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Book
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Abstracts

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Production

Precision weed management in vegetables utilizing artificial intelligence

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Farmers use mainly herbicides for weed management, where fresh-market vegetables are grown, and they follow conventional crop protection strategies (utilizing a vast amount of chemicals) regardless of the negative impacts on the environment and human health. Almost all herbicide applications are made uniformly with conventional spraying equipment, despite the fact that distribution of weeds is typically patchy, resulting in increased input costs, increased risk of crop damage, pest resistance to chemicals, environmental pollution and contamination of products. The integration of machine vision and artificial intelligence (AI) with smart application technology provides a unique opportunity to improve weed detection accuracy, compared with current technology, and enhance precision weed management. Herein, a low-cost and smart technology is presented that utilizes machine vision and artificial intelligence (deep and transfer learning) for precision weed management in vegetables. This smart technology can distinguish target weeds from non-target objects (e.g. vegetable crops), with accuracy of more than 90%, and precisely spray on the desired target/location. A graphical user interface (GUI) was developed to visualize the collected data in real-time, and an RTK GPS was integrated with the smart technology, and an algorithm was developed, to automatically generate weed maps, at the end of each application, to provide historical weed and spraying data to the growers. This smart technology, that integrates a state of the art (AI-based) weed detection system with a novel fast and precision spraying system, can significantly reduce the quantity of agrochemicals applied, especially compared with traditional broadcast sprayers.

Sound velocity estimation of spread spectrum sound positioning system in greenhouse

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In recent years, the agriculture development has been focusing on the technological improvement of the robots. The new technologies of robots and precision farming technology has been the trend of these days, it is obvious that some of the labor-intensive machines will be replaced by the robots while the market does not have many products supporting the greenhouse farming.

An important part of the automated robotics system in greenhouse is the localization method which controls the movement of the robots. The present situation of indoor positioning methods including the machine visions, ultra-wideband and Bluetooth-beacons etc. The disadvantages of these include limited ranges, intolerant to obstacles and the equipment is expensive. Thus, a low cost, high accuracy and high noise tolerance method, Spread Spectrum Sound-based Local Positioning System (SSSLPS) has been

investigated. SSSLPS uses the sound wave properties that can pass through the obstacles and can locate the target precisely with only speakers and microphones. The sound-based positioning system is suitable for controlling the harvesting robots in an indoor area of greenhouse and the current research of SSSLPS is focusing on the improvement of the positioning accuracy as well as the estimation of sound velocity. As the sound-based method calculates position by using flight time of sound and sound velocity under the measurement area, sound velocity measurement error also determines the accuracy of this method. With a controlled greenhouse, the wind factor is minimized by shutting down the fan and ventilation. The spatial distribution of greenhouse temperature as well as the temperature changes during daytime are two major factors affecting sound velocity. The present methodology of sound velocity measures the temperature from the sensor but the problem is that sensors can only show the precise temperature at that location but not covering the whole area. The proposed sound velocity estimation method measures the position and sound velocity simultaneously based on the Time of Arrival (TOA) based localization algorithm. At least four nodes are required to estimate 3D position and sound velocity. Taylor series linearization is being used to optimize the experimental environment and simplify the algorithm. In this research, the objective is to use an estimated sound velocity localization algorithm with SSSLPS to provide accurate positioning results in the greenhouse.

The experiment was conducted in a traditional Japanese small-scale greenhouse at Ehime in the late September. The data was taken every 10 minutes in a day and recording the temperature changes and the target location from SSSLPS. The average performance of the localization system can measure position within 20mm accurately and most of the location measurements using temperature sensor method were around 25mm. The maximum deviation was approximately 40mm and accuracy can still be improved by optimizing the Dilution of Precision (DOP). The estimated sound velocity localization has potential to replace the current system of using the temperature sensors in greenhouse.

The future works of this study including the dilution of precision evaluation, the sunlight intensity relationship with the sound velocity as well as evaluation of this system in worse weather conditions.

Development of automatic precision fodder concentrates feeding system for goat

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The objective of this research is to develop an intelligent automatic precision fodder concentrates feeding system which is suitable for domestic goat feeding management in Taiwan. Depending on the feeding needs of the goat farm and the different growth stages of the goats, the system is designed to be able to mix up and dispense correspondent feeding mixing recipe, feeding volume, as well as feeding time and other feeding parameters for different feeding zones. The key elements of the system will include two feed buckets, a precision fodder concentrates mixing unit, a suspended mobile feeding tank, and some correspondent sensing and control units. Two buckets each can hold 35kg of feed will be used to contain different formulation of feeds for precision mixing. A precision fodder concentrates mixing mechanism uses a roller motor equipped with blades to adjust the dispensed amount ratio from two feed buckets through a programmable frequency converter which changes the rotational speed of the roller motor. The amount of feed in the feed bucket is detected by an ultrasonic sensor. Suspended mobile feed tank is mounted on a monorail trolley, which travels on an I-beam steel rail track. Three-phase 220V power

will be supplied through the rail power supply and a frequency converter is used to control the trolley moving speed. Intelligent automatic feeding control will be implemented through a programmable controller with various types of sensors. Human Machine Interface will be sued for easy parameter setting and operation control. For the first, prototype system will be developed and overall feeding functions will be testing to initially reach the basic functions of automatic feeding. Future tasks will be to implement intelligent feeding management, function stability and other operational improvements of the system.

Development of a blast-type onion stem crusher for investigation the onion stem raising mechanism

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Normally onions are harvested in such a chain - first cut the trunk, after that remove the vinyl and finally collect the onions by digging (In Korea). All these works are time and labor consumed so that it takes 241.2 labor hr /10a for whole onion cultivation process. But only for stem cutting takes 27.6 labor hr/10a, which is the second largest after the planting work. During harvesting stem cutting, digging and collecting the onions required 30%, 60% and 10% labour force respectively. So it is necessary to develop a machine that can raise and cut the stems of onion during harvesting. The purpose of this study was to investigate the mechanism of spin speed of cutting blade to mechanize the onion stem cutting work. To raise the overturned onion, stem before cutting a rotating cutting blade used with edge which provide wind pressure along with cutting action. A drive motor for rotating the cutting blade, a control box for controlling the rotation speed of the blade, and a device for adjusting the height of the onion tray was used here to perform the whole stem cutting operation. The total control mechanism was equipped with a cutting height control unit, an air inlet that can regulate the amount of air inflow, a ventilation hole through which the cut stems and air can escape, monitoring system to observe the stem rising, and three cutting blades with different cutting angles. In order to investigate the stemming mechanism, the harvested onion (moisture content 81.7%) was used without cutting the harvesting stem. The wind speed was measured using a wind speed sensor to select the minimum value of the wind speed of the onion stem raising. For selection of the better design criteria, the test was conducted by setting the angle of cutting edge (20°, 25°, 30°), cutting height (5cm, 10cm, 15cm), and amount of air inlet opening (0%, 50%, 100%). The result was checked by using wind sensor, and found that the minimum wind speed for raising the stem of onions must be at least 2.155m/s to be cut. During the test it was showed that the greater angle of the cutting blade results, the lower the cutting height, And the greater the opening of the air intake results, the shorter time to reach the required onion stem cutting wind speed. As a result, the remaining onion stem after cutting became shorter. Most ideal result was shown during the operation when the cutting blade angle was 30°, cutting height was 5cm, and the air inlet was 100%(36.75cm2) opened. At this time, the minimum rotation speed of cutting blade was 460rpm and the remaining stem length was 8.28cm, which was remains in desirable range of remain stem length (5 ~ 10cm) preferred by the cutting height.

Effect of extrusion conditions on the throughput of extruder for the production of pineapple pomace based fish feed

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Pineapple pomace based extrudates could serve as a fish feed with significant health benefits, supplemented with adequate amounts of other ingredients and mineral-vitamin blends. Pomace are generally disposed of during production in juice processing industries has valuable use in fish production. Response surface methodology was used to examine the extrusion processing effect parameters which include feeding rate (1.28, 1.44 and 1.60 kg/min), screw speed (305, 355 and 405 rpm), barrel temperatures (60, 80 , 100 and 120°C) cutting speeds (1300, 1400 and 1500 rpm) and open die hole (50, 75 and 100%) in relation to moisture content of the mash (16, 19 and 22%) with increased pomace inclusion (5-20%) on the throughput of a single screw extruder. Throughput significantly decreased with increased inclusion of pineapple pomace, moisture content, die cutting speed, open surface hole and reduced screw speed. The extruder worked optimally to achieve a throughput of 46.82 kg/hr at feeding speed (1.60 kg/min), screw speed (405 rpm), moisture (16.0%), temperature (120°C), cutting speed (1400 rpm), pomace inclusion (5.0%) and open surface (100%). The use of pineapple pomace to produce fish feed and extruder performance is a novel approach with potential to reduce environmental nuisance.

Manufacturing and performance test of a prototype for fresh corn harvester

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Corn cultivation is classified as edibility fresh corn and field corn. The grain planter is widely used for corn seeding. Nowadays the field corn is harvesting mechanically, but the edibility corn is dependent on the labor force. So, it is necessary to develop a mechanical harvester for fresh corn to reduce labor force and improve productivity. In this study prototype machine was manufactured and conducted factor tests to design the features for development a fresh corn harvester.

The prototype harvester was equipped with a tractor for factor test. The mechanism of harvest was inserted whole stem of fresh corn. This process was harvested only the fresh corn. This device can cutting, transfer and crushing of corn simultaneously. The location of performance test was corn farmhouse in Suwon city. The experimented corn was grown in 127 days after sowing was targeted (Ilmichal variety). The performance test conditions for this device were row spacing 82.8±2.6 cm, hill spacing 26.8±1.4 cm, height of ridge 17.6±1.2cm. The fresh corn were plant height 221.6±37.5 cm, first corn height 103.7±16.7 cm, length of corn 28.2±4.0 cm, stem moisture content 55.6% w.b. The crushing blade and the stem suction roller speed were changed with the rotation speed (500 rpm, 850 rpm, and 1,050 rpm) of the

main power shaft. The harvesting performance (harvest rate, damage rate, collection rate) of the device for factor test was analyzed.

This factor test for corn harvesting consists of power transmission unit (drive gear box for transmission, power transmission drive joint from PTO), corn conveyor, dividing guide, stem cutting roller and collection box for corn etc. The power transmission drive joint was designed to be able to automatically folding and expand up to 470 mm by the hydraulic cylinder in consideration of the operation range during movement and operation. Performance test result showed that the performance of harvesting rate was good because failure rate of harvesting is only 3.6% and damage rate was 3.0% at 500 rpm. The corn collecting missing rate was analyzed as 15.6%, so it is necessary to supplement the collection transfer part mechanism.

Sustainable livestock production by ensuring optimal working conditions and processes through the use of automated systems

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Sustainable livestock production has been defined as the responsible use of resources. Due to the trend in growth of farm size, inter alia, working time becomes a criterion of scarcity. Structural change increasingly endangers the balance between work requirements and working conditions. Physical aspects as well as psychological stress have to be taken into account when organizing healthy and humane work. Although control of working time is the basis for strategic planning of work processes and production optimization, data are considered too little in agriculture.

In order to find the most efficient use of working time the objective of this paper is to analyze the working time requirements of different work processes to compare the effects of automation solutions in dairy farming systems.

Work analyses subdividing work process into individual sections have been created for production-related tasks as well as for management procedures.

Time data for various operations and working equipment's are measured using video-based technology and time recording software. The evaluated dataset involves data modelling and integration into a modularly structured calculation system.

Four herd sizes with 60, 120, 180 and 240 cows are selected. For each category, the yearly working time requirement for dairy farming amounts 3,283 manpower hour (MPh), 5,016 MPh, 6,842 MPh and 8,916 MPh, respectively. Included is the percentage for farm management which accounts for on average 23 %. Data depend considerably on the housing conditions and other influencing variables. Investing in a milking robot reduces the working time requirements per cow and day by 1, 69 min, 1, 29 min, 1, 17 min and 1,1 min relative to an alternative milking system (herringbone milking parlour). The saving potential of an automated feeding system per cow and day is about 0.73 min, 0.64 min, 0.58 min and 0.48 min, respectively.

In conclusion, knowledge of working time requirement provides valuable calculation information and supports decision making at specific stages of the production and work process. Time scarcity can be managed through the intelligent use of innovative technology. In addition, temporal and spatial

flexibility can help to sustainably maintain individual's physical and mental work ability and, thus, agricultural productivity.

Energy assessment of spring wheat production under conventional and precision farming

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Fossil fuel is an essential energy input in modern agricultural production. However, intensive use of fossil fuel energy, chemical fertilizers, pesticides, and machinery cause some significant human health and environmental problems. Shifting the agricultural sector to sustainable, efficient energy use is the priority.

In conventional farming, fertilizers and crop control substances are applied uniformly over fields, leading to over-application in some places and under application in others. In agricultural production, nitrogen (N) is a nutrient that often limits crop growth and, when applied at rates that are sufficient to optimize yield, represents one of the single largest energy investments. Although N fertilizer can increase crop yields, over application of N can have unintended negative economic and environmental consequences. In many cases, use of fertilizer can be significantly reduced with highly beneficial environmental results and little or no loss of farm productivity. For this purpose, the main tool in precision agriculture (PA) is the variable rate technology (VRT), which consists of varying input rates within a field, based on the local demands.

The aim of this research is to compare precision agriculture with conventional practice in relation to their energy performance by making an energy assessment. In this study, inputs and outputs of the following fertilization methods were assessed: precise fertilization using VRT provided by plant optical property sensors (and using maps of soil agrochemical composition, respectively) in comparison with conventional farming practises applying mineral fertilizers uniform in the field. This research is based on a long-term study, covering a five year period between 2014 and 2018, in Lithuania. The research was carried out with spring wheat crops. The size of the fields used for the analysis ranged from 10 and 12 ha. For the purpose of the experiment, the fields were divided into 36 meter strips for VRT and conventional farming. Crops were maintained with the uniform plant maintenance technology.

The primary goal of the energy performance assessment was to calculate the energy input flow, which consists of direct energy consumption ED (MJ ha-1) and indirect energy consumption EIN (MJ ha-1). The greatest impact on the energy balance is made by indirect energy consumption, mainly by nitrogen fertilizers. This multi-study showed that the highest energy productivity (0.1993 kg MJ-1), nitrogen fertilizer efficiency (19.62 kg kg-1), and overall energy efficiency coefficient (2.79) throughout the investigation period was achieved in 2016 by using VRT fertilization, while, higher crop yields for three (2014/17/18) out of five years were recorded in conventional farming. Due to higher nitrogen fertilizer consumption and its lack of efficiency, under normal farming technology, yield gains are inadequate. Increasing the efficacy of active ingredient content in fertilizers means the same outcomes can be achieved with lower quantities of chemicals, as measured in physical units, resulting in reduction of the environmental impact. Furthermore, with precision agriculture (PA), maximum yields can be achieved

with reduced input. Summarizing the results of 5 years of research VRT application resulted in higher nitrogen fertilizer efficiency (17.73±1.94 kg kg-1) compared to uniform fertilization (14.87±1.42 kg kg-1).

Prediction of the local air exchange rate in animal occupied zones of a naturally ventilated barn

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The air exchange rate is an important parameter in order to evaluate the gas emission of naturally ventilated barns. At the same time, understanding the flow inside such barns helps to evaluate the comfort of the animals inside. In this context, the local air exchange rate in subvolumes of the barn (i.e. individual animal occupied zones) is far more interesting than the total air exchange rate. Yet even the total air exchange rate is difficult to assess mainly because of fluctuating influence stimuli such as wind (speed and direction), temperature, barn geometry etc.

One objective of the BELUVA project, financed by the German Research Foundation, is to address those influences and derive a parametric function for local air exchange rates. These functions will further permit to answer questions associated with precision livestock farming. For example, for a given length/width ratio of a barn and a given inflow speed and angle, in which animal occupied zones a supporting mechanical ventilation must be switch on.

The present study has been carried out in order to evaluate the impact of incoming wind angle and barn's length/width ratio on the local air exchange rate in animal occupied zones of barns. Beforehand the numerical model has been validated with measurements done inside a boundary layer wind tunnel with a down sized 1/100 barn. 3 different incoming wind angles (0°, 45° and 90°) and 3 different ratios of barn's length (L) /barn's width (W) (L/W=2,3,4) have been considered.

The results of this simplified model show that, while the barn's overall air exchange rate is independent of the length to width ratio, the number of animal occupied zones inside the barn requiring the support of mechanical ventilation is not. The latter depends strongly on the incident wind angle. For increasing length to width ratio the variation tend to decrease, particularly under cross flow conditions.

A model extension towards a full-scale building with surroundings and including the effects of animals as obstacles and heat sources is on-going in order to further increase the accuracy of the predicted local air exchange rates.

Effect of extruded plantain peel based fish feed diet on growth performance and nutrient utilization of catfish (clarias gariepinus)

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The increasing cost of fish feed production has led to the need to search for alternative and non-conventional raw materials, including waste. Indiscriminate discarding of plantain peel has led to environmental challenges. A possible way to manage this waste could be to produce fish feed through extrusion cooking. Plantain peel flour produced by drying and grinding fresh peel obtained from a processing plant and was used to replace wheat bran at different levels (0, 5, 10, 15 and 20%) to produce a formulated balanced diet fish feed. The extruded feed was used daily at 5% body weight for eight weeks for the feeding trial. Growth Performance Parameters: Initial Weight (IW), Final Weight (FW), Daily Weight Gain (DWG), Weekly Weight Gain (WWG) and Specific Growth Rate (SGR): and Nutrient Use Indices: Total Feed Intake (TFI) and Feed Conversion Ratio (FCR) were assessed. Data were analyzed using ANOVA at $\alpha 0.05$, for the sensitivity analysis. Feed intake was highest at 15% plantain inclusion, while control had the highest feed conversion rate. The formulated fish feed with 15% plantain peel showed the highest weight gain. For the growth parameters, a significant variation of $p < 0.05$ was observed. Only fish fed with control and 20% ingestion of plantain peel had the highest mortality. It can be concluded that plantain peel could be used to formulate extruded fish feed to reduce production costs.

Enhanced visual odometry algorithm for unmanned vehicles in protected crops

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Precision agriculture is empowering farmers to increase crops yield quality and quantity, by optimising management practices exploiting information about soil and crops condition. In precision agriculture, development of new solutions, designed at making processes more robust and economically bearable, is demanded. In several scenarios, such as huge or hilly fields, unmanned ground vehicles (UGVs) play an important role in automatic and extensive crop monitoring and, even, to perform treatments in an autonomous way, increasing farming efficiency. An UGV requires its up-to-date position and orientation information to autonomously perform in-field operations. This task can be performed by odometry systems, such as wheel odometry, GPS sensor or visual odometry. However, motion estimation based on wheel odometry can be affected by errors in case of slippage whereas GPS based odometry, even being able to provide an absolute position, shows limitations when very-high precision is required or where the

satellite signal is weak, such as in hilly areas or inside metallic structures (greenhouses and walk-in tunnels). Visual Odometry (VO), providing position and orientation of a machine by using information extracted from a set of subsequently acquired images, is not influenced by such problems and its integration in enhanced UGV navigation system is advantageous. The main contribution of the presented work is the development of an economical monocular VO system, able to adopt a simplified and less complex hardware, specifically tuned for localisation and navigation of an UGV on agricultural terrains. In the implemented VO system, an enhanced image processing algorithm has been developed, based on the normalised cross-correlation methodology. Being able to perform sub-pixel analysis, the proposed method achieves highly accurate motion estimation results by exploiting low-resolution images (320x240 pixels), concurrently obtaining a short processing time. The VO system capability and efficiency, in terms of odometry accuracy and processing time, was evaluated by an extensive in-field experimental campaign on several agricultural terrains. For this purpose, more than 16,000 grey scale images were acquired using a low-cost web-camera with a downward looking setup. The camera field of view was shielded with a rigid cover, equipped with LED lighting system, to guarantee uniform light avoiding shadows.

The accuracy of the proposed algorithm, in terms of UGV translation and rotation assessment, was evaluated considering all the couples of consecutive images and, in addition, considering the cumulative error on longer paths. Considering translation assessment, an average Circular Error Probable of 0.16 mm for was obtained, with an increment of 54% with respect to the standard method. In rotation assessment, an even higher improvement (67%) was obtained, with an average error lower than 0.26 degrees. Finally, considering in-field test paths, the overall cumulative error normalised per travelled distance was 60% lower with respect to the standard method, both for translation and orientation assessment. The obtained results demonstrate that the proposed VO system is able to achieve high performances from low spatial resolution images, allowing to exploit low cost hardware and reducing the computing load. The system results, thus, compatible with the real time control of UGVs in agricultural scenarios.

Further development and assessment of an extraction system for small-scale timber harvesting in South Africa

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Small-scale timber growers in South Africa are generally less productive than commercial companies mainly due to the lack of capital available for investment in new and expensive harvesting equipment. These small growers require low-cost equipment that improves the productivity of the harvesting process to make them more competitive in the market. In 2015, the Institute for Commercial Forestry Research proposed the idea to design, construct, test and evaluate a timber extraction system for use by small-scale timber growers on steep slopes. The proposed device was to be designed such that the unit could haul timber on slopes of between 15 and 40 %, is a stand-alone unit that can be loaded onto the bin of a standard pickup truck, must be light enough such that it can be loaded/offloaded and moved by the team that operates it, and can haul in excess of 5 t.day-1. Two teams of two final year students from the University of KwaZulu-Natal (UKZN) attempted to design a machine to meet these specifications in 2015 and 2016. Both attempts were unsuccessful and thus the design, construction and assessment of the

performance of a timber winch was the focus of this study. The final design of the unit proved to be successful, hauling an average of 11.6 t.day-1, which is more than double the design objective of 5 t.day-1. The unit satisfied all the design objectives, and three units have been constructed for use by small-scale timber growers in rural KZN.

Intelligent sensing of crop growth status for greenhouse production

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To meet the increasing demands of high quality and safe agricultural products, it is important to precisely and effectively manage the crop production. This work aimed to develop an intelligent crop growth status sensing system for greenhouse precision cultivation based on spectral imaging and environmental sensing. A ground-based spectral imaging system with plant-oriented sensing algorithm was developed. To obtain the necessary spectral information of seedling growth status in greenhouse, a serial image processing procedures, including spatial calibration, gray-level calibration, image segmentation and image stitching were conducted. In addition, in order to overcome the variation of lighting conditions in the greenhouse, an automatic exposure algorithm for camera shutter and gain control were accomplished to save operation time and to increase system efficiency and stability as well. A mobile environmental sensing system, including temperature, relative humidity and light intensity, was also developed to measure and analyze the spatial distribution of environmental factors in the greenhouse. In this study, vegetables including leafy vegetable (Fengjing Pakchoi) and cabbage seedlings were used as samples. Vegetable samples were cultivated under water stress treatments in a phytotron. Modified Partial Least Squares Regression was adopted to analyze the relation between spectral imaging and leaf water potential, and the correlation coefficients were above 0.8. Irrigation policies based on PLAI (Projected Leaf Area Index), NDVI (Normalized Difference Vegetation Index), water stress of vegetables and greenhouse environmental conditions were established to provide a basis for precision irrigation operations in the greenhouse. The intelligent sensing of crop growth status was conducted on an integrated platform of IoT (Internet of Things), GIS (Geographic Information System) and LPS (Local Positioning System) to provide a non-destructive sensing of crop's growth and to develop a strategy of precision cultivation for variable-rate technology and operations in the greenhouse. The results of this research may provide a basis for the future development of a precision irrigation agri-robotic system in greenhouses.

Modelling labour time requirements of two dock control procedures in organic farming: manual digging and hot-water control

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Broad-leaved dock (Rumex obtusifolius L.) is a widespread and very robust weed in European grassland. In organic farming, the standard method to control the plant is to dig out the whole plant with its regenerative taproot. As an alternative, Agroscope developed a control procedure, which uses hot water to heat up and thereby kill the taproot.

Two field trials were performed to acquire basic labour time data of the new hot-water procedure. Labour time data of manual digging were already collated in former projects. The modelling was performed with the tool PROOF (Agroscope, Switzerland) based on the work element method (REFA Verband für Arbeitsstudien und Betriebsorganisation e.V., 1997).

Results show, that the hot-water procedure has 24% lower labour time requirements than manual digging, if weed infestation is higher than 2000 plants/ha. Different field sizes are not affecting labour time requirements of the two treatments. Furthermore, performance (plants/h) is higher with the hot-water procedure, which leads to even lower costs under Swiss conditions.

Manure happens: An investigation of emission abatement opportunities

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Manure management is a major contributor to emissions from livestock production, particularly greenhouse gas (GHG) and ammonia (NH3). The harmful effects of these are gases are well documented, with their accumulation leading to adverse effects such as climate change and air pollution. Given the share of emissions from manure management, a reduction in emissions can boost our transition towards a sustainable livestock production system.

Manure management consists of a number of connected stages such as animal feeding, animal housing, manure treatment, manure storage, livestock grazing, and manure application. Numerous studies have identified and discussed potential abetment strategies to reduce emissions from manure management. However, a lack of clarity still exists in estimates of emission reductions and in the design of emission abatement strategies. This paper highlights two studies where different techniques were used to (1) reduce variability in emission reduction estimates and (2) aid the design of emission abatement strategies.

A variety of individual abatement options exist to reduce emissions from manure management. A very effective emission abatement technique among them is the reduction of dietary crude protein (CP) in animal diets. However, an array of factors influence emission reductions from reduced CP in animal diets. Estimates from published studies, indicate a variability in the range of 0 to 32%. Understanding the influence of these factors can help increase the efficacy, improve the applicability, and identify caveats associated with using reduced CP as an NH3 abatement option. In our study, we used a meta-analysis of published studies accounting for the above-mentioned factors to analyze its implications on using reduced CP as an NH3 abatement option. Our results showed a pronounced effect of CP reduction for cattle as compared to pigs with a decrease in NH3 emissions of 17 ± 6% and 11 ± 6% CP per unit reduction in CP. The study also showed that factors such as species type, manure management stage, and physiology of animals did not have a statistically significant influence on NH3 emission reductions.

While analysis of individual emission abatement options focusing on a single stage and gas are important, there is also a need for analyses that collectively account for multiple pollutants over the entire manure management chain. In the second study we adopted a whole chain approach to tackle these issues. Our analysis revealed significant interactions between abatement options and emissions at various stages of the manure management chain. In addition, the results also showed significant emission leakages along the manure management chain when the scope is limited to single-stage emission abatement strategies. The results and ensuing discussion highlight advantages of certain abatement options over others, especially those that alter manure characteristics, thus limiting emissions in downstream stages along the manure management chain. Furthermore, various techniques such as proper clustering of abatement options and analysis of influencing factors that can reduce uncertainty in emission reduction estimates are also reported.

The insights presented are important in shaping the future of livestock production in a sustainable manner.

Agro-ecological efficiency of precision fertilizer application systems in the North-West of the Russian federation

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The high spatial soil variability is the natural feature of soil covering in the North-West region of the Russian Federation. This heterogeneity requires site-specific management at the field scale. The main objective of the presented research is to examine the effectiveness of precision fertilizer application by reference of specific features of the agromicrolandscape conditions. The field site is a 22-ha field located in Leningrad region. The soil was typical and gleyic sod-podzolic. The most important characteristic for the present research is the high spatial variability of soil properties. The introduced crop rotation was: potato – spring barley – perennial grasses of the first and second harvest year – winter wheat. Research factors were (1) fertilizer systems (control (no fertilization); CvF - conventional fertilizing system: mineral fertilizers added annually according to conventional agriculture practice; PrF I - mineral fertilizers added annually according to soil properties; PrF II - in 2008 only potassium fertilizers were applied precisely to reduce spatial variability of potassium content. During the following years, the after-effect was observed

and mineral fertilizers were applied uniformly; PrF III – mineral fertilizers added annually according to yield map data; (2) agromicrolandscapes (accumulative-eluvial, accumulative, eluvial and transite-accumulative). The average data of the five-year investigation show that the highest productivity without fertilization was gained in the accumulative agromicrolandscape, and the lowest – in the eluvial agromicrolandscape. The highest yield of all investigated crops was harvested when potassium fertilizers had been applied precisely. In other cases, the yields were almost equal in conventional and precision fertilization.

Mapping chardonnay vineyard yield by GPS application

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Precision Agriculture (PA) with its means and technologies is applied today to approximately 1% of the cultivated land in Italy. The objective of the Italian Government is to reach 10% by 2021, with the development of more responsive to national agricultural production applications. The wine industry sees the greatest and advanced development of PA. This is essentially due to some strong factors of our research system and to the technical and cultural vitality of the sector, but especially to the PA innovative technologies that can offer solutions in line with the current demands of the wine industry. In viticulture, in fact, the maximization of income is especially done by increasing the value of the product, or its quality. To date PA application had the objective of creating vigor maps useful for harvest and provide the ability to perform targeted farming operations, both in space and in time. The objective of this study was to realize a thematic yield map by the application of sensors installed on the harvesting machine in order to record the mass of harvested grapes in the unit of time and surface. A GPS Stonex S5 with Bluetooth and Wi-Fi connections was used for georeferencing and an X5 weighing system by VEI Company equipped with wireless connection. The tests were carried out in September 2018, in a vineyard plot 7.7 hectares wide belonging to Tenuta Rapitalà Company, Camporeale, Italy. The study allowed to obtain an interesting thematic yield map of the plot with a productive variability from 1.9 kg to 3.9 kg per plant. This will allow a heterogeneity vineyard management differentiating the cultivation techniques (fertilization, plant protection treatments, stripping, etc.) with reduced management costs and environmental impact.

Influence of grape pressing conditions on white wines quality

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Grapes pressing is a very important step in winemaking as it promotes the presence and/or absence of enzymatic processes on the must, leading to the creation of different products in terms of chemical composition, especially in white wines. The pneumatic presses commonly used work with a discontinuous cycle, lasting about 3 hours for the extraction of the juice from grapes. During this period, the presence of oxygen in contact with grapes can strongly modify the qualitative characteristics of the future wine. The aim of the study was to test the application of a new pressing system that processes the grapes under inert atmosphere allowing the must extraction in controlled conditions, the non-oxidation of the product and a re-use of the gaseous component (nitrogen). Two operating modes were applied: AP (Air Pressing) mode, the traditional pressing mode in presence of oxygen, and NP (Nitrogen Pressing). Chemical composition of musts and wines was analyzed determining alcohol [%/vol], density [g/l], sugar [g/l], pH, total acidity [g/l], volatile acidity [g/l], malic acid [g/l], citric acid [g/l], tartaric acid [g/l], potassium [g/l], glycerin [g/l], ashes [g/l], absorbance at 420, 520 and 620 nm, polyphenols [mg/l], catechins [mg/l], free sulfur dioxide [mg/l], total sulfur dioxide [mg/l]. The use of the pneumatic press under inert atmosphere allowed to obtain excellent values of volatile acidity, absorbance at 420 nm, catechins in Catarratto white wines and a rich aromatic component both in primary and secondary aromas.

Machine learning algorithms comparison for image classification on anthracnose infected walnut tree canopies

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Anthracnose is a fungal disease that infects a large number of trees worldwide, damages intensively the canopy and spreads with ease to neighboring trees, resulting in potential destruction of whole crops. Even though it can be treated relatively easy, mainly with good sanitation, proper pruning or the spraying of copper, the main issue is the early detection for the prevention of spreading. Precision agriculture paired with machine learning (ML) algorithms, can offer the tools for the automatic collection of images, and their on-site classification. Purpose of this study is to compare the most famous ML algorithms for classification, in order to investigate the applicability and effectiveness of an image-based classifier on anthracnose infected canopies. Various machine learning algorithms were employed, tested, evaluated

and compared based on their abilities and limitations. The comparison is conducted based on several performance metrics and finally, the applicability of the best performing architecture is discussed for real-life applications.

Spatial optimization for orchards in complex field areas

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The establishment is a cornerstone work for orchards and paradoxically is mainly based on empirical and traditional knowledge. This results to low or no improvement at all over the years and even less likelihood to adopt and harness the power of the new technological breakthroughs. The proposed system takes advantage of the abundant computational power to recognise and adapt planting patterns to complex field shapes. Enhancements include among others the integration of new spatial work requirements stemming from the emergent agri-robotics machinery field that can be input data for the design process. Also, the ability to dry-run different planting patterns to fully optimise surface coverage. Furthermore, the work includes modules that quantify and integrate micro-climatic factors, optimising in a non-uniform method the planting pattern. This feature is ground-breaking especially in cultivations that require pollinators, where standard practice was to set a percentile of pollinators, severely affecting productivity. In the work presented the algorithm is shown to be able to reduce the number of pollinators without decreasing their effectiveness, using grid deformation techniques, clustering algorithms with modified criteria imposed by the needs of the agronomic system. Results show significantly increased productivity potential attributed both to the reduced number of pollinators required and the increased spatial efficacy. Additionally, the fully digitised operation offers enhanced postprocessing capabilities to the farm manager as well as a digitised ground truthing tool.

Sustainability

Natural buffer effect on bio-hydrogen production using hot compressed water pretreatment

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Hydrogen is ideal energy carrier with no emission but water on its combustible. Hydrogen production using biological method is greener than other method utilized fossil fuel. One of major factors affected on operation of biohydrogen production is pH level in bioreactor. Restrain declining pH expected to increase hydrogen production. Pretreatment is one key factor on successful biohydrogen fermentation using mixed microbes. Objective of this study is to investigate natural buffer effect on biohydrogen using hot compressed water pretreatment. This batch fermentation experiment operates in 110mL working volume of glass reactor with 3.75g/L glucose as carbon source. Mixed culture obtained from cow dung compost treated with hot compressed water pretreatment 150oC, 0.5 MPa for 40 minutes. As buffer agent, fine dried eggshell powder and calcinated eggshell added with 1g/L, 3g/L and 5g/L concentrations. The result showed that addition 1g/L eggshell obtain highest hydrogen production rate 0.85 mol-H2/mol-glucose. Indicator of hydrogen production associated with butyric acid production. Butyric / Acetic molar ratio generally observed 1.5 with above 2.6 as efficient biohydrogen fermentation. Highest B/A ratio 4.62 shown on 3g/L addition of eggshell powder.

Cow-energy - possibilities of energy management in energy self-sufficient dairy cowsheds

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Renewable and sustainable energy production is an important resource for energy in Germany. As renewable energy production often depends on the occurring weather situation, the energy production is exposed to the volatility of these influences.
In this context, the technology of "Smart Grids" is supposed to adjust the energy consumption in relation to the occurring production. For this, it is necessary to utilize storage capacities and shifting potentials to guarantee electricity supply at any time.
In dairy farming, this flexibility can be realized by automatization and sensor based management of working processes. Furthermore, modern dairy farms produce energy from biogas- and photovoltaic plants, or wind turbines. The combination of these two aspects with energy storage units may lead to an even more flexible energy consumption in the total energy balance. Therefore, the agricultural enterprise

may play an important role in the stabilization of energy grids, as it can be both source or sink for electric power.

Aims of this research are to identify and evaluate potentials of energy storage technologies regarding the energetic flexibility in the production processes.

To do so, process models of the different automatic systems in the dairy production are created and analyzed due to the required forms of energy, e.g. compressed air, hot water, electrical energy etc., in the particular production process. Subsequently storage technologies for these energy forms are evaluated regarding the suitable energy transformation and storage capacity. Additionally, consequences for an autonomous energy- and production management system that should enable an optimized distribution of the energy to the operational processing in the dairy farm will be discussed.

Due to the particular production process, different forms of energy are required. Therefore, the applicability of different storage technologies depends of the required energy forms. Manly used in the production processes are electricity, compressed air, hot water and ice water. The transformability of the stored energy has to be considered from this perspective. In this regard, the advantage of energy storage in form of electrical energy plays an important role, as these storage units can be used bidirectional. Other storage technologies like pressure reservoirs or hot water tanks hardly can be used in a bidirectional way. Therefore, use of these storage technologies is reasonable, if no further transformation into other forms of energy is necessary.

Another important aspect is the storage period, especially in case of intermediate- and long-term storage. In this context, the storage of biogas should be considered. Which might additionally lead to better greenhouse gas balance.

However, to handle these flexible energy systems is very complex. Therefore, future developments will lead to an integrated on-farm energy management system to control and optimise the energy production, distribution and consumption in the total system. In this context, the approach of artificial intelligence in combination with this cyber physical system should be evaluated.

Sustainability of biogas production with small sized plant in South America

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The environmental impacts of biogas systems are dependent on technical concepts and conditions of use. During a process chain, energy is consumed and greenhouse gases (GHGs) are emitted. Life cycle assessment (LCA) of biogas production is influenced by different factors, such as supplement of substrate, biogas production and biogas and digestate utilization pathways. The goals of the study were to assess environmental impacts of biogas production in small-scalle in South America like Columbia.

In order to calculate specific GHG emissions of biogas production, the standardized method-ology of life cycle assessment (LCA) was followed, using the GaBi® 6.0 tool (thinkstep AG, Germany) with Ecoinvent Data base, the ISO 14040 is used as standard for the LCA. The chosen substrates for the biogas production in small-scale in Columbia represent common waste products of Latin American rural house-holds. Most Colombian farmers own cows, therefore choosing cow manure as a basic substrate is a logic consequence. This substrate can either be directly taken out of the stable, if there is one, or must be collected from the pasture land and then be mixed with water to obtain a homogenous matter to feed the biogas digester.

Where people cook, waste is produced, here we are taking a look at average medium-fat kitchen waste as an input option for the fermenter. A more specific waste product from daily cooking is potato peel, since the potato counts as a staple food not only in Columbia but in many South American countries. The co-substrate for the third scenario is the maize plant after the cob is harvested.

The results show the effect of different scenarios (kinds of substrate, technical concepts) on the global warming (GW) which lead to clear recommendations to improve the management option by the biogas plant in Columbia.

Variation in plant nutrient and organic matter concentrations in compost products made with and without animal manure

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Compost is a valuable soil amendment that contains organic matter, major plant nutrients (N, P, K), and important minor plant nutrients that are essential for the production of many crops. Furthermore, production of compost using animal manure mixed with plant waste has become a well-recognized method of aerobic treatment that reduces odor, kills pathogens, and yields a stable soil amendment that meets the requirements for organic production of fruits and vegetables in the USA and other countries. While the benefits of using compost are widely known very little information is available concerning the nutrient and organic matter composition of compost products based on the primary substrates used to produce the amendment. Nine compost products were obtained for the purpose of measuring the concentrations of N, P, K, Ca, Mg, S, Zn, Cu, Mn, Na, total C, organic matter, and moisture. Samples were also collected to determine the bulk density and the electrical conductivity. The composts analyzed included products made from waste plant material only, cow manure, chicken manure, mechanically separated swine solids, and mushroom compost. The carbon sources used were yard trimmings, wood waste, and cotton gin waste. Statistical analyses indicated that the concentrations of plant nutrients and organic matter of the compost products were significantly different depending on whether or not animal manure was included in the mix, and the type of manure used. The N contents ranged from 0.71% to 3.49% on a dry basis. In all cases, the majority of the N was in an organic form (87.4% to 100%). The compost products with the highest N concentrations (2.30% db and 3.49% db) were produced using separated swine solids obtained from a solid-liquid separator. The concentrations of P2O5 ranged from 0.12% to 5.55% db, and K2O ranged from 0.22% to 2.15% db Key secondary nutrients (Ca, Mg, S) were present in higher amounts than expected. Calcium concentrations were the highest (0.77% to 4.35% d.b) followed by Mg (0.09% to 1.50% db), and S (0.06% to 0.92% db). The concentrations of Cu, Zn, and Mn were generally low (0.004% to 0.195% db). The organic matter content of the compost products ranged from 14% to 76% db, and the total-C contents ranged from 9.9% to 44.2% db indicating that the amount added to soil would vary greatly depending on the product used. Electrical conductivity (EC) ranged from 0.21 to 10.1 mmhos/cm. A correlation analysis indicated that K2O and Mg concentrations provided the highest correlations with EC (r = 0.937 for K2O and r = 0.913 for Mg) while correlations with Na and Ca were not significant. Therefore, EC was not a reliable indicator of high salt content. It was concluded that compost application recommendations based on a prescribed depth (cm) or mass per unit area (t/ha) are not adequate. Instead, compost application rates should to be determined based on knowledge of the

concentrations of plant nutrients and organic matter in a compost product, and the fertilization goals for the crop to be grown.

Who buys organic eggs?

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Topics: Organic farming, Open Topics
Keywords: Organic Eggs, Consumers of Organic Products, South Carolina

The present research utilized data obtained from an online survey distributed to South Carolina residents. The objective of the study is twofold. First, examine whether there are statistically significant differences for selected characteristics between organic and non-organic egg shoppers. Second, a logit model was estimated to analyze the effect of selected characteristics on the probability of buying organic eggs. The characteristics examined included: demographics, and lifestyle preferences.

The final data set included 512 shoppers. The survey instrument was pretested with focus groups that included consumers, industry experts and university professors. The survey instrument included screening questions to ensure that the survey participants are South Carolina residents, and the primary decision makers in the household. South Carolina was selected as the focus area due to the importance of the poultry and egg industry in the state. Specifically, according to the South Carolina Poultry Federation, the poultry industry represents 80% of animal agriculture. Moreover, in terms of cash receipts, eggs are ranked as number 4 in the state.

Test of means between organic shoppers and non-shoppers indicated that the former are younger, more educated, have children in the household and more often shop at specialty stores, compared to the latter group. On the other hand, income, and gender were not different between the two groups.

Preliminary results from the logit estimation indicate that if a survey respondent shops from a specialty store then he/she is approximately 40 percentage points more likely to purchase organic eggs. Similarly, respondents who indicated that they always need to know the nutrients the food product contains are 22 percentage points more likely to purchase organic eggs. Regarding the demographic characteristics Caucasian consumers are 7 percentage points more likely to purchase organic eggs. On the other hand, as a respondent's age increased he/she was 0.4 percentage points less likely to purchase organic eggs.

Ammonia volatilization and evaporation losses during irrigation of liquid animal manure

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Topics: Farm waste management, Environmental impact of agricultural production and processing
Keywords: Ammonia Loss, Land Application, Manure Management, Irrigation

Sprinkler irrigation of liquid animal manure onto crop, forage, and pasture land to recycle plant nutrients is a common practice in many regions of the United States. A portion of the total ammoniacal nitrogen (TAN = NH3-N + NH4+-N) can potentially be lost during and following land application of manure as a result of ammonia volatilization. Ammonia volatilization loss during irrigation of liquid animal manure is

an important issue due to the fact that loss of N is a loss of fertilizer value to the farmer, and a potential source of air pollution. Researchers at Clemson University obtained 32 data sets of ammonia volatilization and evaporation losses during sprinkler irrigation of lagoon supernatant. These 32 observations were pooled with 23 additional data sets that were obtained from the literature. The pooled data set included losses from traveling gun, center pivot, and impact sprinkler irrigation of untreated liquid and slurry manure, lagoon supernatant, and effluent from an oxidation ditch. The differences in total ammoniacal nitrogen concentrations between irrigated and ground collected samples were used to quantify ammonia volatilization loss. The TAN concentrations of the ground collected samples were not statistically different from TAN concentrations of the irrigated wastewater. Volatilization losses during the irrigation event were not significant at the 95% level. Manure type and level of treatment did not affect volatilization losses. It was also determined that the concentrations of TKN were not significantly influenced by irrigation. The total solids (TS) content of the ground collected samples were 2.4% greater than the irrigated material. Evaporation losses were small but significant at the 95% level. In addition, it was determined that evaporation was not a major factor in the quantification of ammonia volatilization losses during the irrigation event. A few previous studies have reported TAN losses ranging from 10% to 25% during irrigation of liquid manure. Error analysis of the techniques used in these studies indicated that the majority of the average ammonia loss predicted was due to volume collection error in the irrigate-catch technique that was used, and not evaporation and drift as they assumed. It was concluded that irrigation as an application method was not the source of ammonia loss, instead ammonia losses occurred after the manure was applied to soil or plant residues.

Sediment wattle configuration and optimization of passive polymer application for turbidity reduction in channelized runoff

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Effects of accelerated erosion resulting from such anthropogenic land disturbing activities as agriculture, timber harvesting and construction are numerous and well-documented. Without structural and non-structural best management practices (BMP), erosion can transport sediment, nutrients, and other pollutants into adjacent waterbodies. Large construction projects pose considerable risk for sediment pollution by erosional forces, which ultimately result in impairment to the surrounding aquatic environment. Turbidity from suspended clays and fine silts has gained recognition as an indicator of sediment impairment associated with surface runoff. Previous research shows the flocculent polyacrylamide (PAM) can be effective in reducing soil erosion when applied to irrigation water in agricultural settings. Water soluble anionic PAM was identified as highly effective at preventing erosion and increasing infiltration when used with furrow irrigation. Additionally, it has been shown that current sediment control best management practices commonly utilized in the United States are ineffective at controlling and reducing construction site discharges with elevated turbidity levels.

The focus of this research was to maximize turbidity reduction within channelized flow using passive polyacrylamide (PAM) applications in association with excelsior fiber sediment wattle installation. Four treatments were derived to assess various PAM application methods including; (i) a control with no PAM;

(ii) granular PAM applied in 100-g doses directly on each of five sediment wattles before five simulated runoff events; (iii) granular PAM applied in 100-g doses directly on each of five sediment wattles only once before five simulated runoff events; (iv) granular PAM held in a permeable bag applied with 500-g doses. Additionally, the effect on PAM desiccation caused by dry weather following simulated storm events was observed. Results provide evidence that PAM application can be an effective practice for turbidity reduction within channels. Sediment wattles without PAM application provided no reduction in turbidity (F-stat = 0.0588, p = 0.9975, n = 60). Passively applied PAM was greatly more effective in reducing turbidity than the evaluated permeable PAM bag. Mean turbidity, over five simulated runoff events, was 202 NTU using three sediment wattles when PAM was applied. In contrast, PAM sprinkled once before five simulated runoff events required five sediment wattles, to achieve a mean turbidity of 61 NTU. This research provides considerable evidence that highly turbid, sediment-laden channelized site runoff can be remediated using passive granular PAM application and sediment wattle installation.

Characterization of particulate matter emissions during manure application

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It is a common procedure to apply cattle, poultry and pig manures as sustainable fertilizers on agricultural land. Due to massive usage of antibiotics in animal farming, drug-resistant pathogenic bacteria are highly prevalent in feces. The spread of wind-driven particulate matter with potentially associated antibiotic-resistant bacteria by manure application may pose a threat to public health. We studied whether particulate matter is released by spreading solid organic fertilizer and how the dust-associated emissions varied depending of manure dry matter content, treatment and species origin. To this end diverse wind channel and field experiments were performed. In general, the higher the dry matter content of the substrate, the more particulate matter was emitted. The amount of released dust particles was similar for pig and chicken manure. Furthermore, the fertilizer treatment significantly influenced the particulate matter emissions; most were released from dried manure, followed by composted and stored one, and lowest from fresh manure. It has been observed that there is a species-dependent critical dryness stage where manure started to release particulate matter in the environment. These detailed findings allow deriving an optimal organic fertilizer treatment, by simultaneously reducing particulate matter emissions.

Assessing agricultural sustainability within a farm management information system: a review of indicators

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The use of Farm Management Information Systems (FMIS) is spreading over the last years facilitating operational management leading to increased productivity while minimizing the relevant production costs. FMISs use indicators in order to benchmark the performance of a cultivation usually in terms of its economic return and its environmental impact. However, these are mostly standalone indicators that are not combined and holistically examined towards the determination of an agricultural system's overall sustainability. It is also very important to note that the assessment of agricultural sustainability has been a continuous debate within the scientific community and still a commonly used methodology has not been established. Several methodologies and frameworks have been employed most of which use sets of indicators to assess the economic, environmental and social impacts of agricultural operations. Attempting to address the issue of sustainability benchmarking within a FMIS this paper presents a literature review of sustainability indicators that are used in agricultural sustainability studies at farm level. A total of 36 studies were thoroughly examined in order to extract the individual economic, environmental and social indicators that were employed. The indicators were categorized depending on the examined theme and a frequency analysis was conducted in order to determine the most frequently used. Ultimate goal of the review is to arrive at an easily computable and comprehensible system of indicators that could be used in a Farm Management Information System providing the stakeholders with integrated information regarding the overall sustainability performance of their cultivations

Ergonomics

Interface design of the machine for oak seed scarification

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Oak seeds are scarified before sowing in the plant nurseries. The scarification process evaluates the suitability of seed for reproduction. The appearance of the cotyledons after cutting off the apical part of the seed is the criterion for assessing the suitability of seed for sowing.

Manual scarification was replaced with mechanical scarification using a scarification machine. The machine is controlled via a touch interface.

Interface design and evaluation of its usability were made using ergonomic principles. The process of interface design and evaluation of its usability are the subject of the paper.

Ergonomics of community farming for elderly and challenged people

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Community farming with elderly and challenged people will be one of the option to develop the sustainable society because they provide many types of health and well-being benefits. However, the information regarding the appropriate design for community farming with elderly and challenged people is not clear. This research aim to evaluate the farm work performance physical and physiological factor of elderly and mental disabilities people compare with young adults. Electrocardiogram (ECG), surface electromyogram (EMG), and motion acceleration were monitored and measured continuously using multichannel telemetry systems to find their physiological characteristic and performance of farm work tasks.

19 farming tasks were varied in intensity level and were performed by older (n=7) and young (n=14) adults to find elderly people capabilities related to farm work task and ergonomic issued for farming. The results showed heart rate, muscle activities and motion acceleration increased while performing low-moderate intensity of farm work tasks. Mean amplitude deviation of motion acceleration at trunk body has significantly correlated with increase ratio of heart rate for both elderly (p<0.05) and young adult (p<0.01). However, the elderly people experienced workload capacity reduction significantly compare with young adult in all of farming tasks.

The comparisons between adults with (case group) and without (control group) mental disabilities were also done for farm work tasks. Compared with the control group, the case group had a significantly lower increase in the ratio of the heart rate (IRHR) (5.5%) during low-intensity work (filling pots with soil), but a significantly higher IRHR (16.7%) during high-intensity work (turning over soil). The case group experienced significantly higher levels of fatigue during high-intensity work (digging) than during the rest condition. These findings indicate that appropriate workload allocation, according to health, is necessary

in the community garden setting because reducing the intensity of work assignments for people with mental disabilities will reduce their physical stress.

In addition, on-body personal assist suits (PASs) affect heart rate, muscles, trunk movement, and user acceptance during farm work tasks. 8 males and 6 females' subjects performing 3-min digging tasks were evaluated. For a typical agricultural forward-bending task, such as digging, PAS can significantly reduce strain ($p < 0.05$) on lower back muscles (L3) both of males and female.

These findings indicate that appropriate workload allocation is necessary in the community farming design, because reducing the intensity of work assignments for people.

Requirements for automatic feeding systems in southern German dairy farms

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Agricultural dairy farming is characterized by two major working areas, milking and feeding. After the milking robot has led to a significant change in the area of milking in southern German dairy farms in recent years, a similar development is now emerging in automatic feeding systems (AFS). The aim of this study is to record the technical and specific properties that an AFS must meet in order to be accepted by the majority of cattle farmers in southern Germany.

The survey was conducted via an online questionnaire from April to May 2018. Four questionnaire expert interviews were conducted with representatives from the research, consulting, manufacturers and farmers groups. During the two months of the investigation 112 farmers took part.

The developed questionnaire was divided into two parts. The first part dealt with the registration and classification of the participants to get an overview of currently practiced feeding procedures as well as the respective operating characteristics. The second part was devoted to various technical characteristics in addition to the preferences the participants had. Various questions were asked about the type and frequency of feeding, the distribution of feed and the acquisition costs of an AFS.

The final evaluation of the questionnaire revealed some clear preferences. It was considered by all participants to be able to use an AFS manually for example in old buildings. The most important concern of the respondents was the reliability of an AFS. In addition, the high feed quality must be ensured by the correct storage of the feed, even outside the silos. Another advantage for the participants was the combination of mixing- and feed distributor, in contrast to the stationary mixer. An autonomous locomotion of the distributor, as well as the energy supply by rechargeable batteries were preferred by the majority.

Also, some concerns of the interviewed persons could be categorized. Doubts about safety tend to take a back seat, while the technical reliability of the automatic is in the foreground. Looking back at the discussions that have been conducted for the development of the questionnaire, connections could be established. The Farmers subgroup has already expressed concerns about a possible machine failure, as well as any lack of service by the manufacturers.

It was interesting that the majority of the participants were prepared to invest a higher sum in the acquisition of an AFS, if this can then be operated more cost-effectively and effectively saves working time.

Analysis of design factors for soil disinfection machine

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Submission ID: 122
Topics: Machinery and robotics in agriculture
Keywords: Soil Disinfection, Pest Control, Agricultural Machine

There are productivity risks associated with the deterioration of soil physics and an increase in soil pathogens in the cultivation of field crops. Soil pathogens increase as cultivating same crop repeatedly and Soil with repeated cultivation occurs diseases by soil pathogens such as meloidogyne incognita. Methods to prevent this type of crop disorder include crop rotation, heat sterilization, and chemical control. In this study, we produced a disinfectant point spray test device and analyzed the design factors to develop soil disinfection machine. In order to spray disinfectants with crip watering, we composed system with pumps that inhale and release disinfectants, solenoid valves capable of spraying and stopping disinfectants, drive wheels and limit switch for detecting spraying intervals and a control unit that control valve opening duration from valves on to off for keeping the spread volume constant. The spray volume per time according to the pump flow rate (0.7, 2.2L/min) and solenoid valve opening duration (0.1 - 0.7 s) were investigated at each hose. The results show that it is required 0.6s of valve opening duration to spray about 4 mL per time at 0.7L/min. It is judged to be not suitable for drip watering because of long valve opening duration. At the flow rate of 2.2L/min, the spray volume was 3.6mL at vale opening duration of 0.1s which is the closest to the spread volume of 3 to 4mL per release. Therefore, it is concluded that the pump flow rate of 2.2L/min and the valve opening duration of 0.1s are the most appropriate for the drip watering of soil disinfectants using the solenoid valve.

Equipment development to terminate cover crops and transplant seedlings for small conservation systems

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Submission ID: 143
Topics: Machinery and robotics in agriculture, Sustainable small-scale agricultural production
Keywords: Conservation system, cover crop, roller/crimper, no-till transplanter, walk-behind tractor

Increased vegetable production on small farms is related to consumer demand for fresh and healthy locally grown fruit and vegetables. Small farms usually own walk-behind tractors with tillage attachments, however, for sustainable systems, producers need to adopt conservation practices with cover crops. The main problem with implementing conservation systems on small farms is the lack of appropriate no-till equipment for proper cover crop management and for planting the main crop directly into cover crop

residue without interference from the residue. Cereal rye is a popular cover crop that generates large biomass amounts that can reduce runoff and soil erosion, increase water holding capacity, increase soil organic carbon, and improve weed control. In the Southern US, the recommended time to plant cash crops into desiccated residue cover is typically three weeks after cover crop termination when the termination rate exceeds 90%; this minimizes competition for nutrients and water between cover and cash crops. To provide small farms with proper no-till equipment, a no-till seed drill, cover crop roller/crimper, and no-till transplanter were developed for an Italian made BCS 853 walk-behind tractor at the USDA, National Soil Dynamics Laboratory (NSDL) in Auburn, Alabama. To evaluate effectiveness of these devices and account for different soil types, a replicated field experiment was initiated in the fall of 2016 on two soils: Hiwassee sandy loam and Davidson clay. Cereal rye was planted with an experimental powered coulter seed drill in the fall of 2016 and 2017 and was terminated in the spring of 2017 and 2018 at the early milk growth stage utilizing a patented PTO driven powered roller/crimper. Tomato seedlings were transplanted into rye residue cover in the summers of 2017 and 2018 using a patented no-till transplanter for the walk-behind tractor. Compared to rye termination rates for heavier rollers/crimpers used on larger farms, the powered roller/crimper was as effective as the full-size rollers/crimpers, and in both years exceeded 96% rye termination rates 3 weeks after rolling. During two growing seasons, the powered coulter drill generated effective rye seed emergence (82%). Rye biomass production on the sandy loam was 5509 kg ha-1 in 2017 and 11203 kg ha-1 in 2018. On the clay soil, rye produced 8912 kg ha-1 in 2017 and 11431 kg ha-1 in 2018. Based on two years of data, the no-till transplanter for the walk-behind tractor performed as anticipated by planting tomato seedlings at 0.67 m spacings with more than 85% spacing accuracy. Tomato yield in 2017 was 11120 kg ha-1 on the sandy loam soil and 20343 kg ha-1 for the clay soil. In 2018, tomato yield was higher on both soil types compared to the 2017 growing season. On clay soil, the yield was 23270 kg ha-1, whereas sandy loam produced an even higher tomato yield of 33305 kg ha-1. Higher yield might be related to less insect/pathogen pressure, higher plant available water, and reduced weed pressure due to greater rye biomass production.

Learning motion parameters for a mejdool-date thinning robot

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Fruitlet thinning is an important task of Mejdool-date cultivation. Precise and scrutinized thinning is an essential stage toward attaining high quality yields. Currently, thinning is a labor-intensive process. The time required to thin a single mature tree is about 3.5 hours and more than a million hours of labor are currently required to thin all the Medjool trees in Israel. Automation of this process is essential to enable fruitlet thinning of larger plots with reduced man power. The Mejdool-date fruit cluster grows within the date crown at the top of the tree, between the palm leaves. Hence, careful inside-the-canopy operation is needed to manipulate the thinning process.

We present a motion planning and control algorithm, based on dynamic movement primitives (DMP) developed for a Mejdool-date thinning robot. DMP are a set of nonlinear equations used for encoding motion policies, based on dynamical systems which have parameters whose values can be tuned to facilitate performance of new tasks. The DMP parameters determine the precision of the generated movement and their values are influenced by the task, the robot, and the environment. DMP parameters can be divided into three categories: shape parameters (defining motion trajectory), meta parameters (determine the DMPs frame of operation, e.g., goal point), and external parameters (determine external, high level, environmental constraints that affect DMP operation, e.g., motion start time).

We propose a mapping method that is based on presenting the meta parameters as a function of the task parameters. The mapping facilitates DMP adaptation during run-time which improves movement generalization and precision, both are essential for thinning. The task parameters represent a specific fruit cluster. They are extracted from an image of the cluster based on image segmentation methods. The meta parameters define the location where the robot should reach in order to perform the thinning. This location varies between one fruit clusters to another according to the unique structure of each cluster and its fruitlet load. Since the mapping is a multi-input- multi-output learning problem, it can be modeled using a deep neural-network, in which the task parameters form the input layer and the meta parameters are the output layer.

To attain good accuracy, the neural-network requires a large dataset. As the relevant period for collecting the data is limited to a few weeks each year and entails long working epochs, establishing such a dataset is challenging. To address this challenge, a validated, stochastic model of a fruit cluster was created and visualized in 3D using python OpenGL. The fruit cluster is modeled as an assembly of geometric shapes, each shape has a unique distribution fitted to it. The model was validated by date-palm experts. Further work will examine the use of convolutional neural network for learning the meta parameters.

Instruction and teaching in vocational trainings for farmers

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Submission ID: 146
Topics: Safety and ergonomics in agriculture, Training and educational issues in agriculture and forestry
Keywords: training, OSH, vocational education

The implementation of safety-related instructions is required in many laws, regulations and professional association regulations and represents an important element of prevention in Germany within the health and safety legislation.

Instruction is an aspect of corporate leadership culture. Instruction can be done through different interaction forms:

- An employee must find his way around the company; he needs to know basic health and safety behaviors. Examples: Initial assignment of a new employee, briefing on new work procedures or work equipment.

- Presentation on information, facilitation of health and safety issues, traning of safe and sound behavior on different occasions. For example, evaluation of risk analyzes, health statistics, new working methods, development of standards, setting of rules.

- A specific cause (for example, a mistake, unwanted behaviors, an accident at work) leads to a critical reputation of precious instructions, to a rebuke, to discuss the consequences of wrong behavior or to describe correct behavior.

Agriculural trainees may sometimes receive targeted training before embarking on their first year of training in the middle of the season (such as harvesting cereals, potato harvesting). These trainings are training courses that apply principles of teaching.

So far, neither from the point of view of occupational safety nor from the perspective of vocational educaton and training, has it been examined to what extent the two terms - instruction and teaching - establishes in the respective subject areas can be related to each other. It is also unknown to what extent instruction and teaching are superimposed in vocational training. For this reason, in the research project "Measures of OSH to improve the safety and health of workers at work" (MASIG) vocational training with means of qualitative research are examined. Vocational trainings were recorded and analyzed using grounded theory.

The question was answered with which pedagogical means the instruction - as subject matter and method - finds its expression in the individual courses, which each have differences in their importance for occupational safety and health (including health protection and accident prevention).

The results of this integration of health science research on ccupational safety, health and accident protection and educational science teaching research will be presented in the context of a poster.

Work study, outputs and apple quality using integrated harvest platform conveyors

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Harvest is one of the major challenges of apple production. In recent years, Israeli apple growers have experienced increasing labor costs and decreasing availability of harvest workers. Failing to complete harvest on time has led to loss of yield and decreased quality. Aiming to reduce dependence on casual employees, the sector leaders have decided to focus on mechanical apple harvest technologies. To date, the systems have been assimilated into a small part of the Israeli orchards, since from the orchard owners' perspective, the platforms feasibility and efficiency has not been proven yet. In collaboration with apple growers from Ortal, in the north region of the country, we aimed to study the yield and quality of apple picking using harvest platforms. To this end, we performed a preliminary observation and a pilot experiment. First, a continuous observation in which all actions performed by the apple pickers were timed. The pickers were distinguished by their role: driver, picker positioned on stage, pickers positioned on the ground. One group of pickers was stationed on Frumaco© platform, and the other on N.Blosi© platform. Apples sampled from the conveyors and collecting container were tested for quality. Measurements were collected on four consecutive days during the harvest period of Golden Delicious and Starking Delicious, on September 2018. We conducted an experiment on November 2018, during the harvest of Sun-Downer apples, in which the momentary output was measured, for three different manning orders of driver, stage pickers and ground pickers (order-1: 1,2,1; order-2: 1,2,2; order-3: 1,1,3). Preliminary analysis of the results indicate that while the apple pickers station on the ground spend (on

average) 71% of their time performing actions related to picking, pickers stationed on the platform are less efficient, spending only 57% of their time on average, conducting apple picking or related actions. Respectively, the average output of the ground pickers was twice as large as the pickers on the platform. We noted that the driver of the platform spends on average 63% of his time conducting service operation that are crucial to the progression of the team and the task (i.e., driving, container replacement, and other operations), however their contribution to the productivity was indirect. We found that for non-selective picking of Sun-Downer apples, best performance was found for order-2 on the Frumaco platform, with 132 apples per minute, whereas order-3 was preferable for the N.Blosi platform, with 166 apples per minute. Finally, we found that for both platforms, the damage count was larger in the container relative to the samples taken from the main conveyor, suggesting that damage accumulates during transit to the container. Additional investigations are needed for further exploration of the parameters that may affect productivity of harvest platform teamwork (e.g., platform height, stuff number and order), and fruit quality (e.g., conveyor speed). The preliminary data collected and analyzed during these observations, allowed us to question the efficiency of existing practice, and raise awareness of potential weaknesses in present and future harvesting.

The assessment of plant protection equipment in Calabrian citrus orchards

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The present work presents the analyses of technical performances of three different sprayers used in citrus orchards in Calabria (Southern Italy). Accordingly, foliar deposition and ground losses were assessed, under field conditions. Both quantitative and qualitative analyses using respectively, the colorimetric method and image analyses of hydro-sensitive cards, were performed following simulations of plant protection product application using tartrazine yellow solution (E102). Statistically analysed data performing the Kruskal-Wallis rank sum test showed significant differences between the assessed sprayers considering foliar deposition (Kruskal-Wallis $\chi2$ = 40.327, df = 2, p = 175e-11), revealing also some critical points regarding ground losses and qualitative distribution while performing this practice using the tested sprayers.

Large-Scale point-cloud based global mapping for orchard operations

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Robotic motion in orchard fields consists of several components such as mapping, perception, navigation, and route (path-motion) planning. Route planning and navigation are highly contingent on mapping

functionality whilst the robotic vehicle operates and adapts itself into a partially known work area providing a safe and accurate routing. Traditional mapping techniques entail an unmanned ground vehicle equipped with laser scan sensors and inertial measurement units resulting to a spatial 3-dimension map, which is a comprehensive guide for the robotic vehicle. The proposed system here takes advantage of the complementary mapping operation of an unmanned aerial vehicle's ample flight height for enhancing its mapping ability. This approach can provide a ground-breaking perception solution especially in agricultural fields, where the targeted area covers extremely wide-open spaces. This combined mapping process reduces the time needed by a ground vehicle for mapping the environment by itself, while it reduces the risk of accidents and operational failures. Furthermore, the ability to implement a camera and a GPS sensor on the vehicle, enables the tree indexing resulting to a significantly more accurate ground vehicle navigation. Additionally, the trees are associated with their geolocation providing future applications with valuable information. The digital map documentation is compliant with a seamless integration with the precision agriculture framework, enhancing field mapping value.

Combined UGV and UAV perception of field areas as operational environments

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With the introduction of the Agriculture 4.0, innovative technologies from numerous scientific areas have been implemented in order to facilitate the traditional agricultural methods. In tandem with operational efficiency, robotic systems (both ground and aerial) aggregate towards a promising alternative to the traditional intra-logistic operations within the field. For the purpose of the above, an essential step has to take place. The mapping procedure constitutes a cornerstone towards a fully automated operations that take place in outdoor operational environment, fields. To cope with the abovementioned structure, various of in-door mapping algorithms used by unmanned ground vehicles had been amended. Suffice it to say, the geomorphological divergence between the indoor and the outdoor environment along with the imponderable factors (weather, constantly changing environmental conditions, large-scale areas) led to the deployment of the areal unmanned vehicles. In this paper, a combined perception mapping system is proposed. As a first step, the UAV executes a pre-planned mission to cover the area of interest and aggregates image data in order to create an ortho-mosaic. Consequently, both the operational and executional costs are reduced due to the lack of obstacles. Subsequently, the aggregated geolocated data were analyzed with the implementation of pattern recognition algorithms to extract the areas which denote non-collision navigation and create an initial map for UGV use. The major contribution of this work is the continuous map update when the areas are visited by the UGV. Hence, the UGV is dynamically aware of its operational environment.
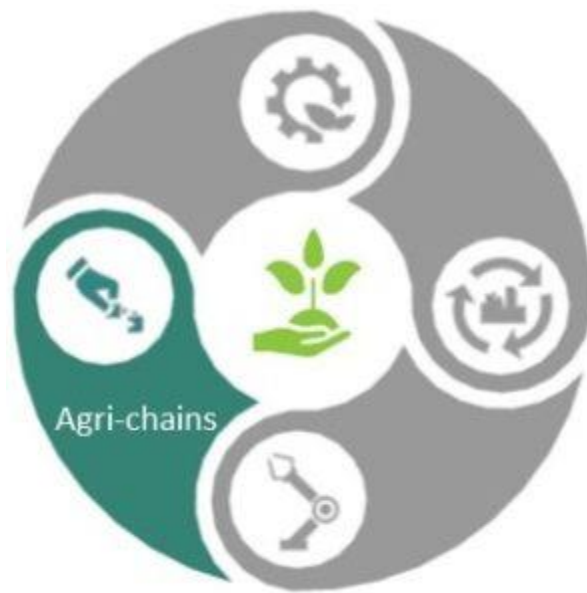
Agri-chains

Sustainable production systems of legumes in south Europe: how feasible is the substitution of imported soybeans and soy meal?

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One of the main challenges of the European Union's (EU) agricultural policy is the decrease of dependency of imported high-protein materials for livestock feed. Until now the trade deficit for Europe is substantially high, reaching 70%. The vast majority of this is covered by imports of soybeans, mainly from American countries and China. The formulation of sustainable, under economic and environmental means, production protocols of legumes could be a promising strategic approach. Based on this, a series of alternative leguminous crops are being examined to substitute soybeans and soy meal, taking into consideration the existing constraints in South European countries, like water scarcity. The species used for this research are the Pisum sativum subsp. arvense L. and the Lupinus Albus. These products are tested as part of meal for milking cows, aiming to cover their nutritional needs at a lower cost, compared with meals which include soybeans or soy meal. Additionally, the environmental impact of the inclusion of leguminous cultivations in a rotation system is evaluated, providing new findings related to major environmental indicators, like soil management and Greenhouse Gas (GHG) emissions. The successful establishment of these production protocols is important for South European countries, where there is a scarcity of water resources, providing incentives to utilize agricultural land where irrigation is not available. Similar strategic choices have taken place globally, combining competitive advantages based on the availability of natural resources and policies aiming to foster the expansion of such crops. These strategies are being presented, comparing at the same time analogous actions being illustrated under the second pillar of the EU Common Agricultural Policy (CAP). Finally, a group of recommendations, which are based on the research findings, are being presented, aiming to provide additional support to such strategic decisions for both crop productions and animal feeding activities.

Deep learning technique for classification of candied orange peel

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During food processing, reliable monitoring tasks are important to assure high-quality products. In particular, in fruit candying, they are based on physical parameters assessment (e.g. colour and texture) usually performed by time-consuming sensorial procedures. A fast and unbiased method for candied fruit classification could be thus advisable. Image analysis techniques have been proved to be profitably exploitable in food product quality assessment and the recent development of deep learning techniques

has extended their capability in automatic sorting and classification systems, allowing to classify food products in complex scenarios, interpreting a wider set of key features.

In this work, the accuracy of a convolutional neural network (CNN), properly tuned for grading and classifying lots of candied orange peel cut in dices, was investigated. Major difficulties in the implemented procedure rely on the inhomogeneities of products, within and between lots, and in the appearance of single candied dice in terms of colour and ratio between external (flavedo) and internal (albedo) parts mass. In this analysis, two different quality classes (first and second) of candied dices were considered. The algorithm, implemented in Matlab®, can be divided into three processing steps: (1) k-mean clustering method to separate the product from the background; (2) conversion of the RGB values in the Lab and HSV colour spaces and computation of indexes and histograms and, after input data normalization, the (3) CNN training phase. The defined CNN architecture consisted of an input layer, three hidden layers and, finally, a classification layer. Each hidden layer sequentially performs a 2D convolutional filtering procedure, an input channel normalization across a mini-batch (batch normalisation layer) and the activation process (features selection by rectified linear unit).

The algorithm validation was performed analysing more than 2,000 images of candied dices, randomly selected from 6 lots belonging to both the first and second choice classes. Dices were placed on a glass capsule according to a 5x4 grid, with the peel surface perpendicular to the capsule to acquire sample pictures showing both the flavedo and albedo parts of the peel. A backlighting layout was adopted in the implemented acquisition system to intensify and gather colour properties of the whole translucent matrix and a black rigid shield was developed to avoid external light interference. Pictures were acquired in a controlled environment allowing to determine the most appropriate DSLR camera parameter settings, such as sRGB colour space, 5260 K fixed white balance, f8 diaphragm aperture, 1/13 s exposure and ISO 400 sensitivity.

The defined CNN architecture was trained using 75% of the overall acquired dataset, performing five epochs (a full pass through the entire data set) and with an initial learning rate equal to 0.001. Using the excluded 25% of the images set for testing purpose, the obtained results have shown a classification accuracy of the model higher than 95%, considering single dices. The classification system results to be extremely fast, with an average classification time less than 0.7 millisecond/image and a training phase of a few minutes.

The Role of using bio-alcohol fuels in sustainable development

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The history of mankind is accompanied by a close relationship with energy sources, and the contribution of these resources is crucial for the development and well-being of human societies. Dependence on energy sources can be traced back to several millennia of history, but nowadays there are a number of issues in their use beyond energy security. For the future of humanity, it is essential to look for solutions to the problems of energy supply and the preservation of the natural environment. Despite the Paris Agreement adopted in 2016, global CO_2 emissions increased in 2017 and a new emission peak was projected by 2018. The troublesome emission values require more effective action to combat climate change. Reducing environmental risks requires an appropriate environmental policy. In this spirit, the

European Commission has accepted a package of documents aimed at promoting Circular Economy. The purpose of Circular Economy is to profoundly transform the use of resources. The current emission trend has to be reversed, in which the use of biofuels can play a major role. The problem of replacing crude oil appears unabated in experimental and research activities. Low-carbon alcohols mixed with petrol can be an effective mean of reducing greenhouse gas emissions. With the first-generation technology, ethanol can be made from plants with high sugar content (sugar cane or sugar beet) or high starch content (cereals). The most important source of ethanol production is maize in the temperate climate zone. An important question is whether environmental benefits are derived from the use of bioethanol from maize for transport. There is no clear answer to this question, and depending on the methodology used, the GHG emissions decreased or increased. One of the difficulties of the first generation of bioethanol production in Europe is ensuring predictable source of raw material. Our climate creates volatile conditions in terms of maize cultivation, with significant annual yield fluctuations. Some projections suggest that such low yields can be realized that there may be no commodity supply for the production of biofuels. Since first generation bioethanol production alone is not able to meet climate policy aims, efforts should be made to use second and third generation fuels to diversify raw materials. Biomethanol produced using renewable resources shows very favourable values in terms of reducing carbon dioxide emissions when used as motor fuel. In the production of biomethanol, non-food plants and organic wastes are used. There is a lot of organic waste produced during agricultural production, the treatment of which is much more expensive than of municipal waste. The waste that accompanies agricultural production is typically biomass which is suitable for biomethanol production. The industry, which considers waste as a raw material, provides opportunities for many countries to be sustainable and competitive. Several studies have shown that waste management based on circular economic principles is beneficial to society from environmental, social, and financial aspects as well. In order to increase the efficiency of the sector, new innovative methods and technologies are needed which treat waste as an important resource.

Current status of bio-based circular economy penetration in European national strategies

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Organic waste is the core element of most countries' bioeconomy strategies worldwide. This is triggered by the urgent need for greenhouse gas emissions minimization and the existing limited landfills capacity, but most importantly due to the fines imposed by European Union due to the low diversion factor from landfills. Moreover, minimization of food waste has been included in the UN Sustainable Development Goals (SDG 2). The proposed EU Circular Economy Package 2030 aims towards minimization of MSW landfilling which needs to be lower than 10%. In Greece, the relevant figure exceeded 81% in 2012, which shows that there are significant opportunities for improvement. In this light, the circular economy model is both a necessity and opportunity for Europe. Maximizing the value get out of products, materials and resources, and minimizing waste generation are essential to the EU's efforts to develop a sustainable,

low-carbon, and resource-efficient economy. As the circular economy is at the top of the EU agenda, the EU Member States should move away from the old-fashioned disposal of waste to more intelligent waste treatment encompassing the circular economy approach in their waste policies. This paper investigates the penetration of circular economy concept into the national strategies across Europe. This research is a part of the ongoing Interreg Europe project BIOREGIO, where bio-based circular economy is boosted through transfer of expertise about best practices, aiming at changing regional policies to support bio-based circular economy.

Logistic benefits of innovative scenarios for fresh meat distribution

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Logistic distribution optimisation can offer significant advantages such as cost reduction, shorter delivery time and improved customer service.

The objective of the paper is the comparison of different scenarios in the distribution of products through the use of a cold room vs traditional shipping to supermarkets from distribution centres. The cold room is a cold cell owned by the distribution company located outside of each hypermarket that can be used 24 hours a day and is therefore available for delivery at any time.

The comparison of the scenarios occurred for hypermarkets of a large distribution chain in the Piedmont region, NW of Italy. In the scenarios considered, fresh meat products distributed at 48 hypermarkets in the province of Turin and Cuneo were the object of study. In order to evaluate the quality of the system, a constant demand of 4 pallets per day of the product was hypothesized for each hypermarket.

The results obtained show how with the cold room transports can be optimised in terms of the number of vehicles used, kilometres travelled, number of employees involved and therefore also fuel costs compared to the traditional case. Benefits imply lower costs and longer shelf life of the product available on the shelf that is crucial for fresh meat products.

Cross-Cutting Themes

The impact of common agricultural policy provisions on sustainable farming

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This contribution analyses the likely impacts of the the CAP 2014-20 on olive farming systems in Spain. We show how the current CAP does not incentivize the adoption of sustainable olive growing systems (organic, integrated), and consequently we provide some proposals for prospective CAP reforms aiming at enhancing sustainability in addition to competiveness of olive production, taking into account EU policy and financial constraints.

The CAP impact analysis uses a Positive Mathematical Programming (PMP) model calibrated with the neutral procedure. The model compares the situation of the average olive farm in base year with its position in a simulated year considering the ending political outcome (scenario 1: all production systems are under CAP green payments) with an alternative scenario 2 where only organic and integrated systems are under CAP green payments.

Simulations were obtained using GAMS/Conopt. They show that for scenario 1 there is no variation in the area of different farming systems with respect to the base year, nor in the gross-margin-before-aids. Subsidies increase slightly due to the fact that agricultural policy does not consider the reduction for modulation included in the base year. Alternatively, in scenario 2 there are increases of integrated and organic farming areas in detriment of the conventional farming. This variation in the distribution of area on the farm is associated with a decrease of total support as consequence of the loss of decoupled aids in conventional farming. The consequence of this fact is a decrease in gross margin plus aids.

It could be argued that while the distribution rules of the green payment established in the current CAP do not support the adoption of integrated and organic farming systems, an alternative policy allowing the implementation of a green payment scheme equivalent to the implemented in annual crops, could have, in a first step, a positive effect in terms of redistribution of aids from less (conventional) to more environmentally friendly farming practices (integrated, organic), which contributes to better rewarding the public goods generated through such public aids (better environment and product quality), and boosting in the meantime the legitimacy of the CAP financial aids. In a second step, it could have a dynamic effect that our estimations cannot capture but would be an additional incentive for the adoption of integrated or organic systems.

What was designed as an alternative scenario (2) could be in the future a tool used to deliver more public goods with decreased expenditures. Its impacts would be significantly reinforced if there is a real and effective CAP sustainable shift. We think that our conclusions can be helpful for other farming systems – especially other Mediterranean permanent productions, as well as for other countries.

Smart farming and digitization of research farms – a holistic concept for science and teaching

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Since personal computers, GPS technology and ISOBUS connectivity have been adopted by farmers in the late nineties, the digitalization of agriculture is in progress. Today there is a huge span of offered digital solutions based on smart sensors and information management systems, like decision support systems, drone usage or automated milking systems. However, the quality of underlying decision and control algorithms sometimes is questionable. These developments are problematic for farmers, as they neither have the skillset to evaluate the quality of the outputs or decisions resulting from these systems, nor do they know whether market prices for these technologies are justified.

Students of agricultural science are prepared to work in scientific research, in agribusiness companies or on farms. Therefore, they need to gather deep insights in the diverse agricultural sector and develop skillsets that enable them to evaluate digital agriculture products of today and for the future. Unfortunately, many German students admonish that their study programs are too theoretical and lack insights to the important topics of digitization and Smart Farming.

The Technical University of Munich (TUM) revised their master study "agricultural system science" (language: German) to focus on the actual challenges of modern agriculture. Therefore, a digitized research farm will be created for research and teaching. This farm belongs to the TUM and comprises crop farming as well as a dairy production line. Within a specific lecture, held by the chair of agriculture systems engineering, students will learn the basic concepts of digitization in agriculture, Smart Farming and Precision Farming. They learn to distinguish the concepts and classify different use-cases. On the one hand, classic Precision Farming topics like GPS, guidance and steering systems, section control for implements and mapping approaches will be interceded. On the other hand, innovative Smart Farming technologies like Farm Management Information systems with decision support or Wireless Sensor Networks are discussed regarding hardware, software, algorithms, infrastructure and connectivity requirements. The students acquire essential skills in hardware design, programming and transmission technology. For example, a Wireless Sensor Network using LoRa-WAN Technology is implemented on the research farm as an exercise for students, to teach the process from hardware design, over Firm- and software integration to data management and -evaluation. The so installed Sensors will give information e.g. about energy flows, gaseous emissions, documentation of working hours and quality aspects for the whole farm. The students will be enabled to gather this information completely provider independent.

Next to the sensibilization of students for digitalization and programming there are benefits for research because of the huge amount of data gathered from establishing the systems on farm. The gathered data in turn, will be used as foundation for future research projects, theses and innovative teaching concepts.

Furthermore, the Digital Farm can be used to showcase farmers the opportunities, chances and risks of the use of sensor network systems and thereby accelerate knowledge transfer and technology adoption. For this, a knowledge transfer institution like a forum can be established to involve different stakeholders.

Data transmission and management for wireless sensor networks in German dairy farming environments

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In Germany, the intensity of crop farming and animal husbandry rises. However, German farms are still very small in international comparison. Many farmers produce high quality products tailored to several niche markets accompanied by documentation and traceability issues. Farm management information systems are on the rise to help farmers cope with the complexity of these very diverse production systems.

In this context, an innovative approach for dairy farming is under development, the "Integrated Dairy Farming" concept. One part of the concept is to support the farmer by providing a digital real time model of his dairy and animal production system. The data needed for this information system is combined information out of existing documentation systems, paired with data from wireless sensor networks on the farm. All the information available is pre-processed by a powerful middleware and displayed in a customized user interface (UI).

In order to run such a complex system, the failsafe and error-free transmission of sensor data must be guaranteed under adverse conditions found on farms. The information out of different existing information systems needs to be transmitted, collected, processed and merged into one central system. Therefore, data transmission in this paper shall not only resemble the transmission technology used to transfer data from point A to point B but shall also reflect on the ability of smart systems to connect to each other automatically.

The methods used are threefold. First, a literature review is carried out, to identify and compare the available transmission technologies, frequencies, standards and protocols, like for example WiFi, LoRa WAN, GSM etc. They are discussed regarding their benefits and shortcomings for agricultural use in a dairy stable environment. As a second step, expert interviews with farmers from southern Germany, that already have gathered first-hand experience from using wireless sensor networks, are carried out. Their needs, wishes and experiences are identified. In a third step, experiences from digitizing the dairy research station of TUM, where the concept of a digital real time model of a dairy farm has already been implemented, are taken into consideration as well.

As results, the Connectivity options and limitations (e.g. available frequencies) in Germany are shown. Successful data transmission starts with considerations about hardware like choosing the right sensors, gateways, cases, antennas or power supplies. Safety considerations like lightning protection and resilience against shutdowns or hacks are important. It is shown, that digitizing a dairy farm requires different network technologies for different tasks. A powerful middleware based on broker models can be a solution to bring together sensor data and information from existing information systems. Application Programming interfaces are important for building these models. It will be discussed, whether proprietary systems or open source systems are beneficial, regarding the needs of farmers. The digital model of the TUM dairy research station is shown as example for the visualization of a UI, as intuitive UIs are needed for a successful adoption of the technology by the farmers.

Temporal workload on family farms

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Shared farm management between life partners is increasingly becoming a subject of discussion in the farming sector. In addition to joint discussions and decisions on investments on the farm, more and more farm-manager couples are starting to discuss and plan day-to-day tasks on the farm and in the family in order to achieve greater flexibility in the accomplishment of work.

Precise labour economics planning data for each individual work process enable farmers to identify potentials for optimisation, thereby making the best possible use of that increasingly expensive and scarce resource – labour – as well as increasing the quality of life through conscious, fact-based decision-making processes. Is the temporal workload of each person on the family farm justifiable? Are activities divided up in a way that is satisfactory for everyone? These and further questions are posed in a vulnerability analysis conducted from a work economics perspective.

Many farm managers are familiar with the time required for different agricultural chores, or can look this up in reference works. But what about the time it takes to deal with household tasks? Knowledge on this subject can help prevent situations where individuals become overburdened.

A work budget is a useful resource for planning agricultural work. Such a planning tool is based on calculation models which link budgeted times at work-element level with the relevant influencing variables. This allows users to individually calculate the working-time requirement for the work to be accomplished on the farm in the case of work- and production processes.

The unity of living and working together is characteristic of a family farm. Until now, a reliable information base for calculating working-time requirement enabling appropriate account to be taken of household tasks in total farm planning and organisation has been lacking. Relevant influencing variables were outdated or ignored, such as e.g. the availability of automated technologies on the farm, or modern household appliances. In the present study, working-time requirement for household activities was surveyed and made available in a work budget.

The budgeted work-management hours are based on data collected by means of video-recordings on commercial farms. The videos are analyzed with a special software program according to a standardized method. The workflows are broken down into farm sectors and branches, as well as production and work processes. The LabourScope planning tool is the further development of the work budget into an online application. The result enables detailed work-economics analyses.

The example of an average Swiss family farm with 25 ha utilized agricultural land and 30 dairy cows' shows that work in animal housing (3376 MpH) accounts for around half of all annual working hours. One-third of the total time is required for household activities (2242 MpH), whilst arable- and fodder-crop production activities account for 546 MpH.

It is up to the farm-manager couple and/or the involved employees to discuss alternative divisions of labour and find the optimum solution for their individual and personal situation. Results from the work budget can provide valuable support for decision-making.

Investigating ways to develop and control a multi-purpose and low cost agricultural robotic vehicle, under scale

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During the last years we are witnessing many successful examples combining innovative and cost-effective credit card - sized computers and education. Although most of the focus is put on primary and secondary education, it is very beneficial for university students to be familiar with these systems as well. The most apparent reason for this is that similar computers will assist (and thus be present) in most parts of our everyday life. Agriculture is a sector that is rapidly changing due to the technological advances of our era, but is not always easy for students to catch up with this fast evolving process. As robotic vehicles will be present in most stages of agricultural production process, students should be familiar with them. A good way to tackle with it is to let them experiment trying to design and to implement (i.e., to construct and program) similar vehicles. The rest of the paper describes exactly the trials being made to develop an electric robotic vehicle, under scale, in a cost effective manner, using metal, wood, recyclable materials and small motors. Students experimented with bipolar stepper motors as well as with brushed DC motors and also performed a comparative study between the two types. Starting from configurations involving only one arduino uno board students shifted to scenarios with more arduinos and even raspberry pi units to better tackle with automatic control functionality (in terms of speed and direction stabilization) and remote operation issues. Options involving human – machine interaction through gestures or voice commands have been implemented as well. Most of the remote interaction scenarios have been carried out through WiFi interfaces, while some of them involved LoRa interfaces to extend the effective controlling distance of the robot. A small solar panel unit has been adapted on the top of the robot. Energy consumption for different configurations is studied. The paper also reports on the trials made to properly program the robot using both visual (e.g. Ardublock and MIT App Inventor) and textual (e.g. Arduino IDE, C, python) programming environments. Finally, the paper concludes with remarkable comments on the experiences gained during the robot development process and use case scenarios and highlights open issues and plans for future work.

Apis: App to evaluate agricultural machine use and operation cost

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The authors previously developed a web app for mobile, named AMACA. Although the APP was very easy to use, the customers observed that the developed app to calculate the agricultural machine cost (AMACA) lacked some features. Among the most requested ones, there was the use of an existent

database to compare different machines configurations, the presence of typical self-propelled machines (as cereal harvesters), and calculation of consumption for the transportation. The new version of the app, now called APIS (Application Pocket Information System) is now equipped with all these items. The end user may arrange different types of evaluations: tactical (e.g. ploughing with a different tractor or plough types), strategic (e.g. a machine change because the operation is too expensive) or dynamically evaluative (e.g. calculation of consumption based on weight to manage the transport). As AMACA, APIS is free, but it is now necessary to log in to have access to the machines database. Also, because of the login, the calculations made by the user are saved in the cloud and can be retrieved at any time and in any place by him for making further comparisons.

In this current version of the web application, made with Drupal version 7, the authors added the transport operations that are very important especially for contractors.

Soil organic carbon estimation with the use of proximal visible near infrared short wave infrared soil spectroscopy

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Soil is an important natural resource, thus monitoring soils' condition in an efficient and quantifiable way is considered of great importance for site specific management practices. However, soil properties estimation is a laborious procedure that entails great amount of cost and time. To address the need for soil information at large scale, proximal sensing applications are considered as an alternative to analytical wet chemistry. In particular, soil reflectance spectroscopy in the visible, near infrared region and short wave infrared (400-2500nm) has been evaluated with promising results. The use of proximal sensing techniques for rapid in situ applications comprise sensors mounted on tractors or at a handheld mode. Soil organic carbon (SOC) is the most widely investigated soil property due to its significance as it affects most of the processes related to soil functions and has presented good correlation with electromagnetic radiation. This article aims to provide a short review of proximal sensing techniques for SOC estimation. It was found that although results have been very promising there are still challenges to be addressed concerning factors that affect measurements i.e. soil moisture and soil roughness.