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Korišćenje modela za prognozu vremena visoke rezolucije za potrebe poljoprivredne proizvodnje

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Numerička prognoza vremena je u poslednje dve decenije doživela snažan razvoj koji je u prvom redu posledica eksplozivnog razvoja informatičke tehnologije. Dovoljno moćne računske mašine neophodne za izvršavanje numeričkih modela za prognozu vremena, koje su donedavno bile dostupne samo retkim stručnjacima u razvijenim zemljama, danas se mogu naći po cenama pristupačnim za svakoga. Za današnju situaciju na ovom polju karakteristično je povećavanje vremenske i prostorne rezolucije (finoće) atmosferskih modela, što omogućava uzimanje u obzir i lokalnih karakteristika područja prilikom izračunavanja (severno-južna padina, lokalni tip zemljišta, melioracije itd.). Drugi pravac je svakako primena izlaza iz modela u različitim sferama privredne aktivnosti. U ovom smislu se mogu posmatrati kako modifikacije samih numeričkih modela tako i razvoj dodatnih, korisnički orijentisanih softvera koji koriste sirove izlaze iz numeričkih modela i na osnovu njih izračunavaju buduće ponašanje pojedinih meteoroloških parametara i parametara životne sredine, kao što su npr. vlažnost zemljišta, temperatura lista, koncentarcija zagađenja, itd. Naravno, poljoprivreda se može posmatrati kao jedan od najznačajnijih konzumenata rezultata numeričke prognoze vremena. U ovom izlaganju su prezentovane vrste izlaza koje mogu da obezbede numerički modeli za prognozu vremena kao i korisnički orijentisani softveri. Pored toga, analizirane su potencijalne mogućnosti primene ovih izlaza za prognozu nastupanja negativnih pojava sa stanovišta poljoprivredne prognoze, kao što su mraz, grad, suša i biljne bolesti.

Izazovi i problemi osiguranja useva u Vojvodini od šteta nastalih delovanjem nepovoljnih meteoroloških pojava

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Osiguranje useva ima zadatak da pruži efikasnu zaštitu od rizika koje poljoprivredni proizvođač ne može da kontroliše. Većinu ovih rizika predstavljaju rizici delovanja nepovoljnih meteoroloških pojava: grad, oluja, mraz, poplava, suša... Osiguranje je postalo nezamenljivo u procesu risk-menadžmenta velike većine poljoprivrednih proizvođača u razvijenom svetu. Od svojih početaka, pre više od 200 godina do danas, osiguranje useva je, nastojeći da što bolje odgovori na potrebe poljoprivrednih proizvođača, razvilo nekoliko grupa proizvoda: osiguranja od šteta prouzrokovanih imenovanim rizicima, osiguranja na bazi prinosa, osiguranja na bazi prihoda, osiguranja na bazi indeksa.

Sa svega oko 2% površina pod usevima u vlasništvu fizičkih lica koji imaju neki vid osiguranja, Srbija je na samom začelju među evropskim zemljama. Brojni su razlozi za tako nešto: od generalno lošeg stanja u poljoprivredi, tradicionalnog nepoverenja poljoprivrednika u finansijske institucije, do neadekvatne ponude programa osiguranja...

Osiguranje useva, zajedno sa poljoprivredom uopšte, u Srbiji a naročito u Vojvodini, može biti rastući posao tako što će poljoprivrednim proizvođačima pružiti adekvatnu i pouzdanu zaštitu pod prihvatljivim uslovima.

Klimatske promene i poljoprivreda: Pregled situacije u subotičkom regionu

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Naša savetodavna aktivnost u regionu subotičko-horgoške peščare doseže do prve polovine 70-ih godina, a vrlo je intenzivna poslednjih 15 godina. U okviru naših redovnih aktivnosti praćene su i zabeležene, hronološki po godinama, aktivnosti insekata, prouzrokovača oboljenja, kao i karakteristike godina u pogledu klimatoloških specifičnosti.

U prezentaciji je načinjen pokušaj da se ti podaci sistematizuju i prikažu u svetlu klimatskih promena, a iz ugla kako to vide stručnjaci-praktičari. Takođe je dato i naše viđenje daljeg uticaja tih promena na rešavanje problema u zaštiti bilja, vodosnabdevanja biljaka i ekonomskog efekta na proizvodnju pojedinih gajenih biljaka.

Uticaj klimatskih promena na poljoprivrednu proizvodnju pokušali smo da prikažemo kroz:

- promenu odnosa sušnih i vlažnih godina, prema našim zapažanjima na terenu,
- promene u agrotehničkim navikama, koje su neki proizvođači već prihvatili,
- intenzivniju pojavu nekih patogena u proizvodnji voća (pojava *Armillaria* i *Alteranria* na jabukama, apopleksija šljiva, pepelnice jabuke i breskve), odnosno povrća (*Alternaria* paradajza i krompira), itd.,
- promene u biologiji pojedinih štetočina (jabučni smotavac), kao i intenzivnija pojava nekih vrsta (tripsi, pamukova sovica, cikade...).

Na kraju je prikazan uticaj klimatskih promena na rentabilnost proizvodnje kroz primere povećanja troškova prilikom navodnjavanja, gubitak prinosa od sunčanih ožegotina, manje prinose u žarkim godinama... a sve u svetlu smanjenja cena poljoprivrednih proizvoda, naročito voća i povrća.

Globalne klimatske promene se u velikoj meri osećaju u poljoprivrednoj proizvodnji, te i proizvođače i stručnu javnost stavljaju pred nove izazove i traže prilagođavanje, sve u cilju očuvanja isplativosti proizvodnje.

Adaptacija na pojavu bolesti izazvanih klimatskim promenama i procene rizika

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Adaptacija na pojavu bolesti izazvanih klimatskim promenama može se posmatrati sa nekoliko aspekata u kojima su biljka (domaćin) i patogen u specifičnim odnosima. Klimatske promene utiču na promenu fizioloških procesa i stepena otpornosti kod biljke, a patogen adekvatno prilagođava svoj ciklus razvoja i agresivnost izražavajući ih kroz stepen patogenosti. Geografska rasprostranjenost domaćina i patogena se menja, uslovljavajući drugačiji interaktivni odnos koji rezultira gubicima useva u prinosu. Iz ovoga proističu promene u efikasnosti primenjenih mera suzbijanja.

Prema literaturnim podacima, povišena koncentracija ozona (O_3) može uticati na razvoj bolesti delovanjem na reproduktivne organe obligatnih patogena strnih žita. Ove promene manifestuju se kroz redukciju broja uredosorusa kod *Puccinia coronata*, prouzrokovača lisne rđe ovsa. Kod *P.graminis* f. sp. *tritici*, prouzrokovača stabljične rđe pšenice, smanjen je porast hifa i formiranje uredospora, dok kod *Erysiphe graminis* f. sp. *tritici*, prouz. pepelnice pšenice, povišena koncentracija ozona tokom perioda inkubacije utiče na povećanje pustula. Kod fakultativnih patogena koji prouzrokuju simptome tipa pegavosti i nekroze (*Dreschlera sorokiniana*), povećan je procenat napadnute (oštećene) lisne površine (Krupa i sar., 2001). Posledice povećane koncentracije ugljen-dioksida (CO_2) i poznati efekti staklene bašte utiču na biljke i patogene. Za to postoje mnogobrojni primeri vezani za interaktivni odnos između biljke i parazita. Takozvani trougao bolesti čine: biljka (domaćin), virulentni patogen i uslovi spoljne sredine. Novija tumačenja u ove odnose uključuju i čoveka, menjajući naziv trougao u tetraedar bolesti.

U našim agroekološkim uslovima registrovane su promene vezane za jaču pojavu patogena koji postaju prevalentni u pojedinim područjima. Na strnim žitima promene u populaciji i virulentnosti *Blumeria* (*Erysiphe*) *graminis tritici*, praćene su preko polnog i bespolnog dela populacije. Ove promene odnose se pre svega na broj generacija patogena tokom vegetacionog perioda. Efikasnost pojednih gena otpornosti (Pm gena) vezana je za temperaturne uslove. Ispoljavanje reakcije na biljkama pšenice manifestuje se brojem i veličinom formiranih pustula na listu, što ima za posledicu različite infekcione tipove. Efikasnost gena otpornosti u zavisnosti od promene temperature (temperature sensitive genes) izraženi su kod prouzrokovača rđa strnih žita. Primeri za to su geni otpornosti prema prouzrokovaču stabljične rđe ovsa Pg3 i Pg4 (Coakley i sar., 1999), zatim gen Lr26 vezan za otpornost na prouzrokovaču lisne rđe pšenice *Puccinia triticina*, kao i uopšteno jača pojava prouzrokovača žute rđe pšenice *P.striiformis*.

Višegodišnji rezultati praćenja intenziteta oboljenja na strnim žitima i promene kod obligatnih i fakultativnih parazita u potpunoj su saglasnosti sa literaturnim podacima u kojima se iznose podaci o klimatskim promenama, o praćenju pojave i suzbijanja bolesti, kao i o uticaju na prinos. Poseban aspekt predstavlja pojava novih patogena koji do sada nisu bili prisutni na teritoriji Srbije ili su se javljali sporadično. Prouzrokovač žutomrke pegavosti pšenice (*Pyrenophora tritici-repentis,* prvi put je opisan 1997. godine (Jevtić, 1997). Klimatske promene uticale su na dominaciju patogena koji za svoj razvoj traže više temperature ili se bolje prilagođavaju uslovima suše.To je razlog što su gljive iz roda *Septoria* spp., preuzele dominantnu ulogu, prouzrokujući značajne štete. Prema podacima Kalentić, Marija i sar. (2006) od 3800 genotipova pšenice intenzitet napada od 30% imalo je 2064 genotipova ili (55,6%). To znači da je više od trećine listova biljke bilo zahvaćeno pegama parazita, što se direktno odražava na prinos. Kod gljiva iz roda *Fusarium*, između mase 1000 zrna i procenta zaraženih zrna patogenom *F. graminearum* utvrđena je veoma jaka negativna korelacija kod sorte tvrde pšenice Dušan (r=-88,9), a jaka (r=-74,0) kod sorte Durumko (Telečki, Mirjana i Jevtić, 2006).

Dugo je u našoj naučnoj javnosti vladalo mišljenje da su teleutospore prouzrokovača glavnice pšenice *Tilletia* spp.*,* koje se nalaze na semenu, osnovni izvor inokuluma i da kritičan period za ostvarivanje infekcije traje samo do momenta nicanja *(*Josifović, 1964., Ivanović i Ivanović, Dragica, 1999). Međutim, svakodnevnim merenjem temperature zemljišta tokom vegetacije pšenice (mini-meteorološka stanica ADAS) u uslovima veštačke infekcije zrna i zemljišta i uslova za ostvarivanje infekcije, Koprivica, Mirjana (2004) došla je do značajnih rezultata. U uslovima kad infekciju pšenice ostvaruju teleutospore prisutne na semenu i u zemlji kritičan period traje od 1 do 120 dana posle setve (r>+0,42). U tom periodu temperature su se kretale od -1,8ºC do 13,1ºC. Maksimalna infekcija je ostvarena u rasponu temperatura od 2,0 do 12,3, odnosno računajući srednje temperature za ovaj period, od 4,0ºC do 5,0ºC. Najveći broj biljaka je zaražen u četvrtoj i nešto manje šestoj dekadi posle setve. Dobijeni podaci ukazaju da je u našim agroekološkim uslovima zemlja značajniji izvor inokuluma i da *Tilletia* sp. infekciju ostvaruje tokom nicanja.

Savremeni sistemi prognoze i izveštavanja ukazuju na neophodnost upotrebe mini-meteoroloških stanica. Jasnić i Jevtić (2007) su proučavali efikasnost fungicida u suzbijanju lisne pegavosti šećerne repe (*Cercospora beticola*) u zavisnosti od načina određivanja vremana tretiranja. Efikasnost fungicida pri vizuelnom načinu odredjivanja bila je 68, 3%, a pri upotrebi prognoze sa mini-meteorološke stanice µMetos 67,6%. Na osnovu ovih podataka možemo zaključiti i da se stalnim praćenjem podataka sa µMetosa i upotrebom njegovog programa za prognozu suzbijanja *Cercospora beticola* mogu dobiti pouzdani podaci o momentu suzbijanja. Gavrilov i sar., (1998), ukazali su na značaj prognoze i modeliranja klimatskih promena u predviđanju reakcije biljnih vrsta, moguće rasprostranjenosti i intenziteta pojave štetnih organizama u vremenu i prostoru. Izrada modela za određivanje momenta tretiranja u cilju racionalne i ekonomski opravdane upotrebe fungicida na strnim žitima je u toku (Jevtić, nepublikovano). Model će uključivati parametre vezane za klimu, predusev, primenjene agrotehničke mere i sortnu specificnost otpornosti prema bolestima

Gajenje biljnih vrsta na određenom području koje je pod uticajem klimatskim promena, tera čoveka da stvara nove genotipove adaptabilne na abiotičke i biotičke faktore ili da postojeće sorte prilagodi novonastalim promenama. Za takva svojstva potrebno je upotrebiti germ-plazmu iz geografski udaljenih delova sveta, gde dominiraju genotipovi sa takvim poželjnim svojstvima. Ova germ-plazma nosi i nepoželjna svojstva, a to je najčešće osetljivost prema patogenima. Novonastala biljna vrsta ili novostvorena sorta sada je prilagođena uslovima gajenja usled klimatskih promena i stupa u interakciju sa populaciom patogena. Zato je potrebno napraviti dobru procenu rizika i predupprediti epidemije bolesti na određenom području.

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Klimatske promene, osetljivost i adaptacione mere u poljoprivredi – proizvodnja voća (Rezultati postignuti u Srbiji)

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Savremena, intenzivna proizvodnja voća u velikoj meri zavisi od uslova sredine. Ako uslovi spoljne sredine nisu odgovarajući, čak ni najbolja sorta uz najbolju agro i pomo tehniku neće dati dobre rezultate. Uzimajući u obzir ovo, ali i činjenicu da su voćke višegodišnje biljke, veoma je važno da se umanje bilo kakvi rizici uticaja spoljne sredine. Najvažniji klimatski parametri važni za rast i razvoj biljke su: svetlo, temperatura, količina padavina, gradobitnost i vetar.

Ograničavajući faktori koji koji imaju velikog uticaja na smanjenje prinosa i kvaliteta u poslednjoj dekadi su: niske zimske temperature, kasni prolećni mrazevi, grad, nagla promena temperatura u zimskom periodu, visoke letnje temperature i nedostatak padavina.

Niske zimske temperature posebno pogađaju neke od koštičavih voćnih vrsta koje su manje tolerantne na niske temperature. Jedine uspešne protiv mere su gajenje otpornijih sorti i izbegavanje gajenja u regionima sa učestalim niskim zimskim temperaturama.

Kasni prolećni mrazevi su, na žalost, česti u Vojvodini i prouzrokuju velike štete kod nekih voćnih vrsta. Sve više proizvođača i jabuke i kajsije instalira protivmrazne rasprskivače koji su se pokazali uspešnim u prevenciji oštećenja. Proizvođači jagoda pokušavaju da zaštite biljke koristeći agrotekstil ili niske tunele. Jedna od inovativnih mera kod kajsije je letnja rezidba. Ovom merom se podstiče razvijanje prevremenih grančica koje cvetaju 3-5 dana posle ostalih grana i na taj način izbegavaju prolećne mrazeve.

Šteta od mraza je veoma česta u nekim regionima u Vojvodini. Ohrabrujuće je da su prve protivgradne mreže postavljene ove godine u nekoliko zasada jabuke.

Posebno negativan efekat u toku vegetacije imaju visoke temperature i visok intenzitet sunčevog zračenja. One uzrokuju ožegotine na plodovima i lišću, ali i na kori debla i grana. Meristemsko tkivo u kori odumire, rane ne zaceljuju, što uzrokuje da cela stabla, a posebno mlada stabla u 2007. godini, odumiru. Veći odnos broja lišća i plodova je neophodan da bi se plodovi zasenčili kod svih vrsta, a posebno jagodastih. Zasenjivanje mrežama, folijama, itd. takođe je preporučljivo.

Uzimajući u obzir klimatske promene, savremeno voćarstvo treba da uvede protivgradne mreže, sisteme za navodnjavanje i antifrost sisteme kao obaveznu meru u većini regiona u Srbiji.

Scenariji klime za područje Vojvodine: preliminarni rezultati

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Tokom poslednjih decenija XX veka sazrela je svest o uticaju globalnih promena klime na svetsku ekonomiju i poljoprivrednu proizvodnju kao njen najosetljiviji deo. Zbog agrarne politike koja se često veoma malo oslanja na naučna dostignuća, kao i nedovoljnih strateških investicija u poljoprivredi, nerazvijene i zemlje u razvoju su naročito osetljive na varijabilnost klime i ekstremne vremenske prilike. Srbija je zemlja u razvoju u kojoj, tradicionalno, poljoprivredna proizvodnja ima značajnu ulogu u nacionalnoj ekonomiji. Prema podacima Republičkog zavoda za statistiku, poljoprivredna proizvodnja u Srbiji je 2004. godine učestvovala sa 11,5% u bruto dodatoj vrednosti, što jasno ukazuje na ranjivost celokupne ekonomije na klimatske promene.

Tokom proteklih decenija, naučna javnost je uložila ogromne napore kako bi bio sagledan uticaj klimatskih promena na poljoprivrednu proizvodnju u okviru globalnih i lokalnih razmera. Nezamenljivu ulogu u procenama reakcije useva na klimatske promene u ovim studijama imaju modeli biljne proizvodnje. Na žalost, u Srbiji je upotreba ovih modela u naučne, a noričito operativne svrhe na najnižem mogućem nivou.

Grupa istraživača okupljena oko Centra za meteorologiju i prognozu životne sredine na Prirodno-matematičkom fakultetu u Novom Sadu, otpočela je pionirski rad na procenama efekata klimatskih promena na poljoprivrednu proizvodnju u Vojvodini korišćenjem klimatskih scenarija i modela biljne proizvodnje. Inicirano kao pilot-projekat u okviru **AGRIDEMA** projekta (“Introducing tools for agricultural decision-making under cilmate change conditions by connecting users and tool-providers“; FP 6-2003-Global-2-003944), ovo istraživanje je nastavljeno u okviru **ADAGIO** projekta (“Adaptation of agriculture in European regions at environmental risk under climate change“; FP6 – ADAGIO – Proj. N^{o} SSPE-CT-2006-044210) sa ciljem da se, što je moguće bolje, procene efekti klimatskih promena na ratarsko-povrtarsku i voćarsku proizvodnju i zaštitu biljaka. Prvi značajan korak u realizaciji ovog cilja je smanjenje vremenskih razmera podataka dobijenih iz klimatskih modela i njihovo prilagođavanje potrebama modela biljne proizvodnje. U tu svrhu korišćeni su modeli ECHAM4 (klimatski model) i Met&Roll (vremenski generator). Dinamički model biljne proizvodnje SIRIUS je kalibrisan i testiran u agroekološkim uslovima novosadskog regiona korišćenjem osmotrenih datuma nastupanja pojedinih fenoloških faza, komponenata prinosa i prinosa.

Prilagođavanje tehnologije gajenja ratarskih biljaka

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Glavne klimatske promene u bližoj i daljoj budućnosti treba očekivati u prilivu energije na površinu obradivog zemljišta. Promena temperature zemljišta prouzrokovaće velike promene u samom zemljištu, kao i na gajenim biljkama. Kako se veza između zemljišta, kao staništa za biljke, i same biljke, odvija preko mineralne ishrane, u toj sferi treba tražiti najveće promene tehnologije gajenja. S druge strane, mobilizacija i usvajanje hraniva je u direktnoj vezi sa stanjem vlažnosti zemljišta. To je razlog zašto će ekonomisanje vodom u sistemu zemljište – biljka biti krucijalni cilj tehnologije gajenja, čak iako postoje sistemi za navodnjavanje. U tom smislu će balansirana mineralna ishrana biljaka, optimalizacija vegetacionog prostora (koji podrazumeva i hranjivi prostor) i izbor genotipova imati ključno mesto u procesu prilagođavanja tehnologije gajenja klimatskim promenama.

Mere nege useva, uključujući i zaštitu od bolesti štetočina i korova, dobijaće na značaju. Na taj način će farmeri uz blagovremene savete struke omogućavati iskorišćavanje proizvodnog potencijala lokaliteta i čitavih regiona.

Promena obrade zemljišta i selekcija useva. Promenom upotrebe zemljišta i izborom biljnih vrsta klimatske promene će neminovno nametnuti izmene u gazdovanju zemljištem, sa neizmenjenim osnovnim postulatima opšteg i posebnog ratarstva. Oni se pre svega odnose na očuvanje plodnosti zemljišta kao trajnog resursa. Razvijaće se principi održive poljoprivrede uz koegzistenciju alternativnih modela proizvodnje, kao što je organska ili biološka. Ključni problemi će biti vezani za osnovnu obradu zemljišta, unošenje organskih i mineralnih đubriva i dosledno poštovanje plodosmene (čak bi se moglo govoriti i o uvođenju plodoreda). Borba protiv korova, posebno višegodišnjih, koji su konkurencija kulturnim biljkama za vodu i svetlost, biće dominantna. Izbor ratarskih useva će se promeniti u pravcu povećanja zastupljenosti žitarica (strna žita, pšenica, ječam tritikale, zatim prosolika žita, sirak za zrno, proso). Kukuruz i soja će se pomerati prema kvalitetnijim zemljištima i prema sistemima za navodnjavanje. Ovo važi i za šećernu repu i uljanu repicu. Gajenje suncokreta, kao najotpornije biljne vrste među ratarskim kulturama na visoke temperature i sušu, verovatno će biti zadržano u sadašnjem arealu.

Pored klimatskih i ekonomski efekti će imati značajnu ulogu u izboru biljnih vrsta.

Treba očekivati da će se oplemenjivanjem stvoriti sorte i hibridi prilagođeniji klimatskim promenama. Otpornost na abiotičke stresove, skraćenje vegetacije uz pojačanje intenziteta stvaranja organske materije, brže formiranje zrna (ploda) biće glavni pravci oplemenjivanje. Uz adaptaciju tehnologije gajenja, novi genotipovi će doprineti lakšem prilagođavanju klimatskim promenama.

Upravljanje strategijom adaptacije na klimatske promene i prilagodjavanje agrarne politike

Prof. Miroslav Malesevic
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Promene klimatskih činilaca će neminovno uticati na biljke, životinje i ljude, kao i na sav ostali živi svet u zemljištu, vodi i atmosferi. Poljoprivredna proizvodnja, ali i način života uopšte trpeće prilagođavanja. U ovom trenutku nije jasno kojim tempom će se promene dešavati. Zbog toga je pravi trenutak da nauka, preko resornih državnih organa i organizacija započne najširu kampanju u cilju edukacije građanstva, a posebno poljoprivrednih proizvođača. Najveća promena treba da se dogodi u svesti ljudi, što je najteži a ujedno i najdramatičniji proces. U tom pravcu je u svetu dosta učinjeno, što se ne može reći i za Srbiju.

Da bi se implementirala strategija adaptacije ona treba da bude utvrđena. Upravljanje strategijom podrazumeva donošenje čitavog niza mera koje će se odnositi na dugoročnu i kratkoročnu agrarnu politiku. Iz strategije adaptacije na klimatske promene proizaći će odgovarajuća zakonska regulativa kao i čitav niz preporuka, uredbi ili direktiva, namenjenih rešavanju konkretnih problema. Glavnu ulogu u kreiranju i sprovođenju strategije imaće autoritativno telo koga će činiti eminentni naučni radnici, predstavnici države, poljoprivrede i građana (**SAVET**). Autoritet (Savet) će imenovati Vlada Srbije. **Savet** će predložiti **Strategiju** za adaptaciju čitavog agro-ekosistema nastajućim promenama klime. Odluke predlozi odluke Saveta će se zasnivati na naučno proverenim činjenicama, istraživanjima u svetu i kod nas. Zbog toga će posebno biti važno da Savet u okviru Strategije predvidi potrebna istraživanja sistema klima – zemljište – biljka. Ovakva istraživanja treba započeti odmah. Rezultat treba da bude funkcionalni model primenjiv u praksi. Savet treba da ima sledeće sektore: za biljnu, životinjsku proizvodnju, zdravlje ljudi, biljaka i životinja i dr.

Istraživanja treba da se odnose naročito na sledeće oblasti:

- oplemenjivanje poljoprivrednog bilja u pravcu stvaranja genotipova prilagođenih izmenjenim uslovima gajenja;

- primenjenim istražđivanjima vršiti odabir sorti ili hibrida za konkretne uslove;
- odabranim genotipovima treba prilagoditi agrotehniku;
- prilagođavanje sistema obrade zemljišta i unošenja mineralnih i organskih đubriva;
- usavršavanje prevencije u zaštiti biljaka;
- razvoj mineralnih đubriva sa postepenim oslobađanjem hraniva;
- uvođenje novih vrsta poljoprivrednog bilja, za koje nisu postojali agroekološki uslovi gajenja ili nije postojao ekonomski interes;
- usavršavanje modela prognoze vremenskih uslova na užem i širem prostoru;
- druga istraživanja.

Savet će preporučivati mere odgovarajućim ministarstvima koje će u vidu direktiva imati obavezujući karakter za proizvođače.

Agroekonomskim merama državni organi će podržavati Strategiju kao i pojedine vidove proizvodnje. Izgradnjom savremenih sistema za navodnjavanje država će olakšati proizvodnju i tako obezbeđivati potrebne količine strateški važnih proizvoda.

Savet će promovisati najefikasnije načine edukacije proizvođača preko razvijene mreže savetodavne službe. Obuka i obrazovanje proizvođača će biti usklađena sa Strategijom.

Rezime: - Koraci koje treba preduzeti:

- formiranje Saveta, imenovanje članova i menadžmenta;
- izrada Strategije adaptacije na klimatske promene;
- usklađivanje Strategije sa okruženjem i svetskim standardima;
- usvajanje Strategije (Ministarstvo, Vlada, Skupština);
- definisanje naučnih i tehnološko-razvojnih istraživanja;
- edukacija proizvođača i obuka kadrova u savetodavnim službama;
- obezbeđenje materijalnih i finansijskih uslova za navedene aktivnosti;
- intenzivno uključivanje u međunarodne projekte iz ove oblasti.

Klimatske promene, ranjivost i adaptacije u poljoprivredi: situacija u Srbiji

Prof. D. T. Mihailović
Poljoprivredni fakultet, Univerzitet u Novom Sadu, Srbija

Termin „klimatske promene“ (takođe poznat i kao „globalne klimatske promene“), ponekad se koristi da označi sve forme klimatskih nepravilnosti, ali s obzirom na to da klima na Zemlji nikada nije statična, navedeni termin je najpravilnije koristiti za označavanje značajnih promena između različitih klimatskih uslova. Iako se u nekim prilikama „klimatske promene“ koriste kao sinonim za „globalno otopljavanje“, naučnici potenciraju korišćenje šireg smisla termina koji u sebe uključuje sve vrste prirodnih klimatskih promena. Okvirna konvencija o klimatskim promenama u svom prvom odeljku definiše klimatske promene kao: „promene u klimi, direktno ili indirektno izazvane ljudskom aktivnošću, koje menjaju kompoziciju globalne atmosfere i koje su, pored prirodnih klimatskih varijacija, uočene tokom određenog vremenskog perioda“. Stoga je UNFCCC napravila jasnu razliku između „klimatskih promena“ povezanih sa odvijanjem ljudskih aktivnosti i „klimatske varijabilnosti“ izazvane prirodnim uzrocima.

Spomenute definicije su sakupljene iz različitih dostupnih izvora i potiču iz različitih institucija u svetu koje se bave analizom globalnih klimatskih promena iz različitih perspektiva. Takva komplikovana definicija simbolički reprezentuje prvi korak u intenzivnoj kampanji koja će biti ostvarena u Vojvodini, kao i u zapadnim delovima Srbije. Ovaj pionirski poduhvat biće realizovan kao deo FP6 projekta pod nazivom ADAGIO (Adaptation of Agriculture in European Regions at Environmental Risk under Climate Change) koji, pored Srbije, uključuje još i Austriju, Češku, Poljsku, Italiju, Rumuniju, Rusiju, Bugarsku, Španiju i Egipat. U Srbiji ovaj projekat će biti vođen od strane Centra za meteorologiju i modelovanje životne sredine (CMEP) Prirodno-matematičkog fakulteta na Univerzitetu u Novom Sadu, i okupiće eksperte sa Instituta za ratarstvo i povrtarstvo (Departman za zaštitu bilja i Departman za pšenicu) u Novom Sadu i eksperte sa Poljoprivrednog fakulteta (Departman za ekonomiku poljoprivrede i sociologiju sela i Departman za voćarstvo, vinogradarstvo i hortikulturu) u Novom Sadu.

U ovom momentu, jasno je da u Srbiji ne postoji sistematsko praćenje mera adaptacije na klimatske promene u poljoprivredi, kao i u ostalim osetljivim segmentima proizvodnje. Pored toga, ne postoji ni sistemski rad na podizanju nivoa svesti ljudi uključenih u proizvodnju hrane o potrebi adaptacije na klimatske promene, isključujući dve postojeće oblasti istraživanja: 1) program ukrštanja žitarica radi dobijanja sorti otpornijih na visoke temperature, koji postoji već duži niz godina, i 2) istraživanja iz oblasti sociologije sela o savetodavnim službama u Vojvodini. Ciljevi ADAGIO projekta su da za navedene regione Srbije: 1) ustanovi postojanje klimatskih promena, 2) kvantifikuje stepen ranjivosti tih regiona, 3) sugeriše potencijalne mere adaptacije u ratarskoj i voćarskoj proizvodnji i 4) da podigne nivo, kvalitet i pouzdanost informacija o klimatskim promenama koje se distribuiraju poljoprivrednim proizvođačima.

Neke zapažene promene u proizvodnji gajenih biljaka

Mr Janko Pap
DP Poljoprivredna stanica Novi Sad, Novi Sad, Srbija

Da li se klima menja? Šta nije isto u biljnoj proizvodnji kao što je bilo? Blaga zima – mineralizacija organske materije u zemljištu odvija se stalno tokom cele godine (na temperaturi 3°C i više). Rezultat – brže se gubi humus. Zemljišta sa manje humusa – smanjena biogenost, naročito manji broj mikroorganizama. Kao posledice javljaju se: teža obrada, veći rizik, i nije moguća proizvodnja nekih biljaka sitnog semena zbog pokorice (paprika – direktna setva, šećerna repa, šargarepa i sl.. Pljuskovite kiše se u proleće ranije i češće javljaju.

Česta pojava pljuskovitih kiša uzrokuje sabijenost zemljišta. Blage zime uzrokuju veći problem sa bolestima i insektima. Poslednjih nekoliko godina, a naročito u proizvodnoj 2006/07, pšenice posejane u optimalnom roku bile su napadnute vašima koje su prenele viruse prouzrokovače žute patuljavosti pšenice i ječma. Žive vaši na biljkama pšenice i ječma primećene su u decembru i januaru?! Temperaturna kolebanja u roku od 24 sata iznose i do 20°C. Potrebno je više navodnjavanja. Ranijih godina navodnjavalo se 3-4, eventualno 5 puta. Poslednjih nekoliko godina za uspešnu proizvodnju istih biljnih vrsta potrebno je 12-15 navodnjavanja. Navodnjavanje obavlja radi hladjenja useva i zemljišta da bi se povećala relativna vlažnost vazduha i da se snizi temperatura u usevu i poveća vitalnost polena (kukuruz). Šta da se radi u biljnoj proizvodnji? Potrebno je: 1) disciplinovano primenjivati ”novu” tehnologiju proizvodnje gajenih biljaka, 2) čuvati vodu, 3) čuvati organsku materiju u zemljištu, obrada, itd., 4) ne paliti žetvene ostatke, 5) pravilno izabrati sortiment i 6) u selekciji staviti akcenat na selekciju jačeg korenovog sistema gajenih biljaka.

Grupni savetodavni rad kao oblik transfera znanja prema farmerima

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Znanje će biti sve važniji i važniji činilac od koga će zavisiti modernizacija vojvođanske poljoprivrede u narednom periodu. Stoga, ulaganja u razvoj i transfer znjanja treba shvatiti i kao vrlo značajnu investiciju, a ne potrošnju, kako se kod nas često pogrešno misli, pogotovo što je poznato i dokazano da se stopa povraćaja finansijskih sredstava u ovu oblast kreće i do 40% i da je vreme povraćaja kraće nego ciklusi u samoj poljoprivrednoj proizvodnji.

Postoje različiti „kanali" dopremanja znanja/informacija prema seljacima /masovni mediji, specijalizovane publikacije, sajmovi, izložbe i smotre, razni organizovani i difuzni oblici edukacije i drugi/, ali nijedan od ovih „kanala" dopremanja znanja ne može da zameni poljoprivredno savetodavstvo.

Poljoprivredno savetodavstvo Vojvodine je najrazvijenije u poljoprivrednim stanicama, koje u narednom periodu treba temeljno reformisati. Neki početni koraci u reformi poljoprivrednih stanica Vojvodine već su napravljeni, a same reforme će biti proces koji će duže trajati dok se ne uspostavi adekvatan savetodavni sistem.

U međuvremenu, dok se takav sistem ne uspostavi, stručnjaci iz naših poljoprivrednih stanica mogu u savetodavni rad uvoditi novine koje su se pokazale uspešnim u poljoprivrednom savetodavstvu razvijenih zemalja. Jedna od tih novina, čija praktična primena pretežno zahteva znanje savetodavca, a ne toliko finansijska sredstva, jeste primena grupnog savetodavnog rada i odgovarajućih metoda grupnog savetodavnog rada. Grupni savetodavni rad podrazumeva da savetodavac raspolaže i znanjima o ciljnim grupama, kako one nastaju, kako se formiraju i održavaju. Primena grupnog savetodavnog rada unutar relativno homogenih grupa farmera posebno je bitna u našim uslovima u kojima, usled nedostatka finansijskih sredstava i nedovoljnog broja savetodavaca, nije moguće obuhvatiti veći broj farmera s kojima savetodavci pretežno rade individualno. Prvi i najvažniji uslov za primenu ovog oblika savetodavnog rada jeste da sami savetodavci budu dobro obučeni i da svoja znanja dalje razvijaju kroz vlastitu savetodavnu praksu. Obuku savetodavaca o grupnom savetodavnom radu, metodama grupnog savetodavnog rada, ciljnim grupama i drugim pitanjima iz ove oblasti mogu da obave saradnici Centra za ruralni razvoj i edukaciju savetodavaca.

Upotreba različitih modela pri donošenju odluka u poljoprivrednoj proizvodnji u uslovima klimatskih promena: špansko iskustvo

Dr Angel Utset Suastegui
ITACYL, Valjadolid, Španija

U godinama koje su pred nama, prema sadašnjim procenama klime, na prostoru Iberijskog poluostrva i čitavog Mediterana može da se očekuje smanjenje količine padavina i porast teperature. Takođe, može da se očekuje češća pojava suše i drugih ekstremnih vremenskih pojava. Ovakvi klimatski uslovi nameću zahtev za optimizaciju tehnologije navodnjavanja i efikasnijim korišćenjem vodnih resursa. Trenutno dostupni modeli biljne proizvodnje i vodnog bilansa mogu uspešno da se kombinuju sa klimatskim scenarijima i vremenskim generatorima u cilju obezbeđenja preporuka za što efikasnije i ekonomičnije navodnjavanje. „Preliminarna procena efekata klimatskih promena u Španiji" i „Nacionalni plan adaptacije na klimatske promene" preporučuju upotrebu ovakvih modela za simulacije u svim studijama koje se u Španiji bave procenom efekata klimatskih promena. Međutim, ovi modeli se još uvek ne koriste operativno prilikom eksploatacije sistema za navodnjavanje u našoj zemlji. Iz tog razloga glavni zadatak projkta AGRIDEMA, finansiranog od strane Evropske Unije čiji je nosilac bila Španija, bio je povezivanje stručnjaka sa univerziteta i istraživačkih centara koji razvijaju ovakve modele sa njihovim korisnicima koji su locirani u poljoprirednim stanicama ili centrima za primenjena istraživanja. U okviru AGRIDEME su kombinovana predavanja sa pilot-projektima što je za cilj imalo primenu ovih modela.

U okviru kurseva organizovanih tokom AGRIDEMA projekta, istraživači su: a) naučili kako da pristupe GCM podacima i sezonskim prognozama, b) stekli su osnovna znanja o vremenskim generatorima, statističkom i dinamičkom „downscalingu", kao i c) o raspoloživim modelima biljne proizvodnje, kao što su DSSAT, WOFOST, CROPSYST, SWAP, i mnogi drugi. U nekoliko evropskih država sprovedeno je oko 20 pilot-projekata, finansijski podržanih od strane AGRIDEMA projekta, čiji je zadatak bio primena navedenih modela u datim agroekološkim uslovima. U Španiji je posebna pažnja posvećena pilot-projektima koji su realizovani u Španiji i oblasti Mediterana. Pored toga, naročito su istaknuta neka zapažanja „korisnika” modela, koja se odnose na klimatske simulacije i modeliranje biljne proizvodnje. Ovakvi komentari su naročito značajni za istraživače koji se bave razvojem modela.

U ovom radu biće prikazan jedan ilustrativni primer koji ukazuje kako modeli mogu da pomognu u boljem organizovanju navodnjavanja šećerne repe pri postojećim i očekivanim klimatskim uslovima. Nekoliko preporuka istraživača vezanih za ovu problematiku biće istaknuto. Ove sugestije su u saglasnosti i sa španskim „Nacionalnim planom adaptacije na klimatske promene”, kao i sa nekim evropskim i međunarodnim uputstvima ove vrste. Naravno, odgovorne osobe će adaptirati aktivnosti vezane za klimatske promene jedino ako spoznaju primenljivost predloženih mera u njihovim specifičnim uslovima. Kako bi postigli ovaj cilj, korisnici modela moraju da obave njihovu kalibraciju i validaciju u datim agroekološkim uslovima. Od naročitog su značaja demonstracije mogućnosti ovih modela vezane za produktivniju i efikasniju politiku u navodnjavanju pri izmenjenim klimatskim uslovima sa kojima će se španski proizvođači eventualno susresti tokom narednih godina.

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The use of the High-Resolution Weather Prediction Models for Specific Forecasts in Agriculture

Mr. Ilija Arsenić

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Numerical weather prediction has experienced strong development during the last two decades as a result of explosive development of informatics technology. Powerful computers, needed for numerical weather prediction model execution, until recently have been accessible only for small number of experts in rich countries while today everybody can find an adequate computer at an acceptable price. Also, the opportunity for building a cluster supercomputer consisting of cheap PC's arose a few years ago. That relatively cheap type of supercomputer gives opportunity to small groups of scientists to join these activities. According to these facts, actual development in this area can be described with increasing time and space rezolution of models, opening possibilities to including in numerical models local characteristics of area of interest such as north-south side of hills, local soil type, irrigation activities, etc. The second direction of development is application of the model outputs to the activities of various industries. Accordingly, we can consider direct modifications of the numerical weather prediction model as well as developing of user-oriented software packages. Based on the model outputs, these software packages calculate time evolution of specific meteorological or environmental parameters such as soil wetness, leaf temperature, air pollution etc. Naturally, agriculture is one of the most important consumers of the mentioned outputs. In this presentation we are focused on the description of type and features of outputs of numerical weather prediction models as well as the description of the user-oriented software packages. Besides, we analyzed possibilities of application of these results to the prediction of occurrence of negative phenomena such as frost, hail, drought and plant diseases.

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Challenges and Difficulties in Crop Insurance Business in Vojvodina Caused by Adverse Meteorological Conditions

Dipl. Ing. Nemanja Beljanski
"Delta insurance", Novi Sad

Crop insurance products should provide effective protection from uncontrollable agricultural risks. Most of them are adverse meteorological conditions: hail, storm, frost, flood, drought... Insurance is one of the most important tools for risk-management procedures in agriculture in developed countries. During more than 200 years of existence in some form, crop insurance has developed several main types of products: damage-based insurance products, yield-based insurance products, crop-revenue insurance products, index-based insurance products.

With only about 2 % of the crops owned by the individual farmers with some kind of crop insurance, Serbia hits the bottom of the European countries list. There are many reasons for this: generally bad situation in agriculture in Serbia, farmer's traditional lack of confidence in financial institutions, inadequate crop insurance products, etc.

Crop insurance business in Serbia, and especially in Vojvodina, along with agriculture in general, can be a fast- growing business by providing adequate, reliable and affordable services to the crop growers.

Change in Climate and Influence on Agriculture
Review of Situation in Region of Subotica (North Backa)

Dr Kata Dulić, dipl. Ing. Robert Šefer,dipl. Ing. Florian Farkaš

"Agropest-Yu" Private Extension Service, Subotica

Our consultants' activity in the region of Subotica-Horgos sand-pit started in early 70's and became very intensive in last 15 years. In the frame of regular occupation we were monitoring and recording, respecting chronological order, activity of insects, appearance of plant diseases causing pathogens as well as climatologically specific elements.

In our presentation, all mentioned elements were systemized and presented taking in consideration climatic changes, all through the spectacles of experts – practitioners. We also illustrated our view on influence of those changes in resolving problems in plant protection technology, plants' water supply as well as effects on economical parameters of agricultural crops growing.

Influence of climatic changes on agricultural production and technology were shown through the following:

- Change in ratio of rainy and dry (rain-lacking) years, as we observed it in the field
- Change in agro-technical (technological) aspects already accepted by some producers
- More intensive appearance of some pathogens
    - Armillaria and Alternaria on apples
    - Plum Dieback (apoplexy)
    - Powdery mildew on apple and peach
    - Alternaria on tomato and potato
- Changes in biological cycle of some insects e.g. Apple codling moth
- More intensive manifestation of pests as for instance Thryps, Helicoverpa (boll worm), Cicadas etc

Finally, we presented repercussions of climatic changes on production profitability taking in consideration increase of production costs due to intensified irrigation, loss of yield caused by sun-burns, lower yields in extremely hot years, all in respect of agricultural products' market prices decrease, particularly fruits and vegetables.

Global climatic changes have deep impact on agricultural production. Producers as well as experts will face tough challenge in finding the best way for adaptation to those environmental circumstances bearing in mind production profitability preservation.

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Adaptation to Diseases Caused by Climatic Changes and Evaluation of Associated Risks

dr Radivoje Jevtić and prof. Stevan Jasnić
Institute of Field and Vegetable Crops, Novi Sad

Adaptation to the occurrence of diseases caused by climatic changes can be viewed from several aspects in which a specific relationship exists between the plant (host) and the pathogen. Climatic changes alter plant physiological processes and resistance levels, while the pathogen adapts its life cycle and agressiveness accordingly and expresses them through the degree of pathogenicity. The geographic distribution of the host and the pathogen changes, which results in a different interactive relationship, bringing about yield losses. This is what causes changes in the efficacy of the control measures implemented.

According to the literature, increased ozone (O_3) concentrations may influence disease development by affecting the reproductive organs of obligate pathogens in small grains. These changes are manifested in a reduced number of uredospores of *Puccinia coronata*, the causal agent of oat crown rust. In *P.graminis* f. sp. *Tritici*, the causal organism of wheat stem rust, increased ozone concentrations reduce hyphal growth and the formation of uredospores, while in *Erysiphe graminis* f. sp. *tritici*, which causes wheat powdery mildew, such concentrations of ozone occurring during the incubation period result in the enlargement of pustules. In the facultative pathogens causing symptoms of spot and necrosis (*Drechslera sorokiniana*), the percentage of leaf area affected (injured) increases (Krupa et al., 2001). Plants and pathogens are affected by the results of increased carbon dioxide (CO_2) concentrations and the familiar greenhouse effects. There are many examples related to plant-pathogen interactions that illustrate this. The so-called disease triangle consists of the plant (host), a virulent pathogen, and environmental conditions. Newer interpretations of these relations include man as well, making the disease triangle a tetrahedron, or pyramid.

In Serbian agroecological conditions, changes have been observed that are reflected in the greater severity of outbreaks of pathogens that are becoming prevalent in some parts of the country. In small grains, changes in the population and virulence of *Blumeria* (*Erysiphe*) *graminis tritici* have been monitored via the sexual and asexual parts of the population. These changes primarily concern the number of generations of the pathogen appearing in the course of the growing season. The effectiveness of the Pm resistance genes is correlated with temperature conditions. Wheat plant response to the pathogen is reflected in the number and size of the pustules forming on the leaves, which has as a result the existence of different infection types. The varying effectiveness of resistance genes depending on changes in temperature (temperature sensitive genes) is pronounced in the case of the causal agents of cereal rusts. Examples include the Pg3 and Pg4 genes for resistance to the causal agent of oat stem rust (Coakley et al., 1999), the Lr26 gene linked to resistance against the causal organism of wheat leaf rust (*Puccinia triticina*), and the generally increased occurrence of the causal agent of wheat yellow rust, *P.striiformis*.

The multi-year results of monitoring disease severity and changes in obligate and facultative parasites occurring in small grains are in complete agreement with the literature data concerning climatic changes and disease monitoring, control and effects on yield. Another aspect is the appearance of new pathogens that have not yet been reported in Serbia or have occurred in the country only sporadically. The causal agent of wheat tan spot (*Pyrenophora tritici-repentis)* was described for the first time in 1997 (Jevtić, 1997). Climatic changes have resulted in the dominance of pathogens that require higher temperatures for their development or are better able to adapt to drought conditions. This is the reason why fungi of the genus *Septoria* spp., have assummed the dominant role, causing significant damage. Kalentić, Marija et al. (2006) studied 3,800 wheat genotypes and found that 2,064 (or 55.6%) of them had attack severity levels of 30% or more. This translates into at least one third of the leaf area being affected by the spots caused by the parasite, which has direct influence on yields. With the fungi of the genus *Fusarium*, Telečki and Jevtić (2006) report finding a very strong negative correlation between 1,000-grain weight and the percentage of grains infected by *F. graminearum* in the hard wheat cultivar Dušan (r=-88.9) as well as a strong correlation of the same kind in the cultivar Durumko (r=-74.0).

The domestic scientific community had long held that teliospores of the causal agents of wheat bunt (*Tilletia* sp.) that are found on the seeds were the main source of the inoculum and that the critical period for the infection ended with the moment of emergence (Josifović, 1964., Ivanović and Ivanović, Dragica, 2001). Recently, however, significant new results have been obtained in this connection by Koprivica

(2004) in a study involving daily measurements of soil temperature during the growing of wheat under the conditions of artificial grain and soil infection and daily monitoring of conditions for the occurrence of infection. When wheat was infected by teliospores present on the seeds and in the soil, the critical period lasted 1-120 days after planting (r>+0,42). Temperatures during that period ranged from –1.8 to13.1ºC. Maximum infection levels were achieved when the temperatures were within the 2.0-12.3ºC range, or 4.0-5.0ºC on average. The most plants were infected during the fourth ten-day period after planting, while a somewhat smaller number were infected in the sixth ten-day period. These findings have shown that in Serbian conditions the soil is the more important source of the inoculum and that infection by *Tilletia* sp. takes place during emergence.

Modern systems of pest forecasting and reporting call for the use of mini weather stations. Jasnić and Jevtić (2007) studied fungicide efficacy in controlling sugar beet leaf spot (*Cercospora beticola*) as affected by the method used to determine the timing of the application. The efficacy of the fungicides was 68.3% when the treatment was timed according to the visual method and 67.6% when forecasts from a mini weather station (µMetos) were used. This shows that reliable data on the best moment for pest control can be obtained by continuous monitoring of data from µMetos and the use of its program for *Cercospora beticola* control prognostication.

Gavrilov et al. (1998) emphasize the importance of predicting and modelling climatic changes in the prognostication of crop response to harmful organisms and the prediction of their possible geographic distribution and incidence. The development of a model for the correct timing of treatments that will result in cost-effective and economically justified fungicide use in small grains is under way (Jevtić, unpublished). The model will incorporate parameters such as climate, preceding crop, cultural practices used, and cultivar-specific resistance to diseases.

Crop cultivation in an area under the influence of climatic changes forces man to develop new genotypes with adaptability to abiotic and biotic factors or to adapt the existing genotypes to said changes. To obtain these traits, germplasm from geographically distant areas in which such desirable traits are dominant needs to be used. This germplasm contains undesirable traits as well, most often susceptability to pathogens. The newly developed crop species or cultivar is now adapted to the growing conditions resulting from the climatic changes and begins to interact with the pathogen population. Because of this, a good risk assessment must be made to prevent disease outbreaks in a given area.

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Climatic Changes, Sensitivity and Adaptability Measures in Fruits Production (Results Achieved in Serbia)

Prof. Zoran Keserović, mr Nenad Magazin

Department for fruitgrowing, viticulture, horticulture and landscape architecture, Faculty of agriculture

Modern, intensive fruits production is greatly dependant on environmental conditions. If environmental conditions are not suitable even the best cultivar helped with best agro technique and pomo technique will not give good results. Considering this, but also the fact that fruit trees are long-living plants, it is very important to minimize any environmental risks. Regarding climatic parameters that are important for plants growth and development, the most important are: light, temperature, precipitation, hail and wind.

Limiting factors that have great influence over yields and quality regression in last decade are low winter temperatures, late spring frosts, hail damage, rapid temperature changes in winter rest period, high summer temperatures and precipitation deficit.

Low winter temperatures are especially affecting some of the stone fruit species that are less winter tolerant. Only successful countermeasures are growing more winter hard cultivars and avoiding growing them in regions with frequent winter frosts.

Late spring frosts are unfortunately quite common in Vojvodina and they often cause a great damage with some or all fruit species. They are affecting opened flowers and small recently formed fruits. More and more growers of apple and apricots also, are installing antifrost sprinkling systems that showed to be successful in preventing frost damages. Strawberry growers are trying to protect plans using agro textile or small poly tunnels. One of innovative measures with apricot is summer pruning. By this measure more lateral branches are developed which are flowering 3-5 days after the rest of branches thus avoiding spring frosts.

Hail damage is quite frequent in some regions of Vojvodina. It is encouraging that first hail nets have been installed this year in a few apple orchards.

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High temperatures and high insulation have particularly negative influence during vegetation period. They are causing fruit and leaf burns, but also burns on trunk and branches bark. Meristemic tissue in bark is being destroyed, wounds are not healing what is causing whole trees, especially young ones in year 2007, to die out. Greater leaf/fruit ratio is necessary for fruits protection by shade with all species, especially with small fruits. Shading with nets, plastic cover etc. is also recommended.

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Considering climatic changes modern fruitgrowing should consider hail nets, irrigation systems and anti frost systems as necessary measures in most of the regions of Serbia.

Climate Scenarios for Vojvodina Region: Preliminary Results

Doc. Branislava Lalic

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During the last decades of the XX century the awareness arises about an impact of the global climate change on the world economy and agricultural production as its most sensitive part. Because of the lack of scientifically based agricultural policy and low level of agricultural inputs, agricultural production in non-developed and developing countries is particularly vulnerable to climate variability and extreme weather events. Serbia is a developing country with its agriculture having, traditionally, important role in the national economy. According to the Statistical Office of the Republic of Serbia, agriculture in Serbia accounts for about 11.5 % of the gross added value for year 2004 and therefore, the vulnerability of the overall economy to changes that affect agriculture could be considerable.

Scientific community invested a significant effort in assessing the effects of climate change on agricultural productivity on global and local scales. In climate impact studies crop models are useful and indispensable tools for assessing a response of crops on climate variations. Unfortunately, agricultural theory and practice in Serbia have been involved in climate change impact assessment studies on the lowest possible level.

The group for meteorology at Faculty of Agriculture, University of Novi Sad, is beginning a pioneer work in assessing climate change impact on agricultural production in Vojvodina region. Starting as **AGRIDEMA** ("Introducing tools for agricultural decision-making under cilmate change conditions by connecting users and tool-providers"; FP 6-2003-Global-2-003944), a pilot project related to calibration and validation of weather generators and crop models for local agroecological conditions and crop varieties, this study continued as a part of **ADAGIO** ("Adaptation of agriculture in European regions at environmental risk under climate change"; FP6 – ADAGIO – Proj. N° SSPE-CT-2006-044210), a project with the main goal to assess effects of climate change on crop and fruit production and protection.

An important first step towards assessment goals is temporal downscaling of climate model outputs and its adaptation to crop model input data format. For that purpose ECHAM4 climate model and Met&Roll weather generator have been used to synthesise crop model input data. The dynamic crop growth simulation model, SIRIUS, was selected because it is a well-defined and well-structured user-friendly model tested in different agroecological regions. Moreover, this model is based on a strong physiological and biophysical background taking into account the most important processes describing the soil-vegetation-atmosphere interaction. At this level of application, the model was calibrated and validated for agrometeorological conditions of Novi Sad region using observed dates of phenological phases, measured grain yield, grain mass and biomass. Finally, there have been presented results of SIRIUS simulations performed using observed data and data generated for 2001-2024 integration period.

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Adaptation of Growing Technologies for Field Crops Cultivation

Prof. Miroslav Malešević
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Major climatic changes are expected to occur in the short and long term in the inflow of energy into areas of arable land. As a result of soil temperature change, large changes will occur in the soil as well as cultivated plants. Mineral nutrition is the link between the soil as the habitat of plants and the plant itself, so it is in this area that the largest changes of growing technology are expected to take place. Nutrient mobilization and uptake are directly connected to soil moisture status, which is why water economy in the soil-plant system will be the crucial goal of growing technology, even in cases when irrigation systems are present. In this context, balanced plant mineral nutrition, optimization of plant growing space (which includes the zone of plant nutrition), and selection of genotypes will play key roles in the adaptation of growing technologies to climatic changes.

Crop tending measures, including pest and weed protection, will grow in importance. With the help of extension services, this will enable maximum use of production potentials of local areas and entire regions by farmers.

Adaptation strategies by changing land use and crop selection. By changing land use and crop selection, climatic changes will inevitably lead to changes in land management without altering the basic postulates of farming, most importantly the maintenance of soil fertility as a lasting natural resource. Sustainable agriculture principles will be developed in parallel with alternative cropping models such as organic or biological farming. Key problems will be related to primary tillage, incorporation of organic and mineral fertilizers, and consistent use of crop rotation. Another dominant theme will be the fight against weeds, especially perennial ones, which compete with cultivated plants for light and water. Field crop selection will move towards increased use of cereals (small grains, wheat, barley, triticale, millet-like cereals, sorghum grown for grain, common millet). Maize and soybean will move in the direction of higher-quality soils and irrigation systems, and will sugar beet and rapeseed. Sunflower, being the most resistant of all field crops to high temperatures and drought, will probably retain its present geographic distribution.

Besides climatic factors, economic ones will also play a significant role in crop selection.

Breeding will likely produce cultivars and hybrids better adapted to climatic changes. The main directions of breeding will include abiotic stresses, shortening of growing season with intensified organic matter production, and faster grain (fruit) formation. Together with adapted growing technologies, the new genotypes will facilitate easier adaptation to climatic changes.

Managing the Strategy of Adaptation to Climatic Changes and Adjustment of Agricultural Policy

Prof. Miroslav Malešević
Institute for Field and Vegetable Crops

Changes of climatic factors will inevitably affect plants, animals and humans and all other living things in the soil, water and atmosphere. Agricultural production and the way of life in general will have to adapt. At this moment, it is not clear at which rate the changes will take place. This is therefore the right moment for science to start the broadest possible campaign of educating the public, especially agricultural producers, through appropriate government bodies and organizations. The greatest changes will have to take place in the minds of people, and these kinds of changes are the most difficult and dramatic of all. A lot has been done to this end in the world already, but the same cannot be said of Serbia.

In order to implement a strategy of adaptation, it has to be determined first. Managing the strategy involves the institution of a whole series of measures concerning the long- and short term agricultural policies. The strategy of adaptation to climatic changes will lead to appropriate legislation and a whole series of recommendations, regulations and directives aimed at solving specific problems. The main role in devising and implementing the strategy will be played by an authority composed of leading scientific workers and representatives of the government, agriculture and the public (the Council). The Council will be appointed by the Serbian government. The Council will propose a Strategy for the adaptation of the entire agroecosystem to the ongoing climatic changes. The Council will make its decisions based on scientifically verified facts and researches carried out home and abroad. It is therefore very important for the Council to allow within its Strategy for the necessary researches of the climate-soil-plant system. These researches need to get under way immediately and must result in a functional model applicable in actual practice. The Council should have the following sectors: crop and animal production, human, plant and animal health, etc.

The researches should especially focus on the following areas:

- Crop breeding to develop genotypes adapted to changed growing conditions;
- Applied research to select cultivars or hybrids for specific conditions;
- The genotypes selected should have appropriate cultural practices adapted for them;
- Adaptation of soil tillage systems and incorporation of mineral and organic fertilizers;
- Improvement of prevention in plant protection;
- Development of mineral fertilizers with a gradual release of nutrients;
- Introduction of new crop species for which there was no economic interest previously or for which there were no suitable growing conditions before;
- Refinement of weather forecasting models for smaller and wider areas;
- Other researches.

The Council will submit measure recommendations to appropriate government ministries, which will then issue directives based on them that will be of mandatory character for the growers.

Government bodies will use agroeconomic measures to support the Strategy and certain specific methods of agricultural production. The government will put in place modern irrigation systems to facilitate crop production and provide sufficient quantities of strategically important products.

The Council will promote the most effective methods for educating the growers via a well-developed network for providing advisory services. The training and education of growers will be synchronized with the Strategy.

Summary: - Steps that need to be taken:

- Constitution of the Council and appointmenmt of its members and management;
- Devising of the Strategy of Adaptation to Climatic Changes;
- Harmonization of the Strategy with regional and world standards;
- Adoption of the Strategy (ministry, government, parliament);
- Definition of scientific and technological/developmental researches;
- Education of growers and training of personnel at the advisory services;
- Provision of material and financial conditions for above activities;
- Intensive participation in international projects in the field.

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Climate Change, Vulnerability, and Adaptation in Agriculture: The Situation in Serbia

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The term "climate change" (also referred to as "global climate change") is sometimes used to refer to all forms of climatic inconsistency, but because the Earth's climate is never static, the term is more properly used to imply a significant change from one climatic condition to another. In some cases, "climate change" has been used synonymously with the term, "global warming"; scientists however, tend to use the term in the wider sense to also include natural changes in climate. The Framework Convention on Climate Change, in its Article 1, defines "climate change" as: "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods". The UNFCCC thus makes a distinction between "climate change" attributable to human activities altering the atmospheric composition, and "climate variability" attributable to natural causes.

The aforementioned definitions are compiled from different sources which are available in worldwide institutions dealing with the global climate change from different point of views. This educationally coloured compilation just symbolically announced the first step in an intensive campaign which will be done in the northern part of Serbia (Vojvodina Province) as well as in its western region. This pioneering attempt will be realised as the part of the FP6 project ADAGIO (Adaptation of Agriculture in European Regions at Environmental Risk under Climate Change) including Austria, Czech Republic, Poland, Italy, Romania, Russia, Bulgaria, Spain, Serbia and Egypt. This project will be conducted by the Center for Meteorology and Environmental Predictions (CMEP), Faculty of Sciences, University of Novi Sad gathering experts from the Institute for Field and Vegetable Crops (Plant Protection Department and Department of Wheat), Novi Sad, and Faculty of Agriculture

(Department of Agroeconomics and Rural Sociology and Department of Fruit and Grape Growing), Novi Sad.

At this moment it can be said that there are not systematic measures in Serbia for adaptation to climate change in (1) agriculture as well as other vulnerable segments of activities and (2) lifting the level of awareness of people involved in food production, except the very old cross-breeding programs for wheat resistant to high temperature and recent rural sociology research about extension services in Vojvodina. This project claims to provide the first reliable results, for the above mentioned regions in Serbia, in: (1) detecting the climate change in them (2) quantifying the level of their vulnerability, (3) suggesting the potential measure of adaptation in crop and fruit production in them and (4) lifting the level, quality and reliability of information for farmers regarding the climate changes.

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Several Noticed Changes in the Production of Grown Plants

mr Janko Pap

DP Agricultural Station Novi Sad, Serbia

Does the climate change? What is not the same in plant production? Mild winter-mineralization of organic matter in soil takes place constantly during whole year (at temperature of 3^{o}C and more). The result, humus is lost much faster. The fields with humus- reduced biogenesis, especially smaller number of micro-organisms. The result is more difficult tillage, greater risk and impossible production of some tiny seed plants because of earth`s crust (paprika direct sowing, sugar beet, carrot and similar). Rain showers appear earlier and more often in spring. Frequent appearance of rain showers causes soil compaction. Mild winters cause a bigger problem because of illnesses and insects. Last few years, and especially in 2006/07 production year the wheats sowed in the optimum period were attacked by lice that carried viruses causing white dwarfness of wheat and barley. Living lice on wheat and barley plants were noticed in December and January!!??

Because of the temperature changes of up to 20^{o}C during 24 hours more irrigation is necessary... in the past years there were 3-4, possibly 5 irrigations. During the last few years 12-15 irrigations were necessary for successful production of the same plant kinds. Irrigation should take place with the purpose of cooling crops and soil in order to increase relative air moisture and to reduce temperature in a crop and increase vitality of pollen (maize).

What to do in plant production?

- disciplinary application of “new” technology for production of grown plants
- preserve water
- preserve organic matter in soil, growing...
- not to burn harvest remains
- right choice of assortment
- in selection strong root system of grown plants should be selected

Group Extension Work as a Way of Knowledge Transfer to the Farmers

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Knowledge will be very important factor on which the modernisation of Vojvodinian agriculture will depend. Therefore, efforts in knowledge development and transfer should be understood as a valuable investment and not as an expenditure, as it is often in Serbia perceived, especially because of the fact that the internal rate of return in this area goes up to 40% and that the period of return is shorter than the agricultural production cycle alone.

There are different channels of knowledge and information dissemination to the farmers (mass media, specialised publications, fairs, group demonstrations, different types of organised and diffused ways of education etc.), but none of these channels of knowledge dissemination can be adequate replacement for agricultural extension (advisory work).

Agricultural extension in Vojvodina is the most developed in the work of agricultural stations, that should be strongly reformed during the next period. Some of the elementary steps in that reform have already been made and the reforms alone will be a *process* that will last for some time until the adequate extension system will have been established.

In the meantime, until that goal has been attained, advisors from the agricultural stations could innovate in their advisory work and practice efficient innovations that proved themselves successful in extension systems of countries with developed extension. One of such innovation is group extension work and the use of the appropriate group extension methods, whose application calls more for knowledge of advisor, than the financial investments. Group extension implies that advisor has set of knowledge and information about target groups, ways of their establishment and development. Application of group extension in relatively homogeneous groups of farmers is especially important in Serbian circumstances in which, due to the lack of finance and number of advisors, it is not possible to cover larger number of farmers and with whom the advisors mostly work individually. The first and most important condition to apply this kind of extension work is that the advisors are well-trained and that they develop their own knowledge through permanent extension practice. Training of advisors in group extension work, methods of group extension, target groups and other issues in this regard could be done at the *Centre for Rural Development, Training and Education of Agricultural Advisors*.

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Introducing Modelling Tools to Support Agricultural-Management Decision-Making Under Climate Change Conditions: A Spanish Experience

Dr Angel Utset Suastegui
ITACYL, Valladolid, Spain

According to climate change assessments, less precipitations and higher temperatures can be expected in the Iberian Peninsula and other Mediterranean zones. Besides, an increment in droughts and other extreme events can be expected as well. Such climatic conditions require an effort to optimize irrigation technologies and to improve water management efficiency. There are currently available water-use and crop-growth simulation models, which can be combined to climate scenarios and weather generators in order to recommend, through many simulations, the most reliable irrigation management. The Preliminary Assessment of the Impacts in Spain due to the Effects of Climate Change and the National Plan for Adaptation to Climate Change recommend the use of such simulation tools in Spanish climate-change impact assessments. Those tools, however, have not been used yet to support irrigation decision-making in our country. In that sense, the EU-funded proposal AGRIDEMA, leaded by Spain, has been addressed to introduce such tools, connecting the tools "providers" from Universities and high-level research centres, with their "users", located in agricultural technological or applied-research centres. AGRIDEMA comprised courses and Pilot Applications of the tools. Local researchers knew in the AGRIDEMA courses how to access to GCM data and seasonal forecasts, they receive also basic knowledge on weather generators, statistical and dynamical downscaling; as well as on available crop models as DSSAT, WOFOST, CROPSYST, SWAP and others. About 20 pilot assessments have been conducted in several European countries during AGRIDEMA, applying the modelling tools in particular cases.

The AGRIDEMA results are commented, mentioning particularly the Pilot Assessments that were held in Spain and in the Mediterranean area. Furthermore, several "users" opinion regarding the available climate and crop-growth simulation tools are also pointed out. Those opinions can be used as important feedback by the tools "developers". An illustrative example on how modelling tools can help to manage Sugarbeet irrigation under present and future climate conditions in Spain is also shown. Several future research directions are pointed out, as followed from the shown example and the AGRIDEMA results. Those research directions agree with the actions recommended in the Spanish National Plan for Adaptation to Climate Change, as well as in the European and international guidelines. Stakeholder will adopt climate-change mitigation options only if they realize the reliability of such options on their specific cases. To achieve this, the “users” of the modelling tools must develop local demonstration proposals, aimed to model calibration and validation, etc. Particularly, some demonstration proposals should be aimed to recommend productive and efficient irrigation water managements under the adverse climate conditions that Spanish farmers will eventually face in the next years.