tests the null of stationarity against the alternative of a unit root process.

Cointegration analysis and Vector Error Correction Modelling

Non stationary variables may be analyzed in a cointegration framework. We test for cointegration using Johansen's multivariate cointegration approach (*Johansen* 1988). This procedure is a Maximum Likelihood (ML) approach in a multivariate autoregressive framework with enough lags introduced to have a well-behaved disturbance term. It is based on the estimation of a Vector Error Correction model (VEC) of the form:

$$\Delta Zt = \Gamma 1 \Delta Zt-1+ \ldots+\Gamma k-1 \Delta Zt-k+1+\Pi Zt-k+ut \tag{4}$$

where Zt = [st, pt, sft]' is a (3x1) vector containing the three I(1) variables, where s stands for Hungarian breeding stock (sow stock), p the log of pork producer purchase price and sf the price of feed, t for time period, $\Gamma 1$,….$\Gamma k+1$ are vectors of the short-run parameters, Π is matrix of the long-run parameters, and ut is the white noise stochastic term. Monthly seasonal dummy variables may also be included.

$\Pi = \alpha\beta`$, where matrix α represents the speed of adjustment to disequilibrium and β is a matrix which represents up to (n–1) co integrating relationships between the non-stationary

variables. There are five possible models in (4) depending on the deterministic specification. Following *Harris* and *Sollis* (2003) these 1 to 5 models are defined as: (M1) no intercept or trend is included; (M2) the intercept is restricted to the cointegration space; (M3) unrestricted intercept without trends; the intercept in the cointegration space is combined with the intercept in the short-run model resulting in an overall intercept contained in the short-run model; (M4) if there exists an exogenous linear growth not accounted for by the model, the cointegration space includes time as a trend stationary variable; and (M5) allows for quadratic trends in Zt.

Dataset and Descriptive statistics of variables

Annual data between 1981 and 2009 were provided by the *Hungarian Central Statistical Agency (HCSA).* The dataset consists of the sow stock, s (used as proxy for the breeding stock), annual average purchase price of live pigs for slaughter, p, and the price one of the most important feed ingredients used in Hungarian pig production systems, soybean meal, sf. Price data was deflated to 1989 by the national Consumer Price Index. *Figures 1., 2. and 3.* present the log of the sow stock, pig purchase price and soybean meal price, respectively. The first graph illustrates the dramatic fall in the Hungarian total stock and indeed breeding stock after the fall of the socialist regime, discussed in the market overview section of this paper. In real terms, however, price data also appears to be downward trended.

Figure 1. The log of Hungarian sow stock

Note: Own calculations, data provided by *HSCA*

Figure 2. The log of pork producer purchase price

Note: Own calculations, data provided by *HSCA*

Figure 3. The log of soybean meal price

Note: Own calculations, data provided by *HSCA*

Table 1. presents the descriptive statistics of the 3 time series.

Table 1. Descriptive statistics of variables

Variable	No. of Observations	Mean	Std. Dev.	Min	Max
s	21	2.583	0.148	2.352	2.885
p	21	1.506	0.115	1.335	1.737
sf	21	3.878	0.125	3.667	4.131

Note: Own calculations, data provided by *HSCA*

Evaluation of results

To determine the properties of the time series data, a battery of unit root tests were applied. The null hypothesis of ADF and PP tests is unit root, against the alternative hypothesis of stationary series. The null hypothesis of the KPSS test however is stationary series against the alternative hypothesis of unit root in the series. *Table 2.* presents unit root test results in the sow stock, pig purchase price and soybean meal price series. The upper panel of *Table 2.* presents test statistics (with 5% critical values below each statistic in brackets) where the test regression contains an intercept only. Results obtained by test regressions with intercept and trend as deterministic specifications are presented in a similar fashion in the lower panel of *Table 2.*

Table 2. Unit root tests

Test statistic (5% crit. value)	s	p	sf
with intercept only			
ADF	–0.462	1.673	–2.454
	(–3.144)	(–3.119)	(–3.02)
PP	–1.804	–2.096	–2.433
	(–3.02)	(–3.02)	(–3.02)
KPSS‡	0.616**	0.63**	0.546**
	(0.463)	(0.463)	(0.463)
with intercept and trend			
ADF	–4.251**	–1.356	–1.084
	(–3.791)	(–3.875)	(–3.875)
PP	–2.06	–6.899***	–2.946
	(–3.658)	(–3.658)	(–3.658)
KPSS‡	0.132	0.322***	0.074
	(0.146)	(0.146)	(0.146)

Note: *** significant at 1%, ** significant at 5%, * significant at 10%
‡ the null hypothesis of the KPSS test is that variable is stationary

Mixed results were obtained. With intercept only, PP and ADF tests cannot reject the unit root null hypothesis, whilst the KPSS test significantly rejects the stationarity null hypothesis.

Figures 1., 2. and 3. however suggest that data might be trended but with intercept and trend specification, the picture is less clear. For the sow stock variable, ADF and KPSS tests suggest that data is stationary, while the PP test does not reject the unit root null. For the purchase price series, PP test rejects the unit root null, but ADF and KPSS tests suggest that the data contain unit root. Similarly, for the soybean meal price, KPSS suggest that data is stationary, however ADF and PP tests conclude that data is not stationary. Considering the notoriously low power and size properties of unit root tests, we carefully conclude that all three time series are not stationary, i.e. integrated of order one, I (1).

Non-stationary data must be cointegrated in order to estimate any long-run relationship between variables. A number of different deterministic specifications were sequentially tested for co integration. Test results for models M2 and M3 (see the methodology section) are presented in *Table 3.*

Table 3. Johansen cointegration tests

Number of CI vectors	**P-value** (intercept only)	**P-value** (intercept and trend)
0	0.029	0.007
1	0.478	0.086
2	0.382	0.376

Note: 3 lags in first differences were selected by AIC criteria

The null hypothesis of no cointegration between the 3 variables is rejected for both specifications. With trend included in the cointegration space, even the one cointegrating vector null hypothesis may be rejected in favour of 2 vectors at 10% level of significance. Based on the results from *Table 3.*, we consider the sow stock, pork purchase price and soybean meal variables co integrated with 1 cointegration vector. The long-run relationship between these variables, basically the supply response function is:

$$s = 2.758p - 1.391sf + 3.794 \quad (5)$$

Since data is in logs, coefficients represent long-run elasticities of the sow stock (breeding herd) with respect to the pork purchase price and soybean meal price. Thus 1% increase in expected pig purchase price induces an increase of 2.75% of the breeding stock, while the 1% increase in the expected feed price decreases the breeding stock by 1.39%. The estimated VECM model of the pork supply response is presented in *Table 4.* with some diagnostics and coefficients of determination in the lower panel. The upper panel contains the long-run supply response (with t statistics in brackets) identical to *Equation 4*. The middle panel presents the short-run dynamics of the VECM also meant to model the rational expectations hypothesis of the pig farmer through the autoregressive lags of variables. The first row of the middle panel contains the coefficients of the error correction term, (α in *Equation 3*, see methodology section) and their corresponding t statistics. These coefficients measure the speed of adjustment towards the long-run equilibrium, i.e. how fast the system returns to its long-run equilibrium path should an exogenous shock occur.

Table 4. Supply response Vector Error Correction Model

Variable	Cointegration equation		
st-1	1.000		
pt-1	–2.758		
	(–14.259)		
sft-1	1.391		
	(8.906)		
C	–3.794		
	(–10.882)		
short-run dynamics			
	Δst	Δpt	Δsft
error correction	0.271	0.478	–1.065
	(1.809)	(2.090)	(–2.364)
Δst-1	-0.162	–1.014	–0.004
	(–0.707)	(2.887)	(–0.006)
Δst-2	0.475	0.920	0.296
	(2.838)	(3.597)	(0.587)
Δpt-1	1.017	1.224	–1.438
	(3.215)	(2.531)	(1.508)
Δpt-2	0.257	0.461	–0.712
	(1.239)	(1.456)	(1.140)
Δsft-1	–0.142	–0.418	0.271
	(–1.001)	(1.923)	(0.632)
Δsft-2	0.052	–0.200	0.106
	(0.717)	(1.792)	(0.483)
diagnostics‡			
LM test AR(1)	0.106		
LM test AR(2)	0.124		
Jarque-Bera	0.706	0.921	0.148
R2	0.601	0.659	0.386

‡ p values (significance) are presented

The coefficients of adjustment are highly significant in the own price and feed price equations, but surprisingly only marginally significant (at 10%) for the breeding stock equation. A non-significant coefficient would mean that the short-run equation does not adjust to deviations from the long-run equilibrium, i.e. it is weakly exogenous on long-run. The model appears to be well specified, the null hypothesis of no first and second order autocorrelation in the residuals cannot be rejected at 5% level of significance. The residuals are normally distributed, while the coefficients of determination range between 38 and 66% acceptable for this kind of analysis.

Conclusions

The Hungarian swine industry, production as well as processing, has undergone extraordinary changes during the past two decades. The increasing competition and the continuous changes in the structure of farming and industry revealed several problems of the pork production in Hungary. In this paper, we showed that there is a long-run cointegrating relationship between the size of breeding stock, pork purchase price and soybean meal price. The analysis revealed the relatively high importance of expected pig purchase price and the price of the most important input, the price of soybean meal in the production decisions of farmers. Estimated long-run elasticities of the sow stock with regards to the pork purchase price and soybean meal are quite high; a 1% increase in expected pig purchase prices induces a 2.75% increase of the breeding stock, while a 1% increase in the expected soybean meal price decreases the breeding stock by 1.39%.

Kínálati reakció alakulása a magyarországi sertéshús szektorban

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Összefoglalás

A sertéstenyésztés még mindig a legfontosabb állattenyésztési ágazat annak ellenére, hogy a baromfihúsok termelése és fogyasztása folyamatosan növekszik mind világviszonylatban, mind az Európai Unióban. A sertéságazaton belül jelentős változás volt megfigyelhető hazánkban az elmúlt évtizedek során. Az állomány drasztikus csökkenése szemlélteti, hogy az 1989-ben még több mint 8,5 milliós állomány napjainkra mindösszesen 3,3 millióra tehető. A rendszerváltás utáni években a hazai sertésállomány jelentős részét képezte az úgymond „háztáji" sertésállomány, napjainkban azonban az állomány kétharmadát gazdasági társaságokon belül állítják elő. Ez a tendencia is szemlélteti, hogy a kisgazdaságoknak minden lehetséges költségcsökkentő alternatívát figyelembe kell venniük versenyképességük javítása érdekében. A sertéstenyésztők döntési reakcióit – ezáltal a hazai sertésállomány változását – vizsgáltuk az értékesítési piac által diktált gyakran nyomott árak, továbbá a takarmányozási költségek – az összes költségen belül elérik az 50–60 százalékot – függvényében. *Hallam* és *Zanoli* (1993) alapján a vektorhiba korrekciós modellt alkalmaztuk.

A becsült hosszú távú elaszticitás alapján előrevetíthetjük a termelők gazdasági döntéseit a vágósertés felvásárlási árak és a szója árak változásainak hatására.
Kulcsszavak: hiba korrekciós modell, kínálati reakció, sertéshús szektor, Magyarország.

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Marketing aspects of purchasing and trading animal products of ecological origin

CSABA BÓDI

Dissertation Adviser: Tamás Sántha, PhD, associate professor

There is a dynamically growing proportion of ecologically farmed land and the volume of sales of ecologic food stuffs in the whole world. This is due to the better environment consciousness induced by the negative influence of environmental changes, sustainable farming and the rising demand on healthy eating on behalf of the consumer society. During the past years there were considerable changes in the growing market of baby food among ecological products or as it is commonly used bio-products. Besides committed bio-farmers and producers, multinational companies appeared on the market urged by meeting the consumers' demands and capturing a market share. They used distribution and marketing instruments, which enlarged the circle of their consumers.

The basic aim of the thesis was to give an account of the development of ecological growing and processing, their legal background and consumer tendencies with special regard to animal origin products, carrying out target group investigations at the field of baby food, analyzing consumers' preferences and making suggestions that can be turned into practice. In order to reach the set objectives we collected secondary and primary data.

In the frame of secondary research we made an account of the development, progress and legal background of ecological production in Hungary and abroad; the situation of ecological animal husbandry in Hungary, the nutritional values and advantages of ecological products, the development of baby food production and its market share.

We prepared a literature review about the relevant marketing and consumers' behavior with special regard to that of ecological food stuffs.

Primary research covered the following items. Focused on baby food we investigated the consumer tendencies of bio-products. We analyzed in focus group interviews within the consumers' purchasing behavior: the preferences towards home made and fabricated baby food, the factors influencing the frequency of buying and consuming baby food and the possibilities of increasing the consumers' motivations

Further more we analyzed in the field of quality factors, motivations and preferences of baby food: the ingredients of good quality baby food and the awareness of nutritional advantages of raw materials from ecological produce. In the field of product structure and range we analyzed: the possibilities of sale, packing and packaging, the product development policies and the choice of baby food. According to the questionnaire interviews the order of quality factors was: quality,

flavour-combinations, healthy, practical packing and free of preservatives. Investigations proved that customers prefer strictly controlled quality parameters much more than bio-quality.
As a summary of own research we elaborated the complex customer model of those who choose the products of Hipp, Kecskemét and Nestlé according to different demographic and marketing specific or non-demographic characteristics.

Economic Analysis of Production Chain Stages of Native Hungarian Grey Cattle

NÓRA GOMBKÖTŐ

Dissertation Adviser: Rózsa Csatai, CSc, associate professor

In the dissertation are subjected the economic parameters and correlations of Hungarian Grey Cattle's total product line. In the course of researching the total product line are phased, the general economics of Hungarian grey cattle are analysed, breeders, processors and salesmen and their relationships are examined in economic ways, eventually problems and deficiencies are shown, and optimal solutions are determined relative to total product line.

New and novel scientific results are the following ones:

1. ***Hungarian Grey Cattle*** (the native cattle breed of our country) has increased lately, it doesn't have an important role in the economy and its ***contribution to the gross domestic product is not important.*** By the greater part of the animal stock the main utilization way is not the production of the meat as a raw material, but increasing the size of the breeding stock, gene conservation and environmental protection.
   The Standard Gross Margin (SGM) and the European Size Unit (ESU) of the Hungarian Grey Cattle keeping farmers were determined. Based on these investigations ***the one fifth of the farms are not viable in our country,*** even though that they keep other farm animals or serve as a tourism attraction, too.
2. The result of the multiple correlation analysis – what shows, that there is no connection between the realized factors of production – lights upon the fact, ***that many keeping technologies are adaptable in case of the Hungarian Grey Cattle keeping,*** from the most extensive to the half-intensive. In this study an extensive and a half-intensive keeping technology were analysed in the aspect of income conditions. The investigation shows that there is a ***minimal*** (could be incidental or caused by a fault) ***difference between the two keeping technologies in the aspect of cost efficiency.*** The resource expenditure is increasing in vain in course of the production, the output that get into the unit cost won't be higher, so it's the same in case of both technologies.
3. In case of the Hungarian Grey keeping, instead of 1.4 animal unit/ha (maximum allowable in our country) the farmers keep 0.8 animal unit per hectare on the average. This means a very low usage and it is unfavourable in the aspect of economy. It is determined that the higher number of the animals kept in a unit pasture size, effects a higher cost efficiency. In case of a higher value, it could be a decrease in efficiency because of the trampling damage, dominance inside the group, etc. In this dissertation a formula ***could be found, that gives a hand to the farmers by determining the optimal size of the livestock.***
4. In course of the Hungarian Grey keeping as a basic activity, because of its multifarious vertical and horizontal diversification possibilities, ***five result category could be determined*** depending on that the which additional income is taken into the production.

5. This research has revealed the distribution channels of the Hungarian Grey Cattle as a raw meat and meat product in Hungary. The marketing channels of the Hungarian Grey are immature and not worked out enough, there is a minimal coordination and business connection between the vertical performers of the market. In course of the investigation the ***different marketing possibilities were compared to each other.*** The result is, that the most effective and the most favourable solution would be the vertical integration for this sector. Furthermore it could be determined – based on the analysis of the prices that evolved on the vertical level – that while the price scissors between the processor and consumer prices is opening significantly because of the lack of integration (a strong exponential connection exists), till then a co-integrated market exists in case of integration (by a strong linear connection).

Economic analysis of production factors and weed management methods in organic farming

JUDIT PETRA KOLTAI

Dissertation Adviser: Rózsa Csatai, CSc, associate professor

Conservation of natural values, protections of environmental values has become a dominant part of the socio-economic life by now. At the back of it there is on one hand the increasing use and depletion of natural resources, and on the other hand the increasing quantity of pollutants released to the environment as an effect of different activities.

The legitimacy of organic farming is not only confirmed with its benefits at quality issues and environmental protection, but also with its yield stability at unfavourable weather conditions.

In contrast with the reduction of average sales prices the constant increase of inputs (material, ancillary and labour costs) is observed. A solution would be if the private organic farms would unionize into a vertical integration, and the added value of organic products would be increased with the establishment and expansion of processing capacities.

Direct weed control is achieved firstly mechanically – manual and by machines. Due to lack of capital the most common methods in organic farming systems can be observed in the conventional farming systems, too. The applied weed control method is not determined by its cost in the farm, the more expensive methods not always prove to be the most efficient ones.

It is difficult to obtain reliable data regarding the time consumption and cost of weed control, because the majority of farmers does not lead a separate record despite these factors affect their profitability notably. Changes made in the structure of the existing registration system could provide information not only for the farmers, but also for various professional and scientific circles to enable rational decision making.

The following new scientific results can be stated based on the surveys:

1. The paper found that there are not any significant differences between the productions systems of conventional and organic farming systems considering labour demand and land use based on the data of FADN of the Research Institute of Agricultural Economics. The comparison of conventional and organic farming showed the indicators of labour force per 100 hectare varied between 7–27%, there were significant changes in case of land use per year.
2. The analysis of secondary data proved that the surplus use-value of organic products recognized by the consumers has a decreasing tendency. 10–20% higher prices could be obtained on the average concerning cereals and row crops in organic farms compared to conventional ones in the years 2004–2007.
3. The farmers' response survey results were classified in factor classes on the basis of data variability. The constraints of effective weed control can be classified into three clusters; the cluster of the most important influencing factors is formed of the environmental and economic-financial conditions. Subsidiary and education system

can also be highlighted regarding the efficiency. The causes of weed damage can be divided into three clusters based on the survey. Above-average effect is attributed to yield reduction, while the crop contamination – control is difficult to solve – acts as a vector factor class is considered mediocre.

4. The dissertation made evident that the labour force characteristics (low-cost labour, high unemployment rate) establish the application of manual weed control also economically.
5. A simulation model has been developed, which enables to investigate the optimal structure of organic farms considering both ecological and economic factors, which should be recognized in the direction of diversification. This model results in the profit maximalization of production activity, and provides a basis to the farmer in the development of a crop rotation.

The use of glycerol generated during the biodiesel production for feeding pig

PÉTER KOVÁCS

Dissertation Adviser: János Schmidt, academician, professor emeritus

The biodiesel, which it is possible to manufacture from different materials, belongs to the renewable energy sources. The use of the huge amount of glycerine arising as the by-product of biodiesel production turned into an important task worldwide. The glycerol has been used for decades with good results for dairy cows to improve the energy supply of the animals. The 2 groups were placed in 4–4 boxes in a concrete grid floor stable. For feeding dry-food self feeders, for watering tipped (Nipple) self watering devices were used. Animals received until 70–75 kg of live weight a growing diet, and then till to the end of the experiment a finishing diet.

The experimental group's diets contained 5% glycerine, with which a part of the corn proportion was replaced. The small decrease in crude protein deriving from the smaller proportion of corn in the diet was compensated by a corn gluten supplement. The animals were individually weighed at the beginning of the experiment, then when changing the feed mixture (on the 57th day of the experiment, 70–75 kg live weight) and at the end of the trial (105–110 kg live weight).

For the consumers, such as restaurants, canteens and households, it is an important question, what the cooking and sensory properties of pork derived from animals fed glycerol. The parameters listed, were determined in part (dripping loss, baking loss, shearing strength, colour and sensory properties) by the experts of the National Meat Industry Research Institute, using by groups 5–5 pork chop samples, which we cut from the 11. rib section. Another part of the laboratory tests (freezing, defrosting and cooking loss) was performed by the laboratory of Department of Animal Nutrition.

However, it is still not widespread in practice in the case of monogastric animal.

The new scientific findings are as follows:

1. 14.01 MJ/kg was the apparent digestible energy content and 13.48 MJ/kg was the apparent metabolizable energy content of the 86.76% feed grade glycerol tested, what amounts to 91.5% and 88.0%, respectively of the tested glycerine's gross energy content. This is counted to 100% glycerine equal to a content of 16.43 MJ/kg apparent DE and 15.54 MJ/kg apparent ME, respectively.
2. The weight of the animals between 25–85 kg and the application rate of the glycerine between 5–10% did not effect the utilization of glycerine.
3. Dose of 5 or 10% glycerol supplement in the diet does not affect the digestibility of feed nutrients either N-retention of pigs.
4. Feeding of 5% glycerine does not affect the results of fattening (weight gain, feed-, energy- and protein utilization), ie. glycerol can replace the corn in pigs' feed, based on its apparent digestible energy value.
5. 5% glycerol has only a small effect on the "de novo" fatty acid synthesis, resulting in a small change in the fatty acid composition of loins, thighs, back-fat and lard.
6. The glycerol feeding reduces the dripping loss of the meat, stored at a temperature between –12 and –20 ^{o}C degrees, after thawing.

Effect of UV radiation on the growth, pigment and hormone content of microalgae

KÁROLY PÁLFFY

Dissertation Advisers: Vince Ördög, CSc, professor and Lajos Vörös, DSc, scientific adviser

Stratospheric ozone depletion discovered during the 1970s has caused an increase in the intensity of solar UV radiation reaching the Earth's surface, which generated extensive research on its effects on living organisms. Algae, as the most ancient photosynthetic organisms, are considered particularly unique in this respect for several reasons. This dissertation focused on the effect of UV radiation on microalgal strains under laboratory conditions after preliminary *in situ* experiments.

New scientific findings:

1. The author was the first to detect UV-effects on phytoplankton photosynthesis in an Hungarian lake (Lake Balaton). As shown by the results, an average of 75% of surface UV photoinhibition was caused by UV-A radiation (320–400 nm). As for areal primary production, the effect of UV radiation resulted in a considerably lower inhibition of 8–14%.
2. UV-induced growth inhibition, changes in photosynthetic pigment content and morphological changes of the green alga *Desmodesmus armatus* have not been studied before. In the presence of UV-A radiation the relative abundance of 4- and 8-celled coenobia decreased, while that of the 2-celled and teratological forms showed an increase over the controls.
3. Results of the experiments on microalgal cultures (Mosonmagyaróvár Algal Culture Collection) suggest that growth inhibition and the decline in chlorophyll-a content showed similar trends between the green algae studied. On the other hand, there was considerable variability among the cyanobacterial strains. As opposed to the green algae with higher UV resistance, cyanobacteria showed high sensitivity in respect of growth in response to the applied UV-A and UV-B radiation.
4. The author successfully detected a UV-absorbing mycosporine-like amino acid (palythine) in the green alga *Klebsormidium* sp. (strain MACC-426). Accumulation of the compound was induced by UV radiation, with UV-B radiation (280–320 nm) having a greater effect.
5. This is the first report studying the effect of UV radiation on the hormone content of a microalgal culture. The applied UV-A intensity slightly inhibited the cellular growth of the green algal species (MACC-458 *Chlorella*), and caused a significant decrease in the dry-matter-related levels of isopentenil-ribozide, indole-3-acetic acid and abscisic acid.

Economic investigation of copper micro-element treatment in winter wheat

ORSOLYA RÉDER

Dissertation Advisers: Lajos Salamon, CSc, professor and Pál Szakál, CSc, professor

Winter wheat is one of the most important cultivated plants in Hungary. In the market-oriented agricultural circumstances decreasing yields and fluctuating quality cause considerable problems to the producers. The objective of the research was to increase and stabilise yields with suitable fertilisation, and as a result to improve profitability.

During the research the effect of copper micro element fertilisers was in the focus, due to the fact that in the past years and decades some essential elements like copper were not supplied sufficiently. In case the soil is deficient in micro elements, one should expect the decrease of yields and decline in content values. Winter wheat fertilisation investigations have been carried out for three years with using copper-amine complex, copper-carbohydrate complex and copper ion-exchanged synthesised zeolite with the objective of defining the best yield-increasing copper micro element fertiliser, the optimal application time. The effect of copper complex fertilisers on yields was also put in numerical form.

In market economic circumstances production should not only focus on excellent quality and high yields; farmers should also produce a reasonable profit with the production. For that reason revenues and expenditures were nominalised and profit level was also defined. It is hard to give exact numbers for the profit originating from higher quality – especially in case of basically good quality winter wheat –, therefore in order to illustrate the usefulness of micro element supply in winter wheat, economic analysis concentrated on the definition of profit increase originating from yield increase.

Investigation results prove the favourable effects of copper micro element fertilisation, based on both natural and value indicators; the following new scientific findings:

1. The yield increasing effect could be proved for all copper micro element fertilisers and for both phenological phases, applied in winter wheat. Applying the suitable doses yields increased considerably in all cases; however, significant differences – compared to the control plots – could not be proved in all cases.
2. Investigation results proved that concerning the three copper micro element fertilisers, applied during both phenological phases, the copper-amine ion-exchanged synthesised zeolite had the most effective yield increasing effect.

   The more favourable time of application was also defined. Concerning the phenological phases, treatments at flowering turned out to be the most effective, reaching higher yields with less copper amount, in an input material saving way.
3. It was demonstrated that the copper microelement fertiliser applied as a supplement to the regular plant nutrition has a profit increasing effect. As a result of the suitable dose of all three copper microelement fertilisers in all research years, profit increased considerably by 25–60%.

   The most useful copper leaf fertiliser was defined, based on economic viewpoints:

economic calculations indicate that copper-amine ion-exchanged synthesised zeolite was the most favourable treatment from all three copper micro-element fertilisers, applied both at tillering and flowering.

4. Concerning the most favourable copper-amine ion-exchanged synthesised zeolite, applications performed at different phenological phases were compared from economic viewpoints. Based on the economic calculations, research results do not indicate significant differences concerning treatments applied at different phenological phases. Analysing the average of the three years, profit increased by more than one and a half times. Profit was the highest with 1.56 kg/ha copper dose applied at tillering, and with 1.35 kg/ha copper dose applied at flowering.

Increasing of conjugated linoleic acid content of broiler meat and egg by feeding

ATTILA TANAI

Dissertation Adviser: János Schmidt, academician, professor emeritus

Nowadays some of the researches which aim to alter the fatty acid content, are primarily investigating the opportunities of increasing the conjugated linoleic acid (CLA) content in fat. This tendency largely depends of the fact that linoleic acid plays a wide parallels range of different roles in the organism. If it comes to these roles, the c9,t11 and t10,c12 CLA isomers are the most important ones. In considerable amount, the human organism initiates its CLA intake by consuming food products, made of ruminants (milk, meat), or by the consumption of different food supplements. In Hungary, beef and lamb consumption per head is insignificant, the yearly milk intake per head also fails to exceed 200 liters, which is, compared to the EU average, is rather low. That is why it would be advisable to increase the CLA content of such food materials – originally low at CLA – which are widely consumed in large amount. Broiler meat and egg could be such materials; of which CLA increase via feeding manipulation got to become the aim of our study. Apart from the investigation of increasing CLA content, we also dealt with the question whether the blissful effect of CLA on the oxidation stability of the meat samples could be boosted by the vitamin E supplementation added to the feed.

On the basis of the outcomes of the experiments on broiler chicken and laying hens the following new scientific achievements could be stated:

1. 1 or 2% CLA product – containing 53.5% CLA, made by alcaline isomerisation of sunflower oil – of the feed significantly increases the daily weight gain of the broilers. 4% CLA product, however, hinders the weight gain.
2. The CLA supplementation of broiler feed does not affect considerably the digestibility of the nutrition, or N-retention. CLA supplementation furthermore does not change the crude protein or crude fat of breast and leg meat significantly.
3. The CLA supplementation of broiler and laying hen feed increases the CLA proportion of the broiler meats (leg, breast) and egg lipids. Regardless of the fact that c9,t11 and t10c12 isomers were present in the CLA product in an equal amount, the proportion of the c9,t11 variation in meats is 1.5; in eggs 4 times higher than of the t10,c12 isomer.
4. As a result of CLA feeding, the amount of saturated fatty acids in breast meat increases, the proportion of mono and poly unsaturated fatty acids decreases. In the lipids of egg yolk, besides the increase of the proportion of saturated fatty acids, the proportion of mono unsaturated fatty acids decreases. The direction of changes in the proportion of the main fatty acid groups, triggered by the linoleic oil, fed simultaneously with the CLA product, cannot be modified.
5. Our results proved that substituting the sunflower oil content of the feed with CLA product aids the oxidation stability of broiler meat. This favorable effect could be strengthened by the combination of CLA supplementation with vitamin E.

Revenue relationships of the actors of poultry (broiler) and swine product planes

SZABOLCS TROJÁN

Dissertation Adviser: Antal Tenk, CSc, professor emeritus

Making consequences we have made several references on positive or negative effects of Hungary's EU accession, but the present state of matters cannot be solely explained by the effects of accession.

The subject of our research was the thorough analysis of the pork and poultry more nearly broiler chicken product planes which are the backbone of domestic meat industry. The choice of topic was motivated by the fact, that both sectors fall within the so called soft regulation of the Common Agricultural Policy, the regulation of the production of both sectors being managed – through animal fodder consumption – by regulation of COPF plants. The accessible data of the past 5 years (2004–2008) has enabled us to perform analyses and based on these to draw conclusions regarding agricultural production within that broiler chicken and pork production and the sector of food industry (meat production).

Our basic aim was the examination of the fodder consuming sectors (poultry and pork) more and more in crisis, with the aim of getting a complex picture of the situation of actors of the two planes regarding income and competitiveness. It was among our goals to discover the factors which can chiefly influence the competitiveness of both examined sectors both on national and regional levels. The aim of this work to present and examine in the network of interrelations the levels of the poultry (broiler) and pork meat product planes according.

The following new and novel results were stated based on our research:

1. With examinations performed based on financial indicators of stages of the broiler and swine product plane a novel approach was used to uncover the economic processes. After performing the calculations, a clearer view can be formed of the financial and revenue status of all actors of the product plane.
2. The revenue and competition situation of both meat product planes falling under the same regulation of Common Agricultural Policy have derogated after the years following EU accession, but the extent of worsening of the situation is not the same in the two product planes. This instance shows, that the basically cost (and price) related revenue – from the side of input – is strongly influenced by the prices of fodder, but these changes can not be solely explained by changes in the prices of fodder. Other factors beside the price of fodder (for example, capital and product concentration) also play an important role in the formation of results. These factors are in the relation of both product planes had negative effects especially on the revenue and competition situation of the processing sector.
3. All indicators of revenue production have improved on national level, and the previous indicators showing deficit have turned into positive regarding the chicken meat (broiler) sector in the examined period of five years (2004–2008). Contrary to this several revenue indicators of broiler producers in the Western Transdanubian Region worsened

or turned to deficit levels. The values of these indicators show that in this sector the assets value- and capital rate have strong influences on the results or production.

4. The revenue situation of swine stall feeding was under the level of broiler production on both national and regional level, and receded significantly after the years of the EU accession. In this sector not only the revenue indicators have deteriorated, but other economic indicators (liquidity rate, debt indicator) have continuously deteriorated. This is especially true for invested capital in the single product plane stages related to the revenue. This can also explain the large amount of dissolution among swine farms with low capital level and low level of concentration that has continued after 2008 as well.
5. Meat processing companies in spite of still having a far larger processing capacity than necessary arrived in a more and more vulnerable situation of the retail chains after the EU accession. Due to the low level of capital concentration represented by them they were forced into a price accepting position, and often are unable to realize their costs in their prices. The profitability of the majority of meat processing companies is even lower than the producers of slaughter raw materials, and this position has become worse in the period of the research and also ever since then.

Tájékoztató és útmutató a szerzők részére

Általános szempontok

1. ***Csak önálló kutatáson alapuló, más közleményekben meg nem jelent,*** a növénytermesztés (kertészet, genetika, növénykórtan, állati kártevők, agrometeorológia, növényélettan, agrobotanika stb.), állattenyésztés (takarmányozástan, állatgenetika, állategészségtan stb.), élelmiszer- és az ökonómiai tudományok témakörébe tartozó ***szakcikket*** közölhetünk. ***Szemle*** rovatunkba a fenti tárgykörökhöz tartozó irodalmi összefoglalók, témadokumentációk, módszertani ismertetések stb. kerülnek.
2. Tudományos folyóiratunkban a dolgozatokat ***angol*** vagy ***magyar*** nyelven tesszük közzé. Ez attól függ, hogy az új tudományos eredmények ***nemzetközi vagy inkább hazai érdeklődésre tarthatnak számot. Más nyelven a továbbiakban már nem fogadunk be cikkeket.*** A közlemények megjelentetésekor, az adott lapszámok összeállításakor az angol nyelvű anyagok előnyt élveznek. A megfelelő nyelvi színvonal fenntartása érdekében ***angolul írt cikk benyújtásakor anyanyelvi lektor által kiállított igazolást is kérünk csatolni.***
3. ***Csak formailag kifogástalan kéziratot fogadunk el.***
4. ***A kéziratot*** – annak mellékleteivel együtt – ***2 példányban kinyomtatva és elektronikusan*** (adathordozón vagy e-mailben) kell megküldeni Dr. Varga Zoltán címére (Acta Agronomica Óváriensis Szerkesztőbizottsága, 9201 Mosonmagyaróvár, Vár 2.; varzol@mtk.nyme.hu).

A kézirat összeállítása

1. Formai követelmények

1.1. A kézirat táblázatokkal és ábrákkal együtt legfeljebb l6 gépelt – számozatlan – oldal legyen, Times New Roman CE betűtípussal 12 pt betűmérettel, körben 2 cm-es margót hagyva. A gépírás fekete betűkkel, irodai (A/4-es) papír egyik oldalára, 1,5-es sorközzel történjék. Fej- és lábléc (másként: élőfej és élőláb) használatát kérjük mellőzni.

1.2. Az alcímeket, fejezetcímeket, egyéb elkülönülő részeket 1–1 üres sorral kell elválasztani a fő szövegtől, aláhúzás és sorszám nélkül.

1.3. Az idegen szavak írását fonetikusan, vagy ha még nem honosodtak meg, eredeti helyesírással kérjük.

1.4. A magyar fajnevek mellett a tudományos nevet (esetenként a címben is) fel kell tüntetni és *dőlt* betűvel írni. A fajták nevét (magyar és külföldi) a minősítésben elfogadott név szerint kell írni szintén *dőlt* betűvel (pl.: *Sinapis alba* cv. *Budakalász sárga).*

2. A kézirat szerkezete

2.1. A dolgozat címe alatt a szerző(k) neve, munkahelye(ik) és annak székhelye szerepeljen. Pontos cím megadása itt kerülendő. A tudományos fokozatot és munkahelyi beosztást nem közöljük.

2.2. A tudományos közlemények kialakult rendjének és kézirat felépítését a következő csoportosítás szerint kérjük:
Bevezetés, Irodalmi áttekintés, Anyag és módszer, Eredmények, Következtetések, Összefoglalás, Irodalom
az Acta Agronomica Óváriensis hagyományainak megfelelően. Egyes fejezetek a téma jellege, terjedelme szerint összevonhatók: Bevezetés és az Irodalmi áttekintés, Eredmények és a Következtetések. Az Anyag és módszer helyett a szerző a Kísérletek leírása címet is használhatja.

2.3. Az Irodalom után kérjük feltüntetni ***a szerző(k) levélcímét*** (név, munkahely és annak székhelye a postai irányítószámmal; e-mail cím).

A fentiek szerint csoportosított kéziratot kiegészítik (külön oldalakra gépelve):

magyar nyelvű közlemény esetén:

- magyar nyelvű összefoglalás a végén kulcsszavakkal,
- angol nyelvű összefoglalás a dolgozat angol nyelvű címével, a szerző(k) nevével és a munkahely(ük) feltüntetésével, a végén angol kulcsszavakkal,
- táblázatok és ábrák,
- angol nyelvű táblázat- és ábracímek,
- az ábrák feliratai és a táblázatok fejlécei angol fordításban, számozva pl:

1. táblázat Az egynyári szélfű előfordulása a Fertő-Hanság-medence kukoricavetéseiben

Table 1. Occurrence of *Mercurialis annua* L. in maize fields in Fertő-Hanság-basin

Felvételezési hely (1)		Egynyári szélfű száma a felvételi négyzetekben (2)				Átlag db/4m² (3)
		1.	2.	3.	4.	
1.	Hanságfalva*	46	72	54	36	52
2.	Jánossomorja	38	27	25	30	30
3.	Hanságliget	2	1	4	0	2

* a tenyészidőszak folyamán sem mechanikai, sem pedig kémiai gyomirtásban nem részesült
(1) location of survey, (2) the number of *Mercurialis annua* L. in sample squares, (3) average pc/4 m², (4) average pc/m²,
* during the vegetation period neither mechanical nor chemical weed control was carried out

angol nyelvű közlemény esetén:

- angol nyelvű összefoglalás a végén kulcsszavakkal,
- magyar nyelvű összefoglalás a dolgozat magyar címével, a szerző(k) nevével és a munkahely(ük) feltüntetésével, a végén magyar kulcsszavakkal,
- külön-külön oldalakra gépelt táblázatok és ábrák (a címek, feliratok, fejlécek magyarra fordítása nem szükséges).

3. Irodalmi hivatkozások

3.1. Az Irodalmi áttekintés című fejezetbe – hivatkozáskor – egy szerző esetében a szerzők családnevének *dőlt* betűvel történő leírásával és zárójelben közleményének kiadási évszámával szerepeljen, pl. *Pocsai* (1986). Szerzőpárosra történő hivatkozás esetén a két név közé „és" szót tegyen: *Pocsai* és *Szabó* (1983). Kettőnél több szerző esetében az elsőként feltüntetett szerző neve után *et al*. rövidítést kérjük: *Schmidt et al*. (1983). Egy mondaton vagy témakörön belül, ha több szerzőre hivatkozik, akkor a mondat vagy a témakör tárgyalása végén zárójelben kérjük a szerzők nevének és közleményei kiadási évszámának a felsorolását: *(Iváncsics* 1971, *Gergátz* és *Seregi* 1985, *Szajkó* 1987). Tudományos közleményben, könyvben szereplő hivatkozásra történő utalásnál a cit. rövidítést kell használni (*Wagner* 1979 cit. *Fahn* 1982).

3.2. Az Irodalom összeállításakor ***a dolgozatban idézett szerzők*** nevét ABC- és megjelenési idősorrendű felsorolásban kérjük. Minden tanulmányt külön sorban kell feltüntetni.

- Folyóiratban megjelent cikkre való hivatkozásnál a szerző családneve és keresztnevének kezdőbetűje *dőlten* szedve, a cikk megjelenésének évszáma zárójelben, a cikk címe, a folyóirat megnevezése, az évfolyam száma **félkövéren**, a lapszám zárójelben és a kezdő-befejező oldal száma kerül felsorolásra.
  pl. *Pocsai K.* (1986): A lóbab vetőmagszükséglet csökkentési lehetőségeinek vizsgálata. Növénytermelés **35,** (1) 39–44.
- Ha az idézett hivatkozás könyvben jelent meg, akkor kérjük a szerző nevét, a könyv megjelenési évszámát zárójelben, a könyv címét, kiadóját és a kiadó székhelyét közölni.
  pl. *Schmidt J.* (1995): Gazdasági állataink takarmányozása. Mezőgazda Kiadó, Budapest.
- Ha olyan szerzőre hivatkozik, aki társszerzőként írt a könyvben, akkor a szerző nevét az általa írt (hivatkozott) fejezet címét kérjük feltüntetni és „in" megjelöléssel a könyv szerkesztőjének a nevét, a könyv címét, kiadóját és a kiadó székhelyét
  pl. *Gimesi A*. (1979): A lucerna vegyszeres gyomirtása. In *Bócsa I. (szerk.):* A lucerna termesztése. Mezőgazdasági Kiadó, Budapest.
- Ha az Irodalmi áttekintésben több szerző által írt tanulmányra hivatkozott, az Irodalomban az összes szerző nevét ki kell írni és a nevek közé szóközzel kötőjelet kell tenni.
  pl. *Varga-Haszonits Z. – Varga Z.– Schmidt R. – Lantos Zs.* (1997): The effect of climatic conditions on the maize production. Acta Agronomica Óváriensis **39,** (1–2) 1–14.
- Külföldi szerző esetében család- és keresztnév közé vesszőt kell tenni. Magyar szerzőknél ez kerülendő.

4. Ábrák és táblázatok

4.1. Kizárólag fekete-fehér ábrákat tudunk elfogadni.

4.2. A digitalizált képeket, ábrákat lehetőleg TIF, JPG kiterjesztésű állományként küldjék, és ***ne a dokumentumba*** ágyazva.

4.3. Táblázatok esetében kérjük, hogy szintén Times New Roman betűtípust használjanak. Lehetőleg mellőzzék a táblázatok különféle kerettel és vonalvastagságokkal történő tarkítását.

4.4. Kérjük az eredeti ábrák, táblázatok külön állományban (pl. XLS) történő mentését, ezeket se illesszék a dokumentumba.

4.5. Ugyanazon adatsorokat grafikus és táblázatos formában nem közöljük.

4.6. Kérjük, hogy a szövegben az ábrákra és táblázatokra (dőlt betűvel írva) minden esetben hivatkozzanak.

5. Lektorálás, korrektúra

5.1. Az angol nyelvű cikkek lektorálása két szinten (anyanyelvi és szakmai bírálat) történik. Mint azt az *Általános szempontokban* említettük, a közlemény beérkezésekor benyújtott anyanyelvi lektori igazolás biztosítja az ***előzetes nyelvi ellenőrzést,*** amit ***szakmai bírálat*** követ.

5.2. A szerzők javaslatot tehetnek a két szakmai lektor személyére. A javasolt lektorok tudományos minősítéssel rendelkező személyek legyenek. A javasolt lektorokat a Szerkesztőbizottság hagyja jóvá, illetve jelöl ki új lektorokat. A lektorok nevét az évi utolsó lapszámban a borító belső oldalán – a bírált cikk megjelölése nélkül – feltüntetjük.

5.3. A lektori véleményeket a szerzőknek a kézirattal együtt megküldjük. Kérjük a szerzőket, hogy dolgozatukat a bírálók javaslata alapján módosítva mielőbb küldjék vissza, ***1 példányban kinyomtatva és CD lemezen vagy e-mail-ben*** (varzol@mtk.nyme.hu). Csak a végleges összeállítású, hibátlan dolgozatot tudjuk szerkeszteni. A nyomdai munka előtt a már szerkesztett közleményt (hasáblevonatot) a szerző címére ***pdf formátumban*** megküldjük, hogy azt a kézirattal egyeztesse, s az észlelt vagy szükséges javításokat hibalista formájában jelezni tudja szerkesztőségünknek. A hasáblevonatot ***3 munkanapon belül*** szíveskedjenek visszaküldeni.

A megjelent dolgozatokért a Szerkesztőbizottság tiszteletdíjat nem tud fizetni, de a szerzők részére díjmentesen ***pdf formátumú digitális különlenyomatot*** küldünk. A kéziratokat a dolgozat megjelenéséig megőrizzük.

A Szerkesztőbizottság

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