

RAZVOJNE TENDENCIJE PROIZVODNJE MALINE U SRBIJI

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Malinarstvo predstavlja značajan segment voćarske proizvodnje u Republici Srbiji, a izvoz maline bitno doprinosi ukupnom izvozu poljoprivredno-prehrambenog sektora. Cilj rada bio je sagledavanje razvojnih tendencija površina, proizvodnje, prinosa i cena maline u Srbiji u periodu 2005–2025. godine, kao i utvrđivanje povezanosti između analiziranih pokazatelja. Istraživanje je zasnovano na zvaničnim podacima Republičkog zavoda za statistiku Srbije. U radu su primenjene metode deskriptivne statistike, analiza godišnjih stopa promene i trendova, Spearmanova korelaciona analiza, Shapiro–Wilk test i Mann–Whitney test. Rezultati su pokazali da su površine pod malinom i ukupna proizvodnja tokom većeg dela posmatranog perioda beležile rast, dok je nakon 2020. godine prisutna tendencija njihovog smanjenja. Prinos beleži skoro kontinuirani pad, a otkupne cene, iako značajno osciliraju, na nivou celog posmatranog perioda beleže značajan rast. Uprkos evidentnom padu prinosa, utvrđena je statistički značajna pozitivna povezanost između površina i proizvodnje, kao i negativna povezanost između prinosa i cena maline. Dobijeni rezultati ukazuju na potrebu unapređenja produktivnosti proizvodnje i prilagođavanja proizvodnje klimatskim promenama.

Ključne reči: malina, proizvodnja, prinos, cena, trend analiza

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Uvod

Malinarstvo predstavlja jednu od najznačajnijih grana voćarske proizvodnje u Republici Srbiji. Zahvaljujući povoljnim agroekološkim uslovima, dugoj tradiciji gajenja i visokom kvalitetu plodova, Srbija se već decenijama svrstava među vodeće proizvođače i izvoznike maline u svetu. Malina ima važnu ulogu u ostvarivanju izvoznih prihoda, razvoju prehrambene industrije, zapošljavanju stanovništva u ruralnim područjima i unapređenju socio-ekonomskog razvoja lokalnih zajednica (Kljajić i sar., 2025).

Proizvodnja maline zauzima posebno mesto u strukturi voćarske proizvodnje Srbije. Prema navodima Kljajić i sar. (2022), malina predstavlja jednu od najvažnijih izvoznih voćarskih kultura, pri čemu se najveći deo proizvodnje plasira na međunarodno tržište u smrznutom stanju. Visoka tržišna vrednost proizvoda, mogućnost ostvarivanja značajnih ekonomskih efekata i relativno brz povraćaj investicija doprineli su njenom intenzivnom razvoju tokom prethodnih decenija. Istovremeno, proizvodnja maline predstavlja značajan izvor prihoda velikom broju poljoprivrednih gazdinstava i jedan je od važnih faktora održivosti ruralnih područja Srbije (Kljajić i sar., 2025).

Ekonomski značaj malinarstva potvrđuju i istraživanja Milić i sar. (2019), koja ukazuju da proizvodnja maline ostvaruje visoku vrednost proizvodnje po jedinici površine i predstavlja jednu od profitabilnijih voćarskih proizvodnji. Profitabilnost proizvodnje zavisi od brojnih faktora, među kojima se posebno izdvajaju ostvareni prinosi, tržišne cene, troškovi proizvodnje i primenjeni tehnološki nivo proizvodnje.

Pored proizvodnih karakteristika, značajan broj istraživanja usmeren je na analizu spoljne trgovine i konkurentnosti maline. Nikolić i sar. (2023) navode da Srbija i Poljska zauzimaju vodeće pozicije na svetskom tržištu smrznute maline, pri čemu Srbija svoju konkurentnost zasniva na kvalitetu proizvoda i dugogodišnjoj prisutnosti na međunarodnom tržištu. Istovremeno, autori ukazuju na rast konkurentnosti drugih proizvođača, naročito Ukrajine, što apostrofira neophodnost unapređenja produktivnosti i efikasnosti ove proizvodnje.

Na razvoj malinarstva veliki uticaj imaju i promene u proizvodnim uslovima, posebno u kontekstu sve izraženijih klimatskih promena. Ortiz-Bobea i sar. (2021) ukazuju da su klimatske promene usporile rast globalne poljoprivredne produktivnosti, što potvrđuje značaj sagledavanja dugoročnih promena prinosa u različitim granama i linijama poljoprivredne proizvodnje. Kada je reč o malini, Aguilar i sar. (2025) navode da povećane temperature tokom rasta i sazrevanja plodova mogu uticati na kvalitet, senzorna svojstva i antioksidativna svojstva plodova maline. Klimatski faktori, dakle, pored tržišnih i tehnoloških uslova, mogu imati značajnu ulogu i u oblikovanju razvojnih tendencija proizvodnje maline.

Iako postoji značajan broj istraživanja koja se bave proizvodnjom, izvozom, konkurentnošću i ekonomskim efektima proizvodnje maline u Srbiji (Milić i sar., 2019; Kljajić i sar., 2022; Nikolić i sar., 2023; Kljajić i sar., 2025), relativno je mali broj studija koje istovremeno analiziraju dugoročne promene proizvodnje, prinosa i cena maline, kao i njihove međusobne odnose tokom dužeg vremenskog perioda. Posebno su retka istraživanja koja kombinuju analizu trendova, korelacionu analizu i poređenje različitih razvojnih faza sektora malinarstva.

Predmet istraživanja u ovom radu jesu površine, proizvodnja, prinosi i cene maline u Republici Srbiji u periodu od 2005. do 2025. godine. Osnovni cilj rada je sagledati razvojne tendencije površina, proizvodnje, prinosa i cena maline u Srbiji u periodu od 2005. do 2025. godine, identifikovati dugoročne trendove i utvrditi povezanost između analiziranih pokazatelja. Ne manje važan cilj je sagledavanje promena koje su se dogodile u različitim fazama razvoja sektora malinarstva i identifikovanje ključnih faktora koji mogu uticati na njegov budući razvoj.

2 Materijal i metod rada

Istraživanje je zasnovano na analizi sekundarnih podataka o proizvodnji maline u Republici Srbiji za period od 2005. do 2025. godine. Podaci su preuzeti iz statističke baze i publikacija Republičkog zavoda za statistiku Republike Srbije. Analizirani su podaci o površinama pod malinom (ha), ukupnoj proizvodnji (t), prinosima (t/ha) i otkupnim cenama maline (din/kg).

U cilju sagledavanja osnovnih karakteristika analiziranih pojava primenjene su metode deskriptivne statistike. Za svaku posmatranu varijablu izračunate su srednja vrednost, minimalna i maksimalna vrednost, standardna devijacija i koeficijent varijacije. Navedeni pokazatelji korišćeni su za ocenu nivoa i varijabilnosti proizvodnih i tržišnih pokazatelja malinarstva u Srbiji.

Izbor statističkih metoda zasnovan je na preporukama iz metodološke literature za analizu ekonomskih i poljoprivrednih vremenskih serija (Field, 2018; Pallant, 2020).

Radi analize dinamike promena izračunate su godišnje stope promene površina, proizvodnje, prinosa i cena prema formuli:

$$\text{Stopa promene (\%)} = ((X_t - X_{t-1}) / X_{t-1}) \times 100$$

gde je:

- X_t – vrednost pokazatelja u tekućoj godini,
- X_{t-1} – vrednost pokazatelja u prethodnoj godini.

Dobijene stope promene omogućile su identifikovanje godina sa najvećim rastom, odnosno padom analiziranih pokazatelja, kao i sagledavanje njihove dugoročne dinamike.

Za utvrđivanje dugoročnih tendencija razvoja malinarstva primenjena je analiza trenda. Trend modeli formirani su za površine, proizvodnju, prinose i cene maline. Reprerzentativnost modela ocenjena je pomoću koeficijenta determinacije (R^2), koji pokazuje u kojoj meri trend model objašnjava promene posmatrane pojave tokom vremena.

Linearni trend analiziran je primenom jednačine: $Y = a + bt$

gde je: Y – vrednost posmatranog pokazatelja, a – konstanta modela, b – koeficijent trenda koji pokazuje prosečnu godišnju promenu posmatrane pojave, t – vremenska komponenta. Pozitivna vrednost koeficijenta trenda ukazuje na rast posmatranog pokazatelja tokom vremena, dok negativna vrednost ukazuje na njegovo opadanje.

Pre primene inferencijalnih statističkih metoda izvršena je provera normalnosti raspodele podataka korišćenjem Shapiro–Wilk testa. Na osnovu rezultata testa utvrđeno je da pojedine varijable ne zadovoljavaju pretpostavku normalne raspodele, zbog čega su u nastavku istraživanja primenjene neparametarske statističke metode.

Za ispitivanje povezanosti između površina, proizvodnje, prinosa i cena maline korišćen je Spearmanov koeficijent rang korelacije. Ova metoda omogućava ocenu jačine i smera povezanosti između analiziranih varijabli bez pretpostavke o normalnoj raspodeli podataka.

Radi sagledavanja promena u razvoju sektora malinarstva posmatrani period podeljen je na dve razvojne faze: period od 2005. do 2020. godine i period od 2021. do 2025. godine. Podela je izvršena na osnovu uočenih promena u kretanju površina, proizvodnje, prinosa i cena maline. Za utvrđivanje statističke značajnosti razlika između navedenih perioda primenjen je Mann–Whitney U test kao neparametarska alternativa t-testu za nezavisne uzorke. Statistička značajnost svih primenjenih testova ocenjena je na nivou značajnosti $p < 0,05$.

Rezultati istraživanja prikazani su tabelarno, dok je njihova interpretacija zasnovana na statističkoj analizi, ekonomskom sagledavanju proizvodnih i tržišnih kretanja, kao i na relevantnim saznanjima iz domaće i međunarodne naučne literature.

3 Rezultati istraživanja i diskusija

3.1. Kretanje proizvodnje, prinosa i cena maline u Srbiji

Podaci prikazani u Tabeli 1 ukazuju da je malinarstvo u Srbiji tokom posmatranog perioda prošlo kroz značajne promene. Površine pod malinom povećane su sa 11.906 ha u 2005. godini na 24.029 ha u 2020. godini, nakon čega dolazi do njihovog kontinuiranog smanjenja na 17.062 ha u 2025. godini. Slična kretanja

zabeležena su i kod ukupne proizvodnje, koja je dostigla maksimum od 127.010t u 2018. godini, dok je u 2025. godini smanjena na 73.571 t.

Prinosi su tokom posmatranog perioda pokazivali izražene oscilacije, pri čemu je najviša vrednost ostvarena 2009. godine (7,65 t/ha), a najniža 2025. godine (4,31 t/ha).

Dobijeni rezultati ukazuju na postepeno smanjenje produktivnosti proizvodnje maline, što može biti povezano sa uticajem klimatskih promena, starošću zasada i ograničenom primenom savremenih tehnoloških rešenja. Slične zaključke navode Radosavljević i sar. (2026), ističući da klimatski ekstremi sve značajnije utiču na produktivnost maline u Srbiji. Iako su tokom posmatranog perioda zabeležene značajne oscilacije u kretanju cena maline, ukupno posmatrano prisutna je izražena tendencija njihovog rasta. Otkupna cena povećana je sa 39,10 din/kg u 2005. godini na 478,85 din/kg u 2025. godini, što predstavlja povećanje od preko dvanaest puta. Ovakva kretanja mogu se povezati sa rastućom izvoznom tražnjom i značajem Srbije na međunarodnom tržištu maline, na šta ukazuju i Nikolić i sar. (2023).

Tabela 1: Kretanje površina, proizvodnje, prinosa i cena maline u Srbiji (2005–2025)

Godina	Površina (ha)	Proizvodnja (t)	Prinos (t/ha)	Cena (din/kg)
2005	11.906	84.331	7,08	39,10
2006	11.425	79.680	6,97	57,22
2007	11.049	76.991	6,97	91,34
2008	11.151	84.299	7,56	171,58
2009	11.371	86.961	7,65	112,67
2010	11.589	83.870	7,24	130,28
2011	11.962	89.602	7,49	82,40
2012	11.996	70.320	5,86	124,89
2013	13.118	74.682	5,69	184,23
2014	14.792	82.683	5,59	152,27
2015	16.211	97.165	5,99	192,89
2016	20.194	113.172	5,60	194,23
2017	21.861	109.742	5,02	131,72
2018	22.654	127.010	5,61	96,26
2019	23.249	120.058	5,16	143,64
2020	24.029	118.674	4,94	196,28
2021	20.807	110.589	5,31	377,37
2022	19.703	116.093	5,89	488,13
2023	19.016	98.674	5,19	189,83
2024	18.625	94.026	5,05	235,61
2025	17.062	73.571	4,31	478,85

Izvor: Republički zavod za statistiku Srbije, 2026

Rezultati deskriptivne statistike (tabela 2) ukazuju na značajne razlike u stepenu varijabilnosti analiziranih pokazatelja. Najveću varijabilnost pokazale su cene maline (CV = 66,50%), dok su proizvodnja (CV = 18,42%) i prinosi (CV = 16,74%) bili znatno stabilniji. Ovakav rezultat je očekivan, imajući u vidu visok stepen izvozne orijentacije sektora malinarstva u Srbiji, gde promene na međunarodnom tržištu direktno utiču na formiranje otkupnih cena (Nikolić i sar., 2023).

Tabela 2: Deskriptivna statistika pokazatelja malinarstva u Srbiji (2005–2025)

Pokazatelj	Srednja vrednost	Minimum	Maksimum	Standardna devijacija	Koeficijent varijacije (%)
Površine (ha)	16.370,00	11.049,00	24.029,00	4.653,16	28,42
Proizvodnja (t)	94.866,33	70.320,00	127.010,00	17.471,52	18,42
Prinos (t/ha)	6,01	4,31	7,65	1,01	16,74
Cena (din/kg)	184,32	39,10	488,13	122,58	66,50

Izvor: Obračun autora na osnovu podataka Republičkog zavoda za statistiku.

Pored analize apsolutnih vrednosti, za potpunije sagledavanje dinamike malinarstva u Srbiji izračunate su godišnje stope promene osnovnih pokazatelja. U Tabeli 3 prikazane su stope promene površina, proizvodnje, prinosa i cena maline u Srbiji u periodu 2005–2025. godine.

Na osnovu podataka prikazanih u Tabeli 3 može se uočiti da su analizirani pokazatelji imali različit intenzitet promena tokom posmatranog perioda. Površine pod malinom su do 2020. godine uglavnom beležile pozitivne stope promene, dok je nakon 2020. godine prisutan kontinuiran pad. Najveći rast površina zabeležen je 2016. godine, kada je iznosio 24,57%, dok je najveći pad zabeležen 2021. godine, kada su površine smanjene za 13,41%.

Proizvodnja maline pokazuje izraženije oscilacije u odnosu na površine. Najveći pad proizvodnje zabeležen je 2025. godine, kada je iznosio 21,75%, dok je značajan pad ostvaren i 2012. godine, u iznosu od 21,52%. Sa druge strane, najveći rast proizvodnje zabeležen je 2015. godine, kada je iznosio 17,52%, i 2016. godine, kada je iznosio 16,47%. Ovakva kretanja potvrđuju da ukupna proizvodnja ne zavisi samo od površina, već i od prinosa po hektaru i proizvodnih uslova u pojedinim godinama.

Najveće oscilacije zabeležene su kod cena maline. Nakon rasta od 92,26% u 2021. godini, usledio je dalji rast u 2022. godini, dok je 2023. godine zabeležen pad od 61,11%. Već 2025. godine cena ponovo raste za 103,24%, što potvrđuje visok stepen nestabilnosti tržišta maline. Posmatrano sa aspekta proizvodnje, posebno je značajan podatak da je u 2025. godini zabeležen pad proizvodnje od 21,75%, uz istovremeni pad prinosa od 14,59%. Takva kretanja ukazuju na pogoršanje

proizvodnih performansi sektora i potvrđuju sve veći značaj klimatskih, tehnoloških i ekonomskih ograničenja u proizvodnji maline.

Tabela 3: Godišnje stope promene površina, proizvodnje, prinosa i cena maline u Srbiji, 2005–2025. godine

Godina	Površina (%)	Proizvodnja (%)	Prinos (%)	Cene (%)
2005				
2006	-4,04	-5,52	-1,54	46,34
2007	-3,29	-3,37	-0,09	59,63
2008	0,92	9,49	8,49	87,85
2009	1,97	3,16	1,16	-34,33
2010	1,92	-3,55	-5,37	15,63
2011	3,22	6,83	3,50	-36,75
2012	0,28	-21,52	-21,74	51,57
2013	9,35	6,20	-2,88	47,51
2014	12,76	10,71	-1,82	-17,35
2015	9,59	17,52	7,23	26,68
2016	24,57	16,47	-6,50	0,69
2017	8,25	-3,03	-10,43	-32,18
2018	3,63	15,74	11,68	-26,92
2019	2,63	-5,47	-7,89	49,22
2020	3,35	-1,15	-4,36	36,65
2021	-13,41	-6,81	7,61	92,26
2022	-5,31	4,98	10,86	29,35
2023	-3,49	-15,00	-11,93	-61,11
2024	-2,06	-4,71	-2,71	24,12
2025	-8,39	-21,75	-14,59	103,24

Izvor: Obračun autora na osnovu podataka Republičkog zavoda za statistiku Republike Srbije.

3.2. Test normalnosti i poređenje razvojnih perioda

Rezultati Shapiro–Wilk testa (tabela 4) pokazali su da distribucija podataka nije normalna za sve analizirane varijable, budući da su kod površina ($p = 0,0131$) i cena ($p = 0,0010$) utvrđena odstupanja od normalne raspodele. Zbog toga su u nastavku istraživanja primenjene neparametarske statističke metode.

Mann–Whitney test primenjen je radi utvrđivanja postojanja statistički značajnih razlika između perioda 2005–2020. i 2021–2025. godine (tabela 4). Rezultati pokazuju da je statistički značajna razlika utvrđena kod cena maline ($p = 0,0007$), dok je kod prinosa utvrđena granična statistička značajnost ($p = 0,050$). Sa druge

strane, kod površina i proizvodnje nisu utvrđene statistički značajne razlike između analiziranih perioda.

Tabela 4: Rezultati Shapiro–Wilk i Mann–Whitney testova

Pokazatelj	Shapiro–Wilk p-vrednost	Prosek 2005–2020	Prosek 2021–2025	Mann–Whitney p-vrednost
Površine (ha)	0,0131	15.534,81	19.042,60	0,208
Proizvodnja (t)	0,1219	93.702,50	98.590,60	0,603
Prinos (t/ha)	0,0636	6,28	5,15	0,050
Cena (din/kg)	0,0010	131,31	353,96	0,0007

Izvor: Obračun autora na osnovu podataka Republičkog zavoda za statistiku.

Posebno je značajan rezultat koji pokazuje da je prosečna cena maline povećana sa prosečno 131,31 din/kg u prvom periodu na 353,96 din/kg u drugom periodu. Istovremeno, prosečni prinos smanjen je sa 6,28 t/ha na 5,15 t/ha. Ovakvi rezultati ukazuju na to da je nakon 2020. godine došlo do promena u funkcionisanju sektora malinarstva, odnosno do smanjenja produktivnosti proizvodnje i istovremenog rasta cena maline.

3.3. Korelaciona analiza proizvodnih pokazatelja

Rezultati Spearmanove korelacione analize (tabela 5) ukazuju na postojanje različitog stepena povezanosti između analiziranih proizvodnih i tržišnih pokazatelja malinarstva u Srbiji. Najjača pozitivna korelacija utvrđena je između površina i proizvodnje ($r = 0,768$; $p < 0,001$), što je i očekivano i potvrđuje da povećanje proizvodnih površina predstavlja jedan od najvažnijih faktora rasta ukupne proizvodnje maline.

Takođe, utvrđena je statistički značajna pozitivna povezanost između površina i cena ($r = 0,527$; $p = 0,014$). Ovakav rezultat može ukazivati da su proizvođači u periodima viših cena bili motivisani za proširenje proizvodnih površina.

Između prinosa i cena maline utvrđena je statistički značajna negativna korelacija ($r = -0,588$; $p = 0,005$) što je i očekivano jer u uslovima stabilne ili rastuće tražnje u godinama sa nižim prinosima usled smanjene ponude rastu cene.

Sa druge strane, interesantno je da između ukupne proizvodnje i cena nije utvrđena statistički značajna povezanost ($r = 0,279$; $p = 0,220$). Ovaj rezultat ukazuje da na formiranje cena maline ne utiče isključivo domaća proizvodnja, već i brojni drugi faktori, kao što su uvezene količine maline, izvozna tražnja, stanje zaliha, konkurentnost drugih proizvođačkih zemalja i kretanja na međunarodnom tržištu. Slične zaključke iznose i Nikolić i sar. (2023), koji naglašavaju izraženu

povezanost sektora malinarstva Srbije sa međunarodnim tržištem smrznute maline.

Tabela 5: Spearmanova korelaciona analiza između proizvodnih i tržišnih pokazatelja

Varijable	Spearmanov koeficijent (r)	p-vrednost
Površine – proizvodnja	0,768	<0,001
Površine – cena	0,527	0,014
Proizvodnja – cena	0,279	0,220
Prinos – proizvodnja	-0,314	0,165
Prinos – cena	-0,588	0,005

Izvor: Obračun autora na osnovu podataka Republičkog zavoda za statistiku.

3.4. Analiza trenda proizvodnje, prinosa i cena maline u Srbiji

Rezultati trend analize ukazuju na različite razvojne tendencije analiziranih pokazatelja malinarstva u Srbiji (tabela 6). Kod površina pod malinom utvrđen je pozitivan trend od 595,83 ha godišnje, uz koeficijent determinacije $R^2 = 0,6313$, što ukazuje da linearni trend objašnjava više od 63% promena ovog pokazatelja tokom posmatranog perioda. Dugoročno posmatrano, dakle, malinarstvo u Srbiji je prošlo kroz fazu intenzivnog širenja proizvodnih kapaciteta, iako je nakon 2020. godine prisutan trend smanjenja površina.

Tabela 6: Analiza trenda proizvodnje, prinosa i cena maline u Srbiji

Pokazatelj	Koeficijent trenda	R^2	Tumačenje
Površine (ha)	+595,83	0,6313	Rast
Proizvodnja (t)	+1.462,11	0,2696	Rast
Prinos (t/ha)	-0,14	0,7466	Pad
Cena (din/kg)	+14,31	0,5249	Rast

Izvor: Obračun autora na osnovu podataka Republičkog zavoda za statistiku.

Kod ukupne proizvodnje takođe je utvrđen pozitivan trend (+1.462,11 t godišnje), ali uz nižu vrednost koeficijenta determinacije ($R^2 = 0,2696$), što ukazuje na znatno veće oscilacije proizvodnje tokom posmatranog perioda. Ovakvi rezultati potvrđuju da na proizvodnju maline, pored promena površina, značajno utiču i drugi faktori, prvenstveno klimatski uslovi i ostvareni prinosi.

Posebno značajan rezultat odnosi se na prinose maline. Trend analiza pokazala je negativan trend od -0,14 t/ha godišnje, uz najvišu vrednost koeficijenta determinacije među svim analiziranim pokazateljima ($R^2 = 0,7466$). To znači da

linearni trend objašnjava gotovo 75% promena prinosa tokom posmatranog perioda, odnosno da smanjenje prinosa nije posledica slučajnih oscilacija već predstavlja dugoročnu razvojnu tendenciju sektora malinarstva u Srbiji. Dobijeni rezultat može se povezati sa nalazima Ortiz-Bobea i sar. (2021), koji ukazuju da su klimatske promene usporile rast globalne poljoprivredne produktivnosti. Takođe, Aguilar i sar. (2025) navode da povećane temperature tokom vegetacionog perioda mogu negativno uticati na kvalitet i razvoj plodova maline. Posmatrano u tom kontekstu, kontinuirano smanjenje prinosa može ukazivati na potrebu intenzivnijeg prilagođavanja proizvodnje novim klimatskim i tehnološkim uslovima.

Negativan trend prinosa predstavlja posebno važan nalaz istraživanja, budući da dugoročno može ugroziti konkurentnost i ekonomsku održivost proizvodnje maline u Srbiji.

Za razliku od prinosa, cene maline pokazuju izražen pozitivan trend od 14,31 din/kg godišnje, uz koeficijent determinacije $R^2 = 0,5249$. Ovakav rezultat potvrđuje dugoročni rast tržišne vrednosti maline i ukazuje na značajnu ulogu tržišnih faktora u razvoju sektora. Rast cena može se povezati sa visokom izvoznom orijentacijom proizvodnje maline, promenama odnosa ponude i tražnje, kao i sa smanjenjem proizvodnih količina u pojedinim godinama.

Posmatrano u celini, rezultati trend analize ukazuju na postojanje dve suprotne tendencije u razvoju malinarstva Srbije. Sa jedne strane prisutan je dugoročni rast cena i širenje proizvodnih kapaciteta, dok sa druge strane dolazi do postepenog smanjenja prinosa. Upravo ova kombinacija opadajuće produktivnosti i rastućih cena predstavlja jedno od najvažnijih obeležja savremenog razvoja sektora malinarstva u Srbiji.

4 Zaključak

Cilj istraživanja bio je analiza razvojnih tendencija površina, proizvodnje, prinosa i cena maline u Srbiji u periodu od 2005. do 2025. godine, kao i utvrđivanje povezanosti između analiziranih pokazatelja i sagledavanje promena u različitim fazama razvoja sektora malinarstva.

Rezultati istraživanja pokazali su da je malinarstvo u Srbiji tokom posmatranog perioda prošlo kroz značajne strukturne promene. Površine pod malinom i ukupna proizvodnja beležile su rast tokom većeg dela analiziranog perioda, dok je nakon 2020. godine prisutna tendencija njihovog smanjenja. Istovremeno, cene maline ostvarile su izražen rast, dok su prinosi pokazali dugoročnu tendenciju opadanja.

Deskriptivna statistika ukazala je na najveću varijabilnost cena, što potvrđuje značajan uticaj tržišnih faktora na razvoj sektora. Rezultati korelacione analize

pokazali su očekivanu statistički značajnu pozitivnu povezanost između površina i proizvodnje, kao i statistički značajnu negativnu povezanost između prinosa i cena maline.

Trend analiza potvrdila je postojanje dugoročnih razvojnih tendencija analiziranih pokazatelja. Posebno je značajan negativan trend prinosa, koji ukazuje na postepeno smanjenje produktivnosti proizvodnje maline u Srbiji. Dobijeni rezultat može se povezati sa uticajem klimatskih promena, starenjem zasada i drugim proizvodnim ograničenjima.

Rezultati Mann–Whitney testa pokazali su da su nakon 2020. godine nastupile značajne promene u sektoru malinarstva, pre svega u pogledu kretanja cena i prinosa. Ovakvi nalazi ukazuju da se malinarstvo u Srbiji nalazi u novoj razvojnoj fazi koju karakterišu više tržišne cene, ali i izraženiji proizvodni izazovi.

Rezultati istraživanja ukazuju da budući razvoj malinarstva treba usmeriti ka unapređenju produktivnosti proizvodnje, obnovi zasada, primeni savremenih tehnoloških rešenja i prilagođavanju proizvodnje klimatskim promenama, kako bi se očuvala konkurentnost Srbije na međunarodnom tržištu maline. Iako je istraživanje zasnovano na agregiranim podacima na nivou Republike Srbije, dobijeni rezultati pružaju pouzdanu osnovu za sagledavanje dugoročnih razvojnih tendencija sektora. Buduća istraživanja trebalo bi usmeriti na regionalne analize i uključivanje klimatskih, ekonomskih i tehnoloških pokazatelja radi detaljnijeg sagledavanja faktora koji utiču na održivost i konkurentnost proizvodnje maline.

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Sukob interesa

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DEVELOPMENT TRENDS OF RASPBERRY PRODUCTION IN SERBIA

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ABSTRACT

Raspberry production represents an important segment of fruit production in the Republic of Serbia, while raspberry exports make a significant contribution to the country's agri-food exports. The aim of this study was to examine the development trends of raspberry acreage, production, yields, and prices in Serbia during the period 2005–2025, as well as to determine the relationships among the analyzed indicators. The research was based on official data obtained from the Statistical Office of the Republic of Serbia. Descriptive statistics, annual growth rate analysis, trend analysis, Spearman's rank correlation analysis, the Shapiro–Wilk test, and the Mann–Whitney U test were applied. The results indicate that raspberry acreage and total production increased during most of the observed period, while a declining trend has been evident since 2020. Yields showed an almost continuous decline, whereas purchase prices, despite considerable fluctuations, exhibited a significant upward trend over the entire study period. Despite the evident decline in yields, a statistically significant positive relationship was identified between acreage and production, while a significant negative relationship was found between yields and raspberry prices. The findings highlight the need to improve production productivity and strengthen adaptation measures to climate change.

Keywords: raspberry, production, yield, price, trend analysis

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1 Introduction

Raspberry production represents one of the most important branches of fruit production in the Republic of Serbia. Owing to favourable agroecological conditions, a long tradition of cultivation, and the high quality of its fruit, Serbia has ranked among the world's leading raspberry producers and exporters for decades. Raspberry production makes an important contribution to agri-food exports, rural employment, and the economic sustainability of many agricultural holdings (Kljajić et al., 2025). The economic importance of raspberry production is further confirmed by the findings of Milić et al. (2019), who emphasize that raspberry cultivation generates a high production value per unit of land and represents one of the most profitable fruit production activities. The profitability of raspberry production depends on numerous factors, among which yields, market prices, production costs, and the applied technological level are particularly important.

In addition to production-related aspects, a considerable body of research has focused on the analysis of foreign trade and the competitiveness of raspberries. Nikolić et al. (2023) report that Serbia and Poland occupy leading positions in the global frozen raspberry market, with Serbia's competitiveness being largely based on product quality and its long-standing presence in international markets. At the same time, the authors highlight the growing competitiveness of other producing countries, particularly Ukraine, emphasizing the necessity of improving productivity and efficiency within the raspberry sector.

The development of raspberry production is also strongly influenced by changes in production conditions, particularly in the context of increasingly pronounced climate change. Ortiz-Bobea et al. (2021) demonstrate that climate change has slowed the growth of global agricultural productivity, confirming the importance of examining long-term yield dynamics across different agricultural sectors. With regard to raspberries, Aguilar et al. (2025) indicate that elevated temperatures during fruit growth and maturation may adversely affect fruit quality, sensory characteristics, and antioxidant properties. Consequently, climatic factors, alongside market and technological conditions, may play a significant role in shaping the development trends of raspberry production.

Although numerous studies have examined raspberry production, exports, competitiveness, and economic performance in Serbia (Milić et al., 2019; Kljajić et al., 2022; Nikolić et al., 2023; Kljajić et al., 2025), relatively few studies have simultaneously analyzed long-term changes in raspberry production, yields, and prices, as well as the relationships among these indicators over an extended period. Studies combining trend analysis, correlation analysis, and comparisons of different developmental phases of the raspberry sector are particularly scarce.

The subject of this research comprises raspberry acreage, production, yields, and prices in the Republic of Serbia during the period 2005–2025. The primary objective of the study is to examine the development trends of raspberry acreage, production, yields, and prices, identify long-term trends, and determine the relationships among the analyzed indicators. An additional objective is to assess changes that have occurred during different developmental phases of the raspberry sector and to identify key factors that may influence its future development.

2 Materials and methods

This study was based on the analysis of secondary data on raspberry production in the Republic of Serbia for the period 2005–2025. The data were obtained from the statistical database and publications of the Statistical Office of the Republic of Serbia. The analysis included data on raspberry acreage (ha), total production (t), yields (t/ha), and purchase prices (RSD/kg).

Descriptive statistical methods were applied to examine the basic characteristics of the analyzed variables. For each variable, the mean, minimum and maximum values, standard deviation, and coefficient of variation were calculated. These indicators were used to assess the level and variability of production and market indicators of raspberry production in Serbia.

The selection of statistical methods was based on recommendations from methodological literature concerning the analysis of economic and agricultural time series (Field, 2018; Pallant, 2020). To analyze the dynamics of change, annual growth rates of acreage, production, yields, and prices were calculated using the following formula:

$$\text{Annual Growth Rate (\%)} = ((X_t - X_{t-1}) / X_{t-1}) \times 100$$

where:

- X_t – value of the indicator in the current year;
- X_{t-1} – value of the indicator in the previous year.

The calculated growth rates enabled the identification of years characterized by the highest increases and decreases in the analyzed indicators, as well as an assessment of their long-term dynamics.

Trend analysis was applied to determine the long-term development tendencies of raspberry production. Trend models were estimated for acreage, production, yields, and prices. The explanatory power of the models was evaluated using the coefficient of determination (R^2), which indicates the extent to which the trend model explains changes in the observed phenomenon over time.

The linear trend was estimated using the following equation: $Y = a + bt$

where: Y – value of the observed indicator; a – model constant; b – trend coefficient representing the average annual change in the observed phenomenon; t – time variable.

A positive trend coefficient indicates growth of the observed indicator over time, whereas a negative coefficient indicates a declining trend.

Prior to the application of inferential statistical methods, data normality was assessed using the Shapiro–Wilk test. The results indicated that some variables did not satisfy the assumption of normal distribution; therefore, non-parametric statistical methods were applied in the subsequent analysis.

The relationships among acreage, production, yields, and raspberry prices were examined using Spearman's rank correlation coefficient. This method enables the assessment of the strength and direction of relationships between variables without assuming normal data distribution.

To examine changes in the development of the raspberry sector, the study period was divided into two developmental phases: 2005–2020 and 2021–2025. This classification was based on observed changes in acreage, production, yields, and prices. The Mann–Whitney U test was applied to determine the statistical significance of differences between the two periods as a non-parametric alternative to the independent samples t-test. Statistical significance for all applied tests was assessed at the $p < 0.05$ significance level.

The research results are presented in tabular form, while their interpretation is based on statistical analysis, economic assessment of production and market developments, and relevant findings from domestic and international scientific literature.

3 Results and discussion

3.1. Developments in Raspberry Production, Yields, and Prices in Serbia

The data presented in Table 1 indicate that the raspberry sector in Serbia underwent significant changes during the observed period. Raspberry acreage increased from 11,906 ha in 2005 to 24,029 ha in 2020, after which a continuous decline was recorded, reaching 17,062 ha in 2025. A similar pattern was observed in total production, which reached its maximum level of 127,010 t in 2018 and subsequently declined to 73,571 t in 2025. Yields exhibited considerable fluctuations throughout the study period. The highest yield was recorded in 2009 (7.65 t/ha), while the lowest was observed in 2025 (4.31 t/ha). These results suggest a gradual decline in raspberry production productivity, which may be associated with climate change impacts, ageing plantations, and the limited

adoption of modern production technologies. Similar conclusions were reported by Radosavljević et al. (2026), who emphasized that climate extremes increasingly affect raspberry productivity in Serbia.

Table 1. Trends in Raspberry Acreage, Production, Yields and Prices in Serbia (2005–2025)

Year	Acreage (ha)	Production (t)	Yield (t/ha)	Price (RSD/kg)
2005	11.906	84.331	7,08	39,10
2006	11.425	79.680	6,97	57,22
2007	11.049	76.991	6,97	91,34
2008	11.151	84.299	7,56	171,58
2009	11.371	86.961	7,65	112,67
2010	11.589	83.870	7,24	130,28
2011	11.962	89.602	7,49	82,40
2012	11.996	70.320	5,86	124,89
2013	13.118	74.682	5,69	184,23
2014	14.792	82.683	5,59	152,27
2015	16.211	97.165	5,99	192,89
2016	20.194	113.172	5,60	194,23
2017	21.861	109.742	5,02	131,72
2018	22.654	127.010	5,61	96,26
2019	23.249	120.058	5,16	143,64
2020	24.029	118.674	4,94	196,28
2021	20.807	110.589	5,31	377,37
2022	19.703	116.093	5,89	488,13
2023	19.016	98.674	5,19	189,83
2024	18.625	94.026	5,05	235,61
2025	17.062	73.571	4,31	478,85

Source: Statistical Office of the Republic of Serbia (2026).

Although considerable fluctuations in raspberry prices were recorded during the observed period, an overall upward trend was evident. The purchase price increased from RSD 39.10/kg in 2005 to RSD 478.85/kg in 2025, representing more than a twelvefold increase. Such developments may be associated with growing export demand and Serbia's important position in the international raspberry market, as highlighted by Nikolić et al. (2023).

The results of the descriptive statistical analysis (Table 2) reveal substantial differences in the variability of the analyzed indicators. Raspberry prices exhibited the highest variability (CV = 66.50%), whereas production (CV = 18.42%) and yields (CV = 16.74%) were considerably more stable. This finding is expected

given the strong export orientation of the Serbian raspberry sector, where changes in international markets directly influence purchase prices (Nikolić et al., 2023).

Based on the data presented in Table 3, it can be observed that the analysed indicators recorded different intensities of change during the observed period. Raspberry acreage generally recorded positive annual growth rates until 2020, while a continuous decline was observed after 2020. The highest increase in acreage was recorded in 2016, amounting to 24.57%, while the largest decrease was recorded in 2021, when acreage declined by 13.41%.

Table 2. Descriptive Statistics of Raspberry Production Indicators in Serbia (2005–2025)

Indicator	Mean	Min	Max	Standard deviation	Coefficient of variation (%)
Acreage (ha)	16.370,00	11.049,00	24.029,00	4.653,16	28,42
Production (t)	94.866,33	70.320,00	127.010,00	17.471,52	18,42
Yield (t/ha)	6,01	4,31	7,65	1,01	16,74
Price (rsd/kg)	184,32	39,10	488,13	122,58	66,50

Source: Authors' calculations based on data from the Statistical Office of the Republic of Serbia.

In addition to the analysis of absolute values, annual growth rates of the main indicators were calculated in order to provide a more comprehensive insight into the dynamics of raspberry production in Serbia. Table 3 presents the annual growth rates of raspberry acreage, production, yields and prices in Serbia during the period 2005–2025.

Raspberry production showed more pronounced fluctuations compared to acreage. The largest decline in production was recorded in 2025, amounting to 21.75%, while a significant decrease was also recorded in 2012, at 21.52%. On the other hand, the highest increase in production was recorded in 2015, amounting to 17.52%, and in 2016, when it reached 16.47%. These trends confirm that total production does not depend solely on acreage, but also on yields per hectare and production conditions in individual years.

The greatest fluctuations were recorded in raspberry prices. After an increase of 92.26% in 2021, prices continued to rise in 2022, while in 2023 a decrease of 61.11% was recorded. In 2025, prices increased again by 103.24%, confirming the high level of instability in the raspberry market. From the production perspective, it is particularly important to note that in 2025 production decreased by 21.75%, while yields declined by 14.59%. Such trends indicate a deterioration in the production performance of the sector and confirm the growing importance of climatic, technological and economic constraints in raspberry production.

Table 3. Annual Growth Rates of Raspberry Acreage, Production, Yields and Prices in Serbia

Year	Acreage (%)	Production (%)	Yield (%)	Price (%)
2005				
2006	-4,04	-5,52	-1,54	46,34
2007	-3,29	-3,37	-0,09	59,63
2008	0,92	9,49	8,49	87,85
2009	1,97	3,16	1,16	-34,33
2010	1,92	-3,55	-5,37	15,63
2011	3,22	6,83	3,50	-36,75
2012	0,28	-21,52	-21,74	51,57
2013	9,35	6,20	-2,88	47,51
2014	12,76	10,71	-1,82	-17,35
2015	9,59	17,52	7,23	26,68
2016	24,57	16,47	-6,50	0,69
2017	8,25	-3,03	-10,43	-32,18
2018	3,63	15,74	11,68	-26,92
2019	2,63	-5,47	-7,89	49,22
2020	3,35	-1,15	-4,36	36,65
2021	-13,41	-6,81	7,61	92,26
2022	-5,31	4,98	10,86	29,35
2023	-3,49	-15,00	-11,93	-61,11
2024	-2,06	-4,71	-2,71	24,12
2025	-8,39	-21,75	-14,59	103,24

Source: Authors' calculations based on data from the Statistical Office of the Republic of Serbia.

3.2. Normality Testing and Comparison of Development Periods

The results of the Shapiro–Wilk test (Table 4) indicate that the data distribution was not normal for all analyzed variables. Deviations from normality were identified for raspberry acreage ($p = 0.0131$) and prices ($p = 0.0010$). Consequently, non-parametric statistical methods were applied in the subsequent stages of the analysis.

The Mann–Whitney U test was used to determine whether statistically significant differences existed between the periods 2005–2020 and 2021–2025 (Table 4). The results indicate a statistically significant difference in raspberry prices ($p = 0.0007$), while yields showed marginal statistical significance ($p = 0.050$). In contrast, no statistically significant differences were identified for acreage or total production between the two analyzed periods.

Table 4. Results of the Shapiro–Wilk Normality Test and the Mann–Whitney U Test

Indicators	Shapiro-Wilk p-value	Mean 2005–2020	Mean 2021–2025	Mann– Whitney p-value
Acreage (ha)	0,0131	15.534,81	19.042,60	0,208
Production (t)	0,1219	93.702,50	98.590,60	0,603
Yield (t/ha)	0,0636	6,28	5,15	0,050
Price (RSD/kg)	0,0010	131,31	353,96	0,0007

Source: Authors' calculations based on data from the Statistical Office of the Republic of Serbia.

A particularly important finding is the increase in the average raspberry purchase price from RSD 131.31/kg in the first period to RSD 353.96/kg in the second period. At the same time, average yields declined from 6.28 t/ha to 5.15 t/ha. These results suggest that significant changes occurred in the functioning of the raspberry sector after 2020, characterized by declining production productivity and simultaneously increasing raspberry prices.

3.3. Correlation Analysis of Production Indicators

The results of Spearman's rank correlation analysis (Table 5) reveal varying degrees of association among the analyzed production and market indicators of the Serbian raspberry sector. The strongest positive correlation was identified between acreage and production ($r = 0.768$; $p < 0.001$), which was expected and confirms that the expansion of production area represents one of the key determinants of growth in total raspberry production.

A statistically significant positive relationship was also found between acreage and prices ($r = 0.527$; $p = 0.014$). This result may indicate that producers were encouraged to expand production areas during periods of higher prices, expecting improved economic returns from raspberry cultivation.

A statistically significant negative correlation was identified between yields and raspberry prices ($r = -0.588$; $p = 0.005$). This finding is consistent with economic theory, as lower yields reduce market supply and, under conditions of stable or increasing demand, contribute to higher prices.

On the other hand, no statistically significant relationship was found between total production and prices ($r = 0.279$; $p = 0.220$). This result suggests that raspberry prices are not determined solely by domestic production levels but are also influenced by imported quantities, export demand, inventory levels, the competitiveness of other producing countries, and developments in international markets. Similar conclusions were reported by Nikolić et al. (2023), who

emphasized the strong integration of the Serbian raspberry sector into the international frozen raspberry market.

Table 5. Spearman's correlation coefficients between the analysed variables

Variables	Spearman's correlation coefficient (r)	p-value
Acreage – production	0.768	<0.001
Acreage – price	0.527	0.014
Production – price	0.279	0.220
Yield – production	-0.314	0.165
Yield – price	-0.588	0.005

Source: Authors' calculations based on data from the Statistical Office of the Republic of Serbia.

3.4. Trend Analysis of Raspberry Production, Yields and Prices in Serbia

The results of the trend analysis reveal different development tendencies among the analyzed indicators of the Serbian raspberry sector (Table 6). Raspberry acreage exhibited a positive trend of 595.83 ha per year, with a coefficient of determination of $R^2 = 0.6313$, indicating that the linear trend model explains more than 63% of the observed variation. From a long-term perspective, raspberry production in Serbia experienced a period of substantial expansion in production capacity, despite the decline in acreage recorded after 2020.

A positive trend was also identified for total production (+1,462.11 t per year), although the coefficient of determination was considerably lower ($R^2 = 0.2696$), indicating greater fluctuations in production levels throughout the observed period. These findings suggest that, in addition to acreage expansion, raspberry production is strongly influenced by other factors, particularly climatic conditions and yield performance.

One of the most important findings of this study relates to raspberry yields. Trend analysis revealed a negative trend of -0.14 t/ha per year, accompanied by the highest coefficient of determination among all analyzed indicators ($R^2 = 0.7466$). This implies that the linear trend model explains nearly 75% of the variation in yields over time, indicating that the decline in yields is not the result of random fluctuations but rather represents a long-term development trend within the Serbian raspberry sector.

This finding may be linked to the results reported by Ortiz-Bobea et al. (2021), who demonstrated that climate change has slowed the growth of global agricultural productivity. Similarly, Aguilar et al. (2025) reported that elevated temperatures during the growing season may negatively affect raspberry fruit development and quality. In this context, the continuous decline in yields may

indicate the need for more intensive adaptation of production systems to changing climatic and technological conditions.

The negative yield trend represents one of the most important findings of this study, as it may threaten the long-term competitiveness and economic sustainability of raspberry production in Serbia.

In contrast to yields, raspberry prices displayed a pronounced positive trend of RSD 14.31/kg per year, with a coefficient of determination of $R^2 = 0.5249$. This result confirms the long-term increase in the market value of raspberries and highlights the important role of market factors in the development of the sector. Rising prices may be associated with the export-oriented nature of Serbian raspberry production, changing supply–demand relationships, and reduced production volumes in certain years.

Table 6. Trend Analysis of Raspberry Production, Yields and Prices in Serbia

Indicator	Trend coefficient	R^2	Interpretation
Acreage (ha)	+595.83	0.6313	Upward trend
Production (t)	+1,462.11	0.2696	Upward trend
Yield (t/ha)	-0.14	0.7466	Downward trend
Price (RSD/kg)	+14.31	0.5249	Upward trend

Source: Authors' calculations based on data from the Statistical Office of the Republic of Serbia.

Overall, the results of the trend analysis indicate the existence of two contrasting tendencies in the development of the Serbian raspberry sector. On the one hand, there has been a long-term increase in prices accompanied by an expansion of production capacity. On the other hand, yields have shown a gradual decline over time. This combination of declining productivity and increasing prices represents one of the most important characteristics of the contemporary development of raspberry production in Serbia

4 Conclusion

The aim of this study was to examine the development trends of raspberry acreage, production, yields, and prices in Serbia during the period 2005–2025, as well as to determine the relationships among the analyzed indicators and assess changes that occurred during different developmental phases of the raspberry sector.

The results indicate that the Serbian raspberry sector has undergone significant structural changes over the observed period. Raspberry acreage and total production increased during most of the study period, while a declining trend

became evident after 2020. At the same time, raspberry prices recorded a substantial increase, whereas yields exhibited a long-term downward trend.

Descriptive statistical analysis revealed that prices showed the highest level of variability, confirming the strong influence of market factors on the development of the sector. The correlation analysis identified a statistically significant positive relationship between acreage and production, as well as a significant negative relationship between yields and raspberry prices. These findings suggest that lower yields may contribute to higher prices through a reduction in market supply.

Trend analysis confirmed the existence of pronounced long-term development tendencies in the analyzed indicators. Of particular importance is the negative yield trend, which points to a gradual decline in production productivity. This finding may be associated with climate change, ageing plantations, and other production constraints affecting the Serbian raspberry sector.

The results of the Mann–Whitney U test indicate that significant changes occurred after 2020, particularly with respect to yields and prices. These findings suggest that the Serbian raspberry sector has entered a new developmental phase characterized by higher market prices but also by more pronounced production challenges.

Overall, the results emphasize that the future development of raspberry production in Serbia should be directed towards improving productivity, renewing plantations, adopting modern production technologies, and strengthening adaptation to climate change. Such measures are essential for maintaining the long-term competitiveness and economic sustainability of Serbian raspberry production in international markets. Although the study was based on aggregated data at the national level, the findings provide a reliable basis for understanding the long-term development trends of the Serbian raspberry sector. Future research should focus on regional analyses and incorporate climatic, economic, and technological factors to provide a more comprehensive understanding of the determinants of the sustainability and competitiveness of raspberry production.

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Conflict of interests

The authors declare no conflict of interest.

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