THESIS OF DOCTORAL (PHD) DISSERTATION

SÁNDOR KALMÁR

MOSONMAGYARÓVÁR

2010

THESIS OF DOCTORAL (PHD) DISSERTATION

UNIVERSITIY OF WEST-HUNGARY
FACULTY OF AGRICULTURAL AND FOOD SCIENCES
MOSONMAGYARÓVÁR

Precision plant production methods Doctoral School

Head of Doctoral School:

Prof. DR. MIKLÓS NEMÉNYI DSc
Doctor of HAS

Farm business relations of crops produced with precision plant production methods sub-program

Head of sub-program and theme consultant:

Prof. DR. LAJOS SALAMON CSc

FARM BUSSINESS RELATIONS OF PRECISION PLANT PRODUCTION

SÁNDOR KALMÁR

Mosonmagyaróvár

2010

1. INTRODUCTION, OBJECTIVES OF RESEARCH

Precision plant production is a major agricultural innovation of the past decades. Technology development is faster than the spread of the innovation, mainly because the advantages of practical application are hard to define (due to the differences of the technological elements, or the specific features of different crops and production locations). The spread of precision plant production is influenced by several factors; the dissertation puts the investigation and evaluation of these factors into the focus.

Thinking in smaller scale (to be able to reveal the reasons of yield differences and use targeted variable rate applications in a smaller scale, that the hectare unit) is a great challenge for those who apply precision techniques in plant production. On one hand precision plant production is an advantage as nutrition and plant protection treatments are applied almost „individually” to the plant, based on its specific needs. On the other hand it is a disadvantage, as investment costs increase, time requirement of data collection and evaluation increases, and site-specific plant production requires special, complex knowledge (e.g. IT skills) from the user, besides the concrete professional knowledge.

The Global Positioning System (GPS) has undergone significant changes, since it is used for civil purposes. After the preliminary difficulties of introducing and using precision plant production (e.g. absence of DGPS signal, understanding the collected data), using GPS for agricultural purposes, there are still several questions unanswered. These still open questions highly influence the wide spread of the technology in agricultural practice.

Most open questions have *economic* nature: size of land where it is worth introducing and applying the technology, rate of savings that can be reached with the application, years of investment return etc. Secondly, questions have social-sociological nature: what knowledge is required from the workers and data processing employees taking part in the precision plant production process, at what age are farmers more open to new knowledge, how the educational background of the farmer influences the application of the technology.

Objectives of research

1. The investigation of possibilities of input material saving and cost reduction resulting from the application of precision plant production technologies in large-scale agricultural units.

Hypotheses: The use of precision plant production technologies may realise input material savings in large-scale agricultural units; these savings result considerable cost savings as well.

2. To carry out a questionnaire survey among agricultural entrepreneurs in order to define the factors that influenced the spread of precision plant production. The identification of these factors supports the spread of the technology. The objective of the survey is to define the relation between the intention to introduce and apply precision plant production, and the age, educational background of the farmer, to define how the size of land affects the use of the new technology.

3. Further objective of the research is to survey the present status of theoretical education and practical training of precision plant production methods, to assess the opinion of managers, teachers and practical trainers of secondary agricultural educational institutes.

The questionnaire survey that has been carried out among secondary school managers and teachers to evaluate how prepared the latter operators are, what theoretical and practical base is provided during the secondary level agricultural education.

Hypothesis: The practical performance of precision plant production technologies requires accurate data collection, recording and data processing (e.g. the performance of accurate application plans for chemicals and fertilizers); it also means that the operator must be well-prepared and have a solid professional knowledge. At the same time it is supposed that the majority of students in secondary agricultural educational institutes do not receive such detailed and thorough theoretical and practical education that facilitates the suitable practical performance of precision plant production technologies.

4. The objective of the research is to elaborate a decision-supporting simulation that can be used by farmers in the planning phase of the introduction of precision technologies. A further objective of the simulation is to facilitate the pre-calculation of the size of land that is needed to realise the economic return of supplementary investment of the precision plant production technology.

Hypotheses: The economic return of supplementary investment of precision tools is calculated from the savings reached by the precision plant production technology, considering the size of land where the certain precision technology is applied.

2. MATERIAL AND METHOD

During the research primer and secondary investigations have been carried out. The research has been conducted at the Lajta-Hanság Public Limited Company (successor: Mezort PLC.) and at the University of West-Hungary, Faculty of Agricultural and Food Sciences Institute of Farm Business and Management Sciences (and predecessors).

The background of research – and practically the topic selection – has been given at the Lajta-Hanság PLC., where the practical work as a plant production engineer between 1998 and 2000 induced further investigations. The experiences gained during this period form an important part of the study; the experiences served as a base for further empirical investigations. Between 2004 and 2006 model calculations related to the application of precision weed control in farm unit circumstances have been carried out. Investigations have been conducted in the field No. 50/2 (51,56 ha; maize variety DK 440 – FAO 330) of the Lajta-Hanság PLC. During the research period the research team investigated the canopy and spread of the recorded dangerous weed species of millet (Panicum miliaceum); the effect of the weed cover on yield has also been surveyed. The costs of pre-emergent chemicals applied equally in the whole field have been compared to site-specific ("field border") post-emergent chemicals applied after weed recording. In the research period operational data of the Lajta-Hanság PLC and the FADN data base of the Agricultural Research Institute (ARI) have been used.

The spread and practical possibilities of precision farming has been surveyed with the primer research method tool of questionnaires. In 2003 120 questionnaires have been sent out to agricultural entrepreneurs; 58 filled-in questionnaires could be evaluated, reaching a 48 % return rate.

Data have been processed and evaluated with the MsExcel software, and the *Tobit method* of the EasReg program package has been used. Based on the research results further investigations have been carried out in 2004 in order to define the influencing effect of educational background, and to evaluate the role of secondary level professional education in providing information on new technologies. Questionnaires have been sent out to 30 secondary level educational institute throughout the country; school directors and teachers of plant production and technical studies have been addressed. 70 % of school directors and 67 % of teachers responded from 14 counties; the answering leading secondary schools educate plant production technicians, agricultural technicians and agricultural mechanical technicians.

The "Precision plant production investment calculator" model has been elaborated to define the return of investment of precision farming, the input material savings and size of land. The model runs on MsExcel software; the FADN data base of the ARI and the retail prices of year 2009 have been used in the model. During the elaboration of the "Precision plant production investment calculator" personal interviews have been carried out with leading distributors of the technology; retail prices of 2009 have been provided by the distributors.

3. RESULTS, CONCLUSIONS

The starting calculations concerning the expectable input material savings resulting from the introduction of precision farming, the actual cost decrease under large-scale farming unit circumstances have been done with the operational economic data of the Lajta-Hanság PLC. Evaluating the fertiliser and chemical cost at the company in 2000 and 2001 (fertiliser 2000: 85 million HUF, 2001: 198 million HUF; chemicals in 2000 43 million HUF, in 2001 50 million HUF) and supposing that precision variable rate application (VRA) of fertilisers and precision plant protection tools are used, calculating with a minimal 10% saving rate in 2000 12,8 million HUF, in 2001 24,8 million HUF input material costs could have been saved. In this case the working time decrease of machinery use and human resources has not been considered. Calculating with the software that facilitates site-specific fertilizer application (app. 1 million HUF) and the field-performance of the VRA fertilizer spreader, it can be stated that the supplementary investment would return within a few (3-5) years, even if savings rates are lower. The spread of precision methods and techniques can highly be influenced by the age of machinery at a given farm, as the compatibility of hardware and software supplementary installed into the machine, the price and the field performance of machines considerably define the specific (pro hectare) costs. Large-scale farm unit experiences indicate that the operation of machines older than 7-10 years (especially harvesters and threshers, fertilizer spreaders and plant protection machines) is not profitable with precision tools, mainly due to the field performance characteristics.

The economic evaluation of precision plant protection and the possibilities of precision weed control have been carried out in April 2003 at the model farm of the University of West-Hungary Faculty of Agricultural and Food Sciences. Weed canopy was registered at the field No. A_1 in winter wheat crop, the recommended chemical and chemical combination costs were used to the calculations. Calculating with the costs of weed recording, costs of machine work and the recommended chemical combination it can be stated that in case the plant protection treatment is performed by the weed recording results site-specifically, on 0,9225 ha area of the 4,05 ha field no chemical was needed. The cost reduction (resulted from the reduction of chemical requirement) of chemicals or combinations recommended in the technology descriptions would have compensated the 2 724 HUF/ha weed recording cost.

Investigations carried out in 2004 and 2006 put the economic effects of site-specific plant protection into the focus. Research took place at the No. 50/2 corn field of the Lajta-Hanság PLC, where millet (Panicum miliaceum) infection reached a considerable level. The size of the field was 51,56 ha (800m x 650m). According to the produced yield map, corn yield (14,5 % corrected) reached 8,45 t/ha, at different field areas where millet infection was present, yields were 2,3-3 t/ha lower. In 2005 pre-emergent treatment was applied in the whole field with Gesaprim and Guardien, Chemical cost was 4000 HUF (Gesaprim 1800 HUF/ha and Guardian 2200 HUF/ha). Supposing that yield reduction was mainly caused by the millet weed infection, post-emergent targeted chemical application at the field borders in 3 m width (3x18 m) would result 15,66 ha protected area (30 % of the whole field). Sales price of corn was 21 000 HUF in 2005; should we multiply this sales price with the expected 2,5 t/ha additional yield, the results is 52 500 HUF. This result would facilitate the financing of the Motivell turbo application and still profit would be realized. The calculation is also supported by the fact that in 2006 this chemical was used at the company against millet canopy.

Several bibliographical references report that precision technologies require considerable human and capital investment, and it is supposed that larger farms are likely to apply precision plant production. Questionnaire survey focusing on the intention to introduce and apply precision technologies indicates that the age of farmer (decision-making person) and also professional educational background are important factors in Hungary. Between the intention to apply precision plant production and size of farm (cultivated area) significant relation could not be proved. Direct effect of size of farm on the introduction of precision plant production technologies require further region- and crop specific research.

The results of the survey show that the educational background and age of the farmers play an important role in the spread of precision plant production. Without state incentives agricultural entrepreneurs – especially those with a farm under 100 ha – are unlikely to invest into precision tools. At the same time this statement does not mean that such farmers do not order several precision technologies from contractors, as paid services. The answering farmers would apply precision technologies because of economic reasons (83%) or support possibilities (40%).

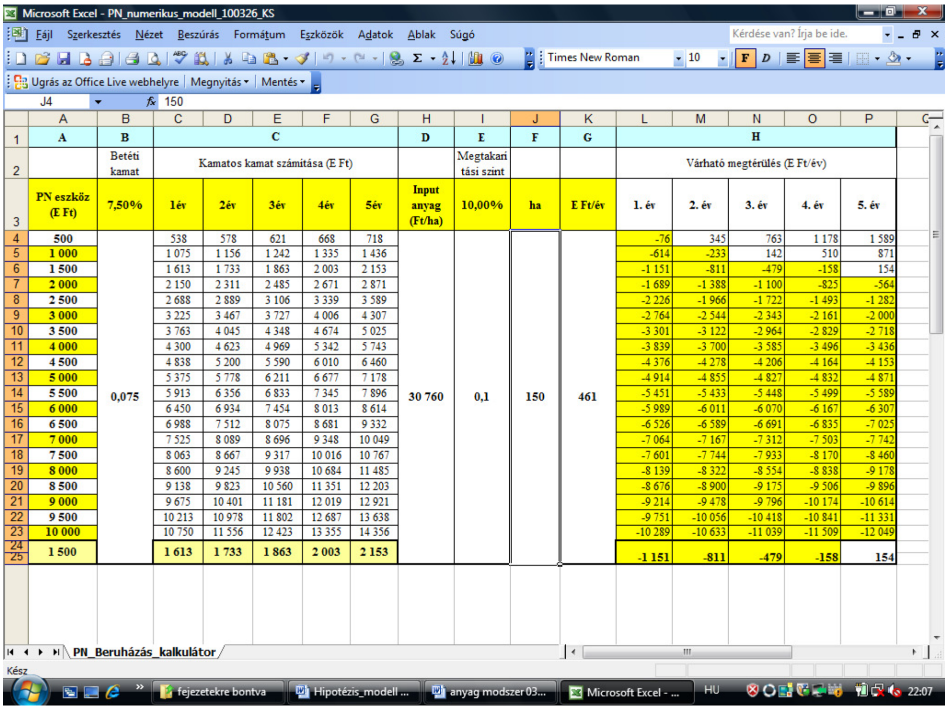
The questionnaire survey carried out among agricultural secondary schools in 2004 indicate that foreign farm practices of the students play an important role in getting experiences (target countries: Germany, Austria, The Netherlands, Denmark, USA). In 71% of the answering secondary schools students have a chance to fulfil practical training abroad; 93% of school directors think that students can get acquainted with the latest technologies during the farm practices (as students returning from the farm practices report). Concerning new technologies it is very important whether the machines used are equipped with IT tools or not – only 19% of the answering schools answered that the machines at the schools have IT tools on board. 71% of students of the technician level branches learn IT at school. 55 % of teachers of plant production and technical studies have heard about precision farming in the 1990's, 25 % in 2000' and 17,5% of teachers answered that the questionnaire survey provided the first information on precision plant production. The primer sources of information are professional magazines, and 62,5% of answering teachers have taken part in professional study tours abroad (primarily in Germany). 92,5% indicated that teachers have enough possibilities to improve the professional knowledge. Teachers report that it is possible to introduce new technologies to students during the teaching hours, and it primarily means the introduction of environment friendly technologies.

The „Precision plant production investment calculator" has been elaborated with the objective to support decision-makers concerning the introduction of precision technologies. A part of variables included in the model depend on the economic circumstances (e.g. interest rate), other variables depend on the production level of the adopting agricultural unit (such factors can be adjusted to the circumstances of the given farm).

The following example shows the use of the "Precision plant production investment calculator" under the following circumstances, for fertiliser application:

1. **Name of precision plant production tool**: Fertiliser spreader control (Insight monitor + GPS recorder (EGNOS) + adjustment unit)
2. **Investment value of precision tool (column "A")**: 1 500 000 HUF (net price, IKR 2009.)

3. **Input material use (column "D")**: 30 760 HUF/ha (ARI FADN data in 2008, national average use of fertilisers at joint companies)
4. **Level of input material savings (column "E")**: 10%
5. **Size of field where precision tool is applied (column "F")**: 150 ha (optional value)
6. **Calculated return**: 3 years (Figure 1).

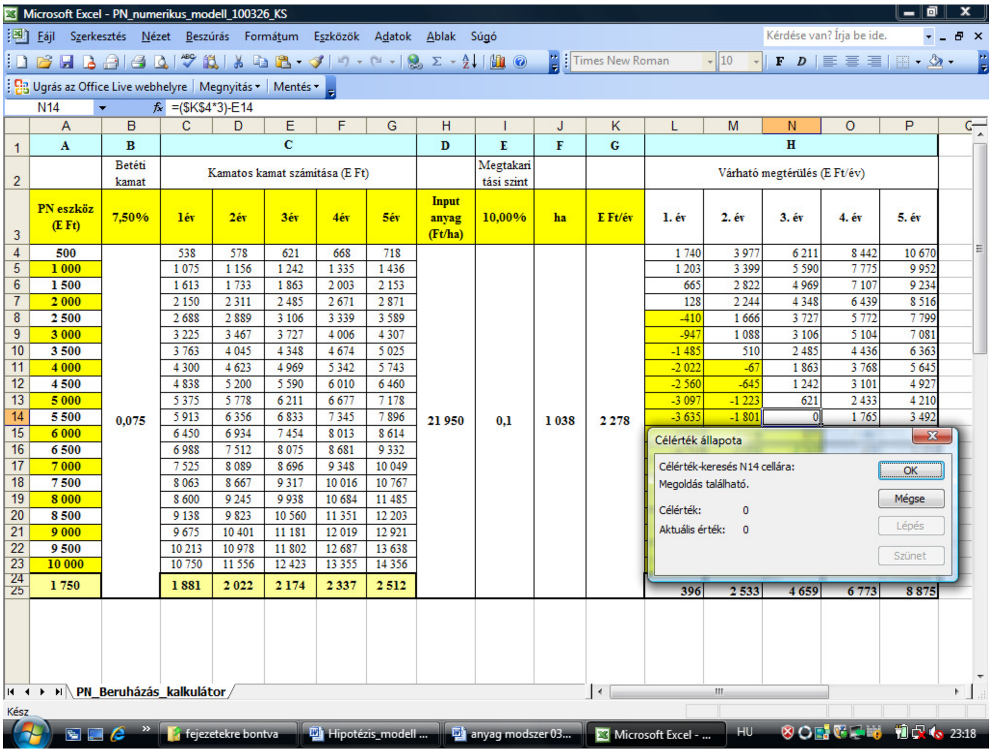


A	B	C					D	E	F	G	H				
	Betéti kamat	Kamatos kamat számítása (E Ft)						Megtakarítási szint			Várható megtérülés (E Ft/év)				
PN eszköz (E Ft)	7,50%	1év	2év	3év	4év	5év	Input anyag (Ft/ha)	10,00%	ha	E Ft/év	1. év	2. év	3. év	4. év	5. év
500		538	578	621	668	718					-76	345	763	1 178	1 589
1 000		1 075	1 156	1 242	1 335	1 436					-614	-233	142	510	871
1 500		1 613	1 733	1 863	2 003	2 153					-1 151	-811	-479	-158	154
2 000		2 150	2 311	2 485	2 671	2 871					-1 689	-1 388	-1 100	-825	-564
2 500		2 688	2 889	3 106	3 339	3 589					-2 226	-1 966	-1 722	-1 493	-1 282
3 000		3 225	3 467	3 727	4 006	4 307					-2 764	-2 544	-2 343	-2 161	-2 000
3 500		3 763	4 045	4 348	4 674	5 025					-3 301	-3 122	-2 964	-2 829	-2 718
4 000		4 300	4 623	4 969	5 342	5 743					-3 839	-3 700	-3 585	-3 496	-3 436
4 500		4 838	5 200	5 590	6 010	6 460					-4 376	-4 278	-4 206	-4 164	-4 153
5 000		5 375	5 778	6 211	6 677	7 178					-4 914	-4 855	-4 827	-4 832	-4 871
5 500	0,075	5 913	6 356	6 833	7 345	7 896	30 760	0,1	150	461	-5 451	-5 433	-5 448	-5 499	-5 589
6 000		6 450	6 934	7 454	8 013	8 614					-5 989	-6 011	-6 070	-6 167	-6 307
6 500		6 988	7 512	8 075	8 681	9 332					-6 526	-6 589	-6 691	-6 835	-7 025
7 000		7 525	8 089	8 696	9 348	10 049					-7 064	-7 167	-7 312	-7 503	-7 742
7 500		8 063	8 667	9 317	10 016	10 767					-7 601	-7 744	-7 933	-8 170	-8 460
8 000		8 600	9 245	9 938	10 684	11 485					-8 139	-8 322	-8 554	-8 838	-9 178
8 500		9 138	9 823	10 560	11 351	12 203					-8 676	-8 900	-9 175	-9 506	-9 896
9 000		9 675	10 401	11 181	12 019	12 921					-9 214	-9 478	-9 796	-10 174	-10 614
9 500		10 213	10 978	11 802	12 687	13 638					-9 751	-10 056	-10 418	-10 841	-11 331
10 000		10 750	11 556	12 423	13 355	14 356					-10 289	-10 633	-11 039	-11 509	-12 049
1 500		1 613	1 733	1 863	2 003	2 153					-1 151	-811	-479	-158	154

Source: Own investigation, 2009

Figure 1: Use of the numeric model

The model has been elaborated with MsExcel 2003 software that facilitates the calculation of target-value. With this function – if the supplementary investment value (e.g. 5,5 million HUF) and year of return (e.g. 3 years) are given –, the value in the marked target cell is zero (as it were the brake even point) and the modifying cell is the required field size (size of land in hectare), the size of land/farm (in the example 1 038 ha) when the investment cost returns can be calculated, supposing that the other factors (level of input material use and savings level) are unchanged (Figure 2).



Microsoft Excel - PN_numerikus_modell_100326_KS

N14 =(K4*3)-E14

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	A	B	C					D	E	F	G	H				
2		Betéti kamat	Kamatos kamat számítása (E Ft)						Megtakarítási szint			Várható megtérülés (E Ft/év)				
3	PN eszköz (E Ft)	7,50%	1év	2év	3év	4év	5év	Input anyag (Ft/ha)	10,00%	ha	E Ft/év	1. év	2. év	3. év	4. év	5. év
4	500		538	578	621	668	718					1 740	3 977	6 211	8 442	10 670
5	1 000		1 075	1 156	1 242	1 335	1 436					1 203	3 399	5 590	7 775	9 952
6	1 500		1 613	1 733	1 863	2 003	2 153					665	2 822	4 969	7 107	9 234
7	2 000		2 150	2 311	2 485	2 671	2 871					128	2 244	4 348	6 439	8 516
8	2 500		2 688	2 889	3 106	3 339	3 589					-410	1 666	3 727	5 772	7 799
9	3 000		3 225	3 467	3 727	4 006	4 307					-947	1 088	3 106	5 104	7 081
10	3 500		3 763	4 045	4 348	4 674	5 025					-1 485	510	2 485	4 436	6 363
11	4 000		4 300	4 623	4 969	5 342	5 743					-2 022	-67	1 863	3 768	5 645
12	4 500		4 838	5 200	5 590	6 010	6 460					-2 560	-645	1 242	3 101	4 927
13	5 000		5 375	5 778	6 211	6 677	7 178					-3 097	-1 223	621	2 433	4 210
14	5 500	0,075	5 913	6 356	6 833	7 345	7 896	21 950	0,1	1 038	2 278	-3 635	-1 801	0	1 765	3 492
15	6 000		6 450	6 934	7 454	8 013	8 614									
16	6 500		6 988	7 512	8 075	8 681	9 332									
17	7 000		7 525	8 089	8 696	9 348	10 049									
18	7 500		8 063	8 667	9 317	10 016	10 767									
19	8 000		8 600	9 245	9 938	10 684	11 485									
20	8 500		9 138	9 823	10 560	11 351	12 203									
21	9 000		9 675	10 401	11 181	12 019	12 921									
22	9 500		10 213	10 978	11 802	12 687	13 638									
23	10 000		10 750	11 556	12 423	13 355	14 356									
24–25	1 750		1 881	2 022	2 174	2 337	2 512					396	2 533	4 659	6 773	8 875

Source: Own investigations, 2009

Figure 2: Search of target value

Foreign and Hungarian bibliographical references regarding the optimal unit size in general indicate that both in the case of developed and developing countries precision plant production technologies are primarily applied in large-scale farms units. As precision plant production is based on IT tools, the tools of today will be out of date in 2-3 years, due to the effect of "technological push". The more complex and complicated the precision element is (e.g. site-specific plant protection), the more expensive the investment is and the investment can only pay back on larger areas.

4. NEW AND NOVEL SCIENTIFIC RESULTS

1. Based on the results of the questionnaire survey it can be stated that *significant relation* (significance level 80%) *can be proved between the age and the intention to introduce new precision plant production technology*. Older farmers (above 50 years of age) apply precision technologies with less likelihood, as they think in shorter time horizon (plan for shorter term) and they do not intent to invest human and financial capital that is needed to precision plant production. Precision plant production – certain elements and the whole system – requires IT skills, primarily from the operator of the technology.

2. *Educational background* and the intention to apply precision plant production technologies also show significant relation. In this case the educational background of the decision-maker at the farm and the operator of the precision technology should be divided. They both play a central role in the application of the technology. The decision-making person realizes and understands the possibilities of precision plant production; the operator of the technology has the necessary basic knowledge that is needed to operate precision tools.

3. Theoretical and practical economic evaluations of precision technologies are supported with the elaborated "*Precision plant production investment calculator" model*. The "Precision plant production investment calculator" model applies a *novel approach*: the *return of investment* of the given precision tool *is calculated from the input material savings*, while calculations methods are usually based on income data. It should be noted that the model calculates the return of investment of supplementary precision tools that are used to apply input materials (e.g. fertilizer, chemical).

4. The precision plant production technology – due to the satellite and IT background – is highly R+D intensive, developers/distributors use different marketing tools to decrease the resistance of the user side and to encourage practical application. As demand is not originating primarily from the user side, *precision plant production is a "push" type innovation*.

V. LIST OF PUBLICATIONS AND PRESENTATIONS IN THE TOPIC OF THE DISSERTATION

Reviewed scientific study in Hungarian language:

1. NAGY S. – **KALMÁR, S.** (2001): A távérzékelés lehetőségei a gyomtérképeken alapuló precíziós gyomszabályozásban. Magyar Gyomkutatás és Technológia (Hungarian Weed Research and Weed Technology) II. évfolyam 1.szám 2001. június 15 p.

Reviewed scientific studies in foreign language:

1. **KALMÁR, S**. – SALAMON, L. – REISINGER, P. – NAGY, S. (2004): Possibilities to apply precision weed control in Hungary. Gazdálkodás 8. English Special Edition 88 p.

2. LŐRINCZ, Zs. – KACZ, K. – **KALMÁR, S.** (2006): Risk and risk management in plant production. Gazdálkodás English Special Edition 2006, L./ 17.

3. RADNICS, Zs. – **KALMÁR, S.** – SALAMON, L.(2004): Investigation of factors affecting the application of precision plant production technologies
Sustain Life Secure Survival II., Socially and Environmentally Responsible Agribusiness, Prague, 22.-24. sept. 2004, (poster + abstract + CD)

Presentation material (whole text) published in Hungarian language:

1. **KALMÁR, S.** (2000): A termőhely-specifikus gazdálkodás első lépése, hozamtérkép készítés VI. Ifjúsági Tudományos Fórum Keszthely, 2000. március 29. ITF kiadvány CD-ROM-on, 2.1. fejezet

2. **KALMÁR, S.** – SALAMON, L. – ORBÁN, J. (2001): A hozamtérkép készítés beruházás igénye és várható megtérülése nagyüzemi gazdaságban. „Erdei Ferenc" Tudományos Konferencia 2001. 08. 30. Agrárökonómiai szekció (Előadás)

3. **KALMÁR S.** – SALAMON, L. (2002): A precíziós gazdálkodás alkalmazásának lehetősége a magyar mezőgazdaságban. Agrárinformatika 2002 Konferencia Debreceni Egyetem Agrártudományi Centrum 2002.08.27-28.

4. **KALMÁR S.** – SALAMON, L. (2002): Precíziós gazdálkodás – alkalmazni, vagy nem alkalmazni. XXIX. Óvári Tudományos Napok, NYME-MÉK 2002. október 3-4

5. REISINGER, P. – NAGY, P. – **KALMÁR, S.** (2004): Vizsgálatok az on-line precíziós gyomszabályozás alkalmazhatóságára XIV. Keszthelyi Növényvédelmi Fórum, 2004. január 28-30.

6. **KALMÁR, S.** – RADNICS, ZS. – SALAMON, L. (2004): A precíziós növénytermesztési technológia bevezetése Magyarországon – a gazdálkodók körében végzett felmérések tükrében (Adoptation of precision agriculture in Hungary – in mirror of the test made among the farmers) WEU Nemzetközi Konferencia Mosonmagyaróvár 2004.05.06-07. 42 p.

7. **KALMÁR, S.** – RADNICS, ZS. – SALAMON, L. (2004): A precíziós növénytermesztési technológia bevezetése a humán tényezők függvényében XXX. Óvári Tudományos Napok, NYME-MÉK 2004. október 7.

8. **KALMÁR, S.** – RADNICS, ZS. – SALAMON, L. (2005): A precíziós növénytermesztési technológia humán tényezői a fenntartható fejlődés szolgálatában. Fenntartható fejlődés, fenntartható társadalom és integráció Konferencia Komárom 2005.04.28 VIII. szekció A fenntarthatóság és a mezőgazdaság

9. RADNICS, Zs. – **KALMÁR, S.** – SALAMON, L. (2005): A Nyugat-dunántúli régió gazdálkodóinak véleménye a növénytermesztés kockázatairól, XLVII. Georgikon Napok, Keszthely, 2005. szeptember 29-30. (előadás + absztrakt + CD kiadvány)

10. **KALMÁR, S.** – NAGY, S. – SALAMON, L. – HAÁSZ, I. (2006): A precíziós gazdálkodás növényvédelmének lehetséges hatásai a kukorica terméseredményére „Növényvédő szer használat csökkentés gazdasági hatásai" 2006. június 9-én Workshop

11. **KALMÁR, S.** (2009): A precíziós gazdálkodás elterjedését befolyásoló tényezők vizsgálata. Gazdálkodás Konferencia 2009. 10. 16 Mosonmagyaróvár (in press)

Study in Hungarian language:

1. **KALMÁR, S**. (2000): A precíziós gazdálkodást megalapozó hozamtérkép készítési módszer, valamint a tápanyag utánpótlási, agrotechnikai és növényvédelmi eljárások alkalmazásának vizsgálata
NymE MÉK (Plant protection engineer post-graduate course) diploma work, Consultant: Dr. habil. Reisinger Péter

Other publications:

1. PECZE, Zs. – **KALMÁR, S.** (1999): Termőhely-specifikus gazdálkodás a gyakorlatban Növényvédelmi Tanácsok VIII. évf. 1999. december 13 p.

2. **KALMÁR, S.** – PECZE, Zs. (2000): Hozamtérkép készítése AGRO-MAP 3.0 programmal Növényvédelmi Tanácsok IX. évf. 2000. január 16 p.

3. **KALMÁR, S.** (2001): Más szemmel nézve … (Távérzékelés, avagy a mindent látó szem)
Növényvédelmi Tanácsok X. évf. 2001. március 52-53 p.

4. **KALMÁR, S.** (2001): Globális helymeghatározás fontossága a mezőgazdaságban a XXI. század küszöbén Növényvédelmi Tanácsok X. évf. 2001. április 15 p.

5. RADNICS, Zs. – **KALMÁR, S.** – SALAMON, L.(2006): Gazdálkodói vélemények a növénytermesztés kockázatairól, Agro Napló, 2006/5, 7-9. p.