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TOPIC 2. WMSDs Work related Musculoskeletal Disorders

Quantification of Trunk Postures Among in Vegetable and Fruit Pickers in Sardinia

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Keywords: Low back injury, Agriculture, Exposure assessment

Objectives

Throughout the world, fruits and vegetables are grown and harvested through labor-intensive work tasks. The labor-intensive manual work involved with harvesting agricultural produce expose workers to high risk of sustaining musculoskeletal disorders. Row crops, grown close to the ground, are especially task intensive and involve physical tasks that have been associated with high risk of low back injury. The purpose of this study was to investigate novel methods to quantify trunk postures during manual harvesting of fruits and vegetables.

Methods

In the first phase of the study 18 vegetable and fruit pickers were recruited from a farm in Sardinia, Italy. Participants wore an accelerometer based motion logging system (ZephyrTM Bioharness) for approximately two hours while har- vesting eggplants (9 workers) and strawberries (9 workers). The posture data was processed in a custom MATLAB script. The magnitude, frequency, and time spent in several categories of trunk postures were assessed. The trunk posture categories were divided into four posture categories 1) less than 0° (hyper extension), 0° to 30° of forward flexion, 30° - 60° and greater than 60° of forward flexion.

Results

While harvesting eggplants, pickers had a mean maximum trunk posture of 82°. The eggplant pickers spent the majority of their time between 0° and 30° of trunk flexion. While harvesting strawberries, pickers had a mean maximum trunk posture of 93°. The strawberry pickers spent the majority of their time with trunk flexion postures greater than 60 degrees. The magnitude and frequency of the trunk postures were different between the two products harvested. In addition, there were significant differences in the time spent in the four posture categories (with strawberry picking involving more time spent at greater degrees of trunk flexion).

Image Analysis for Ergonomic Risk Assessment for Rope Arborists

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Keywords: Tree climbing, Ergonomics, Working postures, REBA Index, RULA Index

Objectives

The work of rope arborist involves multiple risks, as falling from above, the risk of cutting for the use of chainsaw or physical risks (noise and vibrations) that cause professional diseases.
Ergonomic risk also plays an important role. The tree climbers are involved in a work getting not vertical postures to maintain a stable position and performing repetitive movements due to the use of the saws and chainsaw.
This work aimed to assess the ergonomic risk for rope arborists on trees by means of image analysis and indices application.

Methods

The evaluations were carried out during pruning activities in fruit chestnut trees in Viterbo province and the postures of 3 operators have been analyzed from an ergonomic point of view.
To obtain this evaluation, 100 observations were examined, and image analysis was done using an Ergofellow 3.0 ergonomic analysis software applying two indices for postural analysis: REBA (Rapid Entire Body Assessment) and RULA (Rapid Upper Limb Assessment).

Results

From the data analysis, the diversity of the calculation process emerged; the two indices are not interchangeable and return a different level of risk for the same task: "medium with action required" for REBA and "further study required and rapid changes applied" for RULA.
The two indices REBA and RULA were not designed to analyze rope work.
In conclusion, a specific index for rope workers is desirable, which considers postures and work equipment. This work introduces the foundations for the development of this rope worker's risk index.

Oral presentations

TOPIC 3. Machine Milking, Animal Welfare, Sustainable livestock farming

Using of NMR Milk Metabolomics to Evaluate Mammary Gland Health Status in Dairy Cows

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Keywords: Cattle breeds, NMR, Milk metabolites

Objectives

Milk of mammal origin is an important food in the diet during infancy as well as in adulthood, and milk is often described as an almost perfect food. It contains high molecular weight compounds (lipids, proteins, carbohydrates) as important nutrients, bioactive compounds (immunoglobulins, oligosaccharides) and low molecular weight compounds (organic acids, nucleotides, micronutrients, and metabolites) with different properties. Milk metabolites may originate from multiple cell types or metabolisms. Thetechnological and nutritional properties of the milk are essential for high-quality products, and it is well known that milk quality is affected by different factors, such as lactation stage, feed, genetic background, and cow health. Somatic cell count is normally used as an indicator of mastitis. Here we proposed to use milk metabolites as indicators of mammary gland health status.

Methods

A total of 44 dairy cows of four different breeds (Holstein, Simmenthal, Simmenthal x Holstein crossbred, and Podolica) were enrolled for this study. Immediately after morning milking, milk samples (around 60 days after calving) were collected andplaced on ice for transport to the laboratory. Once in the laboratory, the milk samples were aliquoted, skimmed, and frozen at −80°C. Nuclear magnetic resonance (NMR) spectroscopy was used to determine milk metabolites. Samples were classified as "high" (≥400.000) or "low" (≤400.000) SCC content. The metabolite profiles in the twoclasses were analysed to identify differences.

Results

NMR spectra confirmed milk metabolites associated with high number of SCC, already identified in previous studies, where a high number of milk samples were analysed. GLM procedure was used to identify the statistically significant differences of metabolites content. Based on these results, the metabolites (acetate, lactose, lactate, N- acetylglucosamine) here identified could be used as biomarkers of mammary gland health status.

Precision Livestock Farming for Milk (PLF4MILK): a Look Inside the Buffalo Sub-Project

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Keywords: Precision farming, Buffalo, Heat stress, Methane emissions

Objectives

PLF4MILK is part of a wide project, AGRIDIGIT, whose aim is digitalization of crop and livestock production for a sustainable agriculture. PLF4MILK focuses on precision farming of dairy cattle and buffalo and branches out into 5 Working Packages (WPs). This paper refers to buffalo section, condensed in WP 4 (tasks 1 and 2). There are about 400K buffaloes in Italy (90% of European population) out of 204 Mil heads worldwide, mainly located in disadvantaged areas. Local or marginal spread may have induced an underestimation of its potential and a gap in technology. The aim of this WP is to increase efficiency of buffalo farms for milk supply chain through the precision farming approach. Specific objectives are the valorization of the Italian buffalo, also at international level, the development of protocols to assess and manage welfare and thermal stress and to measure individual enteric CH_4 emission on a large scale as well.

Methods

Task 1 relates to the analysis of behavior, welfare and milk production according to season, monitored by individual sensors and punctual weather station. Ear tags measuring high activity, activity, staying, eating, rumination and ear temperature coupled with a milk meters electronic system will be used. Task 2 concerns the study of enteric CH_4 emission trough individual measurements by remote controlled laser detectors. Data will be integrated each other. Multivariate approach and local and/or non-parametric regression may be used to highlight patterns of (co)variance among data from different sensors.

Results

Data will be merged and used to set up algorithms and models suitable for buffalo. A software interface, intuitive and easy to use for stakeholders' decision supporting, will be then released. In conclusion, the project addresses the needs for a greater efficiency in buffalo milk supply chain, while at the same time enhancing animal welfare and environmental sustainability.

Oral presentations

TOPIC 5. Instrumentation, Equipment, Periodic Procedures and Tests

Contribution of Inspection Methods to Monitoring Operator Comfort During Agricultural Operations

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Keywords: Comfort evaluation; Electromyography; Pressure sensors; Kinect

Objectives

In agricultural activities, the tractor driver is subjected to many stresses from physical and psychological point of view. Driving tractors, often of considerable power and large dimensions, obliges the operator to pay great attention both during the agricultural operation and when handling the vehicle. The seat and the driving position play an important role by constituting the interface between man and machine. In recent years, various investigation techniques have been used with the aim of studying the operator's comfort during the mechanized operations. The techniques most aimed at observing posture and postural commitment are reading the positions of specific body parts and their variation over time, the pressure measured between the body and the seat and the muscle electromyographs of the limbs and back.

Methods

In this study, three driving modes have been considered in the development of an agricultural practice of harrowing soil following ploughing. Ten operators were hired to carry out the agricultural practice on the same land in the three different methods: i) manual driving, ii) assisted driving and iii) automatic driving. The method of investigation of the postures assumed by the body consisted in the application of a low- cost 3D camera (Microsoft Kinect), a continuous reading tool of the posture and of the crucial nodes of the body. For the evaluation of the pressures of the operator's body on the seat, a sensorized carpet consisting of a matrix of sensors was used. Finally, portable electromyographs capable of storing data were placed in the shoulders, left arm and back of the operator for the assessment of muscle engagement.

Results

The values collected by the three acquisition methodologies, 3D camera, barometry and electromyography, underwent statistical treatments and were processed with multivariate analysis, in order to verify the contribution of each methodology in the characterization of the driving methods and in the measure the physical effort correlated.

Assessment of External Sprayer Cleaning Efficiency

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Keywords: Chemical contamination; Spray guns; Spay lance; Sprayer tank; Decontamination surfaces

Objectives

The external sprayer contamination by Plant Protection Products can generate risks for both the operators, during the filling and maintenance operation, and environment due to point source contamination. The optimization of the procedure used for the external sprayer cleaning is then essentialto minimize possible hazards thanks to an appropriate chemical decontamination. The cleaning efficiency can be affected by the type of cleaning device, the sprayer architecture and its component materials but also by the operator skills. For better understand the importance of these factors, a set of specific trials were carried out.

Methods

An "ad hoc" methodology was set up. It consists in the i) contamination of the sprayer external surface using copper oxychloride solution uniformly applied and dried in controlled laboratory conditions and then ii) proceed to the external sprayer cleaning using a fixed volume of water. The cleaning efficiency was determined measuring the amount of copper removed compared to that initially applied. All thetests were performed on a mounted vineyard air blast sprayer. At first, the effect of nozzle size ($\diameter$ 1.0, 1.2, 1.5 and 2.2 mm) and spray pressure (0.3, 1.0 and 1.5 MPa) was tested using a spray gun device. Then, three different cleaning devices (spray gun, long-range spray gun and lance), two sprayer tank materials (fiberglass Vs. polyethylene) and different operators were compared separately.

Results

Preliminary results underlined the effect of liquid pressure and nozzle size on the cleaning efficiency, due also to their indirect effect on the time available for performing the cleaning operation when a fixed volume of water is used, and also of the tank materials. On the other hand, in these specific test conditions, the type of cleaning device did not show significant differences as well as the type of operator that has perform the cleaning operation.

Oral presentations

TOPIC 6. Safety Health and Welfare in Building

Spatial Analyses to Assess the Availability of Sheep Wool as Potential Building Component

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Keywords: Sustainable buildings, Natural material, Sheep wool, Natural materials, GIS-based model

Objectives

The main objective of this work was to investigate the yearly availability of an agricultural co-product, i.e., sheep wool, suitable as eco-friendly material in building sector.

Currently, sheep wool is an agricultural special waste contaminated with impurities, with high disposal costs for breeder and often illegally disposed (e.g., buried or burned), with a strong environmental impact.

By considering the green building sector, sheep wool responds to the requirements of green building components because is an eco-friendly material, a surplus, yearly renewable, and totally recyclable. If used as an alternative to common insulation materials (e.g., fiberglass, rock wool, polyurethane foam, polystyrene), or as reinforcement fibre in bio composite materials, sheep wool offers significant benefits for sustainability such as a reduction of both cost for breeder and environmental pollution.

Methods

In this study, a GIS - based model to locate and quantify the yearly amount of livestock co-production, i.e., sheep wool, coming from dairy sheep breeding, was put forward and was applied in a study area located in Southern Italy, highly characterised by this kind of breeding.

Results

The GIS-based model provided the localization and the yearly amount of sheep wool to evaluate its availability as new eco-friendly material.

Moreover, these are basic information for the analysis of the environmental impact related to the logistics and transportation phase of sheep wool to the collection centres.

Oral presentations

TOPIC 7. Agriculture 4.0, Automation, Remote Control, Robot and Innovative Vehicle

Smart Machinery and Devices for the Reduction of Risks from Human-machine Interference

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Keywords: Smart farming, Work safety, Human-machine, Injuries prevention

Objectives

Human-machine interference and the simultaneous presence of self-propelled vehicles and workers on foot is one of the most relevant risk factors in the agricultural and forestry sector and can lead to a dramatic increase in the risk of crush and impact injuries. The emerging technological advances, which involve wireless networks, remote sensing and complex MCU-based autonomous actuation systems make many common practices harder to understand for the operator and thus increase the occurrence of the described hazards.

Methods

Authors have first performed a deep statistical research on workplace accidents which involved such hazards (INAIL national database, SPISAL AULSS9 Veneto - province of Verona), gathering a wide dataset of descriptive details like age of injured people, type of injury, work activity, and use, absence or misuse of protection devices.
In such an evolving context, remote-controlled and autonomous machines require deep safety analysis at design stage. SMARTGRID project, financed by INAIL, hence focuses on developing an integrated system in which onboard sensors and actuators can greatly enhance safety management of smart machines in complex and harsh working conditions like agriculture and forestry operations.

Results

The survey, with the goal of providing a solid scientific perspective of the state-of-art safety advances for agricultural vehicles, identifies the most prominent enhancements in smart technologies, automations, remote-control systems, remote sensing and alarm notification systems adopted on existing machines or at design stage.
SMARTGRID project also foresees to test an innovative safety system onboard of agricultural vehicles and run an experimental test program involving operations meant to check system capability to identify obstacles and to provide notifications and alarms to nearby on-foot workers and other vehicles.
Both statistical results on man-machine interference hazards and early results of the experimental test program are provided in the paper.

Remot Controls of Solar Drier Micro-plants for Process Standardisation

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Keywords: Sensors, Digital agriculture, Traceability, Food transformation

Objectives

Evaluation of the effectiveness and efficiency of the considered transformation processes; verification of the suitability of the chosen digital methodologies for the monitoring of drying processes and their standardisation.

Methods

A drying (with fan active at the top, and with number of revolutions depending on the internal temperature: named MIRO' 1), and a dehydration (with fan always active at the bottom: named MIRO' 2) micro-systems (45x45x45 cm) operating with solar energy were implemented with Arduino sensors for the detection of the main physical parameters useful for process monitoring. Parallel transformation tests on eggplant slices were carried out. The performance of two solar drier micro-plants was compared by monitoring the main involved variables, such as temperature (T), humidity (HR), time (t), weight(W), fan (F). The monitoring of transformation processes with continuous sensors required the optimization of configuration, that means design, programming and positioning of sensors.

Results

The temperature reached by the configuration MIRO' 2, with the fan programmed for a constant number of revolutions is more dependent on the external temperature, in fact, during he hottest hours of the day, it reached higher levels than the configuration MIRO' 1, in which the fan is programmed to counteract thermal excesses. The constant activity of the fan in MIRO' 2 allowed the reduction of the night UR% not contrasted by MIRO'1, in which, in those hours, the fan is inactive. The trend of weight loss (W), showed the effect of night-time humidity, highlighting an increase in the recorded weight. The recorded curves relating to temperature and humidity did not show statistically significant differences between the upper and lower areas of the dryer with active fan (MIRO' 2).

Oral presentations

TOPIC 8. Noise, Vibration, Dust, Endotoxin, Microorganism

Dynamic Characteristics of Seats Equipping Old Tractors

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Keywords: Whole body vibration, Agricultural seat, Transmissibility, Damper

Objectives

The seat is the device that minimize the vibration transmitted to the tractor driver's body by the tractor platform. Accordingly, seats are essential to reduce WBV to the drivers of agricultural (and earth- moving) machines.

All seats require homologation before their installation on the machine, in accordance with the Council Directive 78/764/EEC (Annex XIV), amended with the Delegated Regulation 1322/2014 and with the Delegated Regulation 830/2018.

In Italy there is still a large number of underused tractors (less than 200 hours per year) that are more than 30 years old. Low cost upgrades are often necessary, even though the seat is an expensive cost item. For this reason, the market offers cheaper seat models for already used agricultural machines, but many users choose to repair the seat on their own. The first worn out element of the seat is usually the damper, and unfortunately it is often replaced by a new one, only considering its dimension, not its damping properties.

Aim of the work was to perform a set of resonance tests to investigate the dynamic characteristics of old seats, using different type of dampers.

Methods

The vibration transmission of the suspension seat along the vertical direction was examined with different seat configurations and loading conditions.

Tests were conducted in laboratory with six different types of dampers and with two different static masses: 40 and 80 kg. The signal was transmitted to the hydraulic vibrating bench (where the seat was placed) and the frequency weighted accelerations were simultaneously measured on the platform and on the seat. The acceleration transmissibility was calculated and discussed, because this is the adopted method to study the seat damping properties.

Results

The results showed that the seat suspension was nonlinear, with the transmissibility mostly depending on the amount of the inertial mass. The distribution of the vibration energy was also different, in function of the rigidity of the shock absorber.

How Much are the Hand-arm Vibration and Noise Level Generated by Chainsaw Used at Small-scale Forestry?

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Keywords: Hand-arm vibrations; Noise-induced hearing loss; Health and safety; Chainsaw; Vibrations white finger

Objectives

In small-scale forest management, usually related to small agricultural-forestry farms, the forest work system is commonly semi-mechanized and it represent only a part of theannual work of the operators. Consequently, the chainsaws used by the operators are notrecent and without an accurate maintenance attention.

This work aims to investigate the current level of vibrations and noise to which operators are exposed when using chainsaws not well maintained and some years old and in some cases with poor maintenance.

Methods

Hand-arm vibrations and noise levels were collected from a series of chainsaws used by a sample of operators in Calabria (Southern Italy). A controlled test (same type of wood species, same moisture content and diameter, same operator) was thus defined and applied. The assessment of the exposure to noise and vibrations by the forest operator was carried out during the felling and fine-tuning operations concerning the use of different models of chainsaws. The measurements of the noise levels were carried out using the Delta Ohm HD2010 sound level meter, installed on the blast chiller helmet, by whichthe sound pressure levels absorbed by the ear were recorded.

The hand-arm vibrations were measured with accelerometers installed on the front and rear handles of the chainsaw. A statistical-descriptive analysis was carried out for the data collected with the data collected in a complete way for each case. The statistical approach consists of descriptive analysis and of a multi-factor analysis of variance to determine the quantitative effects of the independent variables (e.g. chainsaw type, wood species) influencing the vibration and noise level.

Results

In this study, the influence on vibration and noise during cutting activities of wood species, wood diameter and type of different chainsaws was examined. The test revealed, in general, that covariables wood species and wood diameter have a minimal influence on chainsaw vibration and noise emissions, while the "type" factor of the chainsaw has always been significant in terms of the effect on vibrations and noise. This evaluation highlights that in the use of the chainsaw for the preparation of the firewood, the type of chainsaw and its level

of maintenance and technological age can have a very significant effect on the level of hand-arm vibration and noise.

Comparison of Whole-Body-Vibration Exposure Between Quarry and Farm Activities

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Keywords: Whole Body Vibration, Quarry activities, Agricultural activities, Workers exposure, Annoyance

Objectives

The aim of this paper consists of comparing the Whole Body Vibration (WBV) exposure for the workers in two different work contexts, quarry activities and farming. In the first one special vehicles are employed, such as dumper, Load-Hump-Dump (LHD) vehicle, diggers, while in farming activities mainly the tractors are used for many different tasks.

Methods

All vehicles used during the work activities represent a danger source vibration for the drivers. The measurements of Whole Body Vibration (WBV), according to the ISO 2631 standard, were performed on many different vehicles during experimental campaigns in quarry sites and farms. Field measurements are conducted in real work conditions with the aim of characterize the real exposure of the workers. The signal of fore-and-aft and vertical accelerations was acquired on the driver's seat by a tri-axial accelerometer. The data acquisition system used permits the analysis of the signal measured in terms of acceleration values and frequencies. The acceleration spectrum measured on the vehicles was analysed in terms of band of third octave. Finally the data were compared in order to highlight the differences of the drivers' exposure by the parameter A(8).

Results

The data carried out from the measurements show a variation in WBV exposure levels between drivers that works in quarry sites and the workers of farm. The dose exposure results similar for all workers while the frequency spectrum highlights relevant differences at low frequencies.

Analysis of Mechanical Vibrations Generated by Tractors: HumanBody Absorption in Drivers with Different Body Mass Index

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Keywords: Vibrations, Tractors safety, Workers health, Vineyard workers

Objectives

The aim of this work was to evaluate the level of vibrations produced by different types of tractors - also utilised with different operating machines connected – and the magnitudeof vibrations impacting the whole human body in case of drivers with different *Body MassIndex* (Kg/m^2).

Methods

Experimental tests concerning vibrations were carried out on several tractors of differentage and size, with different connected operating machines. All the parameters of the tractors and operating machines tested were recorded (speed, tyres, type of soil, type of operation, etc.). Tests were also carried out according to the weight and height of the driver. Vibrations were measured and analysed with an instrument aimed at measuring acceleration on the three axles every second. Noise was also measured.

Results

Results show that the amount of vibrations increases with increasing speed. Vibration rateis higher in case of trailed vehicles. Vibrations during work in vineyard remained below legal requirements.
The impact of vibrations on the whole human body does not seem to depend on the driver's Body Mass Index (normal value =18.5-24.9, low value <18.5, high value >24.9).The role of different values of Body Mass Index of tractor drivers is a negligible variablewhen compared to the amount of vibrations produced by tractors.
The results showed that the amount of vibrations produced by tractors is significant especially during travel along the *inter-farm roads*. Since the inter-farm road journey is downtime, it is advisable to reduce it as much as possible, as this increases the amount of vibrations impacting the whole body.
However, our study suggested that further and exhaustive studies, both from the point of view of new tractors equipped with shock absorbers and from the point of view of the effect on drivers, should be encouraged.

Abatement Systems Efficiency: Comparison of PM Emitted by Biomass Combustion

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Keywords: PM, Emission, Biomass burning, Abatement systems

Objectives

It is known that biomass combustion is an efficient renewable energy source, but it requires the use of dedicated abatement systems to control emissions. The aim of the work is to evaluate the efficiency of the abatement systems on the reduction of PM generated from biomass combustion. The importance and the efficiency of such systems was carried out comparing the results obtained experimentally with those present in literature, in order to compare biomass boilers with other biomass disposal methods (domestic fireplaces, *open burning*, etc.).

Methods

Agroforestry residues were used in a direct combustion process in three different biomass plants. The first plant ($80kW_{th}$) was unprovided with any abatement system and for this reason it was used to simulate the *open burning* process; the second one ($35kW_{th}$) was equipped with a multi-cyclonic filter, while the last plant ($350kW_{th}$) was equipped with a multi-cyclonic filter and a bag filter. During these combustion tests the emissions of TSP (Total Suspended Particles) and the fractions of PM 10 and PM 2.5 were monitored. The TSP were sampled with a *Dado Lab isokinetic probe HP5* while the PM fractions were sampled using a multistage impactor. PM determinations were carried out by gravimetric method by weighing the quartz filters (ø 47 mm) before and after the sampling process. The emissions produced by these combustion processes were compared with literature data on emissions. The tests were conducted in the Research Area of CREA-IT in Monterotondo and the analyses were carried out at the LASER-B laboratory (Renewable Energy and Biomass Experimental Activities Laboratory).

Results

The results show how the open burning process has a significant atmospheric impact in terms of PM emitted, and so it can be considered an unacceptable practice for the atmospheric preservation. The use of abatement systems, on the other hand, allows biomass to be used in energy conversion processes by direct combustion, while protecting air quality. The use of biomass plants and related abatement systems allows to reduce the atmospheric impact and obtain an efficient senergy conversion from agroforestry waste products.

Oral presentations

TOPIC 9. Occupational Health

The Figure of the Occupational Safety Officer (RLS) in Agriculture: a Survey in Some Italian Regions

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Keywords: Skill in safety, Agricultural accidents, Risk assessment

Objectives

The RLS plays a very important role, his impact on safety in the agricultural sector has not been assessed. The aim of this work is therefore to learn more about the figure of the agricultural RLS.

Methods

The research was developed on different techniques aimed at establishing contact with the RLS and the creation and distribution of a questionnaire to understand the preparation and type of RLS consisting of 47 questions.

Results

According to the data obtained from the questionnaires, 92% of the respondents were male and 85% were of Italian nationality, with 41% having a high school diploma, 37% a middle school diploma, and 15% a university degree. As regards the finding of the information necessary for the activity of RLS, a very varied distribution was observed, with a significant proportion of subjects (16%) turning mainly to patronages and trade associations, but also RLS obtaining the specific information directly from information sheets or legislation (11%). Analysing the single groups of items in the first group, "training in occupational safety and health", we note that as many as 83% of the RLS have attended safety courses of various titles and often many more than just one, but also others such as "first aid course", "fire-fighting course", etc. In fact, most of them know the "safety procedures" (93%) and the operational figures at work (responsible for the prevention and protection service; competent MD physician; employer) with a percentage of 95%.

Oral presentations

TOPIC 11. Precision farming and traceability

Blockchain and IoT for Food Traceability

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Keywords: Blockchain, Traceability, Food, IoT, AI

Objectives

In the world of industry 4.0, farming trends moved towards a technology revolution and connectivity is the key word. Connected machines and new digital equipment enable a more cost-effective, environment-friendly and sustainable food production. Precision farming techniques, currently used to guarantee effective cultivation and breeding methods, can also be exploited in the context of the agri-food production chain, as they allow farmers to work with a high degree of precision and safety. The goal of this research is to undertakes a feasibility study on the integration of a cloud system basedon Blockchain technology in the operational system of a national supply chain.

Methods

Blockchain is the technology that can solve this counterfeiting phenomenon and satisfy the need for trust thanks to applications that ensure transparency of the production chain, product traceability and authentication.

Results

The support of Blockchain technology, AI and IoT in precision farming operations help ensure traceability within national food supply chains, especially those with the Made inItaly brand. Every year an increasing number of subjects decide to enrich themselves by exploiting the good name of the renowned Italian-made products. Italian Sounding is the term that describes the phenomenon of companies worldwide that label their products with Italian names even though they don't have any attribution to our country.

Oral presentations

TOPIC 12. Effect of landscapes on human health and welfare

Therapeutic Value of a Green Roof in a Prison. A Case Study in Central Italy

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Keywords: Therapeutic Green, Social Workers, Penitentiary, Restorativeness, Occupational Health and Safety

Objectives

This study aims at investigating the potential benefits of a "green roof" for the inmates of a Women's Correctional Institution in Rome (Italy), as well as demonstrating the rewards for the Public Administration (Ministry of Justice – Department of Prison Administration).
Though the overall benefits could be different, from easy maintenance to environmental sustainability, from low energy consumption to safety education, from training and employment opportunities for disadvantaged women to the therapeutic impact and general well-being for the inmates, this study focuses on the last two topics.
This experimentation is unprecedented and unique in Italy.

Methods

The study follows different steps:
1- Selection of a panel of inmates to administer the questionnaires to.
2- Administration of the first questionnaire concerning the individual relationship with green and the potential impact on the personal well-being.
3- Administration of the second questionnaire concerning the attitude towards safety and green maintenance.
4- Data processing and analysis.

Through the administration of the questionnaires, it will be also possible to evaluate the regenerative capacity of the green roof as well as its therapeutic impact on inmates' employment before and after the test.

Results

In this phase of the study we can foresee an improvement of the overall image and a decent economic contribution for the penitentiary.
At the same time this study could have a significant impact on complex building systems environmental choices; as an absolute novelty in the context of Italian penitentiary architecture, a green roof can develop a potential improvement of the well-being for the inmates. This experimentation works towards putting the Prison Administration, which has always been penalized by a sort of prejudicial isolation, in touch with the scientific community, by involving disadvantaged categories in potential future training processes aimed at reintegrating them into working world.

Oral presentations

TOPIC 13. Environment Safety, People Health Protection and Welfare

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CO_2 use and Energy Efficiency in Closed Plant Production System by Means of Mini-air Handling Unit

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Keywords: CO_2 use efficiency, Energy efficiency, Controlled environment agriculture, Coefficient of performance.

Objectives

The concept of resource use efficiency is strictly related to crops production in closed plant production system (CPPS). In fact, it is essential to maximize the crop yield with the minimum employment of resources. Among the main ones there are the CO_2, to replace that absorbed for photosynthetic activity, and primary energy for the conditioning of the closed environment. In this work the CO_2 level inside CEA is controlled by means of a mini-air handling unit (MAHU) with heat recovery, which renews the air to keep constant the indoor CO_2 concentration. The MAHU is installed in a local firm, and it is equipped as an IoT system and remote control. Both sensors, actuators and controller are not directly connected to the Unit but by mean of a remote unit located in the University laboratory. The overall performance of the connection was evaluated.

Methods

Tests were conducted in an experimental CPPS for the lettuce production. The air conditioned by the handling unit was supplied in the environment by a perforated duct. Three CO_2 probes allowed to measure the concentration inside the supply duct, exhaust duct, and indoor environment. In addition, a set of probes to measure both physic and energy parameter was installed on MAHU to calculate the COP of the system.

Results

The performed tests make it possible to evaluate the efficiency of the MAHU both in terms of overall connection performance and in controlling the CO_2 inside CPPS. The continuous replacement of the indoor air allows to keep almost constant its concentration, leading to an important saving in terms of CO_2 enrichment. Remarkable energy performances were also highlighted. The proposed IoT system well suites the Industry
4.0 paradigm as it allows installation/maintenance of the different parts of the whole system without any other operation on the remaining parts.

Environmental Evaluation of a Conventional Vineyard Airblast Sprayer Through a Mass-balance Approach.

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Keywords: Airborne losses; Ground losses; Canopy deposition; Environmental contamination; Chemical exposure

Objectives

The efficacy and sustainability of pesticide application largely depends on maximizing target coverage, while minimizing off-target losses. Spray canopy deposition as well as spray losses are usually measured using standardized methods that are time consuming and expensive to be extensively used. Furthermore, results obtained are strictly relatedto the weather conditions and application variables that can lead to undetected oroverestimated spray fractions. To overcome these problems an *ad hoc* method designed for the spray mass-balance measurements, were develop and applied.

Methods

Tests were conducted in a vineyard at early and late growth stages, using a conventional airblast sprayer. It was equipped with hollow cone nozzles operated at 1.2 MPa pressureto achieve the applied volume rates of 330 and 824 L ha^{-1} at early and late growthstages, respectively. A device consisting of an adjustable metal frame arch shaped was used to hold two arrays of filter cloth collectors placed at constant interval distance of
0.5 m along the whole arch. It stands in the vineyard over two adjacent rows allowing the sprayer to pass below the structure when applying the spray. Two filter clothes arrays were also placed on the ground. A solution of water and yellow dye tracer, was applied. The laboratory measurements of tracer spray deposit on the collectors enabled the assessment of the amount of spray loss fractions.

Results

Despite the sprayer adjusted to match the canopy target, huge amount of spray losses was measured. In details, the total spray losses amounted to 97 % and 63 % of the applied volume at early and late growth stage, respectively. Therefore only 3 % and 27 % of applied volume rate was deposited on vine leaves. The experimental resultspointed out the high risk of environmental contamination when pesticide are conventionally applied.

A Survey on Safety Among Tree-Climber Professional Arborists

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Keywords: Risk assessment, Urban forestry, Tree rope access, Risk perception

Objectives

Rope-based access methods (tree-climbing), are a bunch of techniques to ascend and operate on tree canopies. Tree-climbing allows a variety of targeted and selective interventions on trees. In urban forestry, climbing trees by ropes is often the only solution to maintain them. The objective of the investigation is to assess the worker's risks associated with this technique and the knowledge and awareness of safety aspects in a group of Italian professional climbing arborists.

Methods

Data was collected using a questionnaire, including 49 questions. The questionnaire was defined based on safety items raised in a focus group with professional arborists with different work experience. A draft version of the questionnaire was submitted to the same participants to the focus group plus other three workers and, then, reviewed according to answers and comments obtained. The final version of the questionnaire was spread by social media (Facebook) and by email to specialized groups of recipients.

Results

The expected results of the survey will allow to evaluate several aspects of the safety of tree-climbing activity and to identify critical areas which may benefit from targeted interventions. At present, 86 responses were collected. Answers obtained from professional operators will make it possible to analyze data collected on real working experiences. Moreover, utilizing statistical models based on mono or multivariate statistical analysis, it will be possible to shed light on the causal relationships between the different investigated aspects.

Oral presentations

TOPIC 14. ROPS and Stability Research

Can Digital Games Be Adopted as a Learning Method to Engage Farmworkers in Training Sessions? Perspectives and Possible Applications

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Keywords: Agriculture; Engagement; Gamification; Human-machine interaction; Safety training

Objectives

The Foldable Roll-over Protective Structure (FROPS), helps to prevent injuries in case of tractor rollover, whereas training programs help to increase the operator's knowledge on the risks and the correct operation behaviour. To be more effective, training interventions should be engaging and make trainees emotionally involved. A game-based training can achieve this objective. The present study aimed to show what is available in the literature concerning safety game-based training and which elements can be used to proceed with the "Safety! Is a serious game" project, which is based on the development of an engaging and usable safety training game platform, to enhance the correct FROPS handling.

Methods

A literature review on game-based safety training allowed to identify: the available technologies, the most used game mechanics and the addressed topics, considering the relationship between the worker and the components of the working system as defined by the SHELL-model (software-hardware-environment-liveware). Areas of gamified interventions in safety training in agriculture are proposed and the project introduced. The project is ongoing and it includes: participatory development of the tool settings; development of visual guidelines which could be also integrated into tractor's user manuals; and game usability testing.

Results

Previous interventions focused on eight macro-topics regarding the interaction with machinery/equipment, work procedures, environment and other workers, that can be encountered also during farm working. Regarding the available technologies, the computer-game was detected as the most adopted, followed by virtual and augmented reality. Although different game mechanics exist, "points", "levels", "challenges" and "discovery" were preferred. Moreover, to be effective and satisfying the game should recreate the decision making processes that operators encounter in hazardous situations. Proceeding with the project and participatory

approach, the game mechanics, degrees of complexity and goals leading to greater player's engagement, satisfaction and knowledgewill be identified and evaluated with the users.

Design, Manufacturing and Strength Test of a 4-post ROPS Fitted on a Very Low-profile Tractor (TRACLAS Project)

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Keywords: Working safety; Tractor overturning; Protective structure; Vineyards and orchards

Objectives

The main cause of accidents in agriculture concerns the tractor loss of control and the consequent overturning. In order to improve the safety level when tractors work on slope under canopy, INAIL (the Italian National Insurance Institute for Occupational Accidents on Labour) funded a research project, named TRACLAS, finalized to develop a prototype of low-profile tractor, not exceeding 1.60 m in overall height, equipped with a fixed ROPS (RollOver Protective Structure).To compare its performance with those of some comparable tractor models already on the market, used in the vineyards, orchards and greenhouses, the prototype was verified by carrying out some field and lab tests. A fundamental step of the project was the strength test of the customized 4-post frame (the ROPS) carried out in compliance with the OECD Code 4. The main features concerning the design, the manufacturing and the validation test of the ROPS are reported in this paper.

Methods

The low-profile compact tractor prototype was obtained starting from a Goldoni 4100 commercial model. The original 2-pillars front mounted foldable rollbar was replacedwith the new customized 4-post frame, complying with the clearance zone requirements provided by OECD Code 4.

Results

The ROPS was tested successfully, being able to fully reach the desired requirement during and after all loads, i.e. the protection of the clearance zone, located with reference to the tractor driving place (operator's seat and steering-wheel).

Thanks to its very robust manufacturing, the stress-strain deformation of the tested frame was very low; this behaviour validated a very important feature, i.e. the possibility of protecting a suitable survival volume around the driving place, despite the very low and compact profile of the tractor.

As an added value, the 4-post frame can be eligible for official OECD homologation.

Oral presentations

TOPIC 15. SHWA & Augmented reality, Gamification, IoT

Smart Glasses' Acceptance by Agricultural Stakeholders using the Technology Acceptance Model (TAM)

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Keywords: TAM, Agriculture, Augmented reality, Behavioural intention

Objectives

The rapid growth and development of Augmented Reality technologies and smart glasses for augmented reality will bring to a widespread diffusion of these digitaldevices in many fields of work such as medicine, engineering and education. Recent studies highlighted that augmented reality could be a useful technology supporting farmers in agricultural activities. This study examines the acceptance level of agricultural stakeholders to use smart glasses for augmented reality in their activities.

Methods

In order to bridge the gap between agricultural-related workers and augmented reality devices the factors related to the acceptance of smart glasses were investigated and evaluated through the Technology Acceptance Model (TAM). The TAM was used considering its prime construct which includes perceived ease of use (PEU), perceived usefulness (PU), attitude to use (AU) and intention to use (IU). The questionnaires were submitted to agricultural stakeholders that had previous knowledge and expertise on augmented reality and smart glasses applied to the agricultural sector.

Results

The results obtained by the survey showed which factors influenced the agricultural worker behaviour on the acceptance of smart glasses as a possible new tool to support on-farm activities.

Oral presentations

TOPIC 17. Food Safety

Applications of Ozone and Sanodyna® in the Agro-food Industry: a Focus on Extra Virgin Olive Oil Production Chain

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Keywords: EVOO; Hypochlorous acid (HOCl); Olive washing water; Safety; Environmental pressures.

Objectives

The production of extra virgin olive oil is associated with several adverse effects on the environment, related to large water consumptions in the olives washing phase and to the fact that the extraction process generates, for each kilogram of oil, approximately four kilogram of impactful residuals. The aim of this work is to assess the effectiveness of ozone and sanodyna® treatments in olive washing stage in order to reduce microbial load, water consumptions and environmental impacts, safeguarding the extra virgin olive oil characteristics.

Methods

With respect to ozonization treatments, 12 samples of olives were tested. Six samples were treated insufflating ozone in closed containers and 6 (not treated) were used as control. Three of the treated samples were processed to produce olive oil in 24 h, while the others three were processed after seven days. The same apply for the six untreated control samples. In this case, the effect on olives microbial load and on the quality of extra virgin olive oil were assessed. Sanodyna® was sprayed directly to olives (at 0.05%) and was also tested at three different concentrations (4, 8, 12%) in the olives washing water. In this case the effects on the microbial load, on washing water characteristics, and on the obtained oil were assessed.

Results

No significant effects were found for the ozonization treatment on the microbial load of olives. Furthermore, ozone showed a detrimental effect on the total phenolic content of the obtained olive oil, highlighting its unsuitability to this application. Also the direct application of sanodyna®, at 0.05%, do not decreased significantly the microbial load.

Despite this, the application of higher dosages in the washing water showed promising results in significantly reducing the microbial load and in extending the duration of washing water, reducing both the environmental pressures and the water consumptions.

Food Process Safety Investigated through NIR Water Absorption Variations

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Keywords: Food, Water absorption pattern, NIR sensors, Food storage

Objectives

To study the Aquaphotomics application, as NIR water absorption variations, to monitor and address food dehydration processes, enlarging its application power for food safety and preservation.

Methods

A drying micro-system (45x45x45 cm) operating with solar energy with a fan always active at the bottom was used. Two tests were carried out: a) eggplant slices; b) apple slices. The water activity (a_w) content was determined at the end of the drying process.

The NIR spectra, were collected in reflectance mode (spectral range: 900-1600 nm) using a portable MicroNIR 1700 (VIAVI Solutions, Italy). After proper pre-treatments, the averaged absorbance spectra were displayed on radial axes defined by the activated water absorbance bandsin the spider Chart (Aquagram). PCA, LDA and MBM (Moving Block Model) were then built up.

Results

Some critical points were identified: a) the positioning of the NIR probe; b) the working temperature and the NIR probe isolation; c) the sample size; d) the identification of the process end. The applicability of Aquaphotomics for the continuous monitoring of food drying processesusing an adequate NIR probe can be a good opportunity to better understand the product safety. Aquagrams can help to identify the actual end point of the process. PCA loadings confirmed the important contribution of the water absorption independently from the food matrix. The combination of NIR and Aquaphotomics is synergistic by combining the specific characteristics of both techniques. The selection of few wavelengths to study food processes and/or quality can promote the optimization of low costs portable instruments and the transfer of instrumental data to IT platforms and networks. Further investigations are in progress to optimize all steps and to check the possibility to transfer on pilot scale the obtained results for a future applicability of these applications at industrial level.

Poster presentations

TOPIC 2. WMSDs Work related Musculoskeletal Disorders

Biomechanical Risk for the Hand-Arm System during Work Activities on Peach Fruit Tree

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Keywords: Risk assessment, Ergonomics, Occupational diseases, Fruit harvesting, OCRA index

Objectives

Biomechanical upper limb diseases represent, in Italy, 25% of the professional diseases reported to INAIL in the last five years in the agricultural sector, representing a quarter of all those physical disablements that push a worker to leave his job. The study carried out on farms with arboreal production where peach trees are grown, focused on the observation and the subsequent assessment of fruit thinning and fruit picking operations carried out in harvest machines for fruit.

Methods

During these phases the attention was focused on positioning of the worker by assessing it, through the study of the image, following the assessment indications of the ISO 11228-3 "Ergonomics - Manual handling of low loads at high frequency".

Results

The survey showed that operators working in this agricultural sector are exposed to significant risk factors, also accentuated by a non-homogeneous body morphology, in the population studied, which significantly influences some factors that contribute to risk assessment. The risk is not negligible despite the workers operating on a variable work surface and therefore are positioned at the optimal point for the execution of the work process.

Health and Safety Risks in Hop-picking Activities: an Analysis of the State of the Art

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Keywords: Hop, Mechanized harvesting, Manual picking, Musculoskeletal disorders, Occupational safety.

Objectives

In the last decade, the cultivation of hop has seen greater interest in small and medium- sized farms due to the rising importance of craft beer microbreweries requiring localraw materials. However, high investments for mechanized harvesters are needed. Small-scale farms cannot face these costs; thus, manual harvesting of hop cones is frequently adopted. The study investigated the risks related to the health and safety of operators during manual and mechanized harvesting, also examining musculoskeletal disorders they can incur.

Methods

Risk factors related to the manual and mechanized harvesting process were investigated through a literature review and secondary data analysis. Furthermore, the operator's workload related to the hop cones picking time was analyzed based on international standards.

Results

The study reports the critical issues operators face during the different tasks of the manual harvesting of hops (e.g. during cutting and removing the bines from the field and the manual cones picking). Some of the operations are carried out at high heights with the risk of falling and assuming inadequate dynamic postures that can pose risks to the operator's health. Furthermore, the study points out major health concerns for the operators because of the repetitiveness of the operations they have to carry out. The mechanization of harvesting involves a significant increase in efficiency by reducing the number of operators involved and the working hours per hectares. This results in an improvement in operators' health conditions. However, the harvesting equipment can represent a safety risk for the operators because of their interaction with moving parts of the machinery.

Poster presentations

TOPIC 3. Machine Milking, Animal Welfare, Sustainable livestock farming

Pre-slaughtering Phases and Meat Quality of Highly Profitable Cattle (Piedmontese fat ox)

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Keywords: Pre-slaughtering, Animal welfare, DFD meat, Piedmontese fat ox

Objectives

The objective of the study was to evaluate the effect of the pre-slaughtering phases on animal welfare of highly profitable cattle (Piedmontese fat ox) and on meat quality, aged for long time (4-6 months).

Methods

The study involved 14 Piedmontese fat oxes from four farms located Piedmont (Northern Italy). The animals were slaughtered in a family-run slaughterhouse and after slaughtering the carcasses were stored in a static refrigerating room at 2 °C and aged for4-6 months. Loading and transportation times, waiting times before stunning and travelling times were recorded. Hair and blood cortisol were measured (ELISA essay kitand chemiluminescence), to evaluate animal welfare respectively at farm level and during slaughter. The pH of meat was measured 72 h post-mortem and every week until the end of aging, using a pH-meter with an infission probe. The meat color was determined at the end of aging, using a colorimeter. Cooking losses were determined by cooking meat samples at a final internal temperature of 71°C, and the Warner-Bratzler shear force (WBSF) test was used to assess their tenderness.

Results

The average distance travelled from the farms to the slaughterhouse was approximately 200 km, with an average travel time of 3 hours and an interval time between loadingand stunning of 8 hours. The average hair and blood cortisol concentrations were respectively 1.05 pg/mg and 4.58 µg/dl. The pH of meat ranged between 5.87 and 5.99 72 h post-mortem and reached values close to neutrality at the end of aging period. The color of meat surface was compatible with the long aging time. Cooking losses were on average 21.6 % of the samples weight. The meat showed a marked tenderness with low shear force values (1.72 kgf/cm^2). Pre-slaughtering phases did not affect animal welfare quality of meat aged for long time.

Calculation of the Mixing Time as a Function of the Dairy Cow Diet Chemical Homogeneity Inside the Mixing Hopper

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Keywords: Total mixed ration, Near-infrared, Mixing wagon

Objectives

The optimal mixing time for a dairy cow total mixed ration (TMR) depends on many factors (type of ingredients, loading order, mixing equipment features and maintenance, inclusion of liquid feeds). Adequate mixing time leads to a more homogenous TMR andless feed sorting contributing to optimize dry matter and nutrients intake and reduce metabolic disorders. The objective of the study was to develop and implement a Near- infrared (NIR) spectroscopy-based system to determine the optimal mixing time of the TMR inside the mixing hopper of a mixer wagon.

Methods

A diode array spectrometer (950-1650 nm range), with a calibration model for predicting the TMR main chemical parameters, was mounted outside the hopper of a horizontal self-propelled mixer wagon, close to the discharge belt conveyor, and was integrated in an on-line and real-time measurement system that is activated during mixing procedure. The optimal mixing time was assumed to be achieved when the stability ratio of the TMR chemical parameters measurement process, calculated over a moving average of 24 samples with a sampling rate of 0.2 Hz, was < 1.5. Student's t- tests were used to compare the distribution of the main nutrients in the TMR inside the mixing hopper and in the TMR delivered. Statistical significance was declared for $P < 0.05$.

Results

Preliminary results showed that the TMR chemical homogeneity inside the mixing hopper was met after an average mixing time of 3.31 ± 0.87 min. On average, the TMR inside the hopper reflected the delivered ration for DM, NDF and starch ($P > 0.05$), while exceeded the delivered ration for CP, ADF and ash ($P < 0.01$) and underfed EE ($P < 0.01$). A fine-tuning of the algorithm used to assess the TMR chemical homogeneity could decrease the observed differences between the two diets.

Gut Inflammation in Adult Pigs Exposed to High Ammonia Levels during Neonatal Life. The Effects of Manure Management on Pig Health.

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Keywords: Swine farm, Ammonia concentration, Gut inflammation

Objectives

The aim of this trial was to investigate, at long term, the effects of high ammonia level inthe farrowing room, on the gut conditions of adult pigs.

Methods

For this purpose, 2 pig farms (F1 and F2) located in Northern Italy were considered. The survey considered, in both farms, the whole production cycle of the animals, from the birth to slaughtering, at a mean live weight of 160 kg, 9 months. All the compartments were investigated for climate, management, nutritional level, production performances and ammonia concentration. In F1 digestate is recirculated for manure removal, F2 is equipped with vacuum system manure removal. At the end of the production cycle, the gut of 6 animals were sampled after slaughtering and morpho-functional aspects of pig intestine were analysed.

Results

Pigs were submitted to the same vaccinal and therapeutic treatments, from birth to weaning. The pigs did not receive any pharmacological treatment during the last phases up to slaughtering. No significant differences were detected for T and RH between farmsin the considered compartment. In farrowing rooms of F1, mean ammonia level was 11.38mg m^{-3} vs. 3.73 mg m^{-3} of F2 (P<0.001). In the F1 fattening room ammonia concentrationwas 5.44 mg m^{-3} vs 4.00 mg m^{-3} of F2 (P<0.001). No significant differences were foundin animal performances. Animals reared in confinement characterized by high levels of ammonia in neonatal life resulted in a significant inflammation (P<0.01) at gut level, showing an increase in the thickness of adherent mucous gel (1.15 µm vs 0.80 µm). Theadherent mucous gel represents the first interface between lumen contents and intestinal epithelium. The study revealed a tight connection between air ammonia level in the earlystage of life and gut inflammation in adult pigs, intended as an excessive activation of mucous secretion.

The Effect of Lift Crates on Piglet Survival Rate During Farrowing

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Keywords: Farrowing room, Lift crates, Piglets crushing rate.

Objectives

Nowadays, in large scale pig farms, pre-weaning mortality is the only key barrier that allows to achieve peak productivity and guaranteeing piglet welfare. The experimental study investigated the effect of lift crates vs. conventional crates during farrowing on animal performance, piglet survival, and sow welfare.

Methods

For this purpose, 72 sows (Landrace x Large white x Duroc, parity 2 to 9) were used to determine the effect of lift crates in farrowing on piglet's survival rate in a pig farm located in the province of Verona (Italy). Sows were randomly assigned to conventionaland lift farrowing crates, in identical rooms for design and management. Litters were standardized to 14 piglets for sow, within the second day after parturition. Daily sow feedintake was measured using electronic feeders. Both solutions were equipped with a heating system, each crate had a heated nest in the creep area. Ventilation was managed by the FRCA (Fancom) control unit system (FANCOM EasyFlow, Panningen, The Netherlands) to maintain the desired temperatures, according to the physiological requirements. Lift crates (Balance Frame, Nooyen) were driven 28 cm above the creep area by postural changes of the sow. Animal performance and survival rate of piglets at day 2, day 3, and day 28, at weaning, and rooms environmental conditions were investigated. Data were analysed using the ANOVA procedure of SAS (Cary, NC), keeping the sow (conventional vs. lift crates) as the experimental unit.

Results

Piglets crushing rate was higher in conventional crates mostly within the 48 h after parturition (0.39 in conventional crates vs. 0.15 in lift crates; $P<0.05$). No significant differences were found from the 3rd day to weaning (0.48 vs. 0.37) in mortality rate due to crushing. The obtained results highlight a significant higher survival rate for lift crate housed piglets.

Use of the Daily Milk Yield Deviations as an Index of Resilience inWater Buffalo

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Keywords: Precision farming, Buffalo, Milking machine

Objectives

Milking Machine, equipped with automatic milk meters, is now common in buffalo farming. Such equipment, usually coupled with a software for heat detection and health management, monitors differences between actual yield and expected one. Recently, several authors have proposed to use daily milk yield records to define a resilience index, starting from thehypothesis that the magnitude and length of milk drop could be an index of the animal's ability to cope with its environment. As milk production is sensitive to diseases (mastitis, ketosis, laminitis) or environmental variations (heat stress, diet,etc...), monitoring day-to-day variation could allow to establish a resilience merit for individual animals. Aim of this work was to investigate individual resilience based on longitudinal data derived from automatic milkmeters in buffaloes.

Methods

Daily milk yield data from 30 complete lactations (DIM=230±25) of Mediterranean Buffaloes farmed at Monterontondo Research Station (CREA) were analyzed by fitting two functions: Wilmink model (y=a+b*expk*DIM+c*DIM), widely used in dairy cattle and a fourth-degree polynomial, more flexible and therefore, suitable to follow the localvariations throughout the milk yield trajectory. Sum of total drops (SD) and time in which they occurred (TD)was calculated for each animal. ANOVA analysis was carried out to evaluate the influence of calving month on new phenotypes.

Results

Milk yield on consecutive days was very variable due to the specific buffalo physiology, with a wide dispersion around the mean (R2 0.75±0.1). SD and TD values were also highly variable, ranging between 3.88-160.6 kg (45.34±36.4)and 7-110 days (60.4 26.2). Results of this preliminary study, although based on a limited number of lactations, showed a strong individual variability and so the possibility of genetically improving resilience traits. In conclusion, data deriving from the daily monitoring can be used for breeding purposes, also in buffalo herds.

Poster presentations

TOPIC 5. Instrumentation, Equipment, Periodic Procedures and Tests

Check and Calibration of Spraying Machinery in Lombardy: Results of More Than 15-years Activity

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Keywords: Health and safety, Pesticide, Tests, Software, Database

Objectives

After 3 years of experimental tests, in 2003 came in force in Lombardy region (Italy), the official check and calibration service of the spraying machinery. In the experimental period about 1000 tests were carried out, including both boom and vineyard/orchard sprayers. Before the coming in force of the official service, several technicians were trained and a number of checking and calibration Centres were accredited. Moreover, a dedicated software package was developed, for the safe storing and the statistical elaboration of the obtained data. The statistics showed that from 2003 to 2012, almost 5.000 checks were carried out, about the 20% of the sprayers fleet in Lombardy. Thanks to the coming in force of EU regulation no. 128, adopted officially in Italy through the PAN (Piano d'Azione Nazionale), the situation improved remarkably, with the execution of more than 14.000 tests in the subsequent years.

Methods

From the beginning of the activity, all test data were recorded thanks to dedicated software programs. The data included the farm and machine main features, and detailed information regarding both check and calibration. Moreover, from 2019, a new software was made available online, to collect the check and calibration information in real time, so allowing the creation of a specific database is immediately possible.

Results

The data analysis confirms the general improvement of the machinery used for the distribution of pesticides in Lombardy, but at the same time highlighted a relevant number of obsolete sprayers, on which the main problem detected was the missing of the tanks for the pre-mixing and the washing of the machine. On the contrary, the hand- washing tank (which presence is mandatory by law for the operator's safety), was present on all checked machines.

Poster presentations

TOPIC 6. Safety Health and Welfare in Building

Lighting of Milking Parlours: Results from a Field Study

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Keywords: Dairy cattle farm, Milking parlour, Lighting, Illuminance

Objectives

The average illuminance for milking parlours according to the technical standard UNI EN 12464/1 2011 is 200 lx. The field study investigated the lighting of milking parlours at pit and milking stall levels.

Methods

The field study was carried out in ten milking parlours with natural light inlets on the sides. The operating average illuminance (E_m) of the milking pit and milking stalls was calculated through the detection of a certain number of illuminance points in relation to the dimensions of the milking parlour and the distance between the lighting fixtures and the surface of measuring illuminance. The measurements occurred on July 2018 before and during the afternoon milking session using a lux meter for assessing the impact of the operator and the animals on the illuminance of milking stalls. A k-means cluster analysis was performed using the JMP 15.2 software (SAS, Cary, NC, USA).

Results

Clustering analysis divided the milking parlours into three groups. Groups 1 (n=5) and 2 (n=3) included herringbone milking parlours respectively with less and more than 12 milking stalls. Group 3 included two parallel milking parlours with 40 milking stalls. Only Group 3 met the reference technical standards with an E_m of 514, 559 and 234 lx respectively at pit level and at milking stall level before and during milking, likely due to large natural light inlets on the sides. Group 1 and 2 showed an E_m at milking stalls lower than reference technical standards both before and after milking. On average, the E_m at milking stall level reduced of 48.4 %, 40.9 %, and 58.1 % respectively in milking parlours of Groups 1, 2, and 3 during milking due to the shadow of the milker and the animals. These results highlight the importance in lamp positioning for proper lighting of the udder area.

Poster presentations

TOPIC 7. Agriculture 4.0, Automation, Remote Control, Robot and Innovative Vehicle

Rovitis 4.0: an Autonomous Robot for Spraying in Vineyards

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Keywords: Precision agriculture, Digital agriculture, Participative projects, SSD, Safety, Autonomous robotics

Objectives

The research project Rovitis 4.0 (www.rovitisveneto.it) was aimed to design and develop two robots capable of automatically spray vineyards. Through these machines a safe application of pesticides is possible, allowing operators to maintain distance from the application zone. This paper describes the features of the robots and shows the main results obtained during the testing of the machines.

Methods

For the evaluation of the performance of the robots, the following parameters have been tested during lab and field experiments:
-safety and performance of the autonomous driving system;
-effectiveness of the correct robot-DSS interaction;
-effectiveness and quality of robotic treatments;
-economic and environmental benefits of the innovation.

Results

The two robots were able to perform the planned tasks in complete autonomy. On one hand, the first machine was able to operate in autonomous driving through the entire 2020 season, leading to a human-less spraying operation; on the other hand, the second machine, through its vegetation recognition system, was able to instantaneously adapt the spraying to the size and position of the target. Moreover, the obtained results showed that a robotic management

of the vineyard can lead to environmental and economic advantages even for medium size farms.

Automatic Image Labelling for Deep-Learning-Based Navigation of Agricultural Robots

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Keywords: Tracked vehicle, Rough terrains, Perception-driven navigation

Objectives

The aim of this work is to define a procedure for the automatic labelling of images used for the training of a deep neural network. The neural network considered is used to learna direct mapping from images to steering angles and collision probabilities. These two values are used to generate respectively the angular and the linear velocity commands todrive a tracked vehicle through rough unstructured terrains, such as vineyards terracesor hillside crops.

Methods

The images are acquired during a manual driving session of the vehicle, along with the distances, measured by an onboard 2D laser scanner, and the driving commands given by the human operator. The timestamps of sensor data and control commands are logged as well. Steering angles are derived by numerical integration over time of the velocity commands given by the operator. Collision probability labels are derived by thedistance measurements of the laser scanner. A combination of two vertically symmetrical sigmoidal functions has been adopted to give higher weight to central readings and to partially neglect peripheral ones (consistently with the vehicle size). In this way whenever the space in front of the vehicle is traversable, i.e. no obstacle is present, it can go straight, even if a close side obstacle is present.

Results

The neural network has been trained with around 4000 images labelled with the approach described above. The trained network proved to be capable of properly regressing both the collision probability and the steering angle. In particular, a fair balance between overestimation and underestimation of the collision probability was observed, which is crucial for the generation of safe linear velocity commands.

Conclusions and Perspectives

A perception-driven navigation controller for a tracked vehicle has been presented. The resulting navigation behaviour turned out to generate safe driving commands for both the

vehicle and the crops. Although results are promising, we aim at further enhancing the current version of the navigation controller in order to obtain smoother trajectories.

Estimating Costs of a Chestnut Mechanical Harvester

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Keywords: Mechanization, Fruit harvesting, Performance.

Objectives

In some European chestnut producing regions, harvest is mostly manually. However, due to the difficulty to find available labour, a significant number of producers are changing harvesting procedures, adopting mechanical harvesters. There is not reliable information about costs associated to this harvesting system. This information can assume great importance for producers' decision. With the objective to contribute for the performance assessment of harvesting equipment based on a vacuum harvester, field trials to evaluate work rates has been carried out in Northeast of Portugal. With the data collected it is possible to estimate associated costs and contribute for a better understanding of the feasibility of this procedure.

Methods

To evaluate the equipment work rate, time for each elementary operation was measured. Working rate was evaluated by the ratio worked area / time.
Harvesting performance is assessed by field efficiency: ratio between the sum ofelementary operation time during harvesting and total working time.
Costs are computed under international standards for agricultural machinerymanagement, as reported by Ortiz-Cañavate (2003) and Hunt (1983).

Results

Under environmental conditions and agriculture systems in the geographical area were field trials took place, vacuum harvesters can reduce harvesting time and associated costs. It can be an answer to the lack of labour required for manual harvesting. Despite the need for further studies, this seems to be a good solution to the problem of lack of manpower. It is also necessary to change some agricultural practices in the fieldto improve the of the harvesting machines performance.

Poster presentations

TOPIC 8. Noise, Vibration, Dust, Endotoxin, Microorganism

Exposure to Heavy Metals in Wood Dust during Dry-pruning in Vineyard

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Keywords: Particulate matter, Safety, Airborne particles, Mechanical pruning

Objectives

The winter pruning of the vineyard, also called dry-pruning, is carried out annually during the period of vegetative rest of the vines. The initial part of this operation is mechanically performed, letting the operators to be exposed to floating particles of wood, which is classified as a carcinogenic agent. This work aims to investigate the workers exposure from wood dust coming from mechanical dry pruning of vineyard located in Sicily (Italy).

Methods

The trials were carried out in five lots situated on the north face of Mt Etna (CT), with the same pre-pruning machinery. The wood dust (both total suspended particles and respirable fraction) was sampled by active filter sampling carried out by means of personal air samplers. The collected wood dust underwent to gravimetric and chemical analysis, including heavy metals.

Results

Apart from the fact that the obtained values of inhalable dust do not exceed the legal threshold of concentration, the first results suggest that attention should be paid to the exposure of the operators to wood dust generated during mechanical pruning of vineyards. Potential risks for the health from longer times of exposure should be carefully evaluated.

Operator's Exposure to Hand-arm Vibration in Little Olive Growing

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Keywords: Hand-arm vibration, Olive, Motorhoe, Chainsaw, Mistblower, Beater

Objectives

Many little sloping olive groves are present in Mediterranean countries, where the olive cultivation is here feasible only by a light mechanization, using brushcutters, motorhoes, chainsaws, backpack mistblowers and hand-held olive harvesters.

All the mentioned machines are unfortunately carrier of possible hand-arm vibrations (HAV) risks onset for the operators in this work environment. Many studies concern thespecific vibration risk of the above mentioned machines. There is however a research shortage regarding the analysis of the HAV operators' exposure during the entire growing season. Aim of this work was to study the operator's exposure to the HAV risk,using both the ISO 5349-1 standard (as requested by the European Directive 2002/44) and the ISO/TR 18570, as suggested to correctly evaluate the vascular risk.

Methods

Vibration transmitted by a motorhoe, a chainsaw, a backpack mistblower and an hand-held olive harvester were measured in an olive grove located in the Liguria Region (Italy, North West). Measurements were performed throughout an entire growing season in field by one operator (from November 2019 to April 2021, delayed due to the pandemic emergency). The simultaneous acquisition of the vibration along the three directions (X, Y and Z) were performed. The signals were therefore frequency weightedusing the weighting curves W_h (ISO 5349-1 standard), and W_p (ISO/TR 18570). The daily operators' exposures $A(8)$ and $E_{p,d}$ were therefore calculated and compared with the current regulation and literature.

Results

The motorhoe, the chainsaw and the hand-held olive harvester showed values far above the admitted limits, independently by the weighting curve. Only the backpack mistblower showed lower hand-arm vibration values, but only concerning the W_h weighting curve (and the $A(8)$ daily exposure).

Hand Arm Vibration: Comparison Between Laboratory and in Field Tests

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Keywords: Safety, Olive harvesting, Vibration exposure, Hand-arm system, Test bench.

Objectives

Hand-Arm Vibration (HAV) is probably the most important risk connected with the use of portable harvesters for olive harvesting. Users are mainly interested in productivity andvery often underestimate ergonomics and safety aspects. Acceleration values reported inliterature present great variability due to the many factors influencing measures (type of machine, worker features and ability, tree characteristics), so it can be of great interest to standardise the measuring conditions, especially under load. In this study a suitable test bench, designed by Roberto Deboli from the Institute for Agricultural and Earth-movingMachines of Italian National Research Council (CNR), Torino, was used to standardise load conditions for olive portable harvesters. To assess whether the test bench allows to record equivalent vibration levels in the practical use, one electrical harvester was testedboth in laboratory and in field.

Methods

Laboratory measurements were carried out both at idling and at full load conditions. Idling tests were carried out with the rod angled of about 45° and each measurement lasted30 s. Full load tests, carried out by using the test bench, lasted about 2 minutes. Finally, field tests during harvesting lasted about 1 minute. All measurements were replicated fivetimes. During all the tests, the portable harvester was driven by two operators. Acceleration was measured on the rod by using three monoaxial accelerometers, arrangedas a triaxial one, with reference axes fixed according to the UNI EN ISO 5349-1:2004 regulation.

Results

Acceleration signal analysis, still under development, will allow comparing laboratory and field conditions. If the acceleration values will be comparable, the test bench could be a useful tool to standardise the measurement procedure.

Fisherman's Exposure to the Noise Emitted by a Prototype of an On-boardrotating Sorting Machine for Clams (*Chamelea gallina*)

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Keywords: Sustainable fishing, Selectivity, Comfort, Safety, Health

In clam fishing, the efficiency in selecting the commercial size depends on the fisherman's ability and the on-board equipment functionality. Therefore, it is essential to increase the efficiency of the selection equipment. On this purpose, an innovative sorting machine was realized, less impacting on the clams to be selected, on the benthic fauna and on the health of the operators. Unlike conventional machines, the new one is not vibrating. It consists of two rotating drums provided with holes and spacing of different sizes. A series of spray washes gently cleans the clams removing the sand and the undersized juvenile that are directly thrown back into the sea. Thereby, the stress on the clams is significantly reduced and, at the same time, the conditions of comfort, safety and health protection of the operators are improved. In light of this, in the present work, the emitted levels of noise were measured, according to the ISO 1999:2013 standard, with both conventional and innovative sorting machine, under normal conditions of use in a day work, as specified by Italian law (Legislative Decree 81/08).

The noise measurement was performed by positioning the microphone at a distance of 0.1 m from the ear of the fisherman by means of a helmet fitted up with a metallic support. The operator worn the helmet during the sorting of the clams. The measurements of noise were carried out under conditions as much as possible ordinary and representative of normal working.

The results indicate the innovative equipment as a possible improvement to the clam fishing equipment to make the selection more effective and safety, in order to promote a more sustainable fishery, which is essential for the management of *Chamelea gallina* resources, and to reduce the fisherman's exposure to high noise levels due to the use ofvibrating sorting machines.

A New Methodology for Assessing Worker's Safety in Agriculture

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Keywords: Human Activity Recognition, Musculoskeletal disorders, Precision farming, Vibration

Objectives

Precision farming aims at optimizing crop production and at improving the quality of the final products driving agriculture towards modernization. Nowadays, the new frontier is represented by Agriculture 4.0 where farm activities are connected throughout the entire supply chain through specific key enabling technologies (KET), such as pervasive Internet of Things (Iot) and cloud technologies. Referring to the safety of operations, such approach allows to substantially rethink the farming activities from human-centric perspective, thus increasing the sustainability of agroindustry systems from a social point of view. This research deals with such topic and proposes a novel approach to the evaluation of the vibrations risks during field operations, based onthe recognition of the workers' activities in an interconnected work environment, through Artificial Intelligence (AI) methods. The workers' exposure to vibration risks can thus be related to the activities performed, therefore improving the task assignment process in order to prevent the occurrence of work-related diseases. The context of Human Activity Recognition (HAR), which nowadays is a highly dynamic and challenging research topic, aims at determining the activities of a person or a group of persons based on sensor and/or video observation data. The underlying activity theory describes an activity as complex tasks performed by a person or a group of persons within a certain time span in a specific context. Activities are described as an aggregation of actions which in turn are understood as set of atomic steps named operations. By implementing advanced methodologies, HAR systems are able of analysing the data collected in a certain time span, and to reconstruct the activities performed from a well-defined information hierarchy of events (based on sensor inputs) fused with additional context information. Recent applications of such technologies in ergonomics can be found in the scientific literature involving body sensors worn on different parts of the body to collect raw data of physiological signals in accordance with the body motion and transmit the data to central processing unit for activity recognition and classification. Several techniques have been recently employed to analyse and classify data gathered from accelerometer sensors on mobile devices and can be applied to the agricultural sector.

Methods

Our experimental study considers HAR systems that rely on a single tri-axial accelerometer sensor, which can be embedded in a miniaturized wearable device. In such context, the present research proposes an innovative system aimed at estimating the hand-arm exposure

to vibration according to the Standard EN ISO 5349-1:2004 in fruit harvesting with the use of portable shakers. In particular, the system employed is based on Micro Electro-Mechanical Systems (MEMS) technology and involves the design of a compact wearable unit to be attached to the waist of the operator and a fixed station for data storage and analysis.

Results

The results obtained in this study are very promising for the application of the HAR methodology to improve the operator safety in agriculture.

Poster presentations

TOPIC 9. Occupational Health

Critical Issues in the Application of the INAIL Methodology for the Assessment of Work-Related Stress in the Agricultural Sector

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Objectives

Employers are obliged to evaluate all the risks present within their company. Among the risks, that of work-related stress must also be assessed. In order to comply with this obligation, in Italy the Permanent Consultative Commission, on the provision of Legislative Decree 106/09, published the indications for the evaluation of work-related stress. Studies carried out previously and confirmed by the National Institute for Occupational Safety and Health (NIOSH), had already shown that this pathology can have harmful effects on workers' health and also on their safety, as stress is potentially able to increase the probability of accident events. INAIL (National institute for insurance against industrial injuries) has drawn up a questionnaire tool indicator which turns out to be, currently in the national territory, a practical reference tool used by the Employers for carrying out the preliminary evaluation of work-related stress. The applicability of this methodology to all production sectors, however, could make the risk incorrectly assessed, generating gaps, which could have harmful effects on the health and safety of workers. Based on these considerations, a study was carried out to assess the reliability of the application of the INAIL checklist on farms, in order to propose an adaptation of the same to the analyzed sector.

Methods

Thirty-two farms belonging to the agro-zootechnical and agricultural sector located in the Lazio region (Italy) were observed. The questionnaires proposed by the INAIL guidelines were administered in the aforementioned farms. The questionnaires were submitted to employers and workers representatives. Subsequently, the data were processed in order to identify any critical issues.

Results

The study brought to light some critical issues in the application of the assessment based on the INAIL checklists applied to the agricultural sector. The most significant discrepancy is that relating to the sub-group "Work environment and Work equipment".

Effects of Climate Change on the Health of People Working in Agriculture and Forestry

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Keywords: Statistics, Strategies, ENASP

Objectives

Highlighting the current effects of climate change on the health and occupational safety of people working in agriculture and forestry in various countries.

Methods

Analysis of statistical surveys, in particular of the institutions responsible for agricultural accident insurance.

Results

Climate change already has measurable effects on health and occupational safety in agriculture and forestry. The conclusions to be drawn from this concern, inter alia, prevention strategies and methods.

Tackling Work-related Diseases in Agriculture

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Keywords: Occupational diseases, Workers health surveillance, SACURIMA

Objectives

To get better insight in the nature and extend of work-related diseases and prevention strategies in the European agricultural workforce.

Methods

Under the umbrella of the SACURIMA COST action (Safety Culture and Risk Management in Agriculture, https://www.sacurima.eu/) a three step-approach was taken in order to gather background information, collecting data on specific diseases associated with specific exposures in the complex agricultural setting and promising prevention programs. Strengths and weaknesses of existing data collection mechanisms were assessed, with discussion on improvements of effective workers health surveillance in the agriculture sector in Europe:

- Review of the literature, using a search string.
- Survey on existing data-collection mechanisms among the members.
- Collection and discussion of Good Practices in participating countries.

Results

A wide range of reviews on specific exposures and health effects have been published, especially on pesticide exposure and long-latency effects as different types of cancer and degenerative neurological diseases. Other good covered categories are respiratory diseases associated with agricultural dust, musculoskeletal disorders, zoonoses and noise-induced hearing loss. Existing data collection systems on work-related diseases in agriculture vary widely within European countries. In most countries only compensated occupational diseases are reported, but in some countries self-employed and in others only employees are covered, because if differences in social security systems. Underreporting is a universal and intractable problem and health surveillance of migrant workers is scarce. Different Good Practices for data collection and prevention programs have been identified that might inspire other countries.

Conclusion and Perspectives

Preliminary findings of the three elements will be presented. The use of complementary data-sets and possibilities and restrictions of analysing big data for workers health surveillance in agriculture will be discussed.

Innovative Solutions to Reduce the Risk Levels of Accidents and Occupational Diseases in Hazelnut Cultivation

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Keywords: Work safety, Dust, Safety cab, WMSDs, Orchards

Objectives

Following the mercantile impulse recorded in recent years, the hazelnut cultivation, in addition to a significant increase in the areas invested, is affected by a progressive application of recent innovations in mechanized management plant. These range from the construction of new plants with mechanical transplanter and GPS technology, to mechanical pruning techniques, and involve the complete mechanization of other cultivation operations, such as soil management and harvesting, which today is moving towards self-propelled machines, capable of reducing costs and at the same time improving operator comfort. The hazelnut sector is characterized by specific risk factors, from accidents to occupational diseases (related to the manual handling of bags and tubes, and to airborne dust). The aim of the work is to analyse the advantages in terms of safety and comfort deriving from the new mechanization models.

Methods

For the various mechanized harvesting systems, the concentrations of respirable airborne inorganic dust (PNOC) are measured. This is one of the main health risk factors deriving from the mechanized harvesting of hazelnuts. With the NIOSH methodology, the risk of operators involved in handling bags and tubes for harvesting machines is assessed. For mechanical pruning, innovative solutions based on an integrated system of sensors and actuators capable of man-aging the safety of a work environment characterized by the presence of operators and mobile machines are analysed.

Results

Experimental tests show that the recommended concentration limits (ACGIH TLV-TWA of the ACGIH, equal, for PNOC, to 10 mg/m3) are almost always largely exceeded, with the exception of machines with pressurized cabs. For operator comfort, the procedures to reduce the risk of WMSDs are analysed.

Finally, the technical solutions and procedures for reducing the risk of accidents related to the use of machines for harvesting and mechanical pruning are defined.

Poster presentations

TOPIC 10. Impacts of crops and livestock productions

Ammonia Emissions from a BAT Farrowing Room. Results of a Yearly Monitoring Survey.

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Keywords: Farrowing room, Lift crates, Piglets crushing rate.

Objectives

The large amount of pollutants emitted by intensive livestock farming, via the ventilation system, has leaded to the adoption of Best Available Techniques (BAT; ILF BREF) to limit pollutant release into atmosphere, from swine and poultry rearing confinements. In the present study the efficiency at limiting ammonia emission was measured in a farrowing room (BAT 4.7.3.3 "Crates with fully slatted flooring and manure pan solution", ILF BREF) vs. a traditional room with slatted floor on deep pit, in North East Italy.

Methods

For this purpose, three farrowing rooms equipped with BAT number 4.7.3.3, and three conventional rooms with slatted floor on deep pit, each lodging 14 sows, were studied in three different seasons of the year. In each room, identical for design and management, ventilation was managed by the FRCA control unit system (FANCOM Easy-Flow, Panningen, The Netherlands). Waste levels and ammonia concentration were measured (Gas Badge Pro analyser) in 7 different points every 3 days. Ammonia emission was calculated multiplying the ammonia concentration values and the ventilation rate. Data were analysed using the ANOVA procedure of SAS (Cary, NC), keeping the room (BAT vs traditional) as experimental unit.

Results

The ammonia emitted by the BAT room was lower than that emitted by the reference room. Considering the value of 4.680 kg/ap/yr of ammonia emitted by the reference farrowing room of the study, lower than the one indicated by the ILF BREF for the traditional system (8.3 - 8.7 kg/ap/yr), the value of 3.234 kg/ap/yr of ammonia corresponds to reduction of 37-39 %, in line with the ammonia reduction efficiency of the solution " 4.7.3.3 Crates with fully or partly-slatted flooring and manure pan" indicated in the ILF BREF manual for data from Netherlands and Belgium (Flanders).

Evaluation of Employed Equipment for Plant Protection Product Application in Olive Orchards

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Keywords: Foliar deposit, Ground loss, Olive growing, Sprayer, Sustainability

Objectives

The present study aims at assessing the performances of the equipment used for plant protection product application in olive growing. Particularly, this includes the determination of foliar deposition, ground, and atmosphere losses, under field conditions.

Methods

Considering the above, experimental trials have been performed in an intensive olive orchard situated in the province of Reggio Calabria, considering different sprayer operating parameters. Hence, olive trees were sprayed with a dye solution, namely, tartrazine yellow E102 (85%) as to simulate a PPP application. Spray quantitative analysis was determined according to the colorimetric method, while qualitative analysis was based on hydro-sensitive paper image analysis.

Results

Statistically analysed data performing the Kruskal-Wallis rank sum test showed significant differences between the considered trials in terms of foliar deposition ($\chi^2 = 11.59$; df = 2; p = 0.0030). Foliar deposition mean values varied between $5.02 + 2.96$ and $7.91 + 3.58$ μL.cm-2. In addition, ground losses varied between 15 and 39 % according to sprayer parameter and field conditions.

Safety in Hazelnut Mechanical Harvesting

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Keywords: Health risk, Safety, Work productivity

Objectives

The core cultivation occupies an area of about 13,000 hectares in Sicily, 10,000 of which are concentrated in the province of Messina, specifically in the pedo-mountain municipalities of the Nebrodi. These are heterogeneous plants by cultivar and planting time. To date, the hazelnut represents a scarcely mechanized marginal crop, with a characteristic training system as the policaule bush. The harvest takes place as soon as the hazelnuts reach maturity and detach from the herbaceous dome that surrounds them falling to the ground. Before harvesting, swathingis carried out by hand using rakes, or facilitated by backpack blowers, or mechanically by means of a swather or with a tractor-mounted blowing tubes. Harvesting is done by hand directly from the ground, with implications for the health of operators; it requires a high need for manpower, increasingly difficult to find. Labor productivity remains very low (10 kg / h per worker). The aim of the research was to study the mechanization of hazelnut harvesting in the Sicilian environment.

Methods

The study involved a comparison between manual and mechanized hazelnut harvesting sites. In both cases, work capacity and the quality of the harvested product were assessed. Mechanical harvesting was carried out using a suction machine carried by the tractor in two ways: equipped with a single suction tube and with two suction tubes. Thetests were carried out in three replicates on 8 m^2 plots each, according to a randomized block scheme. Subsequently, the suction machine was applied on 3 different plots, measuring the working times according to the CIOSTA methodology. The data were subjected to ANOVA and compared via Tukey's test.

Results

Manual harvesting recorded a work capacity of 13.28 kg / h. Mechanized harvesting with only one suction tube provided a working capacity of 62.2 kg / h, while the one with two suction tubes provided a working capacity of 108.5 kg / h. The differences in the values of work capacity obtained in the three plots under study are due to the different field conditions, such as the quantity of fruit on the ground and the presence of impurities.

Potential Bioenergy and Biofertiliser Production from Livestock Waste in Mediterranean Islands

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Keywords: Anaerobic Digestion, Animal manure, Biogas, Digestate, Nitrogen balance, Renewable Energy Sources

The livestock sector can generate steady quantities of manure biomass and, therefore, can be included in a variety of technologies for transformation. This study evaluates the potential biogas and digestate production through the Anaerobic Digestion (AD) process of cattle and pig manure, on a selection of European Mediterranean islands: Balearic Islands, Corse, Sardinia, Sicily, Malta, Crete and Cyprus. These islands share characteristics such as the costs of waste management and energy production, that are much higher than in mainland Europe.

The potential manure generation from cattle and pigs was estimated by using available livestock statistical data so that the potential biogas, bioenergy, and digestate production was quantified by applying established conversion factors.

On the surveyed islands, it was possible to estimate a yearly potential generation of 10.90 million tons of manure, which corresponds to a potential biogas generation of 269.28 million m3, equivalent to 1832.17 thousand GJ of electrical energy and 3402.60 thousand GJ of thermal energy, for a total bioenergy of 5234.77 thousand GJ. Furthermore, the yearly potential production of digestate, which is a biofertiliser that can replace conventional chemical fertilisers, is of 4.69 million tons.

AD process, which is a proven technology, popular in the Northern European countries, could face challenges in Mediterranean environment, due to the particularities of livestock diets and manure handling protocols. The estimated amounts of nitrogen contained in digestate are higher than those which can be spread for fertilisation on the agricultural area utilised for forage and cereal production.

The Influence of Tractors on Soil Compaction in the Last Four Decades

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Keywords: Contact area, Ground pressure, Soil compaction, Soil protection, Tractors tires

Soil compaction is one of the eight factors causing soil degradation identified by the EU in the "Strategy for soil protection". Over the last 40 years, soil compaction has been caused by agricultural machines traffic with increasingly higher power and weight.

In order to reduce soil compaction caused by agricultural machines traffic, the type of tires and their inflation pressure should be carefully selected. The mean ground pressure can be quickly and accurately estimated for several combinations of tractor weight/tires, in order to evaluate the possibility of soil compaction. This research aims to assess whether manufacturers, over the last 40 years, have produced tractors bearing in mind the minimisation of soil compaction.

A total of 783 wheeled tractors manufactured and marketed in the last 35 years (1979-2014) were investigated. Data such as the year of construction, manufacturer, model, power, total weight, weight (load) on the front and rear axle, wheelbase, front and rear type of tires, as well as the tire specifications, were collected.

The mean pressure applied by each tractor onto the soil was calculated.

The research shows, however, that in the specified periods: 1) the average power has increased and the production of 2WD tractors has strongly decreased; 2) the weight/power ratio has diminished from 70 to 60 dN/kW; 3) while in the 1970s most tractors were fitted with cross-ply tires, nowadays almost all tractors are fitted with radial tires with aspect ratio values lower than 85% and even reaching 65%; 4) the average ground pressure is increased, especially for tractors with power higher than 100 kW.

Greater attention is needed by manufacturers in designing machines which do not exceed the limit of 0.1MPa, by decreasing the loads and/or increasing the soil contact area.

A Case Study of Circular Bioeconomy in Sicily through a Home Biowaste Valorisation System

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Keywords: Renewable Energy Sources (RES), Anaerobic Digestion System, Biogas, digestate, Biofertiliser, Sustain-able biowaste management

The worldwide interest in Renewable Energy Sources (RES) is steadily growing. Among the proposed solutions, Anaerobic Digestion (AD) process is more and more spread, as it is able, at the same time, to produce renewable energy and contribute to dispose the biowaste. Therefore, a higher and higher amount of large scale AD plants is setup.

Differently from the most of AD plants, Home Biogas 2.0 is simple and revolutionary equipment that implements AD process for converting kitchen food biowaste into biogas (that can be used for cooking two hours a day) and digestate. This equipment, placed at the agricultural institute of Marsala (Trapani, Italy) and using the biowaste from the canteen of this high school, is surveyed in this work. This equipment had a mean disposal capacity of 4.8 kg of biowaste per day so that it is able to dispose the organic waste produced by 10 persons. In the testing period, the equipment produced 525 L of biogas and 7.78 L of liquid digestate per day. This biofertiliser, after being sterilised by a chlorine tablet, was used for the soilless cultivation of tomato, strawberry, aubergine and pepper plants inside a greenhouse.

Sicily and the other islands of Mediterranean basin are optimal environments for the operation of the tested equipment, that is an example of home and small scale circular bioeconomy implementation and sustainable biowaste management.

Poster presentations

TOPIC 11. Precision farming and traceability

Purpose-Intended Modification of a Conventional Sprayer Machine for Application in Precision Agriculture

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Keywords: Crop protection; Environmental impact; Variable-rate

Objectives

The application of precision agriculture (PA) in the management of agricultural practices is increasingly widespread, especially in crops with higher income such as vineyards. The organization of agricultural operations conducted with precision approaches, provides that the machines may have the information collected from previous years (yield and quality of preceding productions), from surveys prior to agricultural practice (aerial or terrestrial drones, satellite maps) or from on-the-go surveys. The possibility of improving this information depends on the availability of machines capable of distributing inputs to the crop in variable rate (VR) mode. Moreover, in crop protection there is the need to greatly improve centering the target to avoid dispersion of chemicals in the environment.

Methods

In this paper, a study was carried out to design and apply a machine able to distribute plant protection products, modifying some of its mechanical parts in order to obtain a modular effect capable of supporting the variability of a prescription map for variable- rate distributions.
A conventional sprayer machine has been equipped with a prototype device able of varying the air outlet section and the tilt of the fan blades, in order to have modular airflows during the distribution of the product in the vineyard.

Results

The results from different configurations were statistically elaborated to verify their possible correspondence with the clusters of prescription maps based on the canopy index or spectral indices.

Farm Management Information Systems: Digital Register of Farm Management in Southern Italy

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Keywords: New technologies, Smart Grid Technology, Precision farming, Digital Register of Farm Management

The continuous evolution of the agricultural sector pushes farms to consider the use of new technologies. In the urban environment, the issue of environmental sustainability is becoming increasingly important, and the main objective for the future is to guarantee all possible technological innovations, trying to make them perfectly in tune with the environment, real sustainable technologies towards which we are already making many steps forward such as electric cars, photovoltaic panels, stored wind energy and Smart Grid Technology. Precision agriculture is also configured as a management strategy that uses information technologies to collect data from multiple sources, with a view to their subsequent use in the decision-making process. The shared goal of all technologies that fall within the scope of precise farming is the containment of the indeterminacy caused by the infinite variability that is typical of any agricultural land. In this perspective, a software to compile the treatment register offers multiple advantages. It allows you to obtain the result of a complete traceability of agricultural products.

Poster presentations

TOPIC 13. Environment Safety, People Health Protection and Welfare

Environmental and Health Hazard from Urban Waste Compost: the Role of Information to Overcome Users' Beliefs

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Keywords: Information sources; Interest in use; Recycling waste; Sustainability; Users preferences

Objectives

Composting is an eco-sustainable process to recycle urban waste and its application has positive effects on soil fertility. However, adoption of urban waste compost is not yet widespread since many users still associate this material with environmental and health hazards because of possible soil contamination and the bad odour. An insufficientknowledge about the quality of compost might prevent its adoption, while conveying information with the right communication channels, could influence users' decision- making process. The present study aimed to investigate how frequency of information through certain sources could influence the interest in using compost among potential users, overcoming their misguided beliefs about compost application risks.

Methods

A sample of potential users of compost, means who knows what compost is, but does notuse compost yet, was asked to complete a questionnaire which included: participants' sociodemographic characteristics, level of interest in using compost, drivers that would encourage compost adoption, and frequency of use of certain information sources (visitsto other companies, video/internet, magazines/advertising, courses, discussions withexperts) to inquire about compost use and properties.

Results

Three main drivers which would encourage potential users to adopt compost and which could help potential users to overcome beliefs about environmental and health hazards, were identified: providing a certification to the product, receiving more information about the origin of the material and obtaining evidences about its positive effects on soil. Statistical analysis, showed a positive association between frequent use of magazines/advertising as information source and users' interest in adopting compost. In addition, results pointed out that potential users with higher education level (with bachelor's degree or above) are more likely to use urban waste compost than others. In conclusion, the present study suggests that it would be appropriate to redefine targeted communication campaigns in order to promote the benefits associated with the compost application.

Evaluation of Sustainable Weeding Methods for the Control of Spontaneous flora in Urban Areas

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Keywords: Acetic acid, Pelargonic acid, Flame weeding, Mechanical scraper, Cost analysis

Spontaneous flora can be a problem in urban environments and green spaces. Following the current European laws regarding the use of herbicides, a study on alternative methods to the traditional application of glyphosate is pro- posed. Specifically, the goal was to evaluate the effectiveness on weeds control of each method used in order to find the better solution.

The experimental tests took place in two paths of the Montecchia Golf course (Selvazzano, PD). Two bioherbicides and two physical treatments were tested (in 9 m2 plots with 3 replicates for each treatment) and compared with no treated plots (control): acetic acid, pelargonic acid, flame weeding, and mechanical scraper.

After each treatment, photos were taken to evaluate the trend of weed repopulation in each plot. The images were processed using CANOPEO, a Matlab plugin, to obtain a percentage coverage value for each parcel. A cost analysis was done considering fixed e variable costs. Acetic acid showed the lower percentage of weed coverage over the experimental time and a cost of 0.11 euros/m2. Pelargonic acid showed good results but less effective than acetic acid; also, the cost was about the double of it. Flame weeding showed a good initial result acting more quickly on weeds than the other methods, but its effect did not last over the time because weed repopulations were noted a week after each treatment; the cost was 0.14 euros/m2. Mechanical scraper showed the same trend of flame weeding with very low percentages of weed infestation only the first days after each treatment; the cost was the highest among the treatments.

Considering cost analysis and the effectiveness on weeds control, the acetic acid has proved to be the best alternative solution to the traditional weed control with glyphosate

Analysis of Spray Behaviour Using Different Sprayers in Citrus Groves

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Keywords: Citrus, Foliar deposition, Ground losses, Plant protection equipment, Spray analysis

Objectives

This paper reports the results inherent to technical performances of three different sprayers used in citrus orchards in Calabria (Southern Italy). Accordingly, quantitative and qualitative analyses of the spray were performed.

Methods

Spray quantitative assessment, related to foliar deposit and loses to the ground, was based on the colorimetric method; while spray qualitative evaluation considered water-sensitive paper (WSP) image analysis. This was performed sub-sequently to field experimental trials, which consisted in spraying citrus orchards with a dye solution and collecting the required samples, i.e. leaves for foliar deposit, petri dishes for ground loses, and WSP for spray qualitative analysis.

Results

Statistically analysed data showed significant differences between the assessed sprayers considering foliar deposition (Kruskal-Wallis: $?2 = 40.327$, $df = 2$, $p = 1.75e-9$). In addition, some unfavourable aspects were encountered regarding ground losses and qualitative distribution when applying plant protection products with the tested sprayers.

Error on Drop Size Measurement Due to Image Analysis Digitisation

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Keywords: Droplet pulverisation, Water sensitive papers, Image resolution, Stain diameter, ImageJ

Objectives

For spray applications, drop size spectrum is one of the most important factors affecting environment and operator safety. In fact, drop size affects environmental pollution in terms of off-target losses due to evaporation, drift, and run-off, as well as operator safetydue to its effects on dermal and inhalation exposure. Assessment of drop size distribution is based on different techniques, among which those based on image analysis are quite widespread. Errors on drop size measurement when using image analysis systems may depend upon several factors. The main objective of the present research is to evaluate the measurement errors at varying image resolution and drop diameter.

Methods

The error on drop diameters due to the digitisation process was evaluated by simulating water sensitive paper (WSP) images with resolution ranging from 300 to 1200 dpi, each containing a number of not overlapping stains of equal diameter ranging from 20 to 1600 μm. All the procedures needed for WSP image simulations were carried out by writing custom-made functions in *R*. The images simulated were then analysed with the *ImageJ* analysis software. It detects all the particles in the image, providing the area of each one, from which actual diameter was computed. The comparison between actual and reference diameters allowed evaluating the measurement errors.

Results

The first results show a significant effect of image resolution and drop diameter on relative error, especially for small droplets, more subject to drift and more important for worker exposure (stains on simulated WSP lower than 80 μm). As a general result, lower the image resolution, higher the relative error, and higher the diameter, lower the relative error. The average relative error decreases from 68.3% at 20 μm to 1.0% at 80 μm.

Poster presentations

TOPIC 14. ROPS and Stability Research

"Ask me What I Need": Investigating Users' Training Needs and Design Requirements to Encourage the Correct Operation of Foldable Rollover Protective Structures

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Keywords: Ergonomics; Tractor Safety; Education; User-centred Design

Objectives

The Rollover Protective Structure (ROPS) fitted on tractor aim at avoiding the risk of severe injury during rollover by providing the operator with an adequate clearance zone. To facilitate tractor operation in case of overhead obstacles, Foldable ROPS (FROPS) have been developed. However, a high number of tractor rollover fatalities occurs as frequently the operators leave the FROPS in a folded-down position. In the present study we performed an ergonomic analysis of FROPS operation to identify critical issues in training and machine design which would benefit from targeted interventions, to promote the correct use of the protective structure.

Methods

Twenty male farm operators (M_{age}=49.4 years, SD=11.8) were interviewed and observed while manually rising and folding down the rear-mounted FROPS fitted on their tractor. Participants were asked about: 1) the frequency of FROPS operation, 2) information available on the user manuals and training received from the dealers about the correct handling of the FROPS, 3) discomfort in use, and 4) suggestions for a FROPS re-design to overcome the reported sources of discomfort. Postures and behavioral strategies adopted to operate the FROPS were recorded.

Results

Operator manuals lack in specific information regarding FROPS manual handling and they are often left unread. Some training is provided by the dealer but often the operators learn how to operate the protective structure by themselves. Discomfort in grasping the foldable frame was reported by the participants as discouraging the correct FROPS operation and awkward postures and unsafe behaviors to reach the foldable frame were observed. Many participants would have welcomed some FROPS re-design solutions to increase the reachability of the folding frame and to have a more stable support for the feet. The results

highlighted the need for actions at multiple levels to promote the correct use of rear-mounted FROPS among agricultural operators.

A Method to Ascertain the Lateral Stability of Wheeled Narrow-Track Tractors

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Keywords: Safety, Roll-over, Limit angle, OECD Code 6

Objectives

The narrow-track tractors are used in vineyards, orchards, horticultural cultivation, greenhouses and nursery sector. They can be classified considering the design: 1) models derived from the traditional open-field tractors, having rigid body and front and rear wheels of different diameter; 2) models derived from the evolution of the walking tractor, having both rigid or articulated body and iso-diametric wheels. Apart the design, in case of lateral roll-over the behavior of the narrow tractors could be affected by many other features, such as the wheels diameter and the front axle tilting angle, as well as the fitting of important accessories. Similarly, to ISO 16231 standard (Self-propelled agricultural machinery – assessment of stability), this paper is aimed to get experimental data in order to ascertain the behavior of different models of narrow-track tractors, in view of a possible drawing of a protocol aimed to calculate both the Static Overturning Angle (SOA) and the Required Static Stability Angle (RSSA).

Methods

In detail, following what stated in OECD Code 6, at a first step of the survey the "jack" and the "hoist" methods were taken into consideration. Moreover, some other testing combinations were applied, to investigate the lateral stability in some more realistic tractor operation. The output was a database on narrow tractors' stability limit angles.

Results

As expected, the various testing methods applied highlighted significant differences in lateral stability angle values. A discussion about the suitability of them in order to be representative of the real behavior of this tractors is shown.
The results coming out from this survey could be usefully considered both to draw a protocol aimed to calculate the stability performance and to review the rules at present described in the OECD Code 6.

Track Widening for a Safe Travelling of a Timber Tractor-trailer Combination

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Keywords: Curve width, Timber transportation, Driver safety, Forestry road

Objectives

In Italian Alpine Regions, wood transportation from the forest to local terminals is commonly practiced using low powered tractors with trailers (single axis or two axes) on steep downhill tracks, dangerous for the drivers, especially in the curves. The track must be wide enough when cornering. The steering angle of the wheels are written in the machine leaflet, but it does not give information about the steering radius of the tractor-trailer system. It is necessary to consider the trailer connection system (hitch),the trailer coupling system (with fifth wheel or with tow bar). Aim of the work was to study and to define a calculation model to detect the width of the turning carriageway asa function of the turning radius of different tractor-trailer combinations used in the forestry sector for timber transportation.

Methods

When a tractor-trailer system turns, four circumferences are plotted, drawn by the wheels of the tractor and by the wheels of the trailer. The overall widening of the carriageway to make the turn possible is given by the difference between the radius of the circumference described by the external front wheel of the tractor and the radius of the circumference traced by the innermost wheel of the trailer. The track widening is therefore function of two parameters: the distance between the hitch and the rear axle ofthe tractor, and the distance between the towing eye and the trailer axles.

Results

The calculation model studied in this work makes it possible to identify the internal radius of the curve and the width of the carriageway necessary for the transit of a tractor-trailer system. A correct design of the forest track accordingly to the dimensionalneeds of the vehicles is essential for a safe driving, especially in the case of the downhill timber transportation.

ROPS Design Guidelines for the Effective Driver's Protection in Case of Tractor Overturning

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Keywords: OECD Codes, Clearance zone, Strength, Deflection

Objectives

For over 60 years, the Roll Over Protective Structure (ROPS) is the most diffused means to reduce the operator's risk in case of overturning of the agricultural and forestry tractors. The most important requirement provided is the protection of a given volume (named "clearance zone", "deflection-limiting volume", etc.), located at driver's place, provided that he/she is properly fastened with a seat belt. The manufacturers design the ROPS in such a way to satisfy the shown requirement playing on two factors, i.e. the strength ofthe ROPS and its overall dimensions. In other words, the required energy could be absorbed mostly in terms of strength or mostly playing on the deflection. The first case represents a forced solution for the narrow tractors, where the available volume is restricted, and then is necessary to build a very rigid ROPS to assure limited deflections. The second option is more frequently adopted on conventional tractor models, on which generally there is no heavy problems in respecting the clearance zone, even if the deflection is remarkable.

Methods

The ROPS test results of the last 15 years activity of the Italy-Milan Testing Station were investigated, to examine the total, elastic and plastic deflection values, with the aim to fix the manufacturers trend when designing the ROPS. Moreover, once defined the clearance zone location, its effective protection was verified in terms of "margin", i.e. the minimum distance of the ROPS structural elements from the clearance zone contour.

Results

The results highlighted that a ROPS shows a good balance between the elastic (temporary) and the plastic (permanent) deflection values when they both range between 40 and 60% of the total deflection, even if in some cases, very rigid ROPS models were detected, showing a very low elastic deflection.

Poster presentations

TOPIC 17. Food Safety

Effect of Nano Particles of Pomegranate Peel Extract on Shelf Life of some Fruit and Vegetable Products

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Keywords: Gray mould; Punicalagin; Postharvest diseases; $CaCO_3$; Nanocrystals

Objectives

Natural anti-microbial compounds are a valid and safe alternative to agrochemicals to control plants pathologies and post-harvest fruit diseases. Safety and efficacy of these new biopesticides could be enhanced through micro/nanoencapsulation methods and nanomaterials exploitation. Gradual release reduces dosages and frequency of applications improving the sustainability of the system. In this study, *in vitro* and in *vivo* tests were performed to evaluate the effects of pomegranate (*Punica granatum*) peel extract-loaded nanoparticles on the gray mould caused by *B. cinerea*. $CaCO_3$ nanocrystals were selected as carriers and the pomegranate peel extract loading was obtained through physical adsorption. These nanocarriers have been selected thanks to their high bio and eco compatibility.

Methods

Fruit and vegetable products were obtained from a commercial market, while *B. cinerea* was a strain of CRA-DC Roma collection. The powder of NPPPE was obtained through physical adsorption in the range of extract concentrations 0.25-4% W/V. TEM analysis was performed in order to evaluate the NPPPE morphology. NPPPE was analysed by HPLC--MS-MS-ES(-). Spectral measurements were taken using a Fourier Transform Near Infrared FT-NIR spectroscopy. *In vitro* tests were achieved by measuring radial growth on Petri dishes. *In vivo*, fruit and vegetable products were immersed for 30 s in a volume of the respective solutions. Disease severity (DS), disease incidence (DI) and FT-NIR spectra were recorded.

Results

$CaCO_3$ nanocrystals effectively absorb extract and release it with different kinetics depending on pH. *In vitro* tests showed the ability of NPPPE to control *B. cinerea*. The effectiveness was also established by the treatment on plant products to extend the shelf life. Near-Infrared spectroscopy technique on plant products correlated with optical observation of disease incidence. Our study suggests that NPPPE could be an alternative to synthetic products to control postharvest deteriorations, thus improving the quality and healthiness of fruit and vegetables.

Comparison of Cold Brew and Cold Drip Coffee Extraction Methods and Stabilization Technologies to Extend the Shelf Life

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Keywords: Physical treatments, Food safety, Bioactive compounds, Brewing

Objectives

Cold brew coffee is a beverage prepared at low temperatures and over long brewing times resulting in particular physicochemical and sensory characteristics. This type of coffee is usually consumed immediately after preparation because presents the potential problem of microbial and sensory alteration caused by the type of extraction. Thus, the aim of the study was to characterize and to compare two different cold extraction methods (i.e. cold brew and cold drip) and evaluated five stabilization techniques with the aim to extend the shelf life of the cold brew coffee while preserving its peculiar organoleptic properties. The research activity was focused on the evaluation of the treatment's efficacy, through monitoring for 120 days (one for month) of the microbiological and chemical composition of the beverage, and finally with the identification of one or more treatments resulting efficient during the time.

Methods

The effects of the main process variables (temperature and contact time between coffee powder and water) were assessed in a full factorial experiment. Five stabilization techniques were chosen, HPP (High Pressure Processing), microfiltration, UV irradiation, pasteurization and blast chilling process. The effects were investigated over four months, evaluating the caffeine and the chlorogenic acids contents by HPLC-DAD analysis and carrying out an evaluation of selected volatile compounds by HS SPME- GC-MS.

Results

Temperature was found to increase the concentrations of several compounds.Particularly, a higher temperature increases the total solid concentration of caffeine, CQAs and 5 CQA
All the treatments preserved bioactive compounds content and flavour profile at t0. Blast-chilled and UV irradiated samples showed microbiological contamination at t1 After four months of storage, the samples treated with pasteurization and HPPmaintained a stable contentof chemical compounds, guaranteeing also the microbiological safety of the beverage.

Special Session"*Innovation for Smart Dairy Farming*"
(CowBhave project, PRIN 2017 project)

The COWBHAVE Project: an Open-source Accelerometer-based System for Monitoring Dairy Cows' Behavioural Activities

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Keywords: Data collection, Acceleration thresholds, Animal behaviours, Special firmware, Database, GUI

Objective

The main objective of the COWBHAVE project, financed within the ICT-AGRI Call 2017 'Farm Management Systems for Precision Farming', originates from the idea of making available a low cost open-source cow behaviour monitoring system to the European farmers. This system would facilitate herd management by discriminating dairy cow behavioural activities and deviating behaviour.

Methods

A novel firmware version of a MEMS device (Ruuvitag by Ruuvi, Finland) and behavioural classification algorithms were developed in order to build a real-time system based on an accelerometer fixed at the cows' leg and a threshold-based algorithm. A Graphical User Interface developed in php completes the system and open API for the system have been implemented to export the data. Applications of the system were carried out in a cubicle free-stall dairy barn located in the province of Ragusa (Italy).

Results

The results showed the suitability of the system to perform discrimination of the behaviours with minimum data loss, thanks to the specific firmware developed for the Ruuvitag device. Moreover, many advantages derived from the adoption of a client-server architecture and the cross-platform feature connected to the use of Python scripts and PostgreSQL. The GUI Web application facilitates interaction between users and the system, tags handling, data retrieval and analysis; it was developed into sections including cows information, tags information, association between cows and tags, and related editing tools, data analysis, parameters settings (e.g., cow behaviour thresholds), and warnings on behaviours.

PLF and Barn Microclimate

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Keywords: Dairy cows, Barn structure, Barn climate monitoring, Cow welfare, Precision Livestock Farming

Objectives

The barn microclimate has an important influence on dairy cow welfare. High temperatures and humidity lead to heat stress conditions that constitute serious health risks for dairy cows, as well as affect their productive performance. The structure of the barn and the presence of cooling systems, such as ventilators and sprinkler systems, plays an important role in reducing the impact of external weather conditions. Automatic climate monitoring can help to identify periods of intense heat, while automatic monitoring of cow behavior allows to determine how cows are adapting to these conditions and whether their welfare may be at risk. To better understand how heat stress and its negative effects on cow welfare may be reduced or even prevented it is important to understand how the barn structure may abate or intensify such hot weather conditions.

Methods

To understand better how the barn climate affects cow behavior a survey was performed on eight farms in Northern Italy across three periods: thermoneutral, cold and hot. Environmental sensors measured temperature and humidity both inside and outside the barn, while cow behavior was monitored using leg accelerometers and videoanalyses.

Results

During the hot season, the internal climatic conditions on all farms were above the heat stress threshold, which is based on a Temperature-Humidity Index of 72 or higher, for most of the time. The cows responded in this period by changing their time budgets, with decreasing lying time and alterations in daily behavioral patterns. Certain aspects of the farms, e.g. forced ventilation and barn orientation, can play a significant role in abating or intensifying hot weather conditions. Precision Livestock Farming techniques that allow to automatically monitor barn microclimate and cow behavior and to alert farmers of situations of potential welfare risk are becoming increasingly more essential in the dairy farm industry.

Free Access to Pasture for Dry Cows: Effects on Health, Behavior and Production

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Keywords: Dairy cows, Milk production, Welfare, Pasture

In Italy, the practice of grazing dairy cows has largely been abandoned. In the last few years though, scientists and consumers expressed a growing concern that full-time indoor housing negatively impacts animal welfare and hinder natural behavior. On the other side, dairy producers are reluctant to introduce grazing as it is perceived to limit land as well as cows' productivity. The current study aimed at evaluating the effects of allowing high yielding dairy cattle to access an exercise pasture during the dry period. An experimental trial was conducted over the course of 7 months (from May 2020 to December 2020) in a commercial dairy farm located in northern Italy. Seventy-eight Holstein dairy cows were randomly divided and allocated to two treatments during the dry period: housed indoor with no access to outdoor areas (IND) and housed indoor with free access to pasture (PAS). During the dry period, cows in both groups were fed the same ration indoor. During the subsequent lactation, all cows involved were housed indoor and fed the same ration. Results showed that PAS cows were cleaner and had better locomotion than cows IND. Cows in PAS tended to spend more time feeding than cows IND while no differences have been found in ruminating time. Further, during the first 100 days of the following lactation, cows in PAS produced significantly more milk than IND cows. The current study highlighted that allowing dairy cows to freely access an exercise pasture during the dry period can significantly improve animal welfare and have positive effects on milk production. Further research is deserved to explore the mechanisms that lead to a higher milk yield in the subsequent lactation.

PLF and Big Data for the Mitigation of the Effects Ofheat Stress

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Keywords: Big data, PLF, Heat stress, Dairy cattle, Numerical model

Objectives

The wide-spreading installation of automation devices in dairy farms is providing detailed data that could be used to assess health conditions of cattle, in order to improve animal welfare and increase milk production. Moreover, important environmental parameters and animals' activity data are often measured in dairy barns but seldom recorded and systematically integrated in an overall database. This study aims to define a numerical procedure suitable to integrate databases collectedin dairy cattle farms from different devices and to propose a numerical model for the quantification of the influence of the thermo-hygrometric conditions on milk production.This research is part of the PRIN 2017 project "Smart Dairy Farming".

Methods

In a context characterized by big and extremely heterogeneous datasets, novel numerical approaches were defined to identify possible correlations between parameters of milk production, behavioral data of the animals and the environmental conditions of the barn.The study has been developed with reference to study cases of commercial dairy farms located in the in Po valley (Italy), equipped with automatic milking system and activity sensors, with the availability of thermo-hygrometric parameters. Two farms were selectedas study cases to carry out more refined processes of training and validation of the modelsand for this purpose they have been equipped with smart monitoring devices specificallydeveloped within the research project PRIN 2017.

Results

Numerical models were developed and proved suitable to characterize the response of individual cows to heat stress conditions and thus classify the animals in terms of susceptibility to heat stress. The models defined can be considered as building blocks forthe development of smart tools for herd management, capable to support farmers in defining and addressing targeted treatments to mitigate heat stress.

On the Determination of Acceleration Thresholds for the Automatic Detection of Cow Behavioral Activities in Extensive Livestock Systems

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Keywords: Sensor-based systems, MEMS, Cow welfare, Automated monitoring systems

Objectives

The use of wearable sensors to record animal activity may be significant in extensive livestock systems, where there is an infrequent farmer-to-animal contact. As stated in previous studies, algorithms based on statistically defined acceleration thresholds could be easily implemented in a firmware for real-time detection of cow behavior. Therefore, the aim of the present study was to prove the feasibility of using acceleration thresholds for the automatic detection of grazing cow behavior.

Methods

The experimental trial was carried out in an existing semi-natural pasture characterized by good availability of meadow and cultivated grazing areas. Two customized devices were equipped with triaxial MEMS accelerometers, omnidirectional antennas, 32bit Cortex Microcontrollers, GSM/GPRS quad band modules, Li-SOCL2 high-capacitybatteries, and flash memories. These devices were put to the collars of two cows and acceleration data were recorded at 4 Hz and sent to a cloud server one time an hour. Field surveys were carried out to acquire video-recordings of cow behavioral activities (i.e., walking, lying, feeding, and ruminating). Synchronization between the acquired frames and the accelerometer signals was obtained by using an application whichincorporated into the video the time-stamped code acquired from the GSM network. Then video-recordings were labelled to obtain the dataset of accelerations. Statistical tests were carried out to define acceleration thresholds for each behavioral activity investigated in the study.

Results

The study made it possible to classify by acceleration threshold values cow behavioral activities that are relevant for grazing cows, especially when farmer-to-animal contact isnot very frequent. In detail, acceleration values along y and z axes allowed the classification of rumination during the laying activities of the cows, feeding activity, walking activity, and laying without ruminating. Acceleration along x axis made it possible to discriminate only the feeding activity, either in standing or walking position.Further development of the study will regard the best combination among accelerometeraxes to improve the accuracy of behavioral activity classifications.

Application of Computer Vision Systems for Herd Management

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Keywords: Deep learning, Computer vision, Detection, Piebald, Precision-recall

Objectives

The aim of the research is to develop a system for the automatic recognition of individual dairy cows in videos recorded in the barn, which can work in real time and provide time histories for each animal as output. This study is part of the PRIN 2017 project "Smart Dairy Farming" and the final goal of the relevant task is the development of a digital system meant to determine the time spent by individual cows in specific areas of the barn.

Methods

Deep learning techniques for the detection of the cows in a dairy cattle barn were implemented and tested on a pilot farm through computer vision procedures. The research has been structured in the following main phases: 1) random selection in the herd of a sample of cows; 2) recording of the videos; 3) creation of the dataset for the training phase; 4) training of the neural network; 5) validation of the neural network; 6) creation of an augmented "virtual" dataset aiming to improve the detection performances of the network for the classes poorly represented in the frames used for the network training; 7) repetition of the phases from 3 to 5 in order to assess the improvement in the detection performances after the manipulations operated to the frame dataset.

Results

Precision-recall curves were elaborated for the whole dataset and the specific target classes. The mean average precision of the detection showed that it is possible to properly identify individual cows based on their morphological appearance and that the piebald spotting pattern of a cow's coat represents a clearly distinguishable object for a computer vision network. The results also led to obtain indications about the quantity and the characteristics of the images to be used for the network training in order to achieve efficient detections.

PLF and Sustainability in Dairy Cattle Breeding

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Keywords: Dairy cows, Environmental sustainability, Efficiency improvements, Life Cycle Assessment

Objectives

Considering the projected increase of food demand and the problems attributed tolivestock productions in terms of environmental impact and animal welfare, the whole sector needs progresses. Among them, environmentally sustainable productions are required, mainly involving the production of milk, meat and other products/co-products with an increased efficiency, reduced carbon footprint, acidification, eutrophication, land use, etc. Introducing system improvements for a more environmentally sustainable production brings also socio-economic benefits, since the efficiency improvement allows also producing more/better with less/targeted inputs and growing healthy animals. In this context, Precision Livestock Farming (PLF) is very promising because it allows monitoring reared animals, early-detecting problems and identifying the related consequences, finally leading to an immediate decision. In the Project "Smart Dairy Farming: innovative solutions to improve herd productivity" the environmental sustainability of monitored dairy cattle farms has been calculated to quantify the effectof the introduction of PLF tools on the environmental impact of milk production.

Methods

All data concerning the selected farm's crop production and animal management were used to carry out a Life Cycle Assessment (LCA) study of: (a) a baseline scenario in which the farm had no PLF systems installed, and (b) an improved scenario in which PLF systems were introduced on farm. The specific steps defined by ISO 14040 series were followed defining goal and scope, functional unit, system boundary, allocation andcharacterization method.

Results

The improved scenario with PLF systems installed on farm, resulted more environmentally sustainable than the baseline scenario, thanks to the possibility of monitoring the animals and barn environment, thus improving the management operations on farm, introducing targeted inputs and achieving a higher efficiency and animals' health and welfare condition. Technology is becoming more and more effective in monitoring and detecting problems, therefore its use is expected to increase in the future.

The Effect of Microclimatic Conditions on Ammonia Emissions from an Open-sided Dairy Barn During Spring

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Keywords: Temperature, Wind speed, Wind direction, Influencing parameters, Emissionevaluation

Objectives

The aim of the study was to assess the influence of microclimatic conditions on ammonia (NH_3) emissions in an open dairy barn during spring in Mediterranean climate.

Methods

Measurements were carried out in a cubicle free-stall dairy barn located in the province of Ragusa (Italy) from 7th to 21st June 2016. Concentrations of NH_3 as well as carbon dioxide (CO_2) were continuously measured by a spectroscope photo-acoustic analyser. Measurements of climate and microclimatic variables (i.e., temperature, relative humidity, wind speed, wind direction) were acquired by sensors installed inside and outside the barn. The CO_2 mass balance method was applied in order to estimate NH_3 emissions. Data collected were organised in a dataset to carry out statistical analysis on gasemissions for groups of days characterised by different climatic parameters. The first group (G1) was characterised by lower parameters than the second group (G2). The one-way analysis of variance (ANOVA) and correlation analyses were applied in order to identify significant differences for tested groups and relation among them. In the post-hoc analysis the mean values were separated by Tukey's honestly significant difference at P<0.05.

Results

For G1 the correlation between NH_3 concentrations was related to indoor air temperature (r=-0.59) and velocity (r=-0.44), while the correlation between NH_3 concentrations was related to indoor air velocity (r=-0.38) for G2.
NH_3 emissions for G1 were higher (P<0.001) than those for G2.
NH_3 emissions were not significantly influenced by indoor air direction with P>0.1.

Spatial Variability of Ammonia and Carbon Dioxide Concentrations in an Open-sided Dairy Barn

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Keywords: Sampling locations, Vertical variability, Cow behaviour, Barn management, Microclimate conditions

Objectives

The aim of the study was to assess the variability of daily concentrations of ammonia (NH_3) and carbon dioxide (CO_2) at different sampling locations (SLs), horizontally and vertically distributed at the centre of an open-sided dairy barn, located in an area characterised by a hot Mediterranean climate.

Methods

Concentrations of CO_2 and NH_3 were continuously measured at 6 SLs in a cubicle free-stall dairy barn located in the province of Ragusa (Italy). Measurements of climatic and microclimatic variables were carried out by two weather stations installed inside and outside the barn. Data acquired were organised in a dataset and statistical analyses were performed to delineate potential differences in gas concentration distribution. Application of a one-way analysis of variance (ANOVA) tested the equality of the meanvalues of gas concentrations for each group of the parameters analysed for groups of SLs. In the post-hoc analysis the mean values were separated by Tukey's honestly significant difference at $P<0.05$.

Results

Gas concentrations of CO_2 and NH_3 changed in time and with SLs during the day inside the barn. There was a significant difference ($P<0.001$) for NH_3 and CO_2 concentrations at different SLs. In detail, the highest values of NH_3 concentrations were recorded at 40 cm from the floor, whereas CO_2 concentrations were the highest at 2.70 cm from the floor. The lowest values of NH_3 and CO_2 were recorded in the SLs located at 1.55 m from the floor. The microclimatic conditions influenced the spatial distribution of gas in the barn. Specifically, concentration of NH_3 and CO_2 decreased in the prevailing air direction due to the dispersion and dilution effects.