References of CROSTRO members_master and doctoral thesis

Master thesis

1. **Jug Danijel (2005): Effect of reduced soil tillage systems on winter wheat, maize and soybean yields for agroecological conditions of northern Baranja. Faculty of Agriculture, University of Zagreb, Croatia. Mentor prof. dr. sc. Ivica Kisić.**

Abstract: The stationary research of reduced soil tillage systems for winter wheat – soybean crop rotation and maize in the monoculture has been conducted at Chernozem soil type in northern Baranja. Research took three years for winter wheat and maize (1998/99 – 2000/01), and two years for soybean (1999/2000 – 2000/01) at farm "Kneževo", PIK "Belje", in completely randomized block design in four replications, for following soil tillage variants: I) Standard soil tillage based on autumnal ploughing; II) Multi-pass diskharrowing; III) Chiselling and diskharrowing; IV) Single-pass diskharrowing; and V) No-tillage.

For observed parameters, especially on winter wheat grain yield, almost equal effects produced weather conditions and soil tillage systems. For the three-year average, the highest winter wheat grain yield was recorded on Multi-pass diskharrowing (II), whose yield of 6.43 t/ha was significantly higher than yields at Standard soil tillage (I, for 230 kg or 3.7%), Chiselling and diskharrowing (III, for 220 kg or 3.4%) and Single-pass diskharrowing (IV, 210 kg or 3.3%), and highly significant when compared with No-tillage variant (V, 1000 kg or 15.6%).

Differently from the winter wheat, weather conditions had greater effects on maize grain yields than soil tillage intensity. The highest maize grain yield in three-year average was recorded at the Standard soil tillage (I=9.29 t/ha), whereas highly significant grain yield reduction followed intensity of tillage reduction, such as Chiselling and diskharrowing (III=8.37 t/ha), Multi-pass diskharrowing (II=8.07 t/ha), Single-pass diskharrowing (IV=6.99 t/ha) and No-tillage (V=5.94 t/ha).

For soybean, in two-year average, the highest grain yields were recorded at the Standard soil tillage (I=2.60 t/ha), diminishing with declining soil tillage intensity, insignificantly for Chiselling and diskharrowing (III=2.54 t/ha) and Multi-pass diskharrowing (II=2.48 t/ha), and highly significant for Single-pass diskharrowing (IV=1.89 t/ha) and No-tillage (V=1.82 t/ha).

Master thesis

2. **Stipešević Bojan (1997): The influence of reduced soil tillage at winter wheat yield and soil compaction at hydromeliorated gley soil of northeastern Croatia. Faculty of Agriculture, University of Zagreb, Croatia. Mentor prof. dr. sc. Anđelko Butorac.**

Abstract: Eastern Croatia region contains soils of different properties which have need for specific tillage and fertilization treatments. This investigation has been conducted under field conditions on Zupanja hypogley in four replications. They included five soil tillage (the main factor A: basic experimental plot 4320 m^2) 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, diskharrowing and standard sowing); A2=diskharrowing 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 P_2O_5 ha^{-1}) and potassium (100 kg K_2O 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). The conclusion is that under certain environmental conditions is possible to apply reduced soil tillage and moderate N fertilization for winter wheat.

Doctoral thesis

1. **Stošić Miro (2012): Influence of reduced soil tillage and nitrogen fertilization at winter wheat and soybean grain yields at Baranya hipogley soil type. Faculty of Agriculture in Osijek, University J.J. Strossmayer in Osijek, Croatia. Mentor prof. dr. sc. Danijel Jug.**

Abstract: During three years (2006./2007.-2008./2009.), stationary research of reduced soil tillage had been conducted for winter wheat and soybean, at marsh gley (eugley) hydromeliorated soil type of Baranya, near Darda.

Research has been conducted with eight soil tillage treatments (mean factor O), with size of the basic soil tillage plot of 540 m^2, and three nitrogen fertilization treatments (sub-factor G), with basic fertilization plot size of 165 m^2, set up in split-plot design in four repetitions. Soil tillage treatments consisted of four continued soil tillage systems for both crops: OR-Conventional soil tillage; TR-multiple diskharrowing; RT-Chiseling and diskharrowing; NT-No-tillage; and four discontinued soil tillage systems: OsTp-Conventional soil tillage for soybean, diskharrowing for winter wheat in following season; OpTs- Conventional soil tillage for winter wheat, diskharrowing for soybean in following season; NpOs-No-tillage for winter wheat, conventional soil tillage for soybean in following season: NsOp-No-tillage for soybean, conventional soil tillage for winter wheat in following season. Nitrogen fertilization treatment had three levels of applied nitrogen: for winter wheat G-1=120, G-2=150 and G-3=180 kg N ha^{-1}, and for soybean G-1=35, G-2=70 and G-3=110 kg N ha^{-1}.

Weather conditions had significant aberrations during 2006./2007. and 2008./2009. (extremely drought seasons), whereas 2007./2008. season was moderately humid.

At average winter wheat grain yield the highest impact expressed weather conditions (F=735.97**), followed by nitrogen fertilization (F=81.13**) and soil tillage system (F=13.18**).

The relatively high and stabile average winter wheat grain yields had been achieved, with statistical difference among years of research, whereas yield decreased by applied soil tillage systems in following order: RT (7.78) > NsOp (7.75) > OR (7.74) > OpTs (7.62) > TR (7.63) > OsTp (7.58) > NpOs (6.95) > NT (6.92 t ha^{-1}), with emphasize that treatments NpOs and NT recorded significantly lower yields in comparison with OR treatment.

Regarding nitrogen sub-factor, three years' average winter wheat grain yield increased by increase of applied nitrogen fertilizer, in following order: G-120 (7.16 t ha^{-1}), G-150 (7.48 t ha^{-1}), G-180 (7.85 t ha^{-1}), with significant differences among themselves. Significant differences were recorded also among seasons (2006./2007.=6.21 t ha^{-1}, 2007./2008.=8.75 t ha^{-1}, 2008./2009.=7.54 t ha^{-1}).

Three years average soybean grain yield were under the significant influence of weather (F=821.91**) and soil tillage system (F=2.51*), whereas nitrogen fertilization showed no statistical influence (F=0.99).

According to three years averages, normal and relatively stabile soybean grain yield has been achieved, with significant difference among years, whereas soil tillage systems showed following decreasing order: NpOs (2.62) > OR (2.58) > OsTp (2.56) > NsOp (2.49) > TR (2.46) = RT (2.46) > NT (2.42) > OpTs (2.35 t ha^{-1}). In comparison with OR treatment, only OpTs had significantly lower soybean grain yield.

Three year average soybean grain yields were not influenced by nitrogen fertilization (G-35 (2.51 t ha^{-1}), G-70 (2.50 t ha^{-1}), G-110 (2.47 t ha^{-1})), whereas seasons recorded significant differences (2007.=1.47 t ha^{-1}, 2008.=3.60 t ha^{-1}, 2009.=2.41 t ha^{-1}).

The research of soil chemical properties changes ($pH_{(H2O)}$, $pH_{(KCl)}$, P_2O_5, K_2O and humus), under the impact of soil tillage systems, at two depths (0-15 and 15-30 cm), showed the trend of decreasing soil $pH_{(H2O\ and\ KCl)}$ values at 0-15 cm depth and increasing at 15-30 cm depth at treatments with more reduced soil tillage. Significant increase of soil P_2O_5 and K_2O content in shallower depth has been recorded at treatments with more reduced soil tillage, whereas changes were not recorded for humus content in both observed depths.

Measurement of soil compaction by penetrometer showed in winter wheat that, in comparison with OR treatment, significantly higher compaction had all other soil tillage systems and all measured depths. Significantly higher soil compaction in soybean has been determined only at TR treatment. However, all recorded soil compactions expressed no limit for normal growth and development of root systems for both crops, since the highest recorded soil compactions did not exceed 2 MPa.

The study showed, with the optimum of nitrogen fertilization, a very successful application of reduced soil tillage systems, in the production of winter wheat and soybean.

Doctoral thesis

2. **Đurđević Boris (2010): Expert model of land suitability assessment for crops. Faculty of Agriculture in Osijek, University J.J. Strossmayer in Osijek, Croatia. Mentor prof. dr. sc. Vladimir Vukadinović.**

Abstract:A total of 17.404 soil samples (2003rd-2009th year) were analysed in the eastern Croatian. The largest number of soil samples belongs to the Osijek-Baranja county, which together with both Eastern sugar beet Factories (Osijek and Županja), carry out the soil fertility control (~4.200 samples/yr.). Computer model suitability assessment for crops, supported by GIS, proved to be fast, efficient enough reliability, considering the number of analyzed soil samples, which allows the visualization of the agricultural area and prediction of its production properties for the purposes of analysis, planning and rationalization of agricultural production.

With more precise data about the soil (soil and climate as well as reliable Digital Soil Map of Croatia), the model could be an acceptable, not only to evaluate the suitability for growing different crops but also their need for fertilizer, the necessary machinery, the need for repairs (liming, and other measures input of organic matter), to eliminate or reduce effects of limiting factors in primary agricultural production.

Assessment of the relative benefits of soil presented by computer model for the crops production and geostatistical method kriging in the Osijek-Baranja county showed:

1) Average soil suitability is 60,06 percent.
2) Kriging predicted that 51.751 ha (17,16%) of limited resources (N1) for growing crops
   a) 86.142 ha (28,57%) of land is limited suitable (S3),
   b) 132.789 ha (44,04%) is moderately suitable (S2) and
   c) 30.772 ha (10,28%) is excellent fertility (S1).

A large number of eastern Croatian land data showed that the computer-geostatistical model for determination of soil benefits for growing crops were automated, fast and simple to use and suitable for the implementation of GIS and automatically downloading the necessary indicators benefits from the input base (land, analytical and climate) and data from the digital soil maps with the ability:

1) Visualize the suitability for soil tillage,
2) Predict the benefits of growing crops using kriging method and
3) Analysis for production area, planning and/or rationalization with more efficient and economical investment in primary agricultural production.

Application of computer model is accurate for fertilizer crops recommendations, but caution is advised until the model will be calibrate, so that prediction be within acceptable error/risk, because of relatively small number of samples and insufficient reliability of pedoclimatic data.

Doctoral thesis

3. **Jug Danijel (2006): Reaction of winter wheat and soybean on reduced soil tillage on chernozem. Faculty of Agriculture in Osijek, University J.J. Strossmayer in Osijek, Croatia. Mentor prof. dr. sc. Ivan Žugec.**

Abstract: Stationary research of reduced soil tillage for winter wheat - soybean crop rotation had been conducted on Northern Baranja chernozem soil type. Research had been conducted at farm "Kneževo", PIK "Belje", during four years (2001/2002 – 2004/2005), as completely randomized block design in four repetitions, with following soil tillage treatments: four of them with continued soil tillages: I) Conventional tillage based on ploughing–CT; II) Diskharrowing–DH; III) Chiseling and diskharrowing–CH; IV) No-tillage–NT; and four of them with soil tillage alternations: V) Conventional tillage for soybean (odd years) and diskharrowing for winter wheat (even years)–CSDW; VI) Conventional tillage for winter wheat (odd years) and diskharrowing for soybean (even years)–CWDS; VII) Conventional tillage for soybean (odd years) and No-till for winter wheat (even years)–CsNw; VIII) Conventional tillage for winter wheat (odd years) and No-till for soybean (even years)–CwNs.

The strongest effects at yield and yield components, both for winter wheat and soybean, were due to the weather conditions, followed by effects of soil tillage systems. The grain yields were relatively high and stabile for winter wheat. Yields were decreasing in following order: CH (5.76) > CSDW (5.68) > CT (5.62) = CsNw (5.62) > DH (5.59) > CWDS (5.50) > NT (5.40) > CwNs (5.36 t ha^{-1}). In comparison with the CT, highly significantly (**) lower yields were obtained only at NT and CwNs treatments.

The mean four-year soybean grain yields were relatively high but not as stable as w. wheat yields. The soybean yields decreased with higher level of soil tillage reduction, in following order: CsNw (3.10 t ha^{-1}) > CSDW (3.08) > CT (2.92) > CH (2.91) > CWDS (2.83) > DH (2.78) > CwNs (2.63) > NT (2.17). In comparison with the CT, significanlty and highly significantly lower yields were recorded at CsNw*, NT** and CwNs** treatments.

Soil resilience measurements for winter wheat crop were highest for DH (1.98 MPa) and NT (2.06 MPa) treatments, and lowest for ploughed treatments, whereas for soybean crop the highest soil compactions were measured at CWDS (2.53 MPa) and DH (2.44 MPa) treatments. Due to continuous diskharrowing and ploughing tillage depths, the anthropogenic compaction was recorded at 10-15 cm and ploughing depths, but soil compaction values were not limiting for normal crops development for both crops.

Based on this research results, it can be stated that, beside conventional soil tillage, reduced soil tillage systems also can be successfully applied.

Doctoral thesis

4. **Stipešević Bojan (2003): Effects of wheat cover crop desiccation times on soil physical properties and early growth of corn under no-till and conventional tillage systems. Purdue University, USA. Mentor prof. dr. sc. Eileen J. Kladivko.**

Abstract: Cover crops can improve soil physical properties but can present challenges for subsequent cash crop growth. The objectives of this research were to investigate the influence of a winter wheat (*Triticum aestivum)* cover crop on selected soil physical properties and early development of corn in a corn (*Zea mays)* - soybean (*Glycine max)* crop rotation. The measurements were conducted on two Indiana research farms, both with dominant silt loam soil types during seasons 2000, 2001 and 2002. The experimental design was a split-split plot, with tillage treatment as the main effect (spring disking conventional till (CT) and no-till (NT)), two cash crops as the first split (soybean (B) and corn (C)), and three cover crop treatments as the second split (no cover crop (N), early (E) and regular (R) cover crop desiccation).

Soil aggregation was usually increased by either E or R relative to N cover crop, and more consistently so in CT than NT. Both the R and E treatments tended to decrease bulk density, cone resistance and soil temperature, but increase total porosity, air-filled porosity, water retention and vane shear strength in both tillage systems, whereas K_{sat} tended to improve with E or R cover treatments only in CT. Steady-state infiltration, measured on N and R only, tended to improve with R in both tillage systems. For both tillage treatments, both E and R increased soil water content, when compared with N, except in the case of early spring drought, when R transpired more water than E and was similar in water content to N. In years without early spring drought, early corn shoot and root growth following E in CT was either greater or not different than the other two treatments, whereas in NT the R>E>N pattern was frequently observed. In case of early spring drought, the E treatment on both tillage systems had better corn growth than both R and N treatments.

The results suggest that despite generally comparable soil structure improvements by both E and R treatments in both tillage systems, early desiccation is the more desirable treatment prior to corn production due to better soil water conservation in droughty weather.

Doctoral thesis

5. **Kvaternjak Ivka (2011): Tillage methods and timing impact on physical properties of pseudogley soil and on maize and soybean yields. Faculty of Agriculture, University of Zagreb, Croatia. Mentor prof. dr. sc. Ivica Kisić.**

Abstract: Applied tillage system in interaction with the soil and climate significantly affects tphysical properties of soil and yield of crops grown. The aim was to determine the effect of autumn and spring primary tillage and application of appropriate tillage implements, with the reduction of secondary tillage, on soil physical properties, especially mechanical resistance, and yield of maize and soybean seed in the period from 2006. tu 2009. A four-year field experiment with five different variants of tillage in the period 2006 - 2009. was set to determine the influence of tillage system and tillage dates on physical properties of pseudogleiy soil and crop yields. Research was conducted on the College of Agriculture in Križevci. Experimental variants consisted of different combinations of primary and secondary tillage: variant A - primary tillage in the spring and a secondary tillage with combined tool for seedbed preparation, variant B - primary tillage in the spring and a secondary tillage with rotating harrow, variant C - primary tillage in the autumn, winter furrow closing using spike-tooth harrow, and a secondary tillage with rotating harrow, variant D - primary tillage in the autumn, winter furrow closing and a secondary tillage with combined tool for seedbed preparation and E – primary tillage in the autumn, winter furrow closing, disc harrowing and seedbed preparation. Secondary tillage was conducted by a single pass. Maize was grown in the year 2006 and 2008 and soybean in 2007 and 2009. Sowing of maize on all versions of tillage was performed by four-row maize precision sowing machine, and sowing of soybean with a sowing machine for cereals. Fertilization and protection from weeds and pests for both crops was uniform. After emergence, during panicle stage of corn and soybean bloom, bulk density, density of solid particles, the total porosity, retention capacity of soil water, soil air capacity and the current moisture content in soil layer 0-15 cm and 15-30 cm was investigated. Measurement of the mechanical resistance of soil in 2006 and 2007 was performed four times, while in 2008 and 2009 six times for each year studied. As a result of the applied tillage systems, yield of corn and soybean seed was included in the research. A significant influence of climatic conditions was found for all investigated parameters. Mechanical resistance of the soil largely depended on the quantities of moisture. At a depth of 0-10 cm the greatest resistance was found in the variant D and variant E, 10-20 cm in the variant E, and 20-30 cm in the variant C and E. Arable soil layer showed no resistance value which could prevent the development of root system, except at low soil moisture. On the pseudogley soil with the moisture content less than 14% in the arable soil layer, resistance was greater than 7 MPa, and with humidity less than 18% in the subsurface horizon resistance was greater than 6 MPa. In tillage variants with spring primary tillage, less resistance were found during the growing season compared with the variants where the primary tillage was performed in autumn. A significant increase in resistance was found in

a layer of 30-40 cm. Between the layers of 0-15 cm and 15-30 cm, and between tillage treatments there were no significant differences of moisture content. The minimum moisture content in both layers was recorded at the panicle stage of corn and soybean bloom in all study years. Bulk density, as an indicator of compaction, was the highest in the variant E. The increase in this parameter was recorded during the growing season, with minimum value determined after the emergence, the largest after maize and soybean harvest. During the study an increase in bulk density was found. The lowest bulk density was determined in 2006 and the greatest in 2009. The highest total content of pores and macropores was established in 2006 in the layer of 0-15 cm and 15-30 cm, the smallest in 2009. Tillage variant B resulted in the highest grain yields of maize with 12.6 tons per hectare in 2006 and 13.8 tons per hectare in 2008. The highest seed yield of soybean was determined on tillage variant E with 2.2 tons per hectare in 2007 and 3.5 tons per hectare in 2009.

Doctoral thesis

6. **Kovačev Igor (2012): Economic efficiency of non-conventional soil tillage systems in wheat, soybean, barley and maize production. Faculty of Agriculture, University of Zagreb, Croatia. Mentor prof. dr. sc. Silvio Košutić.**

Abstract: Four-year study of non-conventional soil tillage systems was conducted at the experimental field near Nasice (45° 30' N, 18° 06' E) on the gleyic soil type and semi-humid climate. The experiment with four different tillage systems is set on the surface of 4 ha, and applied tillage systems and implements were as follows: 1. Conventional tillage (plough, disc harrow, seed-bed implement), 2. Reduced tillage I (chisel plough, disc harrow, seed-bed implement), 3. Reduced tillage II (shallow chisel plow), 4. No-till system. The study was performed with crops in the rotation: Winter Wheat (*Triticum aestivum* L.), Soybean (*Glycine* max L.), Spring Barley (*Hordeum vulgare* L.), Corn (*Zea mays* L.). The best results based upon economic analysis of production costs and yield of wheat and barley were obtained by no-till system, while in soybean production a reduced tillage system with shallow topsoil tillage with one pass of shallow chisel has proven to be the best option. In maize production the best economic result has been achieved with soil tillage system where ploughing was replaced with deep chiselling. Weather conditions had a great impact on the grain yield of corn causing intensive soil tillage came to the fore. In the relatively normal climatic conditions in the choice of tillage system, assuming uniform levels of yield, the advantage should be given to a system with lower level of tillage intensity, not only to reduce costs, but also because of the simpler production organization due to less machine and human labour requirement.