

References of CROSTRO members

- 1) Zugec, I., Stipesevic, B., Jug, D., Jug, I., Josipovic, M., Tolimir, M. (2006): Tillage and nitrogen effects on winter wheat yield and selected soil physical properties on hypogley of Eastern Croatia. *Cereal Research Communications*, 34(1/1): 355-358. Current Content, Accession number: 039XC-0088.

Abstract: The field research was conducted on hypogley in Vrbanja, Croatia, during four growing seasons from 1992/1993 to 1995/1996. They included five soil tillage systems and three nitrogen fertilization levels in four replications for winter wheat (*Triticum aestivum* L.) after soybeans (*Glycine max* L.) as a preceding crop. Tillage treatments were: PL=conventional tillage (ploughing to 20 cm depth, diskharrowing and standard sowing); DS=diskharrowing and standard sowing; MC=tillage by multitiller and chisel, standard sowing; RS=soil tillage and sowing by RAU-Rotosem; PR=ploughing to the depth of 20 cm + RS. Nitrogen fertilization treatments were 140 (N1), 170 (N2) and 200 kg N ha⁻¹ (N3). Wheat grain yields effects by tillage were as follows: 6.00 (PL), 5.79 (DS), 5.65 (MC), 5.61 (RS) and 5.90 t ha⁻¹ (PR). Significant differences of yields were found only in the first year of testing. Nitrogen fertilization resulted by non-significant differences of yields as follows: 5.56 t ha⁻¹ (N1), 5.85 t ha⁻¹ (N2) and 5.96 t ha⁻¹ (N3). The conclusion is that under certain environmental conditions it is possible to apply reduced soil tillage and moderate N fertilization.

- 2) Jug, D., Stipesevic, B., Zugec, I., Horvat, D., Josipovic, M. (2006): Reduced soil tillage systems for crop rotations improving nutritional value of grain crops. *Cereal Research Communications*, 34(1/2): 521-524. Current Content, Accession number: 038SA-0039.

Abstract: The trial for winter wheat (*Triticum aestivum* L.) or spring barley (*Hordeum vulgare* L.) in rotation with maize (*Zea mays* L.) on lessive-pseudogley in semiarid to semihumid climate of Eastern Croatia was set up during years 1996-1999 with five soil tillage systems: PL) Conventional tillage based on ploughing; PD) Conventional tillage after diskharrowing for previous crop in preceding season; DP) Diskharrowing after conventional tillage for previous crop in preceding season; DD) Continuous diskharrowing, and CD) Chiselling and diskharrowing. During first and second season (1996/97 and 1997/98), recorded winter wheat grain yields were not different, with PL having the highest and DD the lowest yield. Maize showed next differences in first season: PL=PD > CH=DD=DP, and in second season PD=PL=DP=CH > DD. In 1999, spring barley replaced winter wheat, and yields were: PL > DP > PD > CD > DD. Maize yields recorded were: PL > PD > DP > CH > DD. The grain yield results, together with hectoliter mass and mass of 1000 grains, supported that PL can be replaced with other tillage systems for winter wheat and spring barley, whereas continuous diskharrowing may have substantially lower yields for maize during unfavourable years.

- 3) Jug, I., Jug, D., Kovacevic, V., Stipesevic, B., Zugec, I. (2006): Soil tillage impacts on nutritional status of soybean. *Cereal Research Communications*, 34(1/2): 537-540. Current Content, Accession number: 038SA-0043.

Abstract: The Soybean were grown under field conditions on chernozem soil for four growing seasons (from 2002 to 2005). Three treatment of soil tillage were applied as follows: a) conventional tillage, b) reduced tillage (diskharrowing instead of ploughing) and c) no-till (zero-tillage). In general, the characteristics of growing season (the factor "year") were more influencing factor of soybean nutritional status (aerial part in stage of full-developed pods) in comparison with the soil tillage. In our study, low influences of applied soil tillage treatments on nutritional status of soybean were found because significant differences on soybean composition were found only for four (Cu, Cr, Sr

and Ba) from total 20 analysed elements. For example, conventional tillage resulted by the higher plant Cu (by 15% and 18% in comparison with DH and NT, respectively), and the lower plant Sr (by 12% and 16%, respectively) and Ba (by 26% and 23%, respectively), while under DH conditions by 22% lower plant Cr was found. Main nutrient status (P, K, Ca, Mg, S...) were independent on soil tillage. For this reason, usual fertilization practice is recommended for possible application of soil tillage reduction under conditions or calcareous chernozem.

4) Jug, D., Stipesevic, B., Zucec, I. (2006): Effects of conventional and reduced tillage systems in winter wheat – soybean crop rotation on crops biomass development. Cereal Research Communications, 34(2-3): 1137-1143. Current Content, Accession number: 088CK-0037.

Abstract: The Croatian Baranja region contains soils with highly quality crop production properties, but the knowledge of the effects of reduced tillage systems is lacking. Our investigations were conducted under field conditions at Knezevo site chernozem in four replications. They included four soil tillage systems (CT: conventional tillage, with ploughing up to the 30 cm as a primary tillage; DS: diskharowing up to the 15 cm; CH: chiselling up to the 30 cm + diskharowing; NT: no-till seed drilling), both for winter wheat (*Triticum aestivum L.*) - soybean (*Glycine max L.*) in crop rotation during three growing seasons (2002-2004). All measured crop properties were strongly affected by different seasons, especially with the season of 2003 with extreme drought. Crop biomass in five growth stages for winter wheat showed that at the beginning DS and CH had stronger growth than CT and NT, but differences vanished toward final stages. Winter wheat grain yield achieved by reduced tillage systems was in average either higher (CH=5.59 t ha⁻¹) or not different (5.38 and 5.23 t ha⁻¹ for DS and NT, respectively) than CT (5.28 t ha⁻¹). Soybean growth was consistently the most impaired at NT system, especially at the full maturity stage, where also DS and CH had lower biomass than CT. Soybean grain yield confirmed biomass results, since NT (2.11 t ha⁻¹) had always the lowest yield, when compared with other tillage systems (CT=2.88, CH=2.77 and DS=2.72 t ha⁻¹). Our conclusion is that within the Croatian Baranja environmental conditions is possible to replace soil tillage based on the ploughing for winter wheat and soybean with reduced soil tillage systems based on disking and chiselling, whereas no-till system still needs solution which will address drought-related problems.

5) Sabo, M., Jug, D., Ugarcic-Hardi, Z. (2006): Effect of reduced tillage on wheat quality traits. Acta Alimentaria, 35(3): 269-279. Current Content, Accession number: 090XN-0003.

Abstract: The effect of tillage systems (TS) on wheat quality traits including grain yield, thousand kernels weight, hectoliter mass, flour extraction rate and flour rheological properties were evaluated. Five different TS were compared in winter wheat (*Triticum aestivum L.*) production on one experimental field (chernosem) located in the Baranya region, north-eastern Croatia from 1998 to 2001. Tillage systems included conventional tillage (CT), disc harrowing, fine till (DHF), soil loosening (SL) + disc harrowing (DH), disc harrowing, coarse till (DHC) and no-tillage (NT). The most stable grain yield was obtained by DHF and CT in all three experimental years. There was no striking regularity with regard to applied TS and hectoliter mass and thousand kernels weight. The biggest difference of hectoliter mass was determined between CT and NT. TS had significant influence on the flour extraction rate in all three experimental years. The influence of TS on farinographic parameters was significant for all three experimental years for the quality number. Quality number was greater under CT than under other TS. Tillage effect on extensographic and amylographic parameters in the 3-year average did not show statistically significant differences. To sum up, since disc harrowing (DHF) and (DHC) followed by soil loosening with chisel produced equal grain yield and wheat quality parameters were slightly better than conventional tillage, these systems could be presented as an even handed replacement for ploughing.

6) Pančić, S., Jug, D., Ivezić, M., Žugec, I. (2004): Influence of multiple deratization and reduced tillage regimes on population dynamics of common vole (*Microtus arvalis* Pallas, 1778) in winter wheat. *Agriculture*, Vol. 10 (1), 31-34. CAB abstracts, Accession number: 20043135249.

Abstract: The Common vole (*M. arvalis*) is one of the economically important rodents, especially in winter wheat. Multiple deratizations were performed on the locality of Knezevo, Belje d.d., Croatia, in winter wheat with different tillage treatments, in December 1999-March 2000, using brodiflone rodenticide at 10 g/hole. The presence of meadow mouse before deratization was in the 2nd and 3rd categories. After deratizations, a declining trend was noticed in population dynamics. In standard tillage treatment, the efficacy was 97%. In treatment with multiple discing the efficacy was 89.25%. In soil loosening+discing the efficacy was 87.65%. In one-pass discing the efficacy was 94.05%, while in no tillage treatment it was 80.34%. The average efficacy was 91.99%. Multiple deratizations and reduced tillage can significantly reduce the population dynamics of meadow mouse.

7) Jug, D., Blažinkov, M., Redžepović, S., Jug, I., Stipešević, B. (2005): Effects of different soil tillage systems on nodulation and yield of soybean. *Agriculture*, Vol. 11 (2), 38-43. CAB abstracts, Accession number: 20063065145.

Abstract: The A study was conducted during 2002-2003 in northern Baranja, Croatia on a Chernozem to determine the effects of conventional and reduced soil tillage systems on yield components and nodulation of nitrogen fixing bacteria (*Bradyrhizobium japonicum*) in soybean crop. The soil tillage variants were: conventional tillage (primary soil tillage by mouldboard ploughing at 25-30 cm depth); multiple disc harrowing (at 10-15 cm as primary tillage); and no-tillage system. Results showed significantly lower plant density, mass of 1000 grains and grain yield at variants with reduced soil tillage in both years. Reduced tillage systems showed a positive trend on nitrogen fixing bacteria nodulation as indicated by the highest number and mass of nodules per plant.

8) Sabo, M., Jug, D., Jug, I. (2005): Dynamic chloroplast pigments concentration in leaves of soybean (*Glycine max* [L.] Merr.) under reduced tillage. *Archives of Agronomy and Soil Science*, 51(3): 291 – 297. BIOSIS, Accession number: 200600092752.

Abstract: The objectives of this experiment were to determine the chloroplast pigments dynamics of soybean leaves during the growth stages under different tillage systems, which can be a major factor limiting yield of soybean. The greatest differences between the photosynthetic productivity parameters of the investigated soybean were determined from reproductive stages (R2 and R3 – 4). The chlorophyll a, chlorophyll a/b and carotenoids content under CT, DH and NT were greater in the reproductive stages (R2 and R3 – 4) than in the early stages (V3 – 4 and R1). The concentration dynamics of chlorophyll b and chlorophyll a/b was very similar in all growth stages and under all tillage systems in the 2-yr average. The increased drought stress in 2003 was likely critical in the observed lower seed yields in 2003. The yield of soybean was significantly lower under NT than CT and DH treatments in both years. The relationship between the soybean yield and chloroplast pigments concentration is strongly influenced by external factors. In the 2-yr average the soybean yield was considerably affected by the years and tillage systems. Statistical analysis showed a very significant relationship between chlorophyll pigments content, but photosynthetic parameters investigated did not correlate with soybean yield.

- 9) Stipesevic, B., Zugec, I., Juric I., Jug D. (2005): Response of winter wheat to soil tillage and nitrogen fertilization on hypogley of Eastern Croatia. Proceedings of the 15th International Plant Nutrition Colloquium, 14-19. September 2005., Beijing, PRChina, in: C.J.Li et al. (Eds), Plant nutrition for food security, human health and environmental protection. Tsinghua University Press, Beijing, China, str. 1092-1093. ISBN 7-302-11786-1.

Abstract: The Eastern Croatia region contains soils of different properties which have need for specific tillage and fertilization treatments. Our investigations were conducted under field conditions on Zupanja hypogley in four replications. They included five soil tillage (the main factor A: basic experimental plot 4320 m²) and three nitrogen (N) fertilization (the subfactor B) for winter wheat (*Triticum aestivum* L.) after soybeans (*Glycine max* L.) as a preceding crop (four growing seasons from 1992/1993 to 1995/1996) as follows: A1=conventional tillage (ploughing to 20 cm depth, diskharroving and standard sowing) ; A2=diskharroving and standard sowing ; A3=tillage by multitiller with chisel, standard sowing ; A4=soil tillage and sowing by RAU-Rotosem ; A5=ploughing to the depth of 20 cm + A4 ; N fertilization (kg N ha⁻¹) in amounts 140 (B1), 170 (B2) and 200 (B3) with constant fertilization of phosphorus (150 kg P₂O₅ ha⁻¹) and potassium (100 kg K₂O ha⁻¹). Wheat grain yields (4-year means) as affected by tillage were as follows: 6.00 (A1), 5.79 (A2), 5.65 (A3), 5.61 (A4) and 5.90 t ha⁻¹ (A5). Significant differences of yields were found only in the first year of testing. Nitrogen fertilization resulted by non-significant differences of yields as follows: 5.56 t ha⁻¹ (B1), 5.85 t ha⁻¹ (B2) and 5.96 t ha⁻¹ (B3). Our conclusion is that under certain environmental conditions it is possible to apply reduced soil tillage and moderate N fertilization.

- 10) Jug, D., Stipesevic, B., Zugec, I., Knezevic, M., Seput, M. (2006): Effects of conventional and alternating tillage systems in winter wheat – soybean crop rotation. Proceedings of the 17th Triennial Conference of the International Soil Tillage Research Organisation (ISTRO), 28.8.-3.9. 2006., Kiel, Germany, p. 477-482. CD-ROM, ISBN 3-9811134-0CH.

Abstract: The Research was conducted under field conditions at Knezevo site chalcic chernozem soil type for eight soil tillage systems (K1: conventional tillage, with ploughing up to the 30 cm as a primary tillage; K2: diskharroving up to the 15 cm; K3: chiselling up to the 30 cm + diskharroving; K4: ploughing for soybean, in alternation with diskharroving for winter wheat; K5: ploughing for winter wheat, in alternation with diskharroving for soybean; K6: ploughing for soybean, in alternation with No-till for winter wheat; K7: ploughing for winter wheat, in alternation with No-till for soybean; and K8: No-till) in winter wheat (*Triticum aestivum* L.) - soybean (*Glycine max* L.) crop rotation during four growing seasons (2001/02-2004/05). All measured soil and crop properties were strongly affected by different seasons, especially with the season of 2003 with extreme drought. Winter wheat growth and grain yield achieved by reduced tillage systems was either at the same level with K1, or even higher (K2 and K3 in 2001/02), with exception in 2002/03, when K7 and K8 were lower than K1 due to the drought. Soybean growth and yield was consistently the most impaired at K7 and K8 system. Conclusion is that within the Croatian Baranja environmental conditions is possible to replace soil tillage based on the ploughing for winter wheat and soybean with reduced soil tillage systems based on disking and chiselling, whereas no-till system still needs solution which will address drought-related problems.

- 11) Knezevic, M., Djurkic, M., Knezevic, I., Stipesevic, B., Jug, D. (2006): Yield responses of winter and spring cereals to soil tillage and reduced herbicide doses. Proceedings of the 17th Triennial Conference of the International Soil Tillage Research Organisation (ISTRO), 28.8.-3.9. 2006., Kiel, Germany, p. 1366-1371. CD-ROM, ISBN 3-9811134-0-3.

Abstract: The The yield responses of winter wheat and spring barley to different tillage variants and to dose reduction of triasulfuron & chlortoluron herbicide mixture were studied on lessive pseudogley in the north-eastern part of Croatia during 1997-2000. No significant yield differences were observed between conventional tillage with mouldboard plough and reduced tillage variants (chisel ploughing, disk harrowing, disk harrowing alternated with mouldboard ploughing every second year and mouldboard ploughing alternated with disk harrowing every second year), although the average winter wheat yield of 5.7 t ha⁻¹ and spring barley yield of 4.9 t ha⁻¹ were the highest after chisel ploughing. The herbicide dose reduction to one half and one quarter of the recommended rate provided still good control of the total weed dry weight in terms of both crop yields for all tillage variants. The average yield from treated plots was 6% and 4% higher in winter wheat and spring barley, respectively compared to untreated plots.

12) Sabo, M., Jug, D., Ugarcic-Hardi, Z. (2004): Influence of reduced tillage on wheat quality properties. Flour - Bread '03: Proceedings of International Congress, 4th Croatian Congress of Cereal Technologists, Opatija, Croatia, 19-22 November 2003., 70-79. CAB abstracts, Accession number: 20043214059.

Abstract: The The effects of reduced tillage on the quality of wheat (cv. Demetra) were studied in Knezevo, Baranya, Croatia, during 2000/01. The treatments consisted of: conventional tillage (plots were tilled with a mouldboard plough to a depth of 30 cm, followed by disc harrowing to a depth of 10 and 15 cm); disc harrowing (fine tilth; 10-15 cm deep); disc harrowing followed by soil loosening with a chisel to a depth of 25-30 cm and disc harrowing to a depth of 15 cm; disc harrowing (coarse tilth; 15 cm deep); and no-tillage. The most stable yields (6.30 and 6.57 t/ha), coupled with high 1000-kernel weight (39.76 and 39.52 g) and hectolitre mass (74.25 and 73.70 kg), were obtained with conventional tillage and disc harrowing (fine tilth). Disc harrowing (fine tilth) did not significantly reduce grain yield, 1000-kernel weight and hectolitre mass; thus, this system can be considered favourable for wheat production. Disc harrowing with soil loosening had similar effects on soil physical properties (bulk density, porosity, and waterholding capacity) as conventional tillage, but the former was superior with regard to grain yield and quality. No-tillage significantly reduced grain yield, 1000-kernel weight, hectolitre mass and rheological properties compared to the other tillage systems. Reduced tillage reduced milling extraction, quality number and maximum viscosity compared to conventional tillage.

13) Jug, D., Jug I., Kovacevic, V., Stipesevic, B., Sostaric, J. (2007): Soil tillage impacts on nutritional status of wheat. Cereal Research Communications. 35/2-1:553-556. Current Content abstracts, Accession number: 2007-170PS-0096.

Abstract: Winter wheat was grown under field conditions on chernozem soil for four growing seasons (from 2002 to 2005). Three treatment of soil tillage were applied as follows: a) CT-conventional tillage, b) DH-reduced tillage (diskharrowing instead of ploughing) and c) NT-no-till. In general, the characteristics of growing season (the factor "year") was more influencing factor on w. wheat nutritional status (above ground mass in stage of Feekes 10 - inflorescence emergence) than the soil tillage. In this study, very low effects of applied soil tillage treatments on nutritional status of w. wheat were found because significant differences were found only for Cd out of 23 analyzed elements. For example, conventional tillage resulted by the higher plant Cd, by 13% and 21% in comparison with DH and NT. Macronutrient status (P, K, Ca, Mg, S....) was not affected by soil tillage treatments. For this reason, usual fertilization practice is recommended for possible soil tillage reduction for w. wheat production under conditions of calcareous chernozem.

- 14) Jug, D., Stipesevic, B., Jug, I., Samota, D., Vukadinovic, V. (2007): Influence of different soil tillage systems on yield of maize. Cereal Research Communications. 35/2-1:557-560. Current Content abstracts, Accesion number: 2007-170PS-0097.**

Abstract: The five soil tillage treatments (Ploughing=CT, Fine tilled disc harrowing=DHF, Coarse tilled disc harrowing=DHC, Disc harrowing and soil loosening by chiselling=DSL, No-tillage=NT) were tested at monoculture of maize under field conditions on chernozem soil type in Knezevo, Baranya region, Croatia, during three growing seasons (1999-2001). In general, treatments produced CT>DSL≥DHF>DHC>NT order for the maize grain yield and yield components, mostly due to the unfavourable precipitation distribution and lesser efficient soil moisture accumulation over the winter period in reduced tillage systems. For this reason, conventional tillage practice is recommended as the most yielding tillage system for given environment, possible soil tillage reductions can be DSL or DHF, whereas NT should not be accepted without further economical evaluation.

- 15) Jug, I., Jug, D., Vukadinovic, V., Stipesevic, B., Bertic, B. (2007): The influence of the temperature, genetic specificity and seed size at early growth and development of the maize in controlled conditions. Cereal Research Communications. 35/2-1:561-564. Current Content abstracts, Accesion number: 2007-170PS-0098.**

Abstract: The maize hybrids seed from three different FAO groups (FAO 400, FAO 500 and FAO 600) in four fractions (KO, KP, SO and SP) were germinated at three temperatures (10°C, 15°C and 20°C). After achieving the three leaves phenophase, selected phenologic parameters of early maize growth were recorded (shoot height (VI), root length (DK), shoot/root ratio (Rvi), shoot dry weight (STI), root dry weight (STK) and shoot/root dry weight ratio (Rst)). The influence of the temperature, genetic specificity and seed size fraction on tested maize hybrids was very significant for almost all tested parameters. The lowest values of all parameters were recorded at 10 °C and for SO seed size fraction, whereas the largest values were recorded for KO seed fraction. The presented results could serve as the indication for the more thorough research of physiological and biochemical mechanisms of abiotic stress tolerance.

- 16) Jug, D., Krnjaić, S., Stipešević, B. (2006): Yield of winter wheat (*Triticum aestivum* L.) on different soil tillage variants. Agriculture, Faculty of Agriculture in Osijek, Vol. 12 (06), str. 47-52. CAB abstracts, Accesion number: 20063227119.**

Abstract: An experiment was conducted in Baranja, Croatia, during 1998/99-2000/01 to establish an optimum system of reduced soil tillage for winter wheat. The treatments comprised: conventional tillage, i.e. primary soil tillage by mouldboard ploughing at 25-30 cm depth (CT); multiple disc harrowing at 10-15 cm as primary tillage (DH); and no-tillage (NT). The highest yields were recorded at DH with a 3-year average of 6.43 t/ha, followed by CT with 6.20 t/ha, whereas the lowest yields were recorded at NT treatment with a 3-year average of 5.43 t/ha. The highest profit was achieved at DH treatment (1703.83 HRK/ha) followed by NT (1480.22 HRK/ha) whereas the lowest profit was recorded at CT (1032.69 HRK/ha).

- 17) Sabo, M., Jug, D., Jug, I. (2007): Effect of reduced tillage on quality traits of soybean [*Glycine max* (L.) Merr.]. Acta-Agronomica-Hungarica, Vol. 55 (1), str. 83-88. CAB abstracts, Accesion number: .**

Abstract: Four different tillage systems were compared in soybean [*Glycine max* (L.) Merr.] production on one experimental field (chernozem) located in the Baranya region of northeastern Croatia in 2002 and 2003. The dry conditions experienced in 2003 exacerbated the negative effects

of no-tillage on soybean yield. The 2-year average yield of soybean was significantly lower under no-tillage (NT) than in the conventional tillage (CT), soil loosening (SL) and disc harrowing (DH) treatments. The soybean oil and protein contents were very similar in all the tillage systems over the 2-year average. Soybean crude fibre (%) was affected by the main effect of tillage. Averaged over 2 years the crude fibre (%) of soybean grain was greater under NT than in the CT, DH and SL treatments. The ash (%) generally increased as tillage declined.

18) Stipesevic, B., Jug, D., Jug, I., Kovacevic, V., Loncaric Z. (2007): Zinc uptake by winter wheat and soybean in different tillage systems. Proceedings of Zinc Crops 2007 Conference, Istanbul, Turkey, 24-26 May 2007, International Zinc Association & International Fertilizer Industry Association, CD-ROM.

Abstract: Winter wheat and soybean were grown under field conditions on chernozem soil of Knezevo, Croatia, for four years (from 2002 to 2005) in three applied soil tillage treatments: a) CT-conventional soil tillage, based on mouldboard ploughing, b) DH-soil tillage based on diskharowing instead of ploughing; and c) NT-no-tillage. Both crops in showed decreasing concentration of Zn within the plant tissue as a result of the soil tillage reduction in the order CT>DH>NT, presumably due to the limited roots growth in lesser disturbed soil at DH and NT treatments. Winter wheat recorded generally lower than optimal Zn concentrations and higher P:Zn ratios at reduced soil tillage treatments, as a result of lower Zn uptake. The recommendation for the winter wheat production by reduced soil tillage is additional Zn fertilization, whose exact amounts and way of application shall follow further research.

19) Jug, D., Stipešević, B., Jug, I., Stošić, M., Tadić, V. (2008): Influence of soil conservation tillage on soybean after-harvest residue cover. 43rd Croatian & 3rd International Symposium of Agriculture, Opatija, 18-21 February, 2008. 591-595, ISBN 978-953-6135-67-7.

Abstract: This research had a goal to determine the soil coverage by soybean's residues after harvest, in crop rotation with the winter wheat, at northern Baranya chernozem soil type, during the 2003-2005 period. The stationary experiment was laid down as a completely randomised block design in four repetitions, with following treatments of continuing soil tillage systems: CT – conventional soil tillage, based on mouldboard ploughing, DH – diskharowing soil tillage; RH – chiselling and diskharowing; and NT – no tillage. The harvest soybean residues measurements showed the least covered soil at CT treatment (7%), followed by more coverage at DH (16%), RH (21%) and the most covered soil at NT treatment (86%).

20) Jug, D., Stipešević, B., Jug, I., Stošić, M., Cvijanović, D. (2008): Reduced soil tillage influence on winter wheat grain yield components. 43rd Croatian & 3rd International Symposium of Agriculture, Opatija, 18-21 February, 2008. 609-613, ISBN 978-953-6135-67-7.

Abstract: The research of reduced soil tillage for the winter wheat, with the goal to determine the productivity potential of different soil tillage systems through the winter wheat grain yield and yield components, have been conducted at the northern Baranja chernozem soil type in the period of 1998/1999–2000/2001. The stationary experiment with completely randomized block design in five repetition had following treatments: CT – conventional soil tillage, based on mouldboard ploughing; DH – multiple pass diskharowing; RH – chiselling and diskharowing; DR – single pass diskharowing; and NT – no-tillage. Observed yield components did not confirmed superiority of conventional soil tillage by moldboard ploughing. The following winter wheat grain yields were achieved: DH (6,43 t/ha) > DR (6,22) ≥ RH (6,21) ≥ CT (6,20) > NT (5,43).

21) Jug, D., Brmez, M., Ivezic, M., Stipesevic, B., Stosic, M. (2008): Effect of different tillage systems on populations of common voles (*Microtus Arvalis* Pallas, 1778). Cereal Research Communications. 36 (Part 2 Suppl S): 923-926. Current Content abstracts, Accession number:2008-373HX-0063.

Abstract: The cultivation of soil above other advantages has favorable effect in destroying pest shelters and disrupts their life cycles. The aim of this paper is to present the effect of different tillage systems on population of common voles (*Microtus arvalis* Pallas,1778). The experiment was done through three years in Baranya County in Croatia, on winter wheat in crop rotation after soybean. Eight different tillage systems: Conventional soil tillage by ploughing – CT; Diskharrowing – DH; Chiseling + diskharrowing – CH; No-tillage for both crops – NT; Diskharrowing for w. wheat and ploughing for soybean (year before) – CSDW; Ploughing for w. wheat and diskharrowing for soybean (year before) – CWDS; No-tillage for w. wheat and ploughing for soybean (year before) – CsNw; Ploughing for w. wheat and no-tillage for soybean (year before) – CwNs. Results showed statistically significant differences between tillage systems and years. The biggest number of burrows occurred in treatments where soil tillage was omitted in year before and where common voles remained from previous year. Based on all obtained results, it can be concluded that tillage system has great impact on presence of common voles, and continuously deep ploughing decrease their number significantly in comparison to treatments where deep ploughing is omitted, either in current year or year before.

22) Stipesevic, B., Jug, D., Stosic, M., Zucec, I., Jug, I. (2007): Economic analysis of winter barley production for different soil tillage and nitrogen fertilization systems. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Horticulture. 64: 1/2, Str. 538-542. CAB abstracts, Accession number: 20083147455.

Abstract: The winter barley crop production is not adequately researched regarding soil tillage systems, especially in crop rotation with soyabean, both crops gaining importance as food for the animals. The research at the experimental site in Boksic (Croatia), during 2005 and 2006, showed no difference in yields from conventional tillage, based on mouldboard ploughing, and reduced tillage, based on disk harrowing, in each of six nitrogen application levels (0, 30, 60, 90, 120 and 150 kg N ha⁻¹). Regarding N application, the yield increase was not significantly higher after application of 90 kg N ha⁻¹. The disk harrowing with 90 kg N ha⁻¹ showed to be the most profitable tillage system.

23) Jug, D., Stipesevic, B., Zucec, I., Jug, I., Stosic, M. (2007): Economic evaluation of winter wheat production in different soil tillage systems. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Horticulture, 64: 1/2, str. 485-489. CAB abstracts, Accession number: 20083147464.

Abstract: A study was conducted with winter wheat to reduce the inputs in agricultural production through different soil tillage systems in Croatia during 1998/99-2000/01. Five soil tillage treatments were investigated: CT=conventional tillage, based on mouldboard ploughing, DH=multi-pass disc harrowing, CH=disc harrowing+chiselling, RH=single-pass disc harrowing, and NT=no-tillage. For the winter wheat crop production, the highest costs of machine labour have been recorded at CT (319.55 Euro) and the lowest at NT (162.43 Euro). The highest profitability threshold was also calculated for the CT, whereas the lowest profitability threshold was recorded for the NT. Generally, it can be stated that, according to the achieved profit, the conventional soil tillage is inferior in comparison with all other soil tillage treatments, with the achieved profit in the order of CT < NT < CH < DH < RH.

- 24) Babić, D., Stipešević, B., Jug, D., Jug, I., Šamota, D., Kratovalieva, S., Birkas, M. (2008): Comparison of two soil tillage treatments for winter barley – soybean growing based only on residual nitrogen after soybean. *Agronomski glasnik*, 70: 5, 465-473. CAB abstracts, Accession number: 20093078408.

Abstract: The winter barley crop growing has not been adequately researched regarding soil tillage systems, especially in crop rotation with the soybean, both crops gaining importance as food or fodder. Also, productivity of such crop rotation in low nitrogen environment is especially interesting for organic crop growing, where mineral nitrogen fertilization is not allowed. The research on two soil tillage systems, the conventional one, based on mouldboard ploughing (PLOW) and reduced soil tillage, based on discharrowing (DISC), with no other nitrogen source except symbiotic soybean bacterial fixation, was conducted at the experimental site Bokšić (Croatia), during the seasons 2004/05 and 2005/06. Results showed low but stable yields of winter barley, between 2.1 and 2.6 t ha⁻¹, where PLOW treatment recorded lower yield than DISC in 2005, and usual soybean yields (between 2.8 and 3.4 t ha⁻¹), with higher soybean grain yields for PLOW only in 2006. The absolute mass and hectolitre mass did not show any statistical differences among treatments either.

- 25) Jug, D., Stipešević, B., Jug, I., Žugec, I., Stošić, M., Kovačević, V. (2008): Impact of different soil tillage systems on earthworm s population and residue cover. *Proceedings of the 5th International Soil Conference "Soil Tillage – New Perspective". ISTRO – Branc Czech Republic, International Soil Conference 2008, 30.6.-2.7. 2008., Brno, Czech Republic, str. 79-87. CD-ROM, ISBN 978-80-86908-05-2.*

Abstract: To determine soil surface coverage by harvest residues and number of earthworm's as an excellent indicator of soil productivity two soil properties, the research of different soil tillage systems for the winter wheat – soybean crop rotation had been conducted at the north-eastern Croatian chernozem soil type, during the seasons 2002/03-2004/05. The harvest soybean residues measurements showed the least covered soil at CT treatment (7%), followed by more coverage at DH (16%), CH (21%) and the most covered soil at NT treatment (86%). Regarding earthworm population, during three year average, their number was higher with the smaller soil disturbance by more and more reduced soil tillage systems, and it showed CT<CH<DH<NT order. Longer period than three years is needed to reflect positive effects of reduced soil tillage systems on build-up of crop residues and earthworms population.

- 26) Jug, I., Jug, D., Stipešević, B., Vukadinović, V., Vukadinović, V., Sabo, M., Josipović, M. (2008): Effects of different soil tillage systems on chloroplasts pigments concentration in leaves of winter wheat. *Proceedings of the 5th International Soil Conference "Soil Tillage – New Perspective". ISTRO – Branch Czech Republic, International Soil Conference 2008, 30.6.-2.7. 2008., Brno, Czech Republic, str. 201-209 CD-ROM, ISBN 978-80-86908-05-2.*

Abstract: The scope of this research was to determine concentration and dynamic of chloroplast pigments in the winter wheat leaves. The research for winter-wheat after soybean crop rotation has been conducted at the North-eastern Croatia chernozem soil type during the period of 2001/2002–2003/2004, with following continuous soil tillage treatments: CT – conventional soil tillage, based on mouldboard ploughing; DH – multiple pass diskharrowing; and NT – no-tillage. The chloroplast pigments have been measured in four different phenophases after Feekes: 4.0, 8.0, 10.5.1 and 11.1. The concentration of chlorophyll "a", "b", karotenoids has been influenced by year, phenophase, interaction of year x phenophase and year x soil tillage on different significant level. The winter wheat grain yield at NT has been lower than CT and DH only in extremely dry year of 2003.

- 27) Zebec, V., Lončarić, Z., Zimmer, R., Jug, D., Kufner, M., Radaković, U. (2009): Nitrogen fertilization and soil tillage impact on winter wheat yield. 44th Croatian & 4th International Symposium of Agriculture, Opatija, 16-20 February, 2009. 671-675, ISBN 978-953-6331-67-3.

Abstract: Field experiment for research of different soil tillage and nitrogen fertilization impact on winter wheat yield was conducted with three levels of nitrogen fertilization (0, 80 i 140 kg N/ha) and three different soil tillage (conventional, reduced and no till). The experiment includes 27 plots in random design. The highest yield was achieved on plots with conventional tillage and highest N fertilization (5,08 t/ha), and with lowest yield resulted no-till treatment without fertilization (3,1 t/ha). Fertilization impact on yield can be determined during vegetation because of increasing soil Nmin, nitrogen concentration in flag leaf and straw comparing to treatments without and with lower fertilization.

- 28) Šeremešić, S., Milošev, D., Jug, D., Đalović, I., Jaćimović, G. (2009): Changes in Soil Organic Matter Content as Affected by Crop Rotation and Fertilization at the Long-Term Experiment. 44th Croatian & 4th International Symposium of Agriculture, Opatija, 16-20 February, 2009. 643-647, ISBN 978-953-6331-67-3.

Abstract: The study was performed on a long-term crop rotation trial carried out at the Rimski Šančevi Experimental Station of the Institute of Field and Vegetable Crops in Novi Sad. Analyzed treatments were: fertilized three-year crop rotation, fertilized two-year crop rotation, fertilized wheat monoculture; unfertilized two-year rotation and unfertilized three-year rotation. The unfertilized treatment started 1946/47 and fertilized treatments were established 1969/70. Winter wheat grain yield showed temporal variability and significant differences were found among fertilized and unfertilized cropping systems. Obtained results showed decreasing trends of SOM status in top soil during the investigated period. Both, unfertilized and fertilized treatments have lost soil organic matter observed during the 1970s, and the decrease was more pronounced at the fertilized plots. Although wheat monoculture demonstrated the highest loss of SOM, soil after continuous wheat had highest content of organic matter which did not corresponded with attained yield.

- 29) Jug, D., Stipesevic, B., Jug, I., Stošić, M., Teodorović, B (2009): Influence of weather conditions and soil tillage treatments on weed infestation in winter wheat-soybean crop rotation. Cereal Research Communications. 37(Suppl S):375-378. Current Content abstracts, Accession number: 2009-441QP-0093.

Abstract: One of the most important roles of soil tillage, especially conventional one, based on mouldboard ploughing, is the control of biotic factors, among them weed control. Research of influence of different soil tillage treatments on weed population in winter wheat crop has been undertaken at chernozem soil type in Eastern Croatia, during four years (2002-2005), with very different weather patterns. Eight soil tillage treatments, different in intensity of depth and frequency of soil tillage operations, were applied for winter wheat crop, in crop rotation after soybean. For each crop, four treatments had continuous soil tillage system (CT: mouldboard ploughing tillage, DH: disk harrowing tillage, CT: chiselling tillage and NT: no-till) and another four treatments had discontinuous soil tillage system (conventional tillage for one crop, and disk harrowing or no-tillage for another crop, where applied conventional systems for winter wheat were CWDS and CwNs, diskharowing in CSDW and No-till in CsNw). Applied herbicides showed very high effectiveness for all soil tillage

treatments. In droughty season 2003/04, in comparison with seasons 2001/02 and 2004/05, number of weed species (2.03, 3.19 and 2.78 weed species m⁻², respectively) and number of weeds (118, 128 and 141 weeds per m², respectively) were significantly lower. In comparison with CT, only CwNs showed higher number of weeds (134 vs. 211 weeds m⁻²). CWDS, CSDW, CH and NT all had lower number of weeds than CwNs (71, 77, 84, 97 and 211 weeds m⁻², respectively). Regarding w. wheat grain yield, there were no statistical differences between CT (5.62 t ha⁻¹) and CH, CSDW, CsNw, DH and CWDS (+140, +60, 0, -30 and -120 kg ha⁻¹, respectively), thus presenting proper soil tillage systems instead of mouldboard ploughing.

30) Stipesevic, B., Jug, D., Jug, I., Tolimir, M., Cvijović, M. (2009): Winter wheat and soybean zinc uptake in different soil tillage systems. Cereal Research Communications 37(2), pp. 305–310. Current Content abstracts, Accession number: 2009-451BC-0019.

Abstract: Winter wheat and soybean were grown under field conditions on chernozem soil of Knezevo, Croatia, for four years (from 2002 to 2005) in three applied soil tillage treatments: a) CT – conventional soil tillage, based on mouldboard ploughing, b) DH – soil tillage based on diskharowing instead of ploughing; and c) NT – no-tillage. Both crops showed decreasing concentration of Zn within the plant tissue as a result of the soil tillage reduction in the order CT>DH>NT, presumably due to the limited roots growth in lesser disturbed soil at DH and NT treatments. Winter wheat recorded generally lower than optimal Zn concentrations and higher P:Zn ratios at reduced soil tillage treatments, as a result of lower Zn uptake. The recommendation for the winter wheat production by reduced soil tillage is additional Zn fertilization, whose exact amounts and way of application shall follow further research.

31) Jug, I., Jug, D., Sabo, M., Stipešević, B., Stošić, M. (2011): Winter wheat yield and yield components as affected by soil tillage systems. Turkish Journal of Agriculture and Forestry, 35(1): 1-7. Current Content abstracts, Accession number: 2011-732LW-0001.

Abstract: Eight different soil tillage systems (TS) for winter wheat after soybean crop production were compared at the chernozem soil type in Croatian Baranya region in a 4-year period (2001/2002, 2002/2003, 2003/2004, 2004/2005). Tillage systems were: CT) conventional tillage, based on autumn mouldboard ploughing; DH) autumn disc harrowing; CH) autumn disc harrowing + chiselling; NT) No-tillage; CSDW) DH for winter wheat, alternated with CT for previous crop soybean; CWDS) CT for wheat, DH for soybean; CsNw) NT for wheat, CT for soybean; and CwNs) CT for wheat, NT for soybean. The dry conditions experienced in 2002/2003 decreased at half winter wheat grain yield at treatments NT and CwNs. The most stable grain yields were obtained by CT, CH, and CSDW in the third of 4 experimental years. CsNw, DH and CWDS did not result in significant crop yield reduction when compared to CT. There was no striking regularity regarding applied TS at the grain yield components. The strongest effects on yield and yield components for winter wheat were due to the climate conditions. TS had a significant effect on the grain yield and crop population in the earing stage in all 4 experimental years. The biggest difference in stem height was determined between CWDS and CsNw. Mass of plant, number of grains per spike, and hectolitre mass were greater under CT than under other TS. Coefficient of tillering and mass of 1000 grains had approximate values for all applied TS. In conclusion, CH, CSDW, and CsNw produced similar or slightly better quality properties than CT and these systems could be presented as an even-handed replacement for soil tillage.

32) Jug, D., Sabo, M., Jug, I., Stipešević, B., Stošić, M. (2010): Effect of different tillage systems on the yield and yield components of soybean [*Glycine max* (L.) Merr.]. Acta Agronomica Hungarica, 58(1), pp. 65-72. CAB abstracts, Accession number:20103143963.

Abstract: Eight different tillage systems were compared in soybean production on one experimental field (chernozem) located in the Baranya region of Croatia over a 4-year period (2001/2002, 2002/2003, 2003/2004, 2004/2005). The dry conditions experienced in 2003 exacerbated the effects of NT and CWNS on the soybean yield. The most stable grain yield was obtained using CSNW and CSDW in all four experimental years. DH, CH and CWDS did not result in any significant reduction in crop yield compared to CT. There was no clear trend regarding the applied tillage systems and grain yield components. The greatest effects on soybean yield and yield components were due to climatic conditions. Different tillage systems had a significant effect on the soybean grain yield and yield components in the four experimental years. The largest differences in stem height were determined between CSNW and NT. The number of pods per plant, the hectolitre mass and the grain yield were significantly lower under NT than under the other tillage systems. The number of fertile nodes of soybean and the number of branches per plant in the experimental years had approximately the same values for all the tillage systems. To sum up, the results achieved with DH, CH, CSDW, CWDS and CSNW were on par with each other and slightly better than CT, and these systems could represent adequate replacements for conventional tillage. No tillage could not be considered as the most favourable for soybean growing.

33) Birkás, M., Kisić, I., Jug, D. (2009): Pannonian Region in a Crucial Need for Improving Soil Quality and Mitigating Climate Damage. 2nd International Scientific/Professional Conference, Agriculture in Nature and Environment Protection, Vukovar, 04-06. June 2009. 17-25, ISBN 978-953-99440-8-5.

Abstract: Global climate change, in particular, draws attention to the state and quality of agricultural soils. The relationship between soil quality factors that can be affected by tillage and climate effects have been studied in parallel in Croatia and in Hungary in long term tillage experiments and by field monitoring. The scientists focused on factors such as the looseness of the soil, the optimum depth of the loosened layer, the depth at which a compact layer is formed in the soil and the extent of the compact layer, aggregation, soil moisture, surface cover, organic materials and carbon balance as well as earthworm activity. Findings of the research point to a relationship between soil quality improvement and climate stress mitigation. Changing tillage practices – adopting shallow stubble tillage leaving mulch on the soil surface, minimising ploughing or carrying out preparati on promptly at ploughing in the summer, increasingly extensive application of loosening techniques and tillage with cultivators, secondary tillage after ploughing in the autumn and radical reduction of disturbing the soil as well as minimising traffic-induced soil damage in the spring – is growing increasingly important in the Pannonian region.

34) Jug, D., Simić, M., Jug, I., Stipešević, B., Đalović, I., Šeremešić, S., Teodorović, B., Sabo, M., Andračić, Z. (2009): Yield of soybean (*Glycine max* [L.] Merrill) on different soil tillage variants. 2nd International Scientific/Professional Conference, Agriculture in Nature and Environment Protection, Vukovar, 04-06. June 2009. 38-44, ISBN 978-953-99440-8-5.

Abstract: Reduced tillage, as well as the most reduced tillage – No-till – every year are gaining greater importance in our region. Unfortunately, the areas under reduced tillage are still very small, mostly due to certain problems in transitional period. In order to develop the most sustainable system of reduced soil tillage for the soybean, the research site was set on Chernozem soil type in northern Baranja during two growing seasons (1999/2000-2000/2001) with five soil tillage systems: CT) Conventional Tillage (primary soil tillage by moldboard plough at 30-35 cm depth), DH) Multiple Diskharrowing at 10-15 cm as primary tillage CH) Chiseling and diskharrowing (chiseling at 30-35 cm and diskharrowing at 10-15 cm as primary tillage), PD) One pass diskharrowing (diskharrowing at 10-15 cm as primary tillage), and NT) No-tillage system. The highest yields were recorded at CT with

two-year average of 2,60 t/ha, followed by CH with 2,54 t/ha, DH with 2,48 t/ha, and significantly lower PD with 1,89 t/ha and NT with 1,82 t/ha. The highest profit in two-year average was achieved at DH treatment (466,29 kn/ha), followed by CH (302,83 kn/ha) and CT (203,63 kn/ha), whereas losses were recorded for NT (-294,31 kn/ha) and PD (-323,76 kn/ha), mostly due to the unfavorable agronomic conditions in the year 2000.

35) Simić, M., Videnović, Ž., Dolijanović, Ž., Jug, D., Dumanović, Z. (2009): Maize growing under different tillage systems. 2nd International Scientific/Professional Conference, Agriculture in Nature and Environment Protection, Vukovar, 04-06. June 2009. 62-67, ISBN 978-953-99440-8-5.

Abstract: The effects of three tillage systems (conventional and two conservation systems) on the grain yield of the maize hybrid ZPSC 704 were observed in the present study. The two-year (2006 and 2007) trial was set up on chernozem in experimental plots of the Maize Research Institute, Zemun Polje, in Belgrade-Zemun. Maize growing practices that included the conservation tillage system with the chisel plough and different rates of mineral fertilisers provided, especially in 2006, the grain yield at the level of the yield gained by the conventional tillage system that included the conventional plough. The lowest maize grain yields in both investigated years in both watering regimes were obtained under the no-tillage system. The *mineral fertiliser* application and consequent plant *nutrition showed certain* regularity in relation to the watering regimes. Namely, the highest average maize grain yields were obtained under rainfed conditions with a poorer nutrition, while the lowest yields were gained under irrigation regimes also with a poorer nutrition.

36) Jug, D., Stošić, M., Birkás, M., Dumanović, Z., Šimić, M., Vukadinović, V., Stipešević, B., Jug, I. (2009): Soil trafficking analysis for different reduced soil tillage systems. 2nd International Scientific/Professional Conference, Agriculture in Nature and Environment Protection, Vukovar, 04-06. June 2009. 51-59, ISBN 978-953-99440-8-5.

Abstract: The modern plant production systems, altogether with soil tillage systems, which are enabling high grain yields, request also use of modern machines. This kind of approach shows trend of higher machine and tool trafficking over agricultural land, which has an effect at soil degradation, primarily on physical, but also on chemical and biological soil complex. The analysis of farming machine and tool trafficking intensity has been undertaken at soil type chernozem in northern Baranja, in period 1998-2008, on four soil tillage systems. The greatest land coverage by trafficking by pneumatic tires for winter wheat crop has been recorded at conventional soil tillage (CT), with value of 121%, then chiseling (CH), 109%, diskharowing (DH), 77%, and no-till (NT), only 59%, whereas for soybean crop the same trend has been recorded, with values: CT 169% > CH 158% > DH 92% > NT 37%. On CT and DH treatments the ploughing and disking pans had been recorded.

37) Stipešević, B., Jug, D., Jug, I., Žugec, I., Stošić, M., Kolar, D. (2009): Influence of Different Soil Tillage Systems on Soybean Yield and Yield Components. Proceedings of the 18th Triennial Conference of the International Soil Tillage Research Organisation (ISTRO), 15.6.-19.6. 2009., Izmir, Turkey, str. T1-018-1 – T1-018-5. CD-ROM, ISBN: 978-975F-483-823-7.

Abstract: The soybean (*Glicine max L.*) in crop rotation after winter barley (*Hordeum sativum L.*) is not adequately investigated regarding soil tillage systems, both crops gaining importance as an animal feed. The research at experimental site Bokšić (Croatia), during the years 2005 and 2006, used the stationary experiment for soybean-winter barley crop rotation in split-plot experimental design in four repetitions with two soil tillage treatments (CT – conventional soil tillage, based on

mouldboard ploughing; and DH –diskharrowing soil tillage) as a main factor, in combination with six combinations of fertilization as a sub-factor (added nitrogen fertilization in quantities of 0, 40 and 80 kg ha⁻¹ in combinations with N-fixing inoculants - with and without *Bradhyrhizobium japonicum*). The CT treatment had higher yields than DH at N40 and N80 nitrogen fertilization levels, regardless the inoculation status. The highest yield has been achieved by CT-N80-B0 (3.61 t ha⁻¹).

38) Birkás, M., Jug, D., Stingli, A., Kalmár, T., Szemők, A. (2009): Soil Compaction Alleviation as a Solution in the Climate Stress Mitigation. Proceedings of the 18th Triennial Conference of the International Soil Tillage Research Organisation (ISTRO), 15.6.-19.6. 2009., Izmir, Turkey, str. T4-001-1 – T4-001-6. CD-ROM, ISBN: 978-975F-483-823-7.

Abstract: Tillage-induced soil compaction has often occurred in the Pannonian region. This form of compaction occurs on arable lands both in Hungary (1.82 million ha) and in Croatia (0.97 million ha) having negative impacts on crop production. In this study the tillage-induced compaction is discussed as an indicator of climate stress on arable fields. The research is based on soil condition monitoring and measuring that was started 32 years ago and on short and long-term experiments assessing the compaction impacts on the crops. The survey comprised 1870 monitoring places and 38 experimental plots. The following points were chosen for monitoring: 1. Root zone state (to a depth of 0-50 cm). 2. Occurrence of compacted layer (indicating the risk). 3. Extension of the compacted layer (indicating the degree of damage). 4. Long term effects of tillage (deterioration or improvement). 5. Tillage-induced drought and water-logging damage impacts on yield loss. The formation and location of compaction provided information concerning the depth, the method and the type of tillage applied, along with the expected risk for crop production under extreme climate conditions. The main objectives of the study are: 1. Occurrence and the extent of tillage-pan compaction in soils. 2. Consequences on water management in each of the years covered by the experiments. 3. Soil quality consequences. 4. Alleviation of pan-compaction by mechanical and biological methods. Long-term assessing has convincingly proven a correlation between tillage-pan compaction and the degree of climate stress. In view of the findings trends in soil tillage can be grouped into the following categories: climate damage mitigating and climate-stress increasing ones.

39) Birkás, M., Kisić, I., Jug, D., Smutny, V. (2010): The impacts of surface mulch-cover and soil preserving tillage on the renewal of the top soil layer. 3rd International Scientific/Professional Conference, Agriculture in Nature and Environment Protection, Vukovar, 31th May-02nd June 2010. 21-27, ISBN 978-953-7693-00-8.

Abstract: The impacts of surface coverage and soil preserving tillage were studied in a Chernic Calcic Chernozem soil of a degraded structure between 2002 and 2009. The primary purpose of the tillage treatments and the application of the crop sequence were to improve the quality of the soil. The objectives of remedying the soil included loosening up the compact layer to avoid deterioration of the existing compaction, to reduce dust formation and to help crumb formation, to reduce the loss of water and to stop the depletion of organic matter. These goals were achieved by continuous moisture, structure and OM preserving tillage and by keeping the soil covered throughout the growing season during the first 5 years and in the 8th year. Inadequate soil coverage in the 6th and 7th year resulted in a 7% drop in the crumb fraction. Our conclusion is, in view of extreme climate, the coverage of the soil during critical periods is bound to grow in importance in the future.

40) Jug, I., Jug, D., Stipešević, B., Šeremešić, S., Simić, M., Đurđević, B., Grabić, A., Nađ, R. (2010): Content of nitrogen and chloroplast pigments in winter wheat leaves under reduced tillage. 3rd International Scientific/Professional Conference, Agriculture in Nature and

Environment Protection, Vukovar, 31th May-02nd June 2010. 111-116, ISBN 978-953-7693-00-8.

Abstract: The scope of this research was to determine content of nitrogen and concentration of chloroplast pigments in the winter wheat leaves under reduced soil tillage. The research for winter wheat has been conducted at the Virovitica-Podravina County in 2008/2009, with following continuous soil tillage treatments: CT – conventional soil tillage, based on mouldboard ploughing; DH – multiple pass disk harrowing; and NT – No-tillage. The content of nitrogen, dry matter mass and concentration of chloroplast pigments have been measured in two different phenophases after Feekes: 6.0 and 10.1. The concentration of chlorophylls “a”, “b” and karotenoids has been influenced by phenophase and soil tillage treatment. The content of nitrogen and dry matter mass has been influenced only by phenophase.

41) Jug, I., Jug, D., Vukadinović, V., Đalović, I., Bertić, B., Tucak, M., Brozović, B., Sabo, M., Vinojčić, S. (2010): The influence of climatic conditions on the concentration of microelements in soybean under conventional tillage and No-tillage. 3rd International Scientific/Professional Conference, Agriculture in Nature and Environment Protection, Vukovar, 31th May-02nd June 2010. 117-122, ISBN 978-953-7693-00-8.

Abstract: The objective of this study was to determine the influence of different climatic years on the concentration of boron, manganese, copper, molybdenum, iron and zinc in the overhead mass of soybean under conventional tillage and no-tillage. There was a significant influence of climatic conditions on the concentration of microelements, except copper (concentration of B, Mn, Zn and Fe was higher in years with higher rainfall, while the concentration of Mo significantly affected by drought). The effects of tillage were significant for the concentration of iron, manganese and molybdenum. The conventional tillage treatment had a higher concentration of Mo in the soybean mass, while the No-till treatments measured higher concentrations of Fe and Mn.

42) Jug, D., Jug, I., Šimić, M., Stošić, M., Brozović, B., Šeput, M., Markasović Hasanec, V., Dumanović, Z. (2010): Influence of reduced soil tillage and nitrogen fertilization on yield and yield components of winter wheat. 3rd International Scientific/Professional Conference, Agriculture in Nature and Environment Protection, Vukovar, 31th May-02nd June 2010. 123-128, ISBN 978-953-7693-00-8.

Abstract: The aim of the study was conducted to determine the effect of different tillage systems (conventional tillage, disc harrowing and no-till) and different nitrogen fertilization (0, 30, 60, 90, 120 and 150 kg N ha⁻¹) on winter wheat grain yield and yield components (Plant density in the earing, Coefficient of tillering, plant height, number of fertile spikelets, number of sterile spikelets and harvest index). Investigations were conducted in the area of Virovitica-Podravina County during the year 2008/2009. Treatment of soil treatment significantly affected the plant height and yield, while the effect of fertilization was important for almost all tested parameters except for the Coefficient of tillering.

43) Štefančić, D., Stipešević, B., Jug, D., Vukobratović, M., Vukobratović, Ž., Radman, A. (2010): The suitability of demined agriculture land for organic agriculture. 3rd International Scientific/Professional Conference, Agriculture in Nature and Environment Protection, Vukovar, 31th May-02nd June 2010. 168-172, ISBN 978-953-7693-00-8.

Abstract: Republic of Croatia is contaminated with explosives and mines remaining after the Homeland War in about 4,000 km², and by the demining process, this land can be included in the system of organic agriculture. Based on analysis of agricultural land under mines within the municipality of Antunovac (Osiječko-Baranjska county), about 880 ha of mine suspected area after the demining process can be translated into an organic agricultural production. Cleared areas proved to be better in comparison with recently demined and never mined areas, with better soil physical properties. These areas are less compacted, more porous and better soil structure. All monitored parameters indicate that the demined land is very suitable for conversion to organic agriculture, which contributes to better conservation of natural resources, healthier life, less harmful to the environment and sustainable development of agriculture.

44) Vukadinović, V., Bertić, B., Jug, I., Jug, D., Đurđević, B., Kovačić, G., Tomljenović, K. (2010): Degradation pedophysical properties in alkali soils. 3rd International Scientific/Professional Conference, Agriculture in Nature and Environment Protection, Vukovar, 31th May-02nd June 2010. 173-178, ISBN 978-953-7693-00-8.

Abstract: Alkali soils or solonetz have a number of adverse chemical properties. Primarily it is alkaline (pH > 8.5), caused a high concentration of sodium ions in the soil adsorption complex (> 15%). A direct consequence of the strong alkalization is the small amount of available calcium plants. In addition, lack of calcium is a very bad effect on the physical properties of agricultural soils. The aim is to briefly present the work of a segment of the degradation of physical properties of soil with ESP values from 15.41-47.73, the distortion of the structural stability of soil aggregates, reducing hydraulic conductivity and increase soil compaction.

45) Birkás, M., Jug, D., Kisić, I., Kren, J., Jolánkai, M. (2010): Step-by-step adoption of environmentally-sound soil tillage in three Central European countries. 1st International Scientific Conference-CROSTRO, Soil tillage-Open approach, Osijek, 09-11 September, 20-28, ISBN 978-953-6331-83-3.

Abstract: In the last centuries, the need for tillage was to provide suitable soil conditions for plant growth (crop-focusing tillage). During the last decades, traditional goals of soil tillage have really been improved considering environmental consequences (environment-focusing tillage). In the next decade a new task is stressed, that is mitigating the climate induced losses (climate-focusing tillage). New challenges for the future is to reduce climate induced damages by the use of environmentally-sound adaptable tillage. The relationship between soil quality factors and climate effects have been studied in parallel in Croatia, in Czech Republic and in Hungary in long term tillage experiments and by field monitoring. In the environmentally-sound tillage challenge ten important steps are suggested for this region, namely: 1) Awareness of the state of the soil to draw conclusions concerning the likely damage. 2) Preventing the development of compact layers impeding water transport. 3) Eliminating the compact layer in the soil with the aid of a suitable tillage technique. 4) Creating small surface at any time of the season, without compaction stress. 5) Covering the surface with crushed stubble residues to protect soil and moisture. 6) Preserving the soil organic C is crucial at any type of tillage. 7) Protecting the soil structure. 8) Adapting the primary tillage to the soil state improvement. 9) Causing smaller stress in over wet or dry soils. 10) Maintaining the soil's capacity to take in and to store water in irrigated soils.

46) Dumanović, Z., Dragičević, V., Kolčar, D., Ercegović, Đ., Pajić, M., Jug, D. (2010): Environmental aspect of nitrogen availability under subsoiling and mole drainage. 1st International

Scientific Conference-CROSTRO, Soil tillage-Open approach, Osijek, 09-11 September, 169-174, ISBN 978-953-6331-83-3.

Abstract: The problem of compactness of heavy soils could be surpassed by mole drainage and subsoiling. The aim of this study was to investigate effects of mole drainage and subsoiling (treatment) on available nitrogen content in the soil profile, as well as, its uptake by maize and sunflower, on calcareous clay chernozem soil, in rainfed cropping during 2009. The total N output by plants, leaching and evaporation in control (without mole drainage and subsoiling) was higher by 15% in sunflower and by 43%, in maize. Moreover, N deprivation by leaching and evaporation during the growing season of sunflower was 338.13 kg N ha⁻¹ in control and 287.37 kg N ha⁻¹ in the treatment, while it was 475.03 kg N ha⁻¹ in maize in control and 268.63 kg N ha⁻¹ in treatment. The observed situation affected the plant growth during the growing season – biomass of both, sunflower and maize was higher, but the dry weight was lower in control. The N uptake by crops during the growing season was better in the treatment, resulting in the grain yield increase of 10% in maize and of 9% in sunflower.

47) Vukadinović, V., Jug, D. (2010): Geostatistical model evaluation for soil tillage suitability on Osijek-Baranya County example. 1st International Scientific Conference-CROSTRO, Soil tillage-Open approach, Osijek, 09-11 September, 122-130, ISBN 978-953-6331-83-3.

Abstract: This paper presents a computer model to determine land suitability for soil tillage in eastern Croatian based on geostatistical analysis of soil data. As the basis and source of soil types data was used the Croatian soil suitability map in digital form from which used data of soil types and soil chemical analysis data from the interpretative database fertility control of Osijek-Baranja County, a total of 17 341 samples of soil. Presents the model evaluation arable land workability uses a 6 indicators benefits of which three were identified accurately (pH, humus and elevation), and the remaining three are based on Digital Soil Map of Croatian and pedosystemic units whose inherent properties are ranked relative to particular indicators of suitability for soil tillage. Computer simulation using the described models and kriging geostatistical method obtained results showed that 66% of agricultural land belongs to the class of limited suitability for soil tillage (P3), approximately 21% is moderate and very convenient (P2 and P1), and only ~13% belong to the temporary or permanently unsuitable for soil tillage.

48) Macák, M., Smatana, J., Šimanský, V., Ďalović, I., Demjanová, E., Jug, D. (2010): Soil tillage and crop management and their impact on sustainability and soil physical characteristics. 1st International Scientific Conference-CROSTRO, Soil tillage-Open approach, Osijek, 09-11 September, 66-71, ISBN 978-953-6331-83-3.

Abstract: There is the strong decline of mouldboard ploughing during transition period from 90% to 60% of arable land in Slovakia due to economic, marketing and environmental reasons. For adoption of environmental sound tillage systems the research and dissemination is needed. The aim of research was to evaluate the influence of conventional and reduced tillage, FYM and residue management on soil bulk density (SBD) and porosity. The field trial was carried out over the period 2004-2006 at the experimental farm PD Kalná nad Hronom in south-western Slovakia. The sugar beet-spring barley-sunflower crop sequence was evaluated. The soil tillage treatments as follows: T1 conventional mould board ploughing with farm yard manure (FYM) application to sugar beet and incorporation of aboveground biomass of growing crops; T2 conventional mould board ploughing without organic fertilization; T3 no-till Horsch CONCORD CO 9. During June the soil samples were taken from 0.05-0.10m, 0.1-0.20m, 0.2-0.3m. The SBD and total porosity was highly significantly influenced by growing crops and weather conditions of evaluated years and SBD was also

significantly influenced by tillage system. The positive effect of FYM on total porosity was noted in 2004 during sugar beet phase which is in relationship with SBD 1.266 t m³-1.279 t m³ in topsoil layers 0.5-0.20m. In subsequent evaluated years 2005-2006 the topsoil layers 0.5-0.20 m were more compacted with comparison to 2004 after first year of FYM application. In three year average, the conventional mould board ploughing with farm yard manure and incorporation of aboveground biomass form the most suitable soil environment (SBD 1.395 m³, total porosity 43.65%) but we also recommended the no-till (SBD 1.455 m³, total porosity 42.31%) for Haplic Chernozems in this specific area of Slovak region.

49) Jug, I., Jug, D., Stipešević, B., Vukadinović, V., Sabo, M., Grabić, A., Stanić, M. (2010): The impact of reduced tillage on the morphological and physiological parameters of soybean. 1st International Scientific Conference-CROSTRO, Soil tillage-Open approach, Osijek, 09-11 September, 105-111, ISBN 978-953-6331-83-3.

Abstract: The scope of this research was to determine impact of different soil tillage on the morphological parameters (number of branch, pod weight and stem length) and physiological parameters (chlorophyll a, chlorophyll b, chlorophyll a+b and carotenoids) of soybean. The research for soybean has been conducted at the North-eastern Croatia chernozem soil type during the period of 2001/2002–2002/2003, with following continuous soil tillage treatments: CT – conventional soil tillage, based on mouldboard ploughing; DH – multiple pass diskharowing; and NT – no-tillage. The influence of Year was significant for the production of chlorophyll b and carotenoids, while the soil treatment had significant effect on the concentration of chlorophyll (a + b) and chlorophyll b. The interaction Year x Tillage proved to be significant only for concentration chlorophyll b and carotenoids. Agroclimatic conditions significantly affected all the morphological characteristics of soybean, while the effect of tillage was not statistically significant.

50) Jug, I., Jug, D., Đurđević, B., Horvat, T., Habada, V., Brozović, B. (2010): Effect of nitrogen fertilization under reduced soil tillage on chloroplast pigments concentration in leaves of winter wheat. 1st International Scientific Conference-CROSTRO, Soil tillage-Open approach, Osijek, 09-11 September, 72-78, ISBN 978-953-6331-83-3.

Abstract: The scope of this research was to determine concentration of chloroplast pigments in the winter wheat leaves influenced nitrogen fertilization under reduced soil tillage. The research for winter-wheat has been conducted at the Virovitica-Podravina County in 2008/2009 , with six different nitrogen rate (control-0 kg N ha⁻¹, 30 kg N ha⁻¹, 60 kg N ha⁻¹, 90 kg N ha⁻¹, 120 kg N ha⁻¹, 150 kg N ha⁻¹, respectively) with following continuous soil tillage treatments: CT – conventional soil tillage, based on mouldboard ploughing; DH – multiple pass diskharowing; and NT – No-tillage. The chloroplast pigments have been measured in stem extension (after Feekes: 6.0). This research showed that chlorophylls are very sensitive to changes in nitrogen content: concentration of chlorophyll a, chlorophyll b, chlorophyll (a+b) and carotenoids increased with higher fertilization rate. Tillage did not significantly effect on concentration of chloroplast pigments.

51) Jug, D., Jug, I., Stipešević, B., Stošić, M., Brozović, B., Đurđević, B. (2010): Influence of different soil tillage treatments on soil compaction and nodulation of soybean root. 1st International Scientific Conference-CROSTRO, Soil tillage-Open approach, Osijek, 09-11 September, 188-195, ISBN 978-953-6331-83-3.

Abstract: Stationary research of reduced soil tillage for soybean had been conducted on Northern Baranja chernozem soil type. Research had been conducted during two years (2003/2004 –

2004/2005), as completely randomized block design in four repetitions, with following soil tillage treatments: CT - Conventional tillage based on ploughing; DH - Diskharrowing; CwNs - Ploughing for winter wheat (odd years), in alternation with No-till for soybean as a proceeding crop (even years); and NT - No-tillage. Soil tillage resistance measurements for soybean crop were highest for DH (2.39 MPa) treatment. The anthropogenic compaction was recorded at 10-15 cm and 25-30 cm depths, but soil compaction values were not limiting for normal soybean crops development. Reduced tillage systems had positive trend on nitrogen-fixing bacteria nodulation, since the highest values of number and mass of nodules per plant were recorded. In two-year average period higher yields was recorded for treatments with lower reduction of soil tillage intensity, with following CwNs>CT>DH>NT order. This research was run during two average/wet years, so the research needs continuation.

52) Stipešević, B., Brozović, B., Jug, D., Stošić, M., Jug, I., Vukadinović, V., Simić, M., Mladenović-Drinić, S., Toth, B., Levai, L. (2010): The influence of soil tillage system at germination of buckwheat, millet and sudan grass sown as post-harvest summer crops. 1st International Scientific Conference-CROSTRO, Soil tillage-Open approach, Osijek, 09-11 September, 137-141, ISBN 978-953-6331-83-3.

Abstract: Research on the influence of the soil tillage systems (CT - moldboard ploughing, MD – multi discharrowing, SD - single discharrowing) on emergence of buckwheat (*Fagopyrum esculentum L.*), millet (*Panicum miliaceum L.*) and sudan grass (*Sorghum sudanense L.*) crops was done on eutric brown soil at site Široko Polje (Croatia) after winter barley (*Hordeum vulgare L.*) had been harvested in July 2009. The formation of soil surface crust after planting on treatments CT and MD significantly reduced the emergence of all three crops. The soil crust at the CT treatment showed the thickest (2.3 cm) and hardest to break (used crust breaking pressure was 1.9 MPa), the MD's crust was significantly thinner (0.9 cm) and easier to break (1.1 MPa), whereas, due to the large soil surface coverage by harvest residues (>80%), the crust was not even formed at SD treatment.

53) Jug, D., Birkás, M., Seremesic, S., Stipešević, B., Jug, I., Žugec, I., Djalovic, I. (2010): Status and perspectives of soil tillage in South-East Europe (Plenary). 1st International Scientific Conference-CROSTRO, Soil tillage-Open approach, Osijek, 09-11 September, 50-64, ISBN 978-953-6331-83-3.

Abstract: Conservation or reduced soil tillage in different European Countries are mainly specific. This specific arise from different ecological conditions and from possibilities of acceptance a new scientific approaches and technological innovation, and partially of course from different conceptions in soil tillage approaches. However, in most countries conservation tillage are not accepted in proportions which are expected according their natural conditions and possibilities. It should not be forgotten subjective difficulties that require a higher level of education and greater sense of scientific approach to conservation tillage. The aim of this study was to determine the state of soil tillage in Croatia, Hungary and Serbia, and to determine the development prospects of conservation / reduced tillage systems.

54) Birkás, M., Kisić, I., Jug, D., Smutny, V. (2011): Remedying water-logged soils by means of adaptable tillage. 4th International Scientific/Professional Conference, Agriculture in Nature and Environment Protection, Vukovar, 1th – 3rd June 2011. 11-21, ISBN 978-953-7693-01-5.

Abstract: The extreme climate phenomena that wreaked havoc in the Pannonian region in 2010 had very negative impacts on soils as well and this study contains an assessment of some of the

consequences of the stress caused by precipitation on soils. The relatively rapid regeneration of chernozem soils damaged by hail was encouraged by consistent organic matter conserving tillage. Soil settlement along with the damage of the soil structure in the top 50 mm layer was monitored in a long term experiment, applying six different types of tillage techniques, in an environment characterised by 651 mm annual precipitation, from the time of the sowing of maize in the layer loosened by tillage. The best chances of minimised damage were observed in the case of the production of wide-row crops where the soil contained no compact layer and where about 30% of the soil surface was covered. Loosening in the case of tillage carried out in the summer on moist soil occurred only where less heavy damage had been caused, under a minimum of a 40-45% soil surface cover. The value of the relevant studies was increased by the enabling of the recovery of damaged soils and our recommendations were summed up in 18 points.

55) Birkás, M., Jug, D., Kisić, I., Smutny, V., Jolankai, M. (2011): Step-by-step adoption of adaptable soil tillage in Central Europe. 6th International Conference on Crop management practices adaptable to Soil Conditions and Climate Changes, August 31 - September 2, Pruhonice, Czech Rep. Proc. (Eds. Badalikova, B. et al.), pp. 212-220. ISBN 978-80-86908-27-4.

Abstract: For centuries, tillage was regarded by classical authors as a means of ensuring that crops' needs are met. That period is therefore now referred to as the era of crop-focused tillage. Attention shifted to soil conservation later on, thus that period is called the era of soil-focused tillage. A new challenge to be faced in the near future is how to reduce climate-induced damage by the use of climate mitigation tillage. The relationship between soil tillage factors and climate impacts has been studied in parallel in our countries in long-term tillage experiments and by field monitoring. Some of the most important factors that can be used in a step-by-step approach to the adoption of adaptable soil tillage have been identified. Changing tillage practices is considered to be crucial in Central European region and the recommended techniques include a long-term solution.

56) Birkás M., Kisić I., Jug D., Bottlik L., Pósa B. (2012): Soil phenomena and soil tillage defects in the past two years – A scientific approach. 5th International Scientific/Professional Conference, Agriculture in Nature and Environment Protection, Vukovar, 4th – 6th June 2012. 11-23, ISBN 978-953-7858-01-8.

Abstract: Years 2010 and 2011 saw particularly extreme weather patterns in the Pannonian region, as 2010 was a year of extreme amounts of rains, while 2011 saw extremely dry. These weather extremes took their toll on arable soils. The effects of the rain stress (namely, the washing off of dust and clay colloids), soil settlement, the expansion of the existing compact layer and the diminishing in the crumb fraction called for remedial operations to improve the soils condition in the next year. This goal could only partly be met in the soils that lost much of their moisture content during the extremely dry weather in 2011 despite the serious efforts made to achieve some improvement. In our long term *Soil quality – climate* experiment near the town of Hatvan we studied the impacts of compaction – that grew increasingly prominent during the wet year of 2010 – on the clod content of the soil after primary tillage and also that of the seedbed, along with the impacts of the rainy and the dry years on the soil agronomical structure as well as the impacts of a cloddy surface layer and the cavities in the tilled layer on moisture transport in the soil top layer. These years of extreme weather conditions resulted in the loss of some of the improvements achieved in earlier years – e.g. compaction which we had successfully avoided for 8 years appeared and aggravated, in the wake of the breaking up of the compact layer the soil contained a significant clod fraction after primary tillage and the proportion of the crumb fraction fell short of the optimum in both the wet and the dry years. The soil condition factors under review confirmed the advantages of direct drilling and shallow tillage, the quality of the soil was less favourable after the somewhat deeper tine tillage but it was

still much better than the soil condition after loosening and ploughing. Year 2012 is promising to be another testing year for the various tillage techniques.

57) Vukadinović V., Vukadinović V., Kraljičak Ž., Đurđević B., Jug D., Jug I., Kokanović M. (2012): Possibilities online database of land resources. 5th International Scientific/Professional Conference, Agriculture in Nature and Environment Protection, Vukovar, 4th – 6th June 2012. 306-311, ISBN 978-953-7858-01-8.

Abstract: Demanding job of interpretation of data, analysis and evaluation of soil suitability can be accelerated, technically simplified and more user friendly by using the Internet. For this purpose one can use several techniques and free applications, where information about land assessments and the results of its benefits and also the need for fertilization and conditioning are assembled in one place (server) – Interpretive (output) base, and users can access them through the Internet. This paper presents options for online access to soil base of Osijek-Baranja County, using the municipality of Bizovac as an example, and also expert interpretation of soil data on the example of agricultural recommendations. Within these recommendations the need for fertilization, assessment of the relative benefits of soil/land for crops, recommendation for liming and the annual rate of N-mineralizati on are given. Described online techniques can be applied in offline situations because files on the server are not protected and users can download them on their computer and subsequently analyze them.

58) Kvaternjak, I., Kisić, I., Birkas, M., Sajko, K., Šimunić, I. (2008): Soil tillage as influenced by climate change. Cereal Research Communications. 36: 1203-1206.

Abstract: A long-term field trial was set up in order to define the effects of autumn or spring primary tillage upon the physical characteristics and yields of spring row crops – maize and soybean. The objectives were to assess and recommend the most effective tillage method. In the first trial year, the year factor had a stronger influence on maize yields compared to the tillage factor. In the second trial year, however, the situation was quite contrasted. The tillage factor had a stronger impact on soybean yields compared to the year factor. The twoyear investigation period was only allowed to draw some preliminary conclusions. For this reason the research will be continued.

59) Kvaternjak, I., Kisić, I., Špoljar, A., Kamenjak, D., Jelen, R. (2012): Mechanical resistance of soil in selected vineyard of different ages in Križevci area. Proceedings 47th Croatian and 7th International Symposium on Agriculture, Opatija. 74-77.

Abstract: The aim of this study was to determine the soil resistance and the current soil moisture within and between rows in newly planted vineyards and in five and thirty year old vineyards with uniform management. The greatest resistance for soil layers of 10 cm have been identified within the rows in five year old vineyard between 0-40 cm, in thirty year old vineyard between 30-80 cm, and between 0-80 cm for both vineyards. Higher soil moisture in the soil layer below the depth of tillage reduced mechanical resistance of soil between the rows. The study found higher soil compaction due to natural consolidation of soil after five and thirty years within the rows than between the rows where tillage treatments had been executed.

60) Kisić, I., F. Bašić, A. Butorac, O. Nestroy, J. Marušić, M. Mesić, M. Sabolić, J. Petraš (1999): Zaštita tla od erozije s motrišta održivog gospodarenja tlom. Hrvatske vode, 26/1: 15-26.

Sažetak: Proučavanje i borba protiv erozije tla u Hrvatskoj jedno je od nedopustivo zapostavljenih znanstvenih pitanja s obzirom na njegovo značenje. Bilo je doduše verbalne deskripcije erozije, ali je, s obzirom na značaj problema, egzaktnih istraživanja sve donedavna bilo nesrazmjerno malo. Pod pritiskom spoznaje da se, globalno gledajući, erozija tla u posljednja dva desetljeća povećala za 50%, u Europi je u posljednje vrijeme pokrenuto nekoliko projekata istraživanja erozije. Usprkos svim tegobama Hrvatska je u te projekte djelatno uključena, najprije putem regionalnih asocijacija Alpe, Alpe - Jadran i Podunavlje, gdje je iniciran projekt: Trajno motrenje (monitoring) tla. U okviru US-Agroenvironmental Programa za istočne i srednje europske zemlje, za Hrvatsku su prihvaćena tri lokaliteta za istraživanje erozije: Daruvar za zonu pseudogleja, Butoniga u središnjoj Istri za područje fliša, a šire područje Varaždina za tla na laporu Hrvatskog zagorja. U ovom radu bit će prikazan dio rezultata koji je ostvaren kroz trogodišnja istraživanja na eksperimentalnom erozijskom polju Freivogelov brijeg kraj Daruvara. Najveći gubitak tla erozijom u sve tri godine istraživanja utvrđen je na kontrolnoj-standarnoj varijanti prema USLE, koja predstavlja obrađivano, a nezasijano-golo tlo. Oni su višestruko veći od tolerantne erozije (T vrijednosti), procjenjene na 10 t/ha/god, u prvoj godini (kukuruz) iznose 146,3 t/ha, u drugoj (soja) 110,11 t/ha, a u trećoj, kada je na pokusnom polju uzgajana ozima pšenica 86,7 t/ha. Na oranju u smjeru nagiba u uzgoju kukuruza zabilježen je gubitak tla erozijom od 38,5 t/ha, soje 38,1 t/ha, a u uzgoju ozime pšenice samo 0,54 t/ha. Izostavljanjem obrade u uzgoju kukuruza erozija se smanjuje u odnosu na obradu u smjeru nagiba, ali je u uzgoju kukuruza skoro dvostruko veća od tolerantne i iznosi 22,8 t/ha, u soji s 13,5 t/ha prelazi tolerantnu T vrijednost, a uzgoju ozime pšenice s 0,22 t/ha je neznatna. Konvencionalno oranje - okomito na smjer nagiba pokazuje dostatnu djelotvornost u zaštiti tla od erozije u svim uzgajanim kulturama; u uzgoju kukuruza 11,6 t/ha, soje 5,3 t/ha i ozime pšenice neznatnih 0,074 t/ha. U uzgoju kukuruza vrlo dubokim oranjem okomito na smjer nagiba erozija je bila 21,12 t/ha, u uzgoju soje 5,2 t/ha, a ozime pšenice 0,305 t/ha. Podrivanje + oranje okomito na smjer nagiba u uzgoju kukuruza i soje djelotvorno štiti tlo i smanjuje eroziju na samo 2,9 t/ha, a u ozimoj pšenici 0,132 t/ha. Erozija najvećeg intenziteta utvrđena je u proljetnom dijelu godine, napose ako je uzgajana neka od jarina i ako se vrši obrada u smjeru nagiba. U uzgoju jarina neposredno poslije sjetve utvrđeno je preko 80 % ukupne godišnje erozije, bez obzira na smjer obrade. Izostavljanje obrade i oranje okomito na smjer nagiba imala su značajno manju eroziju vodom u odnosu na obradu tla u smjeru nagiba. U uzgoju ozime pšenice erozija je izrazito niska, pa u obzir dolaze svi istraživani načini obrade.

61) Bašić F. Kisić I. Butorac A. Nestroy O. Mesić M. (2001): Runoff and soil loss under different tillage methods on Stagnic Luvisols in central Croatia. Soil Tillage Res. 62(3-4):145-151.

Abstract: Owing to humid climate and unfavourable relief, the problem of extensive soil erosion in central Croatia is of prime importance. The main objective of this research was to determine how soil erosion is influenced by deep (30 cm) soil tillage practised for deep-rooted row crops in comparison with other tillage methods, on Stagnic Luvisols. Soil loss quantity was recorded during the 4-year investigation cycle (1994-1998), under common field crops grown under six tillage methods. Appreciably higher rates of soil erosion were recorded in low-density row spring crops than in high-density winter crops under the same tillage methods. The time immediately following the sowing of spring crops was the most critical period, i.e. the period when highest soil loss occurs. The results showed that erosion processes cannot be completely stopped; however, they can be reduced to an acceptable level by an appropriate tillage method. Efficient soil conservation on Stagnic Luvisols was achieved by no-tillage and all across the slope tillage methods.

62) Kisić I., Bašić F., Mesić M., Butorac A. (2003): Procjena erozije tla vodom prema vodnim slivovima Republike Hrvatske. Zbornik radova: 3. Hrvatska konferencija o vodama – Hrvatske vode u 21. stoljeću. str. 301-308, Zagreb.

Abstract: In an attempt to quantify soil erosion by water as precisely as possible, we tried to estimate the total erosion drift from agricultural areas within 4 river basins in the Republic of Croatia using the results of the erosion studies done so far and applying USLE (Universal Soil Loss Equation) – the prognostic method applied worldwide in investigations of this kind. According to the said equation, the total erosion drift in the Sava basin amounts to 1,449,110 t/year, which makes 1.16 t/ha/year from the agricultural land in this basin. Total erosion drift in the Drava and Danube basins is 686.940 t/year, or 1.04 t/ha/year. Erosion drifts of 623,808 t/year, or 1.37 t/ha/year, were recorded in the Littoral-Istrian catchment areas, while the erosion drift from agricultural areas in Dalmatian river basins amounted to 1,042,659 t/year, or 1.35 t/ha/year. The overall annual erosion drift in the whole territory of the Republic of Croatia amounts to 3,802,517 tons or 1.21 t/ha of agricultural soil. As the problem of erosion touches on different scientific disciplines, erosion research should have a multidisciplinary character in the future. Such research should include agronomists, water management specialists, civil engineers, foresters, geologists, hydrologists, and all those whose aim it is to protect the natural resources of Croatia and thus preserve them for the coming generations.

63) Kisić I., Bašić F., Nestroy O., Mesić M., Sabolić, M. (2003): Održivo gospodarenje na tlima izloženim djelovanju erozije vodom. *Gazophylacium*, VIII/1-2, str. 25-35, Zagreb.

Abstract: Soil erosion by water is a multiply harmful process, which damages or destroys the two essential natural resources in agriculture – soil and water. Soil erosion is a natural process that cannot be fully prevented, but it may be reduced to a tolerable level by appropriate land management – tillage and plant cover. Soil investigations were carried out in the region of the town of Ilok with the aim of defining land management guidelines for reducing erosion to a tolerant level. Special attention was paid to selecting optimal tillage practices and the plant cover for the space between the rows of perennial plantations (vineyards and orchards) for major soil types of the Ilok region in different topographic conditions (slope and slope length). Considering the erosion risk caused by rain erosiveness, soil properties and topographic conditions of the Ilok region, it was determined that land management in plant production does not tolerate bare, unprotected soil in any part of the year. It is mandatory that grass should be grown in the space between the rows, notably in plantations oriented down the slope. Research results point to the need of introducing the mandatory practice of covering inter-row space with grass on regosol, the soil type prevailing in the majority of perennial Ilok plantations, also on the smallest slopes, on which rows tend downwards. Further, the practice of plot orientation and ploughing rows of perennial plantations down the slope should be reexamined. From the aspect of soil protection from erosion, the row orientation following the contour lines is by far more efficient. With regard to the target value of protecting soil with the plant cover – USLE indicator C, it was found that agricultural crops can be grown without greater constraints only on slopes not exceeding 4 % and on slopes not longer than 100 m. Assortment of crops that can be grown on slopes longer than 150 m is considerably narrowed. When planting orchards and vineyards, rows should be oriented across the slope, that is, follow the contour lines, and the spaces between the rows must be always covered with grass.

64) Bašić F. Kisić I. Mesić M. Nestroy O. Butorac A. (2004): Tillage and crop management effects on soil erosion in central Croatia. *Soil Tillage Res.* 78(2):197-206.

Abstract: On soils of high erosion risk, acceptable tillage practices harmonized with the concept of sustainable land management are the most efficient tool for soil conservation. Erosion risk and erosional drift quantity were recorded during the five-year research project (1994-1999) on Stagnic Luvisols in central Croatia, using typical agricultural crops and six tillage treatments common to this area. The most disastrous erosion risk of all test plots was predicted by USLE (Universal Soil Loss Equation) to occur on the check plots, which involved black fallow – tilled, unsown soil, without any vegetation cover. Indeed, the greatest soil losses each year were recorded on those check plots. Soil

loss on these plots was several times higher than tolerant soil loss (T value), estimated at 10 t ha⁻¹ yr⁻¹. When tillage was performed up and down the slope, erosion risk was extreme and erosional drifts higher than tolerance occurred if spring crops were grown (maize and soybean), but it was not the case with winter crops (winter wheat and oil seed rape). On the no-tillage plot, erosion risk was extreme, erosional drift quantity was double the tolerance level in maize (*Zea mays* L.). On the same plot, high erosion risk and erosional drift quantity slightly higher than tolerant was recorded in soybean (*Glycine hispida* L.). Insignificant erosion risk and insignificant soil erosion was recorded in winter wheat (*Triticum aestivum* L.); oil-seed rape (*Brassica napus* var. *oleifera* L.), and spring barley (*Hordeum vulgare* L.) with soybean (1998/99). All treatments involving plowing across the slope, i.e. conventional plowing; very deep plowing; and sub soiling + conventional plowing rendered satisfactory efficiency in terms of soil conservation when growing all the studied crops (with the exception of maize grown with very deep plowing). Since erosion did not surpass the tolerant soil loss threshold in these tillage practices, their application is recommended for the general practice. Based on this research, erosion risk can be used as a reliable indicator of sustainable land management.

65) Kisić I. Bašić F. Mesić M. Sabolić M. (2006): Influence of tillage systems on soybean yield characteristics. Cereal Res. Commun. 34/1:223-226.

Abstract: Aimed at determining the optimal ploughing depth and making tillage simpler and less costly, taking into account edaphic and climatic conditions as well as biological and agrotechnical requirements of crops grown, long-term investigations (1995-2005.) of the optimal depth of basic tillage are carried out on Stagnic Luvisols of sloping terrains in central Croatia. This paper presents the results relating to the yields of soybean (*Glycine hispida* L.). Yields achieved by the studied tillage treatments point to the conclusion that the no-tillage variant on the soil type under study (Stagnic Luvisols) cannot match the classical, standard soil tillage. Conventional tillage (plowed) to different depths in any direction is still a safe warranty for higher yields on this soil type. In the first trial year (1996.), the highest yield of 2.13 t ha⁻¹ was obtained with perpendicular plowed. In the second trial year (2001.), the highest yield of 3.34 t ha⁻¹ was achieved in the variant involving perpendicular subsoiled till 60 cm, plowed 30 cm deep. In the last trial year best result (3.59 t ha⁻¹) was on perpendicular plowed till 60 cm. With respect to the topical trend of applying any of the reduced tillage treatments in our agriculture, and considering the complexity of this problem, namely, application of a new soil tillage technology, further detailed, long-term and complex multidisciplinary research work is necessary, which should include researchers from all fields relating to these problems.

66) Kustura, A., Kisić, I., Bašić, F., Jurišić, A. (2008): Soil Erosion by Water in Perennial Plantations of the Ilok Region. Agriculturae Conspectus Scientificus. Vol 73/2; 75-83.

Abstract: Soil erosion by water is a natural process, in which soil particles get detached from soil mass, transported and deposited at a distance. Erosion depends on a number of natural factors, such as terrain slope, amount and intensity of precipitation, soil (structure, mechanical composition, permeability, infiltration, etc.), wind, crop rotation, and plant cover. Soil erosion by water is one of the most dangerous soil damaging processes. In the hilly part of the studied region, erosion causes great problems to fruit and wine production. The principal goal of this work is to find ways of reducing erosion by applying appropriate agricultural management practices, different methods of plant residue management, and radical conservation practices. Research results indicate that erosion cannot be prevented (especially in case of extreme weather conditions – very intensive precipitation), but it may be reduced to a tolerable level by selecting optimal agricultural practices.

67) Kisić I., Bašić F., Birkas M., Jurišić A., Bićanić V. (2010): Crop Yield and Plant Density under Different Tillage Systems. *Agriculturae Conspectus Scientificus*, 75/1: 1-7.

Abstract: To determine the optimal ploughing depth and to make tillage simpler and less costly, but also taking account of edaphic and climatic conditions as well as biological and agrotechnical requirements of crops grown, long-term investigations (1994-2009) have been carried out on Stagnic Luvisol of sloping terrains in central Croatia near Daruvar. The paper presents the results relating to plant density and yields of maize (*Zea mays* L.), soybean (*Glycine max* L.), oilseed rape (*Brassica napus* L.), winter wheat (*Triticum aestivum* L.) and spring barley (*Hordeum vulgare* L.). Investigation results point to the conclusion that high density crops (winter wheat, spring barley and oilseed rape) are suitable for growing under reduced tillage systems. Yields of low density spring crops (maize and soybean) obtained under the no-tillage system are not satisfactory, especially in climatically extreme years.

68) Kisić, I., Milašin, M. (2007): Procjena rizika od erozije i mjere zaštite vinogradarskih tala Brodskoga Stupnika. *Hrvatske vode*, 15(61): 273-284.

Abstract: The main objective of the paper is to apply the prognostic USLE method (Universal Soil Loss Equation) to assess potential and real soil erosion by water on the prevailing soil types in the vineyards of Brodski Stupnik, as well as to appraise whether it surpasses the tolerable level or is below it. Potential and real soil erosion was calculated for regosol and rendzina on marl on slopes of 3, 6 and 9%, and four different slope lengths: 2.5, 5, 7.5 and 10 meters. Potential and real soil erosion for luvic pseudogley and pseudogley of sloping terrains was calculated for slope lengths of 25, 50; 75 and 100 meters, and identical slopes of 3, 6 and 9%. Lengths and slopes considered were determined during field investigations. On all studied soil types, significant potential erosion was determined, which points to the need of applying certain soil protection measures (e.g. inter-row cover cropping, across-the-slope tillage and planting, subsoiling, mulching, etc.) if the soil is to be used for permanent plantations. The degree of soil erosion risk ranges from moderate to disastrous values, with prevalence of high and extreme values. The authors conclude that with the application of recommended agricultural management practices and conservation measures, erosion will be reduced to tolerable levels on most of the soils studied.

69) Kisić I., Bašić F., Nestroy O., Sabolić M. (2010): Soil erosion under Different tillage and Cropping Systems in Central Croatia. Chapter in book: *Global change: Challenges for Soil Management. Advances in GeoEcology 41. Catena Verlag GMBH, p. 141-149.*

Abstract: Our objectives were to quantify water erosion (referred to as soil loss) during a 14-year investigation period (1994-2008) on Stagnic Luvisols, in central Croatia, under common agricultural crops grown in six tillage treatments. This paper presents the results of research into the total soil loss, with special reference to the occurrence time of soil loss per crop and developmental stages of the crops grown in the investigation: Maize (*Zea mays* L.); Soybean (*Glycine hispida* L.); Oilseed rape (*Brassica napus* var. *oleifera* L.); Winter wheat (*Triticum aestivum* L.) and Spring barley (*Hordeum vulgare* L.). The largest erosion in the 14-year period was recorded in the check treatment. Following was the variant that involved ploughing and sowing up and down the slope. Much lower soil losses were recorded in no-tillage treatments and treatments with ploughing and sowing across the slope. Much higher soil losses were recorded in spring growing seasons (row crops, maize and soybean) than in winter seasons (wheat, barley and oilseed rape). In spring row crops growing season soil losses were not evenly distributed, quite the contrary. The period of seedbed preparation, or the period immediately after sowing spring crops (the last decade of April, May and the first decade of

June) was the most critical period with the highest risk of erosion. In spring crops growing season over 70% of the overall annual soil loss occurred in all tillage treatments. During the winter growing season (wheat, barley, oilseed rape - crops of high density), critical periods were not observed and water erosion was insignificant.

70) Kisić I., Bašić F., Nestroy O., Mesić M., Sabolić M. (2011): Tillage erosion in growing arable crops. Soil Protection Activities and Soil Quality Monitoring in South Eastern Europe. 68-76. JRC Scientific and Technical Reports. European Union 2011.

Abstract: Water erosion continues to be a primary cause of soil degradation and the soil loss throughout the world. Our objectives were to quantify water erosion (referred as soil loss) during the 15-year investigation cycle (1995-2009) on Stagnic Luvisols, in central Croatia, under common agricultural crops grown in six tillage treatments. The largest erosion in the 15-year period was recorded in the control treatment. Following was the variant that involved ploughing and sowing up and down the slope. Much lower soil losses were recorded in no-tillage treatments and treatments with ploughing and sowing across the slope. Much higher soil losses were recorded in growing of spring row crops (Maize and Soybean) than in autumn crops (Wheat and Oilseed rape). In growing of spring row crops, soil losses were not evenly distributed during crop growing, quite contrary. The period of seedbed preparation, or the period immediately after sowing spring crops is the most critical period with the highest risk of erosion. In growing of spring crops, this is the period when over 80% of the overall annual soil loss occurs in all tillage treatments. In growing of high density autumn crops, no critical periods were observed and water erosion was insignificant. Investigation results show that an adequate choice of the tillage method and growing referred crops in hilly region may efficiently protect the soils at the slope. In other words, the choice of tilling direction and crops is a key issue in creation of environment-friendly land management in that area.

71) Kisić, I., Bašić, F., Birkaš, M. (2011): Effects of soil tillage on quality of soil loss. 6th International Conference: Crop management practices adaptable to soil conditions and climate change, p. 44-48, Pruhonice, Czech Republic.

Abstract: Quantity and quality of soil loss was measured on Stagnic Luvisol under six tillage treatments in the Central Croatia during the 15-year investigation cycle (1995-2010). The trial involved the following tilling treatments: 1. Black fallow; 2. Tillage up and down the slope; 3. No-tillage; 4. Tillage across of the slope; 5. Very deep ploughing (till 60 cm) and 6. Subsoiling to the depth of 60 cm + tillage across of the slope. The intention was to establish whether there is a difference between the soil texture and chemical properties of natural, not eroded soil and soil loss removed from the trial plots. The results obtained point to the conclusion that soil loss was very often richer in colloids, that is to say in clay particles. Since more colloid fraction particles were determined in the texture of soil loss, and since due to its large active surface the colloid fraction is the main nutrient carrier in soil, it is realistic to expect great diversity of chemical properties. A somewhat higher soil pH, higher soil organic matter, higher ion exchange capacity and a larger amount of available phosphorus and potassium were regularly determined in soil loss. Some kind of minimum tillage and tillage across of slope are recommended as efficient practices of sustainable land management on erosion threatened Stagnic Luvisol.

72) Kisić, I., Bašić, F. (2012): Influence of tillage soil erosion: Book chapter: Impact of tillage and fertilization on probable climate threats in Hungary and Croatia, soil vulnerability and protection, p. 89-100. Godollo.

Abstract: The damage caused by water erosion can be divided into direct and indirect, i.e. the changes that occur on the locations of erosion processes and changes that occur outside the locations of erosion processes (Table 1). Direct damage can be: reduction of organic matter and plant nutrients, loss of upper layer of soil and water holding capacity, loss of soil structure, reduced soil biodiversity and loss of soil fertility in arable layer. Indirect damage as a result of displacement of soil by erosion is: the introduction of sediment into watercourses and rivers, destruction of or damage to the roads and other buildings and structures, and the occurrence of landslides. Based on years of research (Kisić et al., 2005; Kisić et al., 2010) the conclusion was made that the decisive factor in the appearance of erosional processes are the implemented methods and tillage, plant mass density on the soil surface and the shape and the intensity of precipitation that occurs in a certain area. Man has a decisive influence on the manner of processing and the selection of crops grown, and no influence on the shape and the intensity of precipitation. During the 16-year period (1995 - 2010) daily monitoring of the erosion and daily half-hour rainfall intensity in the area of Daruvar, indicates a change in the intensity of rainfall. Although the studied period is short, the total amount of rainfall has not changed, but there was a noticeable change in the intensity of rainfall. The rains are increasingly occurring in short intense form, causing, among other things, increased erosion on sloping terrain. When summarizing their total monthly or annual amount, they do not deviate from the long term average, but significant differences in the intensity of rainfall have occurred. At the moment, is hard to predict which direction the erosion processes will take in the future, but it is assumed that the extreme climatic conditions will be happening more often, which will, among other things, cause more often extreme consequential effects of extremely wet (2010.) and extremely dry (2011.) years.

73) Kisić, I., Bašić, F., Nestroy, O. (2012): Runoff and Soil-Loss on Different Tillage Treatments in Growing of Arable Crops. 5th International Scientific Conference BALWOIS 2012. Ohrid, Republic of Macedonia, 28 May – June 2.

Abstract: Our objectives were to quantify water erosion (referred as a runoff and soil loss) during the 16-year investigation cycle (1995-2011) on Stagnic Luvisols, in central Croatia, under common agricultural crops grown in six tillage treatments. This paper presents the results relating to the total soil loss, with special reference to the time occurrence of soil loss per crop and development stages of the crops grown: Maize; Soybean; Oil-seed rape; Winter wheat and Spring barley. The largest erosion in the 16-year period was recorded in the standard treatment (black fallow). Following treatment was the treatment that involves ploughing up and down the slope. Much smaller soil losses were recorded in no-tillage and treatments with ploughing across the slope. Much higher soil losses were recorded in growing of the spring row crops (Maize and Soybean) than in the winter crops (Winter wheat, Spring barley and Oil-seed rape). In growing of spring row crops, soil losses were not evenly distributed during crop growing, quite contrary. The period of seedbed preparation, or the period immediately after sowing spring crops (May and first decade of June) is the most critical period with the highest risk of erosion. In the period of growing the spring crops over 80% of the overall annual soil loss occurs in all tillage treatments. The period from May to mid-June is the riskiest period for water erosion in the agroecological conditions of central Croatia if low-density spring row crops (Maize, Soybean, Potato, Tobacco, Sugar beet, Sunflower) are grown in the field. The trend of increasing participation of low-density spring crops compared to high-density winter and fodder crops on the arable areas in the Republic of Croatia indicates that the problem of water erosion on sloping terrains will be increasingly present. During the winter crops growing (wheat, barley, oil-seed rape) - crops of high density, no critical periods were observed and water erosion was insignificant. We are recommending some reduced tillage and ploughing across the slope due to the all advantages and drawbacks of studied tillage methods in 16 years investigation for a wide application in crop growing on this soil type.

74) Špoljar, A., Kvaternjak, I., Kisić, I., Birkas, M., Marenčić, D., Orehovački, V. (2009): Influence of tillage on soil properties, yields and protein content in grain of maize and soybean. Journal of Environmental protection and Ecology, 10 (4): 1013-1031.

Abstract: Influence of different tillage methods on soil properties, yield and protein content in maize (*Zea mays* L.) and soybean (*Glycine hispida* L.) grain was investigated at the experimental station of the College of Agriculture at Krizevci (Republic of Croatia) in 2006 and 2007. In the two investigation years, an averagely higher moisture content at MPa 0.033 was determined in treatment E (more intensive tillage) and averagely higher humus content was recorded in treatment A (reduced tillage). The highest yield of maize grain was achieved by reduced tillage (treatment 13) and of soybean grain by more intensive tillage (treatment E). Correlation and regression relationships were also determined between some physical and chemical soil properties and grain protein contents of these crops. Significantly higher protein content in maize and soybean grain was recorded under more intensive tillage (treatment E) compared to other tillage methods studied ($p < 0.05$). Very weak positive correlation was determined between soil water capacity at 0.033 MPa, maximum soil water capacity and protein content in maize grain, and a very weak negative correlation with particle packing density. These relationships are not statistically significant ($p < 0.05$). No correlation was established between the studied soil physical properties and protein content in soybean grain. Positive correlations were determined between humus content and soybean grain protein content. Relationships between these variables are statistically significant ($p < 0.05$). At this level of statistical significance, a positive correlation was determined between soil reaction, measured in I M KCl, and grain protein content of both crops. Positive correlation was found between total soil nitrogen and total protein content in soybean grain ($p < 0.01$) and also between the same variables in maize grain ($p < 0.05$). More intensive soil tillage, along with more favourable soil physical and chemical properties, has a beneficial effect on protein content in maize and soybean grain.

75) Sajko, K., Kisić, I., Bašić, F., Špoljar, A. (2010): Resilience of Soil in Modified Climatic Conditions. *Novenytermeles//Crop production* , Vol. 59 , Suppl: 121-124.

Abstract: During the last decade, rapid climatic changes have occurred and through water cycle disturbance strongly affected agricultural production. Appearance of long draught intervals through vegetation periods has been detected. Annual precipitation remained at the same level, but the data indicate the increasing presence of extremely intense rainfall that cannot meet the needs of crops for water. Therefore, it is necessary to devote special attention to management of water that is available during winter time and preserving water quantities for possible draughts intervals during vegetation period. The aim of this research is to determine optimal soil tillage system that will provide sufficient water quantities for crops and increase resilience of agroecosystems. For that reason field experiment with 4 soil tillage systems was set up in Central Croatia. Tillage systems differed in implementation time of separate tillage interventions. Experiment started in 2007 and in 2008 corn was cover crop. During vegetation period soil resistance, soil moisture, bulk density, humus content and yield data were collected. Statistical data analysis showed significant differences of corn yields, hectolitre and absolute weight between treatments. Yields varied from 5.4 to 9.7 t ha⁻¹ depending on tillage system.

76) Špoljar, A., Kvaternjak, I., Kisić, I., Marenčić, D., Orehovački, V. (2010): Utjecaj obrade na tlo, prinose, sadržaj ukupnih masti bjelančevina u zrnu kukuruza. *Agromoski glasnik*. 63 (2): 91-110.

Sažetak: Na pokušalištu Visokog gospodarskog učilišta u Križevcima u tijeku 2008. godine istraživana je utjecaj različitih načina obrade na značajke tla i prinose zrna kukuruza (*Zea mays* L.). Uz navedeno, istraživana je utjecaj obrade i značajki tla na ukupni sadržaj masti i bjelančevina u zrnu kukuruza. Uglavnom je utvrđen povoljniji utjecaj reducirane obrade na fizikalne značajke tla u odnosu na intenzivnije načine obrade. Kod svih istraživanih načina obrade tla ustanovljeni su pozitivni korelacijski odnosi između sadržaja ukupnih masti, bjelančevina i kapaciteta tla za vodu. Najveći korelacijski koeficijent utvrđen je za bjelančevine kod varijante B ($r = 0,51$; $p < 0,05$), a za ukupni sadržaj masti kod varijante E ($r = 0,56$; $p < 0,05$). Veće vrijednosti kapaciteta tla za zrak također su utjecale na veći sadržaj ukupnih masti (signifikantno kod varijante D s vrijednošću $r = 0,65$; $p < 0,01$) i bjelančevina (signifikantno kod varijante D s vrijednošću $r = 0,63$; $p < 0,01$). Utvrđen je također nepovoljan utjecaj zbijenosti tla na sadržaj ukupnih masti (signifikantno kod varijante D s vrijednošću $r = -0,77$; $p < 0,001$) i bjelančevina (signifikantno kod varijante D s vrijednošću $r = -0,51$; $p < 0,05$) kod svih istraživanih načina obrade tla. Signifikantno manje vrijednosti sadržaja humusa u tlu bile su kod varijante E (intenzivnija obrada) u odnosu na ostale istraživane načine obrade tla, osim u odnosu na varijantu B ($p < 0,05$), a glede ukupnog sadržaja dušika u tlu statistički opravdanih razlika nije bilo. Također su utvrđeni pozitivni korelacijski odnosi između sadržaja bjelančevina i količine humusa u tlu (signifikantno kod varijante B; $r = 0,73$; $p < 0,05$) i uglavnom pozitivni između ukupnog sadržaja masti i količine humusa ($p > 0,05$). Slični korelacijski odnosi dobiveni su između sadržaja ukupnih masti u zrnu i ukupnog sadržaja dušika ($p > 0,05$). Većinom su utvrđeni negativni korelacijski odnosi između ostvarenih prinosa i sadržaja bjelančevina u zrnu, a također je dobiven najveći negativni korelacijski koeficijent između ukupnog sadržaja masti u zrnu i prinosa ($p > 0,05$). Signifikantno niži prinosi zrna kukuruza bili su na varijanti A (reducirana obrada) u odnosu na ostale istraživane načine obrade tla ($p < 0,05$).

77) Špoljar, A., Kvaternjak, I., Kisić, I., Marenčić, D., Orehovački, V. (2010): Utjecaj obrade na tlo, prinose, sadržaj ukupnih masti i bjelančevina u zrnu kukuruza. *Agronomski glasnik*. 63 (2): 91-110.

Sažetak: Na pokušalištu Visokog gospodarskog učilišta u Križevcima u tijeku 2008. godine istraživana je utjecaj različitih načina obrade na značajke tla i prinose zrna kukuruza (*Zea mays* L.). Uz navedeno, istraživana je utjecaj obrade i značajki tla na ukupni sadržaj masti i bjelančevina u zrnu kukuruza. Uglavnom je utvrđen povoljniji utjecaj reducirane obrade na fizikalne značajke tla u odnosu na intenzivnije načine obrade. Kod svih istraživanih načina obrade tla ustanovljeni su pozitivni korelacijski odnosi između sadržaja ukupnih masti, bjelančevina i kapaciteta tla za vodu. Najveći korelacijski koeficijent utvrđen je za bjelančevine kod varijante B ($r = 0,51$; $p < 0,05$), a za ukupni sadržaj masti kod varijante E ($r = 0,56$; $p < 0,05$). Veće vrijednosti kapaciteta tla za zrak također su utjecale na veći sadržaj ukupnih masti (signifikantno kod varijante D s vrijednošću $r = 0,65$; $p < 0,01$) i bjelančevina (signifikantno kod varijante D s vrijednošću $r = 0,63$; $p < 0,01$). Utvrđen je također nepovoljan utjecaj zbijenosti tla na sadržaj ukupnih masti (signifikantno kod varijante D s vrijednošću $r = -0,77$; $p < 0,001$) i bjelančevina (signifikantno kod varijante D s vrijednošću $r = -0,51$; $p < 0,05$) kod svih istraživanih načina obrade tla. Signifikantno manje vrijednosti sadržaja humusa u tlu bile su kod varijante E (intenzivnija obrada) u odnosu na ostale istraživane načine obrade tla, osim u odnosu na varijantu B ($p < 0,05$), a glede ukupnog sadržaja dušika u tlu statistički opravdanih razlika nije bilo. Također su utvrđeni pozitivni korelacijski odnosi između sadržaja bjelančevina i količine humusa u tlu (signifikantno kod varijante B; $r = 0,73$; $p < 0,05$) i uglavnom pozitivni između ukupnog sadržaja masti i količine humusa ($p > 0,05$). Slični korelacijski odnosi dobiveni su između sadržaja ukupnih masti u zrnu i ukupnog sadržaja dušika ($p > 0,05$). Većinom su utvrđeni negativni korelacijski odnosi između ostvarenih prinosa i sadržaja bjelančevina u zrnu, a također je dobiven najveći negativni korelacijski koeficijent između ukupnog sadržaja masti u zrnu i prinosa ($p > 0,05$). Signifikantno niži prinosi zrna kukuruza bili su na varijanti A (reducirana obrada) u odnosu na ostale istraživane načine obrade tla ($p < 0,05$).

78) Špoljar, A., Kisić, I., Kvaternjak, I., Kamenjak, D., Orehovački, V. (2011): Utjecaj obrade na konzervaciju vlage u tlu te na prinose i sadržaj ukupnih masti i bjelančevina u zrnu soje. *Agronomski glasnik*, 73 (1-2): 93-105.

Sažetak: Na pokušalištu Visokog gospodarskog učilišta u Križevcima u tijeku 2009. godine istraživana je utjecaj različitih načina obrade na sadržaj vlage u tlu i prinose zrna soje (*Glycine max L.*). Uz navedeno, istraživana je utjecaj obrade i vlažnosti tla na ukupni sadržaj masti i bjelančevina u zrnu soje. Najviši prinos zrna soje bio je kod intenzivne obrade (varijanta E), ali ove razlike nisu bile signifikantne ($p > 0,05$). Najveći ukupni sadržaj bjelančevina u zrnu soje dobiven je kod reducirane obrade (varijanta B), a ukupnih masti kod intenzivne (varijanta E). Većinom su, glede sadržaja fiziološki aktivne i optimalne vlažnosti tla, dobiveni povoljniji rezultati na reduciranim varijantama obrade. Najpovoljnije stanje sadržaja fiziološki aktivne i optimalne vlage u tlu zabilježeno je kod reducirane obrade (varijanta A) u stadiju cvatnje. Utvrđeni su pozitivni korelacijski odnosi između sadržaja fiziološki aktivne i optimalne vlažnosti tla te ukupnog sadržaja masti i bjelančevina u zrnu soje te prinosa. Najveći sadržaj nepristupačne vlage zabilježen je kod intenzivne obrade u žetvi. Ustanovljeni su negativni korelacijski odnosi između ukupnog sadržaja bjelančevina i masti u zrnu kod svih varijanata obrade, a bili su statistički opravdani samo kod varijanata B i D ($p < 0,01$). Budući da je jedna godina prekratko razdoblje za donošenje preciznijih zaključaka, istraživanja bi trebalo nastaviti.