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2ND INTERNATIONAL CONGRESS ON SUSTAINABLE DEVELOPMENT IN THE HUMAN ENVIRONMENT & CURRENT AND FUTURE CHALLENGES

October 23-26, 2024 – Antalya, TÜRKİYE

PROCEEDINGS BOOK

EDITOR

Prof. Dr. Atılgan ATILGAN

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2nd INTERNATIONAL CONGRESS ON SUSTAINABLE DEVELOPMENT IN THE HUMAN ENVIRONMENT- CURRENT AND FUTURE CHALLENGES

October 23-26, 2024 – Antalya, TÜRKİYE

CONGRESS PROGRAM

Participant Countries: Türkiye (18), Poland (34), Lithuania (9), Hungary (9), Serbia (4), Bosnia and Herzegovina (1), Republic of Croatia (1), Sri Lanka (2), Scotland (1), Ethiopia (1)

23.10.2024
HALL- CRYSTAL BALL ROOM

Ankara Local Time: 14:00

REGISTRATION	14:00 – 17:00
Welcome evening	from 19:00

24.10.2024 PLENARY SESSION HALL- CRYSTAL BALL ROOM

Ankara Local Time: 09:00

REGISTRATION	**9:00-10:00**

OPENING CEREMONY			**10:00-10:30**
PLENARY SESSION I KEYNOTE SPEAKERS **HEAD OF SESSION: Anna Krakowiak-Bal - Roman Rolbiecki**			
Atıf Bayramoğlu	Alanya Alaaddin Keykubat University, Turkiye	**IMPORTANCE OF FIRST AID**	**10:30-11:00**
Leszek Kuchar	Wroclaw University of Environmental and Life Science, Poland	**AGROCLIMATIC CONDITIONS OF CROP PRODUCTION IN POLAND, CURRENTLY AND IN THE COMING YEARS – BASED ON CLIMATIC WATER BALANCE (CWB) AND HYDROTHERMAL COEFFICIENT (HTC)**	**11:00-11:30**
Monika Marković	University of Osijek, Croatia	**IRRIGATION IN CROATIA – CHALLENGES AND PERSPECTIVES**	**11:30-12:00**

24.10.2024 SESSION I
HALL - CRYSTAL BALL ROOM

Ankara Local Time: 13:30-15:00

HEAD OF SESSION I : Atılgan Atılgan- Justyna Bauza-Kaszewska
Time for presentation 15 minutes maximum

Gitana Vyčienė Vilda Grybauskienė	*Lithuanian University of Applied Engineering Sciences*	**ROOFTOP RAINWATER HARVESTING FOR SUSTAINABLE WATER USAGE IN LITHUANIAN FARMS**
Sedat Boyacı Adil Akyüz	*Kırşehir Ahi Evran University Kahramanmaraş Sütçü İmam University*	**EVALUATION OF SOME MEASURES TO INCREASE ENERGY EFFICIENCY IN GREENHOUSES**
Marta Śliwa Katarzyna Glińska-Lewczuk	*University of Warmia and Mazury in Olsztyn*	**PREPARING SOCIETY FOR CLIMATE CHANGE: A METHODOLOGICAL APPROACH TO BUILDING CLIMATE RESILIENCE THROUGH ENVIRONMENTAL VIRTUE ETHICS AND REGIONAL CAPACITY STRENGTHENING**
Ercüment Aksoy	*Akdeniz University*	**INVESTIGATION OF THE RELATIONSHIP BETWEEN NO2, LAND SURFACE TEMPERATURE AND VEGETATION COVER USING LANDSAT-8 AND SENTINEL-5P SATELLITE IMAGES AND GOOGLE EARTH ENGINE: THE CASE OF ANTALYA**
M.H.N. Oshada H.M.A.G.B. Thilakarathne K.G.S. Nirmanee M.K.N. Kumari M.H.J.P. Gunarthna	*Rajarata University of Sri Lanka National Water Supply and Drainage Board*	**GEOSPATIAL TECHNIQUES FOR GROUNDWATER RECHARGE POTENTIAL MAPPING IN SIVALAKULAMA CASCADE, ANURADHAPURA, SRI LANKA**

24.10.2024 SESSION II
HALL - CRYSTAL BALL ROOM

Ankara Local Time: 15:15- 16:45

HEAD OF SESSION II : Antanas Juostas- Joanna Kocięcka Time for presentation 15 minutes maximum		
Ali Gül Sertan Sesveren	Ministry of Agriculture and Forestry Kahramanmaras Sutcu Imam University	**DETERMINANTS OF THE ADOPTION OF PRESSURED IRRIGATION SYSTEMS AND TECHNICAL ISSUES ON RESEARCH IN ANKARA, TÜRKİYE**
Vilda Grybauskiene Gitana Vyciene Paulius Cepas	*Lithuanian University of Applied Engineering Sciences* *Kaunas Educational Center of Technologies*	**RAINWATER STORAGE AND FLOW CONTROL IN GREEN ROOFS' LAYERS**
Servet Tekin Şuanur Paksoy Attila Yazar Yeşim Bozkurt Çolak Sunay Tekin	*Kahramanmaraş Sütçü İmam University* *Cukurova University* *Malatya Turgut Ozal University* *TARSİM Adana Regional Directorate*	**EFFECT OF MOLECULAR OSCILLATION TECHNOLOGY USED IN DRIP IRRIGATION SYSTEMS ON FLOW CHANGE RATE AND COEFFICIENT VARIATION**
Kęstutis Romaneckas Austėja Švereikaitė Rasa Kimbirauskienė Aušra Sinkevičienė Algirdas Jasinskas Jovita Balandaitė	*Vytautas Magnus University*	**IMPACT OF VEGETATIVE PERIOD HUMIDITY ON THE FUEL CONSUMPTION, ENERGY AND GHG INDICES IN MAIZE-LEGUMES INTERCROPPED CULTIVATIONS**
Árpád Illés János Nagy Adrienn Széles Endre Harsányi Brian Ssemugenze Akasairi Ocwa Csaba Bojtor	*University of Debrecen*	**ANALYSIS OF THE RELATIONSHIP BETWEEN FLIGHT PARAMETERS, NUTRIENT LEVELS AND HYBRIDS IN A SMALL PLOT FIELD EXPERIMENT USING A MULTISPECTRAL UAV**
Algirdas Jasinskas Gvidas Gramauskas Rolandas Domeika Edvardas Vaiciukevičius Kęstutis Romaneckas	*Vytautas Magnus University*	**INVESTIGATION AND ANALYSIS OF INVASIVE PLANTS PROCESSING AND UTILIZATION FOR THE PRODUCTION OF PRESSED BIOFUEL**

24.10.2024 SESSION III
HALL - CRYSTAL BALL ROOM

Ankara Local Time: 17:00- 18:30

HEAD OF SESSION III : Adrienn Széles- Mirosław Kobierski
Time for presentation 15 minutes maximum

Vyacheslav Savinov	*Yu.M. Potebni ZNU*	**INFLUENCE OF MAGNETIC FIELDS ON THE OPERATION OF INTERNAL COMBUSTION ENGINES BY CHANGING THE FUEL STRUCTURE**
Joanna Kocięcka Marcin Stróżecki Radosław Juszczak Daniel Liberacki	*Poznań University of Life Sciences*	**HOW SUBIRRIGATION AND SILICON APPLICATION CAN AFFECT BIOMASS YIELD AND CARBON DIOXIDE BALANCE OF A THREE-CUT MEADOW?**
Meysam Soleimani	*Bursa Technical University*	**SHOVADAN; A NETWORK OF UNDERGROUND PRIVATE AND PUBLIC SPACES**
Onur Özbaş Duygu Arslan Nazlı Erdoğan Hakan Aktaş	*Enza Zaden Turkey Research & Development* *Isparta University of Applied Sciences*	**THE EFFECT OF OLD-GOLD CRIMSON (ogc-1), hp-1 and hp-2 GENES ON LICOPENE CONTENT IN F1 HYBRID TOMATO LINES**
Abdilgefar Kemal Berhanu Bekele Wondimu Ayele Bogale Wolde Tagesse Tadesse	*Wachemo University*	**REPRODUCTIVE STATUS AND BREEDING PRACTICES IN DAIRY COWS IN CENTRAL ETHIOPIA**
Atılgan Atılgan Hasan Ertop Burak Saltuk	*Alanya Alaaddin Keykubat University* *Ministry of Agriculture and Forestry*	**CALCULATION OF THE DISTRIBUTED POLLUTANT LOAD OF ANIMAL WASTES: THE CASE OF CATTLE**

25.10.2024 PLENARY SESSION HALL - CRYSTAL BALL ROOM

Ankara Local Time: 10:00- 11:30

PLENARY SESSION II KEYNOTE SPEAKERS HEAD OF SESSION: Hakan Aktas - Arkadiusz Migdalski			
Antanas Juostas	Vytautas Magnus University, Lithuania	**INNOVATIVE TECHNOLOGIES FOR SMART AGRICULTURE**	**10:00-10:30**
Éva Horváth	University of Debrecen, Hungary	**ANALYSIS OF AGRICULTURAL LAND USE OF HUNGARY (2000–2020)**	**10:30-11:00**
Tomasz Jakubowski	University of Agriculture in Krakow, Poland	**MAGNETIC FIELD AS A PHYSICAL FACTOR IN THE STIMULATION OF SEED MATERIALS**	**11:00-11:30**

25.10.2024 SESSION IV
HALL - CRYSTAL BALL ROOM

Ankara Local Time: 13:00 – 14:30

HEAD OF SESSION IV: Csaba Juhász- Eglė Jotautienė Time for presentation 15 minutes maximum		
Roman Rolbiecki Stanisław Rolbiecki Hicran Sadan-Ozdemir Anna Figas Dorota Wichrowska Barbara Jagosz Anna Krakowiak-Bal Piotr Stachowski Wiesław Ptach Daniel Liberacki Ferenc Pal-Fam Atilgan Atilgan	*Bydgoszcz University of Science and Technology* *University of Agriculture in Krakow* *Poznań University of Life Sciences* *Warsaw University of Life Sciences* *Szent István University* *Alanya Alaaddin Keykubat University*	**THE GROWTH AND YIELD OF CHOSEN EUROPEAN ASPARAGUS CULTIVARS AS EFFECTED BY SUBSURFACE DRIP IRRIGATION UNDER VERY LIGHT SOIL CONDITIONS IN THE KUYAVIA REGION IN POLAND**
Péter Zagyi Éva Horváth Károly Simon Ibtissem Balaout Adirenn Széles	*University of Debrecen*	**DYNAMICS OF MAIZE EMERGENCE, DEVELOPMENT AND YIELD AT DIFFERENT SOWING TIMES**
Vivien Pál László Zsombik	*University of Debrecen*	**THE ROLE OF OIL RADISH (*RAPHANUS SATIVUS* CONVAR. OLEIFERUS) GREEN MANURE IN CROP ROTATION**
Ceyhun Emir Nazlı Erdoğan Gülnur Aydın Hakan Aktaş	*Isparta University of Applied Sciences*	**DETERMINATION OF PUMPKIN VARIETY CANDIDATES SUITABLE FOR ROOTSTOCK**
Eglė Jotautienė Rolandas Domeika Davut Karayel Antanas Juostas Ramūnas Mieldažys	*Vytautas Magnus University*	**ORGANIC GRANULAR FERTILIZERS FROM AGRICULTURE WASTE FOR SUSTAINABLE ENVIRONMENT**
Hakan Kavur Ozan Artun	*Çukurova University*	**INVESTIGATION OF WEST NILE VIRUS CURRENT STATUS IN EAST MEDITERRANEAN REGION BY USING GIS**

25.10.2024 SESSION V
HALL - CRYSTAL BALL ROOM

Ankara Local Time: 14:45 – 16:15

HEAD OF SESSION V: Anna Baryła- Kęstutis Romaneckas
Time for presentation 15 minutes maximum

Csaba Juhász Margit Nagy Nóra Mendler-Drienyovszki Katalin Magyar-Tábori László Zsombik	*University of Debrecen* *Plant and Soil Protection Directorate of Szabolcs-Szatmár-Bereg County Government Office* *Institutes for Agricultural Research and Educational Farm*	**EFFECT OF POSTEMERGENTLY APPLIED HERBICIDES ON THE DEVELOPMENT OF SWEET WHITE LUPINE (*LUPINUS ALBUS* L.).**
Hüsne Gök Olgaç Hakan Polatcı	*Kahramanmaraş Sütçü İmam University* *Tokat Gaziosmanpaşa University*	**DRYING PEACH AND APRICOT PULPS UNDER DIFFERENT CONDITIONS AND DETERMINING QUALITY PARAMETERS**
Csaba Bojtor János Nagy Adrienn Széles Endre Harsányi Brian Ssemugenze Akasairi Ocwa Árpád Illés	*University of Debrecen*	**NITROGEN USE EFFICIENCY OF MAIZE IN DIFFERENT FERTILISATION LEVELS BASED ON LONG-TERM FIELD EXPERIMENT**
Atılgan Atılgan Yücel Çardakçı Coşkun Harmanşah	*Alanya Alaaddin Keykubat University* *İzmir Directorate of Provincial Agriculture and Forestry* *Ege University*	**MECHATRONIC SYSTEMS AND ARTIFICIAL INTELLIGENCE IN THE FUTURE OF ANIMAL PRODUCTION**
Yücel Çardakçı	*İzmir Directorate of Provincial Agriculture and Forestry*	**ANALYZING THE EXPECTATIONS OF AGRICULTURAL STRATEGY TARGETS FOR IZMIR WITHIN THE FRAMEWORK OF ECOLOGICAL AGRICULTURAL MARKETING WITH PLM METHODOLOGY**
Murat Can Fırat Arslan Hasan Değirmenci Müge Kirmikil	*State Hydraulic Works* *Alanya Alaaddin Keykubat University* *Kahramanmaraş Sütçü İmam University* *Bursa Uludag University*	**CAN THE NEW SHAPE INDEX BE USED IN THE EVALUATION OF PROJECTS UNDERTAKEN BY STATE HYDRAULIC WORKS?**

25.10.2024 SESSION VI
HALL - CRYSTAL BALL ROOM

Ankara Local Time: 16:30 – 18:00

HEAD OF SESSION VI: Eva Horvath- Mateusz Malinowski Time for presentation 15 minutes maximum		
Edita Abalikštienė Vilma Šalkauskienė	*Lithuanian University of Applied Engineering Sciences*	**INVESTIGATING WATERLOGGED LAND AREAS IN LITHUANIA**
Katarzyna Glińska-Lewczuk K.G.S. Nirmanee Nadeeka Kumari Janaka Gunarathna Paweł Burandt	*University of Warmia and Mazury in Olsztyn* *Rajarata University of Sri Lanka*	**ISOTOPIC TRACERS (δ18O AND δ2H) AS A TOOL SUPPORTING WATER MANAGEMENT IN SRI LANKA'S DRY ZONE**
Ceyhun Emir Nazlı Erdoğan Gülnur Aydın Hakan Aktaş	*Isparta University of Applied Sciences*	**DETERMINATION OF PUMPKIN VARIETY CANDIDATES SUITABLE FOR ROOTSTOCK**
Ercüment Aksoy Atılgan Atılgan Hasan Ertop	*Akdeniz University* *Alanya Alaaddin Keykubat University* *Ministry of Agriculture and Forestry*	**INVESTIGATION OF DROUGHT EFFECT OF METEOROLOGICAL AND FIELD DATA USING GOOGLE EARTH ENGINE AND EARTH OBSERVATION TECHNOLOGIES: ALANYA CASE**
Agit Ferhat Özel Gamze Turun	*Altınbaş University* *Yıldız Technical University*	**SUSTAINABLE EDUCATION MATERIALS**
Tomasz Piotrowski	*Biostyma Company, Poland*	**COOPERATION OF BIOSTYMA COMPANY WITH THE BYDGOSZCZ UNİVERSITY OF SCIENCE AND TECHNOLOGY**

25.10.2024 SESSION VI POSTERS
HALL - ANATOLIA ROOM

Ankara Local Time: 18:00 – 19:00

POSTER PRESENTATIONS

HEAD OF SESSION: Krzysztof Buczkowski - Ulas Senygit

18:30 session's summary, presence of the Authors is mandatory

Posters in pptx format will be displayed throughout the Congress days in the Anatolia room

Anna Figas Roman Rolbiecki Stanisław Rolbiecki Barbara Jagosz Ariel Łangowski Hicran Sadan Ferenc Pal-Fam Atilgan Atilgan	*Bydgoszcz University of Science and Technology* *University of Agriculture in Krakow* *Hungarian University of Agriculture and Life Sciences* *Alanya Alaaddin Keykubat University*	**RESOURCE-EFFICIENT IRRIGATION MANAGEMENT OF *SILPHIUM PERFOLIATUM* L. FOR ENERGY PRODUCTION: WATER NEEDS AND RAINFALL DEFICITS**
Krystian Obolewski	*Kazimierz Wielki University*	**ARTIFICIAL INTELLIGENCE IN ORGANISM IDENTIFICATION AS A NEXT-GENERATION BIOMONITORING TOOL**
Anna Figas Stanisław Rolbiecki Roman Rolbiecki Barbara Jagosz Anna Krakowiak-Bal Atilgan Atilgan	*Bydgoszcz University of Science and Technology* *University of Agriculture in Krakow* *Alanya Alaaddin Keykubat University*	**IMPACT OF CULTIVATION CONDITIONS ON ENERGY PROPERTIES OF CUP PLANT *SILPHIUM PERFOLIATUM* L.- POLAND CASE STUDY**
Anna Baryła Agnieszka Karczmarczyk Agnieszka Bus	*Warsaw University of Life Sciences (SGGW)*	**HOW GREEN ROOFS CAN HELP COOL CITIES**
Monika Marković Marko Josipović Željko Barač Danijel Jug Atilgan Atilgan	*Josip Juraj Strossmayer University of Osijek* *Agricultural Institute Osijek, Department for Agricultural Technique and Amelioration* *Alanya Alaaddin Keykubat University*	**THE IRRIGATION WATER REQUIREMENTS OF THE MAIN SUMMER CROPS IN THE CONTINENTAL REGION OF THE REPUBLIC OF CROATIA**
Péter Streb János Nagy Éva Horváth Adrienn Széles	*University of Debrecen*	**ANALYSIS OF AGRICULTURAL LAND USE OF HUNGARY (2000–2020)**
S.H.S.R. Silva L.S.B. Dhanapala M.H.J.P. Gunarthna G.Y. Jayasinghe	*Rajarata University of Sri Lanka*	**MODELING HYDROLOGICAL PARAMETERS USING SOIL AND WATER ASSESSMENT TOOL (SWAT) IN THE NILWALA RIVER BASIN OF SRI LANKA**
Jędrzejczyk Iwona Rewers Monika Łojko Agnieszka	*Bydgoszcz University of Science and Technology*	**GENOME SIZE DIVERSITY OF THE SELECTED PHACELIA SPECIES**
Péter Balogh László Huzsvai Csaba Juhász Péter Czine	*University of Debrecen*	**CONSUMER PREFERENCES FOR CULTURED PORK MEAT: A COMPARATIVE STUDY OF CZECH AND HUNGARIAN MARKETS**

László Huzsvai Péter Balogh Csaba Juhász Péter Czine	*University of Debrecen*	**INVESTIGATING HUNGARIAN FARMERS' PREFERENCES TOWARDS SPRAYING DRONES**
Péter Czine Zsanett Blága Péter Balogh Béla Juhász	*University of Debrecen* *University Pharmacy*	**EXAMINATION OF PREFERENCES FOR VACCINES- A HYBRID CHOICE APPROACH**
Agnieszka Karczmarczyk Anna Baryła	*Warsaw University of Life Sciences*	**RETHINKING GREEN ROOF DESIGN**
Željko Barač Monika Marković Tomislav Jurić Ivan Plaščak Atilgan Atilgan	*Josip Juraj Strossmayer University of Osijek* *Alanya Alaaddin Keykubat University*	**NEGATIVE IMPACT ON THE OPERATOR'S HEALTH FROM THE ASPECT OF ENVIRONMENTAL POLLUTION**
Piotr Prus Małgorzata Szczepanek Dariusz Pańka	*Bydgoszcz University of Science and Technology*	**THE ROLE OF INNOVATION IN ADAPTING AGRICULTURE TO CHANGES IN THE AGRIBUSINESS SECTOR**
Mirjana Zorić Tatjana Veselinović Gordana Mrdak Vladimir Sabadoš	*Agriculture Extension Service "Sombor"*	**TESTING THE EFFECTIVENESS OF HERBICIDES APPLIED TO THE SUNFLOWER CROP**
Tamás Rátonyi Tamás András Péter Fejér Éva Horváth Adrienn Kakuszi-Széles Péter Ragán Csaba Bojtor Árpád Illés Csaba Juhász Enikő Somogyi Endre Harsányi	*University of Debrecen*	**EVALUATION OF SOIL MOISTURE DYNAMICS IN A LONG-TERM FIELD EXPERIMENT SET UP ON CHERNOZEM SOIL**
Jacek Frasz	*Władysław Biegański Regional Specialist Hospital*	**AN INCREASE IN THE NUMBER OF REVISIONAL BARIATRIC SURGERIES**
Anita Woźny Patryk Czerwiński	*Bydgoszcz University of Science and Technology*	**THE THERAPEUTIC IMPORTANCE OF GREENERY IN THE HUMAN ENVIRONMENT**
Mateusz Malinowski Zuzanna Basak Tomasz Jakubowski Atılgan Atılgan	*University of Agriculture in Krakow* *Alanya Alaaddin Keykubat University*	**ANALYSIS OF THE HYBRID DRYING PROCESS OF APPLE POMACE**
Vytaute Juodkiene Irena Tulabiene	*Kauno kolegija Higher Education Institution*	**RESEARCH AND DIGITAL MODELLING OF ENVIRONMENTAL NOISE**
Anetta Siwik-Ziomek Renata Kuśmierek-Tomaszewska	*Bydgoszcz University of Sciences and Technology*	**RESPONSES OF SOIL ENZYMES TO SPRINKLER IRRIGATION AND DIFFERENTIATED NITROGEN FERTILIZATION IN BARLEY CULTIVATION**
Jelena Ivan Zoran Boca Olivera Sekulić Vladimir Sabadoš	*Agriculture Extension Service "Sombor"*	**THE EFFECTS OF AGRICULTURAL PRACTICES ON SOYBEAN YIELD IN SOMBOR REGION IN SERBIA IN 2014 – 2023 PERIOD**
Jacek Leśny Beata Olszewska Monika Panfil	*Wrocław University of Environmental and Life Sciences* *Local Education Authority Wrocław*	**COULD THE LOCAL WATER PARTNERSHIP IN LOWER SILESIA MITIGATE THE EFFECTS OF THE FLOOD IN 2024?**

Roman Rolbiecki Krzysztof Buczkowski Arkadiusz Migdalski Jacek Frasz Michał Miszewski Jacek Wróbel Piotr Dunal	*Bydgoszcz University of Science and Technology* *L. Rydygier Collegium Medicum in Bydgoszcz* *Regional Specialist Hospital 'Lombard' Jack Sparrow Company*	**CURRENT CHALLENGES OF SUSTAINABLE DEVELOPMENT IN HUMAN ENVIRONMENT- POLAND CASE STUDY**
Olivera Sekulić Vladimir Sabadoš Danijela Žunić Jelena Ivan Zoran Boca	*Agriculture Extension Service "Sombor"*	**THE IMPORTANCE OF OLD VARIETIES IN CONDITIONS OF CLIMATE CHANGE**
Anna Krakowiak-Bal Dorota Lech	*University of Agriculture in Krakow*	**IMPACT OF TRANSPORT ACCESSIBILITY ON THE RURAL DEVELOPMENT- CASE STUDY FROM POLAND**
Joanna Kocięcka Daniel Liberacki Piotr Stachowski Michał Napierała	*Poznań University of Life Sciences*	**GREEN ROOFS AS A SOLUTION FOR RAINWATER RETENTION IN URBAN AREAS**
Aleksandra Rolbiecka	*LPP Scotland*	**THE MOST COMMON MISTAKES IN WRITING RESEARCH ARTICLES IN ENVIRONMENTAL AND HEALTH STUDIES**
Ali Çaylı Duran Güleç Fatma Akpınar	*Kahramanmaraş Sütçü İmam University*	**EFFECTS OF CLIMATIC CONDITIONS ON BROILERS: A COMPREHENSIVE REVIEW OF THERMAL MANAGEMENT AND PRODUCTION PERFORMANCE**
Vladimir Sabadoš Danijela Žunić	*Agriculture Extension Service "Sombor"*	**VALUE OF pH REACTION AGRICULTURE LAND IN SOMBOR REGION IN SERBIA**
Rewers Monika Gierwatowska Julia Jędrzejczyk Iwona	*Bydgoszcz University of Science and Technology*	**THE EFFECT OF MELATONIN ON POLYSOMATIC AND NON-POLYSOMATIC SEEDS GERMINATION**
Anna Goździejewska Katarzyna Glińska-Lewczuk Marek Kruk Ireneusz Cymes	*University of Warmia and Mazury in Olsztyn*	**ZOOPLANKTON- A ROBUST INDICATOR OF LAND USE IN A RIVER CATCHMENT**
Dawid Mazur	*Bydgoszcz University of Science and Technology*	**FUTURE OF PHOTOVOLTAICS**
Justyna Bauza-Kaszewska Barbara Breza-Boruta Jakub Biesek	*Bydgoszcz University of Science and Technology*	**ALUMINOSILICATES APPLICATION AS A METHOD OF DRY SANITISATION OF LITTER IN SLAUGHTER CHICKEN PRODUCTION**
Jakub Frasz	*Nicolaus Copernicus University in Toruń*	**THE MOST COMMON INJURIES IN MIXED MARTIAL ARTS AND THEIR CONSEQUENCES**
Piotr Ignaczak	*Department of Rheumatology and Connective Tissue Diseases, Jan Biziel University Hospital No. 2 in Bydgoszcz and Intercor Medical Center*	**(MULTİ) VİTAMİN D. MULTİ-ORGAN EFFECTS OF VİTAMİN D AND THE ROLE OF SUPPLEMENTİNG İTS DEFİCİENCY İN HUMANS**
Krzysztof Buczkowski Elwira Piszczek Agnieszka Buczkowska Arkadiusz Migdalski Sandra Janiak	*Nicolaus Copernicus University Poznan University of Medical Sciences*	**FACTORS RELATED TO PARENTAL VACCINE HESITANCY- QUALITATIVE STUDY**
Krzysztof Kwaśniewski, Arkadiusz Migdalski	*Department of Vascular Surgery and Angiology, Nicolaus Copernicus University in Toruń, Poland*	**D-DİMER-TO-FİBRİNOGEN-RATİO İN PATİENTS WİTH SYMPTOMATİC AND ASYMPTOMATİC CAROTİD STENOSİS UNDERGOİNG CAROTİD ENDARTERECTOMY OR STENTİNG**

Maciej Kawczyński Klaudia Górnostaj Joanna Olejnik-Wojciechowska Joanna Wielopolska Katarzyna Radomska Elżbieta Petriczko	*Department of Otolaryngology for Adults and Children and Otolaryngological Oncology, Pomeranian Medical University, Szczecin,* *Department of Pediatrics, Endocrinology, Diabetology, Metabolic Disorders and Cardiology of the Developmental Age, Pomeranian Medical University, Szczecin,*	**INTERDISCIPLINARY MANAGEMENT OF LİFE-THREATENİNG SEVERE OBESİTY İN CHİLDREN**
Joanna Kocięcka Atılgan Atılgan Teerachai Amnuaylojaroen Mariusz Ptak Nefise Yasemin Tezcan Mariusz Sojka	*Poznań University of Life Sciences,* *Alanya Alaaddin Keykubat University* *University of Phayao* *Adam Mickiewicz University* *Akdeniz University*	**PAST CHANGES AND FUTURE PREDİCTİONS HEAT WAVES (POLAND AND TURKEY CASE STUDY)**
Adam Rolbiecki	*Bydgoszcz University of Science and Technology*	**DETECTION AND ANALYSIS OF EMOTIONS BASED ON FACIAL EXPRESSIONS USING A MOBILE APPLICATION**
Stanisław Rolbiecki Roman Rolbiecki Barbara Jagosz Wiesława Kasperska-Wołowicz Ewa Kanecka-Geszke Hicran Sadan-Ozdemir Ariel Łangowski Małgorzata Szczepanek Renata Kuśmierek-Tomaszewska Jacek Żarski	*Bydgoszcz University of Science and Technology in Bydgoszcz,* *University of Agriculture in Krakow* *Poland Institute of Technology and Life Sciences*	**THE INFLUENCE OF CLIMATE CHANGE ON WATER REQUIREMENTS IN THE CULTIVATION OF *CUCURBITA PEPO* L. IN CENTRAL POLAND**
Urszula Ziemiańczyk	*University of Agriculture in Krakow*	**EXPLORING THE WELL-BEING NEEDS: A PERMA MODEL APPROACH**
Mirosław Kobierski, Krystyna Kondratowicz-Maciejewska, Mateusz Pawłowski, Beata Łabaz	*Bydgoszcz University of Science and Technology in Bydgoszcz* *Wroclaw University of Environmental and Life Sciences*	**IMPACTS OF AGRICULTURAL PRACTICES ON PROPERTIES AND HUMUS CONTENT OF FLOODPLAIN SOILS**

25.10.2024 Farewell evening
HALL - CRYSTAL BALL ROOM

Ankara Local Time: 19:00

26.10.2024
Study tour

Ankara Local Time: 10:00

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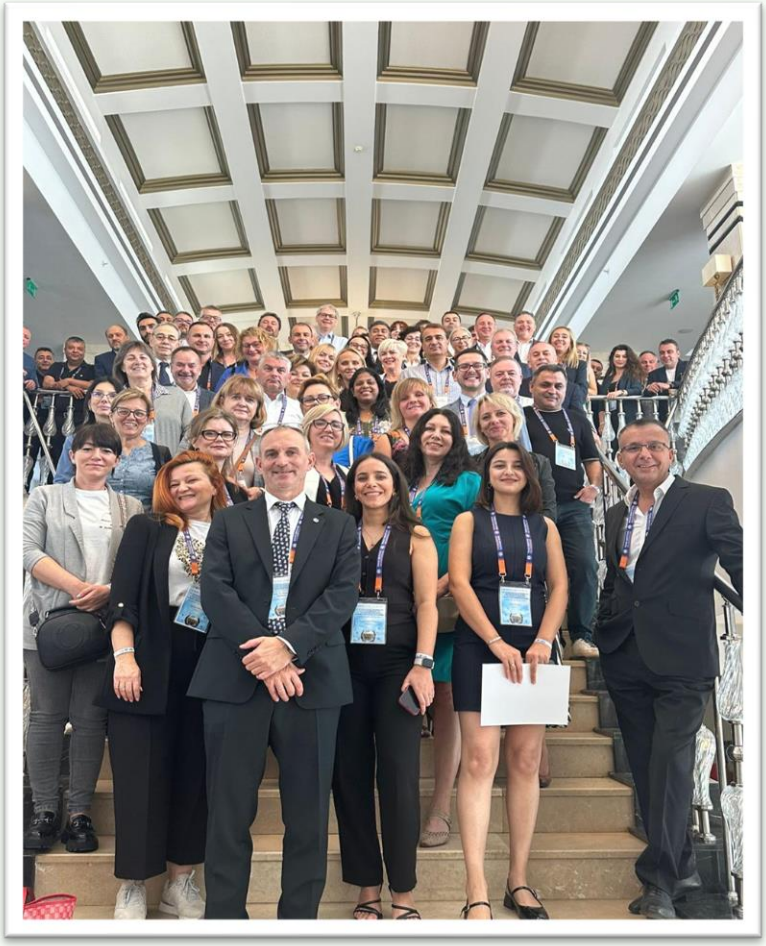

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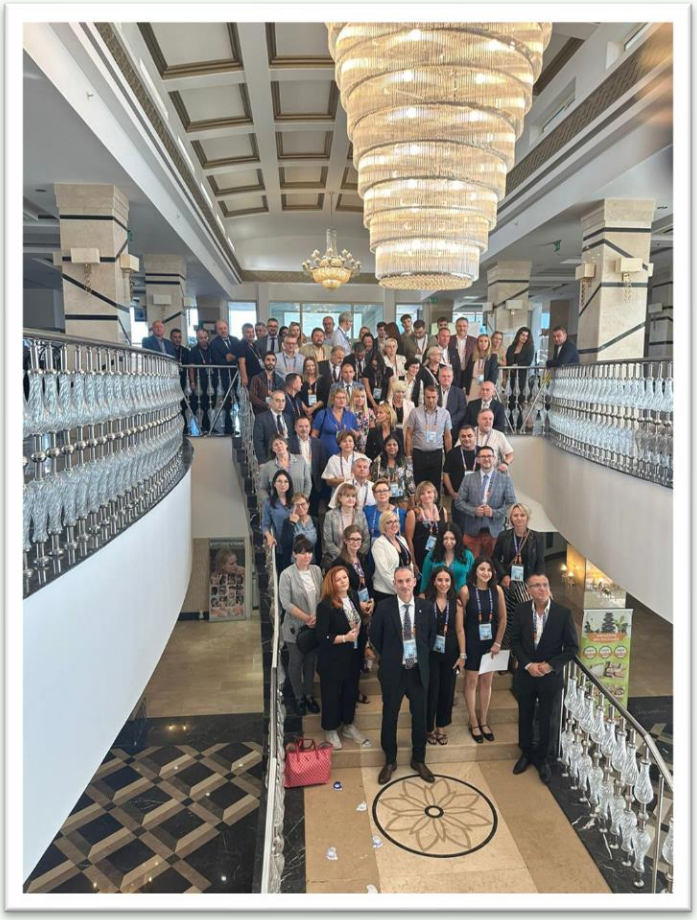

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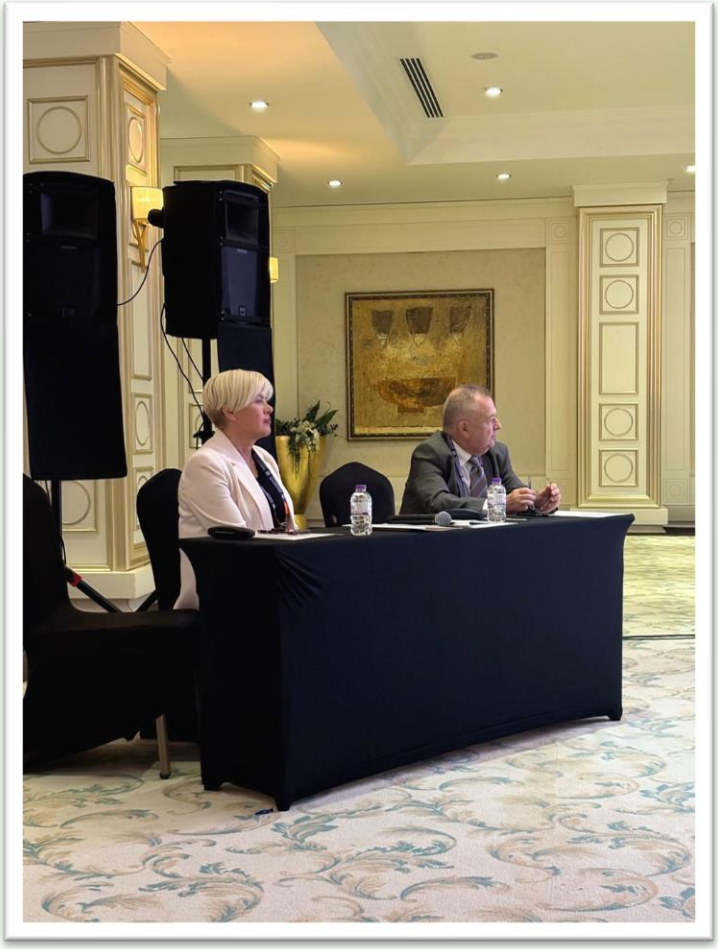

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RESOURCE-EFFICIENT IRRIGATION MANAGEMENT OF *SILPHIUM PERFOLIATUM* L. FOR ENERGY PRODUCTION: WATER NEEDS AND RAINFALL DEFICITS

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ABSTRACT
Among its various applications, the cup plant (*Silphium perfoliatum* L.) is particularly intriguing for its potential in biomass production for energy purposes, including biofuel manufacturing and thermal energy generation. This species primarily thrives in habitats with high air and soil humidity. Rainfall deficits are common throughout Poland, especially in central regions, necessitating crop irrigation. To design and manage resource-efficient irrigation systems for cup plant energy plantations, it is essential to estimate water needs and rainfall deficits in their cultivation. The research aims to assess water needs, rainfall deficits, and their temporal and spatial variations for cup plants in energy plantations across four provinces of central Poland from 1981 to 2020. The study focused on the growing season, which for cup plants is from April 1st to September 30th. Water requirements were evaluated using potential evapotranspiration and the plant coefficient derived from reference evapotranspiration. The Ostromęcki method was utilized to assess rainfall deficits. The research results revealed varying water needs values depending on the province, with the highest monthly water requirement occurring in July. Over the forty-year analysis period, a notable upward trend in water needs was observed across all provinces during the growing season. From April 1st to September 30th, rainfall deficits were observed in all central Polish provinces during normal, medium-dry, and very dry years. The results obtained in this research are crucial for planning, constructing, and managing irrigation systems for cup plant energy plantations in central Poland. Understanding water needs and rainfall deficit in cup plant cultivation will enable precise estimation of water reservoir sizes, which are fundamental elements of any irrigation network, which can consequently lead to reduced investment costs by optimizing water consumption.
Keywords: biomass, cup plant, evapotranspiration, precipitation deficit, sustainable agriculture, water requirements.

ARTIFICIAL INTELLIGENCE IN ORGANISM IDENTIFICATION AS A NEXT-GENERATION BIOMONITORING TOOL

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ABSTRACT
Aquatic insects and other benthic macroinvertebrates are widely used as bioindicators of freshwater ecological status. However, the time and cost-intensive process of species identification poses a significant challenge to reliable next-generation biomonitoring (NGB) of aquatic ecosystems globally. This study presents a deep learning (DL) - based method for species identification of Chironomidae larvae, utilizing information from publicly available datasets. Transfer learning was implemented using a deep convolutional neural network (CNN) pre-trained on multiple larval images. This method facilitated accurate determinations of the taxonomic composition of Chironomidae, which were then used to establish values for monitoring indicators. Thus, a new tool leveraging artificial intelligence capabilities has been proposed for identifying insects and other groups of organisms. This innovative approach is poised to revolutionize the field of biomonitoring, particularly with the forthcoming implementation of the EU Biodiversity Strategy 2030, where precise knowledge of the taxonomic diversity of biocenoses will be foundational.
Keywords: indicators, mechanic lerning, deep lerning, identification

IMPACT OF CULTIVATION CONDITIONS ON ENERGY PROPERTIES OF CUP PLANT SILPHIUM PERFOLIATUM L. - POLAND CASE STUDY

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ABSTRACT
Perennial energy crops (PECs) can have a positive impact on the functioning of ecosystems in Central and Eastern Europe, contributing to a more environmentally friendly production of renewable resources, and providing an alternative to intensive maize cultivation for energy purposes. One of such plants is the cup plant *Silphium perfoliatum* L. It is a potentially valuable material that can be used in many ways, both as a source of biomass for energy production, valuable feed for cattle, and in recultivation, phytoremediation and beekeeping. The possibilities of its use, the size and quality of the yield depend largely on the growing conditions, such as irrigation, fertilization, and climatic conditions. In nature, the cup plant grows mainly in habitats with high air and soil humidity. Long-lasting periods of drought cause the dying of lower leaves and turning buds brown, and in extreme cases, might cause growth inhibition in *S. perfoliatum.* This research aims to analyze the impact of various cultivation conditions on the yield and energy parameters of biomass of the cup plant. Cultivation conditions include drip irrigation and fertigation with magnesium sulfate. Research material was collected from experimental field located in Central Poland. The results confirmed that, depending on the irrigation and fertilization doses used, the average annual yield of green biomass is approximately 60-68 $Mg \cdot ha^{-1}$, and the amount of obtained biogas exceeds 4 500 m^3.
Keywords: cup plant *Silphium perfoliatum* L., cultivation conditions, drip irrigation; biomass, calorific value

HOW GREEN ROOFS CAN HELP COOL CITIES

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ABSTRACT
Population growth in cities causes a number of problems and threats that are amplified by observed and projected climate changes. The most dangerous are extreme meteorological and hydrological phenomena, which include high air temperatures, rainstorms causing floods and flooding, and long periods without precipitation causing droughts. One of the solutions to lowering the temperature in urban areas may be green roofs. The aim of the study was to compare changes in the surface temperature of green roofs with those of a conventional roof. The research was carried out from May to August 2023 on models of green roofs covered with a flower meadow, sedum and a conventional roof. The measurement was performed using the FLIR SC620 thermal imaging system, and the surface temperature reduction index (STR) was determined. In the summer months, the differences between the temperature of a green roof and a conventional roof amounted to a maximum of 30°C. During the summer, both the average and maximum surface temperature of green roofs were significantly lower than the conventional roof, because STRav and STRmax were invariably smaller than the unit value. The obtained results showed that the roof with vegetation can significantly contribute to the mitigation of the urban heat island phenomenon in urban areas during summer periods.
Keywords: green roof, conventional roof, surface temperature, thermograms.

THE GROWTH AND YIELD OF CHOSEN EUROPEAN ASPARAGUS CULTIVARS AS EFFECTED BY SUBSURFACE DRIP IRRIGATION UNDER VERY LIGHT SOIL CONDITIONS IN THE KUYAVIA REGION IN POLAND

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ABSTRACT
Irrigation, used to compensate for periodic deficiencies in precipitation, allows for high and good quality crops for many species, and also keeps soil in good condition. The objective of this study was to verify the response of 10 European asparagus cultivars grown for green spear production using subsurface drip irrigation. The field experiment was carried out in 2006–2008 on a very light sandy soil in Kuyavia region in Poland. Irrigation treatments were applied using the tensiometer indications. Water needs of asparagus were calculated on the base of reference evapotranspiration and crop coefficients. The following evaluations were made: height, diameter and number of summer stalks, as well marketable yield, weight and number of green spears. Drip irrigation applied for two years in the post-harvest period, had a positive effect on all studied traits, both summer stalks and green spears in 2007–2008. A significant increase in the height, number and diameter of summer stalks, as well as an increase in the marketable yield, weight and number of green spears was observed for most of the cultivars. Both factors, the irrigation used, and the asparagus cultivars significantly modified the antioxidant content in asparagus spears. The Rapsody cultivar accumulated significantly more, and the Grolim cultivar significantly less, total polyphenols in asparagus spears at unirrigated plots. An inverse relationship was obtained in the Grolim cultivar with respect to the content of vitamin C, which accumulated the most of it under the irrigation conditions. The Ramada cultivar from irrigated plots contained significantly the highest amount of total carotenoids. In turn, the Cipres and Grolim cultivars from irrigated plots were characterized by the highest antioxidant activity.
Keywords: *Asparagus officinalis* L.; cultivars; irrigation; spears yield; light soil; water needs; water use efficiency.

THE IRRIGATION WATER REQUIREMENTS OF THE MAIN SUMMER CROPS IN THE CONTINENTAL REGION OF THE REPUBLIC OF CROATIA

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ABSTRACT
In 2005, the National Project of Irrigation and Land and Water Management in the Republic of Croatia was launched with the aim of increasing irrigated areas, changing the sowing structure, increasing the efficiency of plant production and to mitigate the negative consequences of climate change. The total area of public irrigation schemes that have been implemented, are being implemented or have been rehabilitated is 16.382 ha, until year 2020. The most irrigated crops are field crops: seed corn, soybeans, sunflowers (sprinkler system), vegetables and orchards (dripping system). In the past two decades, frequent changes of extremely rainy and dry years have been recorded on the territory of continental Croatia, where it is important to point out that even during wet years there are dry periods, most often during June and July, which certainly makes crop production difficult. Irrigation water requirement (IWR) is determined by CROPWAT 8.0 computer model. As an example, the soil of silty clay loam was taken, while the weather conditions represent the long-term average (1960-1990) for the observed area. Effective rainfall according to the FAO/AGWL method is 273 mm, while the average evapotranspiration is 1.71 mm/day. The crop water requirements (CWR) for observed crops are: 241 mm (maize), 223 mm (soybean), 255 mm (sunflower), 314 mm (sugar beet), 330 mm (cabbage), 282 mm (pepper), 323 mm (tomato), 269 mm (melon), and 263 mm (tobacco). The IWR for summer crops are as follows: 143 mm (maize), 131 mm (soybean), and 144 mm (sunflower), 189 mm (sugar beet), 194 mm (cabbage), 165 mm (pepper), 197 mm (tomato), 154 mm (melon) and 154 mm (tobacco).

Keywords: crop water requirements, irrigation requirements, summer crops

A COMPREHENSIVE STUDY ON CLIMATE CHANGE IN BOSNIA AND HERZEGOVINA

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ABSTRACT
This research contributes a comprehensive analysis of the impact of climate change upon Bosnia and Herzegovina. This research investigates the past trends in climate, the future projection of climatic conditions, and possible environmental, economic, and social impacts in Bosnia. Some of the central findings include: the temperature in Bosnia and Herzegovina rose by 0.8°C over the past 50 years, accompanied by more frequent heat waves and a more extreme trend. Precipitation patterns have become more irregular, with longer periods of drought followed by heavier rainfall, leading to floods. Climate change is likely to reduce agricultural production, elevate the chances of forest fires, and threaten biodiversity in the mountainous parts of the country. Among the social and economic consequences are threats to the security of water and food, damage to infrastructure, increased health risks, and pressure on traditional sectors like forestry and tourism. Priority adaptation and mitigation strategies for Bosnia and Herzegovina should center on building resilience and reducing greenhouse gas emissions. This, in turn, will provide an extensive understanding of the problems in climate change facing Bosnia and Herzegovina to policymakers, stakeholders, and the general public and serve as an important source for building effective response measures.
Keywords: Climate change, environment, Bosnia and Herzegovina

ANALYIS OF AGRICULTURAL LAND USE OF HUNGARY (2000–2020)

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ABSTRACT
Hungarian agriculture has undergone significant changes between 2000 and 2020. Only 25% of the 965000 farms active in agriculture in 2000 were in operation in 2020. The number of farms engaged in crop production (273 thousand) has fallen dramatically, by almost half. In the following years, the number of economic organisations increased, and the number of individual farmers decreased significantly. Both for economic organisations and individual holdings, arable crops dominate. The common farm sizes of between 1 and 5 hectares were replaced by medium farm sizes, and these holdings accounted for 57% of the total agricultural area.
The share of arable land decreased from 83% of the country's area (7.7 million hectares) to 78.7%. The share of agricultural land decreased, the share of domestic forest increased, and the share of reed and fishponds remained substantially unchanged. The share of arable land increased, the share of orchards remained similar, while the share of kitchen gardens, vines and grassland decreased. The area sown to wheat and maize is stable (1–1.2 million hectares), but in some years the area sown has fallen below 1 million hectares. The importance of both crops is shown by the fact that, despite fluctuations in area in recent years, a significant proportion of the arable land in Hungary is under wheat (22–23%) and maize (24–26%). The sowing area of sunflower has more than doubled and that of rapeseed has almost tripled. The area under fruit crops and vines has declined sharply. Vegetables have experienced a similar decline as fruit crops. The volume of crops increased steadily, with wheat and maize growing by 41.7% and 71.4% respectively compared with 2000. At the same time, weather extremes caused by climate change have become a growing problem in recent years, leading to an increase in the average yield per hectare.
Keywords*:* land use, land use categories, yield

DYNAMICS OF MAIZE EMERGENCE, DEVELOPMENT AND YIELD AT DIFFERENT SOWING TIMES

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ABSTRACT
The objective was to study the effect of different sowing dates on the emergence dynamics, development and grain yield of maize. Our studies were conducted at the Látókép Experimental Station of the University of Debrecen in a random block design field trial in 2023. Three different sowing times (Sowing time I, Sowing time II, Sowing time III) were used, on 17/04, 24/04 and 23/05, for the H1: FAO 380 and H2: FAO 490 maize hybrid. In the scope of the emergence dynamics study, the first five days of emergence were marked with different colours. SPAD and NDVI were measured in phenological phases V6, V12 and R1. The first plants emerged in sowing period I after 13 days from sowing, with an accumulation of 42.66 °C useful heat. During the first two days of emergence, 76% of the H1 hybrid and 75% of the H2 hybrid sprouted. In sowing period II, 10 days elapsed from sowing to emergence, with a useful heat accumulation of 40.88°C. On the first two days, 84% of hybrid H1 and 88% of hybrid H2 germinated. In sowing period III, the emergence started after day 5 from sowing, by which time the population had accumulated 56.39°C of heat. In the first two days of emergence, 87% of the H1 hybrid and 84% of the H2 hybrid germinated. In the case of hybrid H1, the highest SPAD values in all three phenophases (V6: 42.03, V12: 54.04, R1: 60.14) were measured in the case of sowing time II, which was statistically confirmed in the V12 growth stage. For hybrid H2, the highest SPAD values at six (V6) and twelve leaf (V12) stage were at sowing time III (V6: 46.68, V12: 50.54; $p<0.05$). At 50% silking (R1), the highest SPAD values were detected at sowing time II (59.36). The highest yield of hybrid H1 was in sowing time I (14.959 t ha-1; NS) and of H2 in sowing time II (14.208 t ha-1; NS). It can be stated that the late sowing time was unfavourable for maize. Accurate determination and evaluation of maize emergence and development can help farmers to make timely decisions on the application of further technological treatments to maximize maize yield.
Keywords: Maize, Emergence dynamics, NDVI, SPAD-value, Yield, Sowing time

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CONSUMER PREFERENCES FOR CULTURED PORK MEAT: A COMPARATIVE STUDY OF CZECH AND HUNGARIAN MARKETS

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ABSTRACT
Alternative meat production techniques are considered eco-friendly and sustainable compared to traditional animal slaughter methods. Cultured meat, also known as 'in-vitro meat', involves culturing animal cells externally from the original donor animal. Our research aimed to determine the level of interest in 'cultured pork meat' among Czech and Hungarian consumers. We used a widely applied preference assessment procedure called Best-Worst Scaling and analysed consumer preferences based on seven aspects. These aspects were meat texture, meat from an indigenous breed (not a hybrid or modern breed), meat appearance, meat smell, health impact compared to conventionally produced meat, meat freshness, and taste. In our primary market research, we used a quantitative online representative questionnaire survey in 2022 involving 1600 people (800 people per country) for Czech and Hungarian consumers. Respondents in both countries ranked meat freshness and taste as the two most important aspects. The third and fourth most important aspects were the health impact compared to traditionally produced meat and the smell of the meat, for which the ranking scores were very close. For Czech consumers, these were followed by the appearance of the meat and whether the meat was from a native breed (not a hybrid or modern breed). The texture of the meat was the least important aspect for Czech consumers. On the other hand, Hungarian consumers rated the texture and appearance of the meat very closely, with the last element being whether the meat was from a native breed (non-hybrid or modern breed). Our analysis showed a difference between the preferences of Czech and Hungarian consumers for cultured meat from animals with indigenous genetics and that meat texture is more critical for Hungarians than for Czech consumers.
Keywords: cultured meat, consumer acceptance, Best Worst Scaling

INVESTIGATING HUNGARIAN FARMERS' PREFERENCES TOWARDS SPRAYING DRONES

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ABSTRACT
Efforts and innovations to increase the efficiency of agricultural production have been a major focus of research in recent years. Drones are cutting-edge tools in precision agriculture that significantly enhance sustainable and efficient farming through advanced remote sensing capabilities and flexible usage and performance. Assessing the demand is challenging because profit maximization isn't the primary goal for all farmers. The decision to purchase drones is heavily influenced by subjective factors. However, several authors argue that the age of the farmers and the size of the farm are key determinants. The aim of our research is to investigate the preferences of Hungarian farmers regarding spraying drones. To do this, we conducted a stated choice experiment with 200 farmers, asking them to make multiple choices between three hypothetical spraying drones. Based on the results of the MNL model estimation, the presence of the stock detection attribute, the increase in performance, battery uptime and efficiency have a positive effect on producers' preferences, while the increase in price has a negative effect. Based on our MNL model estimated in a hybrid context (with farmers perceived usefulness of drones in agriculture as a latent variable, measured across four statements), we found that as perceived usefulness towards drones increases, the perceived utility of having the stock detection attribute increases. Integrating vegetation detection into everyday farming practices marks a major advancement towards global food security while reducing agriculture's environmental impact. Our study indicates that financial subsidies can incentivize farmers to adopt new technologies.
Keywords: precision arable farmer; drone technology; hybrid choice modelling; perceived usefulness

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EXAMINATION OF PREFERENCES FOR VACCINES — A HYBRID CHOICE APPROACH

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ABSTRACT
Although the world today may have recovered from the shock and damage caused by the COVID-19 pandemic, the critical years have shown that pandemics cannot be sufficiently managed. Developing and manufacturing vaccines quickly enough and ensuring public acceptance will always be of critical importance in such situations. Therefore, it is crucial to study and understand vaccine preferences as deeply as possible.
The aim of this study is to investigate the preferences of the residents of Debrecen, the second largest city in Hungary, regarding COVID-19 vaccines.
To achieve this, a discrete choice experiment was conducted with 1 011 participants, presenting eight hypothetical decision situations. Each scenario contained three hypothetical vaccine alternatives and one "no choice/do not vaccinate" option. The vaccines were characterized by the following attributes: country of origin, efficiency, side effect, and duration of protection.
The models were estimated using a simple random parameter logit specification and an extended specification incorporating a latent variable (pandemic awareness) — a hybrid choice model.
The model estimates show that vaccines of Hungarian and European origin are most preferred by respondents; as vaccine efficiency increases, respondents' perceived utility of the vaccine increases; short-term side effects are preferred over long-term side effects; and as the duration of protection guaranteed by the vaccine increases, respondents' perceived utility of the vaccine also increases. The model estimated in the latent context indicates that as pandemic awareness increases, vaccine choice (vaccination) becomes increasingly preferred over no-choice (no-vaccination). And the level of pandemic awareness is significantly higher for people with chronic illnesses and lower for those working in the health sector.
The conclusions of this research can contribute to understanding public preferences for vaccines and, through this, to developing appropriate actions to make them more attractive and acceptable to the public.
Keywords: vaccine preferences; hybrid choice modeling; pandemic awareness

ROOFTOP RAINWATER HARVESTING FOR SUSTAINABLE WATER USAGE IN LITHUANIAN FARMS

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ABSTRACT

The rooftop rainwater harvesting means the collection of water from the rooftop of any structure. The tank is the most expensive and critical component of rainwater harvesting system.

The study was conducted at an individual farms in five different Lithuania regions in 2022-2023 years. The aim of the study is to determine the theoretical potential of rainwater collection from the roof of the farm building and selection of the optimal volume of the tank in years of different humidity.

The precipitation data of Lithuanian regions over 10 years was analyzed for the water harvesting potential. In the calculations, water demand for the vegetation period is taken into consideration according to the quantities specified by the farmer.

It is determined that rainwater harvesting potential during the vegetation period is 7.53 m^3 in dry years, which can meet around 24 % of the farm's water needs when the catchment area is 50 m^2. Even in the wettest year, the farm's water demand could be satisfied only for two months. When the catchment area is 200 m^2 over 7 months period, it would be possible to accumulate 40.16 m^3 of water and it would fully satisfy four months water demand of the farms in dry years. In wet years, all accumulated water during the vegetation period can cover all of the farms water demands. Optimal volume of the tank is 11 m^3 for dry and average humidity years, and up to 14 m^3 in wet years, respectively.

As it can be seen from the study, the volume of the tank mainly depends on the amount of precipitation, roof area and the farm's water demand.

Keywords: rainwater harvesting, rooftop, the volume of water storage tank

INVESTIGATING WATERLOGGED LAND AREAS IN LITHUANIA

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ABSTRACT
In Lithuania, soils become waterlogged differently each year due to variations in rainfall, the ability of soils to absorb and evaporate excess moisture, temperature, and the poor condition of unmaintained and newly installed drainage systems.
The aim of the research is to investigate the extent of waterlogged land surface in Lithuania.
The objectives of the research are to assess the benefits of the installation of drainage systems for rational land use; to analyse the factors influencing waterlogging; to determine the area of waterlogged land from a spatial dataset and to assess the accuracy of the data through a field survey in selected areas; to identify the causes of waterlogging in the research areas.
The research was carried out over the period 2022-2024 in 4 different locations in Lithuania.
The methods used for the research were analysis of scientific literature sources, field survey, comparison, interpretation and generalisation. Analysis of literature sources and cartographic material and field research. The spatial datasets available on the Lithuanian Spatial Information Portal were analysed, providing information on soil composition, productivity score, reclaimed areas and reclaimed areas in poor condition. The data collected was analysed and systematised. The analysis of the factors influencing waterlogging showed that waterlogging is directly related to the amount of rainfall, soil type and composition, the poor condition of drainage systems, the unevenness of the terrain, and human activity.
Keywords: Waterloggens land, soils, drainage systems in Lithuania

INNOVATIVE TECHNOLOGIES FOR SMART AGRICULTURE

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ABSTRACT
As advantage of intelligent systems, such as automated driving and telemetry system, are studying from an environmental impact, optimization standpoint for smart agricultural machinery, and work organization perspective. Continues parameters adjustment of the automatic steering system, agricultural vehicles can significantly minimize energy consumption while simultaneously addressing environmental concerns.
This study analyses the primary intelligent systems used in modern combine harvesters, exploring their operation and benefits. Based on remote telemetry server data the impact of fuel consumption in relation to the level of process automation in combine harvesters is being considered. The research findings indicate that, on average, during the harvesting of various crops, the combine engine operates at only about 65 percent of its capacity. This highlights the importance of not only understanding the smart systems employed in modern harvesters but also ensuring their purposeful utilization during harvesting.
To conclude, the analysis of the telematics data provides detailed information on overall machine performance efficiency and working process optimization possibilities. It's crucial to understand not only what intelligent systems are used by modern agricultural machines, but also whether they are effectively utilized during the technological process.
Keywords: smart agriculture, intelligent systems, telemetry data, crop, environmental.

THE ROLE OF OIL RADISH (*RAPHANUS SATIVUS CONVAR. OLEIFERUS) GREEN MANURE IN CROP ROTATION*

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ABSTRACT
In order to preserve environmental potential, the concept of sustainability has become more important, and regenerative farming practices are becoming more widespread worldwide. One of the pillars of sustainable, regenerative farming is using green manures to sequester CO_2 and enhance the soil organic matter level. Oil radish (*Raphanus sativus convar. oleiferus*) could be a promising green manure, due to its great biomass and large root system. We set up our crop rotation experiment in 2019 in Hungary, on humic sandy soil to evaluate the effect of oil radish green manure on the soil moisture content and the yield of the subsequent cash crop (triticale, oat, and corn). Next to the green manure application, we applied fertilized (80 kg ha^{-1} N) and control treatments (fallow) for comparison. We found that the biomass productivity of oil radish has a strong correlation (r=0,860) with the amount of precipitation fell in October. The above-ground biomass weight ranged between 3,59 and 24,22 t ha^{-1}, depending on the amount of precipitation. Oil radish had a long-term effect on soil moisture content. During the growing period of the next crop, we evaluated higher moisture content in the 50–75 cm and 75–100 cm soil layers in a wet cropyear (2021), and significantly higher moisture values were observed in the whole examined soil depth in a dry year (2022). Before winter cereals, the application of oil radish green manure led to a decrease in yield in a dry year compared to the control treatment. However, in case of spring cereal, oil radish green manure had a similar effect as fertilization for two cropyears. In case of corn yield, the effect of oil radish green manure did not differ significantly from the fertilized treatment and exceeded it in drought circumstances.
Keywords: oil radish, green manure, crop rotation, regenerative, soil moisture, yield

NEGATIVE IMPACT ON THE OPERATOR'S HEALTH FROM THE ASPECT OF ENVIRONMENTAL POLLUTION

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ABSTRACT
Ergonomics is the science that studies the relationship between the operator, machine, and environment. One of the factors that affects this relationship is noise. Regarding the operator, noise can have negative effects such as increased blood pressure, cardiac arrhythmia, fatigue, reduced performance, insomnia, and hearing loss. Short-term loss is the operator's exposure to higher decibels over a shorter period, while permanent loss occurs with exposure to both lower and higher decibels over a longer period, for example, listening to loud music with headphones or exceeding the permissible noise limit of 87 dB as stipulated by EU Directive 2002/44 during agricultural operations. Noise during operation is produced by the engine, transmission, exhaust pipe, air cleaner, and attached machinery. There are two types of noise: internal and external. Internal noise primarily affects the operator of the agricultural tractor, whereas external noise impacts everything else. External noise is generated in the environment and becomes a major pollutant. Noise pollution is most evident in urban areas (heavy traffic, shopping centers, industrial zones, factories), but also in less urban areas such as field machinery operations and similar activities. To reduce the aforementioned negative impact on human health and environmental pollution, regulations and directives on permissible noise levels have been introduced. Reducing noise levels and pollution involves better construction solutions for tractors, improved insulation of glass, cabin materials, and windows in buildings, sound barriers along high-intensity roads, and the use of protective aids (ear plugs, earmuffs), among others. People are still not sufficiently aware of how noise can negatively affect their health and the environment, as the consequences often do not appear immediately but only after prolonged exposure.
Keywords: ergonomics, environment, health, operators, machines.

ISOTOPIC TRACERS ($\delta^{18}O$ AND $\delta^{2}H$) AS A TOOL SUPPORTING WATER MANAGEMENT IN SRI LANKA'S DRY ZONE

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ABSTRACT
Isotopic tracers in water management studies have become more and more popular as they act as natural tracers, providing valuable information about the sources, pathways, and dynamics of water, particularly in areas vulnerable to climate change. This study investigates the use of stable isotopes, specifically oxygen-18 ($\delta^{18}O$) and deuterium ($\delta^{2}H$), to analyze the sources of water focusing on the Tank Cascade Systems (TCS) in the Malwathu Oya catchment in the dry zone of Sri Lanka. The study aims to determine the origins and pathways of water feeding into these systems during the monsoon and post-monsoon periods. The isotopic composition of various water sources, including rainfall, shallow groundwater, deep groundwater, and tank water, was analyzed to understand their contributions to the TCS. Results indicate significant variability in isotopic signatures due to factors such as evaporation, local climatic conditions, and water-rock interactions. We analysed the relationship with the Global Meteoric Water Line (GMWL) and explored the deuterium excess (d-excess) as an indicator of vapor source conditions. Our findings showed that the primary direct source for TCS waters is precipitation (on average 40%). The strong relationship of the isotope tracers with the electrical conductivity indicates applicability of the isotopic analysis in water management. Our study highlights the importance of isotopic data in identifying reliable water sources, understanding water quality, and developing strategies for sustainable water management in the face of climatic variability. Findings from this research provide critical insights for optimizing water use efficiency and ensuring the sustainability of ancient irrigation practices in the face of changing environmental challenges.
Keywords: stable isotopes $\delta^{18}O$; $\delta^{2}H$; groundwater; tank cascade system; Malwathu Oya

MAGNETIC FIELD AS A PHYSICAL FACTOR IN THE STIMULATION OF SEED MATERIALS

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ABSTRACT
Currently, many scientific papers written by biologists and biophysicists describe the effect of a magnetic field on plants. Research on the influence of a magnetic field on plants has been conducted for many years. However, the mechanism responsible for the changes caused by this physical factor has not yet been precisely explained. There are several known hypotheses explaining the influence of the magnetic field on the life processes of plants, these may be: (1) changes in the functioning of entire protein structures, (2) reaction with ferromagnetic elements occurring in prosthetic groups or enzymes transporting the electrons of the chain, (3) changes caused by phenomena physical effects induced by a magnetic field (changes in the properties of liquid crystals) or (4) Hall effects, (5) Dorfman effects or (6) Ettinghausen effects. Stimulation of seed material using physical methods may be an alternative to chemical methods. The main advantage of using magnetic stimulation methods over traditional chemical processes is the lack of toxic residues.
Keywords: physical methods, magnetic field, plant, seed,

ORGANIC GRANULAR FERTILIZERS FROM AGRICULTURE WASTE FOR SUSTAINABLE ENVIRONMENT

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ABSTRACT
To protect the soil health and the environment, it's essential to apply fertilizers in line with agrotechnical guidelines. Unfortunately, in pursuit of higher yields, fertilizer rates have been on the rise. Manure, straw, and wood waste constitute a significant portion of agricultural waste. A promising waste management approach involves converting these materials into organic granular fertilizers, which can enhance soil fertility while minimizing environmental impact.
In this study, the experimental manure and biochar samples were tested. Given findings indicate that the optimal moisture content for the granulated mass falls within the range of 20% to 25%. When the moisture content drops below 15%, additional moisture is necessary for the raw material. Furthermore, the physical-mechanical properties of the produced manure granules were studied. Interestingly, the inclusion of molasses increased the strength of cattle and cow manure granules by up to 9%. Additionally, the use of waste additives influenced the density of the granules across all cases. From an environmental perspective, granulating manure reduces greenhouse gas emissions by a significant factor, approximately 11.4 times, compared to storing the same amount of manure in a barn or manure storage facility.
Keywords: organic waste, granulation, fertilizers, environment.

RETHINKING GREEN ROOF DESIGN

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ABSTRACT
Since the 1960s, work has been carried out on the technique of green roofs (GR) in Europe, from implementing the first structures through the creation and improvement of construction guidelines, the search for alternative construction materials, and introducing modifications that increase their environmental functions. Global environmental problems like climate change, overexploitation of resources, waste production, water deficits, and water pollution require transforming existing solutions to be more multifunctional and sustainable, thus transitioning from green to regenerative design. The research aims to create a framework for the design method of green infrastructure (GI) facilities based on regenerative design (RD) and circular economy (CI). Regenerative design emphasizes a co-evolutionary, partnered relationship between humans and the natural environment. A circular economy focusing on the circulation and regeneration of resources requires both the reconfiguration of existing infrastructure and the creation of new infrastructure to facilitate these flows. The proposed approach aims to protect and improve the ecological conditions of the analyzed area while saving resources, using waste, recovering and reusing water, reducing pollutant loads discharged to receivers, and promoting production and utility functions, leading to the development of a sustainable approach to the implementation of nature-based solutions in the future. The following steps of the methodology development are proposed: (i) analysis of the level of implementation of the RD and CI assumptions in existing GR; (ii) analysis of the possibilities of integrating traditional and sustainable approaches; (iii) phase of co-creating a sustainable solution; (iv) assessment of the environmental effect, and (v) assessment of the sustainability of the technique. This work presents the preliminary results of the first stage of the project, i.e., the analysis of existing solutions in terms of meeting RD and CE requirements and focuses on defining the gaps in this area.
Keywords: green roof, regenerative design, circular economy, sustainability

THE ROLE OF INNOVATION IN ADAPTING AGRICULTURE TO CHANGES IN THE AGRIBUSINESS SECTOR

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ABSTRACT
Dynamic changes are taking place in rural areas. They are related to constantly changing economic conditions, as well as a response to changes in the natural environment. These changes also apply to agriculture and broadly understood agribusiness. Polish agriculture has faced enormous challenges related to Poland's accession to the European Union, which resulted in the opening of the domestic market to products from member states. On the other hand, it allowed Polish producers to enter the European market with their own products. Currently, a significant challenge facing agriculture is adapting to the climate changes that we have been observing recently. In order to meet these challenges, it is necessary to stimulate innovation among farmers, as well as in the entire agribusiness sector. An excellent example of this type of activity is the activity of the EPI Operational Groups, which include farmers, entrepreneurs, agricultural advisors, scientists and other stakeholders. These activities are intended to cause a rapid transfer of knowledge from scientists to practitioners. Moreover, this type of vertical integration (integrating various stakeholders working for agribusiness) results in the use of synergy effects, through mutual assistance and the use of various competences possessed by individual members of the operational groups. The paper will discuss three exemplary operational groups, led by Bydgoszcz University of Science and Technology: Ancient Grain, Gardena and Nova Grass.
Keywords: innovations, cooperation, knowledge transfer, agriculture, agribusiness.

GEOSPATIAL TECHNIQUES FOR GROUNDWATER RECHARGE POTENTIAL MAPPING IN SIVALAKULAMA CASCADE, ANURADHAPURA, SRI LANKA

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ABSTRACT
In Sri Lanka, groundwater is an essential natural resource that is needed to supply water demands in different climate zones. Because of its reliance on groundwater, the Anuradhapura region in the Dry Zone emphasizes the importance of identifying and managing possible groundwater extraction and recharging potential zones. This study focuses on identifying groundwater recharge potential zones within the Sivalakulama cascade area (21.37 km²). Spatial variation of overburden thickness, specific yield, infiltration rate, land use, and geological layers were considered for the assessment of groundwater potential. A 2-D electrical resistivity survey was conducted within the study area and an overburden thickness map was generated by estimating the thickness of the soil layer above the bedrock. Samples of soil were taken at fifteen sites, each of which represented a distinct land use class. A specific yield map was developed based on the textural classes of those samples. Infiltration rate was measured in each land use type using double ring infiltrometer. Spatial variability maps for each soil parameter were created using Inverse Distance Weighting (IDW) interpolation. Overburden thickness, specific yield, infiltration, land use, and geological layers were integrated using a weighted overlay analysis in ArcGIS by assigning ranks and weights to each layer based on existing literature. The area's potential for groundwater recharge is rated as moderate in 44.66% of the study area and good in 55.34%. The zones with good recharge potential are mainly located in the middle to lower parts of the cascade according to overlay analysis. These results offer a useful foundation for upcoming groundwater recharge initiatives in the area.
Keywords: Dry zone, IDW, GIS, Overburden thickness

MODELING HYDROLOGICAL PARAMETERS USING SOIL AND WATER ASSESSMENT TOOL (SWAT) IN THE NILWALA RIVER BASIN OF SRI LANKA

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ABSTRACT
The impact of land use, land change, and climate change on Sri Lanka has been perilous in recent decades. SWAT simulates the quality and quantity of watersheds and the impact of climate change at a small watershed to river basin scale. A study was carried out to (a) explore the performance of the SWAT in simulating streamflow from the Nilwala river basin of Sri Lanka, and (b) execute a sensitivity analysis utilizing SWAT Calibration and Uncertainty Program (SWAT-CUP). ArcSWAT was used to create the model of the Nilwala River sub-basin. The basic inputs for this study were topography, soil type map, land use, and climate data [daily rainfall, minimum and maximum Temperatures from 1997 to 2015]. Calibration and validation of the model sensitivity analysis were performed using the Sequential Uncertainty Fitting Algorithm (SUFI-2) of the SWAT-CUP. The analysis used a study period spanning 1997 to 2015, with a four-year warm-up period for model setup, 2001 – 2011 period for calibration and 2012 – 2015 period for validation. Using eight parameters, the model was successfully calibrated for observed stream flow data from Pitabaddara. The findings of the uncertainty analysis revealed that the R- factor-1.08 and P- factor- 0.83 are both acceptable. The model performance evaluation also revealed that the acceptable value ranges of Nash Sutcliffe Efficiency, Observations standard deviation ratio, and Percent Bias for calibration were 0.78, 0.47, and 4.1, respectively, whereas during the validation periods the values were 0.86, 0.38, and 3.7, respectively. The model captured well the patterns and trends in the observed flow series, confirming its suitability for modelling future scenarios.
Keywords: Hydrological modeling, Streamflow, SUFI-2, Nilwala river basin.

EFFECT OF MOLECULAR OSCILLATION TECHNOLOGY USED IN DRIP IRRIGATION SYSTEMS ON FLOW CHANGE RATE AND COEFFICIENT VARIATION

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ABSTRACT
The study aimed to affect the molecular oscillation technology (merus ring) on the rate of flow rate change (ΔQ) and coefficient variation (Cv) of dripper design in drip irrigation systems under saline water (electrical conductivity of 4.0 dS/m) conditions. In the experiment, saline water treatment (TS) and molecular oscillation technology with saline water (M-TS) subjects were created and applied to the in-line dripper of the saline water created subjects under a total of 80 irrigation programs, 40 irrigation programs each year. While in the study the average ΔQ rate in TS for four different irrigation periods in 2019 was 4.3 %, the average ΔQ value in 2020 was 15.0 %, while this value for M-TS was determined to be 5.0 % in the first year and 5.1 % in the second year. In TS, Cv value in the first year was 1.06%, while Cv value in the second year was 4.32%. In the case of M-TS, the average Cv values were 1.05% for the first year, while this value was 1.24% in the second year. In the case of Merus salt water, an increase of 18.09% was calculated in Cv values between the first year and the second year. The Merus ring treatment had lower Cv values when using saline water, with saline water potentially leading to emitter clogging and increased Cv. This resulted in high dripper clogging in TS, causing uneven distribution of dripper discharges.
Keywords: Saline water, irrigation, coefficient variation, flow change rate, merus ring

IMPACT OF VEGETATIVE PERIOD HUMIDITY ON THE FUEL CONSUMPTION, ENERGY AND GHG INDICES IN MAIZE-LEGUMES INTERCROPPED CULTIVATIONS

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ABSTRACT
Mixed crops can solve the energy and GHG balance problems, but the emergence, development and productivity of such mixed crops are at risk due to uneven distribution of precipitation. For this reason, investigations were performed at the Experimental Station of Vytautas Magnus University, Lithuania. Single maize crop was compared with Crimson/red clover, Persian clover, and alfalfa intercropped maize cultivations. Results showed that under arid conditions, the intercrops biomass was about 4 times less than under humid. Humid conditions were less suitable for maize and when growing with intercrops they produced about 3-5 t ha^{-1} less dried biomass, and when growing sole - about 6 t ha^{-1} less biomass than in arid conditions. Due to the higher yield of maize biomass in arid season, better energy indicators of the crop were obtained in arid conditions than in humid. The difference between net energy was about 122-123 MJ ha^{-1} in all treatments, except for the maize crop with intercropped alfalfa, where the difference was 62 MJ ha^{-1}. All tested technologies were environmentally friendly, CO_2 equivalent varied between treatments from 804 to 884 kg ha^{-1}. Uneven distribution of precipitation during vegetative season makes us think about the improvement of intercropping technologies. Sowing intercrops at the same time with maize could improve its germination but increase the problem of weed spread.
Keywords: *Zea mays* L.; *Fabacea* intercrops; fuel; energy; CO_2 ekvivalent.

EVLUATION OF SOIL MOISTURE DYNAMICS IN A LONG-TERM FIELD EXPERIMENT SET UP ON CHERNOZEM SOIL

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ABSTRACT
One of the most crucial environmental factors determining the success of corn cultivation in Hungary is the soil water content available to the plant. The soil moisture content directly affects the nutrient uptake of the plant, the quality and quantity of the yield, and therefore plays an important role in the success of agricultural production.
The studies were carried out in a long-term field experiment at the Látókép Crop Production Experimental Station of the Institutes for Agricultural Research and Educational Farm of the University of Debrecen, Hungary (N 47° 33' E 21°26'). The split-split-plot design of the long-term experiment includes three soil tillage treatments (winter ploughing, strip tillage and rippering), three fertilizer levels (0 kg N ha^{-1}; 80 kg N ha^{-1} and 160 kg N ha^{-1}), and two plant densities (60 and 80 thousand plants ha^{-1}) under irrigated and non-irrigated conditions. Soil moisture measurements were conducted in a long-term field experiment on calcareous chernozem soil. Using an FDR sensor, the probe recorded soil moisture content as a percentage of field capacity (FWC). The aim of the study is to monitor soil moisture dynamics during the growing period of maize.
In the long-term experiment, tillage, fertilization and irrigation all significantly affected the moisture content of the top 0-80 cm soil section. It was found that soil moisture content was also high in the year with very good rainfall and positively influenced the yield of the test crop. In the non-irrigated treatments, the strip-tillage had the highest soil moisture content, while the irrigated treatment had the lowest. The rate of nutrient amendment also influenced soil moisture status. In the non-irrigated treatment, higher soil moisture was measured in the control plots than in the fertilized treatments. In the highest dose of nitrogen fertilizer treatment had the lowest soil moisture.
Keywords: soil moisture dynamics, corn cultivation success, tillage and fertilization effects

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REPRODUCTIVE STATUS AND BREEDING PRACTICES IN DAIRY COWS IN CENTRAL ETHIOPIA

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ABSTRACT
This study was conducted at two agro ecological zones (midland and lowland) of the Hulbareg district to assess reproductive status and dairy cattle breeding practices. Data was collected using semi-structured questionnaire from a total of 290 households selected by systematic random sampling technique for interview. The collected data were presented using descriptive statistics, index and Chi-Square test. The mean age at first calving and dry period of local dairy cows were significantly varied ($p<0.05$) between midland ad lowland agro ecologies. The mean milk production per cow per day in midland and lowland were significantly different ($p<0.05$) for local cows. The study further indicated that most of the respondents selected trait of animals for breeding by considering the expected milk yield, parents' history, size/body appearance and growth rate. The reproductive problem, sickness, productive problem, persistent poor body condition and unwanted physical characteristics used criteria for culling. The minimum and maximum number of pregnancy rate was 8.4% and 18.3% in the studied district. The major constraint for low conception rate of dairy cows was animal selection, technicians' efficiency, protection of farmers, and hormone problems. In general, the breeding practices of study area were traditional and poor breeding systems and the perception of estrous synchronization were very low. Most of the respondents were not satisfied with the results of the estrus synchronization and mass insemination (ESMI) program as the conception rate in local dairy cows were very much below their expectation.
Keywords: Breeding practice, Dairy cattle, Ethiopia, Hulbareg, Synchronization

INVESTIGATION AND ANALYSIS OF INVASIVE PLANTS PROCESSING AND UTILIZATION FOR THE PRODUCTION OF PRESSED BIOFUEL

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ABSTRACT
The following studies were conducted to achieve the goal of determining and investigating quality indicators and the characteristics of pressed biofuel. Invasive species Sosnowky's hogweed (*Heracleum sosnowskyi*) and Giant knotweed (*Fallopia sachalinensis*) are common in Lithuania. These plants produce a lot of biomasses, which can be processed and compressed for use as solid biofuel. For comparison, the biomass of pinewood was used as the control. Pressed biofuel was produced by gathering and drying this plant material. Plant biomass was chopped, processed, and then compacted into cylindrical briquettes after being harvested and dried. After evaluation of the physical and elemental properties of prepared briquettes, it was determined that their density ranged from 615.60 to 867.31 kg m^{-3}, and when briquettes were exposed to compressive forces ranging from 783 N to 1219 N, the briquettes disintegrated which determined their critical compressive strength resistance. The lower calorific value of briquettes was measured to be between 15.90 and 18.60 MJ kg^{-1}. When the hazardous gas emissions from the test biofuel briquettes were measured, they were determined to be suitably low and within allowable parameters. Biomass harvesting and biofuel production were also determined to be beneficial for energy production.
Keywords: invasive plants, solid biofuel, briquettes, Sosnowsky's hogweed, Giant knotweed.

PREPARING SOCIETY FOR CLIMATE CHANGE: A METHODOLOGICAL APPROACH TO BUILDING CLIMATE RESILIENCE THROUGH ENVIRONMENTAL VIRTUE ETHICS AND REGIONAL CAPACITY STRENGTHENING

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ABSTRACT
This paper addresses the critical question of whether society can be adequately prepared for the broad and profound impacts of climate change, and if so, how this can be achieved. Drawing from the perspective of environmental virtue ethics, as articulated by T. Hill, who argues that "preserving the environment begins with the moral agent's inner self and motivation to act virtuously," (1983) we explore the methodological framework of climate change resilience. Specifically, we present the PATHWAYS2RESILIENCE initiative, a key EU-funded flagship program that supports the European Union's Mission on Adaptation to Climate Change.
PATHWAYS2RESILIENCE aims to strengthen regional capacities for transformative climate adaptation by assisting 100 regions in developing and implementing innovative climate adaptation solutions. This initiative promotes an accelerated and equitable transformation towards climate resilience, with a focus on fostering adaptation pathways, innovation agendas, and investment plans. As a case study, we highlight the Warmia and Mazury region of Poland, a member of the European Regions Research & Innovation Network (ERRIN), which is part of the first cohort of ambitious regions working towards these goals in alignment with the EU Mission on Adaptation to Climate Change.
This abstract discusses the potential for societal readiness in the face of climate change through the lens of environmental virtue ethics, while outlining a concrete, EU-supported methodology for achieving climate resilience at the regional level.
Keywords: Climate resilience, Environmental virtue ethics, PATHWAYS2RESILIENCE, EU Mission on Adaptation to Climate Change, Regional Capacity.

FACTORS RELATED TO PARENTAL VACCINE HESITANCY- QUALITATIVE STUDY

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ABSTRACT

Vaccinations are one of the most effective methods of preventing infectious diseases. Currently, they prevent 2-3 million deaths annually. Data published in recent years indicate that the largest decline in the implementation of routine childhood vaccinations in 30 years has been recorded. Vaccine hesitancy is an increasingly serious problem, recognized by the World Health Organization as one of the ten greatest threats to global health. Vaccine hesitancy encompasses a wide range of attitudes, from the outright refusal of all vaccinations without doubt to the acceptance of all vaccinations without hesitation, as well as those who fall between these two extremes.

The aim of the study was to identify factors related to parental vaccine hesitancy.

Material and methods

We arranged 33 semi-structured interviews with parents of children who had doubts about or refused to vaccinate their children. The interviews were recorded, transcribed, and then analysed using descriptive qualitative methods.

Results

Main themes were identified: (1) Concerns about the long-term effects of vaccines, (2) Relationship with medical personnel, (3) Sources of information, (4) Risk assessment, (5) Perception of the vaccine industry

Conclusion

The main reason for vaccine hesitancy was concerns about the long-term effects of the vaccines and the relationship with medical staff. Additionally, the sources of information, the assessment of the benefits and side effects of vaccinations, as well as the perception of the vaccine industry, were significant.

Keywords: vaccination, vaccine hesitancy, children, parents

NITROGEN USE EFFICIENCY OF MAIZE IN DIFFERENT FERTILISATION LEVELS BASED ON LONG-TERM FIELD EXPERIMENT

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ABSTRACT
Maize is one of the leading crops produced worldwide. Improving nitrogen use efficiency (NUE) in maize production is an impetus to higher productivity which is essential for maximizing economic returns while protecting the environment and maintaining soil health. Besides, higher NUE potentates' sustainable productivity of crop agroecosystems. Therefore, this study evaluated the long-term effects of the nitrogen, phosphorus and potassium fertilisation levels on the physiological characteristics and yield of FAO 420 maize hybrid.
A long-term split-plot multifactorial fertilisation field experiment was set up in 1983 at the Látókép Crop Production Experimental Site of the University of Debrecen, Hungary. The research was conducted in two seasons (2022 and 2023) with dry and average rainy type agroclimatic scenarios. Five increasing nitrogen levels (N_1 = 30 kg*ha^{-1}; N_2 = 60 kg*ha^{-1}; N_3 = 90 kg*ha^{-1}; N_4 = 120 kg*ha^{-1}; N_5 = 150 kg*ha^{-1}) were included in the study with a control (unfertilised plot). The treatements were tested under irrigated and non-irrigated conditions. The nitrogen use efficiency of maize were tested thorough physiological parameters (leaf area index - LAI and normalized difference vegetation index - NDVI) measured in three important vegetative phenological stages (V_8, V_{10} and V_{12}), and was compared to yield quantity. Statistical analyses were done using simple and multiple analysis of variance and Fisher's least significant difference test.
Overall, for an average crop year (2023) nutrient levels resulted in significant increases in all cases on the physiological and yield parameters of maize. In contrast, in the dry year (2022), higher nutrient levels caused yield reduction. As a result, better yield results and also higher values of crop physiological parameters were obtained with lower nutrient doses. It can therefore be concluded that the effectiveness of nutrient supplementation is strongly influenced by environmental conditions.
Keywords: fertilisation, maize, nitrogen, physiological parameters, yield

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ANALYSIS OF THE RELATIONSHIP BETWEEN FLIGHT PARAMETERS, NUTRIENT LEVELS AND HYBRIDS IN A SMALL PLOT FIELD EXPERIMENT USING A MULTISPECTRAL UAV

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ABSTRACT
The rapid growing human population and decreasing arable land make the application of agricultural innovations to improve the efficiency and profitability of crop production inevitable. Moreover, the efficacy of multispectral UAV to produce results with high precision depends on factors such as equipment calibration, time of measurement, crop factors, among others. In this study, we used a DJI Mavic 3 M multispectral UAV at different times, and flight settings to find out the variations in the settings and thus make the recordings more efficient and analysable. This investigation was conducted at the Látókép Crop Production Experimental Site of the University of Debrecen, Hungary in 2023 season. The experiment had two different maize sowing directions i.e 120- and 210-degree seeding angle. Remote sensing (measurements) done at 6 AM, 12 PM (midday) and 6 PM in the evening. Results show a significant increase in the average daily values in the 120-degree seed angle direction and 210-degree seed angle direction. The trend of maximum vegetation index maximum in the 120-degree seeding angle direction significantly decreased during the daily measurement. Contrary, the minimum values, of the vegetation index in the 210-degree seeding angle increased gradually during the day and decreased in the 120-degree seeding angle. However, the standard errors of the values in both experiment was decreased during the day. Based on these results, we can conclude that the time of the remote sensing within the day significantly influences the vegetation index parameters, even if the Drone is recording with automatic light compensation. The same parameters, such as light intensity, sowing direction, and time of day, should be sought in the remote sensing.

Keywords: maize, remote sensing, UAV, long-term experiment

INFLUENCE OF MAGNETIC FIELDS ON THE OPERATION OF INTERNAL COMBUSTION ENGINES BY CHANGING THE FUEL STRUCTURE

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ABSTRACT
Currently, the world community is setting more stringent limits for the operation of land transport, more stringent environmental conditions for controlling emissions of combustion products from cars. At the same time, the number of transports is growing every day. Many engineering companies are improving the efficiency of a car engine. Along with classical methods of improving engine performance, there are alternative ways to change engine performance. These include hydrogen, it is used by injection into the air line and fuel processing with magnetic fields using vortex flows created in a closed system, through the use of different designs and permanent magnets located inside.
These systems were developed by the authors and are tested in city and highway operating conditions, as well as under various weather and temperature conditions. Patents have been registered for these systems. The systems show operation after fuel passes through them; changes in the operation of the engine are audible to a person when the fuel-air mixture is injected into the combustion chamber. Fuel consumption indicators after installing the magnetic system on the vehicle show an increase in power - up to 20%, the reduction in exhaust gases up to 50%, the reduction in the load on the engine up to 15%, the reduction in fuel consumption from 15-20%, thereby increasing the life of the engine before repair, improving the environment and reducing vehicle maintenance costs.
Keywords: internal combustion engine, magnetic fields, improving engine performance, reducing exhaust emissions

EFFECTS OF CLIMATIC CONDITIONS ON BROILERS: A COMPREHENSIVE REVIEW OF THERMAL MANAGEMENT AND PRODUCTION PERFORMANCE

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ABSTRACT
Understanding the effects of climatic conditions in the broiler house on the health and production performance of chickens is critical for developing effective thermal management strategies. This study aims to comprehensively examine the impacts of climatic factors such as indoor temperature, relative humidity, airflow, and lighting on the biological and behavioral responses of chickens. It will detail the effects of temperature and relative humidity on feeding habits, growth rates, and general health status, as well as evaluate the role of airflow and lighting in behavioral adaptations and stress levels. Preventing heat stress and optimizing the indoor environment are crucial for increasing production efficiency in chicken farming, particularly in tropical regions. In this context, effective thermal management parameters and strategies for house design will be identified to maximize production performance. In this study will present the effects of these climatic factors on chickens, supported by scientific data, and provide practical recommendations and guidelines for optimal poultry house design. The research findings will highlight the long-term impact of thermal management on poultry health and productivity and suggest strategic approaches to enhance the sustainability of chicken farming in tropical and subtropical areas.
Keywords: Broiler, Poultry, Heat Stress, Poultry Houses, Environmental Conditions

RAINWATER STORAGE AND FLOW CONTROL IN GREEN ROOFS LAYERS

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ABSTRACT
The extensive green roofs offer a multifaceted approach to stormwater management in cold and wet climates, providing benefits for both the environment and urban infrastructure and newly constructed buildings are subject to stricter requirements - the building must not harm the environment, they must be energetically and economically efficient, comfortable, ecological, etc. One such green energy-saving idea is green roofs and walls of buildings. The amount of water collected and evaporated on a green roof depends on three things: types of plants growing on the roof (moss accumulates moisture better than ordinary grass); the depth of the substrate (extensiveness/ intensity of planting); the type of substrate.
This study aims to determine the dynamics of rainwater runoff under real natural conditions, in a typical green roof construction, compared to runoff from a roof covered with bituminous tiles. The study was conducted in 2022-2023 by installing two 1 m^2 stands, which are affected by real climatic conditions. One stand was covered with traditional bituminous tiles, but the other was covered with a 'green roof coating. Meteorological data were obtained from the Kaunas City meteorological station. During the first months of observation, it was possible to record the tendency that rainwater runoff is slow in the case of a green roof, but it continues even after the intense rain has ended. Analysing the data, it was found during the research that the regression coefficients are very small in assessing the relationship between average daily temperatures and runoff in individual months, R^2 - 0.0453 to 0.0553. The study showed that under certain meteorological conditions, a green roof can accumulate up to 35-45 percent more water than a roof covered with bituminous tiles. This means the water accumulates and then slowly drains into the rain collection systems. The main target, to take out rainwater peeks from rain collectors can be reached. During the study, it was found that a green roof has the potential to reduce the load on rainwater systems and retain precipitation in roof layers. The research also observed that rainwater runoff is slow in the case of a green roof, and it continues even after the intense rain has ended. This confirms the claims of foreign authors that green roofs accumulate, retain rainwater, and reduce the runoff peak during rain.
Keywords: rainwater, green roof, precipitation, water collection.

INVESTIGATION OF DROUGHT EFFECT OF METEOROLOGICAL AND FIELD DATA USING GOOGLE EARTH ENGINE AND EARTH OBSERVATION TECHNOLOGIES: ALANYA CASE

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ABSTRACT
Global climate change poses major threats to all layers of the earth, including the atmosphere, land and sea. Floods, Storms, Forest Fires and Droughts are among the negativities that threaten humanity. Changes occur as a result of long-term negativities. These negativities are considered natural disasters.
Remote sensing, geographic information systems, sensor technology, climate modeling, open-source data platforms, and open-source programming, which are among the Earth observation technologies, have increased in use as important solution tools in combating these negativities.
Drought study was carried out by producing an integrated solution model on Google Earth Engine (GEE) platform using 10m Annual Land Use Land Cover (LULC), TerraClimate, MODIS data from Earth Observation data. Vegetation Condition Index (VCI), Vegetation Health Index (VHI), Temperature Condition Index (TCI) and Palmer Drought Severity Index (PDSI), Maximum temperature (tmmx), Minimum temperature (tmmn) indices, agricultural drought due to climate change was revealed in Alanya province terrestrial areas as a result of 20-year data.
Keywords: Google Earth engine, Geographic Information Systems, Remote Sensing, Open-source programming, Vegetation Status Index, Vegetation health index. Temperature Status Index, Maximum temperature, Minimum temperature

INVESTIGATION OF THE RELATIONSHIP BETWEEN NO2, LAND SURFACE TEMPERATURE AND VEGETATION COVER USING LANDSAT-8 AND SENTINEL-5P SATELLITE IMAGES AND GOOGLE EARTH ENGINE: THE CASE OF ANTALYA

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ABSTRACT
Human life is negatively affected by environmental changes and global warming. The increase in the atmospheric concentration of greenhouse gases is one of the main causes of global warming. An important first step in fighting air pollution is to determine the amount of greenhouse gases in the atmosphere.
In a sustainable development, the amount of air pollution and industrial productivity should be in harmony. Monitoring this coexistence by collecting numerical data is an important step in maintaining control.
An important study for sustainable development is the measurement of pollutants and agricultural data in cities where urban and rural patterns interact by using earth observation technology. Steadily developing software and satellite observation studies enable planners to make increasingly more precise decisions.
Antalya province was selected as the study area of this study due to its agricultural and urban characteristics. Land surface temperature (LST), Enhanced Vegetation Index (EVI), Normalised Vegetation Index (NDVI) and NO2 data were collected for three years of winter and summer seasons of the study area. Sentinel-5P and Landsat 8 satellites were used in the study. Using statistics and ground observation technology, this study revealed the detrimental effects of increasing NO2 and Land Surface Temperature (LST) on EVI and NDVI.
The relationship between the increase in temperature on the earth's surface and the increase in air pollution with the adverse effects on agricultural production was revealed using earth observation technology.
Keywords: Landsat-8, Sentinel-5P, Google Earth Engine (GEE), NO2, Enhanced Vegetation Index (EVI), Normalized difference vegetation index (NDVI), Land Surface Temperature (LST)

THE THERAPEUTIC IMPORTANCE OF GREENERY IN THE HUMAN ENVIRONMENT

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ABSTRACT
The belief that greenery has a positive effect on human health has existed for hundreds of years and appears in various cultures. Today, this opinion is supported by numerous scientific studies in the fields of medicine and psychology. The results of observations prove that contact with nature even, through its passive observation, significantly reduces stress levels, improves well-being, and increases creativity. Among the theories explaining why being in a natural environment, surrounded by greenery, improves human health and well-being, the most frequently indicated is the biophilia hypothesis described by the famous biologist and philosopher Edward O. Wilson. It assumes that all living beings, including humans, have an innate sense of community with the natural world, necessary for the proper development of us as individuals. For thousands of years, people have been more, or less consciously seeking connections with nature and other forms of life. Hortitherapy (horticultural therapy) is one of the forms of unconventional therapy which uses plants to improve the physical and mental condition of people. It is recommended for a wide group of patients among others, disabled, handicapped, mentally ill or elderly people as well as children with developmental disorders.
In recent years, public spaces for special purposes have been increasingly designed in Poland, including sensory gardens used, among others, in the education and rehabilitation of children and people with disabilities. Moreover, greenery present in public spaces has a positive impact on building social bonds and intergenerational integration, and also increases the sense of security and life satisfaction. Considering the growing urbanization and related health problems such as stress, lifestyle diseases and social alienation, research on the role of greenery in shaping human physical and mental well-being is a key area of interdisciplinary analysis.
Keywords:greenery, hortitherapy, physical and mental health, landscape design, therapeutic environments

ANALYSIS OF THE HYBRID DRYING PROCESS OF APPLE POMACE

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ABSTRACT
Dried fruit is a product obtained from plants or their parts, which can be used for food, medicine, energy or agricultural purposes. The main raw material for the production of dried fruit is fresh fruit, but also waste (and by-products) resulting from their processing. The process of producing dried fruit is energy-, cost- and time-consuming, so new methods of drying waste and products that will positively affect the overall efficiency of the drying process are still being sought. The main aim of this study is to analyze the hybrid drying process of apple pomace (comprising a mix of different varieties) in comparison to conventional drying. The research was conducted on 18 variants of hybrid drying, alongside 6 control variants (conventional drying). The material for the study was apple pomace from the Gala variety. A specialized laboratory benches (BKB 100 bioreactors) were used to conduct the study. The experiment shows that microwave radiation has a positive effect on the course of the drying process (shortening it and reducing energy expenditure compared to convection drying), but not always the use of the highest microwave power, results in the best efficiency of the conducted process. The application of microwave radiation in hybrid drying at power levels of 300 and 400 W significantly accelerates the drying process, leading to reduction in the duration of the process in compared to both the control variants and those employing lower microwave power (200 W). The use of microwaves reduced 20% energy consumption compared to control samples. The most favorable variants of the analyzed processes are with microwaves with a power of 300 and 400 W.
Keywords: waste, apple pomace, drying, microwave rediation

RESEARCH AND DIGITAL MODELLING OF ENVIRONMENTAL NOISE

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ABSTRACT
It has been established that noise reduces the immune system's resistance, and it is warned that noise, as a chronic source of stress, affects the central nervous system and leads to various health disorders. Even relatively moderate noise levels of 60–70 dBA can cause headaches, dizziness, tinnitus, insomnia, and deterioration of memory, attention, and orientation. The study aims to evaluate the noise dispersion from stationary and mobile sources in the industrial environment and assess the noise level in the nearest residential areas. Noise calculations were performed using the IMMI software. Noise dispersion maps were modeled using ArcGIS 10.8 software. Noise calculations are typically carried out by assessing the noise emitted by mobile, linear, and areal sources of economic activity during daytime, evening, and night periods. The software allows for quick calculations of noise dispersion influenced by different scenarios of economic activity and infrastructure development (considering various variables: traffic intensity, speed, the percentage of heavy and light vehicles in the counted flow, noise from linear and areal sources, and their operating times), comparing results, and selecting the best option for area development, buildings, or noise reduction measures.
It has been found that upon implementing the planned activities, the dominant noise source in the environment will remain the background noise generated by the trans-European network road E262 (Kaunas-Zarasai-Daugavpils). The calculated noise level from the planned economic activities, without background noise sources, in the nearest residential areas will comply with HN 33:2011 standards for residential buildings (homes) and public buildings (excluding catering and cultural buildings). The maximum noise level during the day will reach 43.1 dBA, while the threshold value is 55 dBA.
Keywords: industrial noise, noise modeling, maps, background noise sources, planned economic activity.

RESPONSES OF SOIL ENZYMES TO SPRINKLER IRRIGATION AND DIFFERENTIATED NITROGEN FERTILIZATION IN BARLEY CULTIVATION

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ABSTRACT
The amount of nitrogen available to plants is positively correlated with the mineralization of organic matter in the soil, biological nitrogen fixation, fertilization, and the total and distribution of atmospheric precipitation. Enzymes indicate the metabolic level of the microbial community in soil and catalyze specific reactions in the carbon and nutrient metabolism. Free enzymes excreted by plants and animals and associated mainly with or within cellular structures are called exoenzymes. Later, they are released into soil after cell lysis and death. Therefore, if soil use and management influence the soil's microbial environment, changes in the activity of soil enzymes can also be observed.
Our study aimed to assess the impact of sprinkler irrigation on the activity of selected soil enzymes in terms of nitrogen metabolism and oxidation–reduction processes in soil with different doses of inorganic nitrogen fertilizers. An Alfisol was sampled from an experimental field of spring barley within the University Research Center in the central part of Poland, namely the village of Mochełek with a moderate transitory climate, during the growing seasons of 2015–2017.
The soil resistance (RS) was derived to recognize the resistance enzymes during drought. In the maturity phase, nitrate reductase activity was 18% higher in irrigated soil and the activities of other enzymes were higher than in the non-irrigated plots by 25% for dehydrogenase, 22% for peroxidase, 33% for catalase, and 17% for urease. The development phase in the barley influenced nitrate reductase activity. Enzymatic activities changed throughout the research years. During the maturity stage, a lower ammonium nitrogen content in the soil resulted from a higher spring barley uptake due to drought stress. Irrigation probably contributed to increased leaching of nitrate in the soil. The highest index of resilience was found in the soil catalase activity.
Keywords: urease; nitrate reductase; dehydrogenase; peroxidase; catalase; moderate transitory climate; soil; index of resilience.

SHOVADAN; A NETWORK OF UNDERGROUND PRIVATE AND PUBLIC SPACES

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ABSTRACT
The present study focuses on the physical and social dimensions of a particular space in traditional Iranian houses that was built to control extreme climatic conditions. In the dry and humid climate of southern Iran, underground spaces were considered as a solution in traditional architecture to provide comfortable living conditions including cooler temperatures. An extreme form of underground spaces in Iranian architecture is Shovadan, which is built at a depth of 10 to 20 meters, especially in the cities of Shushtar and Dezful. With its low thermal conductivity, subsoil acts as a thermal barrier to prevent heat transfer between underground and open space. By a passive environmentally friendly method, Shovadan is warmer in winter and cooler in summer without consumption of energy. Large traditional houses often had one or more Shovadans, which were used to store food and water, to rest in hot summer weather, and to hide in dangerous situations such as war.
As Shovadan is connected to the underground water supply system (Qanat), it could act as a shelter to stay for a long time. Some people who could not afford building Shovadan went to their neighbors' houses to rest in the 50-degree summer heat. By Tals (tunnels) houses were connected to each other and then to mosque or castle in some cases. The present study investigates this network of private, semi-public and public spaces formed as an underground city. Nowadays, underground structures are widely constructed for different purposes such as providing shelter in risky and emergency situations. Can the traditional Shovadan be a model for future settlements that have to face the problems of climate change or the increasing risk of war?
Keywords: Shovadan, Iranian Traditional Architecture, Underground Structure, Future Settlement

AGROCLIMATIC CONDITIONS OF CROP PRODUCTION IN POLAND, CURRENTLY AND IN THE COMING YEARS – BASED ON CLIMATIC WATER BALANCE (CWB) AND HYDROTHERMAL COEFFICIENT (HTC)

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ABSTRACT
The study analyzed changes in relative climatic water balance (relative precipitation evaporation index) - RCWB during plant vegetation and the long-term period of plant production for Poland. Simultaneously, simulations and assessment of changes in the hydrothermal index (HTC) in the context of expected climate changes and plant water needs were presented.
RCWB values were determined on the basis of standardized climatic water balance (CWB) values for which potential evaporation was calculated by the Penman-Monteith method.
It was found that the average RCWB values show a decreasing tendency, in particular in the last decade of years (2011-2020). The RCWB changes were the result of an increase in the moisture deficit and a greater frequency of moderately dry, very dry and extremely dry periods. This is especially true in the south of the country with historically higher rainfall.
RCWB changes were compared with the average national yields of crops (cereals, root crops and industrial plants) obtained from the Public Information Bulletin of the Central Statistical Office. The response to plant yielding was different and varies depending on the species analyzed. Adaptation measures for climate change can also were noticed, expressed in the regionalization of crops, the selection of varieties and changes in agrotechnics.
Simultaneously, simulations and assessment of changes in the hydrothermal index (HTC) in the context of expected climate changes and plant water needs were presented. Daily values of air temperatures and precipitation were generated for current and expected conditions according to SRES and RCP scenarios and was calculated for hydrothermal index HTC in rolling 30-day periods from April to September.
The course of the hydrothermal index values was presented in graphs for mean values, standard deviations, 99% of critical areas and empirical probabilities of extremely dry, very dry, dry and fairly dry periods for 2060-2080.
Keywords: climate, climate change scenarios, crop production.

DETERMINATION OF PUMPKIN VARIETY CANDIDATES SUITABLE FOR ROOTSTOCK

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ABSTRACT
The rootstocks used in vegetable species are known to provide tolerance to both biotic and abiotic stress conditions, and to provide benefits to the early growth, yield and quality characteristics on the scion. The use of rootstocks is almost necessary for plants to build resilience to the ever-increasing negative soil stress conditions. Therefore, the identification of genotypes with the potential to be tolerant to all kinds of stress factors in the soil constitutes the basic principle of rootstock breeding. This study was carried out to determine the pumpkin variety candidates that can be used as rootstocks in grafting by growing the pumpkin lines in our existing gene pool into seedlings and to determine some of the characteristics of these lines and to obtain scientific data for the possibility of using them in rootstock breeding. Some morphological parameters were examined in 40 pumpkin lines used for the study. According to the data obtained, it was determined that the seeds of the lines germinated between 37-100%, the cotyledon leaves became parallel between 6-10 days and the first true leaves emerged between 10-12 days. Hypocotyl length varied between 11.76-64.63 mm, hypocotyl diameter between 2.32-7.04 mm, while root length varied widely between 11.16-32.60 cm. Pumpkin rootstocks are important rootstocks used in Cucurbitaceae. The fact that these rootstocks are known to have a strong root system will facilitate the uptake of water and nutrients and therefore the grafted plants will have stronger plant growth. In addition, it is thought that knowing the most effective ratios of length and thickness in the hypoctoil part will be effective on the success of compatibility in grafting.
Keywords: Rootstock, Grafted Seedling, Pumpkin, Stress

THE MOST COMMON MISTAKES IN WRITING RESEARCH ARTICLES IN ENVIRONMENTAL AND HEALTH STUDIES

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ABSTRACT

Writing an article in environmental and health studies can cause numerous problems and speculations for non-English speakers. The aim of this paper is to focus on the most common mistakes that can occur while writing a research article, or thesis. It mainly presents the popular challenges, commonly known to the authors, such as language errors, repetitions, or grammar mistakes. It also draws attention on the topic of the lack of prosperous structure, that often leads to unprofessional reception of the article. Furthermore, it describes the issues concerning the usage of specific names form given scientific fields, which can be posing many problems even for specialists in a given area of studies. Last but not least, the paper describes the potential influence of plagiarism that negatively affects the thesis and its reception in scientific community. It also explains the phenomenon of Chat GPT and disputes whether it is going to positively or negatively affect the process of creation scientific writings.

Keywords: environmental and health studies, writing, grammar mistakes, specialized vocabulary, plagiarism, chat GPT

CURRENT CHALLENGES OF SUSTAINABLE DEVELOPMENT IN HUMAN ENVIRONMENT - POLAND CASE STUDY

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ABSTRACT
Thanks to high GDP growth, the Polish economy ranks 8th in the EU. Sustainable development occupies a key place among the development priorities of global societies and economies. In today's world, sustainable development becomes a kind of compromise between environmental, economic, social and health goals that determine the survival and well-being of the present and future generations. This means securing resources in the form of natural, man-made material, intellectual and social capital. The social aspect, which is usually equated with education and gaining the ability to solve social and health problems, is a particularly important challenge for present and future generations. The challenges faced by humans in the context of the ongoing COVID-19 pandemic and after it seem to be extremely important. The evolutionary but visible nature of changes in the human environment is a natural process, caused by the need to adapt to the changing reality as well as the economic and social environment in every country. Therefore, it is important that this mostly literature study allows to design and propose a model of sustainable development of human environments, as well as to meet the current and future challenges in the functioning of health care, especially in the aspect of the COVID-19 pandemic and the production of healthy food in harmony with the natural environment in Poland.
Keywords: sustainable development, human environment, pandemic,

THE EFFECT OF MELATONIN ON POLYSOMATIC AND NON-POLYSOMATIC SEEDS GERMINATION

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ABSTRACT
Polysomatic seeds contain cells with varying degrees of endopolyploidy in their tissues. This phenomenon results from the endoreduplication process, which consists of successive cycles of DNA replication with the simultaneous blocking of mitosis. This process has been observed in various tissues and organs of many higher plants. However, there are also plants/seeds/organs/tissues in which the process of endoreduplication does not take place and is referred to as non-polysomatic. Melatonin is a universal signalling molecule that plays a vital role in protecting plants from environmental stresses, and there are indications that it also affects the cell cycle. The aim of the study was to analyze the effect of melatonin on the intensity of DNA synthesis during germination of polysomatic seeds of common bean (*Phaseolus vulgaris*) and non-polysomatic seeds of sunflower (*Helianthus annuus*). Sterile seeds of the tested species were sown on filter paper moistened with distilled water (control) or melatonin solution at 100 µM or 500 µM and were incubated at 15°C in darkness. Energy and germination capacity were determined. Using flow cytometry, the intensity of DNA synthesis in mature seeds, in seeds during germination *sensu stricto*, and in young seedlings after radicle protrusion was estimated. Cytometric analyzes confirmed the presence of cell nuclei with DNA content from 2C to 128C in common bean, which proved polysomaty of the seeds. In sunflower seeds, only nuclei containing 2C and 4C DNA content were present, which indicated that the seeds of this species are non-polysomatic. The results of the laboratory germination tests revealed a positive effect of melatonin on the germination of seeds of both species, however, in the case of polysomatic seeds it was greater. The use of 100 µM melatonin concentration turned out to be the most effective variant. In common bean, using melatonin at the concentration of 100 µM caused a change in the intensity of DNA synthesis both in the axis and cotyledons.
Keywords: cell cycle, endoreduplication, flow cytometry, melatonin

GENOME SIZE DIVERSITY OF THE SELECTED PHACELIA SPECIES

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ABSTRACT
Phacelia belongs to the family Hydrophyllaceae and is the most numerous and diverse genus, comprising approximately 200 annual herbaceous plants and perennials native to North and South America. *Phacelia* is most abundantly represented in the western United States and northern Mexico. Species of *Phacelia* are primarily cultivated as ornamental plants. The most significant species in terms of utility is blue phacelia (*Phacelia tanacetifolia*), which is highly attractive to bees. The honey produced from phacelia has medicinal applications due to its antibacterial and anti-inflammatory properties. The aim of this study was to determine the nuclear DNA content, which can be used as a parameter for the preliminary identification of species. The research material included forty species of phacelia. Cytometric analyses were conducted following the procedure established by Jedrzejczyk and Śliwińska (2010). Three different internal standards were used for genome size estimation: *Raphanus sativus* 'Saxa' (1.11 pg/2C), *Solanum lycopersicum* 'Stupicke' (1.96 pg/2C) and *Zea mays* 'CE-777' (5.43 pg/2C), depending on analyzed target species. Measurements were performed using a CyFlow SL Green flow cytometer (Partec, Germany). The 2C DNA content was calculated based on the proportional relationship between the mean peak position of the studied plant and the internal standard. Statistical analysis revealed significant differences in genome size among the studied species, ranging from 1.00 pg/2C (*Ph. cilliata*) to 3.61 pg/2C (*Ph. egena*). All analyzed species exhibited very small and small genomes. Among the forty studied species, 18% could be distinguished based on the genome size, indicating that flow cytometry can be used to identify some species within the genus *Phacelia*. The next step of the research will focus on the possibility of using SCoT molecular markers to identify and assess genetic diversity in the studied species of phacelia.
Keywords: DNA content, flow cytometry, *Phacelia*, genome diversity

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ZOOPLANKTON - A ROBUST INDICATOR OF LAND USE IN A RIVER CATCHMENT

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ABSTRACT
Land use forms can significantly impact interspecies interactions in aquatic ecosystems. We tested the hypothesis that catchment management distinctly influences the dynamics, significance, and types of relationships within the zooplankton community structure of a postglacial river (northern Poland). Zooplankton interspecies interactions were assessed using network graph modeling across four diverse catchment sections: natural (NAT) urban (URB), urban/agricultural (URB/AGR), and agricultural (AGR). The natural river zone exhibited significant habitat heterogeneity. The NAT network was the most cohesive, dominated by taxa feeding on various food sources (*Asplanchna priodonta, Testudinella patina, Chydorus sphaericus, Thermocyclops crassus*), with balanced positive and negative interactions, what sign of ecosystem balance and resistance. The intensification of urban and agricultural pressures led to a weakening of the strength and significance of negative interspecies relationships, causing decentralization of the URB and AGR networks. Small, common bacterio-detritophagous and actively feeding rotifers (*Filinia terminalis, Anuraeopsis fissa, Polyarthra longiremis*) played a key nodal role there, which indicates homogenization and reduced ecosystem resistance. The graph layout highlighting connected components allowed us to observe the environmental filtering process between the studied sections, identifying phenomena of adaptation, or elimination of zooplankton species. This study provides an innovative approach to understanding the functioning of biotic structures in rivers and underscores the importance of sustainable management strategies of river basins undergoing urbanization and agricultural expansion.
Keywords: zooplankton network, interspecyfic interactions, graph modeling, river ecosystem health

FUTURE OF PHOTOVOLTAICS

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ABSTRACT

Photovoltaics, a technology for converting sunlight into electricity, is gaining importance in the global energy mix. With growing energy needs and the need to reduce greenhouse gas emissions, its future looks promising.

Technology development: New materials, such as perovskites, and bifacial technologies, which use incident light on both sides of the panel, are expected to significantly increase the efficiency of photovoltaic systems.

Integration with other technologies: Photovoltaics will increasingly be integrated with energy storage and heat pumps for better energy management. Virtual prosumers will be able to sell surplus energy to the grid, increasing the profitability of investments.

Applications in various sectors: Photovoltaics will find applications in the residential, industrial, agricultural and transportation sectors, helping to reduce fossil fuel consumption.

Challenges and prospects: The main challenges are high initial installation costs and dependence on weather conditions. However, with advances in technology, photovoltaics have the potential to become one of the world's major energy sources by the middle of the 21st century.Moreover, the versatility of photovoltaic technology allows for its application in diverse environments, from urban rooftops to rural farmlands, and even in remote areas where traditional power grids are not feasible. This widespread adoption can significantly reduce greenhouse gas emissions and dependency on fossil fuels, contributing to global efforts to combat climate change. Innovations in materials science, such as the development of perovskite solar cells, promise to further revolutionize the industry by offering higher efficiency rates and lower production costs.

Keywords: New Technologies, Photovoltaic, Challenges, Efficiency

DRYING PEACH AND APRICOT PULPS UNDER DIFFERENT CONDITIONS AND DETERMINING QUALITY PARAMETERS

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ABSTRACT
In this study, peach and apricot pulps were dried in shade and sun conditions with oven dryers, vacuum dryers, laboratory type convective dryers at temperatures of 50°C, 60°C and 70°C, and the most suitable drying method and temperature were determined. In addition, drying performance, mathematical modeling, color values, acidity value (pH), titratable acidity (TA) and water-soluble solids (WSS) values were determined. Mold formation was observed in peach and apricot pulps dried in shade. Considering the drying performance, the shortest drying time was determined as 4.5 hours for peach pulp and 5.5 hours for apricot pulp at 70°C in a laboratory type convective dryer. Different equations were used in mathematical modeling. Among these, the model that best predicted the drying curves was Wang Sing for peach pulp and Page for apricot pulp. When the color values of peach pulp were examined, it was determined that the closest to fresh L value was 50.84 and b value was 25.92 in the oven dryer at 50 °C and vacuum dryer at 60 °C. In apricot pulp, it was determined that the closest to fresh L value was 55.78 and b value was 34.58 in the vacuum dryer at 60 °C and 70 °C. When the chemical analyzes were examined, it was determined that the closest to fresh pH value for peach pulp was 4.17, TA value was 1.15 and WSS value was 52.5 in the vacuum dryer at 60 °C. For apricot pulp, the values closest to fresh were determined to be pH 4.38, TA 1.68 and WSS 63.0 in the vacuum dryer at 70 °C. When all data were examined considering the quality parameters, it was determined that the most suitable drying method for peach and apricot pulp was the vacuum dryer and the most suitable drying temperature was 60-70 °C.
Keywords: Peach, Apricot, Pulp, Drying, Color, Modeling

ALUMINOSILICATES APPLICATION AS A METHOD OF DRY SANITISATION OF LITTER IN SLAUGHTER CHICKEN PRODUCTION

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ABSTRACT
The microbiological quality of the animal husbandry environment is a factor influencing the level of health risks associated with the raw materials used for food production. High total microbial counts and the presence of indicator and potentially pathogenic microorganisms in the litter used in poultry farming can lead to an increased risk of contamination of eggs and meat, and a higher frequency of food poisoning in consumers of these products. Implementing appropriate practices to reduce the level of microbial contamination in litter has a positive impact on both animal welfare and food safety. The aim of the present study was to determine the hygienization efficiency of aluminosilicates used for dry sanitisation of litter in slaughter chicken production. The experiment lasted 6 weeks and microbiological analyses of the litter were carried out immediately after the start of the experiment and after 2, 5 and 6 weeks. The aluminosilicate mixture (80% zeolite, 20% halloysite) was applied to the litter at different frequencies: for experimental groups 1, 2, 3, a single application (day 1), two applications (days 1 and 21) and six applications (days 1, 7, 14, 21, 28, 35), respectively, of 125 g aluminosilicate per 1 m^2 were applied. The control group K, on the other hand, was maintained on cut cereal straw bedding without the addition of aluminosilicate. Microbiological analyses included determinations of total microbial counts and fungal counts. Isolation of microorganisms was carried out by standard culture methods using solid general and selective media. Preliminary results from analyses of total microbial counts and fungi suggest no effect of aluminosilicates on their concentration in poultry litter. A significant increase in the number of microorganisms tested was observed at each of the subsequent analysis dates. Initial total microbial counts reached 10^7 - 10^8 cfu-g^{-1} and fungal counts 10^8 cfu-g^{-1}. After six weeks of cultivation, these values were 10^{16} and 10^{10} cfu-g^{-1}, respectively. The rapid increase in the number of microorganisms in the litter was related to the increasing amount of organic matter from the animals' digestive tract.
Keywords: microorganisms, poultry litter, aluminosilicates, sanitisation

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AN INCREASE IN THE NUMBER OF REVISIONAL BARIATRIC SURGERIES.

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ABSTRACT
Recently, an increasing number of revision bariatric surgeries has been observed, which is probably related to the huge number of procedures performed, increasingly better long-term follow up and a change in the approach to treatment planning. Currently, we are planning staged bariatric treatment of extremely obese patients, which itself forces planned revisional procedures. In my work, I analyze the material from my own department, comparing it with the works published in recent years, particularly common early and late complications and the ways in which they are treated. The most common primary procedures were sleeve gastrectomy and Roux en Y gastric bypass. The most common revision surgeries were conversion from sleeve gastrectomy to Roux en Y gastric bypass and hiataloplasty. The most common early complications for all procedures were bleeding and anastomotic leaks. As for late complications for sleeve gastrectomy, were exacerbation of reflux disease and sleeve stenosis. For gastric bypass, internal hernias and also anastomotic stenosis were observed most frequently. In my own material, I have observed a change in the qualification method for primary bariatric procedures related to late postoperative complications. Currently, we perform primary gastric bypass or sleeve gastrectomy with simultaneous hiataloplasty much more often, hoping that it will decrease the number of complications in the future.
Keywords: revisional bariatric surgery, bariatricstaged treatment, bariatric follow up, late complications of bariatric surgery.

THE MOST COMMON INJURIES IN MIXED MARTIAL ARTS AND THEIR CONSEQUENCES

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ABSTRACT
The aim of this work is to understand and analyze the side effects of Mixed Martial Arts (MMA), their long-term effects on health, precautions, and the crucial role of recovery in this sport. MMA is rapidly gaining popularity worldwide; the rules, equipment, and the allowed techniques are continuously modified to make it safer for the fighters. At the beginning of this sport, athletes fought without any gear (bare-knuckle), but the rules were updated, and the design of the gloves have been improved, which minimizes the risk of injuries. In my presentation, I will address the most common injuries in MMA and their consequences. As the author, I have trained in Mixed Martial Arts and participated in numerous tournaments, which has led me to conduct an in-depth analysis of this topic. The main points of my work include brain damage, fractured bones, muscle injuries, joint injuries, and overtraining along with their causes and impacts on athletes. In my project, I examine the beginnings of these injuries and their effects on the human body. Understanding these causes and effects can help in developing better preventive and rehabilitative strategies for fighters and their physiotherapists during the preparatory period and in the recovery phase.
Keywords: Injuries, Health, Mixed Martial Arts, Improvement, Recovery

HOW CAN SUBIRRIGATION AND SILICON APPLICATION AFFECT BIOMASS YIELD AND CARBON DIOXIDE BALANCE OF A THREE-CUT MEADOW?

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ABSTRACT
Climate change and the associated droughts and water shortages significantly affect agricultural productivity. This situation, combined with an ever-increasing demand for food, is forcing a search for solutions to increase yields while reducing water use. Furthermore, in the face of ever-increasing CO_2 emissions, it is crucial to take action to reduce emissions not only from industrial areas but also from agricultural. One possible solution to this problem is using antitranspirants (AT)- products that reduce plant transpiration. Antitranspirants are mainly used on fruit and vegetable crops, whereas their use in grassland areas has not received much attention.
This study aimed to determine the effect of the application of silicon-containing antitranspirant on the yield and net exchange of carbon dioxide fluxes in a three-cut meadow with a subirrigation system. Field measurements were conducted on a meadow in Poland in 2021-2022. For the duration of the experiment in the subirrigation system, a closed valve on the ditch was left, thus obtaining two study sites: one with a high groundwater level and the other with a lower groundwater level. Within each, two plots (one with and one without AT application) were separated. CO_2 fluxes were measured using the dynamic closed chamber method. Furthermore, the yield obtained was assessed during each cut. This study showed that applying an antitranspirant with silicon reduced the yield of the meadow in each cut in both the sites with high and lower groundwater levels. The annual reduction was 11.1-17.8%. It was also observed that in the first year of measurements (2021), net CO_2 emissions predominated in the meadow, while in the second year (2022), net CO_2 assimilation dominated. There was a positive effect of the AT application on increasing gross primary production (GPP), but only in the site with high groundwater levels. The cumulative annual net ecosystem exchange (NEE) values indicate that the AT with silicon application improves the meadow carbon balance (by reducing net emissions or increasing net assimilation depending on the year) in the site with a high groundwater level.
Keywords: grassland; net ecosystem exchange; CO_2 emission; subirrigation; groundwater level; yields; silicon; antitranspirant

PAST CHANGES AND FUTURE PREDICTIONS HEAT WAVES (POLAND AND TURKEY CASE STUDY)

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ABSTRACT
The aim of this study is to present the temporal and spatial variability of past and future heat wave changes. The study material comprises daily air temperatures from 1970-2023 from 10 and 8 meteorological from Poland and Turkey respectively. To project air temperature in the years 2024-2100 the data from nine Global Climate Models (GCMs) were integrated under two emission scenarios: SSP245 and SSP585. The GCMs utilized include the Norwegian Earth System Model version 2, medium resolution (NorESM2-MM); Max Planck Institute Earth System Model version 1.2, high resolution (MPI-ESM1-2-HR); European Consortium Earth System Model version 3 (EC-Earth3); Alfred Wegener Institute Climate Model version 1.1, medium resolution (AWI-CM-1-1-MR); Beijing Climate Center Climate System Model version 2, medium resolution (BCC-CSM2-MR); Meteorological Research Institute Earth System Model version 2.0 (MRI-ESM2-0); Geophysical Fluid Dynamics Laboratory Earth System Model version 4 (GFDL-ESM4); Community Earth System Model version 2 with Whole Atmosphere Community Climate Model (CESM2-WACCM); and the Euro-Mediterranean Center on Climate Change Climate Model version 2, strategic research configuration (CMCC-CM2-SR5). To ensure consistent comparison and enhance the reliability of the aggregated projections, we standardized each model's data to a uniform grid resolution through regridding and bias correction techniques. We then applied Bayesian Model Averaging (BMA) to combine the outputs from these models. This approach provides a probabilistic forecast with quantified uncertainties, offering a more comprehensive understanding of potential future climate scenarios in the studied regions. The intensity and duration of heat waves were calculated based on daily air temperatures using the heatwaveR package developed by Schlegel and Smit (2021). Considering the location of case study countries in the Northern Hemisphere, we focused our analysis on summer to define heatwaves. The direction and extent of heat waves changes were conducted using the Mann–Kendall and Sen's tests by means of the modifiedmk package developed by Patakamuri and O'Brien (2022). The detection of single change points in heat waves time series data was conducted using the Pettitt test by means of the trend package developed by Pohlert (2023).
Keywords: climate change, trends, RCP245, RCP585, air temperature, multi-model ensemble, heat stress

GREEN ROOFS AS A SOLUTION FOR RAINWATER RETENTION IN URBAN AREAS

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ABSTRACT
Increasing urbanization and the sealing of more and more land contribute to reducing retention and increasing rainwater runoff from urban areas. One way to store water is green roofs. This solution makes it possible to significantly reduce the volume and intensity of rainwater runoff from rooftop surfaces or even make it disappear in the initial phase of rainfall. The retention capacity of the roof is directly related to the thickness of the applied ground layers and the drainage design solution.
This study aimed to determine the amount of water retreated by different green roof type. The experiment tested three green roof models: extensive, intensive and mixed. The models differed in the type of vegetation, the substrate used and the drainage layer. An automatic irrigation system simulating a preset amount of rainfall was installed on each model. The tests were performed two times (variants) to reflect different meteorological conditions. The first variant included wet conditions - before the experiment, the roofs were irrigated daily. The second variant, extremely different reflected dry conditions - no rainfall. In each variant, sprinkling of the surface of each of the three individual green roof models was carried out at a rate of 1.8 l/min for 15 minutes in a series of 6 repetitions. After each repetition, the volume of runoff water was measured, and the relative retention rate was calculated. The highest value of runoff volume was obtained from the extensive roof and was 8.18 l under wet conditions. The same conditions achieved 4.45 l for an intensive roof and 1.83 l for a mixed roof. Analyzing the results obtained in dry conditions, it can be seen that the outflows were smaller than in wet conditions. This trend is evident for all three models. The highest value was obtained for the extensive roof and was 3.96 l , and the lowest value of 1.08 l for the mixed roof. Moreover, the time after the outflow from each type of roof occurred was measured. The longest delay time for drainage was on the mixed roof under dry conditions and amount 14 minutes and 44 seconds. The best result for the mixed roof was also achieved in wet conditions. The extensive roof achieved the shortest runoff delay values of 3 min 51 seconds under dry conditions and 4 min 42 seconds under wet conditions. This indicates its lowest retention efficiency relative to the other solutions. Confirmation of the high rainwater absorption capacity of green roofs is the retention rate. It varies in wet conditions in the range of 70%93%. The above solutions present even greater absorption capacities in the dry season, where the retention rate increases and ranges from 85 to 96%. During the experiment, the mixed roof distinguished the highest retention rate, which achieved a value of 96% in dry conditions and 93.22% in wet conditions. The lowest retention rate of all three models was achieved for the extensive roof in wet and humid conditions. These results are consistent with the trend observed for runoff delay time.
Keywords: green roofs, rainwater management, surface sealing, retention in urban areas.

IMPACT OF TRANSPORT ACCESSIBILITY ON THE RURAL DEVELOPMENT - CASE STUDY FROM POLAND

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ABSTRACT
Transport accessibility affects the distribution of population and the inflow of capital. The higher it is, the better the conditions for demographic and economic development. Hence, analyses and monitoring of transport accessibility in the selected area seem to be justified.
The paper determines the communication accessibility of selected rural areas, considering the distance, time and cost of travel. The analysis takes into account transport accessibility using the public system and private. Accessibility was measured by indicators of the infrastructure equipment including the direct, physical, real and time distance to the required destinations. Access to public services was analysed, as well as the spatial arrangement of public transport stops.
GIS tools were used in the spatial analysis, and communication accessibility indices and the entrepreneurship index were also determined- as one of the determinants of economic development. The relationship between communication accessibility and the level of entrepreneurship in selected areas was verified. The research was conducted for the selected area in the Małopolska province in the south of Poland.
Keywords: public transport, accessibility, rural development, entrepreneurship.

COULD THE LOCAL WATER PARTNERSHIP IN LOWER SILESIA MITIGATE THE EFFECTS OF THE FLOOD IN 2024?

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ABSTRACT
Local Water Partnerships (LWP) is a program covering the entire territory of Poland. The idea of the program is to support cooperation and create a network of contacts between local society and institutions and offices in the field of water management in rural areas, with particular emphasis on agriculture. In the Lower Silesian Voivodeship, the initiative to create LWP was taken by agricultural advisory centers operating in individual counties. Water companies, local government authorities - commune, county, region, services of the State Water Management Polish Waters, units responsible for environmental issues, experts operating in the field of hydrology and hydrotechnics, State Forests and farmers were encouraged to join.
The Lower Silesian Agricultural Advisory Center organized a series of meetings, inviting lecturers from the University of Life Sciences in Wrocław, Wrocław University of Science and Technology, State Forests Institute of Meteorology and Water Management and Polish Waters. It should be added here that the institution that currently invests the most in water management is the State Forests, and we are not talking about maintaining existing infrastructure, but about new investments, or restoring infrastructure from several decades ago, which has been neglected and fallen into ruin.
The next step in the activities of the LWP projects was to prepare strategic action plans for broadly understood water management in each district. An important part of these plans was information collected from LWP members regarding planned and necessary investments. Unfortunately, public awareness, i.e. officials, residents, farmers, still does not reach the knowledge that in the processes of improving water retention, one of the most important elements is increasing its resources in the soil or slowing down the runoff of water in the event of heavy rainfall. The flood in September 2024 mainly affected districts located in mountainous areas. The greatest destructive effects were caused by the breach of the dam creating a dry flood reservoir in the town of Stronie Śląski, and LWP's activities had no influence on this. However, it should be acknowledged that the activities of the LPW in the field of promoting knowledge about water retention in the landscape could have had an immeasurable effect in the form of increasing awareness that not only the construction of embankments, but also slowing down the runoff of water from rainfall can provide even better protection against floods.
Keywords: local water partnerships, retention, flood 2024.

THE INFLUENCE OF CLIMATE CHANGE ON WATER REQUIREMENTS IN THE CULTIVATION OF *CUCURBITA PEPO* L. IN CENTRAL POLAND

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ABSTRACT
Sustainable horticulture aims to enhance crop productivity while minimizing environmental impact, which is particularly crucial in the era of global climate warming. This research aimed to assess the water requirements, trends in their changes, and rainfall deficits for summer squash cultivation in Central Poland. Estimates covered both reference (1981–2010) and forecasted periods (2021–2050), considering cultivation on bare and mulched soil. Monthly average air temperature and total precipitation projections for 2021–2050, based on the climate change scenario SRES: A1B, were utilized. Reference values were taken at the weather station. Water requirements were determined using the crop coefficient method based on reference evapotranspiration calculated by the Penman–Monteith method. Results showed higher water requirements in the forecasted period compared to the reference period, with an 8% increase for bare soil and a 9% increase for mulched soil. Notably, August exhibited a significant 16% increase in water needs regardless of the cultivation method. Rainfall deficits were more pronounced in the fore-casted period and during cultivation on bare soil compared to reference period and cultivation on mulched soil. The findings aid precise water tank capacity estimations for irrigation systems in summer squash plantations in Central Poland, contributing to efficient water management.
Keywords: evapotranspiration; global warming; irrigation management; rainfall deficit; soil drought

DETECTION AND ANALYSIS OF EMOTIONS BASED ON FACIAL EXPRESSIONS USING A MOBILE APPLICATION

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ABSTRACT
This article presents a mobile application designed for the detection and analysis of human emotions based on facial expressions. Leveraging advanced machine learning algorithms and computer vision techniques, the application captures and processes facial images to identify key emotional states, including happiness, sadness, anger, surprise, and neutrality. A dataset comprising diverse facial expressions was utilized to train the model, ensuring high accuracy and robustness across different demographics and lighting conditions. The application offers realtime feedback, enabling users to gain insights into their emotional states and fostering emotional intelligence. Additionally, the findings highlight the potential applications of this technology in mental health monitoring, user experience enhancement, and interpersonal communication. Future work will focus on integrating multi-modal data sources to enrich emotion analysis and exploring ethical considerations surrounding privacy and data security.
Keywords: Facial expresion, machine learning, dataset, mobile application

THE EFFECT OF OLD-GOLD CRIMSON (ogc-1), hp-1 and hp-2 GENES ON LICOPENE CONTENT IN F1 HYBRID TOMATO LINES

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ABSTRACT
Natural and high nutrient foods play an important role in human health and nutrition. As a matter of fact, with the production model that prioritizes continuity and efficiency in order to meet the nutritional needs of the growing world population, food quality has become secondary, and people have not been able to eat properly. As the effects of lycopene, a natural antioxidant, on human health have become known, the importance of its amount in foods has been better understood. The aim of this study was to determine the effect of ogc-1, hp-1 and hp-2 genes on lycopene content in F1 hybrid tomato (*Solanum lycopersicum*) lines when they are present separately or together in their parents. Among the 65 F1 hybrid lines resulting from crossbreeding, 10 F1 hybrid lines do not contain these genes similar to their parents. The 10 F1 hybrid lines with no gene in their parents had the lowest lycopene content at 6.66 mg (100g). Lycopene content in F1 hybrid lines containing these genes in their parents was determined between 7.49-11.47 mg (100g). As a result of the research, it was observed that the hybrid lines containing hp1 and ogc1 genes together in the paternal lines contained the highest lycopene content of 11.47 mg (100g). The results showed that the parents containing these genes increased the lycopene content in the crossbred F1 hybrid lines with each other.
Keywords: Quality, Lycopene *ogc-1, hp1 and hp2, Solanum lycopersicum*

INVESTIGATION OF WEST NILE VIRUS CURRENT STATUS IN EAST MEDITERRANIAN REGION BY USING GIS

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ABSTRACT

West Nile Virus (WNV) is a mosquito-borne RNA virus that has recently regained prominence, triggering various neurological symptoms in humans, horses, birds, and wild animals. The symptomatic WNV infection cases, which have been intensively detected in recent years, have shown that mosquito-borne diseases have the potential to become a significant public health problem in our country and have demonstrated the need for a comprehensive faunistic list of mosquito species transmitting the virus.

In our project, extensive field studies are planned to be conducted in coastal localities of Mersin and Adana. By identifying the species of mosquito samples collected from these areas and we aimed to map the risk of WNV infection using geographic information systems. Our project is expected to contribute to the findings of similar studies previously conducted in our country. Additionally, the project's broad sampling area, the isolation of arboviruses from mosquitoes, and the production of risk maps distinguish it from its counterparts in terms of scope depth.

In our study live mosquito samples has been collected in the afternoon and evening hours using mechanical aspirators and light traps at 19 designated localities. Field studies has been conducted three times for each locality during the summer months.

A database has been created using geographical and climatic data recorded, along with other environmental parameters obtained from satellite images. Parameters that support the presence of WNV vector mosquitoes has been identified. Risk maps showing current and future projections of the study areas has been produced using ecological niche modeling with MaxENT software. The weights of the criteria affecting mosquito distribution and presence has been determined using Analytical Hierarchy Process (AHP) Analysis software.

In conclusion, it is expected that local government environmental health teams will consider these maps, contributing to vector control efforts.

Keywords: West Nile Virus, Mosquito, Epidemiology, GIS, Turkey

INTERDYSCYPLINARY MANAGEMENT OF LIFE-THREATENING SEVERE OBESITY IN CHILDREN

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ABSTRACT
Obesity is a chronic, recurrent disease associated with pathological accumulation of adipose tissue. The etiology of simple obesity is a positive energy balance. Secondary obesity is associated with endocrine disorders, medications taken and genetic diseases. Treatment is based on strict adherence to dietary recommendations, regular physical activity, psychological support, drug treatment and bariatric treatment. The exponentially increasing number of children with severe obesity results in the tragic consequences. Obesity diagnosed in two patients hospitalized at the University Clinical Hospital No. 1 in Szczecin had different causes. The 9-year-old boy with Prader-Willi syndrome, severe obesity (73.5 kg, 137 cm), obstructive sleep apnea, hypertension and status post myocarditis, was hospitalized due to recurring episodes of desaturation up to 70-80%. A physical examination revealed a tonsillar hypertrophy, but the boy was disqualified from tonsillectomy due to persistently elevated inflammatory exponents. Respiratory support using Bi-level Positive Airway Pressure was effective. The second patient was a 5-year-old girl with extreme simple obesity (87 kg, 120 cm), obstructive sleep apnea and hypothyroidism, hospitalized in the Intensive Care Unit for sudden cardiac arrest, caused by excessive fat tissue compressing the airway. Despite the treatment, tracheotomy and tonsillectomy, the girl remained unconscious during 7 months of hospitalization. Currently, her health is slowly improving as her weight drastically goes down. In both cases, serious consequences were observed due to non-adherence to dietary recommendations and lack of regular medical check-ups. The use of appropriate interdisciplinary treatment brought about dramatic improvement. Conclusions: Obesity has a significant impact on quality of life and on the development of the body. It underlies metabolic and systemic diseases, increasing the risk of cardiovascular episodes, as well as those resulting from the increased weight pushing down on the respiratory system. Proper interdisciplinary treatment is essential to return such patients to society.
Keywords: Obesity, OSAS, interdisciplinary treatment.

SUSTAINABLE EDUCATIONAL MATERIALS

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ABSTRACT
The resources nature provides to living beings are limited. Sustainability can be defined as methods of effectively utilizing these limited resources without depleting them. In this context, sustainability can be considered a roadmap for long-term coexistence between nature and living beings. Sustainability serves as a vital tool to prevent the increased burden on nature caused by uncontrolled consumption, selfishness, the encouragement of consumption through social media, and waste. When evaluating sustainability from a broad perspective, issues such as ecology, energy efficiency, and the prevention of unnecessary and uncontrolled consumption come to the forefront. These broader sustainability topics include, more specifically, the use of eco-friendly materials, waste management, recycling, and the organization of public and private spaces for energy efficiency.
The aim of this study is to establish a foundation that will contribute to the development of educational materials designed to raise awareness of sustainability in future generations and to pave the way for integrating sustainability into educational curricula.
Keywords: Sustainability, Education, Sustainable Educational Material

D-DIMER TO FIBRINOGEN RATIO IN PATIENTS WITH SYMPTOMATIC AND ASYMPTOMATIC CAROTID STENOSIS UNDERGOING CAROTID ENDARTERECTOMY OR STENTING

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ABSTRACT

Introduction: Stroke is a serious condition often caused by critical carotid artery stenosis. Surgical interventions like endarterectomy or stenting can reduce stroke risk. However, standardized guidelines for selecting patients for these procedures are unclear. Recent research suggests the D-dimer to fibrinogen ratio (DFR) may help predict cardiovascular events.

This study analyzed data from over 400 patients to explore whether the DFR could improve patient selection for surgery.

Objectives: To analyze data from patients undergoing surgical procedures for critical carotid stenosis. To assess whether there is a statistically significant difference in the D-dimer to fibrinogen ratio (DFR) between symptomatic and asymptomatic patients.

Materials and Methods: We recruited a total of 426 patients admitted to the Department of Vascular Surgery and Angiology with the indication for invasive surgical procedures — either carotid endarterectomy or stenting — between 2013 and 2023. Preoperative levels of D-dimer and fibrinogen were assessed in all patients. The cohort was divided into two subgroups: symptomatic and asymptomatic. Symptomatic patients were defined as those who experienced a stroke, transient ischemic attack (TIA), or amaurosis fugax within the six months preceding the operation.

D-dimer levels were measured in mg/L, and fibrinogen levels were measured in g/L. The D-dimer to fibrinogen ratio was calculated by dividing the D-dimer concentration by the fibrinogen concentration. The statistical significance was set at $p < 0.05$.

Results: We included a total of 426 patients who underwent surgical procedures between 2013 and 2023. Of these, 265 were men (62.21%) and 161 were women (37.79%). The mean age of the cohort was 68.97 years (median: 69, standard deviation: 7.38). The minimum age was 46 years, and the maximum was 94 years.

Of the total patients, 289 were classified as asymptomatic (67.84%) and 137 as symptomatic (32.16%). Symptomatic patients were defined as those who had experienced a stroke, transient ischemic attack (TIA), or amaurosis fugax within the six months preceding surgery (in accordance with guidelines). A total of 152 patients had diabetes (35.68%), compared to 274 without diabetes (64.32%).

The average D-dimer to fibrinogen ratio (DFR) was 0.26, with a range from 0.04 to 3.86 and a standard deviation of 0.37.

The mean DFR was significantly higher in asymptomatic patients compared to symptomatic patients (0.2826 vs. 0.2073, $p < 0.05$), as shown in Figure 1.

We also compared the DFR between men and women, as well as between diabetic and non-diabetic patients, but no statistically significant differences were observed in these comparisons ($p > 0.05$). Additionally, age did not have a statistically significant influence on DFR ($p > 0.05$). Furthermore, we assessed whether there were significantly more symptomatic patients in the diabetic group or if sex influenced the number of symptomatic patients; however, these differences were not statistically significant either ($p > 0.05$).

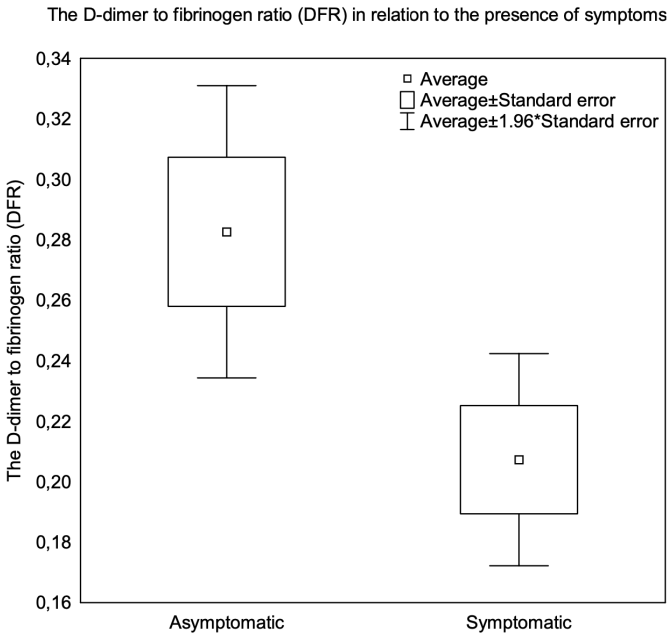

Figure 1 The D-dimer to fibrinogen ratio (DFR) values in symptomatic and asymptomatic patient groups. The DFR was statistically significantly higher in the asymptomatic group ($p < 0.05$).

Conclusions /Discussion: Current guidelines from the European Society for Vascular Surgery lack clear and standardized criteria for selecting patients who would benefit from carotid endarterectomy or stenting. Given this gap, there has been increasing interest in identifying reliable biomarkers to aid in clinical decision-making. Biomarkers related to coagulation and fibrinolysis, such as D-dimer, fibrinogen, and the D-dimer to fibrinogen ratio (DFR), have emerged as promising predictors of cardiovascular events.

DFR is a recognized indicator of thrombus activity in thrombotic diseases; however, its clinical role in acute cardiovascular events, particularly in relation to carotid artery stenosis, remains underexplored. Recent studies have demonstrated the potential of these biomarkers in various cardiovascular conditions. For example, Abebe et al. and Chen et al. highlighted the utility of D-dimer, fibrinogen, and DFR as affordable, non-invasive biomarkers for detecting ischemic stroke, particularly in hypertensive individuals, providing clinicians with an early diagnostic tool and improving therapeutic guidance.

Further research by Lin et al. has shown the relevance of the DFR in classifying stroke subtypes as cardioembolism and atherosclerotic stroke. Additionally, Afran et al. found that elevated levels of D-dimer and prothrombin fragment (F1+2) were associated with poorer event-free survival in patients with peripheral artery disease, underscoring the prognostic value of these markers for risk stratification.

Jiang et al. demonstrated that D-dimer levels at admission were independently predictive of short-term outcomes in patients with cardiogenic shock complicating acute myocardial infarction, adding incremental predictive value to traditional risk models. Similarly, Zhang et al. identified DFR as a potential independent predictor of in-hospital mortality in patients with acute myocardial infarction.

In our study, we observed statistically significant differences in DFR between symptomatic and asymptomatic patients with critical carotid artery stenosis. These findings suggest that DFR could serve as an additional factor in the preoperative assessment for carotid endarterectomy or stenting. Incorporating DFR into routine evaluation may improve patient selection, enhance surgical safety, and lead to better clinical outcomes in patients undergoing these procedures.

Keywords: D-dimer, stenting, carotid stenosis

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EXPLORING THE WELL-BEING NEEDS OF DOCTORAL STUDENTS: A PERMA MODEL APPROACH

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ABSTRACT
This study aims to explore the well-being of PhD students using the PERMA model, which includes five key elements: Positive Emotions, Engagement, Relationships, Meaning, and Accomplishment. Rooted in positive psychology and the cognitive-behavioral approach, the study highlights the importance of building resilience, leveraging personal strengths, and fostering supportive relationships to promote mental health and prevent burnout.Positive psychology focuses on what helps individuals face challenges effectively, offering strategies to improve mental well-being. The study also emphasizes the critical role of social connections, as strong support networks can significantly enhance the ability to manage stress.To guide this investigation, the research applies Martin Seligman's PERMA model (1990, 2011) to understand how these five dimensions contribute to overall well-being. By assessing doctoral students' perceptions of these areas, the study aims to identify their specific needs, preferences, and overall mental health status. The PERMA model serves as the framework for evaluating and operationalizing well-being in this context.The research was conducted on a group of 55 PhD students (32 women and 23 men), aged 24 to 49 (M = 30.58, SD = 5.77). We analyzed key aspects of the participants' well-being and its relationship with selected demographic factors such as age, marital status, living conditions, using various statistical tools, including Pearson's and Spearman's rank correlations, Shapiro-Wilk tests, and Wilcoxon and Friedman tests. Results revealed that participants generally reported high levels of engagement, positive emotions, and achievement, with notable preferences in the areas of emotional development, self-awareness, and goal setting. Age was positively correlated with several well-being indicators, suggesting that older students tend to experience greater emotional regulation and goal achievement. These findings highlight specific areas where interventions could be targeted to improve the well-being of PhD students in academic environments.
Keywords: well-being, researchers, PERMA model, needs

EFFECT OF POSTEMERGENTLY APPLIED HERBICIDES ON THE DEVELOPMENT OF SWEET WHITE LUPINE (*LUPINUS ALBUS* L.).

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ABSTRACT
Sweet white lupine (*Lupinus albus* L.) shows weak competitiveness against weeds and there is no authorized post-emergent herbicide in lupine species in Hungary. The Nyíregyháza Research Institute's 'Nelly'cultivar was sown on 24 April 2023 in weakly acidic sandy loam soil. On May 24th, we applied flumioxazin (0.06 kg ha^{-1}), chlortoluron (2.8 L ha^{-1}), prosulfocarb (2.5 L ha^{-1}), carfentrazone-ethyl (35 g ha^{-1}) and sulfosulfuron at two different doses (13, 17 g ha^{-1}). On June 2nd we sprayed in late post-emergence halauxifen-methyl at three different doses (0.4, 0.5, 0.6 L ha^{-1}) and halauxifen-methyl + picloram at two different doses (0.25, 0.5 L ha^{-1}). During the growing season, normalized difference vegetation index (NDVI) data sets were collected from the plants and did phytotoxicity examination to determine the effects of herbicides on lupines. Weed abundance was recorded from the plots. Post-harvest crop contamination and cleaned seed yields were compared. The plants were most sensitive to the two applied doses of halauxifen-methyl + picloram. The lowest seed yield values were also measured in these two treatments. Seed yield in control plots was exceeded by several post-emergent (flumioxazin, carfentrazone-ethyl, sulfosulfuron (13 g ha^{-1})) and late post-emergent (halauxifen-methyl (0.4, 0.5, 0.6 L ha^{-1})) treatments, but important to note, based on mean measured values halauxifen-methyl at 0.5 L ha^{-1} caused mild to definite symptoms, carfentrazone-ethyl caused definite symptoms and flumioxazin caused damage according to the applied phytotoxicity scale. Spearman's rho correlation results confirm the effectiveness of the recording methods. The re-testing of active substances found to be safe in this trial is justified to demonstrate selectivity in lupine.
Keywords: phytotoxicity, NDVI, seed production,

INTRODUCTION
Lupines can be grown for a variety of purposes, including as a valuable source of nutrients due to their high protein content, as a soil amendment, for pasture improvement, and as an ornamental plant (Uzun et al., 2007; Zsombik 2018; Zafeiriou et al., 2021). White lupine can be a significant grain legume in the farming system, such as in Ethiopia, where it is primarily cultivated on marginal lands for food, feed, soil fertility management, and income generation (Atnaf et al., 2020). Weed control can be a problem in lupine seed production in Hungary and internationally, due to the lack of applicable herbicides. The presence of weeds like annual ryegrass (*Lolium perenne* Gaud.), when germination occurs simultaneously with lupines, can significantly reduce grain yields, even by as much as 47% compared to a weed-free plant stand. The rate of reduction is in relation to the density of ryegrass plants. The seeds of lupine species can often be contaminated with several weed species, as some herbicidal active substances only control certain weed species and some are tolerant to certain herbicides (Allen,

1977). Weeds have a direct and indirect effect on the crop production efficiency. Weeds play a crucial role in attracting pests due to their availability as a "green bridge" for them between major crop sowings (Sá et al., 2009; Dalazen et al., 2017). The presence of certain weed species can significantly affect the degree of pest infestation in the field, suggesting a close relationship between weed management and pest control strategies in agricultural settings (Castro et al., 2020). Weeds have a negative impact on crop yields, as they compete for water and nutrients, and also take the place from the crop, making them undesirable plants (Gyawali et al., 2022). The presence of allelopathic weeds can disturb the growth of crop seedlings, affecting root and shoot development and causing oxidative damage, ultimately impacting seed yield (Abbas et al., 2018). The frequent lack of awareness among farmers regarding the economic and environmental implications of weed invasion necessitates multidisciplinary efforts to educate and implement effective weed control strategies (Gyawali et al., 2022). Herbicide application is a cost-effective and efficient method for weed control, contributing to improved crop productivity and profitability (Otieno, 2023). Flumioxazin is an active substance that functions as an inhibitor of protoporphyrinogen oxidase (PPO) in weeds (Radchenko et al., 2022). Chlortoluron is commonly used to control weed growth in cereal and poppy (*Papaver somniferum* L.) crops (Kočárek et al., 2005). Halauxifen-methyl is a novel synthetic auxin herbicide, part of the 6-aryl picolinate family, and due to the action of the active substance effect, tissue swelling, and stem twisting in plants occur, leading to growth inhibition and eventual plant death (Epp et al., 2018; Xu et al., 2022). Prosulfocarb is a thiocarbamate herbicide substance that has seen a rise in its utilization due to occurrence of weed resistance to other herbicides, and restrictions on different chemicals (Devault et al., 2019). Being a contact herbicide, carfentrazone-ethyl (aryl triazolinone) is absorbed directly through leaf tissues into the chloroplast, bypassing the need for translocation via xylem and phloem (Raudenbush et al., 2021). In susceptible plants, the sulfosulfuron functions as herbicide by blocking acetolactate synthase (ALS), an enzyme necessary for the synthesis of branched-chain amino acids, such as isoleucine, valine, and leucine (Chaleff & Mauvais, 1984). Sulfosulfuron is effective in controlling unwanted invasive annual grasses without significantly hindering the growth and physiology of desirable rangeland grasses, making it a useful management tool for rangelands (Monaco & Creech, 2004). Our research evaluated the effects of active substances that have not yet been tested in lupine species. Our study incorporated active substances that have been utilized in practical applications for a significant period, along with newly applied active substances. Several active substances with a broad spectrum of effects have been tested. Another aim was to test the effectiveness of the measurement methods used in the research.

MATERIAL AND METHODS

Experimental design and treatments

In the experiment, seeds of 'Nelly' cultivar (bred by the Research Institute of Nyíregyháza) were sown on weak acidic sandy loam soil. Randomized complete block design (RCBD) was used with plot sizes of 2 x 10 m in four replications. The seed rate was set based on the 1000 seed weight which was 240 g. Accordingly, a quantity of about 192 kg ha^{-1} was sown. Seeds were sown continuously on 24 April using a conventional seed drill, and plots were formed by a ground milling machine.

A Szolnok PP01HT sprayer, designed for experimental small plot purposes, was used to apply the active substances, thus minimizing spray drift. Flumioxazine (T1), chlorotoluron (T2), prosulfocarb (T8), carfentrazone-ethyl (T9), and sulfosulfuron (T10, T11) were applied in BBCH 2.3 when the base of some basal leaf was clearly separated from each other. Halauxifen-methyl treatments (T3, T4, T5) and halauxifen-methyl + picloram treatments (T6, T7) were applied late post-emergence at BBCH 2.5 developmental stage when several leaf bases are clearly separated (GRDC, 2017) (Table 1). The experiment was carried out in cooperation with the Plant and Soil Protection Department of the Szabolcs-Szatmár-Bereg County Government Office. The active

substances were selected in collaboration with the expert for weed control from the government office.

Table 1. Summarising herbicide active substances, doses, and treatment codes

Active substances	Doses	Codes
Flumioxazin	0.06 kg ha^{-1}	T1
Chlortoluron	2.8 L ha^{-1}	T2
Halauxifen-methyl	0.4 L ha^{-1}	T3
Halauxifen-methyl	0.5 L ha^{-1}	T4
Halauxifen-methyl	0.6 L ha^{-1}	T5
Halauxifen-methyl + Picloram	0.25 L ha^{-1}	T6
Halauxifen-methyl + Picloram	0.5 L ha^{-1}	T7
Prosulfocarb	2.5 L ha^{-1}	T8
Carfentrazone-ethyl	35 g ha^{-1}	T9
Sulfosulfuron	13 g ha^{-1}	T10
Sulfosulfuron	17 g ha^{-1}	T11
Control	-	T12

Methodology for the evaluation of herbicide effects

At plant flowering (BBCH 3.5) growing stage, normalized difference vegetation index (NDVI) datasets were recorded with the Trimble GreenSeeker HCS-100. The GreenSeeker sensor is utilized for non-destructive recording crop growth information in real time. By utilizing normalized vegetation indices such as rNDVI and rRVI, GreenSeeker enables accurate prediction of grain yield, correlating well with relative yield percentages (Zhang et al., 2019). The GreenSeeker is employed as an optical sensor unit for measuring plant stress-related characteristics efficiently. With its capability to calculate the NDVI, the GreenSeeker assesses the normalized difference vegetation index, offering insights into the vegetation's health status (Moroni et al., 2009).

We applied the herbicide test methodology defined by Dancza (2004), to evaluate their phytotoxicity, which we used in several studies (Juhasz et al., 2023; Juhász et al., 2024). As before, in the common vetch (*Vicia sativa* L.) and sweet white lupine, the recorded scale values have been converted to a form that the SPSS software can handle, as in the original Dancza method there are too large differences between the values, and this can produce misleading results. This means that the higher the value, the more harmful the herbicide was, with 9 being the maximum that could be given, which means total extinction (Table 2). It is important to note that it is likely to be difficult to give a completely symptom-free value and a value indicating extinction, as seed quality and sowing defects can sometimes seem phytotoxic in visual assessment, and sometimes time is needed for complete extinction of plots.

Table 2. The phytotoxicity score scale used in study

Symptoms	Score
No symptom	1
Very mild symptoms	2
Mild symptoms	3
Moderate symptoms	4
Mild damages	5
Severe damages	6
Serious damages	7
Very serious damages	8
Plant death	9

The 0.5 m x 0.5 m frame was applied for measuring weed density and weed species. This frame was essential for obtaining consistent and comparable data on weed presence and distribution across the different experimental conditions in the field (Parasca et al., 2024). By far the most numerous species in the area was the redroot pigweed (*Amaranthus retroflexus* L.). Weed monitoring can only be done easily for a limited period as it is difficult to find weeds after the foliage has closed. The weed monitoring was carried out when the lupine was in the flowering stage (BBCH 3.5). This method is also used in other research to determine weed density.

To simplify harvesting, desiccation was carried out on 10 August with diquat dibromide at a dose of 1.5 L ha^{-1}. On 22 August, we harvested with the Zürn 150 se plot combine. The harvested seeds were dried and then passed through a Westrup Kamas La Ls laboratory seed cleaner. The size of the sieves was as follows: the top 12 mm round, the bottom 4.25 mm oval. The post-cleaning seed yield and plant contamination, including broken seed, flat seed, weed seed, dried and green plant parts, were proportionally divided by percentage. The Westrup Kamas played a crucial role in preparing the samples for analysis, ensuring that the seeds were separated into distinct size groups for comparative quality testing (Kostić et al., 2008).

Changes in rainfall and temperature conditions during the growing season

The month with the highest rainfall was June, which was also the month of the flowering and ripening of the pods due to the late sowing. The lupine is sensitive to water deficit in certain phenological stages, such as germination, post-germination, pre-flowering, and seed development periods (Bélteky & Kovács, 1982). The growing season began in late April and ended in early August when the average temperature increased to varying degrees. The impact of temperature plays a role in yield components like seeds per pod, plant height, and ultimately, seed yield in sweet white lupine based on planting dates and temperature variations (Keeve et al., 2000). Table 3 shows the precipitation and temperature conditions that most impact the growing season.

Table 3. Rainfall and temperature trends during the growing season (Nyíregyháza 2023, Hungary)

	Growing season 2023					
	March	April	May	June	July	August
Precipitation (mm)	48.7	46.4	47.8	99.4	53.6	59.1
Temperature (°C)	7.0	9.8	16.5	19.7	22.4	22.8

Statistical analysis

The collected data on NDVI, phytotoxicity, weed number, and seed yield were separately imported into IBM SPSS software, where a post hoc test based on Duncan's was evaluated ($p < 0.05$). The relationships between the measured values were tested by Spearman's rho correlation at two levels of significance ($p < 0.05$; $p < 0.01$).

FINDINGS

The Normalized Difference Vegetation Index (NDVI) results obtained at the flowering stage on plots treated with herbicides

The control (T12) plots showed the highest NDVI value, which was significantly different from those measured on plots treated with flumioxazin (T1), chlortoluron (T2), and halauxifen-methyl + picloram 0.5 L ha^{-1} (T7). The plots treated with halauxifen-methyl + picloram 0.5 L ha^{-1} (T7) showed the lowest NDVI value. The halauxifen-methyl + picloram 0.5 L ha^{-1} (T7) treatment differed significantly from the other treatments (Figure 1).

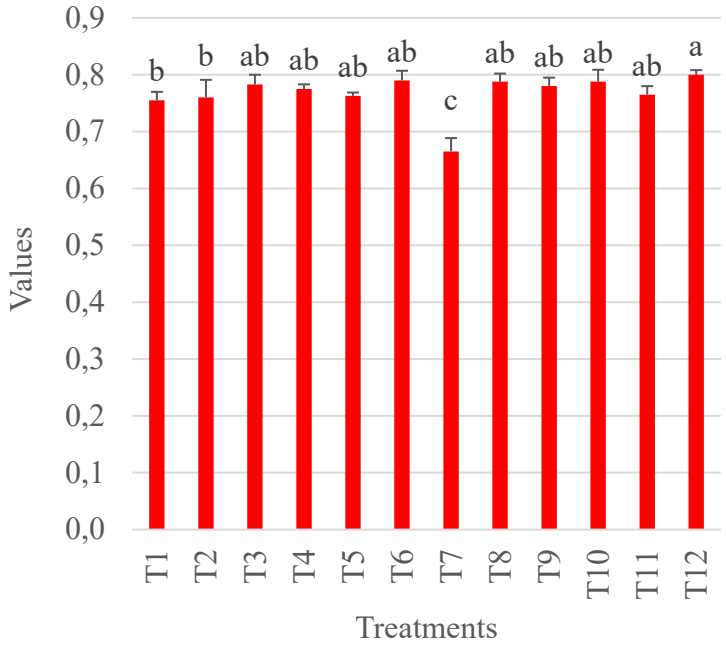

Figure 1. NDVI values for various lupine herbicide treatments are evaluated during the colored flower stage (mean+SD). Significantly different results between treatments are indicated by different small letters ($p<0.05$).

Results of the visually assessed phytotoxicity test

The lowest average phytotoxicity value was measured in plots treated with 0.4 L ha^{-1} of halauxifen-methyl (T3). The two treatments (T6 and T7) with the highest phytotoxicity differed significantly from the others. The plots treated with halauxifen-methyl + picloram 0.5 L ha^{-1} (T7) showed the highest phytotoxicity. This was closely followed by the plots treated with halauxifen-methyl + picloram 0.25 L ha^{-1} (T6) (Figure 2.).

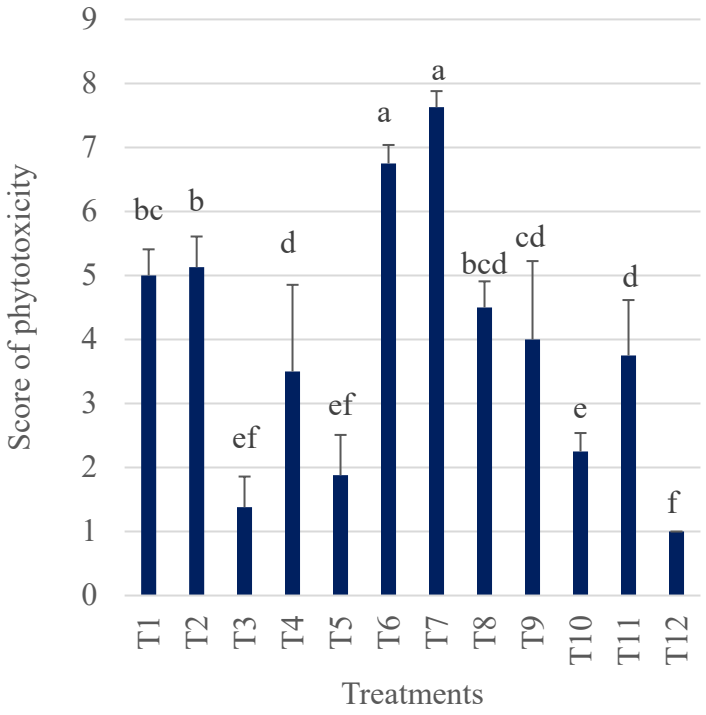

Figure 2. Phytotoxicity scores of herbicide treatments on lupine (mean+SD). Significantly different results between treatments are indicated by different small letters ($p<0.05$).

Photo documentation was taken of the plots 18 days after the late post-emergence treatments. The plot treated with halauxifen-methyl 0.5 L ha^{-1} (T4) was over-flowering in places, the plants were robust and healthy (Figure 3A). However, in plots treated with halauxifen-methyl + picloram at a dose of 0.5 L ha^{-1} (T7), flowering was delayed or largely absent, the plot was sparser and the plants were smaller (Figure 3B). Different doses of halauxifen-methyl + picloram (T6, T7) caused severe drying symptoms in plants.

(A) (B)

*Figure 3***.** The plot was treated by halauxifen-methyl 0.5 L ha^{-1} (T4) (A), and the plot was treated by halauxifen-methyl + picloram (T7) (B), 18 days after late post-emergent treatments.

Effectiveness of herbicides against weeds in the field

The lowest number of weeds was counted in the carfentrazone-ethyl (T9) plots. The highest number of weeds was found in halauxifen-methyl + picloram 0.25 L ha^{-1} (T6). There were no significant differences, only differences in tendency could be found (Figure 4).

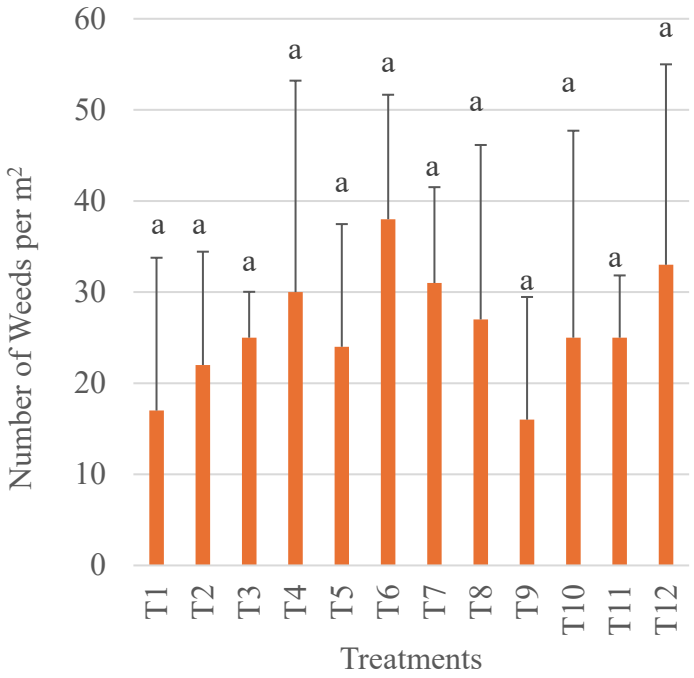

Figure 4. Effects of different herbicides on the number of weeds in the lupine experiment (mean+SD). Significantly different means between treatments are indicated by different small letters ($p<0.05$).

Effect of applied herbicide active substances on the cleaned seed yields

The lowest yields were measured in the halauxifen-methyl + picloram 0.5 L ha^{-1} (T7) treated plots, followed by the halauxifen-methyl + picloram 0.25 L ha^{-1} (T6) plots, which were significantly lower than the results of control plot and other treatments except for T8 (prosulfocarb 2.5 L ha^{-1}) and T11 (sulfosulfuron 17 g ha^{-1}) treatments. Plots treated with halauxifen-methyl 0.6 L ha^{-1} (T5) had the highest seed yield (Figure 5).

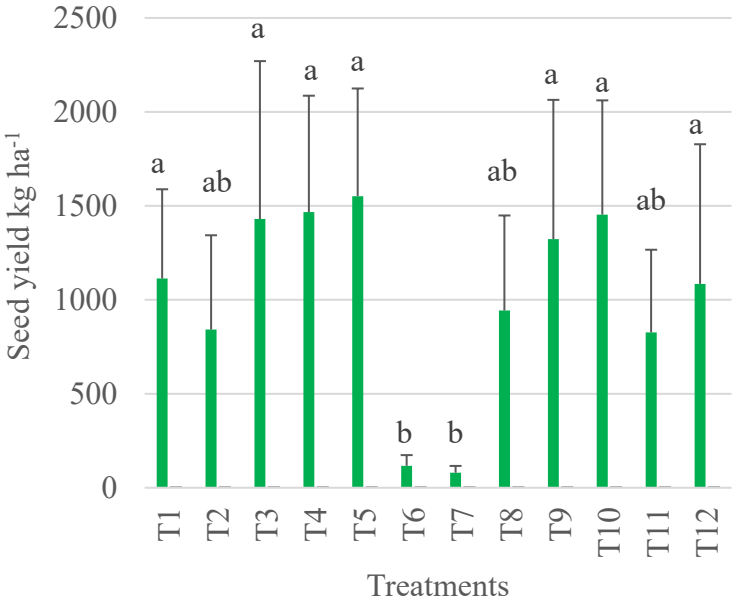

Figure 5. Effects of herbicide active substances on lupine seed yield (mean+SD). Significantly different results between treatments are indicated by different small letters ($p<0.05$).

The effect of herbicide treatments on the proportion of seed yield contamination with plant debris

The highest contamination (100 kg ha^{-1}, 46.1% of yield) was found in plots treated with halauxifen-methyl + picloram 0.25 L ha^{-1} (T6) (Figure 6). The plots treated with 0.5 L ha^{-1} halauxifen-methyl (T4) exhibited the lowest percentage of contamination (3.5%). This level of contamination corresponded to a weight of 53.3 kg ha^{-1}.

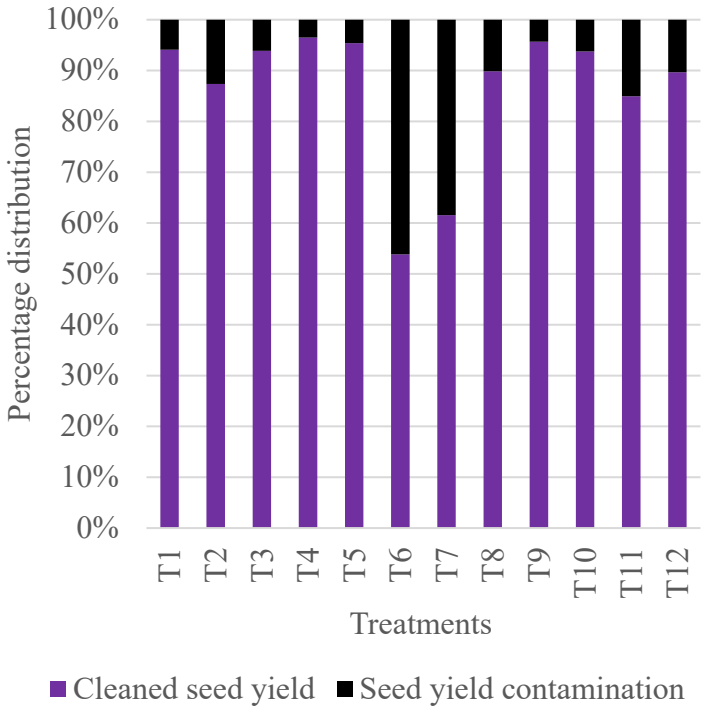

Figure 6. Comparison of the cleaned seed yield and seed yield contamination in lupine.

Spearman's rho correlation test results

There were both negative and positive correlations between the data sets. A negative correlation was found between NDVI values and phytotoxicity at the 0.01 level (r = -0.391). The relationship between NDVI values and seed yield exhibited a positive correlation, at the 0.05 level (r = 0.326). Also, there was a positive correlation between NDVI values and seed yield contamination at the 0.05 level (r = 0.296). The strongest negative correlation between phytotoxicity and seed yield was measured at the 0.01 level (r= -0.644). There was also a negative correlation at the 0.01 level between weed abundance and seed yield (r = -0.501) (Table 4.).

Table 4. Spearman's rho correlation results represented on a heat map

	Results of NDVI	Results of phytotoxicity	Number of weeds	Results of seed yields	Seed yield contamination
Results of NDVI	1.000	-0.391**	-0.055	0.326*	0.296*
Results of phytotoxicity	-0.391**	1.000	0.105	-0.644**	-0.118
Number of weeds	-0.055	0.105	1.000	-0.501**	0.219*
Results of seed yields	0.326*	-0.644**	-0.501**	1.000	-0.209
Seed yield contamination	0.296*	-0.118	0.219*	-0.209	1.000

**: The correlation is statistically significant at the 0.01 level. *: The correlation is statistically significant at the 0.05 level.

DISCUSSION

The most favorable value of 1.38 for the phytotoxicity results was obtained with ha-lauxifen-methly (0.4 L ha^{-1}) (T3). According to our knowledge, there is no published information regarding the use of halauxifen-methyl in lupine species. Phytotoxicity of halauxifen-methyl (5 g ha^{-1}) was tested in soybean field experiments (in Indiana) at different periods (0, 1, 2, 3, and 4 weeks before planting). None of the preplant intervals at any site showed soybean phytotoxicity in 2015. The halauxifen-methyl used one week before planting, and two weeks before planting at different sites in 2016 showed 0% to 15% phytotoxicity at 14 days after planting. Only 14 days after planting, unifoliate soybean leaves showed phytotoxicity. In any site year, halauxifen-methyl pre-plant application intervals had no impact on soybean stand counts or grain yield (Zimmer et al., 2019).

With no significant difference, carfentrazone-ethyl (T9) controlled the weeds best with 16 pcs m^{-2}. The efficacy of various doses of carfentrazone-ethyl in controlling complex weed flora in wheat was evaluated through a field experiment conducted in India during the season of 2020-2021. When used in different doses, carfentrazone-ethyl was better at managing weeds than 2,4-D amine (Sahu et al., 2023). Our results show some similarities

with the results of a study conducted in 1997. Following ploughing the white lupine genotype Detn 20 was sown in the United Kingdom. The pre-emergence application of carfentrazone- ethyl at 20 g ha^{-1} exterminated more plants than rimsulfuron but did not affect the vigor of the remaining plants. (Shield et al., 2000). In our experiment carfentrazone-ethyl (T9) had an effect on lupine with a moderate phytotoxicity (phytotoxicity score was 4). It was not among the safest active substances, causing severe drying and leaf curling, but interestingly its seed yield was above that of the control.

The lower dose of sulfosulfuron (13 g ha^{-1}) (T10) caused only very mild symptoms and seed yields were higher than the control (T12), but the higher dose (17 g ha^{-1}) (T11) caused mild to moderate symptoms and seed yields were below the control (T12). Sulfosulfuron has not yet been used in lupines, but a laboratory experiment has been set up in green gram (*Vigna radiata*). At 200 µg kg^{-1} of soil of sulfosulfuron, seed yield increased by 10% on average. Moreover, sulfosulfuron applied 45 days after sowing at 200 µg kg^{-1} of soil dose increased the *Bradyrhizobium* nodules number per plant by 7%. The application of sulfosulfuron (400 µg kg^{-1} of soil) resulted in an average maximum grain protein of 182 mg g^{-1}, while the application of isoproturon (400 µg kg^{-1} of soil) and atrazine (400 µg kg^{-1} of soil) produced a minimum grain protein (124 mg g^{-1}; 125 mg g^{-1}) (Khan et al., 2006). Our results showed that plants treated with chlortoluron (T2) had lower NDVI values than control (T12) plots, damaged the plants, and underperformed control (T12) plots and several other treatments in seed yield. Prosulfocarb (T8) also caused moderate symptoms to mild damage and the seed yield results were inconclusive. Dewitte et al. (2006) concluded that chlortoluron (1.5 kg ha^{-1}) and prosulfocarb (2.4 kg ha^{-1}) did not cause significant phytotoxicity symptoms, however, these active substances were applied pre-emergently and, at reduced doses compared to the suggested technology (chlortoluron; prosulfocarb).

Our experiment in 2022 we found that in the flumioxazin pre-emergence treated plots the seed yield was slightly higher than in the control plots (Juhász et al., 2024). After post-emergence application, the yield of treated plots slightly exceeded the seed yield of control (T12) plots. Although it controlled weeds well, it caused phytotoxicity on lupines, and the NDVI values were lower than those of in the control (T12). The most serious damage was caused by halauxifen-methyl + picloram (T6, T7) treatments and the lowest seed yields were harvested from these plots. Spearman's rho correlation between phytotoxicity and seed yield was the strongest, these two indicators being negatively correlated. The inverse relationship between phytotoxicity value and grain yield indicated that higher phytotoxicity resulted in lower grain yield in Rabi sorghum cultivar [*Sorghum bicolor* (L) Moench], demonstrating the importance of selecting low-phytotoxicity pesticides for crop management (Ambarish et al., 2017).

CONCLUSION

To our knowledge, these active substances have been tested for the first time by post-emergent application in sweet white lupine. Based on the measured indicators, one year's results show that halauxifen-methyl + picloram (T6, T7) is not applicable in sweet white lupines (these treatments were the most phytotoxic, caused the lowest cleaned seed yields, and these plots were the most contaminated). Chlortoluron (T2), prosulfocarb (T8), and the higher dose of sulfosulfuron (17 g ha^{-1}) (T11) caused phytotoxicity to varying degrees in lupines, and resulted in seed yields below those of control (T12) plots and other treatments. Flumioxazin (T1), carfentrazone-ethyl (T9), sulfosulfuron (13 g ha^{-1}) (T10), and all doses of halauxifen-methyl (T3, T4, T5) applied treatments trended towards higher seed yields than control (T12) plots. However, phytotoxicity scores of the treatments flumioxazin (T1), halauxifen-methyl (0.5 L ha^{-1}) (T4), carfentrazone-ethyl (T9), and sulfosulfuron (13 g ha^{-1}) (T10) differed significantly from the control (T12), with the highest scores in the plots treated with flumioxazin (T1). Halauxifen-methyl (0.4, 0.6 L ha^{-1}) (T3, T5) were the safest treatments in the experiment, and the phytotoxicity results of plots treated with two doses of this substance did not differ significantly from the control (T12).

Overall, the highest dose of halauxifen-methyl (T5) was the most prominent in the experiment, these plots showed the best results in what we considered to be the most important measures, with the highest seed yields from this plot, and the second lowest phytotoxicity measured here, which was almost symptom-free. It is necessary to test the active substances for several years, and it is justified to increase the number of measurement dates, and additional data such as 1000 seed weight and hectolitre weight should be collected.

RECOMMENDATIONS

In our perspective, halauxifen-methyl, carfentrazone-ethyl, and sulfosulfuron could be worth testing in lupines under different soil types and climatic conditions. It would be worthwhile to test the effects of post-emergent and late post-emergent application and to use lower and provocative higher doses. For these types of herbicide trials, a plot size smaller than the plot size used may be sufficient in our view.

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EVALUATION OF SOME MEASURES TO INCREASE ENERGY EFFICIENCY IN GREENHOUSES

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ABSTRACT
Heating greenhouses where off-season cultivation is carried out has a positive effect on product quality as well as increasing productivity. However, while it increases heating production costs, it also negatively affects the environment due to carbon dioxide emissions into the atmosphere when fossil energy resources are used. For this reason, it has become necessary to increase energy efficiency as well as heating in heated greenhouses. For this purpose, the study determined the savings rates that can be achieved as a result of technical measures such as reducing the cover surface areas that cause heat loss in greenhouses, using cover material with high heat conduction resistance, and correct installation and use of thermal screens. In addition, the effect of the accuracy of sensors measuring in the greenhouse on the indoor climate was determined and the contribution of automation systems to energy efficiency was evaluated. As a result of the study, it was determined that a significant amount of energy can be saved, and energy efficiency can be increased in greenhouses with different technical measures to be taken. However, it is important that the measures are properly designed and operated in order to achieve savings. At the same time, comparing the investments made for heat saving with the amount of energy saved is important in terms of production economy. The results of the study could be useful greenhouse growers regarding the necessary technical measures to be taken to increase energy efficiency.
Keywords: Greenhouses, greenhouse heating, energy saving, technical measures

INTRODUCTION
Energy saving is becoming urgent due to the scarcity of energy reserves, the sharp increase in energy prices and increasingly serious environmental problems such as global warming, ozone depletion and climate change. The use of renewable energy sources and the adoption of energy saving measures are of vital importance for all sectors such as industries, transportation and agriculture (Cuce et al., 2016). Recent reports have revealed that building construction contributes to approximately 40% of energy consumption and 25% of greenhouse gas emissions in the world (Hong et al., 2016). With the increasing demand for food worldwide, controlled environment agriculture is an important strategy for year-round crop production. One of the important types of controlled environment agriculture is greenhouses (Iddo et al., 2020). A greenhouse is an agricultural structure that extends the production season of various crops by providing controlled indoor microclimate conditions (Iáñez –Rodríguez et al., 2017). Basic indoor environmental parameters such as carbon dioxide, humidity, lighting and temperature must be maintained for proper crop growth in greenhouses (Iddo et al., 2020). Greenhouse agricultural production is evolving towards industrialization and scale with the modernization of facility agriculture. The greenhouse industry is heavily dependent on fossil fuels, which contribute to significant greenhouse gas (GHG) emissions (Gorjian et al., 2021). Due to lightweight construction and inefficient operation, greenhouses consume more fossil fuel energy in the operation of mechanical systems and have larger carbon footprints than other similarly sized buildings. In fact, greenhouses are one of the most energy-intensive sectors of the agricultural industry (Iddo et al., 2020). Greenhouse, an energy-intensive building sector, has a significant contribution to this situation. Heating consumption accounts for the largest proportion, where more than half of the energy is consumed (Djevic and Dimitrijevic, 2009). The greenhouse production cost has increased by about 40-50% due to energy consumption and labor cost (Jamil et al., 2022). Therefore, reducing greenhouse heating costs can make greenhouse production more economical and sustainable (Ahamed et al., 2019). Increasing energy demand has become an important issue for greenhouse sectors to achieve sustainable development (Zhang et al., 2020). Sustainability in greenhouses can be achieved by increasing energy efficiency (Zaimoğlu, 2017). In order to increase energy efficiency, it is necessary to reduce the required heat energy value (Baytorun and Gügercin, 2015).

Reducing heating costs is a major challenge for greenhouse growers, especially in cold regions (Ahamed et al., 2019). Technical measures to be taken in greenhouses allow for significant energy savings and increased energy efficiency (Baytorun et al., 2019). At the same time, with the measures to be taken, the chance of competition can be increased in regions that are disadvantaged in terms of heating costs (cold regions) (Çaylı and Temizkan, 2018). For this reason, research to be carried out to reduce the energy required in greenhouses is gaining more and more importance every day.

For this purpose, the study aimed to evaluate some technical measures that can be taken to increase energy efficiency in greenhouses (constructing greenhouses as mono span/multi span, selection of covering material, thermal curtains, heating system, selection of heating boiler, indoor temperature strategies, ventilation temperature and calibration of measurement sensors) and to determine their effects on energy saving.

MATERIALS AND METHODS

In the study, calculations were made for 6 different graound areas, mono span and multi span, in order to determine the heat requirement. Calculations were made for side walls and roofs with different covering materials and combinations. In addition, greenhouse features with the same dimensions were used to eliminate the effect of greenhouse dimensions on the calculations. The diameter of the steel pipes used for heating the greenhouses was 51 mm, the water inlet temperature was 70°C, and the water outlet temperature was 50°C. The dimensions of the greenhouse used in the calculation of heat requirement are given in Table 1.

Table 1. Dimensions of the greenhouse used in calculating the heat requirement

Greenhouse type	Dimension	Ground area, m^2	Structure specificatons	Dimension
Mono span	1x500	500	Span width	8.00 m
Multi span	2x500	1000	Greenhouse length	62.5 m
Multi span	3x500	1500	Roof slope angle	27.70 °
Multi span	4x500	2000	Lattice beam spacing	2.50 m
Multi span	5x500	2500	Side wall height	3.50 m
Multi span	6x500	3000	Ridge height	5.60 m

The calculation of heat energy requirement in greenhouses was made using the ISIGER expert system. In the ISIGER expert system, heat power and heat energy requirement in greenhouses are calculated by going from hourly climate values (temperature, solar radiation and wind speed). The most important feature of the ISIGER expert system is that the actual temperature in the greenhouse depending on the regional climate, greenhouse type, equipment and greenhouse type and the temperature increase resulting from the energy stored in the greenhouse are taken into account (Baytorun and Gügercin, 2005).

RESULT AND DISCUSSION

Energy efficient design is very important to reduce the heating costs of traditional greenhouses located in cold regions. The aim of energy efficient design is to increase solar energy gain and energy retention inside the greenhouse. Factors that greatly affect the heating requirement in greenhouses include the construction of greenhouses as mono span/multi span structures, selection of cover materials, use of thermal curtains, placement of the heating system, determination of basic heat requirement in the selection of heating boilers, use of automation systems in indoor conditioning and calibration control of measuring sensors.

Construction of Greenhouses as Mono Span/Multi Span

Generally, greenhouses are divided into two types: (i) mono-span (single module) and (ii) and multi-span (multi module). Multi-span greenhouses are more energy efficient than mono-span greenhouses because less surface is exposed to the outside per unit floor area (Ahamed et al., 2019). Therefore, it will save energy by reducing the energy required.

The heat energy required per unit floor area in mono-span (single module) and multi-span (multi module) greenhouses covered with PE (polyethylene) covering material is given in Table 2.

Table 2. Required heat energy values per unit floor area in mono span/multi span greenhouses

Greenhouse type	Ground area, m^2	Cover material surface area, m^2	Cover material area/Ground area, Ac/ag	Energy requirement, kWh/m^2year	Savings rate according to mono span, %
Mono span	500x1	1099.90	2.20	819.18	-
Multi span	500x2	1762.20	1.76	670.91	18.10
Multi span	500x3	2424.60	1.62	579.85	29.22
Multi span	500x4	3087.00	1.54	550.23	32.83
Multi span	500x5	3749.30	1.50	532.67	34.98
Multi span	500x6	4411.70	1.47	521.10	36.39

In order to reduce energy losses originating from the cover surface areas in greenhouses, the construction of greenhouses as multi span instead of mono span units during the establishment phase will reduce the cover surface area.

As can be seen from the table, as the greenhouse ground area increases, the heat energy required per unit area decreases. Accordingly, when 6 mono span greenhouses with a base area of 500 m^2 are built, the heat energy required per unit area is calculated as 819.18 kWh/m^2year. In a greenhouse built as a mono span with a ground area of 3000 m^2, the heat energy requirement decreases by 36.39% to 521.1 kWh/m^2year

According to the calculations, the heat energy requirements and saving rates per unit floor area in case of greenhouses being constructed mono span and as multi span are given in Figure 1.

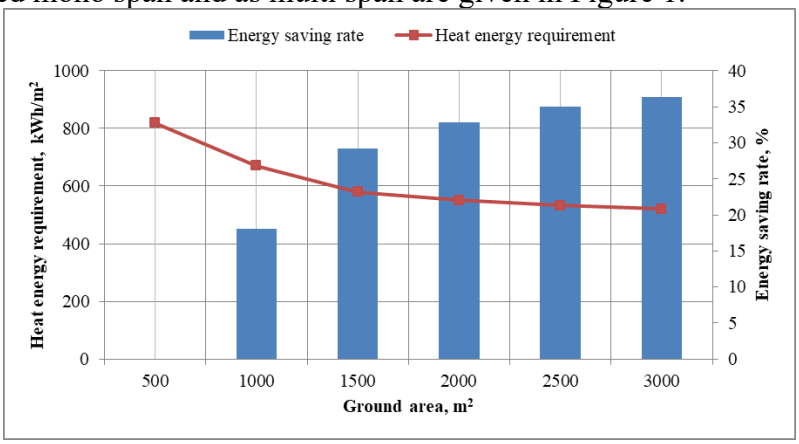

Figure 1. Required heat energy per unit floor area and saving rates

According to Figure 1, energy requirement decreased due to the increased greenhouse floor area. The reason for this is that the ratio of the greenhouse floor area to the cover surface area (Ac/Ag) decreased in greenhouses constructed as blocks (Figure 1, Table 1). Accordingly, while the (Ac/Ag) ratio is 2.20 in a mono span PE greenhouse with a base area of 500 m^2, the (Ac/Ag) ratio decreases to 1.47 in a single block constructed with a thermal curtain of 3000 m^2. Thus, it was observed that the ratio of the greenhouse cover surface area to the base area decreases and the energy required for the unit area decreases. In the study conducted by von Zabeltitz (2011), it was stated that 8% energy can be saved if the greenhouses are constructed as blocks compared to mono module greenhouses of the same size. Djevic and Dimitrijevic (2009) studied the energy consumption of various types of double-layered plastic film covered greenhouses in Serbia and reported 4-10% less heating energy consumption in multi-span greenhouses compared to different types of mono-span greenhouses. Baytorun and Gügercin (2015) In the case of construction of 5 single module greenhouses with thermal curtains and a ground area of 480 m^2 in Antalya climate conditions, the heat energy requirement per unit area during the production period was determined as 98 kWh/m^2. In the case of construction of the greenhouse as a single block with thermal curtains on a ground area of 4800 m^2, the heat energy requirement was determined as 64 kWh/m^2, decreasing by 34%. The results obtained in our study are in line with the results of previous studies carried out by the researchers.

Accordingly, if the greenhouses to be established are constructed as blocks instead of mono-span, the heat energy required per unit area will decrease and energy efficiency will increase.

Selection of Covering Material in Greenhouses

Covering materials that separate the indoor and outdoor environments in greenhouses affect the required heat energy depending on their heat transfer coefficients. In the study, the energy requirements calculated at the same indoor temperature values in greenhouse with a ground area of 3000 m^2 in case of using different covering materials and combinations are given in Table 3.

Table 3. Thermal energy requirement in greenhouses covered with different covering materials

Cover materials	Energy requirement, kWh/m^2year	Saving rate compared to single layer glass material, %
Single layer PE plastic	521.1	-
Roof single layer plastic and side walls double layer PE plastic	489.16	6.1
Roof single layer plastic and side walls double layer hard plastic PMMA (16 mm)	480.92	7.7
Double layer PE plastic	368.28	29.3
16 mm PMMA on roof and side walls	328.48	37.0

In the calculations, it was determined that if the roof and side walls of the greenhouse are covered with 16 mm double-layer PMMA (polymethyl meta-acrylate), 37.0% energy saving can be achieved compared to the greenhouse covered with single-layer PE material. For plant growth in greenhouses, the daily total solar radiation value is desired to be greater than 2.34 kWh/m^2day (Nisen et al., 1988). Accordingly, if the daily total solar radiation values are low in the region where the greenhouses are installed, instead of using multi-layer cover materials for heat conservation in the entire greenhouse during the winter months when outdoor temperatures are low, it would be more appropriate to use them only on the sidewalls and facades. Considering this situation, the study compared the situations of using single-layer plastic in the greenhouse and single-layer plastic on the greenhouse roof and double-layer PE plastic on the side walls. As a result, if the side walls and facades are double layered, the heat energy that can be saved is approximately 6.1%. This rate will be 7.7% if 16 mm double-layer PMMA is used.

Using Thermal Curtains in Greenhouses

Some of the technical measures applied in greenhouses for heat conservation include measures such as reducing losses in the transmission of heat energy, using thermal curtains and protection from wind (von Zabeltitz, 2011). The rates of heat energy that can be saved with these technical measures vary between 5-40%, and the highest heat savings can be achieved with thermal curtains (Ruhm et al., 2007).

The effect of with and without using thermal curtains in greenhouses on the required heat energy values is given in Table 4.

Table 4. The effect of using thermal curtains in greenhouses on heat energy saving

Cover materials	Heat energy requirement kWh/m^2year		Difference, kWh/m^2yıl	Savings rate, %
	Without thermal curtain	With thermal curtain		
Roof and side walls single layer PE	521.1	353.32	167.78	32.2
Roof single layer plastic and side walls double layer PE plastic	573.25	340.13	233.1	40.7

Accordingly, in case of using thermal curtains in single-layer PE greenhouse with a 3000 m^2 floor area, a 32.2% energy saving can be achieved. This saving rate will increase energy efficiency. Therefore, it will increase the profitability of enterprises by reducing the share of heating in production costs. At the same time, it will also reduce the release of CO_2 emissions and the negative impact on the environment caused by the use of fossil energy. Thermal curtains used in greenhouses provide additional thermal resistance by reducing heat transfer in the environment (Arinze et al., 1986; Sethi and Sharma 2008). The heat saving rates of thermal curtains used in greenhouses vary depending on the sealing of the curtains (Meyer 1984; Müller 1987). The heat energy requirement and saving rates calculated depending on the sealing of the thermal curtains used in a greenhouse with a base area of 3000 m^2 and covered with single-layer PE plastic are given in Table 5.

Table 5. Heat energy required during the production period depending on the sealing of the thermal curtains used

Heat energy requirement, kWh/m^2year				Saving rates, %		
Without thermal curtain	Curtain sealing					
	Bad	Medium	Good	Bad	Medium	Good
521.1	482.34	417.85	353.32	7.4	19.8	32.2

Depending on the sealing of the curtains (poor, medium and good), the heat energy rates that can be saved vary between 7.40-32.20% (Table 5). As seen in Table 4 and Table 5, a significant amount of energy can be saved depending on the thermal curtains and their sealing. Therefore, importance should be given to the weaving properties and sealing conditions of the curtain used.

Placement of Heating Systems in Greenhouses

The heat energy consumed in greenhouses varies depending on the heating system installed. In conditions where the heating systems are placed in different locations of the greenhouse with the same characteristics, the heat energy values required throughout the year for a greenhouse with a floor area of 3000 m^2 and a single-layer PE plastic cover are given in Table 6.

Table 6. Heat energy values required for heating systems during the production period depending on their placement in the greenhouse

Heating systems	Heat energy requirement, kWh/m^2year	Saving percentage compared to a piped heating system placed high, %
Piped heating system placed high	525.59	-
Pipeded heating system placed on side wall	521.10	1
Pipeded heating system near the floor	431.26	18

According to Table 6, if the heating pipes are placed high in greenhouses, the heat energy requirement increases. If the heating pipes are placed close to the greenhouse floor instead of high, the heat energy requirement will be 18% less than the first situation. Accordingly, it has been determined that the correct placement of the heating pipes, considering the characteristics of the heated air and the cultivation to be done, is very important in terms of reducing the energy required in the greenhouse.

Determining the Basic Heat Requirement in greEnhouse Heating Boiler Selection

In greenhouses where heating is used, determining the maximum heat power and its recurrences during the year is important in determining the heating boiler dimensions and heating management. The heat power requirements for a greenhouse covered with polyethylene and with a base area of 3000 m^2 with thermal curtains (bad, medium, good insulation) and without thermal curtains are given in Figure 3.

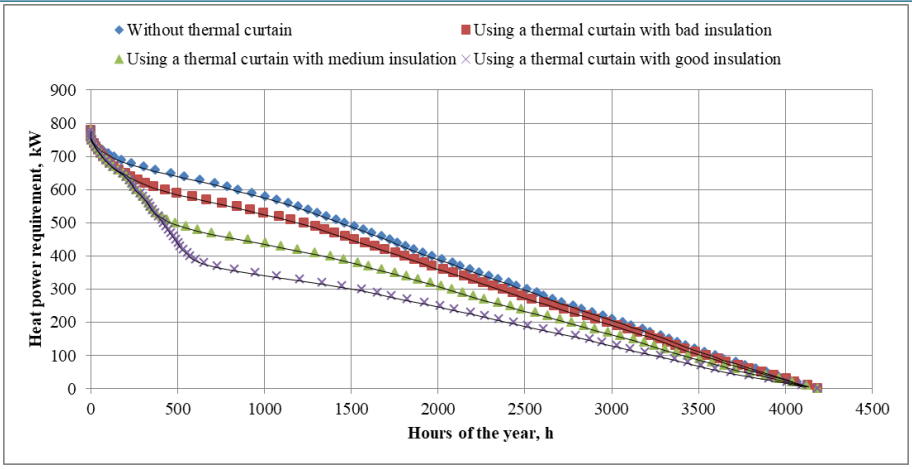

Figure 3. Heat power requirements in greenhouses

As can be seen from the figure, if the indoor temperatures in the greenhouse are kept at 16/21°C Day and night, the greenhouse without a thermal curtain will need 4187 hours of heating during the year. In this case, the maximum heat power required is 780 kW. If a 500-kW boiler is used in the greenhouse, 89% of the basic heat requirement can be met. In this case, the temperature can be kept at the desired values (16/21°C) outside of 1462 hours of the year.

Using a well-insulated thermal curtain in the greenhouse will reduce the heat power. In this case, heat power required is 400 Kw. In this case, the temperature can be kept at the desired values (16/21°C) outside of 573 hours of the year. In this case, 90% of the basic heat requirement in the greenhouse can be met. Therefore, it would be more energy efficient to use the 400-kW boiler as the first boiler in the greenhouse and to use the second boiler of 780 kW to meet the heat energy requirement that will arise in extreme cases. Because in this case, savings can be made in the initial investment and heating costs due to the reduction in the size of the boiler that will meet the basic heat need of the greenhouse.

Using Energy-Efficient Temperature Control Strategies in Greenhouses

The use of computers in greenhouse control has allowed the development of new strategies for controlling climatic factors. The control strategies used in greenhouses today can be divided into two main groups: static and dynamic control strategies. One of the dynamic control strategies used in greenhouses in recent years to save energy is total temperature control. This method is based on the principle that a certain total temperature, rather than a fixed day/night temperature, is sufficient to achieve a certain production target. Reducing the temperature in the greenhouse during the night provides significant heat energy savings. For this reason, reducing the temperature to the lower critical limit during the night hours and compensating for the missing temperature in the total daily temperature by increasing the ventilation setpoint temperature during the day hours has been used in recent years in greenhouses to save energy.

The heat energy values required for different temperature control strategies in a greenhouse with a base area of 3000 m^2 and covered with single-layer PE plastic are given in Table 7.

Table 7. Required heat energy values according to different temperature control strategies in the greenhouse

Cover material	**Static Control, kWh/m^2year**		**Dynamic control, kWh/m^2year**
	Fixed Day/Night 21°C	Fixed Night / Day 16/21°C	Minumum Night / Day 14/21°C
Single layer PE plastic	595.50	521.10	502.09

According to Table 7, in case of application of dynamic control strategy (14/21°C) in the greenhouse, 18.60% less heat energy will be required compared to fixed day/night 21°C and 3.79% less compared to fixed day/night 16/21°C.

Sigrimis et al. (2000) reported that as compared to the fixed temperature strategies, the dynamic control strategies reduced the energy consumption by up to 23%. Baytorun and Üstün, (2022) determined that in temperate climate conditions, a maximum of 30% energy saving can be achieved with the dynamic control and static control strategy

depending on the desired night temperature in the greenhouse, and 9% in continental climate conditions. Accordingly, controlling greenhouse indoor temperatures with automation and applying dynamic control strategies for energy efficiency will provide significant energy savings.

Control of Ventilation Setting Temperature in the Greenhouse

In the ventilation performed to control the indoor climate in the greenhouse, it is important to select the ventilation temperature correctly, especially in the winter. Because selecting the ventilation temperature too low causes energy to be wasted in the heated greenhouse. Therefore, opening and closing the ventilation flaps with the automation system and selecting the appropriate ventilation temperatures can prevent significant energy loss. Accordingly, the effect of different ventilation temperatures in the greenhouse on energy saving is given in Table 8.

Table 8. Changes in heat energy requirement values at different ventilation temperatures

Cover materials	Heat energy requirement, kWh/m²year		Energy saving rate, %
	Ventilation temperature		
	20°C	25°C	
Roof is single-layer plastic and side walls are double-layer PE plastic	535.65	521.10	2.72

According to the calculations made according to the table, it was determined that adjusting the ventilation temperature in the greenhouse to 25°C instead of 20°C could provide approximately 2.72% energy savings in the greenhouse. Accordingly, controlling the indoor climate parameters with automation systems instead of manual systems is important in terms of regulating the indoor parameters as well as saving energy.

Calibration Control of Measuring Sensors

It is very important that the measurement sensors used to control the indoor climate values in greenhouses are placed in appropriate horizontal and vertical positions within the greenhouse. At the same time, maintenance and calibration of the measurement sensors will contribute to the accurate transmission of the results to the control computer. Otherwise, ± directional deviations in the measurements will cause more/less energy to be consumed in the greenhouse.

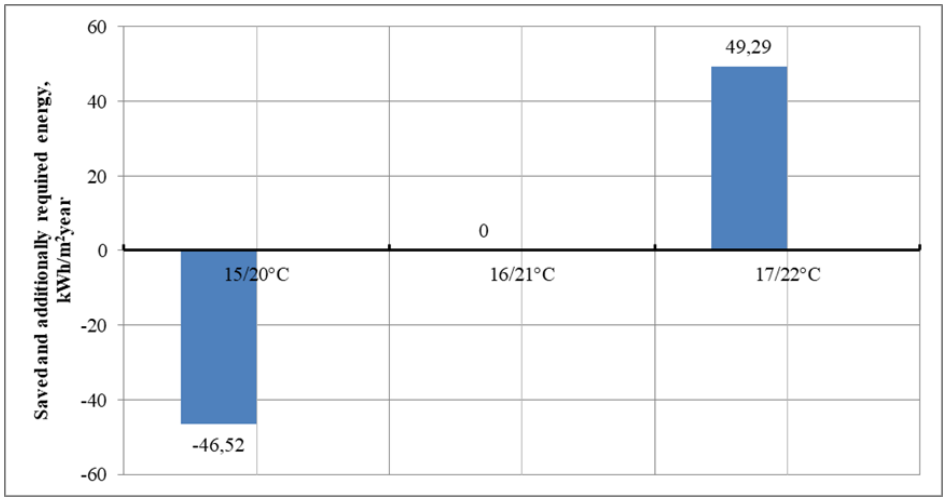

Figure 4. Savings and additional heat energy required depending on temperature deviation in sensors

In a single-storey polyethylene plastic greenhouse without thermal curtain, the heat energy requirement arising from the deviations in temperature values has been calculated as 521.1 kWh/m²year for 16/21°C during day/night. It has been calculated as 474.58 kWh/m²year for 15/20°C during day/night in the greenhouse and 570.39 kWh/m²year for 17/22°C. Accordingly, in case of ±1°C deviation of the measurement sensors, an energy change of approximately ±%9 is given in Figure 4. This situation will increase/decrease the energy costs in the greenhouse and will also affect homogeneous plant cultivation.

CONCLUSION

In greenhouses where cultivation is carried out out of season, heating should be done in order to make the temperatures inside the greenhouse suitable for plant cultivation during the months when the external climate values are low. Heating in greenhouses positively affects the quality of the products grown as well as the increase in yield. However, increasing energy costs negatively affect the production costs in greenhouse cultivation, and the fossil energy sources used to meet the excess energy needed cause CO_2 emissions into the atmosphere and harm the environment. For this reason, it has become mandatory for greenhouse enterprises to take measures to increase energy efficiency in heated greenhouses. When the results obtained in the study are examined, it is seen that technical measures such as building greenhouses as blocks instead of mono span, using greenhouse cover materials with low heat transfer coefficients, ensuring that the thermal curtains used are well sealed, choosing the right ventilation temperatures, and placing the heating pipes correctly help to save a significant amount of energy in greenhouses. The amount of energy saved is also extremely important in terms of reducing the share of heating in production costs in greenhouse enterprises and in terms of profitable cultivation.

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ANALYZING THE EXPECTATIONS OF AGRICULTURAL STRATEGY TARGETS FOR IZMIR WITHIN THE FRAMEWORK OF ECOLOGICAL AGRICULTURAL MARKETING WITH PLM METHODOLOGY

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ABSTRACT
The growing awareness towards ecology and environmentalism, and the growing concerns for ecological sustainability in recent years have led to a profound change in the operational and organizational understanding of organizations. Most of the initiatives implementing ecological agricultural marketing strategies in the world are undertaken by farmers, consumers, food processors and retailers, still they are also undertaken by some civilian organizations, too. since successful stories of sustainable animal marketing initiatives are not clearly visible and widespread in Turkiye, it is importannt to identify medium- and long-term strategies and performance targets to increase these practises. In this context, feasibility studies and pprojects submitted by the public agencies in order to support green marketing should be examined in terms of product life cycle management dimensions, holistic marketing and the necessary conditions must be set and met.
In this study, it is mainly aimed to examine, analyze and discuss the strategies of regional agricultural enterprises in ecological marketing management of 40 large enterprises in the field of agricultural marketing from Torbalı District in the Küçük Menderes Basin, where livestock farming is intensively carried out in Izmir Province. In the study it is emphasized that a focus on Product Lifecycle Management (PLM) is necessary for ecological marketing of agricultural enterprises, not only economics.
Keywords: Ecological Agricultural Marketing, PLM, Livestock, Marketing Objectives

INTRODUCTION
Today, ecological marketing is gradually moving into the sustainability phase. Sustainability is a holistic concept with environmental, economic and social development dimensions (Karaca 2007). However, it is one of the newest fields formed by the combination of social sciences and eco-engineering and is the intersection of innovative technologies of the future. According to the renewed global conditions, attracting customers can be costlier than retaining existing customers. Therefore, organizations can use ecological strategies to increase sales, while choosing to produce high quality and customized products to retain buyers.
The importance of marketing and sustainability action has become a center of attraction for non-agricultural areas (Güler, 2016). Globally, there are various environmental, social and economic problems such as pollution, increase in population and consumption of energy resources, global warming and depletion of ecological resources. Due to the fact that sustainability has become a center of attraction in the world, it can be seen that businesses aiming to be successful and survive are looking for many marketing practices to meet current needs by taking into account the ecology that will be sufficient for future generations in order to combat these problems. In this sense, actors in the new business world are demonstrating that sustainable marketing can be a good and appropriate strategy (Boughton et al., 2011). The need to identify the problems faced by farmers in agricultural marketing in developing countries and to create sustainability solutions for these problems is supported by various studies (Adanacıoğlu, 2014). Difficulties and disruptions in access to markets, variable and low prices constitute the main problems of agricultural producers (Atalay Oral and Akpınar, 2011). Marketing can be one of the most important problems for the spread of sustainable agricultural practices in industrialized countries (Güneş, 1996; Karacan, 2007). Nevertheless, sustainable agricultural marketing strategies can be a successful alternative for many organizations interested and engaged in this field.
Although initiatives on ecological marketing are few and developing, global climate change has led to an effective awareness in Turkey in terms of important strategies that can be followed in sustainable agricultural marketing. As a matter of fact, in the Eleventh Development Plan, developing and implementing the strategies required by the global policy axis for solutions to the country's problems in agricultural marketing is put forward as a goal,

and one of the three issues that may be a priority in this context is emphasized as "designing policies that comply with the definitions of sustainable rural development and ecological-green growth in line with RIO+20" (Presidency of the Republic of Turkey Strategy and Budget Directorate, 2024). TUBITAK's 2023 vision also emphasizes the importance of this issue in order to draw attention to the importance of the subject, stating that "in the field of green agriculture, production is carried out in sustainable ways with Agricultural Big Data Repository and Agricultural Information Systems" (TUBITAK, 2024). Among the strategies of the EU's Common Agricultural Policy since 2013, the striking point is the increase in competitiveness in the field of agriculture, sustainable management principles of ecological resources and balanced regional-based development.

Considering the global trends and the strategies announced by Turkey in this direction, it is clear that initiatives for agricultural marketing development in Turkey in the coming years should be based on a "competitive and ecological agricultural marketing approach that takes into account the product life cycle".

In this context, emphasizing thematic values such as the safety of human and environmental health and biodiversity in marketing mix activities and ecological production methods is necessary for the success of strategic market life cycle management. In addition, in order to make products ecological, it is necessary to internalize the ecological marketing philosophy with an effective understanding and to continuously evaluate and examine the ecological effects of the product throughout its life cycle. The product lifecycle management (PLM) construct can be used as a tool to support corporate management in marketing forecasts and management strategies.

Accordingly, in this study, by examining the medium and large-scale cattle breeding enterprises selected from Torbalı District, where intensive animal husbandry is carried out in Izmir, within the framework of livestock life cycle management, taking into account the fertilizer and other damaging elements that are likely to harm the environment, marketing mix suggestions with strategic targeting within the scope of regional development in order to make the animal product ecological.

THE RELATIONSHIP BETWEEN ECOLOGICAL AGRICULTURAL MARKETING CONCEPT AND PRODUCT LIFE CYCLE MANAGEMENT (PLM)

With the introduction of scientific approaches into production areas, the continuous production and economic goals of organizations have led to the irresponsible use of ecological resources, while production and domestic wastes have started global pollution. In this case, acid gases originating from the industry of these countries move in the air conditions and cause damage by causing acid rain formation on the agricultural fields of another country thousands of kilometers away (Yücel; 1997).

After the latter part of the 1980s, organizations began to understand that the public's concern about ecological problems had increased considerably, especially the concept of sustainable development, which had been established by the World Commission on Environment and Development in 1987 with the publication of the Report on Our Common Future, made society and institutions more sensitive to ecological issues.

Sustainable development is "meeting present needs without compromising the ability of future generations to meet their own needs" (Nemli, 2000). In sustainability, it is essential that current consumption and expenditures are not covered by debts that will have to be paid in the future. Ecological resources should not be used unconsciously, in a way that exceeds the carrying capacity and in production.

The four main elements important for sustainability are (Ottman, 2004):

- The attention being paid to the state of ecology,
- Pressure from authority actors to minimize air emissions and take back products for recycling,
- New potential market opportunities for sustainable technologies covering resource and energy management,
- New requests from customers.

Sustainable development can also be defined as the process by which society and business life can continue to live in harmony with ecology (Karaca, 2007). The desire of society and most organizations to grow in the economic field has been replaced by the aim of protecting the environment and improving the quality of life (Erkuş et al., 2005).

The change in the sustainability of a rural community can be measured by socio-economic as well as environmental indicators, and this eco-strategy needs to be realized for sustainability (Sullivan, 2003).

In these years, ecology became an important consideration, and in the early 1990s the concept of ecological marketing emerged, which would be of particular interest to organizations.

The concept of ecological marketing was first discussed at a seminar on "ecological marketing" organized by the American Marketing Association in 1975. As a result of this seminar, the American Marketing Association made the first definition of ecological marketing. Within the framework of this definition, ecological marketing is "the branch of science that examines the appropriate and inappropriate parts of marketing studies, consumption of exhaustible resources and energy consumption in terms of ecological pollution" (Uydacı, 2002).

Ecological marketing, which is based on a relative infrastructure, can become quite complex from conceptual expressions to implementation. Ecological marketing is concerned with the production of products that comply with environmental protection principles. If ecological marketing is defined briefly, it is possible to define it as "the activities of organizations that can meet the demands and needs of customers in an ecologically sensitive manner".

In general, in the region of the research scope, the results can be seen that the severity of food security has increased due to the uneven access of small and medium-sized farming and agricultural organizations to markets and marketing initiatives, which has a negative impact on ecological agricultural models. Under these conditions, agricultural producers are forced to turn to cash-cyclical fodder crops and short-term livestock breeding activities rather than dairy farming in order to survive. Although farmers with agricultural inputs consisting of scarce resources face significant costs to implement protection measures against ecological pollution caused by animal manure, the rate of change in animal manure management may increase as long as farmers can see an economic advantage that may occur with the implementation of these protection measures (Çardakçı, 2022). In this case, farmers will be more likely to be enthusiastic about using manure to cultivate their land and make investments that can increase their eco-innovative productivity. This shows that marketing services should take a more active role when targeting ecological agriculture. In this sense, it is of great importance to provide market support to animal producers to use agricultural structures for animal husbandry purposes and to act in accordance with practical market-based initiatives and policies in order to make investments that will increase fertilizer infrastructure management and agricultural productivity (Candoğan and Özdemir 2021; Çardakçı, 2021).

In this context, it is necessary for the success of holistic strategic marketing management to emphasize thematic values such as sustainable production methods, the safety of human and environmental health and biodiversity in promotional activities and related marketing mix elements, especially agricultural producers. It is also necessary to internalize a directly effective understanding of the ecological status of the product and to continuously evaluate and examine the ecological effects of the product throughout its life cycle. The product life cycle management construct can be used as a tool to support corporate management in marketing forecasts and management strategies.

PLM is a holistic application that refers to the management of processes such as design, development, production and maintenance throughout the life cycle of a product (Figure 1). PLM is the activity of managing all the processes of companies from the birth of their products to the end of their lifecycle in the most effective way (Sayer & Ülker, 2014). This approach aims to ensure compliance with sustainability practices throughout the entire product life cycle from design to reduce the environmental impact of products.

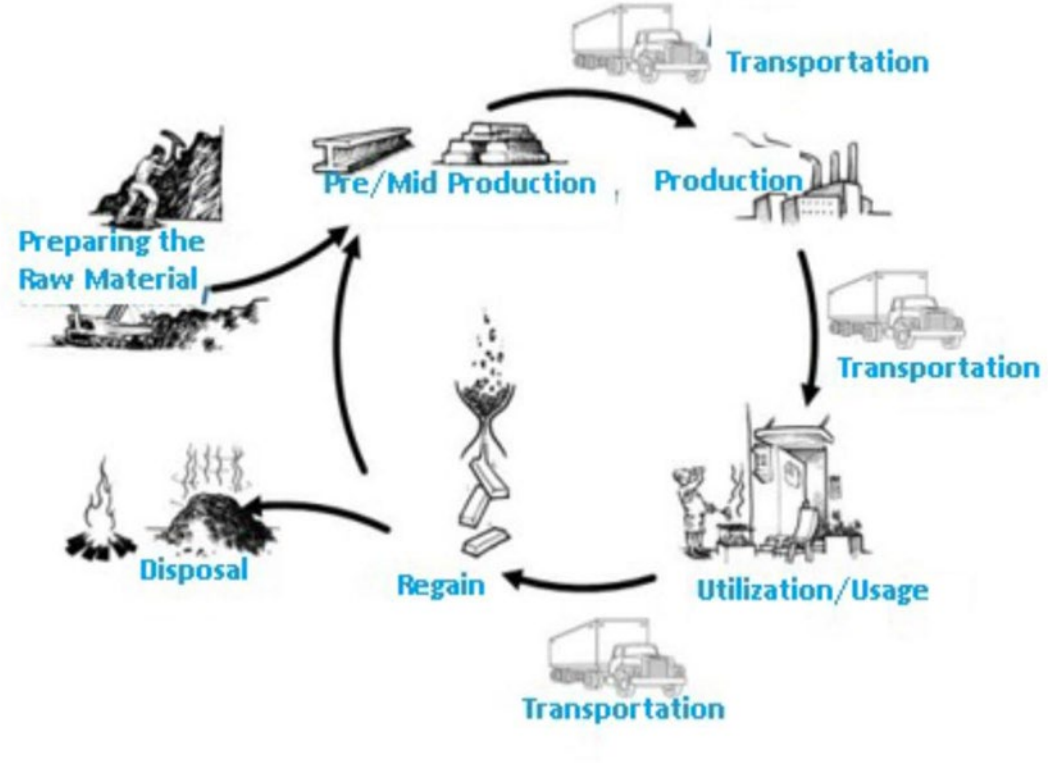

Figure 1. Product Lifecycle Management (PLM) (Ötleş, 2015)

Although the role of each organization within the organization is important in ecological product development, the main responsibilities consist of design, marketing, production and supply chain (Ötleş et al. 2015). The steps to be taken when developing an innovative eco-product are listed as follows: Idea generation (ideation), filtering of ideas, concept development process and testing, operational engineering, prototype development process and test marketing (Yüce et al. 2018). In the ideational development process, it is important to consider the ideas of external stakeholders such as consumers, distributors, suppliers and competitors as well as employees at all levels of the organization. Then, within the scope of these ideas, the selection of ideas can be made by evaluating price, market share, development time and ecological purposes. Then, the eco-innovative image of the product can be created by focusing on synthesis such as the analysis of the preference of this ecological product by the customer. A specific eco-strategy is developed before its launch. In this process, first of all, the target market is identified, and forecasts are made for sales to be determined by profits for future time periods. In the following periods, the ecological product price and marketing budgets are planned. Finally, marketing targets are determined in accordance with long-term eco-strategic profit targets. After this process, the design is transformed into a physical product and prototypes are made. The product is tested in small target markets through marketing tests. Finally, the ecological product is put on the market by determining the place and time of production (Güneş, 2006).

Therefore, it is necessary to analyze the ecological marketing mix separately from traditional marketing (Onaran, 2014). While traditional marketing initiatives focus on continuously increasing consumption, ecological marketing aims to offer products that can be suitable for socio-economic and environmental sustainability and to support green consumer behavior (Reutlinger, 2012). The ecological marketing mix can be expressed as marketing that can make traditional components compatible with ecology and utilize limited resources, providing a prosperous and healthy lifestyle for today's society and realizing responsibility to prevent the damage and gradual decline of ecological resources and nature for generations.

In summary, there is a strong relationship between ecological marketing, strategic marketing planning and integrated PLM. This relationship extends from product design and development to the implementation of direct marketing strategies, customer awareness and sustainable practices. An ecological strategic planning approach will encourage the design and development of environmentally sensitive products and minimize the

environmental impact of their production and use. In addition, considering that integrated PLM covers all processes from the design of products to their disposal, it will also be ensured that the environmental impacts in these processes can be reduced and compliance with the basic principles of sustainability will be ensured. All processes at every stage of a product's life cycle will be affected by this compliance. In short, both strategic planning in ecological marketing and integrated PLM are two important concepts that ensure compliance with sustainability principles. By producing and marketing environmentally friendly products, companies can fulfill their environmental responsibilities. As can be seen, these two concepts share common goals and support each other.

MATERIALS AND METHODS

The research material of this study conducted in Izmir province consisted of 40 large-capacity cattle breeding facilities in Torbalı district where animal husbandry is intensive. For this purpose, the facility was visited and information about the situation in the facility such as manure management information, the effect of manure structure on milking, raw milk storage conditions and registration and marketing status of the products were obtained through direct / face-to-face interviews. Based on the information on the current situation, suggestions for agricultural marketing strategies were presented by determining the deficiencies and defects of the cattle breeding facility in the ecological marketing axis and evaluating the development possibilities within the framework of Product Life Cycle Management (Figure 1).

FINDINGS AND EVALUATION

In this study, strategic marketing objectives for the ecological marketing mix developed by considering cattle breeding and related agricultural products, which occupy an important place in the Küçük Menderes Basin, together with life cycle management in the perspective of ecological sustainable agriculture and marketing are presented.

According to the study, 70% of the agricultural structures create environmental pollution with animal waste due to low fertilizer and other adequate conditions and low use of information and technology. In order to overcome this, it is necessary to design, construct and install agricultural structures in accordance with ecological sustainability. However, although the ecology of all districts such as İzmir Torbalı district, where milk production is intensive, is very suitable for animal breeding, it is seen that their physical conditions, techniques and technologies, economies, and marketing capacities are quite inadequate (Table-1).

Table 1. Results of the study on the current situation regarding sustainable cattle production in Torbalı District

Number of Cattle Enterprises	40 pieces
Statement made in the study	Environmentally sensitive agricultural systems
Positive emerging concepts (Explanation on sustainable agriculture has been made)	The need to protect the environment
	Animal welfare
	Food safety
	Sustainability
Existing agricultural structure situation found to be positive	Number of enterprises with projects: 12.
Negative current situation (Explanation on sustainable agriculture was made)	There are no enterprises engaged in sustainable production.
	There are no environmentally sensitive enterprises in sustainable post-production processes.
	Environmental Cost
	Food safety
	Non-ecological agricultural structure

In Table 1, which was created according to this study considering ecological marketing, which is thought to be inevitable after ecological production in sustainable dimensions in the future, it was seen that the farmers who avoided the ecological agricultural system (production and marketing main process, etc.) took this decision due to personal concerns such as high price, and the current situation, within the framework of the data obtained through observations, due to the lack of food safety due to the non-ecological structure and health concerns, it was seen that the real meat and milk taste expected during the consumption of non-ecological animal products could not be provided. According to the study, those who expressed a positive opinion on the consumption and marketing of non-ecological meat and milk stated that they made this decision due to their concerns about the need to reduce environmental stress, animal welfare and ecological sustainability.
In this context, the objectives of ecological marketing, in terms of its mixed components, recommended to regionally based agricultural organizations are shown in Table 2. These ecological marketing objectives, in summary, focus on the ability to add cyclically to the ecology in a renewable way through the use of animal waste as fertilizer or in the production of electrical energy, the durability of the animal product and the reuse of water and other elements of production inputs, and the product life cycle analysis and management of how post-use wastes may affect the ecology today and in the future.

Table 2. Strategic Objectives in the Ecological Marketing Mix

Mixed Elements of Marketing	Targets	Mixed Elements of Marketing	Targets
Product	According to the product life cycle management, which varies depending on the characteristics of the animal product and the decisions to be taken regarding the animal production phase, minimizing the pollution and waste caused by other substances such as fertilizers etc. occurring in each product	Distribution	Reliable animal production and subsequent distribution management. • Minimizing pollution and waste from transportation, storage and storage of all animal products separately • Minimizing pollution from production, use and subsequent transport of animal waste for fertilizer and electrical energy production or transport for biogas production • Distribution management according to livestock product life cycle analysis
Promotion	Training of individual stakeholders on agro-ecological issues, strengthening the image of eco-responsibility of livestock (regarding the organization's activities and animal products), which directly or indirectly has a positive impact on current and future marketing	Price	Determining accurate and complete product prices to include all environmental costs in unit costs

In the research, results that can guide agricultural enterprises were found. Livestock enterprises with a manure infrastructure and management, i.e. environmental waste program, agricultural engineer unit are around 10% in the region, and it is seen that they are quite successful in reducing manure waste output, using sustainable energy and environmentally sensitive technologies, active internal and external stakeholder communication, environmentally sensitive corporate image and recycling works and processes compared to enterprises without these qualities. Therefore, it is essential to define animal manure infrastructure and management under the responsibility of agricultural engineering, ecological marketing strategy and performance program and ecological

marketing mix elements. However, in Turkey, as in the region, advanced environmental performance in livestock farms with the same conditions can be realized by reducing the indiscriminate storage and unconscious use of manure to reduce the impact on the ecology and by redesigning the livestock structure and the production process and product made within it. This corresponds to important indicators of the implementation of eco-agricultural strategies in studies on the balance between environmental protection and utilization.

CONCLUSION

Ecological agricultural marketing is becoming more and more serious for organizations for sustainable agricultural marketing, green product life cycle management, competitive and profitability advantage. The end customers of organizations are becoming more and more aware of ecology and the components of the ecological environment. Some companies are discovering the socio-economic and environmental dimensions of ecological agricultural marketing, i.e. the effects of sustainability. These companies will be in a very advantageous position in future competitions. The fact that there are now more consumers than ever before who are willing to pay considerably more for ecological products offers an attractive market opportunity for companies that will engage in ecological businesses and transactions. The key to ecological marketing ownership is management's commitment to buy environmentally designed products and to support environmental protection. This requires an awareness of philosophy and a process of implementation from the lowest level of the organization to the duties and obligations of the human resources at the top. Therefore, it should not be forgotten that the definition of eco-agricultural marketing is holistic for every business and transaction in the organization. In building ecological credibility that can reassure external consumers, the organization's managers should not neglect the need to have the ecological marketing agreement first validated by the organization's internal consumers.

Despite natural resources with a certain capacity, the earth is faced with the problems of drought, climate change, greenhouse gas emissions, destruction of forests, ever-growing population and hunger, and it is clear that the physical lines of the earth have become virtual with globalization, and that a real competence will be gained for the solution of these problems and the continuity of change in sustainability through organizations that can use ecological marketing practices and ecological marketing strategies in their economic activities. Ecological marketing strategies will be an important guide for organizations that want to be at the forefront in the deep competition that can be experienced in product variety, price and consumer satisfaction after the sales process.

In order to spread and internalize eco-agricultural marketing initiatives more rapidly in the region and Turkey, there is a need for management and organizational assistance in the project cycle stages, as well as training and adoption of the average 90% of enterprises that do not have environmental management subject to research for these initiatives. This management and organization can be carried out through local administrations, agricultural cooperatives and producer unions, together with community organizations.

Relevant organizations, the use of direct marketing strategies in ecological agricultural marketing campaigns that can be implemented in Turkey as well as in the region, and integration with the PLM platform in marketing are important for the success of the campaign. It is necessary for the marketing success of these campaigns to emphasize marketing strategies such as safe production methods, protection of human and environmental health, regional flavors, regionalism, regional arts and eco-biodiversity in the marketing mix and especially in promotional activities, with thousands of PLM approaches, i.e. analysis of high-volume customer data and decision support systems for marketing managers.

Finally, in line with these assessments, the establishment of a separate department to monitor environmental management in agricultural enterprises and the employment of specialized agricultural engineers, sustainable agricultural systems and program, product life cycle management, and the construction of adequate fertilizer infrastructure in accordance with standards and having environmental supervision play a decisive role in the ecological marketing practices, ecological marketing mix elements, environmental obligations and consumer relations of enterprises. Moreover, the ecological marketing strategies of agribusinesses interact positively with public environmental regulations, PLM for stakeholder and customer relations, and the objectives of the enterprise.

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DETERMINANTS OF THE ADOPTION OF PRESSURED IRRIGATION SYSTEMS AND TECHNICAL ISSUES ON RESEARCH IN ANKARA, TURKEY

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ABSTRACT
In this study, the factors and the technical considerations that affect the adoption of Pressured Irrigation System among innovative producers engaged in agricultural production in the city of Ankara were examined. Research data were collected through the surveys performed on a total of 105 producers, of whom 50 were from Sincan, 52 were from Ayaş, and 3 were from three different state farms located in Polatlı, Bala and Gölbaşı. Chi-square test was used for the statistical analysis and the investigation of the data. As a result of this study, we found that there was a dependence at the significance level of 5% between the adoption of Pressurized Irrigation System and age, education level, presence of the equipment, total size of the land, the modern irrigation system used, income level, interacting with agricultural consultants and technical stuff through communicational technologies while no dependence has been found for the problems faced, experiments, attendance to exhibitions and fairs, and consultancy services ($p>0.05$). Besides, in the companies using the drip irrigation system, the four most important issues were determined as blockage (71%), abrasion, animal-damage (40%) and cracks (37.8%), respectively. Our findings appear to support the knowledge that low quality, inexpensive drip irrigation systems are used in especially small-scale family farms and that the problems faced in the innovative systems are similar to the ones experienced in the adoption of the sustainable drip irrigation systems. It should be expected that the technology providers would help the producers in the topics of qualified material, technical services and sustainability as well as that the providers would re-consider their marketing techniques. In addition, decision-makers should develop and present new policies to apply in order to increase the success on the adoption of innovative irrigation technologies at the governmental level.
Keywords: Pressured irrigation systems, Agricultural extension staff, technical issues, Innovators, Technology innovations affect

INTRODUCTION
Along with the increasing food demand due to global population growth, the need for agricultural water is also rising. It is a known fact that usable water resources are limited. According to research from the International Water Management Institute (IWMI), one-third of the world's population will face water scarcity after 2025. With the world population estimated to reach 8 billion in 2025, food security will become the most important issue globally in the near future. To meet the nutritional needs of this growing population, a two-fold increase in production is required over the next 50 years (Howell et al. 2001). One projection suggests that by 2050, the demand for food, clothing, shelter, and fresh water will be twice as much as it is today (Postel et al. 2001).
According to the 2015 data from DSI (State Hydraulic Works), 16% of Turkey's annual average total usable water potential of 112 billion m^3 is consumed for drinking and domestic use, 12% for industry, and 72% for agricultural irrigation. These figures indicate that agricultural irrigation is the most important element in the management of water resources. Increasing water use efficiency (WUE) in irrigation and saving water are of great importance. It is essential to prioritize policies that encourage farmers to adopt pressurized irrigation systems, which can lead to significant water savings.
Modern pressurized irrigation systems are widely used in water-scarce areas of developed countries, allowing for more efficient water use in irrigated agriculture. These technologies can enhance agricultural productivity, increase incomes from crop yields, and improve household food security. Studies aimed at adopting pressurized irrigation systems have yielded positive results, and governments and organizations have actively supported incentives for modern agricultural technologies. The use of pressurized irrigation methods in agricultural practices is crucial for the efficient use of water resources. According to ICID (2024), almost all irrigated agricultural areas

in Israel and the United Kingdom, 87% in Ukraine, 56% in Russia, 77% in Brazil, 74% in Spain, 57% in Italy, 57% in the United States, and 38% in Turkey utilize pressurized irrigation methods.
Surface irrigation methods are used in over 90% of the irrigated areas in Turkey. Among these, the flood irrigation method, which has an extremely low irrigation efficiency, is applied in approximately 60% of the area. In contrast, water application efficiency values in developed countries are notably higher, reaching at least 60-70% for surface irrigation, 70-75% for sprinkler irrigation, and 80-90% for drip irrigation (Çevik et al., 2000). Considering the topographic features of our country, the presence of agricultural areas, and the potential for water resources, the application of pressurized irrigation systems is more suitable for irrigated areas. From a technical perspective, it has been determined that pressurized irrigation methods should be used in 63% of the irrigable area within the 0-6% slope group, regardless of economic factors. These systems contribute to both the protection of water resources and the reduction of environmental impacts caused by irrigation by promoting economical water use.
Micro irrigation technologies are considered a solution to the increasing demand and decreasing water resources. In developing countries, the low-cost inputs and management initiatives offered by modern agricultural technologies have improved food security and living standards (Polak and Yoder, 2006; Burney et al., 2010; Woltering et al., 2011). Drip irrigation supports sustainable development for commercial farmers, partly through increased yield and irrigation efficiency (Blum, 1991; Postel, 1999; Ibragimov et al., 2007). Despite these advantages, users of drip irrigation, one of the pressurized irrigation technologies, account for approximately 4% of total global irrigation (ICID, 2012). In Turkey, agriculture is the largest water-consuming sector, representing around 77% of total water use according to 2022 data, while irrigation efficiency stands at approximately 50% (Anonymous, 2023).
To ensure the appropriate use of water resources, it is essential to improve the irrigation technologies currently in use and to implement pressurized irrigation methods where necessary. This approach will enable a broader area to be irrigated using the potential of existing water resources (Yıldırım, 2004; Yılmaz and Toprak, 2024). The effective use and management of water resources, along with the adoption of modern irrigation technologies, are crucial for sustainable development and food security.
Recently, with advancements in technology, the adoption of modern pressurized irrigation systems and machinery for agricultural activities has rapidly increased among producers. These innovations aim to improve the quality of products in line with market demands, facilitate the work of producers facing challenging physical conditions, and reduce production costs to enhance international competitiveness. Looking back at agricultural development, we can see that technology users have evolved based on experience. In this context, it is essential to explore the question of "*What can be done, and why have many previous attempts failed*?" in order to successfully adopt the innovative technologies that are anticipated.
For this purpose, the study was conducted in the Ayaş, Sincan, Gölbaşı, Polatlı, and Bala districts of Ankara province, where agricultural functions are intensive and irrigated agriculture is prevalent. These districts are where agricultural technologies are most widely applied; they not only meet the product needs of the capital but also contain agricultural lands suitable for growing industrial crops desired in the domestic market. Additionally, the study examined the interest of innovative producers in modern pressurized irrigation systems in the region, investigated the determinants and technical factors influencing the adoption of these systems, and explored the problems encountered. The identified issues were analyzed under the following subheadings.

(i) To identify the technical issues affecting the adoption of innovative technologies in pressurized irrigation systems and the responsibilities of producers through face-to-face surveys conducted with them.

(ii) To understand how the factors influencing the adaptation of pressurized irrigation systems in the Ankara region manifest and to evaluate their quantitative effects.

(iii) To determine the impact of pressurized irrigation systems on the agro-socio-economy of the region.

(iv) To identify the determining factors influencing the adoption of pressurized irrigation systems by innovative producers in the study area.

MATERIAL AND METHODS

Ankara is located in the northern part of the Central Anatolia Region. With a surface area of approximately 2,563,200 hectares (Anonymous, 2022a) and an altitude of 890 m above sea level, Ankara province is situated between 38° 40' and 40° 45' north latitudes and 30° 50' and 33° 53' east longitudes. Due to its large area, the province experiences climate variations from place to place. A steppe climate prevails in the south, while the northern region has a rainy and temperate Black Sea climate. Summers in Ankara are hot, and winters are cold. The long-term average for the province (1927-2022) indicates an average annual precipitation of 391.1 mm, a temperature of 12 °C, and a daily sunshine duration of 6.7 hours. Annual precipitation is distributed as follows: 120 mm in winter, 132 mm in spring, 63 mm in summer, and 76 mm in autumn (Anonymous, 2024a). Examining the annual precipitation and its seasonal distribution highlights the importance of irrigation for agricultural production in the Ankara region.

Ankara is the second largest province in Turkey in terms of agricultural area, with approximately 45% of its surface area consisting of agricultural lands (Anonymous, 2022c). The province has 12 significant protected plains, covering a total area of 207,447 hectares (Anonymous, 2022a). Ankara's irrigation water resources include both surface and underground water sources. Table 1 presents the water potential of Ankara province according to its source. According to the table, Ankara has a total water potential of 5.72 billion m³ per year, of which 5.43 billion m³ is from surface water and 286 million m³ is from underground sources. This data indicates that a substantial portion of the water resources potential (94.7%) comes from surface resources. Approximately 500 million m³ of the total water resources potential is utilized in agriculture, accounting for 9% of the total water potential (Anonymous, 2015).

Table 1. Water resources potential and agricultural use of Ankara province

Water resource	Water potential (Billion m³/year)	Amount used in irrigation (Million m³/year)	Irrigation usage rate (%)
Surface water	5.43	434.5	8
Underground water	0.29	65.5	23
Total	5.72	500	9

According to data obtained from Anonymous (2022d), approximately 142,680 hectares of agricultural land in Ankara province are irrigated using 14,341 licensed farmer wells. Overall, a total of 176,427 hectares of agricultural land are irrigated in Ankara province. This includes 33,242 hectares managed by irrigation organizations, 505 hectares by the Polatlı Agricultural Enterprise Directorate, and 142,680 hectares irrigated through public irrigation from licensed wells.

After determining the districts included in the research, 20 villages (10 villages from two districts) where pressurized irrigation systems are most commonly applied were selected. The villages constituting the main population of the research are Bacı, Beyobası, Çokören, Girmeç, Malı, Tatlar, Temelli, Türkobası, Yenicimşit, and Yenikent in the Sincan District of Ankara Province, as well as Faruz, Gökler, Gençali, Ilıca, Sinanlı, Oltan, Ortabereket, Uğurçayırı, Pınaryaka, and Yağmurdede in the Ayaş District. Additionally, State Production Farms located in the Polatlı, Bala, and Gölbaşı districts were included in the scope of the research (Figure 1).

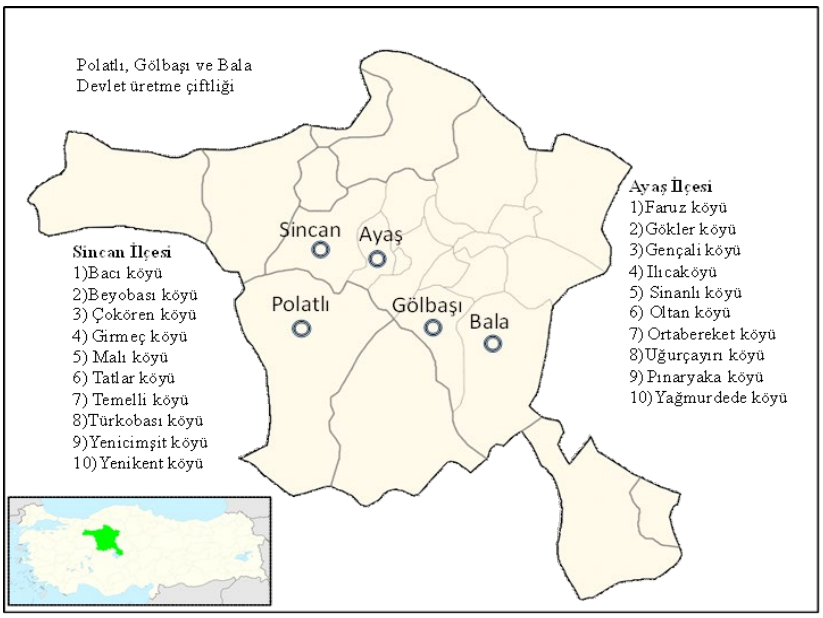

Figure 1. Districts of Ankara Province where the study was conducted.

The factors affecting farmers' behavior in adopting modern irrigation methods in agriculture were examined. Additionally, the effective use of pressurized irrigation systems in small family farms and state institutions was assessed. The study utilized research conducted by individuals and institutions on the subject, including statistical results, articles, theses, and other written materials.

Information on the survey applied in the research

The study was based on survey data collected from innovative producers using pressurized irrigation systems in five different districts of Ankara. The surveys were designed to align with the research objectives and to provide comprehensive information. Additionally, relevant research conducted in our country and abroad was also utilized. The surveys were administered during the months of March, April, and May in 2016.

Selection of sample villages and farms

Villages and state production farms in the Sincan and Ayaş districts were selected as research areas because the State Production Farms utilize planned and modern pressurized irrigation systems. Additionally, farmers in these areas are inclined to adopt modern irrigation practices and exhibit a positive attitude toward accepting innovations.

Data collection application

The surveys that form the core database of the research were administered using the face-to-face interview method during March, April, and May of 2016. Each survey took approximately 25-30 minutes to complete. One-on-one interviews were conducted with 250 farmers across 30 villages over a three-month period, identifying innovative farmers who adopted practices aligned with our survey questions.

Surveys were conducted in 10 villages, including 50 farmers in Sincan district, 52 farmers in 10 villages of Ayaş district, and a total of 105 farmers utilizing pressurized irrigation systems. Additionally, technical staff implementing modern irrigation techniques were interviewed at three State Production Farms selected through purposeful sampling. No interviews were conducted with farmers engaged in dry farming.

The surveys were designed to provide comprehensive information in accordance with the research objectives. Any additional comments or explanations from the surveyed farmers were also noted. The survey forms were prepared based on the face-to-face interviews conducted by the researcher in the communities.

Method applied in data evaluation

Absolute and relative distributions were used to evaluate the survey data collected from farmers. A coding plan was developed for this purpose, and data from all farmer surveys were recorded and entered into a computer system. In analyzing the data, farmers who were identified as adopters of pressurized irrigation systems were considered the primary focus, based on prior one-on-one interviews with technical staff.

The chi-square test was employed to assess the tendencies and behaviors of local farmers. The calculated values obtained from the chi-square test were compared with table values at a 95% confidence level, and the research findings were presented accordingly.

The chi-square test was used to evaluate the data in the study (Düzgünes, O., 1983).

$$X^2 = \frac{(f - f^1)^2}{f^1} \quad (1)$$

In the equation, X^2 represents the chi-square calculation value, f denotes the observed frequency, and f^1 refers to the expected frequency parameters.

The mean and standard deviation values were calculated based on the responses to the survey questions, and the characteristic values were counted. The variables indicating these characteristics were identified using the chi-square test. While conducting the chi-square test, qualitative variables were examined.

RESULT AND DISCUSSION

Socio-Economic and agronomic characteristics of irrigation organization producers

The research examined the factors influencing the socio-economic characteristics of innovative producers, including age, education level, agricultural experience, access to agricultural credit and its sources, status of tools and equipment, land size, and income level.

As a result of the survey, it was found that the youngest producers in the regions where the research was conducted were 36 years old, while the oldest were 67 years old. Additionally, it was determined that 12.4% were in the 36-42 age group, 33.3% in the 49-54 age group, 36.2% in the 55-60 age group, and 1% were aged 67 and above. This indicates that the majority of producers belong to the older age groups. The age distribution of the producers included in the research was categorized into three groups: young (<36), middle-aged (36-60), and old (≥61). The average age of the producers was 49.5 years, with the majority falling within the 49-60 age range.

The study found a linear relationship between the early adoption of innovations and age. It concluded that age is a significant factor influencing farmers' early decisions to adopt technology, engage with agricultural consultants and technical extension personnel, and understand irrigation system technologies. Several conditions affect farmers' decisions regarding technology adaptation, including natural factors (such as climate, soil, and topography), institutional factors (like government policies), and farmer-specific factors (including education level, age, household size, and attitudes). Turner and Taylor (1998) and Rogers (1995) noted in their studies that early adopters of innovations did not differ from late adopters in terms of age. Similarly, Musaro et al. (2010) found that age, gender, marital status, and the agricultural education level of the household head significantly influenced farmers' decisions to adopt pressurized irrigation technology. The results of these studies support the findings of the current research.

An important structural issue in Turkish agriculture is the education level of those engaged in agricultural production. A low education level is seen as a significant barrier to the transfer of innovative technologies. In the research area, the majority of producers have completed primary school, while others hold middle school, high school, or university degrees. Notably, there are no uneducated individuals in the literacy rate distribution. This situation has facilitated the adoption of pressurized irrigation techniques and other innovative-driven agricultural practices. The higher education levels of producers who adopt and implement technological innovations have enabled them to be recognized as innovative farmers. In a study conducted by Ceylan et al. (1988), it was noted that there is a directly proportional relationship between the adoption of innovations and the level of education. Similarly, Musaro et al. (2010) reported that 66.7% of educated farmers accepted pressurized irrigation systems, compared to 33.3% of uneducated farmers. These findings align with the results of the current study.

Agricultural experience can significantly influence producers' attitudes toward the application of modern irrigation techniques and their related maintenance and repairs, facilitating the adoption of innovations. More experienced producers are better equipped to identify deficiencies or faults in their operations and are more receptive to guidance on adopting modern technologies to address these issues. The research revealed that 42.9% of the producers had 20-29 years of experience, 41.9% had 30-39 years, 14.3% had 40-49 years, and 1% had 50

years or more of experience. The average duration of experience among producers in the research area was determined to be 40 years, with an 84.8% distribution rate. Observations indicated that these producers often resolved issues independently, relying on the experience they had gained over the years with technical equipment, fittings, and malfunctions in pressurized irrigation systems, frequently without consulting their technical advisors. In some regions where the study was conducted, smallholders faced delays in adopting modern technologies due to high installation costs. These producers participated in trials and training sessions at certain times of the year, influenced by their education levels, cultural backgrounds, and income levels. After receiving information and gaining experience, they decided to install irrigation systems in their enterprises. In Turkey, it is generally recommended that credit be used to encourage farmers engaged in small-scale operations who are facing financial difficulties to adopt modern technologies. However, survey responses indicated that farmers who implemented modern irrigation systems did not utilize credit for this purpose. Instead, they reported using credit for other agricultural activities, citing their own financial resources as sufficient for the installation of irrigation systems. As the rate of innovation adoption among producers increases, so too does the level of tool and machine usage and the experience of the producers (Singh et al., 2015). This study observed that the presence of equipment, particularly for water intake and irrigation, along with other agronomic activities, significantly enhances the potential for adopting modern pressurized irrigation systems in the region.

Since producers do not incur costs for information, they tend to consult anyone they consider knowledgeable about agricultural issues. The study found that half of the producers do not utilize formal consultancy services. According to the survey results, they primarily seek advice on fertilization (21.9%), followed by inquiries about diseases and pests (10.5%). However, the topic of irrigation—specifically related to pressurized irrigation systems, which is the focus of our study—remained notably underrepresented.

Similar to European Union countries, Turkey implemented a certified agricultural consultancy system in 2006. This system includes producer organizations, non-governmental organizations, the private sector, and freelance agricultural consultants, alongside public sector services that provide agricultural publications. Despite consultancy services being part of state incentives, several challenges hinder access to these services. High costs, the remoteness and scattering of agricultural enterprises, varying product patterns, and a shortage of trained expert consultants all contribute to the difficulties in obtaining effective consultancy.

Total land assets significantly impact producers' income levels and serve as an indicator of their status. Recognizing that land size influences the adoption of innovations, the research examined the total land area of the producers. According to the survey results, the average land size of producers engaged in irrigated agriculture is between 50 and 100 decares. Additionally, the study included an examination of 3 State Production Farms and 2 commercial enterprises in the research area.

One of the most important factors in the adoption of pressurized irrigation systems is the size of the irrigated land. Since technology requires direct irrigation application, the extent of land available for irrigated agriculture is crucial. The usability and likelihood of adoption increase in direct proportion to the size of the irrigated area. The sizes of irrigated land in the regions where the study was conducted are presented in Table 2. It was observed that land sizes were predominantly 500 decares and above in state and commercial enterprises.

Table 2. Irrigation land assets of enterprises in the regions where the study was conducted

Irrigation Land	Small Family Business		State		Commercial	
	Producer	%	Producer	%	Producer	%
1-50 da	43	43	-	-	-	-
51-150 da	35	35	-	-	-	-
151 da and above	22	22	3	100	2	100

The acceptance of an innovative irrigation technique among producers largely depends on their ability to cover the initial investment cost and to have sufficient income to offset any potential financial loss. The vast majority of producers indicated that they are economically low-income. However, the results show that nearly 50% of the producers fall within medium to high-income levels, which facilitates the adoption of modern pressurized irrigation techniques in the study area. This financial capability suggests that they are inclined to continue implementing the system and demonstrate innovative practices.

According to a study conducted by Rogers (1983), innovators are highly willing to try new ideas, with risk-taking being a key measure of innovation. He linked the applicability of modern agricultural techniques in rural settlements to the sufficient income levels of farmers. Similarly, in his study, Tatlıdil (1989) noted that innovators must possess adequate financial resources to compensate for potential losses that may arise after trying an innovation.

Modern pressurized irrigation systems are widely used in water-scarce areas of developed countries, enabling more efficient water usage in irrigated agriculture. These technologies can enhance agricultural productivity in the face of climate change, increase incomes from product yields, and improve household food security. To support the adoption of pressurized irrigation systems, various studies have demonstrated their benefits, and technology incentives have been actively promoted by governments and other organizations. For successful implementation, producers need to maintain strong, ongoing relationships with agricultural technicians and engineers. While technology providers globally continue to organize meetings and demonstration studies for promotion and implementation, such activities have seen a significant increase in recent years, particularly in developing countries.

In the villages where the research was conducted, the participation rate of local producers in activities related to irrigation systems, such as trials and demonstrations, was found to be quite high, achieving a participation rate of 88.6%. This suggests a positive relationship between participation and the adoption or prolonged use of pressurized irrigation techniques in agricultural practices. The trials and demonstrations, which play a crucial role in the acceptance of innovations in agriculture, were deemed sufficient. The results indicated that while the participation of producers in agricultural training and trials was commendable, the regulatory support from the state or commercial organizations could be enhanced. By doing so, awareness-raising and participation-encouraging measures could be further accelerated.

Farmers' attitudes and behaviors regarding irrigation

According to the survey results, the use of sprinkler irrigation systems predates that of drip irrigation systems. The longest reported use of sprinkler irrigation was 40 years in family businesses and 28 years in state enterprises, while the figures for drip irrigation were 20 years in family businesses and 25 years in state enterprises. The average duration of sprinkler irrigation use ranged between 10 and 30 years, whereas for drip irrigation, it was between 5 and 15 years (Figure 2). In commercial businesses, both irrigation methods had a usage period of approximately 10 years. This indicates that the drip irrigation system has only recently begun to gain recognition and implementation.

In Figure 2, the extent of pressurized irrigation techniques is presented on a logarithmic scale to illustrate variations among small-scale family farms. Upon examining the correlation between the lengths of time a farmer has used each irrigation method, no significant relationship was found. However, the area applied to sprinkler irrigation networks was larger than that of drip irrigation. Specifically, the area for drip irrigation ranged between 10 and 100 decares, while for sprinkler irrigation, it ranged from 10 to 1000 decares.

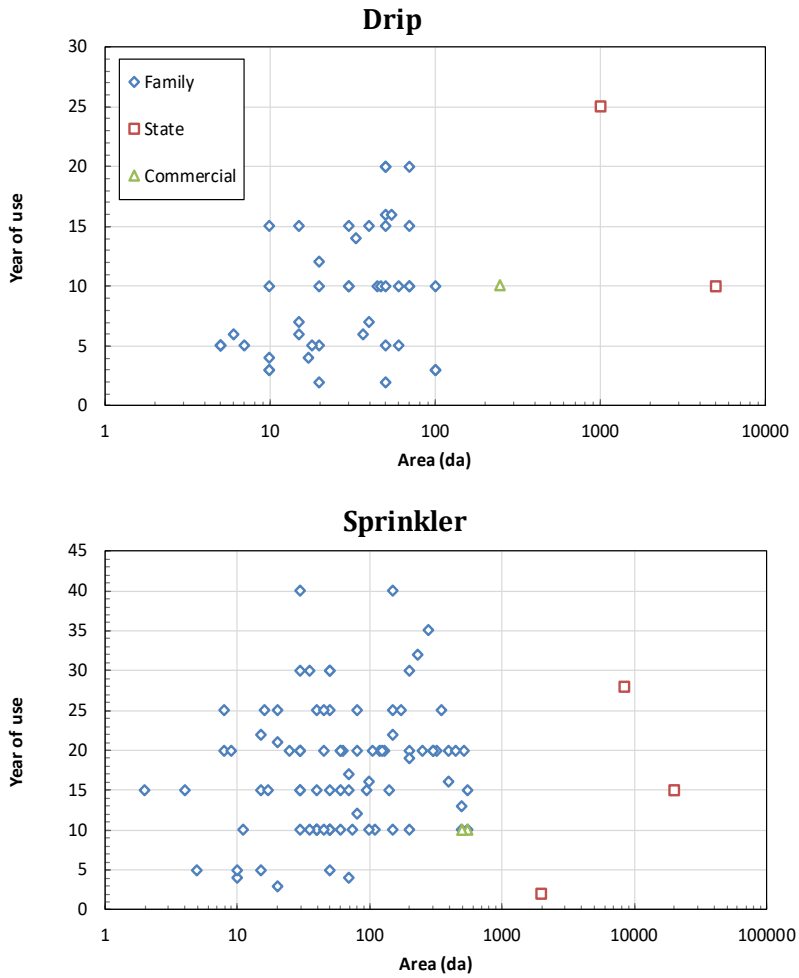

Figure 2. Years of use of pressurized irrigation systems (drip and sprinkler irrigation methods) by area sizes in the study region

Woltering et al. (2011) reported that technology providers can gain an advantage in adoption by organizing farmers into groups while selling higher-quality systems. This approach, akin to that implemented by TIPA in West Africa, may enable poorer farmers to invest in technologies with a longer lifespan. The study noted that individual farmers, who typically rely on their own livelihoods, expressed concerns about the durability and continuity of low-cost systems.

The reasons for preferring pressurized irrigation systems have provided valuable insights into their adoption and spread. Notably, both irrigation techniques are favored for their economic advantages, as they are more cost-effective compared to traditional surface irrigation methods and contribute to higher income. Additionally, lower labor requirements and costs have also influenced this preference. When considering these factors, the benefits of these irrigation techniques become evident. In the case of drip irrigation, advantages such as water savings and ease of transportation further enhance its appeal.

The study found that the sources of supply for pressurized irrigation systems were similarly reported for both irrigation techniques. Innovative producers supplied the highest percentage (53.3%) of materials for sprinkler systems using their own resources. In drip irrigation systems, this rate was slightly lower at 50.5%. State support accounted for 22.9% of material supply in state-supported sprinkler systems and 30.5% in drip irrigation systems. Additionally, credit was utilized for material supply at rates of 23.8% for sprinkler systems and 19.0% for drip irrigation systems.

In recent years, the growing preference for drip irrigation, which offers high yields through water savings and efficient use of land, underscores the effectiveness of related studies and policies. However, banks have lagged in providing adequate support, highlighting the need to explore alternative financing options and support

structures for producers, beyond traditional bank loans. It is also important to consider that other innovative agricultural technologies deserve support, particularly those operated privately and aligned with global standards, as they can serve as good examples. Additionally, the surveys and interviews conducted revealed a strong consensus on the need for increased state support for both irrigation methods. A doctoral study on this topic emphasized that state assistance is essential for improving the irrigation systems of producers (Kıymaz, 2006).

Technical aspects

During the interviews with the enterprises, respondents provided answers that could be either single or multiple choices. It was noted that enterprises utilizing services from agricultural consultants typically received information regarding the operation of irrigation systems, the challenges they face, and potential solutions.

It has been observed that younger producers who use pressurized irrigation systems are more proactive in addressing issues within these systems. They frequently communicate with agricultural consultants and district technical support staff for assistance. Among the general problems identified, blockage issues were the most significant, reported by 71% of respondents, followed by wear and tear (40%), animal damage (40%), and leaks, discharges, and cracks (37.8%) as the four most critical problems (Figure 3).

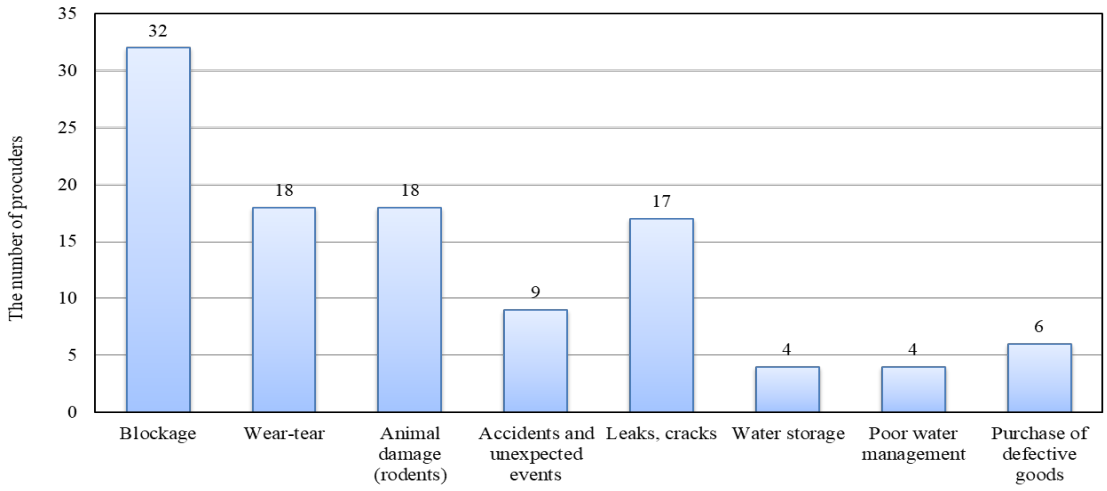

Figure 3. Sources and distribution of technical problems encountered by innovative producers in drip irrigation systems.

These results align with the application challenges identified in sustainable drip irrigation adaptation (Kulecho and Weatherhead, 2005; Belder et al., 2007). Factors such as water quality, and the lack of filtration systems contribute significantly to clogging issues. Additionally, animal damage, particularly from rodents, is a notable concern. It has been observed that small family businesses often do not prioritize this issue or allocate a sufficient budget for pest control.

When investigating the reasons behind these problems, the results shown in Figure 4 were obtained. Among the causes of clogging issues, the accumulation of sand, silt, and gravel was the most significant, accounting for 42.2%. Other factors, such as algae growth, calcification, and poor water quality, were reported at lower percentages. Additionally, poor material quality was identified as a general reason by 40% of respondents, followed by the inadequacy of consultants and a lack of education, which were cited by 13.3%.

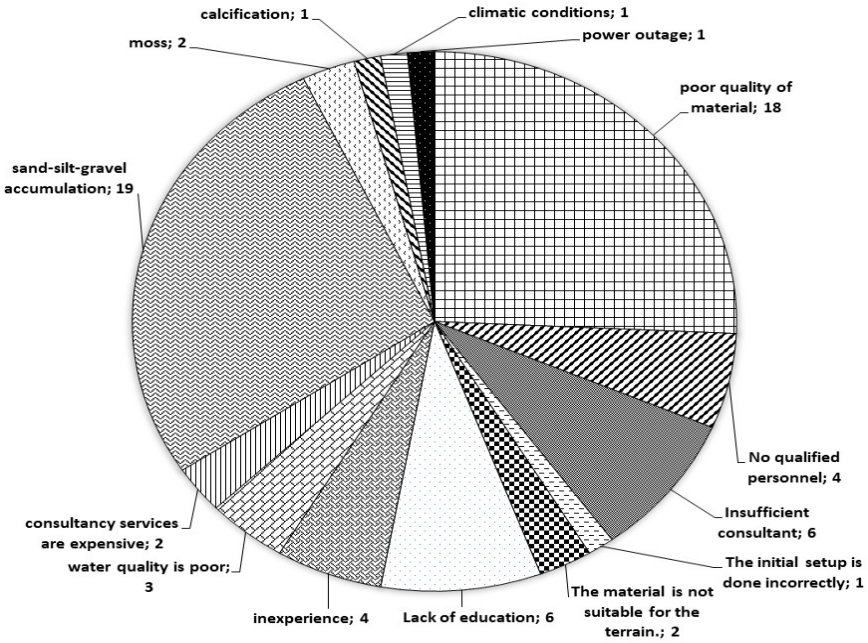

Figure 4. Causes of problems involving drip irrigation system elements

It has been observed that repairs and maintenance activities are closely aligned with the specific system components where problems occur. For instance, in cases of blockage, the most common solution is washing the filters, which accounts for the highest percentage of responses. This is followed by washing the laterals and clearing blocked pipes, both of which are also reported at high rates. Additionally, the replacement of damaged components due to poor material quality and patching of holes and tears are significant actions taken (Figure 5).

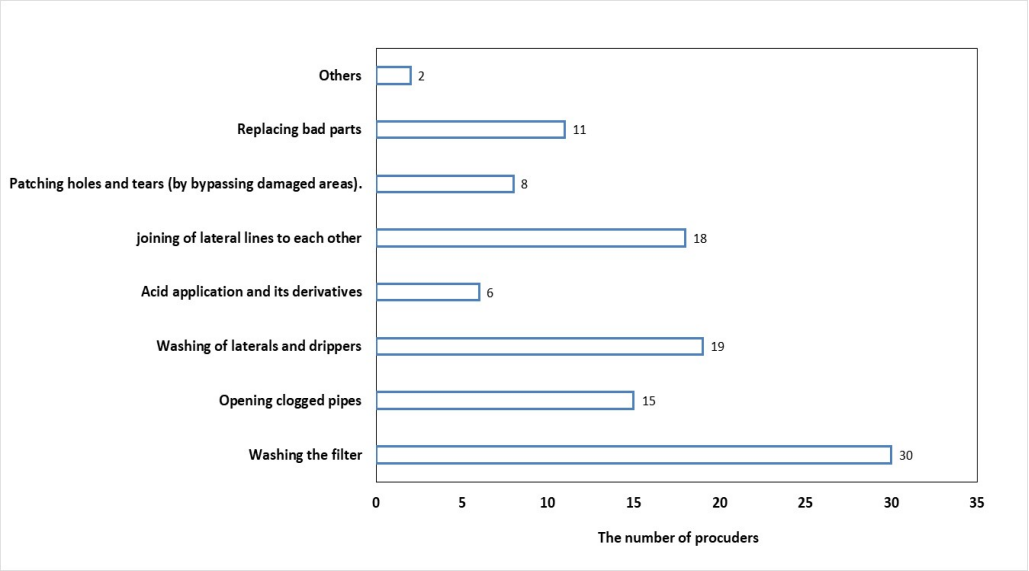

Figure 5. Distribution of repairs made by users of the drip irrigation system

The survey results indicated which parts were most frequently replaced during repairs. Valves were replaced with a frequency of 60%, followed by the replacement of laterals and manifolds at 46.7% and connection parts at 42.2%. Filter replacement was reported at a frequency of 33.3%.

While adopters generally express satisfaction with the support received, the primary issues identified are the lack of continuity in technical services and challenges in obtaining spare parts. Respondents reported that providers often fall short in maintenance and repair services due to problems such as breakage, leakage, and clogging. Additionally, transportation difficulties faced by personnel responsible for providing technical support are significant concerns (Kulecho and Weatherhead, 2005).

Analysis and study of some socio-economic, irrigation and technical features

The adoption of new technology is a prerequisite for agricultural development. Implementing technological innovations in agriculture is essential for advancing the agricultural sector. This section presents the findings from the chi-square analysis conducted to examine the relationships between the level of use of advanced innovative irrigation technologies and factors such as irrigation awareness, technical issues, and socio-economic characteristics.

The results of the chi-square analysis indicate a dependency between age and irrigation method preference at the 5% significance level. This suggests that age significantly influences the choice of irrigation method (Table 3).

Table 3. Relationship between producers' age and irrigation method

Age		What method do you use for irrigation?			Total
		Sprinkler	Drip	Flood	
36-42	Producer	9	1	3	13
	%	69,2	7,7	23,1	100,0
43-48	Producer	3	8	0	11
	%	27,3	72,7	0,0	100,0
49-54	Producer	16	19	0	35
	%	45,7	54,3	0,0	100,0
55-60	Producer	13	16	9	38
	%	34,2	42,1	23,7	100,0
61-66	Producer	3	1	3	7
	%	42,9	14,3	42,9	100,0
67 and above	Producer	1	0	0	1
	%	100,0	0,0	0,0	100,0
Total	Producer	45	45	15	105
	%	42,9	42,9	14,3	100,0

$X^2=33.64$, $X^2_{(0.05;10)}= 26.87$

The correlation between producers' economic situation (income level) and their reasons for preferring the sprinkler irrigation system was calculated. The results indicate that the economic situation of innovative producers influences their preference for the sprinkler irrigation method (Table 4).

Table 4. Relationship between producer's economic situation (Income Level) and reasons for choosing the sprinkler irrigation system

		Reason for choosing sprinkler irrigation system				Total
		Economic	Lack of workmanship	The material is cheap	Providing high income	
Low income	Producer	19	14	11	8	52
	%	36,5	26,9	21,2	15,4	100,0
Medium income	Producer	11	4	3	9	27
	%	40,7	14,8	11,1	33,3	100,0
High income	Producer	4	8	8	6	26
	%	15,4	30,8	30,8	23,1	100,0
Total	Producer	34	26	22	23	105
	%	32,4	24,8	21,0	21,9	100,0

$X^2=10.48$, $X^2_{(0.05;6)}= 9.82$

Since half of our producers are low-income individuals based on the economic development level of their rural area, they prefer this system because they can purchase the materials used in sprinkler irrigation at the lowest

possible cost. Additionally, other important factors in choosing this irrigation system include the affordability of the materials, low labor costs, and the potential for high income. Furthermore, the dealers supplying these materials are nearby, allowing producers to quickly replace items in case of damage or loss, which is why they continue to rely on this irrigation system.

While determining the relationship between income level and the adoption of the drip irrigation system, the calculated p-value was found 0.031 (Table 5). This indicates that producers expressed a desire to use the drip irrigation system regardless of their income level.

Table 5. Relationship between producers' income and adoption of the drip irrigation system

		Where did you source the materials used in the drip irrigation system?			Total
		with my own means	bank loan	government support	
Low income	**Producer**	26	10	16	52
	%	50,0	19,2	30,8	100,0
Medium income	**Producer**	13	5	9	27
	%	48,1	18,5	33,3	100,0
High income	**Producer**	14	5	7	26
	%	53,8	19,2	26,9	100,0
Total	**Producer**	53	20	32	105
	%	50,5	19,0	30,5	100,0

X^2=0.278, $X^2_{(0.05;4)}$= 0.277

According to the Chi-square analysis conducted to assess the relationship between education level and irrigation type, there is a dependency at the 5% significance level, indicating that education influences the choice of irrigation method (Table 6).

Table 6. Relationship between producers' education level and Irrigation type

What is your education level?		What method do you use for irrigation?			Total
		Sprinkler	Drip	Flood	
No education	**Producer**	22	26	8	56
	%	39,3	46,4	14,3	100,0
Primary school graduate	**Producer**	6	6	0	12
	%	50,0	50,0	0,0	100,0
Secondary school graduate	**Producer**	9	6	3	18
	%	50,0	33,3	16,7	100,0
High school graduate	**Producer**	8	7	4	19
	%	42,1	36,8	21,1	100,0
Total	**Producer**	45	45	15	105
	%	42,9	42,9	14,3	100,0

X^2=5.42, $X^2_{(0.05;6)}$=3.77

More than half of the producers are graduates of middle school and high school, while university graduates among the business owner farmers are more open to technological innovations. Their position at the upper end of the adoption spectrum has significantly influenced their use of pressurized irrigation technologies.

Regarding the connection between the type of agriculture and irrigation methods, the p-value calculated using the Chi-square test is small ($p < 0.05$), indicating a relationship between agricultural type and irrigation types. Given that the economic situation of our farmers is a priority in choosing their agricultural practices, those in better financial conditions tend to use higher-quality and more robust irrigation systems (Table 7). The study also found that the materials and equipment used in the irrigation technologies of State Production Farms are of high quality

and economical. Additionally, the presence of technical service providers contributes to the preference for these systems.

Table 7. Chi-square test for the relationship between producers' farming and irrigation types

What kind of farming do you engage in?		What method do you use for irrigation?			Total
		Sprinkler	Drip	Flood	
Family	Producer	42	43	15	100
	%	42	43	15	100
Commercial	Producer	1	1	0	2
	%	50	50	0	100
State	Producer	2	1	0	3
	%	66.7	33.3	0	100
Total	Producer	45	45	15	105
	%	42.9	42.9	14.2	100

X^2=5.13, $X^2_{(0.05;4)}$= 4.13

According to the Chi-square analysis conducted to examine the dependency between the source of knowledge about the sprinkler irrigation system and the choice of irrigation system, it was determined that there is a significant dependency at the 5% level (Table 8).

Table 8. The Relationship between the source of knowledge about the sprinkler irrigation system and the selection of irrigation system.

Who or where did you hear about the sprinkler irrigation system from?		What factors influenced your choice of a sprinkler irrigation system?				Total
		Economic	Labor is low	Material is cheap	High income	
Adviser	Producer	8	8	7	8	31
	%	25,8	25,8	22,6	25,8	100,0
Grower	Producer	15	9	6	3	33
	%	45,5	27,3	18,2	9,1	100,0
Agriculture Province/District	Producer	11	9	9	12	41
	%	26,8	22,0	22,0	29,3	100,0
Total	Producer	34	26	22	23	105
	%	32,4	24,8	21,0	21,9	100,0

X^2=7.12, $X^2_{(0.05;6)}$= 6.66

When asked where they learned about the sprinkler irrigation system, many of our producers indicated they received this knowledge from the technical staff working in the Provincial/District agricultural organization, followed by agricultural consultants. Some producers also mentioned that they learned through observation and experience from other farmers. This suggests that farmers generally prefer to acquire knowledge about these technologies from their own experts, reflecting their serious commitment to the issue.

According to the chi-square analysis conducted to assess the dependency between producers recommending the drip irrigation system to others despite the problems they encounter, no dependency was found at the 5% significance level (p: 0.720 > 0.05) (Table 9). It is evident that our innovative producers have been applying drip irrigation systems, considered a part of pressurized irrigation technologies, in their own enterprises for years. Despite experiencing malfunctions and technical problems, they continue to implement these systems and recommend them to other farmers.

Table 9. Relationship between recommending the drip irrigation system despite encountered problems

Would you suggest the drip irrigation system to other farmers?	What have you done regarding repairs and maintenance on drip or micro irrigation systems?					Total
	Filter washing	Opening clogged pipes	Washing lanterns and drippers	Acid application and its derivatives	Patching holes and tears	
Yes	17	20	29	19	4	89
No	4	4	6	1	1	16
Total	21	24	35	20	5	105

$X^2=2.08$, $X^2_{(0.05;4)}=2.54$

Due to technical problems with drip or sprinkler irrigation systems, producers often do not receive timely responses from the technical staff they contact. Consequently, they tend to seek advice from nearby farmers or relatives engaged in similar agricultural activities.

The statistical analysis conducted in this study revealed no significant relationship between participation in fairs and the type of irrigation used (Table 10). However, it was observed that younger farmers were more likely to participate in trials, exhibitions, panels, competitions, and fairs where irrigation systems were showcased and discussed. They actively engaged in these events and subsequently applied their gained experiences and knowledge to their own enterprises.

Table 10. Relationship between participation in fairs and choice of irrigation method

Have you participated in any fairs related to agriculture or irrigation systems?		What method do you use for irrigation?			Total
		Sprinkler	Drip	Flood	
Yes	Producer	7	6	0	13
	%	53,8%	46,2%	0,0%	100,0%
No	Producer	38	39	15	92
	%	41,3%	42,4%	16,3%	100,0%
Total	Producer	45	45	15	105
	%	42,9%	42,9%	14,3%	100,0%

$X^2=2.58$, $X^2_{(0.05;2)}=4.39$

In activities conducted by the Chamber of Agricultural Engineers across various provinces, it has been observed that farmers embrace their roles in adopting technological innovations by participating in panels, fairs, competitions, exhibitions, and trials. These activities enhance their knowledge and skills regarding the adoption and spread of irrigation systems, which are critical to agricultural development (ZMO Newsletter, 2012). In the enterprises examined, the impact of receiving consultancy services on the selection of irrigation methods was analyzed. According to the Chi-square analysis, no significant relationship was found between receiving consultancy services and the choice of irrigation methods ($p > 0.05$). However, the analysis did reveal a correlation between the frequency of meetings with consultants and the selection of irrigation methods. Farmers expressed high satisfaction with the consultancy services they received and emphasized the importance of ongoing state support for these services. Additionally, those who collaborated closely with technical extension officers from Provincial/District agricultural directorates—recognized as the official application points in agriculture—reported feeling more secure. The perception that continued state support for pressurized irrigation systems facilitates these activities further reinforces their value.

Table 11. Relationship between receiving consultancy services and irrigation method

Do you utilize consultancy services for all the agricultural activities in your business?		What method do you use for irrigation?			Total
		Sprinkler	Drip	Flood	
Yes	Producer	27	17	8	52
	%	51,9	32,7	15,4	100,0
No	Producer	18	28	7	53
	%	34,0	52,8	13,2	100,0
Total	Producer	45	45	15	105
	%	42,9	42,9	14,3	100,0

$X^2=4.55$, $X^2_{(0.05;2)}=4.59$

CONCLUSIONS

Summary of remarkable results:

1. ***Youthful adoption:*** The producers who widely adopt pressurized irrigation technologies in the region are primarily young. Their close contact with technology enables quick access to information and resources.
2. ***Education and enterprise size:*** Educated farmers who adopt modern pressurized irrigation technologies tend to have larger enterprises compared to their less educated counterparts and place greater importance on agricultural experience and consultancy services.
3. ***Awareness and decision-making:*** Agricultural programs on television significantly raise awareness of pressurized irrigation technologies. Additionally, agricultural consultants and technical staff from Provincial/District agricultural directorates play a crucial role in the decision-making and implementation stages.
4. ***Economic independence:*** Producers with higher incomes typically purchase and implement irrigation systems using their own resources rather than relying on state support.
5. ***Modern management in state farms:*** The pressurized irrigation systems used in State Production Farms are highly modern, managed by professional units. Experienced technical staff oversee water management and planning, ensuring economical use and consistent water yield, with materials supplied by the state.
6. ***The training of technical staff:*** Technical staff and workers managing the irrigation systems in State Production Farms generally receive formal training and courses on irrigation practices.
7. ***Influence of agricultural consultants:*** The survey indicated that producers are keeping up with technological developments in pressurized irrigation systems, influenced by the agricultural consultants they work with, as well as by training and visits from technical extension personnel. They adopt and recommend these systems to other farmers.
8. ***Registration in farmer support systems:*** Most producers participating in the study are registered in the farmer registration system, which is used to determine eligibility for support provided by the Ministry of Food, Agriculture, and Livestock.
9. ***Experience with pressurized irrigation:*** Innovative producers utilizing pressurized irrigation systems have been using these technologies for an average of 20 years, influenced by their age, education, and experience.
10. ***Openness to innovation:*** The producers in the study region actively follow technological advancements and are receptive to innovations in irrigation systems, indicating a strong level of education

Suggestions for enhancing the study results:

- ***Adoption of efficient practices:*** Producers should strive to meet modern agricultural demands by optimizing irrigation water use, especially during periods of water scarcity. By pursuing higher yields per unit area and embracing new irrigation technologies, they can enhance productivity and sustainability.
- ***Emphasis on product diversity and training:*** Cultivating a diverse range of crops and ensuring that operators are well-trained and experienced is crucial. Producers should actively consult with their agricultural

consultants on various topics—such as irrigation, pest control, and fertilization—to make informed decisions that leverage their own experiences.

- ***Utilization of information sources:*** To effectively implement pressurized irrigation systems, agricultural producers should tap into the expertise of their agricultural consultants, as well as utilize printed and visual media (e.g., TV, radio, newspapers) and resources from Provincial/District technical staff for updates on irrigation techniques and innovations.
- ***Socio-Economic considerations in training:*** When planning farmer training and extension activities, it is essential to consider the socio-economic backgrounds of the operators and regional characteristics. Training personnel should be well-equipped, knowledgeable and skilled in their subject matter to effectively support producers.
- ***Targeted training activities:*** Training initiatives should focus on producers who can demonstrate tangible results from their applications. Utilizing strategies such as young farmer demonstrations, competitions, and technical trips can foster engagement. The compatibility of new technologies with existing enterprise conditions should also be a key consideration, as the scale of the operation significantly impacts adoption and income outcomes. Additionally, land consolidation projects should be promoted to combat land fragmentation.
- ***Maintenance to prevent clogging:*** To mitigate clogging in drippers within pressurized irrigation systems, regular maintenance and cleaning of filters are essential. The application of diluted acids (such as hydrochloric or ortho-phosphoric acid) during the irrigation season and after the last irrigation can also be beneficial.
- ***Pre-training for maintenance:*** Producers should receive expert-led training on proper maintenance practices, including the cleaning and replacement of system components, to enhance the longevity and efficiency of their irrigation systems.
- ***Support for climate resilience:*** Technology providers and policymakers should design programs that bolster agricultural production against climate change challenges. Support should focus on providing access to quality materials, technical services, and sustainable practices within pressurized irrigation systems. Producers should also be encouraged to innovate their marketing strategies to align with these advancements.

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THE EFFECTS OF AGRICULTURAL PRACTICES ON SOYBEAN YIELD IN SOMBOR REGION IN SERBIA IN 2014 – 2023 PERIOD

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ABSTRACT
In the Sombor region soybean is grown on over 20,000 ha each year, and in Serbia it is grown on more than 200,000 ha, which makes Serbia a significant producer of this industrial crop. The Agriculture Extension Service Sombor has been monitoring soybean production in Sombor region for three decades. Beside influence of weather conditions, the correlation between agricultural practices and soybean yield is our topic of interest. Large and small plot trials help us provide a good picture of all important traits for soybean production. The following cropping practices are monitored: time of primary tillage, impact of previous crop, usage of mineral fertilizers, time of sowing and selection of variety. Each of these measures are in the hands of agricultural producers and through these measures, producers affect the level of soybean yield.
The primary tillage in dry conditions preserves the necessary moisture in soil and it is one of the most important moments in production. Proper usage of mineral fertilizers, the choice of the appropriate previous crop and sowing time also have a very significant impact on soybean yield.
Also, the choice of soybean variety has a great influence on production. In this study the productive parameters of soybeans were investigated in ten years, in 2014-2023 period.
Keywords: soybean, primary tillage, sowing time, mineral fertilizers, previous crop

INTRODUCTION
Soybean is one of the most important industrial crops, from which more than 20.000 products are obtained. Soybean is classified as protein crop with almost 40% of protein, but also high oil content can classify soybean as important oil crop (Đorđević and Nenadić, 1980). From year to year this plant species occupies more and more areas in our country and in the world regions (Čurović, 2011). The economic importance of soybean is increasing year by year due to its very diverse use in the food, livestock, pharmaceutical and processing industries.
In the Sombor region soybean is grown on over 20,000 ha each year, and in Serbia it is grown on more than 200,000 ha, which makes Serbia a significant producer of this industrial crop. Climate change has a significant impact on cultivated crops, reducing yield and its stability. By adjusting agrotechnical measures to climate change farmers can increase yields. Soybeans have low total production costs per hectar which is why it is interesting to our producers. Fungicides are not used to protect soybeans, so this production is important for environmental protection. In our region near rivers and canals there are quite favorable natural conditions for soybean production.

MATERIALS AND METHODS
In our region we have over 140.000 ha of land suitable for high yield soybean production (Sabadoš, 2019). In this study the productive parameters of soybeans were investigated in ten years, in 2014-2023 period, soybean ranged from 18.000 to 23.000 ha every year. Beside influence of weather conditions, the correlation between agricultural practices and soybean yield is our topic of interest. Agriculture Extension service collects data about agrotechnical measures in soybean production. This study is based on 53.000 ha of soybean production in period

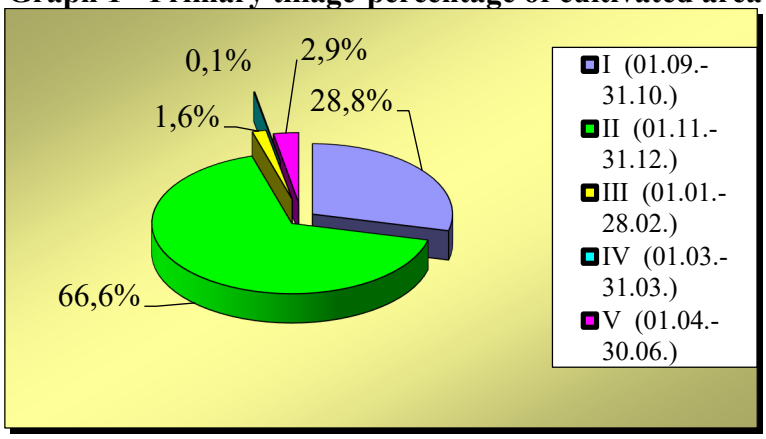
from 2014 to 2023 (a total of 10 years). Large and small plot trials help us provide a good picture of all agronomically important traits for soybean production. At the end of the growing season, producers fill out the field books with data on applied agricultural techniques. Producers of our region also fill out the questionnaires about the production that they deliver to our station. Our extension service prints brochures and organizes lectures about soybean production in the end of growing season.

FINDINGS

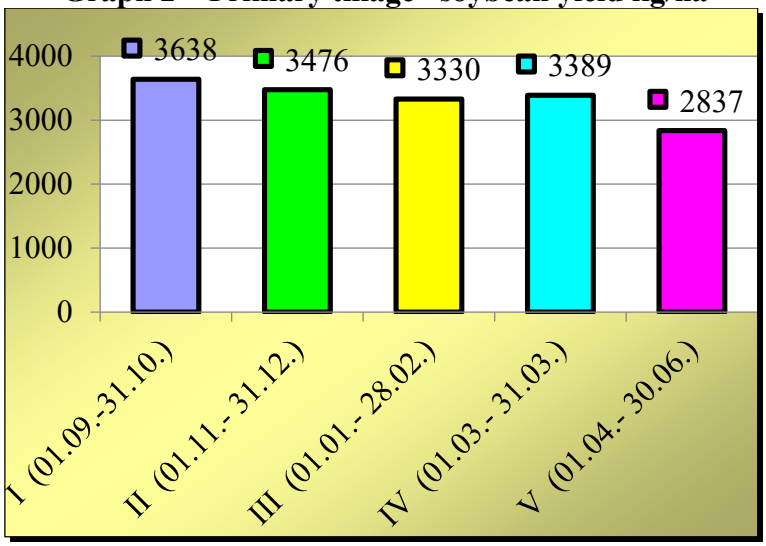
1. **Primary tillage** –For the successful soybean production primary tillage is particularly important. High quality primary tillage contributes to better application of other agrotechnical measures (Nenadić, 2006). The time and method of primary tillage depend on previous crop, as well as on weather conditions. We observed time of primary tillage through five periods: I period (01.09. - 31. 10.), II period (01. 11. - 31. 12.), III period (01.01. – 28.02.) , IV period (01.03.-31.03.) and V period (01.04.-30.06.). As we can see in Graph 1 on 29% of production area primary tillage is done in September and October. On 67% of area primary tillage is done in November and December. Only a few percent are early and late spring primary tillage.

Graph 2. shows as the yield decreases if primary tillage is delayed. Early tillage is especially important for drier soils as well as those with a heavier mechanical composition (Nenadić, 2006). Any earlier tillage is preferable to late tillage, and the worst one is in the spring.

Graph 1 - Primary tillage-percentage of cultivated area



Graph 2 – Primary tillage –soybean yield kg/ha

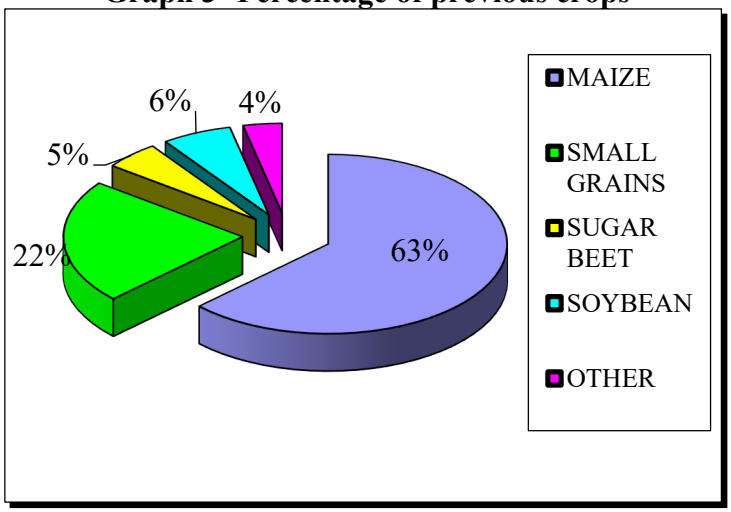


2. **Previous crop**. Crop rotation is very important from the aspect of integrated plant protection (Aćimović, 1988). Previously there was an opinion that soybeans are not particulary sensitive to the choice of previous crop,

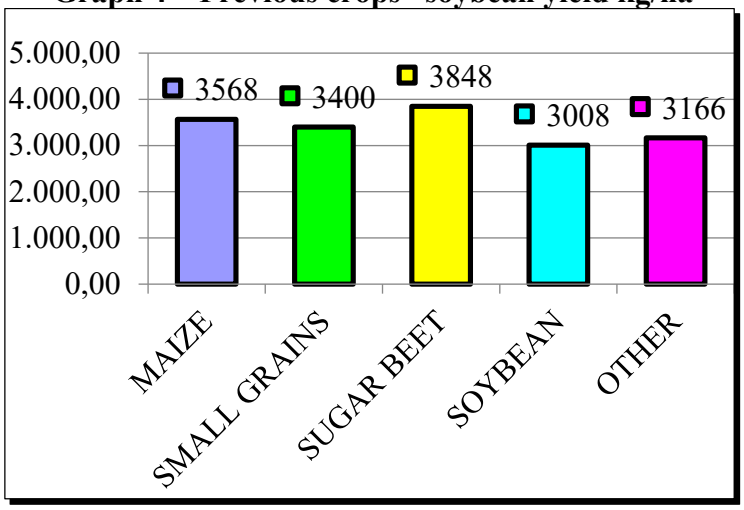
but recent research refutes this view. Soybeans must be grown in crop rotation. In the soybean crop rotation, it can come after different crops. With 63% the most represented previous crop for soybean is maize. In Sombor region the percent of monoculture is 6%. Monoculture is not recommended due to the increased risk of diseases, pests and weeds (Miladinović, Hrustić and Vidić, 2011).

In the observed period sugar beet was the best previous crop for soybeans, average soybean yield was 3848 kg/ha. However, in dry years, sugar beet as a large consumer of water, is not a good previous crop for soybeans. Maize is also good previous crop in soybean production, with 3568kg/ha of soybean. Primary tillage after maize must be done in time (Molnar, Milošev and Kurjački, 1996). If primary tillage is done late and the maize crop is not plowed well the soybean yield will be unsatisfactory. Small grains are also good previous crops since they leave the fields earl, they were on 22% of the fields.

Graph 3- Percentage of previous crops



Graph 4 – Previous crops –soybean yield kg/ha



3. **Mineral fertilizers.** Mineral plant nutrition depends on the presence and rations of 17 necessary elements (Kastori, Ilin, Maksimović and Putnik Delić, 2019). High yields cannot be expected on those fields where certain nutrients are missing. The number of mineral fertilizers recommended for each plot should be based on the agrochemical analysis of the soil.

In Agriculture Extension Service Sombor we have a laboratory that examines soil fertility. After the analyzes done, the producers receive recommendations for fertilizing. Quantities are expressed in kg / ha of active substance: nitrogen (N), phosphorus (P2O5) and potassium (K2O). In Graph 5, it can be seen that the use of fertilizers varied from 82 kg/ ha to 133 kg/ha active substance during the previous decade. The specificity of

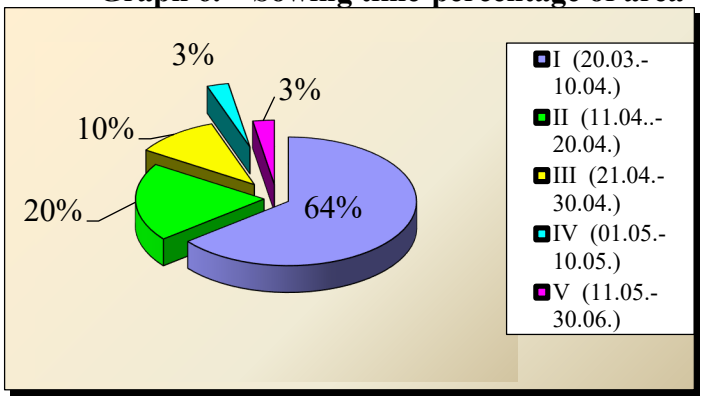
soybean is that it can provide a significant amount of nitrogen from the air. Three weeks after germination soybean plants are capable of nitrogen fixation from the air.

Graph 5. Use of mineral fertilizers expressed in kg of active substance per ha

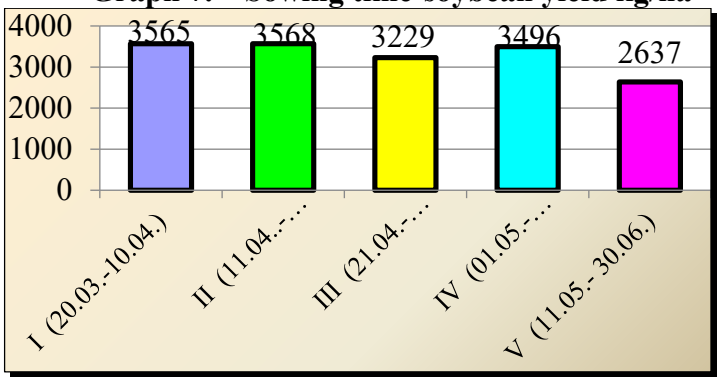
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
N	48	34	53	48	33	32	34	40	15	21
P2O5	32	31	31	39	38	26	29	42	34	31
K2O	30	32	28	44	48	36	41	51	33	37

4. **Sowing time** – We observed time of sowing time through five periods: I period (20.03. – 10.04.), II period (11.04 - 20.04), III period (21.04. – 30.04.), IV period 01.05. - 10.05.) and V period (11.05 – 30.06). The largest area under soybeans is sown at the beginning of April. Also, the best yield was achieved when soybeans were sown in the middle of April. The decision on the time of sowing should be based on the temperature of the sowing layer, not on the basis of the calendar. (Crnobarac, Đukić and Balešević Tubić, 2007). r.
The optimal time for sowing soybeans is when the temperature of sowing layer is 10-12 ^{0}C (Miladinović, Hrustić and Vidić, 2011). Young sprouted plants can withstand short frosts from -3^0 C to -4^0 C.

Graph 6. – Sowing time-percentage of area



Graph 7. – Sowing time-soybean yield kg/ha



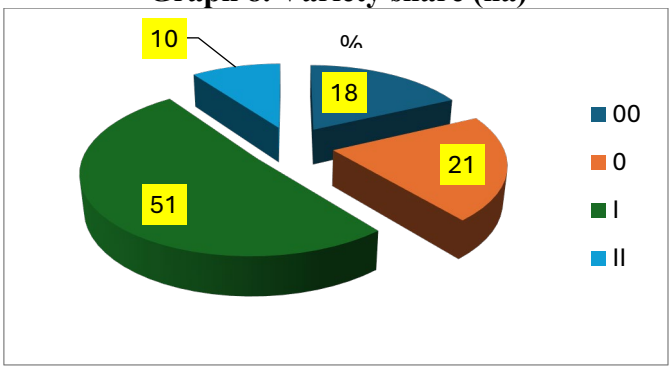
5. **Choice of varieties** – The choice of variety should be approached very seriously because the correct selection of the variety directly affects the yield and profitability of the production. The variety can have a high production potential under ideal conditions, but it may not come to expression when variety is faced with unfavorable,

stressful conditions (Đorđević, Malidža and Vidić, 2019). Maturity group, i.e. the length of the growing season significantly affects the yield. It is necessary to choose the variety that will reach physiological maturity before the first autumn frosts, and it is important to take into account the occurrence of dry periods during the summer. In certain years, early varieties give better yields than late varieties because they avoided the dry period during the critical stages of development (Đorđević, Malidža and Vidić, 2019).

As we can see in Graph 8. in Sombor region on about 50% of area varieties of I maturity group are grown. On about 20% of area producers grow 0 soybean maturity group.

Varieties from II maturity group are grown on about 10% of fields. On other areas, varieties of shorter vegetation are grown in after crop production.

Graph 8. Variety share (ha)



CONSLUSION AND DISSCUSION

In our region we have over 140.000 ha of land suitable for high yield soybean production. In this study the productive parameters of soybeans were investigated in ten years, in 2014-2023 period, soybean ranged from 18.000 to 23.000 ha every year. Large and small plot trials help us provide a good picture of all agronomically important traits for soybean production. For the successful soybean production primary tillage is particularly important. High quality primary tillage contributes to better application of other agrotechnical measures. As we can see on 29% of production area primary tillage is done in September and October. On 67% of area primary tillage is done in November and December. The highest yield is achieved when the primary tillage is done during the first period (01.09. - 31. 10.). The most common previous crop for soybean is maize. Sugar beet was the best previous crop, average soybean yield after sugar beet was 3848 kg/ha. The number of mineral fertilizers recommended for each plot should be based on the agrochemical analysis of the soil. The use of fertilizers varied from 82 kg/ha to 133 kg/ha active substance during the previous decade.

The largest area under soybeans is sown at the beginning of April. Also, the best yield was achieved when soybeans were sown in the middle of April.

The decision on the time of sowing should be based on the temperature of the sowing layer, not on the basis of the calendar. Maturity group, i.e. the length of the growing season significantly affects the yield In Sombor region on about 50% of area varieties of I maturity group are grown.

RECOMMENDATIONS

In soyabean production all agrotechnical measures should be applied on time and with high quality.

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TESTING THE EFFECTIVENESS OF HERBICIDES APPLIED TO THE SUNFLOWER CROP

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ABSTRACT
Sunflower (*Helianthus annuus*) is one of the most important oil crops in Serbia. Sunflower is a spring crop with a large inter-row spacing, in the early stages of development it represents weak competition with weeds. In the first stages of development, the sunflower develops slowly, and weed species easily occupy free areas. In this regard, the application of PRE EM herbicides in conventional sunflower hybrids, and the application of a combination of PRE and POST EM herbicides in Clearfield and Express technology hybrids, represents a successful measure of sunflower protection against weeds. Also, this season, we tested Viballa™ EC, a new post-emergence herbicide based on the innovative active ingredient Arylex™ active in all sunflower hybrids. This herbicide is also characterized by a unique application period: from the appearance of 4 true leaves to the beginning of the budonization stage (BBCH 14-39). On the plots there were broad-leaved and narrow-leaved weeds specific to our production area. The experiments were set up in the sunflower crop (Neostar CLP) in 2020 at the PSS Sombor experimental plot. Application of PRE-EM herbicide was done two days after sowing, and POST-EM application at the stage when the crop was from cotyledons to the third pair of leaves (BBCH 9-15). Viballa herbicide was applied at the stage of bud formation (BBCH 39). The experiments examined a combination of herbicides from the chemical groups: chloroacetamides, triazines, pyridazinones, chloroacetamides, imidazolinones, arylpicolinates, cyclohexanediones and aryloxyphenoxy propionates. Efficiency ranged from 50 to 96%. The best efficiency was recorded in variants where PRE- and POST-EM herbicides were applied. In CLP sunflower hybrids, the best efficiency was achieved by the application of combinations of herbicides from the chemical groups: chloroacetamides+pyridazinones+arylpicolinates+cyclohexanediones, which resulted in a good crop yield.
Keywords: sunflower, weeds, herbicides

INTRODUCTION
Sunflower (Helianthus annuus) is one of the most important oil crops in Serbia. The areas under sunflower in our country change from year to year and range from 150,000 to over 230,000 hectares. These changes largely depend on economic factors, price policy, climatic conditions and a number of other factors. Sunflower breeders in the world and in our country are trying to create as productive hybrids as possible. The previous decade was characterized not only by the creation of productive high-oil hybrids, but also by the accelerated creation of hybrids for special purposes (cosm, high-olein, bird-feeding hybrids...), which enabled the production of high-value final products and better human nutrition. (Škorić, Vrebalov, Ćupina, Turkulov, Marinković, Masirević, Atlagić, Tadić, Sekulić, Stanojević, Kovačević, Jančić and Sakač, 1988). Sunflower is a spring crop with a large inter-row spacing, in the early stages of development it represents weak competition with weeds. In the first stages of development, the sunflower develops poorly, and by the time the rows are assembled, weed species easily occupy free areas. (Kojić and Šinžar, 1985). In this regard, the application of PRE EM herbicides in conventional sunflower hybrids, and the application of a combination of PRE and POST EM herbicides in Clearfield and Express technology hybrids, represents a successful measure of sunflower protection against weeds (Vuković and Dozet, 2010). Also this season, we tested Viballa™ EC, a new post-emergence herbicide based on the innovative active ingredient Arylex™ active for controlling problematic broadleaf weeds in all sunflower hybrids

(Conventional, Clearfield and Express). This herbicide is also characterized by a unique application period: from the appearance of 4 true leaves to the beginning of the budonization stage (BBCH 14-50). https://www.agroklub.rs/poljoprivredni-oglasnik/oglas/viballa-resava-sirokolisne-korove-u-suncokretu/46977/.
In addition to chemical measures in the protection of sunflowers, agrotechnical measures are also very important, which include crop rotation, high-quality tillage and inter-row cultivation. (Kojić and Janjić,1997)

Picture 1: Sunflower (orig)

MATERIALS AND METHODS

The experiments were set up in the sunflower crop (Neostar CLP) in 2020 in the fields of PSS Sombor (loc. Gakovo). Sowing was done on April 27, 2020. The size of the basic plot was 28m². The experiment was performed with 8 variants in three repetitions, where each repetition had a control plot that was not treated. All varieties were treated with herbicides, from 1 to 4 treatments, while the application was carried out with a Euro Pulve EZC sprayer with 4 nozzles, with a water consumption of 200 l/ha. The following weed species were present on the plots: Ambrosia artemisiifolia, Chenopodium album, Xanthium strumarium, Abutilon theophrasti, Solanum nigrum, Bilderdykia convolvulus, Polygonum persicaria, Datura stramonium, Hibiscus trionum, Sorghum halepense (seed and rhizome). Application of PRE-EM herbicide was done two days after sowing, and POST-EM application at the stage when the crop was from cotyledons to the third pair of leaves (BBCH 9-15). Viballa herbicide was applied at the stage of bud formation (BBCH 39).
Evaluations of the effectiveness and phytotoxicity of the tested herbicides were done every two weeks from the application of the herbicide up to two months. Using a 100x100 cm frame, the number of weeds in each basic plot was determined Phyrotoxicity was evaluated visually on a scale of 0-9 (0-no symptoms, 9-complete decay of plants) at the same time as the efficiency evaluation. (Janjić, V.,1985)
The yield of sunflower seeds was calculated based on the yield from each basic plot and reduced to 9% moisture. In the trials, the PRE-EM combination of herbicides was tested: (S-metallochlor 960 g/l (1.2 l/ha) + Terbuthylazine 500 g/l (1.4 l/ha), ; S-metallochlor 960 g/l (1.2 l/ha) + Terbuthylazine 500 g/ 1.5 l/ha + Flurochloridon 250 g/l (2 l/ha); S-metallochlor 960 g/l (1 l/ha) + Flurochloridon 250 g/l (3 l/ha); Dimethenamid 720 g/l (1 l/ha) + Flurochloridon 250 g/l (2 l/ha), then POST EM herbicide combination for broadleaf: Imazamox 40 g/l (1.2 l/ ha); Imazamox 50 g/l (1 l/ha), Arylex active (1 l/ha) and herbicides for narrow-leaved weeds (Fluazifop P-butyl 150 g/l (1.3 l/ha), Kletodim 120 g/ l (2 l/ha), Cycloxidim 100 g/l (2 l/ha).

Table 1.Variants in the trial, applied quantities of preparations and time of application

Order no.	Variant	Dose (l/ha)	Time of application
1.	S metalohlor 960 g/l (1,2 l/ha) + Terbutilazin 500 g/l (1,4 l/ha)	1,2 l/ha+1,4 l/ha	PRE EM
	Fluazifop P- butil 150 g/l	1,3 l/ha	BBCH 18
2.	Imazamox 40 g/l	1,2 l/ha	BBCH 12
3.	Imazamox 50 g/l	1 l/ha	BBCH 12
	Fluazifop P- butil 150 g/l	1,3 l/ha	BBCH 18
4.	S metalohlor 960 g/l + Terbutilazin 500 g/l +Flurohloridon 250 g/l	1,2 l/ha+1,5 l/ha+2 l/ha	PRE EM
	Imazamox 40 gl	1,2 l/ha	BBCH 12
5.	S metalohlor 960 g/l + Flurohloridon 250 g/l	1 l/ha + 3 l/ha	PRE EM
	Arylex active	1 l/ha	BBCH 18
6.	UNTREATED CONTROL		
7.	Dimetenamid 250 g/l + Flurohloridon 250 g/l	1 l/ha+ 2 l/ha	PRE EM
	Halauksifen-metil 3,131 g/l	1 l/ha	BBCH 18
	Cikloksidim 120 g/l	2 l/ha	BBCH 30
8.	Imazamox 40 g/l	1,25 l/ha	BBCH 12

Herbicides used in the experiment belong to the following chemical groups: chloroacetamides, triazines, pyridazinones, imidazolinones, arylpicolinates, aryloxyphenoxy propionates, cyclohexanediones.

Chloroacetamides HRAC and classification: K3 inhibits cell division and the process of tissue differentiation. It also inhibits the process of synthesis of very long chain fatty acids. Selective soil herbicides. Plants generally take it up through the shoot of the ponicle, and it can also be taken up by the root and epicotyl. Movement in the plant is very limited (xylem).

Triazines HRAC and classification: C1 - Acts on the photosynthesis process as an inhibitor of electron transport in photosystem II. Selective, translocation herbicide. It is taken up predominantly by the root, although it can also be taken up by the leaf, after which it is translocated by the xylem. It accumulates in the apical meristem and leaves. It acts in chloroplasts, on thylakoid membranes. (Aleksić, Brkić, Gašić, Jovanović-Radovanov, Kljajić, Marčić, Miletić, Pavlović, Radivojević, Rekanović, Stević, Tamaš, Vučinić, and Vuković, 2016).

Pyridazinones, HRAC classification: F1 - acts on the biosynthesis of carotenoids. It inhibits the activity of the enzyme phytoene desaturase (PDS). Selective herbicide. It also has a residual action. Plants adopt it by root, shoot and coleoptile. Movement in the plant is very limited. (Mitić, N.V., 2020)

Halauxifen-methyl - derivatives of picolinic acid HRAC classification O hormonal herbicide of the auxin type (synthetic auxin). It exhibits the action of the type of growth regulator. Selective translocation, foliar herbicide, absorbed by the leaf. The specific mechanism of action is still unknown, it is believed to mimic the action of the plant hormone auxin and lead to growth disturbances in sensitive plant species. (Mitić, N.V., 2020)

Imidazolinones HRAC classification: B - acts on the biosynthesis of amino acids, which results in stopping cell division and plant growth. It inhibits the activity of the enzyme acetolactate synthetase-acetohydroxy-acid synthetase (ALS or AHAS), stopping the process of biosynthesis of essential amino acids valine, leucine and

isoleucine. Selective, translocation, foliar herbicide. It is taken up by leaves and roots. It moves through the xylem and phloem in the plant. It accumulates in the meristem tissues where it acts. (Mitić, N.V., 2020)
Aryloxyphenoxypropionates and cyclohexadiones HRAC classification: A - affects lipid biosynthesis. It inhibits the activity of the acetyl-CoA-carboxylase (ACC) enzyme, stopping the process of fatty acid biosynthesis. Selective, translocation, foliar herbicide. It is approved by letter. In the plant, it moves through xylem and phloem. It accumulates in the rhizomes and stolons of perennials as well as in the meristem tissues of annual and perennial grass species (Mitić, N.V., 2020).

FINDINGS

Ten days before the application of soil herbicides, there was no precipitation at the location of the test field in Gakovo, and ten days after the application of the herbicides, we had 24 mm/m² of precipitation. As is well known, in order for soil herbicides to show their effectiveness, it is necessary to have a minimum of 10 mm/m² of precipitation after application. After the application of soil herbicides in our experimental field, we had a sufficient amount of precipitation for the soil herbicides to show their effectiveness.

Table 2. Rating of herbicide effectiveness 05/14/2024. based on the number of weeds/m²

Order no.	Variant	Date of treatments	Ratings of herbicide treatments										
			14.05.2020.										
			Datula stramonium	*Ambrosia artemisifolia*	*Chenopodium album*	*Hibiscus trionum*	*Xanthium strumarium*	*Polygonum persicaria*	*Solanum nigrum*	*Abuthilon theophrasti*	*Sinapis arvensis*	*Bilderdykia convolvulus*	*Sorghum halepense*
1.	S metalohlor 960 g/l (1,2 l/ha) + Terbutilazin 500 g/l (1,4 l/ha) Fluazifop P-butil 150 g/l	29.04. 13.06.	1	5	1							2	3
2.	Imazamox 40 g/l	22.05.	2	5	1		5						
3.	Imazamox 50 g/l Fluazifop P-butil 150 g/l	22.05. 13.06.	3	6	2		4		1	2			2

4.	S metalohlor 960 g/l + Terbutilazin 500 g/l +Flurohloridon 250 g/l Imazamox 40 g/l	29.04. 22.05.	2	5	1	1	4			1	2		1
5.	S metalohlor 960 g/l + Flurohloridon 250 g/l Halauksifen-metil 3,131 g/l	29.04. 13.06.	3	4	3		2			1			2
6.	UNTREATED CONTROL	-	2	4	1	1	3	1		2	1	2	2
7.	Dimetenamid 250 g/l + Flurohloridon 250 g/l Halauksifen-metil 3,131 g/l Cikloksidim 120 g/l	29.04. 13.06. 19.06.	1	5	1		2						3
8.	Imazamox 40 g/l	22.05.	4	5	1		3						1

Table 3. Rating of herbicide effectiveness 05/29/2024. based on the number of weeds/m²

Order no.	Variant	Date of treatments	Ratings of herbicide treatments										
			29.05.2020.										
			Datula stramonium	*Ambrosia artemisifolia*	*Chenopodium album*	*Hibiscus trionum*	*Xanthium strumarium*	*Polygonum persicaria*	*Solanum nigrum*	*Abuthilon theophrasti*	*Sinapis arvensis*	*Bilderdykia convolvulus*	*Sorghum halepense*
1.	S metalohlor 960 g/l (1,2 l/ha) + Terbutilazin 500 g/l (1,4 l/ha) Fluazifop P- butil 150 g/l	29.04. 12.06.	1	7	2							2	6
2.	Imazamox 40 g/l	22.05.		4			1		1				1
3.	Imazamox 50 g/l Fluazifop P- butil 150 g/l	22.05. 12.06.		4					1				4
4.	S metalohlor 960 g/l + Terbutilazin 500 g/l +Flurohloridon 250 g/l Imazamox 40 g/l	29.04. 22.05.		3			2						3
5.	S metalohlor 960 g/l + Flurohloridon 250 g/l Halauksifen-metil 3,131 g/l	29.04. 13.06.	4	6	4		2			1			2
6.	UNTREATED CONTROL	-	4	6	2	1	5	1		3	1	2	3
7.	Dimetenamid 250 g/l + Flurohloridon 250 g/l Halauksifen-metil 3,131 g/l Cikloksidim 120 g/l	29.04. 13.06. 12.06.	2	7	2		3						5
8.	Imazamox 40 g/l	22.05.		1									1

Table 4. Rating of herbicide efficiency 23.06.2024. based on the number of weeds/m², herbicide efficiency, phytotoxicity

Order no.	Variant	Date of treatments	Ratings of herbicide treatments											The number of weeds per	Efficiency %	Phytotoxicity %	Yield kg/ha
			23.06.2020.														
			Datula stramoniu	*Ambrosia artemisifoli*	*Chenopodium*	*Hibiscus trionum*	*Xanthium strumariu*	*Polygonum persicaria*	*Solanum nigrum*	*Abuthilon theophrasti*	*Sinapis arvensis*	*Bilderdykia*	*Sorghum halepense*				
1.	S metalohlor 960 g/l (1,2 l/ha) + Terbutilazin 500 g/l (1,4 l/ha) Fluazifop P- butil 150 g/l	29.04. 12.06.	1	7	2		2					2	1	14	50	0	3032
2.	Imazamox 40 g/l	22.05.		4			1		1				1	7	75	0	2372
3.	Imazamox 50 g/l Fluazifop P- butil 150 g/l	22.05. 12.06.		4					1					5	82	0	2822
4.	S metalohlor 960 g/l + Terbutilazin 500 g/l +Flurohloridon 250 g/l Imazamox 40 g/l	29.04. 22.05.		3			2						3	8	71	0	2994
5.	S metalohlor 960 g/l + Flurohloridon 250 g/l Halauksifen-metil 3,131 g/l	29.04. 13.06.	2										2	4	86	3	3610
6.	UNTREATED CONTROL	-	4	6	2	1	5	1		3	1	2	3	28			2594
7.	Dimetenamid 250 g/l +	29.04.	1											1	96	3	3556

	Flurohlorid on 250 g/l Halauksife n-metil 3,131 g/l Cikloksidi m 120 g/l	13.0 6. 12.0 6.															
8.	Imazamox 40 g/l	22.0 5.		1									1	2	9 3	2	321 6

Herbicide efficacy was assessed 15 days after each treatment. Efficiency ranged from 50 to 96%. The best efficiency was recorded in variants where PRE and POST-EM herbicides were applied. In CLP sunflower hybrids, the best efficiency was demonstrated by the application of Dimethenamid 720 g/l (1 l/ha) + Flurochloridon 250 g/l (2 l/ha) + Arylex™ active (1 l/ha) + Cycloxidim 100 g/l (2 l/ha), which resulted in a good crop yield. The lowest efficiency was recorded in the variant where we had only PRE EM sunflower protection S metallochlor 960 g/l (1.2 l/ha) + Terbuthylazine 500 g/l (1.4 l/ha, and in POST EM correction for narrow-leaved weeds with herbicide based on the active substance Fluazifop P-butyl 150 g/l 1.3 l/ha.

Pictures 2,3,4 sunflower trials (orig)

CONCLUSION

The herbicide based on the active substance imazamox showed excellent effectiveness on broad-leaved weeds Datula stramonium (which, in addition to Ambrosia artemisisfolia, was the dominant weed species in the test, which you can see in the table). It also showed excellent effectiveness on the weed species Chenopodium album and Abuthilon theophrasti. It showed good effectiveness on the weed species Ambrosia artemisifolia, which was of the age of cotyledons, and on Ambrosia artemisifolia, which was of the age of the first to the second pair of leaves, it showed a weaker effectiveness. The herbicide based on the active substance imazamox also showed a weaker effectiveness on the weed species Solanum nigrum. Herbicide based on the active substance Halauksiphen-methyl, which is used in all sunflower hybrids (Conventional, Clearfield and Express) and which we tested for the first time this year in a sunflower trial, showed excellent effectiveness on all ages of stubborn weed species Ambrosia artemisifolia, Chenopodium album, Xanthium strumarium. On the also very numerous weed species Datula stramonium in our experiment, but also in our production area, it showed poor efficiency.

DISSCUSION

Sunflower is an early hoeing with a large inter-row spacing and in the early stages of development represents weak competition with weeds. In the first stages of development, the sunflower develops poorly, and by the time the rows are assembled, weed species easily occupy free areas. (Kojić and Čanak., 1972). Protection of sunflowers from weeds in the past was quite limited because conventional hybrids were available to us, where chemical

protection from weeds was based only on herbicides after sowing and before crop emergence. If in that period there was not enough rainfall (10-20 mm/m²) to activate the PRE EM herbicide molecule, the protection was unsuccessful, and we had weedy crops. By introducing sunflower hybrids resistant to imidazolinones and tribenuron methyl, protection of sunflowers from broad-leaved weeds was made possible after crop emergence BBCH 9 until the third pair of leaves BBCH 15.

With all the mentioned sunflower hybrids, an excellent solution for dealing with large-seeded weeds that sprout later thistle, abutilon and ragweed is a herbicide based on Halauxifen-methyl 3.131 g/l, which is applied after crop emergence - from stage 4 of true leaves to the stage of sunflower budding. Best control of ragweed (Ambrosia artemisiifolia) yet in sunflower. Also, the combination of PRE EM AND POST EM combination of herbicides gives the best protection against weeds and therefore we respect the concept of anti-resistant strategy. (Vrbičanin, Malidža, Božić, Pavlović, Konstatinović, Jovanović-Radanov, Samardžić and Rajković., 2019)

RECOMMENDATIONS

Given that the fight against weeds is one of the most important components in the complete sunflower production program, weed monitoring should be part of the integral protection system. (Petanovic, Klokočar-Šmit, and Spasić., 2000). The suppression of weeds in sunflowers must not be based only on the application of herbicides, but on a complete system of integral control of weeds (crop rotation, quality soil cultivation and pre-sowing preparation).

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THE IMPORTANCE OF OLD VARIETIES IN CONDITIONS OF CLIMATE CHANGE

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ABSTRACT
On the territory of Vojvodina, there is a long tradition in the production of vegetables, which is why there are a large number of varieties and populations of vegetables with different characteristics in this area. In traditional home gardens, different genetic material was passed down through the generations, multiplied, crossed with each other, and in this way new interesting varieties were created. (Sabadoš and Žunić, 2024).
With the commercialization of vegetable production, the varieties and ecopopulations created in this way become endangered and are in danger of being permanently lost. It takes a lot of time, a lot of effort, a lot of positive coincidences in natural or agroecological conditions to create an autochthonous variety. However, it is necessary to emphasize that biological heritage quickly decays due to carelessness and that once a variety or ecopopulation is lost, it is impossible to reconstruct it. Accordingly, it is necessary to develop programs that would save the most threatened varieties and ecopopulations of different plant species from permanent disappearance. PSS Sombor 03.12.2007 launched the Project "Let's save old Vojvodina vegetable varieties". The goal of the project was to save the old domestic varieties of vegetables that are traditionally grown in our area from permanent loss. During the three weeks of sample collection, 5296 samples of vegetables and other plant species were collected, and the total number of students who actively participated and brought samples was 617. During the following years, the biological properties of plants were evaluated according to the DUS descriptor, as well as the production properties of vegetables and of other plant species obtained by sowing seeds from collected samples. It is a fact that climate changes greatly affect the yield and production of vegetables, and in this sense autochthonous varieties are of great importance.
Keywords: autochthonous varieties, climate change, vegetables, production, characteristics

INTRODUCTION
Vojvodina has a long tradition of vegetable production, which is why there are a large number of varieties and populations of vegetables with different characteristics in this area (Sabadoš, 2019). Traditional home gardens abounded with different genetic material that was passed down through the generations, multiplied, crossed with each other, and thus new interesting varieties were created. Population migrations, trade, seed exchange of different vegetable crops, then spontaneous crossbreeding and natural selection in the given agroecological conditions created valuable local populations and varieties of vegetables. The increasing commercialization of vegetable production has led to the disappearance of traditional peasant gardens and vegetable gardens, and thus the danger of losing certain plant species, varieties and populations of vegetables has been expressed. Nowadays, one, two or a few of the most profitable, most commercial varieties are mostly grown in large productions, leaving no room for many other interesting varieties.
They may not be so superior from a commercial point of view, but they may carry different resistance genes for some plant diseases or carry substances needed by diabetics, for example, or possess some other valuable feature that makes it important to preserve, examine and reproduce. The variety is selected according to the purpose of production, and those resistant to stress and pathogens are preferred (Sekulić, Malešević, Lazić, Đurovka and Lazarević, 2008).

MATERIALS AND METHODS

Data from meteorological stations indicate significant climate changes in Serbia. Observed climate change trends have numerous negative impacts on agricultural production. The decrease in water potential is reflected in various ways in the life processes of plants (Kastori, Ilin, Maksimović and Putnik-Delić, 2013). Climate changes make many activities in integrated agricultural systems difficult and affect the disappearance of certain species, genes and ecosystems. Irrigation of agricultural crops, which is a factor of high and stable production, in the area of the city of Sombor is represented by less than 5% of the total agricultural areas (Sabadoš, 2019). Climate change can have adverse effects in terms of reduction or loss of biodiversity. In Serbia, numerous autochthonous populations and old varieties that were ecologically adapted to certain areas due to climate change are endangered. Examples of such local varieties are Futoška cabbage, Somborka pepper and Gradistanac bean. Numerous nations with a developed social awareness have developed programs that protect the most endangered varieties and ecopopulations of plant species from permanent disappearance. That's why PSS Sombor launched the pilot project "Let's save and protect old Vojvodina vegetable varieties". The campaign was launched on December 3, 2007 and lasted for three weeks. The goal of the project was to save the old domestic varieties of vegetables that are traditionally grown in our area from permanent loss. 22 elementary schools participated in the campaign, when 3163 students collected 5296 samples. . All samples are marked with information on the name and surname of the student, class, name of the variety and address of the student. The samples were then sorted by plant species, marked with the letters A or B, numbers were assigned to them, a database was created and the samples were prepared for sowing. The number of samples collected by plant species was as follows: beans 745, peppers 537, green beans 381, popcorn and sweet corn 371, onions 320, lettuce 312, pumpkin 286, garlic 251, zucchini 243, cucumbers 216, tomatoes 202, flowers 176 , melon 101, spinach 101, peas 93, poppy seeds 79, carrots 76, parsley 76, herbs 72, cabbage 54 and other 604. During the following years, biological properties were assessed according to the DUS descriptor, as well as production properties of vegetables and other plant species obtained by sowing seeds from the collected samples.

A description of the cultivated varieties and populations during the growing season was performed, the health status and resistance of the varieties and populations to the most important pathogens was evaluated. Data on qualitative and quantitative traits are in the database and each variety is documented with a large number of photographs (Ilin and Sabadoš, 2010).

FINDINGS

During the past years, trait evaluations were performed on all plant species collected in the project. In this paper, the evaluations made in 2022 on the cabbage populations collected in the project are highlighted. 4 populations were singled out, which stood out for their characteristics as worth preserving for production in conditions of a changed climate.

Old variety B 799

In the sampled cabbage population, the head is diagonally elliptical with the position of the maximum diameter in the middle, firm and fine-textured. The weight of the head is about 1.8 kg. Without high requirements for production, medium-late variety. It is very suitable for processing, i.e. pickling, and that is if it is produced from

seedlings in late sowing. The origin of the original seed of this cabbage population is from Prigrevica in the municipality of Apatin. The length of the head is 19 cm, the width is 24 cm, and the length of the stem is 4 cm. The firmness of the head on a scale from 1 to 9 is 8. The color is green, and the content of dry matter determined by drying in a dryer at 105^0C to constant mass is 10.5%, while the yield per hectare was 35.5 t.

Old variety B 1463

This is a variety of cabbage with good and fine texture, green color of the head that is completely covered. Weight of the head about 1.95 kg Solid head suitable for further processing. There are no special requirements for production. It has a very short growing season. The origin of the original seed is from Karavukava, Odžaci municipality. The length of the head is 21.0 cm, the width is 24.0 cm, and the length of the stem is 10.0 cm. The firmness of the head on a scale from 1 to 9 was 9. The color is green, and the content of dry matter determined by drying in a dryer at 105^0 C to constant mass is 9.6%, and the yield per hectare was 39.3 tons.

Old variety B 1806

Medium late variety of cabbage, heads round and firm. The mass of the head is about 2020 kg. It is best to use it for fresh consumption. No special agrotechnical requirements for production. It has a medium length of vegetation. The origin of the original seed is from Karavukovo, and the test seed was produced at the Agricultural Expert Service in Sombor. The length of the head is 21.2 cm, the width is 26.3 cm, and the length of the brake is 7 cm. Head strength on a scale from 1 to 9 to 8. The color is green, and the dry matter content determined by drying in a dryer at 105^0 C to constant weight is 7.7%. The yield per hectare was 49.2 tons

Old variety B 1401/1

Medium-early variety of cabbage, with a diagonal-elliptical head shape and whitish-yellow inner color of the head. Crack resistant, no special requirements for production. Medium fine interior texture and good firmness. The mass of the head is about 1.90 kg. It has a medium vegetation length, very suitable for fresh consumption as well as processing. The length of the head was 17.0 cm, the width was 24.0 cm, and the length of the stem was 5.0 cm. The hardness of the head on a scale from 1 to 9 was 9. The color is green, and the content of dry matter determined by drying in a dryer at 105^0 C to constant mass is 8.2%. The yield per hectare was 36.2 tons.

CONCLUSION AND DISSCUSION

In Vojvodina, there is an obvious increase in the cultivation of leafy vegetables in the open field (Krasnić, 2008). Cabbage occupies a prominent place among vegetables, because people use it almost every day in their diet (Maksimović, 1992, p.188). Cabbage is the most important and widespread vegetable in this region, primarily due to its wide range of uses as well as the large number of known species and varieties (Lazić, 2001, p.269).
It is a very adaptive plant species, so today there are a large number of varieties and populations related to a specific locality (Futoški, Bjeljinski, Varaždinski, etc.). Futoški cabbage was described in the literature from 1870 because of its good qualities for cultivation (Radić, 2009). Cabbage is most often grown in the open field, although some kind of sheltered area can also be used for early production. The obtained results indicate that the characteristics manifested in the observed old varieties, such as resistance to cracking, firmness of the head, content of dry matter, which provide the possibility of cultivation in changed climatic conditions.

RECOMMENDATIONS

It is indisputable that climatic factors significantly affect product quality (Ilić, Falik and Dardić, 2009) The preservation of old varieties is of great importance due to the preservation of biodiversity, which in the conditions of climate change plays an important role in plant production.

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VALUE OF pH REACTION AGRICULTURE LAND IN SOMBOR REGION IN SERBIA

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ABSTRACT
Soil reaction as a property has a great influence on chemical, biological and physiological processes in the soil. The dynamics of the elements of mineral nutrition, their accessibility to plants and their absorption depend on the reaction of the soil. The reaction of the soil depends on the concentration of H+ and OH- ions. The pH value can vary in agricultural land between 3.5 and 9.5. The Agriculture Extension Service "Sombor" tested the pH value at 156 permanent points at two depths: from 0 to 30 and from 30 to 60 cm. The potentiometric method was used to determine the reaction of agricultural land. It is based on the measurement of the electromotive force that occurs when reference and indicator glass and platinum electrodes are introduced into the soil suspension. The results are ranked according to reaction value categories, types and land ownership. At a depth of 0-30 cm, the minimum value of the reaction is 5.14, the maximum is 9.71, and the mean value is 7.59. At a depth of 30 to 60 cm, the minimum reaction is 5.63, the maximum is 9.54, and the average is 7.74. The highest values in the 0-30 and 30-60 level are areas owned by the state, because it owns significant areas of rural pastures and meadows managed by local self-government units, while the second reason is the irrational management of state-owned agricultural land. After 12 years, all fixed points were analyzed again, where the results show that the value in KCl increased by 0.12. An increase was found in most types of land, while stagnation was found in the land type meadow blackberry and saline lands.
Keywords: pH, soil, reaction, concentration

INTRODUCTION
Soil reaction as a property has a great influence on chemical, biological and physiological processes in the soil. The dynamics of mineral nutrition elements, their accessibility to plants, but also their immobilization, i.e. absorption, depends on the reaction of the soil (Antosiewicz, 1992). The reaction of the soil depends on the concentration of H+ and OH- ions. It is expressed by the pH symbol throughout the world. If the mentioned ions are in approximately the same ratio, the soil reaction is neutral. If hydrogen ions predominate, the reaction of the soil is acidic, and if the hydroxyl OH ion predominates in the solution, the reaction will be basic. The pH value can vary in agricultural land between 3.5 and 9.5. Neutral soils have a pH value of around 7. Soils below this value are acidic, and above this soil are alkaline (basic). The largest number of plant species prefers a neutral reaction (around 7), however, some plant species (such as potatoes) achieve the highest yields with a slightly acidic reaction of the soil solution (pH 4 to 5). There are much fewer plants that tolerate an alkaline reaction. Chamomile tolerates the highest value among cultivated plants. Soil reaction affects plants directly and indirectly (Godzik, 1993). The direct influence is reflected in the pH of the cell juice (Aeru, 1997). The indirect impact is reflected in the availability of nutrients for plants. In an acidic reaction (below pH 5), for example, phosphates quickly change into inaccessible forms (Goering, 1994). The greatest accessibility of phosphorus and nitrogen is at a neutral reaction. Information about the reaction of the soil is important for evaluating the buffering capacity of the soil and the soil solution. This is an important feature of the soil that speaks of resistance to changes in reaction. The pH value determines the direction and intensity of oxidation-reduction processes in the soil. In addition to the pH value, this property of the soil is affected by temperature, humidity, aeration (presence of oxygen), etc (Krupa, 1995). The reaction of the soil dictates the choice and dynamics of applying mineral and organic fertilizers (Myśliwa–Kurdziel, 2004). The pH value is a fairly stable property, especially in the donor layer. Soil reaction is most often evaluated with pH in KCl, as was done in this study on the quality of agricultural land in the area of the city of Sombor.

MATERIALS AND METHODS

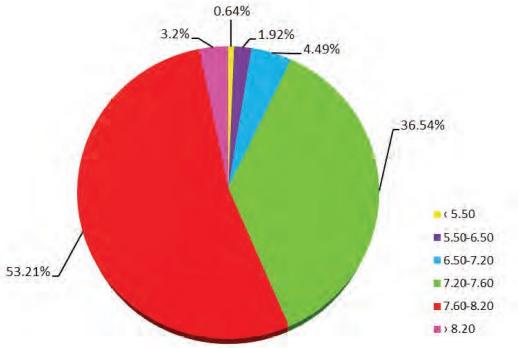
The potentiometric method was used to determine the reaction of agricultural land (Barcelo, 1990). It is based on the measurement of the electromotive force that occurs when a reference (calomel) and indicator glass or platinum electrode is introduced into the soil suspension. The potential of the reference electrode does not depend on the pH value of the tested solution, while the potential of the indicator electrode is directly dependent on the pH of the solution.

The working part of the glass electrode consists of a thin glass membrane. When measuring pH, a potential difference occurs between the membrane and the solution, the size of which depends on the activity of hydrogen ions in the solution. The pH value is determined based on the potential difference between the glass and calomel electrodes. The pH value indicates the negative decade logarithm of the content of hydrogen ions - H+ in the soil solution. Generally, soil pH value is measured in soil suspension treated with water or neutral salts (KCl or CaCl2). By using distilled water to obtain soil suspension (pH in H2O), current or active acidity is determined. Using a KCl solution in the pH determination process (pH in KCl) measures the substitutional acidity of the soil. The value of pH in water better reflects the concentration of hydrogen in the soil and this value is higher than pH in KCl. In practice, this difference has no significant role. Determination of pH in KCl is a more widely used method.

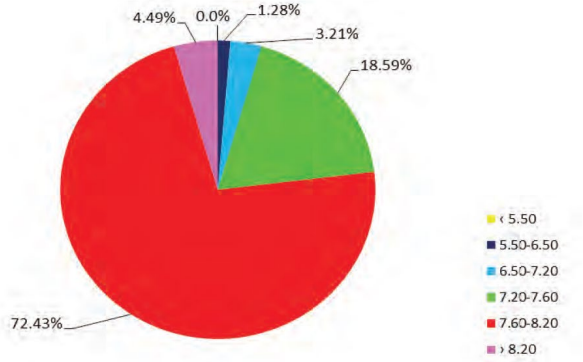
FINDINGS

The obtained results of pH values of agricultural land (pH in 1N KCl) show that the pH values significantly higher at a depth of 30 to 60 cm compared to the depth of the arable layer from 0 to 30 cm. According to the received according to the results in the layer from 0 to 30 cm, the lowest value was point 149 in K.O. Doroslovo and 5.14, which shows that these lands belong to acidic soils. They belong to poorly productive lands, but their participation in the area of the city of Sombor is below 1%. Point 17 in the cadastre had the highest pH value in 1N KCl municipality of Stanišić, and this value is 9.71, so it belongs to the group of very alkaline soils. This confirms the fact that such lands have weak production characteristics and are usually called salt marshes. Such surfaces in this research it was 1.92%. The number of samples with a neutral pH value was 36.54%, which would be very favorable when the largest part of the samples (53.21%) would not belong to the group of weakly alkaline and alkaline soils, which is worrying, given that pH values for the last 60 years increased by 0.2 to 0.4%. This information was obtained by observing the results on the same plots, and the increase in pH value is certainly a consequence of inadequate application of agrotechnical methods measure in production. The mean value of the tested samples pH in KCl is 7.59 at a depth of 0 to 30 cm. The plots belonging to the chernozem soil type have the lowest average pH values in the examined samples obese and with a value of 7.31; other subtypes and types of chernozem in the layer from 0 to 30 cm have average pH value in the range from 7.50 to 7.63. The highest average values have saline soils, 8.04. The minimum, maximum and mean values of the soil reaction at both tested depths are given in the table. If we observe the soil reaction values in the 0 to 30 cm layer by type of use, we can state that pastures have the greatest value in the territory of the city of Sombor and that they are alkaline, that is, salty lands whose repair is very expensive, but not impossible. Such procedures require large financial resources, and recovery of such lands is not recommended. It is recommended to change the way of using salty lands, that is slatina, through changing the composition and improving grass mixtures with plant species that tolerate higher pH values, as well as the cultivation of plant species that tolerate higher soil reaction values: chamomile, chickpea or chickpea, miscanthus, wild pear and other, lesser-known plant species. Arable land, gardens and orchards in the area of the city of Sombor belong to neutral and weakly alkaline soils, which is a very suitable reaction of agricultural land for the cultivation of most plant species. At such values soil reactions, high yields and very good product quality are achieved. What can be noticed and what is not good is the increase in the pH value of the land in the city area Sombor. In the last 60 years, many soils have changed from neutral to weakly alkaline or even alkaline soils. This process can hardly be stopped, but it can be slowed down, primarily by using biologically acidic fertilizers in agricultural production.

Graph. 1 Percentage representation of examined samples of agricultural land in the layer from 0 to 30 cm in the area of the city of Sombor, according to the categories of land reaction values



Graph 2. Percentage representation of tested samples of agricultural land in the layer from 30 to 60 cm in the area of the city of Sombor, according to the categories of land reaction values



Soil classification according to pH-value in 1 N KCl: very sour until 5.50, sour 5.50 to 6.50, slightly acidic 6.50 to 7.00, neutral 7.00 to 7.30, neutral slightly alkaline 7.30 to 7.60, slightly alkaline 7.60 to 7.90, alkaline 7.90 to 8.20, very alkaline over 8.20.
The test results include the results of the soil reaction at 156 permanent points, at two depths: from 0 to 30 and from 30 to 60 cm; at a depth of 0 to 30 cm, the minimum reaction value is 5.14 (point 149, KO Doroslovo), the maximum is 9.71 (item 17, KO Stanišic), the mean value is 7.59. At a depth of 30 to 60 cm, the minimum reaction value is 5.63 (point 149), the maximum is 9.54 (point 17) and the mean 7.74. Average reaction values of agricultural land by type in the city area Sombora in a layer from 0 to 30 and from 30 to 60 cm.

Values of the reaction of agricultural land (pH in KCl) in the area of the city of Sombor according to land types:

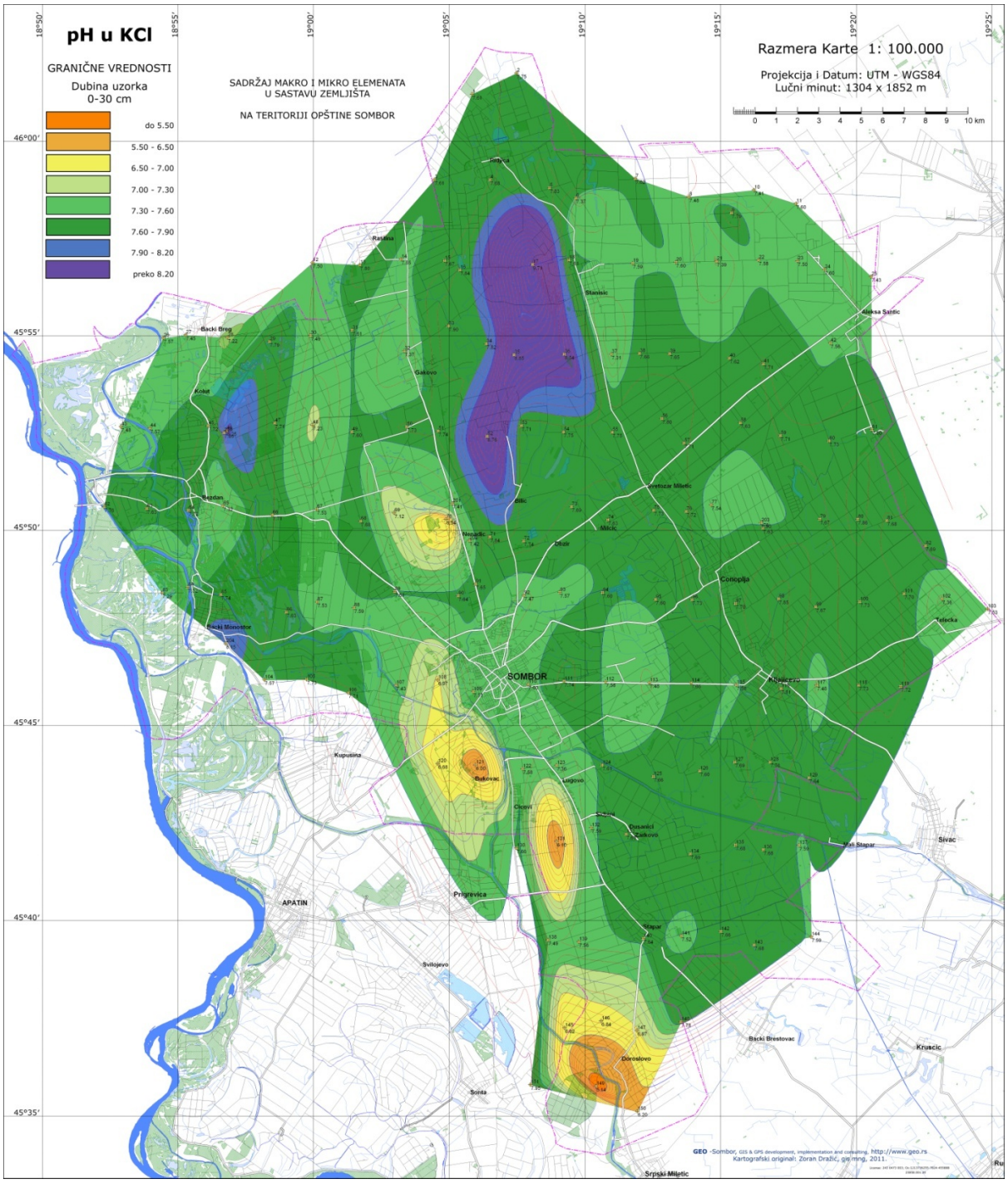
depth	min max aver	chernozem on loess plateau on loess plateau	carbonate chernozem on the loess terrace	chernozem cultivated	chernozem on sand	meadow black carbonate soil on the loess plateau	meadow black soil carbonate on loess terrace	salty land	alluvium	rite black
0-30	min	7.31	6.10	5.14	7.37	7.36	6.20	7.48	7.29	7.63
0-30	max	7.86	7.90	8.25	7.83	7.85	7.81	9.71	8.15	7.85

0-30	medium	7.61	7.50	7.31	7.63	7.65	7.52	8.04	7.60	7.75
0-60	min	7.32	7.03	5.63	7.61	7.36	6.86	7.54	7.50	7.63
0-60	max	8.03	8.08	8.25	7.94	7.73	8.10	9.54	8.30	8.16
0-60	medium	7.69	7.71	7.48	7.77	7.61	7.70	8.21	7.70	7.87

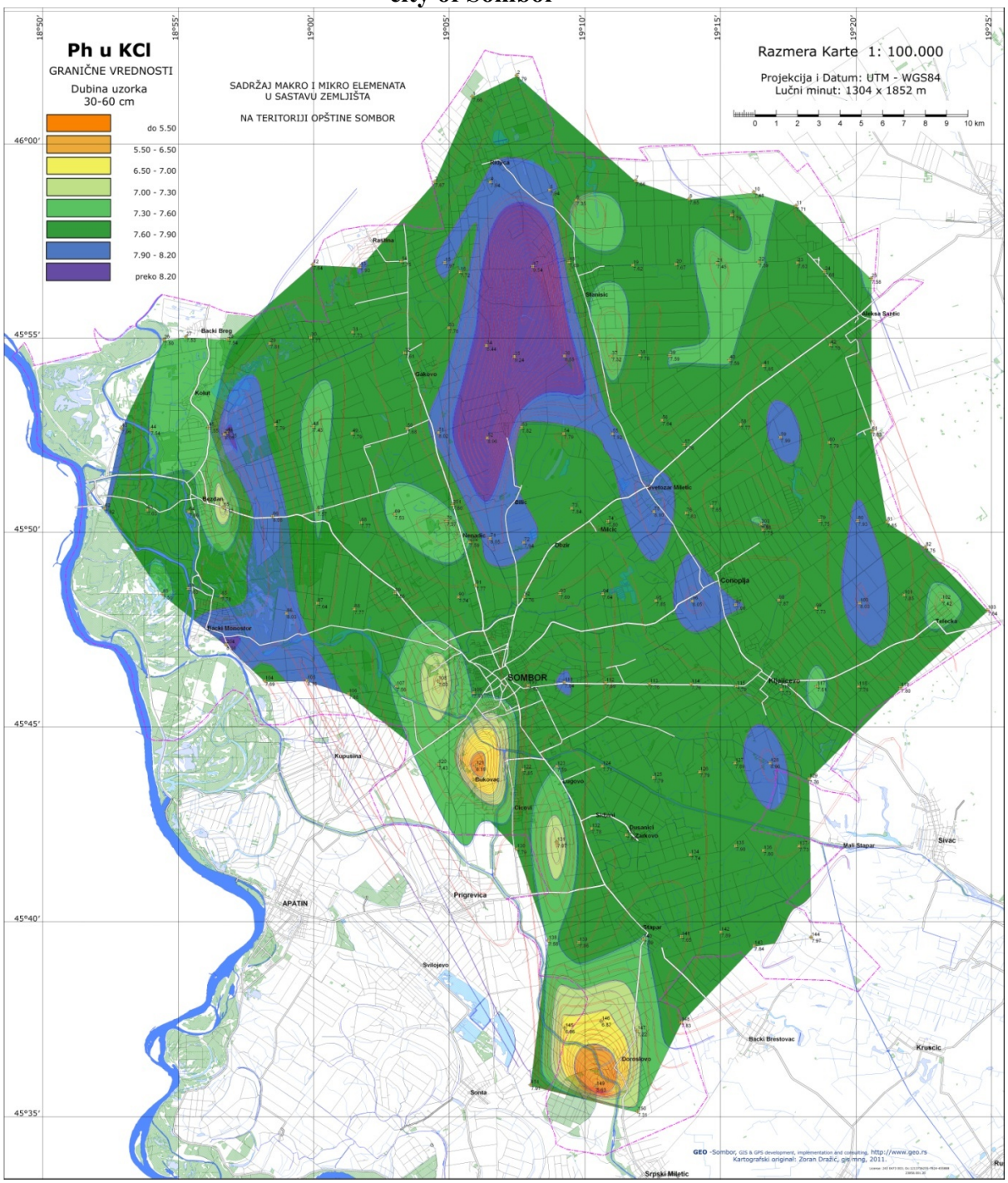
According to analyzes of soil reaction values in the layer from 0 to 30 cm, the highest values have surfaces owned by the state. This can be explained in two ways. First of all, the state owns significant areas of rural pastures and meadows managed by local self-government units, i.e. cities or local communities. Another reason is the irrational management of state-owned agricultural land, especially when that land is leased on a short-term basis, which is not good for preserving the quality of agricultural land in state property. As for the results of the soil reaction values in the 30 to 60 cm layer, the pH values in KCl increase in the majority of tested samples, the pH values increase in the layer of 30 to 60 cm in all examined types of agricultural land. That's right, apparently according to the way of agricultural land use, in the second examined layer from 30 to 60 cm are also larger values of the reaction of agricultural land, which can be of great importance in production in orchards and other perennial plants. This is information that needs to be taken into account when planning and building long-term plantations. These results can determine the type and method of raising perennial plants.

The values of the reaction of agricultural land in relation to the ownership category are also higher in the layer of 30 to 60 cm compared to a layer of 0 to 30 cm, which indicates primarily the influence of natural factors and not the influence of man, that is, the way agricultural land is used and the application of production technology. From these results it can be concluded that the majority of agricultural land belongs to neutral and weakly alkaline soils, while weak acid soils include lands in the cadastral municipalities of Sombor, Stapar and Doroslovo. Land with high values of pH in KCl are most represented in the cadastral municipalities of Sombor, Gakovo, Stanišic i Riđica. Values of the reaction pH in KCl of agricultural land by sampling site in a layer of 30 to 60 cm. From these data it can be concluded that the soil reaction values are significantly higher at a depth of 30 to 60 cm in relation to the reaction values of agricultural land in the arable layer from 0 to 30 cm.

Map 1. Reaction values of agricultural land at a depth of 0 to 30 cm in the area of the city of Sombor



Map 2. Reaction values of agricultural land at a depth of 30 to 60 cm in the area of the city of Sombor



DISSCUSION

This information was obtained by observing the results on the same plots, and the increase in pH value is certainly a consequence of inadequate application of agrotechnical measures in production. The mean value of the tested samples pH in KCl is 7.59 at a depth of 0 to 30 cm. The lowest average pH values in the tested samples have plots that belong to the chernozem soil type with a value of 7.31; other subtypes and types of chernozem in the layer from 0 to 30 cm have an average pH value in the range of 7.50 to 7.63. The highest average values have saline soils, 8.04. Arable land, gardens and orchards in the area of the city of Sombor belong to neutral and weakly alkaline soils, which is a very suitable reaction of agricultural land for the cultivation of most plant species. At

such soil reaction values, high yields and very good product quality are achieved. What can be noticed and what is not good is the increase in the pH value of the land in the area of the city of Sombor. In the last 60 years, many soils have changed from neutral to weakly alkaline or even alkaline soils. This process can hardly be stopped, but it can be slowed down, primarily by using physiologically acidic fertilizers in agricultural production.

CONCLUSION

If we observe the soil reaction values in the 0 to 30 cm layer according to the type of use, we can conclude that pastures have the highest value in the territory of the city of Sombor and that these are alkaline, that is, salty soils whose repair is very expensive, but not impossible. Such interventions require large financial resources, and the recovery of such lands is not recommended. It is recommended to change the way of using salty lands, i.e. marshland, through changing the composition and improvement of grass mixtures with plant species that tolerate higher pH values, as well as the cultivation of plant species that tolerate higher soil reaction values: chamomile, chickpea or chickpea, miscanthus, wild pear and other, less known plant species. It is also possible to change the purpose of the pasture for the construction of ponds, water reservoirs, etc. According to the analyzes of soil reaction values in the layer from 0 to 30 cm, the highest values have surfaces owned by the state. This can be explained in two ways. The state owns significant areas of rural pastures and meadows that are managed by local self-government units, i.e. cities or local communities. Another reason is the irrational management of state-owned agricultural land, especially when that land is leased on a short-term basis, which is not good for preserving the quality of agricultural land in state property. As for the results of the soil reaction values in the layer from 30 to 60 cm, the pH values in KCl increase in most of the tested samples: the pH values increase in the layer from 30 to 60 cm in all tested types agricultural land. Also, in terms of the way agricultural land is used, in the second investigated layer of 30 to 60 cm, there are also higher values of the reaction of agricultural land, which can be of great importance in the production of orchards and other perennial crops. This is information that needs to be taken into account when planning and planting long-term plantings. These results can determine the type and method of raising perennial plants.

The values of the reaction of agricultural land in relation to the ownership category are also higher in the layer from 30 to 60 cm compared to the layer from 0 to 30 cm, which indicates primarily the influence of natural factors and not the influence of man, that is, the way agricultural land is used and application of production technology. The values of the reaction of agricultural land by sampling site in the layer from 0 to 30 cm are given on the map. From these results it can be concluded that the majority of agricultural land belongs to neutral and weakly alkaline soils, while the lands in the cadastral municipalities of Sombor, Stapar and Doroslovo belong to weakly acidic soils. Soils with high values of pH in KCl are most represented in the cadastral municipalities of Sombor, Gakovo, Stanišic, Riđica and Kolut. Values of the reaction pH in KCl of agricultural land by sampling site in a layer of 30 to 60 cm given are on the map. From these data, it can be concluded that the soil reaction values are significantly higher at a depth of 30 to 60 cm compared to the agricultural soil reaction values in the arable layer from 0 to 30 cm.

RECOMMENDATIONS

The recommendation to agricultural producers is to use and apply mineral fertilizers more rationally and to manage land rationally. Large application of fertilizers and irrational use lead to changes in the structure of the land.

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CALCULATION OF THE DIFFUSE POLLUTANT LOAD OF ANIMAL WASTES: THE CASE OF CATTLE

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ABSTRACT
There is a great diversity of agricultural activities in Antalya province. There are different breeding activities in terms of both plant production and animal production. In animal breeding activities, animal waste management is a subject that requires great attention. In this context, determining the amount of diffuse pollutant load based on the presence of beef and dairy cattle may be important in order to have an idea about the studies on reducing environmental pollution. In this study covering the districts of Antalya province, the total nitrogen diffuse load amount was calculated as 1346,704 tons per year (TN/year) and the total phosphorus diffuse load amount as 149,633 tons per year (TP/year) based on the 2023 beef and dairy cattle animal presence data. It is anticipated that the obtained diffuse pollutant load may create awareness about possible pollution risks to water resources.
Keywords: Animal waste, Nitrogen, Phosphorus, Water resources, Pollutant load

INTRODUCTION
Livestock farming enterprises produce a high amount of waste. The solid and liquid waste accumulated in these enterprises must be stored under appropriate conditions to prevent negative effects on the environment (Atılgan et al., 2006). If the manure generated in livestock enterprises is evaluated in an appropriate and controlled manner, it can be an additional source of income for the enterprise (Atılgan et al., 2015). If the waste generated in livestock enterprises is not stored under appropriate conditions, it can cause environmental pollution (Çayır et al., 2012).
Animal waste, which is a widespread pollution source, can pollute surface and groundwater resources as a result of uncontrolled waste management. This event occurs due to the direct access of animals to a water source, surface water flows from manure piles, shelters and open feeding areas, leachate from manure storage areas, flooding of storage areas and surface water flows from areas where manure is applied (Polat and Olgun, 2009). Animal waste has the characteristics of fertilizer and can be used in agricultural lands in order to increase soil fertility. The fact that these wastes contain high levels of nutrients such as nitrogen (N), phosphorus (P) and potassium (K) provides the plant nutrients necessary for plants, makes the general structure of the soil suitable for plant growth, changes the microorganism population and increases the water retention capacity of the soil (Salihoğlu et al., 2019). However, unconscious storage of these wastes on the soil surface or excessive application of fertilizer to the soil causes these plant nutrients to mix with water resources, causing pollution in both water resources and soil (Boyacı et al., 2011). Substances such as nitrogen and phosphorus mixed with water from animal wastes cause eutrophication and deform water quality (Biçer, 2011; Akdoğan et al., 2015). As a diffuse pollution source, animal waste is carried from surface waters and accumulates in underground and coastal waters. For this reason, the quality of water resources is deformed and becomes unusable. In addition, diffuse pollution sources damage life in water resources by sedimentation, turbidity, depletion of dissolved oxygen, increases in the number of algae and decrease in fish population (Yontar, 2009; Biçer, 2011).
The aim of this study is to calculate the diffuse total nitrogen (TN) and diffuse total phosphorus (TP) loads resulting from cattle farming activities in Antalya and to draw attention to their damage to water resources.

MATERIAL AND METHODS

Location and geographical features of the study area

Antalya is located in the west of the Mediterranean Region. Antalya's land structure consists of two parts, the mountainous area known as the Western Taurus Mountains and the coastal areas on its edge. In the west, the Eşen, Elmalı and Korkuteli Plains, the Teke Plateau and the Bey Mountains and Akdağlar, which have varying elevations between the coast and the mountainous areas, present a topographic appearance fragmented by streams. Korkuteli Plain is 7-8 kilometers long and 2-3 kilometers wide and is a fertile plain between the mountains. The central and eastern parts of Antalya are the Antalya Plain where greenhouses are abundant and the Western Taurus Mountains rising on the eastern and western sides of the inner parts of this plain form the general morphological structure (Şensoy et al., 2020).

In the study, the amount of diffuse pollutant load originating from cattle farming activities in the districts of Antalya province was calculated. For this purpose, the number of meat and dairy cattle as cattle assets of the Turkish Statistical Institute in 2023 was taken into account.

As a result of this data, equation (1) was used to calculate the amount of waste originating from cattle farms in the districts of Antalya province and the manure production per unit animal was taken as 29 kg/animal-day for beef cattle and 43 kg/animal-day for dairy cattle. (Ekinci et al., 2010; Ertop et al., 2018; Atılgan et al., 2021; Ertop et al., 2022a).

$$MA=NAxMPAx365 \quad (1)$$

Here:

MA: Fresh manure amount (kg/year)

AN: Animal number

MPA: Average Daily Manure Production per Animal (kg/animal-day**) (**Ekinci et al., 2010; Ertop et al., 2018; Atılgan et al., 2021; Ertop et al., 2022a)

After calculating the amount of waste originating from cattle, the diffuse pollutant loads that may occur from animal sources were also calculated. The amount of animal waste production and the nitrogen and phosphorus unit loads emitted to the environment may vary depending on the feeding habits of these animals, the type of food, and the frequency of water drinking. (Kocabey, 2019; Tırınk, 2021).

$$Q_{TN}= Q_{NDL}* A_{LW} *D_N*365/1000 \quad (2)$$

$$Q_{TP}= Q_{PDL}* A_{LW} *D_P*365/1000 \quad (3)$$

Q_{NDL}; Diffuse pollutant load varies according to daily nitrogen load, D_N; the percentage of diffuse nitrogen pollution reaching the receiving environment, Q_{PDL}; Diffuse pollutant load varies according to daily phosphorus load, D_P; the percentage of diffuse phosphorus pollution reaching the receiving environment.

In calculating the diffuse pollution load from animal sources, the total diffuse pollution loads that will occur annually must be calculated. The diffuse pollution loads that will occur annually from nitrogen are calculated as specified in Equation 2, and the diffuse pollution loads that will occur annually from phosphorus are calculated as specified in Equation 3.

In Equation 2, Q_{TN} is the Annual nitrogen-based diffuse pollutant load (kg/number of animals/year), in Equation 3, Q_{TP} is the annual phosphorus-based diffuse pollutant load (kg/number of animals/year), and A_{LW} is the live animal weight (kg) according to the animal species.

For cattle, A_{LW} live animal weight is 500 kg and Q_{NDL}, Q_{PDL} daily diffuse pollutant load (kg/ton animal number/day), which varies according to the type of pollutant, was taken as 0.3 for nitrogen and 0.1 for phosphorus (Biçer, 2011; Derin et al., 2019; Tırınk, 2021; Ertop et al., 2022a).

D_N and D_P values express the percentage of pollutants reaching the receiving environment. With the prediction that some amount of nitrogen and phosphorus will be lost through transport processes, calculations were made assuming that 15% of these values for nitrogen and 5% for phosphorus can reach the receiving environment (Biçer, 2011; Derin et al., 2019; Tırınk, 2021; Ertop et al., 2022a).

The conversion of the diffuse pollution loads (tons/year) to be calculated with Equations 2 and 3 into load units is calculated as specified in Equations 4 and 5.

$$Q_{TN'} = Q_{TN} * N_{LW}/1000 \quad (4)$$
$$Q_{TP'} = Q_{TP} * N_{LW}/1000 \quad (5)$$

In Equation 4, $Q_{TN'}$ represents the annual TN diffuse pollution load (ton/year), in Equation 5, $Q_{TP'}$ represents the annual TP-related diffuse pollution load (ton/year), and N_{LW} represents the number of live animals by species. The total diffuse pollutant amounts originating from animal wastes in the study area were interpreted on maps created in the ArcGIS program by coloring the numerical data according to class values.
The provinces in these maps obtained were evaluated in 5 different color categories and the color categories in which the provinces are located were tried to be classified according to the total diffuse pollutant amounts (Figure 1). Color categories;

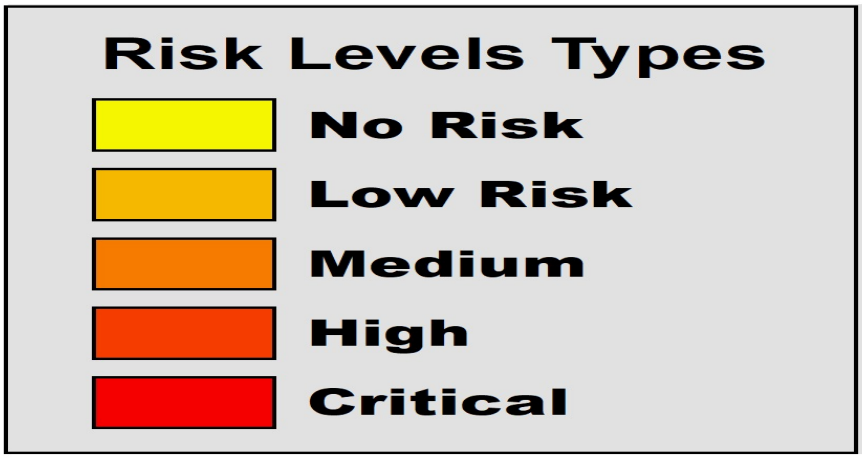

Figure 1. Risk color categories

Color categories were determined as five different colors and the lowest diffuse pollutant amount range was evaluated as color category 1 and the highest diffuse pollutant amount range was evaluated as color category 5. In addition, diffuse pollutant amount ranges were evaluated separately for TP and TN.

FINDINGS AND DISCUSSION

The cattle population and the amount of fresh manure in Antalya province are shown in Table 1.

Tablo 1. Cattle stock and annual obtainable fresh manure amounts in Antalya districts

County	Beef cattle (head)	Fresh manure (kg)	Dairy cattle (head)	Fresh manure amount (kg)
Akseki	408	4318680	621	6403560
Aksu	2184	23117640	3773	34277880
Alanya	3978	42107130	6877	62434710
Demre	122	1291370	228	1914790
Döşemealtı	9988	105722980	14226	156761660
Elmalı	5442	57603570	11129	85412190
Finike	190	2011150	334	2982050
Gazipaşa	1921	20333785	3250	30150095
Gündoğmuş	285	3016725	396	4473075
Kaş	1554	16449090	2413	24390030
Kemer	272	2879120	404	4269040

Kepez	3183	33692055	4846	49957185
Konyaaltı	622	6583870	1011	9762290
Korkuteli	19139	202586315	23144	300386605
Kumluca	446	4720910	702	6999970
Manavgat	10853	114879005	14645	170337835
Muratpaşa	211	2233435	571	3311645
Serik	5102	54004670	6770	80075890
İbradı	934	9886390	1808	14659130
Toplam	66834	707437890	97148	1048959630

When the table of cattle in Antalya is examined, it is seen that there are 66834 beef cattle and 97148 dairy cattle, and the total cattle is 163982. It was determined that the district with the lowest beef cattle in the study area is Demre with 0.18% and the district with the highest beef cattle is Korkuteli with 28.64%. Similarly, it was calculated that the lowest dairy cattle rate was in Finike with 0.34% and the highest dairy cattle rate was in Korkuteli with 23.82%. The reason why Korkuteli district has the largest share in both beef and dairy cattle rates can be shown as the development of cattle breeding activities due to the climatic conditions of the district restricting agricultural diversity. In addition, it was determined that the total amount of fresh manure in Antalya province was 1756397.52 tons/year. As a result of uncontrolled storage of this fresh manure amount, possible environmental pollution may occur, especially with precipitation. Ertop et al., (2022b); In their study to determine the biogas and electricity production potential that can be obtained from cattle waste, they determined that the amount of fresh waste generated from the presence of meat and dairy cattle in Antalya was evaluated in biogas energy and the amount of biogas energy was 22409125.22 MJ/year and the electricity equivalent of this biogas energy was 6229.77 MWh/year. Therefore, the idea of using the resulting animal waste in biogas energy can be popularized both to prevent possible environmental pollution and to provide economic gain to the region. It can be considered that a biogas facility to be planned especially in Korkuteli district can be beneficial in the evaluation of animal waste both in Korkuteli district and in the districts and settlements close to Korkuteli district.
Pollution loads originating from cattle farming activities in Antalya are given in Table 2 and the digital map of TP (ton/year) originating from cattle farming activities in Antalya is given in Figure 3 and the digital map of TN (ton/year) is given in Figure 4.

Table 2. Pollution loads from cattle farming activities

County	Total number of cattle	Percentage of total number of animals (%)	TN (ton/year)	Percentage distribution of TN load (%)	TP (ton/year)	Percentage distribution of TP load (%)
Akseki	1029	0,63	8,451	0,63	0,939	0,63
Aksu	5957	3,63	48,922	3,63	5,436	3,63
Alanya	10855	6,62	89,147	6,62	9,905	6,62
Demre	350	0,21	2,874	0,21	0,319	0,21
Döşemealtı	24214	14,77	198,858	14,77	22,095	14,77
Elmalı	16571	10,11	136,089	10,11	15,121	10,11
Finike	524	0,32	4,303	0,32	0,478	0,32
Gazipaşa	5171	3,15	42,467	3,15	4,719	3,15
Gündoğmuş	681	0,42	5,593	0,42	0,621	0,42
Kaş	3967	2,42	32,579	2,42	3,620	2,42
Kemer	676	0,41	5,552	0,41	0,617	0,41

Kepez	8029	4,90	65,938	4,90	7,326	4,90
Konyaaltı	1633	0,99	13,411	0,99	1,490	0,99
Korkuteli	42283	25,78	347,250	25,78	38,583	25,78
Kumluca	1148	0,70	9,428	0,70	1,048	0,70
Manavgat	25498	15,55	209,402	15,55	23,267	15,55
Muratpaşa	782	0,48	6,422	0,48	0,714	0,48
Serik	11872	7,24	97,499	7,24	10,833	7,24
İbradı	2742	1,67	22,519	1,67	2,502	1,67
Total	163982	100,00	1346,704	100,00	149,633	100,00

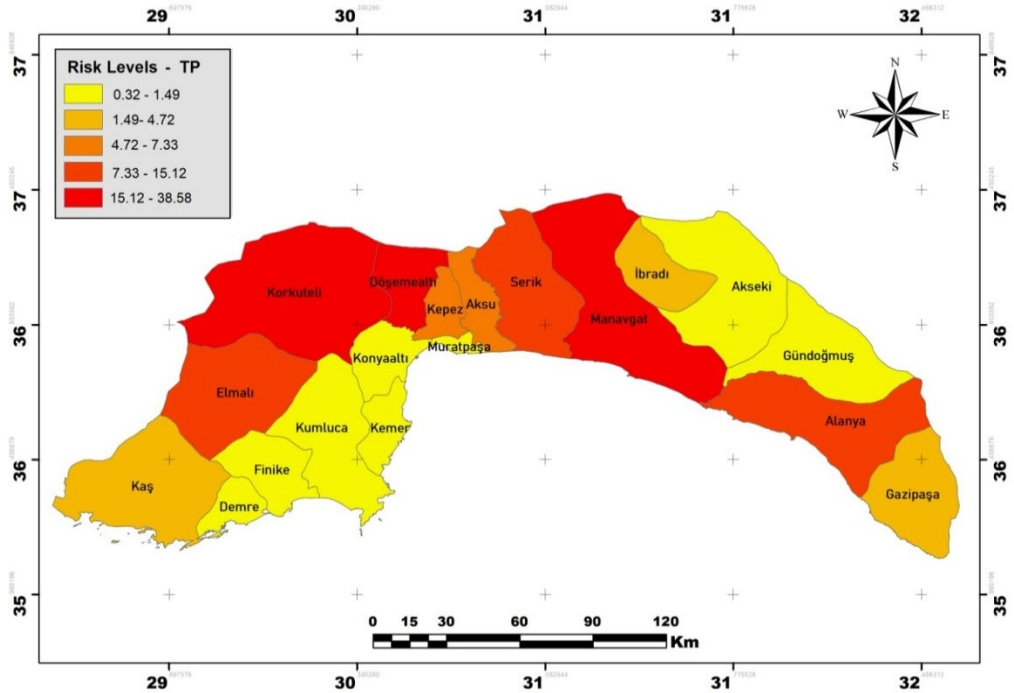

Figure 3. TP originating from cattle farming activities in Antalya province (ton/year)

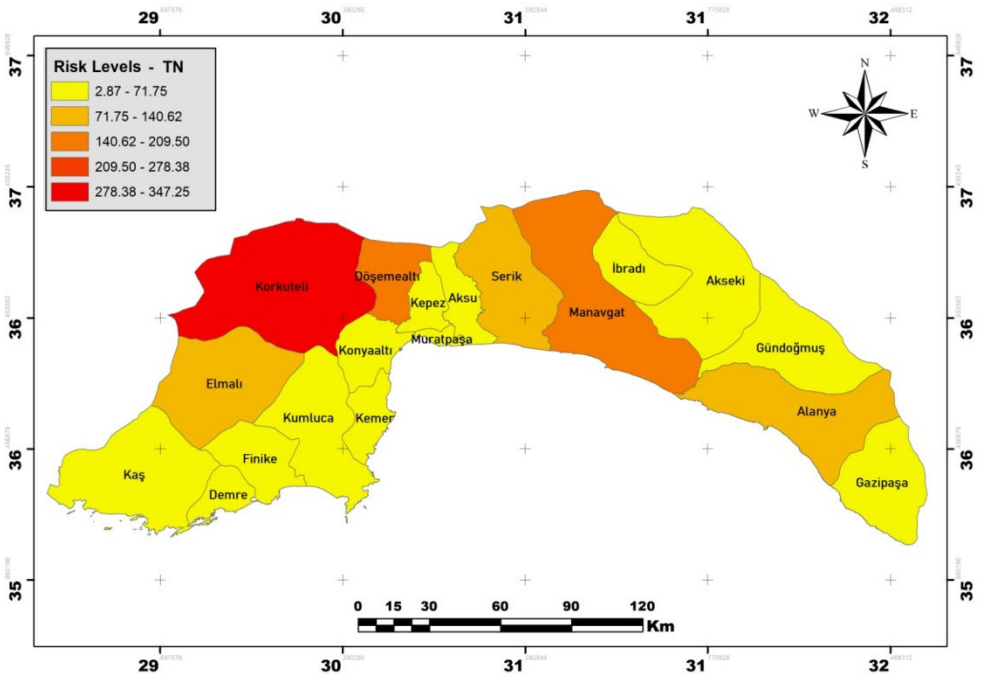

Figure 4. TN originating from cattle farming activities in Antalya province (ton/year)

When the digital map of Antalya's TP load originating from cattle farming activities is examined; it is seen that Demre, Finike, Kumluca, Kemer, Konyaaltı, Muratpaşa, Akseki and Gündoğmuş districts are in the 1st color level of the risk-free pollution category; Elmalı, Korkuteli, Döşemealtı, Serik, Manavgat and Alanya districts are in the 5th level, which is the highest pollution risk category. However, when the digital map of TN load is examined; it is seen that Kaş, Demre, Finike, Kumluca, Kemer, Konyaaltı, Muratpaşa, Kepez, Aksu, İbradı, Akseki, Gündoğmuş and Gazipaşa districts are in the lowest pollution risk level; Korkuteli district is in the 5th risk level, which is the highest risk level.

Demre, Finike, Kumluca, Kemer, Konyaaltı, Muratpaşa, Akseki and Gündoğmuş districts are in the 1st color category, which is a risk-free color category, both in terms of TP load and TN load. It can be said that the fact that these districts are in the risk-free color category depends on the dynamics of the districts. In this context, it has been concluded that Demre, Finike, Kumluca, Kemer, Konyaaltı and Muratpaşa districts are in the risk-free category in terms of pollution load due to the fact that tourism activities are widespread in general, and the agricultural production type is more than other districts. On the contrary, it is thought that the reason why Akseki and Gündoğmuş districts are in the risk-free category despite being limited in terms of tourism and agricultural production diversity is that sheep farming activities are more common than cattle farming activities. Furthermore, Korkuteli district is in the 5th color category, which is the riskiest color category, both in terms of TN load and TP load. In addition, it was determined that Elmalı, Döşemealtı, Serik, Manavgat and Alanya districts are in the risky category in terms of both TP load and TN load. Although Manavgat and Alanya districts are at the forefront in terms of tourism activities, it can be thought that the fact that the district borders are towards mountainous areas and that animal husbandry activities are carried out more in these areas compared to the coastal areas has an effect on these districts being in the risky category. However, the main reason for the districts being in different color categories according to TP and TN loads can be shown as the fact that the diffuse pollutant load, which varies according to the daily pollutant type, and the percentage of diffuse pollutants reaching the receiving environment are included in the calculations according to different assumptions for nitrogen and phosphorus.

In addition, the TN load originating from cattle farming activities in the study area was determined as 1346.704 tons/year and the TP load as 149.633 TP/year. The lowest TN load was calculated as 2.874 tons per year in Demre district and the highest TN load was calculated as 209.402 tons per year in Korkuteli district. However, the lowest TP load was determined as 0.319 tons per year in Demre and the highest TN load was determined as 38.583 tons per year in Korkuteli district. Hacısalihoğlu (2022) determined that the total diffuse pollution load that can occur

due to total nitrogen originating from cattle, sheep and poultry throughout Bursa is 3241,944 tons TN/year, and the total diffuse pollution load that can occur due to phosphorus is 341,327 tons TP/year. We can say that it is necessary to include cattle, sheep and poultry enterprises in the diffuse load calculations.

CONCLUSION AND RECOMMENDATIONS

Calculation of pollutant loads originating from animal husbandry activities is important for environmental health. The placement of monitoring stations that will be periodically controlled in local areas to investigate the effects of pollutant loads on underground and surface water resources within the study area may be important for the control of possible environmental pollution. The establishment of monitoring stations may play an active role in determining pollution loads for future periods.

It can be said that the districts of Demre, Finike, Kumluca, Kemer, Konyaaltı, Muratpaşa, Akseki and Gündoğmuş will be least affected by the pollutant diffuse loads originating from cattle waste. However, although the risk rate of these districts is low, the water resources in these districts are faced with the danger of pollution. Therefore, the establishment of standards for manure storage structures will be an important step in preventing the damage that the diffuse pollutant loads will leave on the environment. It should not be forgotten that if there is no standard for manure storage structures, both water resources and soil and other environmental elements may be damaged. In addition, considering that the risk category of Manavgat district is high, it can be said that the Manavgat River may also be negatively affected by this situation. It is thought that the fish population living in this river will also be negatively affected as a result of the pollution of the Manavgat River.

Our region represents a region that can be considered rich in terms of water potential compared to the rest of Turkey. The main water resources of our region are Eşen-Karaçay, Demre Stream, Finike-Başgöz Stream, Finike-Alakır Stream, Kırkgözler Stream, Düden Stream, Aksu Stream, Köprüçay, Manavgat Stream, Karpuz Stream, Alara Stream, Kargı Stream, Dim Stream, Sedre Stream and Bıçakçı Stream. Our region has 9% of our country's water potential with 15.907 billion m^3 and 788.88 million m^3 safe groundwater water potential (Anonymous, 2022). Total nitrogen and total phosphorus loads resulting from animal husbandry activities pass to surface waters through surface flow and to groundwater through deep penetration (Yontar, 2009; Biçer, 2011). In this context, it can be said that it is very important to take the necessary precautions to prevent water resources in both risky and nonrisk categories from being affected by pollution. In addition, integrated monitoring systems can be used to monitor changes in animal numbers and dispersed pollutant loads.

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CAN THE NEW SHAPE INDEX BE USED IN THE EVALUATION OF PROJECTS UNDERTAKEN BY STATE HYDRAULIC WORKS?

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ABSTRACT
Land consolidation is carried out in our country with the aim of reducing land fragmentation, constructing roads and irrigation channels for each parcel, and establishing sustainable agricultural enterprises by increasing agricultural production. Land consolidation has conducted in Türkiye and has been increased its importance in terms of sustainable agriculture. Many researchers have been investigating land consolidation performance and created some indicators. One of the most important issues that land consolidation affects is that parcel shapes can increase agricultural production in terms of agricultural practices. In this study, the opportunities for the use of the "new shape index" developed by Arslan (2020) in land consolidation projects in our country were investigated through face-to-face interviews with 12 experienced engineers in the DSI 1st Region. According to the research results, approximately 80% of the participants stated that parcel shapes are important; more than 90% found the use of the new shape index either suitable or completely suitable; approximately 70% considered the classification of the new shape index appropriate, and about 85% recommended its use. Consequently, it is understood that the new shape index could be a usable parameter in land consolidation studies, and it could be employed in the future to identify priority areas for land consolidation or for performance evaluations.
Keywords: Land consolidation, parcel shapes, shape indices

INTRODUCTION
In countries like Türkiye, which have not yet completed their agricultural infrastructure and have limited resources, land consolidation holds significant importance in reducing costs in agricultural investments, improving working conditions in the production environment, and creating agricultural areas suitable for modern management. Structural measures such as eliminating land fragmentation and dispersion, improving the shapes of land parcels, enhancing farmers' working conditions, and delivering other services to the land can be carried out within the framework of land consolidation efforts. Therefore, land consolidation primarily provides the necessary conditions for improving production conditions, increasing the quantity and quality of agricultural products, economizing labor in agriculture, and enhancing the net income and productivity of agricultural enterprises (Köseoğlu and Gündoğdu, 2004; Uçar and Kara, 2006; Küsek, 2014; Aslan, 2018; Kirmikil and Arıcı, 2013).

Various indicators are used to evaluate land consolidation projects. These include criteria such as the number of before and after parcels, changes in the length-to-width ratio of parcels, changes in road length for access to parcels, changes in the required amount of labor, and changes in the possibilities for mechanized farming. In assessing the shapes of parcels, rural area metrics, which have been developed in North America since the mid-1980s, have been used in many scientific studies (Blaschke, 2000; Kirmikil, 2010). Schnakenburg and Schmieder (2007), in their study, used rural area metrics to determine the changes in settlement areas before and after land consolidation. Gonzalez et al. (2004; 2007), in their study, calculated the area shape factor values using area and perimeter parameters and used this value to measure the success of land consolidation projects with a combined shape and size index.

Various indicators have been developed by numerous researchers to determine the effects of land fragmentation on land (McCarigal and Marks, 1995; Bonfati et al., 1997; Elkie et al., 1999; McCarigal et al., 2002; Rutledge, 2003; Kirmikil and Arıcı, 2013).

Agricultural production plays a critical role in food security and economic development globally. Success in this field depends on the interaction of various factors, with parcel shapes being one of the most significant (Ertunç, 2020). The shape of an agricultural parcel is crucial in the planning and management of farming practices. Parcels with different geometric shapes, such as rectangles, squares, and triangles, can offer significant advantages in optimizing land use and organizing agricultural activities. Moreover, maintaining appropriate distances between parcels can be effective in preventing the spread of plant diseases. These factors demonstrate that the correct selection of parcel shapes is critical for enhancing productivity and ensuring soil sustainability (Aslan, 2021).

Water management is one of the fundamental elements of agricultural production, and parcel shapes directly affect this management. From terracing on sloped lands to drainage systems on flat lands, parcel shapes can be designed to ensure the regular and efficient use of water. This not only ensures the effective use of water resources but also provides economic advantages to farmers by reducing irrigation costs (Arslan et al. 2024).

Erosion control is another important aspect of agricultural parcel shapes. Soil erosion is a serious issue that negatively affects the productivity of agricultural lands. The correct selection of parcel shapes can be an effective strategy in reducing erosion and preventing soil loss. Therefore, the role of parcel shapes in erosion control is of great importance for the sustainability of agricultural practices (Geisse and Hudekova, 2019).

Measuring parcel shapes in agriculture is a fundamental element for modern agricultural management and planning. In this context, accurately determining the geometric properties of agricultural parcels is necessary as it affects important factors such as productivity, water management, and sustainability (Zhang and Zhang, 2018). The indices developed for measuring agricultural parcels are designed to analyze parcel shapes precisely and with computer-aided methods (Arslan et al., 2021).

Indices used in measuring parcel shapes (Kwinta and Gniadek, 2017) typically involve remote sensing, geographic information systems (GIS), and other advanced technological tools. These indices (Kirmikil and Arıcı, 2013) are developed to quickly and accurately evaluate factors such as the area of agricultural parcels, environmental irregularities, boundaries, and slopes. For instance, indices like the Normalized Difference Vegetation Index (NDVI) are used to assess plant health and growth in agricultural areas, while GIS-based indices are effective in determining parcel boundaries and measuring geometric irregularities. These indices provide more precise and comprehensive data to agricultural managers, farmers, and researchers, playing a significant role in the planning and optimization processes of agricultural parcels.

In their study, Akkaya Aslan et al. (2007) observed that the Fractal Dimension (FD) values in Serem village, which ranged from 1.30 to 1.80, and in Beykoy village, which ranged from 1.30 to 1.60, concentrated within these ranges before land consolidation. After land consolidation, these values fell below 1.60 in both villages, resulting in more regularly shaped parcels, depending on the size of the parcels.

In another study, Kirmikil and Arıcı (2013) calculated the Shape Index (SI) values and FD values for each parcel before and after land consolidation. They found that the SI value, which deviated from 1 before consolidation, approached 1 proportionally as parcel sizes increased after consolidation. Similarly, before land consolidation, FD values indicated that the average parcel sizes were around 5000 m², with FD values primarily ranging from 1.40 to 1.60. After land consolidation, these values concentrated between 1.35 and 1.40, indicating the formation of more regularly shaped parcels.

In this study, a survey was conducted to explore the potential for using the "new shape index" developed by Arslan (2020) by the State Hydraulic Works (DSI), given that studies on this index are insufficient. The survey's goal was to assess the new shape index's applicability with simple questions in use of in land consolidation projects. It was crucial that the participants had experience in land consolidation projects to evaluate this index effectively. The survey was conducted with engineers working in the land consolidation field at the DSI 1st Regional Directorate.

MATERIAL AND METHOD

The new shape index is calculated by dividing the area of the smallest enclosing rectangle of a parcel by the parcel. A shape index value approaching 1 indicates that the parcel shapes are suitable for agricultural production, while values deviating from 1 suggest that the shapes are becoming less optimal (Figure 1).

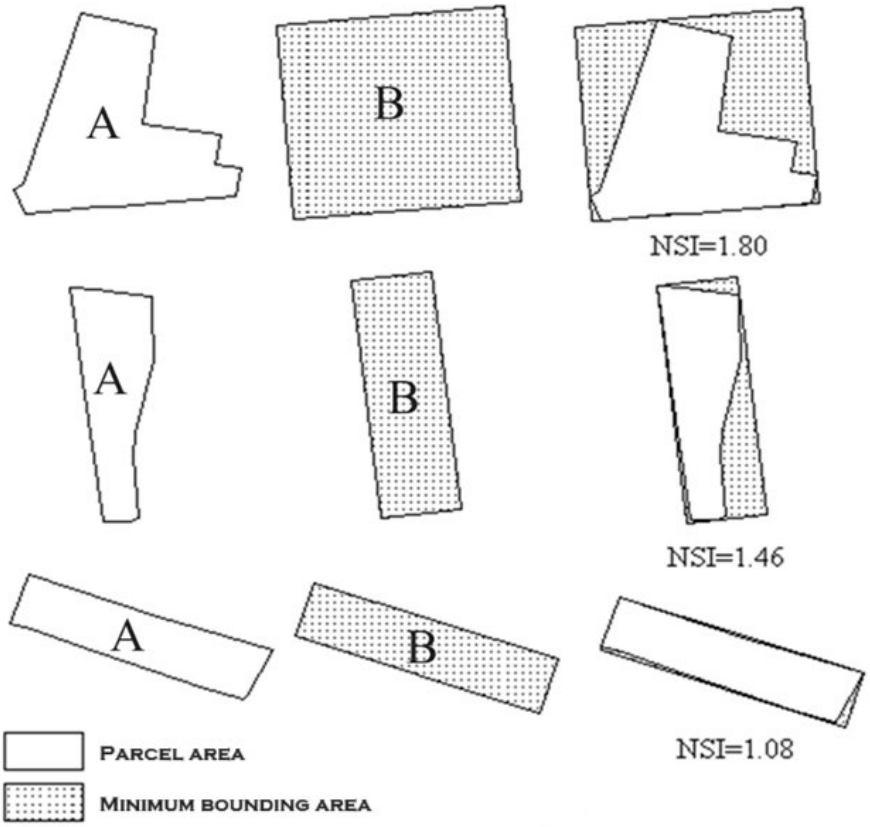

Figure 1. The new shape index (Arslan and Değirmenci, 2018; Arslan, 2020)

The classification of shape index values is illustrated in Figure 2 (Arslan, 2020):

Parcels with an NSI value between 1.00 and 1.10 are classified as "rectangular."
Parcels with an NSI value between 1.10 and 1.20 are classified as "partially rectangular."
Parcels with an NSI value between 1.20 and 1.30 are classified as "partially distorted."
Parcels with an NSI value between 1.30 and 1.50 are classified as "distorted."
Parcels with an NSI value between 1.50 and 2.00 are classified as "poor."
Parcels with an NSI value greater than 2.00 are classified as "very poor."

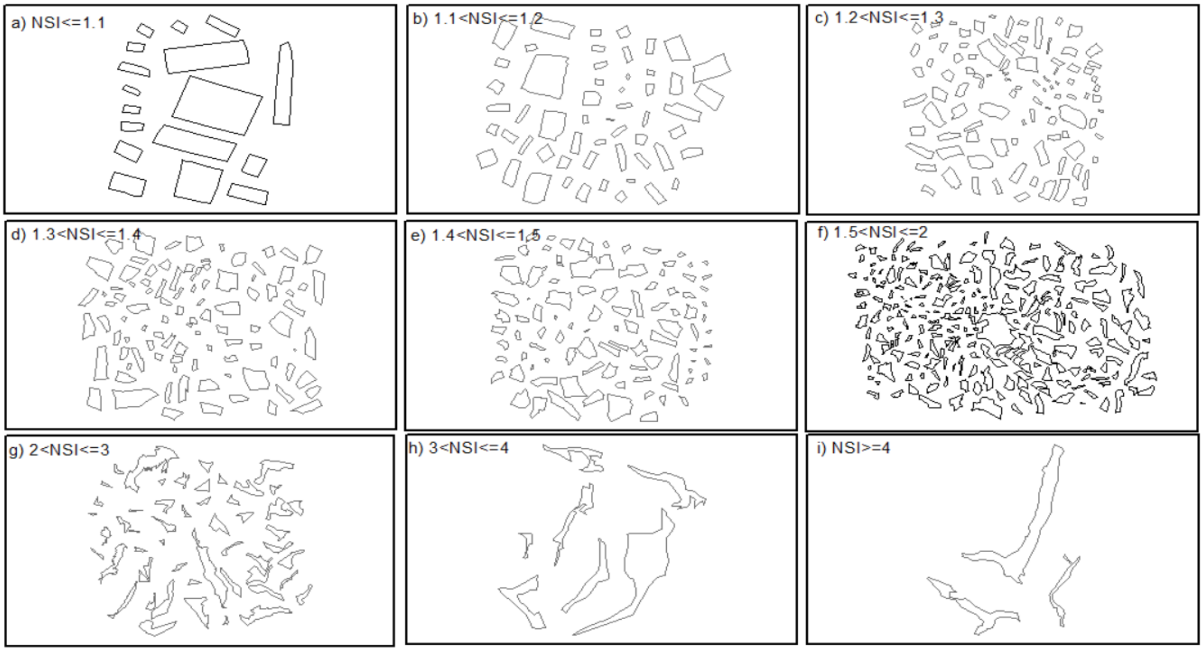

Figure 2. Classification of parcels according to the new shape index (Arslan, 2020)

In this study, data was collected through face-to-face surveys conducted with all personnel working on land consolidation projects in the DSI 1st Region. The survey consisted of a total of 6 questions, including questions about profession, years of experience in the field of land consolidation, and 4 additional questions:

1. How important are parcel shapes in land consolidation projects?
2. Is the new shape index (Arslan, 2020) suitable for use in land consolidation projects?
3. Is the classification of new shape index values (Arslan, 2020) appropriate?
4. Would you recommend the use of the new shape index (Arslan, 2020) in land consolidation projects in Türkiye?

RESULTS

A total of 2 surveyors and 10 agricultural engineers participated in the survey. The average experience in land consolidation projects among the participants is 12.5 years, with the least experienced engineering 4 years and the most experienced having 32 years. It can be said that the participants have been experienced in land consolidation projects. In response to the first question, "How important are parcel shapes in land consolidation projects?", 83.3% answered "Very important," and 16.7% answered "Important." Regarding the question, "Is the new shape index (Arslan, 2020) suitable for use in land consolidation projects?", 41.7% responded "Completely suitable," 50% responded "Suitable," and 8.3% responded "Not suitable." For the third question, "Is the classification of the new shape index values appropriate?", 33.3% said "Completely suitable," 41.7% said "Suitable," and the remaining participants were undecided. In the fourth question, "Would you recommend the use of the new shape index (Arslan, 2020) in land consolidation projects in Türkiye?", 33.3% responded "Definitely recommend," 50% said "Recommend," one participant was "Undecided," and one participant responded, "Definitely do not recommend." Results show the thought of the participants considering their land consolidation expertise.

DISCUSSION

Land consolidation projects are significant interventions aimed at increasing the productivity of agricultural lands in rural areas and facilitating their management. The indicators and metrics used in these projects play a critical role in determining the effectiveness of the implementation processes and the success criteria of the project (Arslan, 2020). For this reason, parcel shape index is of great importance for evaluating the projects. Evaluating the geometric shapes of parcels in land consolidation projects is crucial for determining the success criteria of the project and making effective decisions during the planning process. In this context, the selection of appropriate

indicators is considered a strategic step to enhance the efficiency and sustainability of the projects. Studies evaluating the potential indicators that could be used in assessing parcel shapes in land consolidation projects are limited (Arslan et al., 2021). In the light of previous studies, broadening the new index can be helpful for decision makers.

The selection of indicators to evaluate parcel shapes takes into account the specific needs and objectives of the projects. Factors such as the geometric complexity of the area, edge lengths, and concavity or convexity play an important role in the selection of potential indicators (Demetriou et al., 2013). They used an index that calculation involves area, edge lengths, concavity, convexity, however, the new shape index is calculated with minimum bounding area and the parcel area.

The selection of indicators for evaluating parcel shapes in land consolidation projects directly impacts the success criteria of the projects. However, considering the limitations and evaluating the potential for improvements is important to make land consolidation projects more effective and sustainable (Demetriou, 2016). The new shape index can help reporters, engineers and decision makers in terms of fast and easy calculation of it. These attributes give effective ways of evolving land consolidation projects.

CONCLUSION

In this study, parcel shapes, which are one of the most closely monitored aspects in land consolidation projects, were surveyed. The survey participants consisted of volunteer engineers working in the DSI 1st Region. The possibilities of using the "new shape index" in land consolidation projects in Türkiye were investigated among experienced engineers in land consolidation. When the survey results were examined, participants provided positive responses regarding the usability of this index. Nearly 90% of the participants recommended the use of this index in land consolidation projects. More detailed results could be obtained by using and evaluating the new shape index in a broader context. In this case, more detailed information about the use of the new shape index could be accessed.

In the following studies, this study can be improved with more participation working in land consolidation area. And, it can be said that the index can be modified with suggestions of new participants who are working on land consolidation in Türkiye scale.

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MECHATRONIC SYSTEMS AND ARTIFICIAL INTELLIGENCE IN THE FUTURE OF ANIMAL PRODUCTION

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ABSTRACT
Animal production is an essential agricultural activity that has existed throughout history and continues to serve mankind with its basic food supply. Economically important animals, such as ruminants, bees, and poultry, may be grown, cared for, and fed using agricultural facilities intended specifically for animal production. This will ensure the continuation of animal production while also supplying the public's demand for livestock-based food. Most farms in the world, including our country, can continue their animal husbandry operations through manpower. As technology advances, manpower activities are gradually being replaced by modern agricultural structures. Advances in artificial intelligence AI), IoT, and mechatronics are quickly boosting the use of digital technology in agricultural and animal husbandry.
These ideas reveal that animal production may be optimized by using modern technology and lowering human-related errors and the demand for workforce. In this study, image processing systems, AI applications, and autonomous farm technologies were investigated within the context of animal production literature. The studies show that an integrated decision support system based on AI would play an essential role in enhancing the speed and quality of animal production while also lowering human-related errors. Also, the use of AI-driven systems capable of making autonomous decisions plays a key role not just in animal husbandry and production but also in the diagnosis of diseases. In our investigation, we observed that the highest accuracy rate (98.44%) was achieved with machine learning while performing facial image classification in animal production.
In our country, it is clear that the spread of AI and mechatronic systems for sustainable agricultural practices, beginning with livestock that use traditional technology at around 10%, is determined by the speed of paving the way for advanced agricultural structures studies with agricultural innovation, as well as the magnitude of its multiplier effect on the country's economy.
Keywords: Animal Production, Farm Structures, Artificial Intelligence Application, Mechatronic Systems.

INTRODUCTION
It can be observed that artificial intelligence has entered our lives suddenly and in most areas. It can make calculations, operations and determinations that used to be made by only human intervention. It is widely used in fields such as agriculture and animal husbandry, medication, logistics, manufacturing, aviation industry and spatial design.
A philosophical approach lies at the heart of artificial intelligence applications on which mathematical models have been developed. In history, Aristotle (385-323 BC) first mentioned the term automata in his book Politics [1]. In the following centuries, scientists such as Al-Jazari, an important name in the philosophy of science, and Leonardo da Vinci made important contributions to the studies in this field. In 1943, during the Second World War, Alan Mathison Turing is considered to be the first person to put forward the idea of artificial intelligence, initiating a scientific debate in the form of the question "Can a machine think?" [2]. Since then, the scope of artificial intelligence has progressed from being a problem or an idea to the generation of alternative solutions with mathematical models. Artificial intelligence can be divided into sub-sections such as deep learning, machine learning, pattern recognition, natural language processing, expert systems, genetic algorithms, speech understanding, computer vision, robotics and optimization. Each of these focus on finding solutions to different problems and questions.

The needs related to eating and drinking, which have been going on for generations, are obtained from agricultural and animal production. Agriculture and husbandry have always been important for mankind to survive and develop. The impact of artificial intelligence on every field is also reflected in livestock production. At this point, it is aimed at minimizing the problems caused by human errors. With artificial intelligence, it is expected to carry out and accomplish the work and operations within the most optimum conditions and at the best times with as little cost as possible. It can be used in many fields such as daily routine care of animals, collection of products to be obtained, increasing the welfare level, controlling reproductive needs and disease diagnosis.

In this study, artificial intelligence and mechatronic technologies will be examined and their applications in animal production will be discussed. On the other hand, completely unmanned livestock farms will be discussed and developments and applications in fuzzy logic, deep learning and machine learning, which are within the scope of artificial intelligence technologies, will be evaluated.

ARTIFICIAL INTELLIGENCE

Input and outputs are needed for the realization of production and service-related works and transactions. Outputs can be obtained by processing input data with the help of algorithms [3]. Artificial intelligence can have the ability to examine the inputs in question, to learn the final outputs based on evidence, and to fulfil the desired tasks and operations by adapting to certain targeting [4]. Artificial intelligence can be divided into many subdivisions in terms of its structure.

Artificial intelligence aims to optimize the functioning and maximize the performance goals by analyzing the input data. For AI data inputs to result in logical outputs, the features of the data must be consistent, clean and organized [5]. For these main reasons, it should work together with data science (Figure-1) [6].

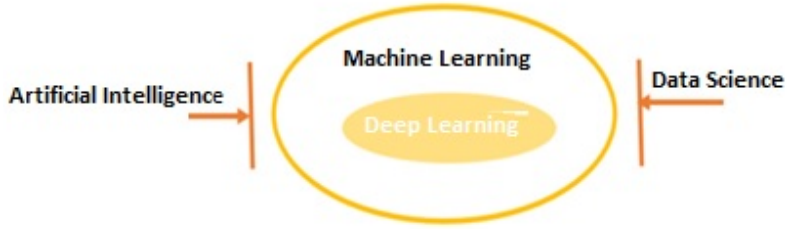

Figure 1. The relationship between artificial intelligence and data science

Many subdivisions of artificial intelligence have unique problem-solving methods. Thanks to these sub-categories of artificial intelligence that serve a common purpose, it can solve the problem with the highest success with the input data at hand.

Many scientists have worked in this field until today. New methods and models have been developed. With these methods, the problem-solving framework continues to expand optimally. In this paper, we will examine the methods that are widely available in literature. Studies will be evaluated within the framework of animal husbandry, which provides basic requirements for farms through the combination of artificial intelligence and another technology.

APPLICATIONS OF DEEP LEARNING AND MACHINE LEARNING

Deep learning and machine learning can be considered as subdivisions of artificial intelligence. In machine learning, training data is used in terms of modeling and analysis of data in order to obtain outputs from data inputs of algorithms. Figure 2 shows the differences between traditional programming and artificial intelligence [7].

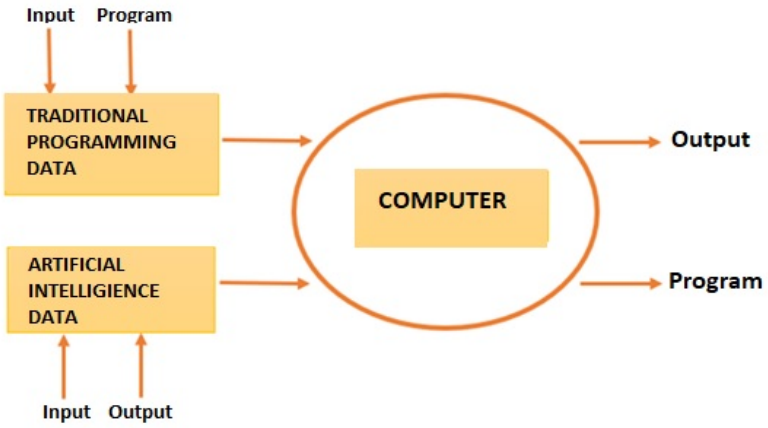

Figure 2. Artificial intelligence vs. traditional programming.

When the literature is examined, it is observed that there are quite a number of studies on animal husbandry. The studies on this subject are analyzed and given in Table 1.

Table 1. Animal husbandry applications with machine and deep learning methods in the literature.

Topics	Results	Source
System for Monitoring Farms	According to the results of the study, the highest success rate of 89.6% was achieved.	Raksha R. and Surekha P. [8]
Remote supervision and care in monitoring goat breeding	Temperature, gas and humidity values were predicted successfully with 94% - 97.5%.	Rao Y. et al [9]
Classification in Face Imaging	According to the results of the study, 98.44% accuracy was achieved.	Dandil E. et al [10]
Mastitis Disease Diagnosis	According to the study, 84.9% was the highest achievable accuracy.	Ebrahimi M. et al [11]
Prediction in Heat	According to the study, an accuracy between 82% and 100% could be achieved.	Shahriar et al [12]
Detection of farm animals' behaviors such as grazing, rumination, lameness	According to the results of the study, the operating characteristics curve for receptors was highest at 0.76. Specificity: 0.94, Sensitivity: 0.54	Warner D. et al [13]
Automatic classification of animal species in the wild	According to the results of the study, an Accuracy of 98% was obtained.	Tabak M. et al [14]

APPLICATIONS RELATED TO FUZZY LOGIC

Fuzzy logic consists of processes related to control and decision-making with information that is logical in fuzzy logic and modeling close to the human way of thinking (Figure 3) [15]. It is generally used in image identification in information systems and optimization in automatic control systems [16]. When the animal husbandry areas in the literature are examined, it is observed that there are many applications of fuzzy logic. The fuzzy logic model mechanism is given in Figure 3 below.

Figure 3. Working mechanism in fuzzy logic systems

The studies conducted in this field are analyzed and given in Table 2.

Table 2. Livestock husbandry applications with fuzzy logic models in the literature.

Topics	Results	Source
Health status and milk quality monitoring system on farms	According to the results of the study, the cut-off level was: 0.7, Specificity: 73%, Sensitivity: 81%.	Zaninelli M. et al [17]
Mastitis disease diagnosis	The study has an error rate between 95.5% and 41.9%.	Rao Y. et al [18]
Quality determination of raw milk	According to the results of the study, a success rate of 82.5% was achieved.	Mehraban et al [19]
Breast health monitoring	0.1 cut-off level: Specificity: 27%, Sensitivity: 99 0.9% cut-off level: Specificity: 92%, Sensitivity: 56	Zaninelli M. et al [20]
Monitoring agricultural structure and herd health status and electrical conductivity values	According to the study results, Specificity: 69%, Sensitivity: 81	Zaninelli M. et al [21]

MECHATRONIC SYSTEMS

Mechatronic systems are both general work and operations and robotic work and activities, in other words, automation. It is seen that it is widely used in production applications, service sector, industrial sector, manufacturing industry and construction sector. The main purpose of mechatronic and robotic systems is to prevent situations caused by human errors and to ensure the continuity of work. Mechatronic robots that can work continuously are highly efficient and sustainable with their expenditure costs. They appear as long-term systems with engineering costs. Mechatronic robotic systems can provide the manufacturer with optimization in many parameters such as performance and quality.

With the acceleration of today's technology, it is easier for these systems to manifest themselves in workplaces and homes. Mechatronic robotic systems are used in every situation where there is every routine activity in human work in various fields. There are differences in mechatronic and robotic solutions according to the operations that can be done systematically. In this study, the use of mechatronic robotic systems in animal farms will be examined. When the literature is examined, it is seen that most routine tasks and problems in the livestock sector are solved with these systems. Brief summaries of some studies conducted in this field are given below.

Orsini R. et al. [22] in the project of PFRLab research supported by the Università Politecnica delle Marche aims to ensure food safety and sustainability of crop systems. They planned to establish a precision agriculture and mechatronic robotic agriculture laboratory in a multidisciplinary component for food safety.

Lauguico et al. [23] chose vertical agricultural applications with a mechatronic arm as the focus of their research, taking into account the increasing demand for agricultural products by the global population and the fear of food shortages. In this study, the research was simulated using Universal Robots and MATLAB.

Nguyen V. et al [24] analyzed the mechatronic vehicles used in agricultural field. With the continuous development of mechatronic technology and sensor technology, it has been characterized as a future structure in terms of future studies.

Kounalakis T., Triantafylidis G. and Nalpantidis L. [25] used a mechatronic system to create an input data set with weed images from dairy farms. Both transfer learning method and deep learning were applied, and a weed image recognition algorithm was prepared. Thus, a system that can group weeds from real-time input data is proposed.

In the study by Mundan D. et al [26], the economic analysis of livestock farms that can work together with robotic milking systems and the opportunities and challenges encountered are mentioned. Investments in mechatronic farms aiming to eliminate the cost of labor have been directed. As an output of the study, it was revealed that the transition of large farms to mechatronic systems is more attractive.

In the studies carried out by Hyde J. and Engel P. [27], the costs and returns in the investment of robot milking systems were mentioned. The estimation of the numerical data of the income and expenses of the robot milking systems (RMS) was carried out using Monte Carlo simulation method.

Wagner-Storch A. and Palmer R. [28] investigated the milking behavior, milk yield and nutrition of cows using a robotic milking system and cows milked with traditional milking method in a livestock farm. The study revealed that future mechatronic milking systems directly affect the project designs of feeding and transportation facilities.

Borshch O. et al [29] examined the adaptation values of cows to robot milking systems. The study was conducted on German Holstein, French Holstein breeds and brown Swiss breed cows in a mechatronic livestock farming enterprise, and as a result, it was stated that a very short adaptation period was observed in the German Holstein breed.

Butler D. and Bear C. [30] proposed the use of an unmanned mechatronic milking system (AMS) for livestock farms. Detailed input data was recorded by the robotic system. The study aimed to improve cow welfare and health through the milking routine, focusing on the relationship between the stockman and the AMS.

In the studies conducted by Rossing W. et al [31], robotic udder and arm cleaning devices, milking stalls and equipment in the Netherlands country in 1996 were examined. The study indicated that the milking frequency could be increased from 2 to 3 times and 1000kg milk yield could be achieved. It is also emphasized that the positive effect of mechatronic milking with robotic systems on producers can be seen.

It is seen that such studies generally focus on the developments in the sensors and controllers used and the place and importance of mechatronic robotic technology in agriculture and try to set visionary future goals [32].

CONCLUSION

In this study, mechatronics, robotics, and artificial intelligence technologies are examined within the framework of possible applications in the livestock sector. In our study, it is seen that solutions to problems can be produced when digital data, video or visuals are available. Our study states that when given complete, impeccable and perfect data, artificial intelligence can offer solutions to the hardest problems and shows that rapid digital transformations will be experienced in this field. Fuzzy logic and machine learning for problems related to prediction and classification in fully automated farms are expected in the near future, and deep learning applications for more difficult problems can be planned. The ability to obtain proven and precise outputs from numerical input data with artificial intelligence can convince producers of successful predictions. Large livestock farms will need to adapt to these new trends for their survival and high-yield sustainable products. The combination of mechatronics and robotics with the performance of AI for high-performance decision making is the most important component for fully automated smart agribusiness. AI's skills in decision-making, image processing, prediction, classification and herd management systems can solve many of the problems that require human ingenuity in animal farms. Optimum feeding, disease diagnosis, detection of animal behavior, analysis of animal health and collection of animal crops can be done with artificial intelligence. Meeting these requirements in animal farms with technological progress has significant potential for future studies. Scientific studies for fully automated livestock farms show that the technological transformation in this field will add significant momentum.

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Ref : Academic Incentive 11/11/2024

The *2nd INTERNATIONAL CONGRESS ON SUSTAINABLE DEVELOPMENT IN THE HUMAN ENVIRONMENT & CURRENT AND FUTURE CHALLENGES*, held in Antalya, Türkiye, from October 23-26, 2024, took place in Ankara, Türkiye, with the participation of academics/researchers from 10 different countries (18 from Türkiye and 62 from other countries). The congress was organized by the amendment made to the *Academic Incentive Payment Regulation* on January 16, 2020, which stipulates that "For an event held domestically or internationally to be considered international, at least five speakers presenting papers must come from outside Türkiye, and the majority of presentations must be made by participants from outside Türkiye"

Submitted for your information,

Respectfully

Prof. Dr. Hakan AKTAŞ
Isparta University of Applied Sciences
CONGRESS CHAIRMAN

BYDGOSZCZ UNIVERSITY
OF SCIENCE AND TECHNOLOGY
Faculty of Agriculture and Biotechnology

HR EXCELLENCE IN RESEARCH

Bydgoszcz, 23rd March 2024

TO WHOM IT MAY CONCERN

Faculty of Agriculture and Biotechnology Bydgoszcz University of Science and Technology is participating in the "2nd International Congress on Sustainable Development in the Human Environment-Current and Future Challenges (ICSDEV 2024)", which will be held in Antalya between 23-26 October 2024, in cooperation with the Economic Development and Social Research Institute (İKSAD).

Prof. Dr. Jacek Długosz from Biochemistry and Soil Science Laboratory is appointed as a member of the Scientific Committee.

Sincerely yours,

Prof. Dr. Roman Rolbiecki

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UNIVERSITY OF AGRICULTURE
in Krakow

Faculty of Production and Power Engineering

Kraków, 22nd March 2024

TO WHOM IT MAY CONCERN

The Faculty of Production and Power Engineering, University of Agriculture in Krakow is participating in the "2nd International Congress on Sustainable Development in the Human Environment-Current and Future Challenges (ICSDEV 2024)", which will be held in Antalya, 23-26 October 2024, in cooperation with the Economic Development and Social Research Institute (İKSAD).

Assoc. Prof. Mateusz Malinowski, from the Department of Bioprocess and Power Engineering and Automation is appointed as a member of the Scientific Committee.

Sincerely yours,

Assoc. Prof. Anna Krakowiak-Bal

T.C.
KAHRAMANMARAŞ SÜTÇÜ İMAM ÜNİVERSİTESİ
REKTÖRLÜĞÜ
Ziraat Fakültesi Dekanlığı

TÜRKİYE CUMHURİYETİ'NİN YÜZÜNCÜ YILI

Sayı : E-83501499-051-299564 21.03.2024
Konu : Sempozyum Düzenleme Kurulu (Prof. Dr. Adil AKYÜZ)

İLGİLİ MAKAMA

İktisadi Kalkınma ve Sosyal Araştırma Enstitüsü (İKSAT) işbirliği ile 23-25 Ekim 2024 tarihleri arasında Antalya'da düzenlenecek olan uluslararası "II. International Congress on Sustainable Development in the Human Environment-Current and Future Challenges (ICSDEV 2024)" isimli sempozyuma Fakültemiz Biyosistem Mühendisliği Bölümü öğretim üyesi Prof.Dr. Adil AKYÜZ düzenleme kurulu üyesi olarak görevlendirilmiştir.

Bilgilerinize arz/rica ederim.

Prof. Dr. Galip BAKIR
Dekan

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