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# Journal of Agricultural Engineering

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### INNOVATIVE SOLUTIONS FOR THE MECHANIZATION OF AGRICULTURAL AND FORESTRY SYSTEMS)

#### CONCEPT OF AN INNOVATIVE TILTABLE PLATFORM FOR THE EXPERIMENTAL TEST OF THE STABILITY OF AGRICULTURAL MACHINERY

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*Key words: innovative tiltable platform, stability of agricultural machinery, static and dynamic stability tests, circular path on a slope.*

Current systems used to test the rollover stability of agricultural machines are simple albeit effective in their way of operating. They renounce to identify in detail the position of the centre of gravity but, rather, investigate the static performance of a vehicle in a condition as close as possible to the reality: the vehicle to be tested, equipped with its own tires, is placed on a tiltable flat platform and the angle of the platform necessary to have a side overturning of the vehicle is identified. This system has some limits: vehicles are tested under static conditions at the side overturning only, with their steering members (wheels, central joint) in a configuration corresponding to a straight-path travelling.

Therefore, this paper is intended to present a new equipment for testing the stability of machines, able to overcome the limitations of current systems. For its development, a "top-down" logic was followed: starting from some macro-requirements, the attention was focused on aspects of this system with an increasing level of detail and on smaller and smaller parts, expressing the minimum technical requirements that the various subsystems must have.

In particular, with the aim of having evidences as close as possible to those ones normally experimented by employees in their everyday practice, the design process started from the need to use the new platform for the following (completely new) tests:

- stability evaluation of a vehicle having its longitudinal axis angled with respect to the maximum slope direction of the support surface and, in particular, eventually engaged in a steering manoeuvre;
- stability evaluation of a vehicle engaged in a steering manoeuvre while entering/exiting from an interrow, therefore with a change of slope in the trajectory, however circular;
- lateral overturning evaluation of a vehicle in dynamic conditions, *i.e.* while steering on the platform at different speeds.

The turning manoeuvre is always critical for the safety: the steering wheels (for traditional vehicles) or the two halves (for articulated vehicles) are angled and the supporting polygon is modified.

Based on the requirements expressed here, the system will be

therefore provided with a wide tilting plane (approximately 15x15 m) allowing a vehicle, eventually equipped also with a trailer, to travel on it along a complete circular trajectory. The tangent line at each point of this circumferential trajectory has a different inclination, comprised in particular between  $-180^\circ$  and  $+180^\circ$  with respect to the maximum slope direction of the platform.

The same support surface will have an articulation hinge, positioned at the centre of the supporting surface and having an extension equal to the platform width. This hinge will allow to angle the two flat parts that concur in it and on which the vehicles are placed and made travel: therefore, thanks to it, it will be possible to create an edge similar to a change in the slope.

Once completed, this platform will be part of the permanent equipment of the "Agroforestry Innovation Laboratory" of the Free University of Bolzano, located at the upcoming "NOI - Technology Park".

#### DEVELOPMENT AND TESTS OF A VARIABLE RATE SYSTEM FOR THE DISTRIBUTION OF LIVESTOCK SLURRY WITH PRESSURIZED TANKERS

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*Key words: Variable-rate distribution, Pressurized Slurry tankers, Precision agriculture, Slurry spreading control.*

As is known, effluent management has become increasingly important among livestock farming activities because of: i) the need to valorise a sub-product with a high fertilizing potential, ii) the high costs associated with spreading operations, and iii) the environmental impacts that could result from inadequate effluent management at the farm level. Due to this issue, the European Commission issued several Directives aimed at protecting the environment while ensuring that farmers could achieve proper production levels. In particular, Directive 91/676/EC is currently the main regulation aimed at protecting water from nitrate accumulation due to farming operations. Due to this directive, nitrate vulnerable zones have been set with strict regulations regarding the timing and rates of nitrogen application in these zones. In the vulnerable zones, a specific threshold limits the application rate to 170 kg/ha per year for nitrogen whilst, in the remaining areas, the threshold is 340 kg/ha.

The present study aimed to develop a variable-rate (VRT) system, including electro-mechanic components, capable of automatically controlling the nitrogen distribution rate in the open field. The VRT system was specifically designed for pressurized slurry tanker, *i.e.*, equipped with a vacuum/pressure pump (the most diffused spreading technology used in Italy), and according to a "retrofit" logic as a self-standing module that can be adapted and mounted on existing pres-

surized slurry tanker equipment. Moreover, this system can work with any distribution system, including a spreader plate, crawling nozzles, soil injectors, etc. For field-testing purposes, this system was mounted on a double-axis 10 m<sup>3</sup> slurry tanker equipped with a crawling nozzle distribution unit. Field experiments were conducted at two typical forward speeds (2 and 3 km/h) and three different nitrogen application rates (170, 250, and 340 kg/ha). Based on the experimental results, the system was generally capable of limiting the differences between the nominal and measured application rates to less than 9%. In addition, the data analysis indicated that the slurry spreading was not significantly affected by the forward speed of the tanker. Finally, the uniformity of nitrogen spreading was evaluated according to the UNI EN 13406:2002 standard. The results showed that the transverse field distribution was uniform throughout the working width of the machine and at all tested operating conditions, with maximum deviations that were limited to less than 15% (limit value imposed by UNI standard).

### REAL-TIME MILK ANALYSIS AND SEPARATION IN MILKING PARLORS: PRELIMINARY SURVEY

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*Key words: milk quality, online measurement, cheese.*

The aim of this work was to evaluate the efficiency of real time milk separation during cow's milking through the use of the Afimilk MCS (Milk Classification Service). The study were carried out in three conventional dairy farms located in the Arborea (Oristano) area, where in existing milking parlors were installed the Afimilk MCS devices to analyze and separate milk of each milked cow. The Afimilk MCS analyzed the milk through the Afilab™ (S.A.E. Afikim, Israel), a spectrometer that works in real-time and performs measurements of milk's components. The Afilab™ were installed in the milking parlor, next to the milk meter, one for each station. The tool becomes an integral part of the system, allowing to analyze the milk of each animal in the herd at every milking. The analysis of Afilab™ is based on near-infrared spectroscopy; during milking, the milk of a bovine (each 200 g) is traversed by a ray of light and Afilab™, reading the refraction of light striking the milk, it is able to determine the content of fat, protein, lactose and somatic cells.

The installation of the Afimilk MCS system has proceeded to modify the pre-existing milking parlors with an additional milk pipeline, to allow the conveying of the two types of milk (concentrated fraction and poor fraction), in the two different cooling tanks. The concentrated fraction is milk suitable for the production of soft cheeses (due to the higher content of fat and protein), while poor fraction is used as drinking milk. After the installation of the Afimilk MCS a calibration period of 10-20 days have been done for each of the three dairy farms. From May to September 2015 about 200 samples of separated milk were tested and analyzed by the ARAS (Associazione Regionale Allevatori Sardegna) laboratories. The separation tests were carried out by calibrating the system Afimilk MCS with three different levels of separation to identify the best combination between the quantity and quality of the separated milk: 40% concentrated fraction and 60% poor fraction; 50% / 50%; 70% concentrated fraction and 30% poor fraction. At each level of separation there was an increase in the content of fat and protein in the milk of the concentrated fraction. The milk separation level with a better relationship between quality and quantity of the components of the milk was found to be the one being set to 50%. The results

obtained for this level of separation showed, for the concentrated fraction, a fat content from 4.78% to 5.00% and from 2.50% to 2.67% of the poor fraction. As it regards the content of protein were observed the following range of values: 3.28% - 3.36% for the concentrated fraction and 3.05% to 3.09% for the poor fraction.

### A PORTABLE DEVICE FOR ESTIMATING THE SOMATIC CELL COUNT IN SHEEP MILK

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*Keywords: electrical conductivity, ion sodium, software, animal welfare.*

Somatic cell count (SCC) represents a marker to monitor the udder health in dairy ruminants. In a situation of non-specific illness, such as infections by microorganisms, shocks and/or injuries to the breast tissue, improper milking and environmental stress, the immune system sends in the breast the white blood cells and, consequently, milk presents an increase in SCC. An indirect method widely used for the estimation of the somatic cells is the measurement of the milk electrical conductivity (EC). The value of EC depends on several factors including the ions Na<sup>+</sup>, K<sup>+</sup> and Cl<sup>-</sup>, which represent, in addition to lactose, the osmotically active components of milk. Portable and online EC meters are commercially available, however the correlation between EC and SCC is low both in sheep ( $R^2 = 0.37$ ) and cow milk ( $R^2 = 0.39$ ).

The objective of this work was to study the relationship between the ion Na<sup>+</sup> and the main components of sheep milk, in particular somatic cells. Moreover, a portable device for estimating SCC in sheep milk was designed. The study was conducted on 75 Sarda breed sheep, randomly selected from three different farms located in Sardinia (Italy). A weekly sample of 50 ml of milk was taken from each half udder during the morning milking. Sampling lasted from March to June 2015, and a total of 1,500 samples were analyzed.

The milk components examined were: fat, proteins, lactose, pH, sodium chloride, urea (Milkoscan FT 6000, Foss Electric, Hillerød, Denmark), SCC (Fossomatic 5000, Foss Electric, Hillerød, Denmark) and the ions Na<sup>+</sup> (Laquatwin B725, Horiba, NY, USA) in the ARA (Associazione Regionale Allevatori) certified laboratory (Oristano, Sardinia). Arithmetic means, standard deviations and Pearson correlation coefficients were calculated on the parameters. Values of SCC were transformed into natural logarithm to determine the relationship between sodium ions and SCC. The correlation between Na<sup>+</sup> and SCC corresponded to  $R^2 = 0.76$  ( $P < 0.001$ ).

The prototype developed incorporates two containers which receives milk samples taken from each half udder. Each container has integrated inside two sensors, one to detect the level of Na<sup>+</sup> in the milk and the other one to compensate the milk temperature. The mathematical model, loaded into the microcontroller by a firmware written in C / C ++, analyze the data and gives back the estimate of SCC level. The device is also equipped with a slot for memory card (SD card) that allows to storage the measured data. The portable device developed would allow farmers and stakeholders to monitor the ewes health status by periodically comparing the somatic cell counts of each half udder.