Topic 2

“Machine Milking, Animal Welfare, Work Organisation”

Oral Presentation

Effect of different vacuum levels on buffalo milking

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Abstract
The aim of this study was to determine the effects of three different working vacuum levels (40, 46 and 52 kPa) on the milk production, milk flow rate and milking times in Mediterranean Italian buffalo.
A total of four hundred and four milk flow curves were recorded at random from all of the four hundred and fifty animals in different parity and stage of lactation over a period of 12 weeks, with electronic milk flow meters (Lactocorder®).
The different vacuum levels tested did not affect significantly both the individual milk production per milking (on average 4.00±0.06 kg) and lag time before milk ejection. When diminishing vacuum level, a decrease in average and peak flow rate occurred (P<0.001), as well as an increase in effective milking time between attaching the teat cup and reaching the value of 0.20 kg/min at the end of milking (P<0.001).

Keywords: animal welfare, milking, Mediterranean Italian buffalo**,** vacuum.

Introduction

Dairy buffalo farming have increased in the last ten years in Italy. There are now 358,341 head of buffalo in 2,462 farms (ISTAT, 2010).and the mechanized milking is largely diffused because it is the principal way of increasing work productivity and improving milk quality. Buffaloes are difficult to milk (Sastry et al., 1988) because of their slow milk ejection reflex and the thickness of the sphincter muscle around the streak canal (Stahl Hogberg and Lind, 2003). The udder cistern of buffalo is absent or has a very small volume and, therefore, little or no cisternal milk is available. A vacuum of up to 45 kPa in buffalo is generally ineffective unless alveolar milk ejection has occurred (Ambord et al., 2009). For these reasons the animals are often exposed to a long period of vacuum without any ejection of milk (Caria et al., 2011). Teat stimulation before milking is important to start milking ejection and to reduce lag time (Thomas et al., 2005). The vacuum level applied to buffalo varies in the range of 45-68 kPa (Thomas, 2004) and in Italy, the most used are 44-46 kPa (range 40-53 kPa) (Caria et al., 2011). The use of high-working vacuums combined with the absence of milk can cause irritation in the delicate mammary tissues and, thus, stress the animals (Bruckmaier & Blum, 1996). A positive relationship between increasing working vacuum and the milk somatic cell counts (SCC) has been found in buffalo (Badran, 1992; Pazzona & Murgia, 1992). As for the milking vacuum, higher values of pulsation rate and ratio increases both milk flow rate and somatic cell counts (Dogra et al., 2000; Badran, 1992).
The aim of this study was to determine the effects of three different working vacuum levels (40, 46 and 52 kPa) on the milk production, milk flow rate and milking times in Mediterranean Italian buffalo.

Materials and methods

Experiments were conducted at the buffalo dairy farm located in Pontinia, Lazio, Italy. A total of 450 Mediterranean Italian buffalo of different parity and at different stages of lactation were milked over a period of 12 weeks. in a 2x28 parallel milking parlor with a low level milking system (DeLaval, Tumba, Sweden). The cluster (Harmony Plus, DeLaval) weighed 1.80 kg and was equipped with conic rubber liners (diameter of mouthpiece lip = 20 mm), 450 mL claw size, 12.5 mm short milk tube diameter, 16 mm long milk tube diameter. The pulsator rate was 60 cycles/min and the pulsator ratio was 65%. The working vacuum was tested for values of 40, 46 and 52 kPa, from all of the animals in lactation. Milk flow curves were recorded at random during evening milking, each vacuum level was tested for two weeks using 3 electronic mobile milk flow meters (LactoCorder, WMB, Balgach, Switzerland; Bava et al., 2007; Bava & Zucali, 2007; Borghese et al., 2007; Ambord et al., 2009; Caria et al., 2011). Before milking, teats were cleaned with tap water and subsequently dried with towels; the milking cluster was then applied. During milking sessions the animals were not fed with any concentrates.

Variables measured per each milking were: MY (kg) total milk yield per head from the beginning to the end of the milking; LT (min) lag time from the beginning of measurement until a 0.50 kg/min threshold in the milk flow was reached; MET (min) milk ejection time from milk flow rate >0.50 kg/min until milk flow decreased below 0.20 kg/min; AFR (kg/min) average milk flow rate during milk ejection time; EMT (min) effective milking time between attaching the teat cup and reaching the value of 0.20 kg/min at the end of milking; 2MY (kg) milk yield from the beginning of measurement to completion of 2 min measuring time; 3MY (kg) milk yield from the beginning of measurement to completion of 3 min measuring time; MMY (kg) main milk yield milked in the milk ejection time (MET); PFR (kg/min) peak flow rate in the main milking process within a time interval of 8 measuring points (22.4 sec); IPT (min) time of incline phase from the start of milking from >0.50 kg/min of flow to the start of plateau phase; PPT (min) the time of plateau phase from the vertex of the incline phase to the vertex of the decline phase; DPT (min) time of decline phase, a period of milk flow from end of plateau phase to flow rate <0.20 kg/min at the end of milking.

A total of 404 individual milk flow curves were recorded. All data are presented as arithmetic mean values and standard error of the mean (SEM). Parameters measured were compared by ANOVA using SPSS software (ver. 13.0, SPSS, Inc., Chicago, IL, USA). Differences in means were localized by Bonferroni's t-test in order to classify the effect of the different vacuum levels. $P<0.05$ was considered significant.

Results

The effects of different vacuum levels on the milk flow curve parameters are shown in Tables 1 and 3. The average milk yield (MY) of 404 milk flow curves obtained during our tests (4.00±0.06 kg/milking) agree with data recorded in previous studies (Bava and Zucali, 2007; Borghese *et al.*, 2007; Caria *et al.*, 2011) (Table 1). There was no significant variation in milk yield during the experiment, confirming that all vacuum levels allowed udders to be completely emptied.

Table 1. Milk production and milk flow rate per buffalo (mean±SEM) at different vacuum levels.

Parameter *	Milking vacuum (kPa)				P-value
	40	46	52	Tot	
MY (kg)	4.30±0.16	3.95±0.15	3.73±0.11	4.00±0.06	P=NS
2MY (kg)	1.79±0.04 [a]	2.02±0.04 [ab]	2.27±0.04 [b]	2.03±0.03	P<0.001
3MY (kg)	2.56±0.09 [a]	2.71±0.09 [ab]	3.02±0.09 [b]	2.76±0.04	P<0.001
MMY (kg)	3.75±0.17	3.45±0.16	3.33±0.12	3.51±0.06	P=NS
AFR (kg/min)	0.82±0.03 [a]	0.88±0.03 [ab]	0.93±0.02 [b]	0.88±0.01	P<0.001
PFR (kg/min)	1.22±0.04 [a]	1.40±0.04 [b]	1.41±0.04 [b]	1.34±0.02	P<0.001

*N 404 for each parameter considered; MY, total milk yield; 2MY, milk yield in the first two measuring minutes; 3MY, milk yield in the first three measuring minutes; MMY, main milk yield; AFR, average milk flow rate; PFR, peak flow rate. [a-b]Means within a row with different letters are significantly different (P<0.05).

An increase in vacuum level produced a significant increase in milk yield at the beginning of milking, i.e. at 2 and 3 min (2MY; 3MY). In fact, 2MY represented 41.63% of the total milk extracted at 40 kPa (Table 2). This rose to 51.14% at 46 kPa and 60.86% at 52 kPa. Similar considerations can be made for 3MY which showed a constant increase from 59.53 to 80.97% of MY when the vacuum level rose from 40 kPa to 52 kPa. In contrast, main milk yield (MMY), representing milk yield during milk ejection time (MET), was not significantly influenced by the vacuum level, being an average 87.75% of MY.

Table 2. Milk yield fractions as a percentage of total milk yield per head.

Parameter	Milking vacuum (kPa)		
	40	46	52
MMY/MY (%)	87.21	87.34	89.28
2MY/MY (%)	41.63	51.14	60.86
3MY/MY (%)	59.53	68.61	80.97

The vacuum level affected both average (AFR) and peak (PFR) flow rate (P<0.001). The comparison between 40 and 52 kPa showed an increase in AFR of 13.41% (0.82 *vs* 0.93 kg/min) and an increase in PFR of 15.57% (1.22 *vs* 1.41 kg/min). AFR and PFR values obtained at a vacuum level of 45 kPa reported by Borghese et al. (2007) (0.77 kg/min and 1.22 kg/min, respectively) and Boselli et al. (2010) (0.79 kg/min and 1.13 kg/min, respectively) are consistent with the values obtained in this study at vacuum levels of 40 kPa (AFR 0.82 kg/min and PFR 1.22 kg/min, respectively).

Variation in milking times at different vacuum levels is shown in Table 3. The effective milking time (EMT) decreased by 20.14% when passing from 40 kPa to 52 kPa (7.15 *vs* 5.71 min; P<0.001). This confirms that, as reported for dairy cows (Reinemann et al., 2001), the milking time increases as the working vacuum is reduced. By separating lag time (LT) and milk ejection time (MET) from the EMT, we can identify which of the two phases was most influenced by the vacuum level. While MET increased as the working vacuum was reduced, vacuum level did not influence LT. This could be explained by the anatomy of buffalo's teat where the canal closure is quite tight and requires a tactile stimulation to be opened, rather than by the vacuum applied (Ambord *et al.*, 2010). These results are in contrast to the findings of Caria *et al.* (2011) who reported that a difference in vacuum level between 36 and 42 kPa did not influence MET (P=0.138) while it did affect LT (P=0.049).

Table 3. Milking times per buffalo (Mean± SEM) at different vacuum levels.

Parameter*	Milking vacuum (kPa)				P-value
	40	46	52	Tot	
EMT (min)	7.15±0.24 [a]	6.39±0.22 [ab]	5.71±0.15 [b]	6.64±0.09	P<0.001
LT (min)	2.50±0.21	2.39±0.20	2.13±0.12	2.42±0.08	P=NS
MET (min)	4.64±0.17 [a]	4.00±0.17 [b]	3.58±0.11 [b]	4.22±0.07	P<0.001
IPT (min)	0,30±0,03	0.33±0.03	0.31±0.04	0.32±0.02	P=NS
PPT (min)	2.23±0.12 [a]	1.67±0.11 [b]	1.59±0.08 [b]	1.91±0.05	P<0.001
DPT (min)	2.11±0.15 [a]	2.00±0.14 [a]	1.67±0.08 [b]	1.99±0.05	P<0.001

*N 404 for each parameter considered; EMT, effective milking time; LT, lag time; MET, milk ejection time; IPT, time of incline phase; PPT, time of plateau phase; DPT, time of decline phase. [a-b]Means within a row with different letters are significantly different (P<0.05).

Analysis of the three main phases (incline, plateau and decline phase) provided by Lactocorder® to describe the highest part of the milk flow curve provides an additional tool in the evaluation of individual milk emission profiles. Average incline phase (IPT) was 0.32±0.02 min and no difference was seen between all the vacuum levels tested. The duration of the plateau phase (PPT), that is generally influenced by the different distribution of milk among the quarters and the udder health status, can be shortened by an irregular milk ejection or vacuum instability. In this study PPT decreased with an increase in vacuum level (P<0.001), similar to results reported for cow milking (Ambord and Bruckmaier, 2010). When using lower vacuum levels, there was an increase in decline phase (DPT) (P<0.001). Long DPT can indicate that the milk flow is low or absent. This is associated with a higher risk of mastitis infection due to the possible passage of pathogens throughout the open teat canal.

Conclusions

Results of the study into the effects of milking buffalo at different vacuum levels (40, 46 and 52 kPa) on milk production, milk flow rate and milking times showed that:

- the Mediterranean Italian buffalo is suitable for mechanical milking at different working vacuum levels;
- milk yield (MY) was not influenced by the working vacuum level and was also satisfactory at 40kPa;
- average and peak milk flow rate (AFR and PFR) increased significantly along with an increase in working vacuum level. Consequently, the time between attaching the teatcup and reaching the value of 0.20 kg/min (EMT) was reduced with an increase in vacuum level;
- vacuum levels of 40 kPa provided good milkability conditions in which the plateau phase (PPT) was longer than the decline phase (DPT), while lag time (LT) was not affected by vacuum level.

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Ergonomic exposure assessment of posture and muscle activity among dairy parlor workers in US large herd operations

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Keywords: dairy, agriculture, electromyography, posture

Objectives

The US dairy industry has experienced a relatively rapid transformation from small herd farms to large-herd, mass production operations. During the last 30 years the number of US dairies decreased while herd sizes and milk production increased. This transformation has led to significant changes in work tasks and in ergonomic challenges due to the highly repetitive work nature of the milking process. Minimal research has addressed ergonomic issues in these mass-production environments. Field-based direct measures of physical exposures have been limited in these challenging work environments. The purpose of this study was to evaluate the usefulness of full-shift quantitative exposure assessment tools for assessing posture and muscle activity among large herd parlor workers.

Methods

Study participants were recruited from large herd dairy operations in the states of Colorado, New Mexico and Texas. Each participant was Hispanic, worked full-time in a dairy parlor, and was free from pain or pathology in the upper extremity. Shoulder elevation and trunk inclination angles were estimated using triaxial accelerometers. Accelerometers were wireless, battery powered, and packaged in a small pager sized portable casing with 2 megabytes of built in datalogging memory. Surface electromyography (EMG) was sampled continuously during an entire work shift while workers performed milking tasks. EMG samples were composed of continuous recordings of the upper trapzezius, finger flexors, finger extensors and anterior deltoid (shoulder flexor). These muscles were chosen for their relevance when performing milking tasks as well as the ability of researchers to position surface electrodes over muscle bellies.

Results

Results suggest parlor workers are exposed to extreme exposures (awkward postures, high movement velocities, high repetition, high muscle forces, and inadequate rest). These physical exposures are often associated with the development of upper limb pathology. These findings warrant the need for continued research to investigate these working environments to facilitate the development of cost-effective intervention strategies. Several ergonomic strategies to reduce the physical exposures have been developed and are currently being evaluated for effectiveness.

Bull-Related Attacks – An Owner's Potential Liability

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Keywords: bulls, livestock injuries, agriculture, bull attacks

Objectives:

The hazards associated with breeding livestock, including bulls, have been well documented in the agricultural safety literature (Sheldon, 2009) and earliest annals of literature, including codes and regulations related to animal ownership. To date the database of bull-related attacks at Purdue University has documented over 300 cases of which approximately half were fatal. Due to the lack of a comprehensive surveillance system for agricultural injuries, the numbers of these events is probably much higher especially with respect to non-fatal incidents that go largely unreported. The goal of this effort was to review the legal questions related to bull attacks and to explore owner responsibilities in light of past legal precedents. Specific objectives included:

1. Review of the literature on past bull-related incidents resulting in litigation.
2. Explore specific bull owner liability issues with respect to appropriate restraint and containment of bulls to prevent personal injury or property damage.
3. Develop recommendations for bull owners that would reduce the risk of bull attacks and owner liability in the event of bull-related damages.

Methods:

Bull-related injury data was updated and summarized based upon work published in 2009 by (Sheldon, et.al.). Over 300 cases documented in the U.S. between 1980-2012 were reviewed for reports of civil litigation.

A search was conducted of current laws and regulations related to bull ownership and requirements for ensuring worker and public safety.

Results:

Bull attacks continue to be a serious issue for dairy and beef producers in both the U.S. and elsewhere. There is a long history of laws and regulations that have recognized the risks associated with bulls and the responsibilities of owners to protect others from bull-related injuries. Of the 300 bull attacks documented approximately half were fatal. Since most involved the owner or family member few resulted in civil litigation.

Key findings from the review of prior civil litigation included issues related to the owner's prior knowledge of unsafe bull behavior, failure to warn, and inadequate restraint or containment of bulls. In several cases where the bull had shown no prior aggression towards humans, the findings of the court generally favored the bull owner rather than the injured party.

Recommendations considered most significant included the need to assess how essential is the ownership of breeding bulls versus utilization of artificial insemination practices; enhanced awareness of the unpredictable and aggressive nature of breeding bulls; and the need for enhanced restraint and containment facilities, especially when bulls are maintained in open pastures and feedlots.

Changes in the US dairy industry require development of comprehensive employee training and safety programs

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Keywords: dairy, safety, training program

Since WWII the US dairy industry has changed to more efficiently produce dairy products to meet higher domestic and international demands. In 1944 the US dairy Industry produced 53 billion kg of milk with 25.6 million cows while in 2007 37% more milk was produced with 64% fewer cows. The number of dairy farms has declined while herd sizes continue to increase. Because of shrinking margins and consequential advantages of economies of scale, it is not an entirely unlikely scenario to see a new US model where economic equilibrium is reached with 9 million dairy cows consisting of 900 dairies with 10,000 cows each; as opposed to 9,000 dairies with 1,000 cows each.

As the number of large-herd operations continues to rise these dairies will continue to employ more workers. Currently it is common on dairies in the Western US to see one employee per 80-100 milking cows. Having larger numbers of employed workers presents new challenges for dairy owners and managers of ensuring safe working environments and complying with state or federal occupational safety and health regulations. Many dairy owners and managers are now responsible for managing human resources and safety programs, yet most have not had formal training in employee management or occupational safety.

The increased size of many of the southwestern dairies actually presents a unique opportunity for the development of tailored training programs since daily duties and tasks on the dairy have become highly specific and specialized. Historically, the task of training and supervision of employees typically was that of upper-management. With increasing employee numbers, this task is often delegated to employees with seniority (mid-level management). Formal training, including basic and theoretical study explaining the rational or the science behind particular work related activities, is not common. Often employees will know “what” to do but may lack the understanding “why”. Super-imposed on this, the large majority of workers on dairies in the US are from different geographical and cultural origins; it is therefore imperative and appropriate that any training and safety program be based on understanding of linguistic and cultural barriers and attitudes towards working with animals and/or equipment.

It is imperative that insufficient understanding of the task can impact the outcome of the task in many ways: job motivation and hence job performance, thoroughness, expedience, accuracy, and finally but not any less important job safety. The organizational support to implement a successful training program has to be developed, and operational and managerial commitment to such a program is required.

A new testing technique for measuring the skid resistance of hard and soft flooring materials in dairy housing

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Keywords: dairy cows, floors, skid resistance

Objectives

The floors slipperiness is one of the main factors of hoof and leg injuries in dairy cow housing. The friction coefficients, static and dynamic, are the parameters commonly used for a specific evaluation. But the testing techniques commonly in use appear not very suitable since not capable of reproducing the real interaction between the animal foot and the floor surface, especially with soft floors, being the skid resistance also depending on the elastic deformation.
Therefore we realized and tested a new instrument capable of measuring the real skid resistance with all kinds of flooring materials, especially the soft ones.

Methods

The instrument is based on the drag method and consists of: a device capable of exerting a vertical force up to 250 daN; a test body in the shape of a claw, made of polypropylene, set on a sled; a pushing device capable of exerting a horizontal force so as moving the sled at a constant speed; a system of sensors and load cells measuring various parameters (vertical and horizontal force, tilting angle, penetration of the test body).
The ratio of the horizontal limit force, immediately before the claw displacement, to the vertical force gives the static coefficient of friction (COF). The same ratio during the movement represents a sort of dynamic COF, reproducing the variable reaction of the floor to the hoof while slipping.
In the first laboratory trials nine commercial flooring materials were tested. In a second trial, field tests were conducted in dairy houses.

Expected Results

From the measured parameters some indicators capable of describing the various aspects of the slip mechanism can be derived. Such indicators make it possible to evaluate and compare the performance of all types of flooring materials, especially the soft ones, and can indicate which characteristics (physical and geometrical) of the various commercial products can better perform in real housing conditions.

A farm configuration system to supply lca inventory analysis needs for the assessment of orchard performances

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Abstract

The possibility to certify the quality of agricultural productions is moving also towards the capacity to evaluate both the *C-footprint* and the *total energy consumption* (including direct and indirect components) related to the expected, or actual, behaviour of the farm. This is particularly felt by farming systems ensuring high gross margin values, such as viticulture and apple-orchard systems. To this aim, the possibility to be able to refer to a single standard farm model, able to deal with both planning and monitoring tasks, is therefore increasingly strong. The paper provides the proposal of a new farm conceptual model through a farm configuration tool completed with database and related modular software interfaces for storing information of both the features of the production environment and of its management dynamics. Every farm is treated as a complex system, in which different type of components (climate, biological, technological, organizational, economic etc.) interact continuously. Because of this, all the operational areas must be regarded with a level of detail consistent with each other, because each part affects the other directly or indirectly. This led to define a farm ontology (FO) based on a single general reference model, in which all the major entities and relationships of the system are represented with a detail able to satisfy all most common applications across the farm, regardless of the farming system at hand. This FO facilitates any LCA application, allowing the use of common methods and databases in the early stages of inventory analysis.

Keywords: farm ontology, farm modelling, energy analysis, process certification, farm information systems

Introduction

ICT solutions currently available to farmers for the most part are designed to meet a specific need (warehouse or livestock management, farm site-specific distribution, etc.) (Pierce and Elliot, 2008). However, they generally preclude the possibility of integration in case the use of more farm management procedures is required. The problem becomes even more relevant when the need of considering strategic tasks by modelling tools is included, as well. Thus, the need to define a new (and more "flexible") conceptual model to be used as unique standard reference in every task of farm modelling is nowadays felt more then ever. This could even match the goals of *inventory analysis* foreseen by LCA applications when assessing the sustainability levels of some farm processes (Audsley, 1997; Audsley et al., 2006; Berry et al., 2006). This approach can also satisfy the analysis of planned and executed farm-field processes, focused on the capacity to evaluate both the *C-footprint* and the *total energy consumption* (including direct and indirect components) related to the expected, or actual, behaviour of the farm.

The farm configuration here proposed considers the farm as a whole, so one can achieve all its aspects, both structural and functional, in an integrated and holistic view. In addition, it enables the farmers to include both planning and management aspects (nominal plans vs executed plans), in order to be able to analyze comparatively the expected and the actually carried out operations within the same computational framework (and within a common database). Planning procedures could be even used to simulate scenarios that are alternative to a reference situation, whilst management procedures enables several applications such as climate or crop monitoring, the control of the way an operation is performed, the filling of field registers, till the automatic control of the behaviour of some machines (that is typical of many precision farming applications). Such an approach requires the preliminary development of a proper ontology, say a Farm Ontology (FO), similarly to what was previously performed in other enterprise sectors (Uschold et al., 1998) and in similar agricultural contexts (Martin-Clouair and Rellier, 2009).

Material and methods

The general Farm Design Pattern

The general conceptual model of a "farm system" is shown by Figure1. The entity **`Farm`** is firstly seen as a collection of **`Asset`** and **`Action`** classes, in accordance with the definitions given in Table 1. The class **`Asset`** defines the *Farm Configuration*, say the structural composition of any mean used (or produced) at the enterprise. Assets are then split into **`Resource`** and **`Material`** classes, and the latter are in turn divided into **`Input`** and **`Output`** classes, depending on the type of relationship an instance of **`Material`** and/or **`Resource`** has with an instance of the **`Action`** class.

Table 1 – Main entities provided by the Farm Ontology with related definitions.

ENTITY	DEFINITION
Asset	Any entity with **monetary value** in charge to the farm administration.
Action	Any virtual entity, implying a dynamic procedure and determining something's **behaviour**, produced by a decision-making process at the farm.
Resource	An asset always available at the farm that can be **used** by an action.
Material	An asset **consumed** (*input=factor*) or **generated** (*output=product*) by an action.
Externality	Chemical or physical event occurring during the execution of an action that thus generates adverse impacts to the environment external to the farm system and to the operators involved.
Performance	A numerical index expressing a quantitative evaluation on the behaviour of the farm in relation to a particular *domain of interest*. It can regard both **ex-ante** or **ex-post** behaviours.
Efficiency Index	Dimensionless index quantifying how an ex-post performance meets the prefixed target established by an ex-ante performance.

At this preliminary level, the concept of "*action*" is very general: it can firstly be seen as the result of a decision-making process. As such, it implies a generic dynamic concept established by any previous <u>decision</u> (of strategic, tactical or operative nature), destined to cause some changes into the current farm structure, thus even determining the farm behaviour. There are two types of actions: **`Planned`** and **`Executed`**, depending whether the dynamic sequence of tasks established by the action is simply foreseen or it has been already actually processed, respectively. Whatever the case, any instance of **`Action`** is expected to have one or more relationships with **`Asset'`**s instances. Thus, by definition we can have:

- an **`Action`** that *uses* a **`Resource`** (the same asset is available prior the action and returns available for other actions after use);
- an **`Action`** that *consumes* an **`Input`** (the input material, even named *factor*, is available prior the action and is no longer available for other actions after use);
- an **`Action`** that *produces* an **`Output`** (the output material, even named *product*, is not available prior the action, being generated during the action itself, and becomes available for other actions after use).

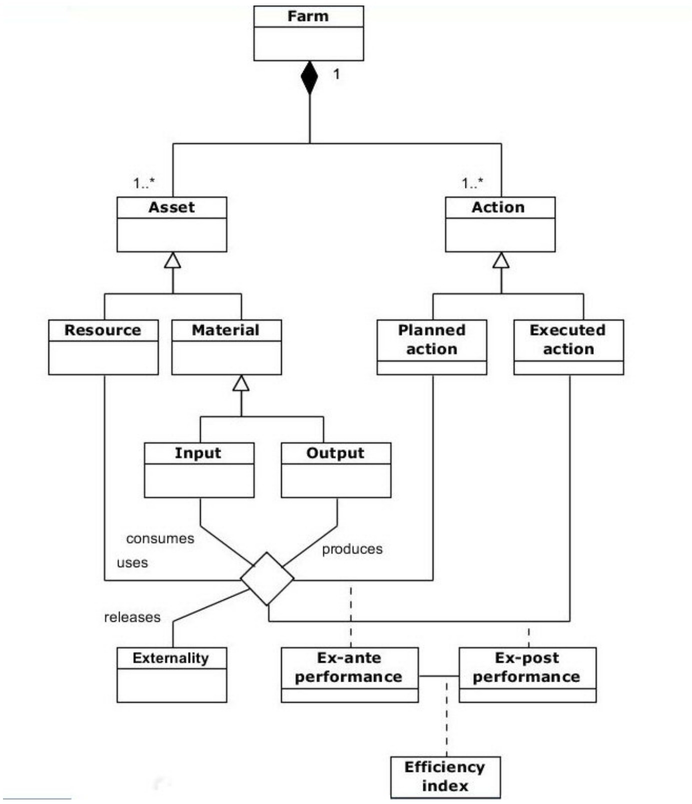

Figure 1. General design pattern of the Farm Configuration System here proposed.

In addition we can also have an **`Action`** that *releases* an **`Externality`**, occur-ring every time a negative impact on the surrounding environment is generated through the release of harmful substances (or otherwise undesirable) or the creation of noxious physical and chemical effects. For example, the evaluation of the *C-footprint* impact starts just from here, as well as all the negative physical effects potentially providing professional risk for human health (such as *noise* and *vibrations*) can be attribute to that class.The farm behaviour can be finally evaluated throughout one or more *indices of performance*, all instances of the classes **`Ex-Ante_Performance`** or **`Ex-Post_Performance`**, depending if the behaviour at hand is related to a planned or executed action, respectively. An *efficiency index* can be finally computed, as instance of the class **`EfficiencyIndex`**, when comparing an actual performance with an expected one, foreseen by an evaluation plan.

The Farm-DB

The persistence of the information is provided by the tables of a relational database (*Farm-DB*) that is designed in accordance with the conceptual logic of the FO and with the above Farm Configuration design pattern. Such a Farm-DB can be used as a data reference structure for many modelling applications. Its information detail is sized on the need of treating data retrieved from actually executed management tasks (typically from ex-post actions). Thus, some information could be redundant and not required for some strategic applications (e.g., when evaluating alternative scenarios for alternative ex-ante actions). To overcome this aspect and even in order to facilitate the work of the final user, the DB can also be arranged to provide aggregate information and default data to be referred to *ordinary* (average or most probable) situations.

The DB data-entry can be carried by: **a)** a *final user*, directly, **b)** a *simulation model*, and **c)** a *monitoring system* provided with data-loggers for automating the data collection. The case ***c)*** obviously requires the maximum data detail. In fact, being based on the observation of the activities actually executed, it has to be able to take a sort of "photograph" of the reality, as much accurately as possible. The automation of this shot generally requires the contextual, integrated use of *sensors*, *identification systems* (to detect what entity took part to the activity) and *positioning systems* (to contextualize the above information in a geo-referenced space). Alle the data automatically collected (*raw data*) must be previously converted into *inferred data* (i.e., intelligible information to be used in management decision-making processes) before be inputted into the Farm-DB. The conversion *Raw-data → Inferred-dat*a is usually performed by an **inference engine** that must be provided together with the Farm-DB.

Farm resource

By the given definition, a farm resource must be here intended as whatever type of entity, taking part in a process, that is available at the enterprise both before and after the execution of the process. Resources then include a wide range of very different types of entities, all with the common feature of having an "*utility*" that can be spread over several year at the farm. The utility duration is even named *useful life*. Such an utility necessarily must be formalized through a relationship between the entities **`Farm`** and **`Resource`** that can have different *kind* according to the contractual form the resource is annexed to the farm: ownership, rental, leasing, permanent recruitment etc. The achievement of a new resource implies *making an investment*. So, the farm resource set represents the long-term structural allocation of an enterprise and must be congruent with its production goals.

Typical farm resources regard lands, building, machinery, plants and labour. Each resource type is then modelled through a specific child-class descending from the **`Resource`** mother-class and specializing its own properties and methods (Figure 2). Regardless of the type, each resource can be equipped with a data logger in case of automating monitoring tasks for detailed ex-post evaluations. Specific classes (**`Datalogger`** and **`Datalogger-Allocation`**) and related tables in the Farm-DB enable to manage all the basic information for the resource automatic identification.

The main reference class for land resources is **`Cadastral-Parcel`**. This is because it is the entity for which it is possible to assess unequivocally the type of formal relationship between the resource and the farm (rental, ownership etc.). Anyhow, regi-stered parcels are used only when the application has even to face with administrative tasks. In general, the unit of land that is actually processed is the field, e.g. something practically identifiable by means visible boundaries, and implemented by the **`Field`** class.

The two classes are linked by a many-to-many relationship (**`Fie-ldOnParcel`**, specifying how fields and cadastral parcels cross one another) that is not used when administrative goals are not to be satisfied. A simulation model dealing with strategic and/or tactical problems typically considers **`Field`** class only, and all the main land properties must be specified with reference to this class. All the resources related to the farm machinery set are treated by a unique **`Machinery`** class. It includes both *stationary* (heaters, electric power generators) and *mobile user points* (tractors, self-propelled units and implements). Relevant machine-related properties regard the *driving system* (supplied and required; say, what form of power a machine can offer or demands, i.e. traction through drawbar, power from mechanical, hydraulic or electric p.t.o.), the *coupling system* and the *sizes*. These latter, when referred to the main working bodies (engine nominal rated power, working front width, loading capacity volume etc.), can be used to compute an estimate of fuel consumptions and working times of a given tractor-implement combination. This is very useful to provide both default values and quick-available evaluations for ex-ante performances analysis.

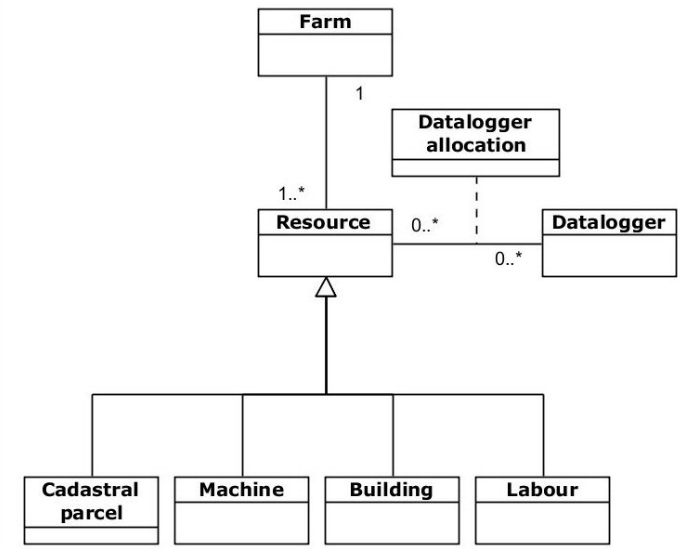

Figure 2. Farm Resources.

Unlike the **`Machine`** class, that is unique for all the machines, it was decided to specialize the different types of farm buildings into several child-classes all descending from the **`Bulding`** mother class. The latter includes all the general properties related to sizes, volumes and types of materials used for the building structure. Child classes provide more detailed information on the functional properties of the building at hand.

Finally, what is generally named "*plant*" is here treated as a one-to-many relationship (**`Plant`**) between the **`Machine`**-class and a generic descendant functional **`Building-`**class, where the machine instance is generally represented by a stationary user device. Many building-entity instances have relationships with material-instances when performing storage and/or conservation tasks.

Actions

In the FO *any action is the result of a decision*. Thus, we can also speak of *strategic*, *tactical* and *operative* actions. In addition, any action holds an *ex-ante* and *ex-post* status, depending on the fact it is simply planned or actually already executed. Anyhow, in the FO any action refers to an event that is under the direct control of a responsible (entrepreneur, farm manager, worker) and that implies relationships with resources and materials finalized to productive goals. The basic type of actions defined by the FO are shown in Table 2 and the related general design pattern showing **`Action`** classes and relationships is in Figure 3.

The "master" action *Production Goal* is implemented by the class **`Production-Expected`**, that is a relationship between instances of **`Material`** and **`Nominal-Plan`**. In practice, when selecting what to produce, the entrepreneur must contextually have in mind how to get such a target. This means to select also the *Nominal Plan* by which the expected production (that is an instance of **`Material`**) can be achieved.

In ex-ante evaluations the *Nominal Plan* can be easily composed also retrieving standard default operations (say, instances of the **`Operation`** class), to be considered – in a given region - as reliable references of the most common and representative work practices usually there carried out. To this operation, a tractor/implement combination must be firstly allocated, as instance of the class **`MachineryCombination`**. Such a class, on its hand, derives from a recursive many-to-many relationship on the **`Machinery`** class. This means that any combination could include more than one power-unit (that is important when stationary plants have to be taken into consideration) and more than one implement (e.g., a tractor coupled with a seeder and a sprayer), thus ensuring great flexibility in the way a combination can be composed.

Table 2 – Main type of actions defined by the Farm Ontology with related definitions.

ACTION	DEFINITION
Production Goal	Strategic action assessing and selecting the farm resource set required to pursue the implementation of a collection of homogeneous products.
Farming System	Strategic action selecting the list of all the possible Production Goals to be realized at the farm.
Process (or **Operation)**	Tactical action in which "technical" resources (say, machinery and buildings) and input/output materials are allocated to generate modifications in some materials or in the environmental work-context for completing a step of the Production Goal. It can also generate some Externalities. The setup machine allocation requires a combination of **power-units** and **implements**. The setup material allocation requires a list of **working specifies**.
Nominal Plan	Tactical ex-ante action selecting the list of all the Operations needed to fully achieved a Production Goal. Conceptually, it can be treated as a POS (*partially ordered set*).
Scheduled Process	Tactical ex-ante action by which the allocation of a pre-defined Process is completed also in terms of **responsibility** (the executor, a person responsible for the process), **space** (where it is expected to take place) and **time** (when it is expected to start).
Scheduled Activity	Part of a Scheduled Process delimited by a specific **time range**.
Monitored Activity	Activity documented throughout a **monitoring procedure**, thus always related to an *already executed* scheduled process. Conceptually the execution can be performed both actually at the real farm or by a simulation model. In the first case, the monitoring procedure can be carried out both manually (direct observations) or by data-logger (automated monitoring).

An operation becomes "*scheduled*" when its resource allocation is completed with the assignment of instances of **`Labour`** and **`Field`** classes (in case of cultivating operations), and when its work time profile is computed. To do this, a **`Field`** must be previously assigned to a **`NominalPlan`**. This is performed by the class **`CropRotation`**, that is a relationship implementing the medium-term management action by which a field is associated along the timeline to a crop. According to the FO, here a "*crop*" is an instance of **`NominalPlan`** featured by an *expectation of production*. It must be finally noted that, in practice, every **`ScheduledOperation`** is actually carried as a sequence of activities (implemented by the **`ScheduledActivity`** class, not indicated in Figure 3).

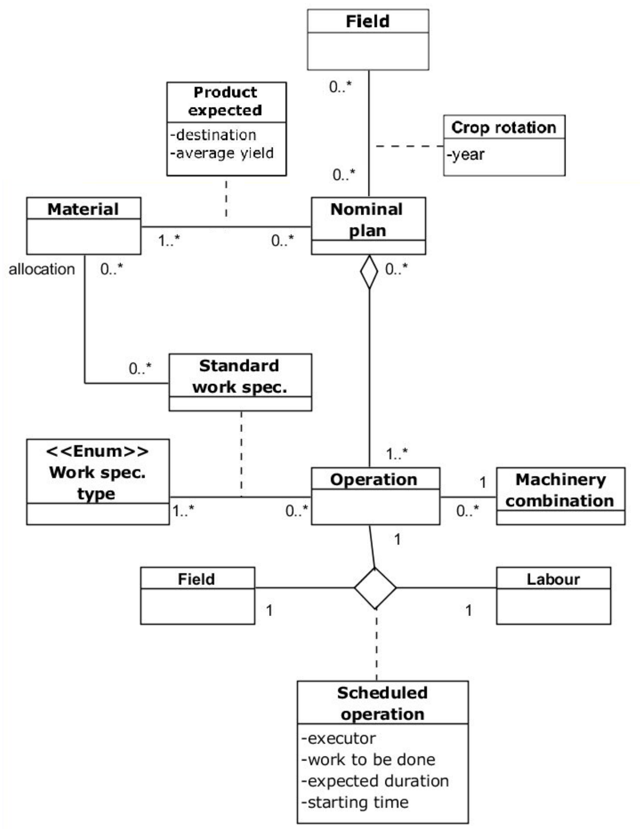

Figure 3. Design pattern for actions in the FO

In ex-ante evaluations, any activity-type action is commonly obtained crossing an Operation, which duration is spread over several days, with the working daily shifts of the farm. In ex-post evaluations, the activity is always derived by a monitoring procedure and it is more properly managed by instances of the **`Monitored-Activity`** class.

The classes **`ScheduledActivi-ty`** and **`MonitoredActivity`** clearly mark the boundary between ex-ante and ex-post evaluations, the most relevant difference between the two classes being represented by the way the material/resource allocation and work-timing data are provided (by planning and monitoring actions, respectively). Apart from that, all other classes can be used equally both for ex-ante and ex-post applications. The main difference concerns the sequence by which the information details are provided. In planning tasks, a *top-down* sequence must be followed: from **`NominalPlan`** down to **`ScheduledActivity`**. Conversely, in monitoring tasks a *bottom-up* procedure has to be applied, from **`MonitoredActivity`** up to **`NominalPlan`** (that thus achieves the status of “*executed*”).

Applications

The first FO applications were carried out to perform strategic evaluations on alternative cropping systems in Italy, dealing with both arable and mixed-livestock farms (Mazzetto et al., 2004; Fumagalli et al., 2011). In all those cases the methodological approaches resulted to be quite satisfying due both to the modularity and the flexibility of the implemented tools. This enabled to extend the use of this FO also to farm management applications. In particular, it was then successfully applied also as main conceptual model to develop a *farm information system* including methodological procedures to carry out a remote, permanent on-line monitoring activity of animal effluents spreading (with mass balances) within a voluntary-based network of livestock farms in Lombardy (Figure 4, Mazzetto et al., 2009). This has been one of the first applications aiming at providing reliable tool for *process certification* at farms based on an automatic detection of the operations actually there carried out.

This certification is now interesting even the orchard farming systems (in particular the ones involved in apple cultivations) with the aim to perform *both process and environmental certifications* to be commercially spent as added value in favour of the quality of the final primary products. Certification tasks necessarily requires a reliable monitoring activity of the processes actually carried out throughout an ex-post management analysis that can include also LCA evaluations. To this aim, the FO-model, with its related data structure, is highly suitable to be considered as proper tool to carry out *inventory analyses* in agricultural LCA-related issues. A project on these tpoics is now in progress in some horticulture farms in Northern Italy.

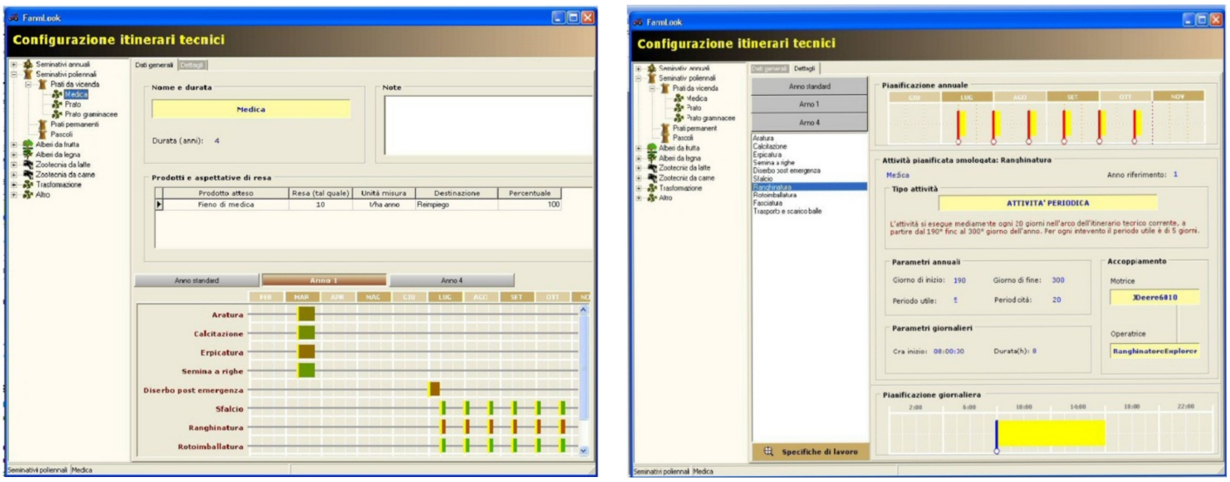

Figure 4. Setup examples of planned ctions: nominal plans and operations

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Topic 2

“Machine Milking, Animal Welfare, Work Organisation”

Poster Presentation

Ergonomic postures assessment of workers during milking of she asses

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Abstract

The aim of this study is to examine the work position of the workers during the milking of she-asses due at risks deriving from repetitive upper limb movements. The assessment concerns the whole daily exposure to risk, taking into account the other activities carried out by the worker, that are strictly connected with milking. The analysis carried out in this paper will be useful to the farm in perspective of a plan based on increasing of head in number.
We selected three typical farms situated in Eastern Sicily (Italy). The first was on the slope of Mt. Etna at 550 m a.s.l.. It has around 80 heads, 40 adult female (18 – 20 in lactation), the second farm has around 12 female in lactation and is equipped with a bucket milking machine, while the third farm has 8-10 female in lactation and the milking is performed manually.
We assessed the musculoskeletal risk to the upper limbs by means of the OCRA Checklist (Colombini et al., 2005). The tasks processes were broken down into fundamental phases (CIOSTA – AIGR methodology). The examination of video films shot during the work period made it possible to deduce or confirm information about frequency, posture and the stereotypical nature of the work.
The research shows that in she-asses farming workers are exposed to musculoskeletal risks due to repetitive movements and incorrect postures. Those equipped with a milking parlour with pit parlour show the same problems observed in cow farming, but the small number of head per farm makes small the connected health problems.

Keywords: WMSDs, operator safety, milking parlour, pit parlour

Objectives

The demand for she-asses milk is increasing because of its recognised anti-allergic qualities (*Chiarelli and Di Michele, 2007; D'Amico et al., 2007; Nazzaro et al., 2007*). But it is not easy to obtain a commercial quantity of she ass milk, because the female in lactation can't be more than 1 to 4 heads with a very limited production of about 1200-1500l/day. As concerns the milking parlour, the level of mechanization in most of farms is rather limited. In this working conditions, the milker expose oneself to musculoskeletal disorders, as already demonstrated by other research on cows and other animals (*Gustafsson and Lundqvist, 1987; Gustafsson and Lundqvist, 2003; Kolstrup C., 2008; Lundqvist et al., 1997; Lundqvist, 2010*).
The aim of this study is to examine the work position of the workers during the milking of she-asses due at risks deriving from repetitive upper limb movements. The assessment concerns the whole daily exposure to risk, taking into account the other activities carried out by the worker, that are strictly connected with milking. The analysis carried out in this paper will be useful to the farm in perspective of a plan based on increasing of head in number.

Methods

We selected three typical farms situated in Sicily (Italy). The first has around 80 heads, 40 adult female (18 – 20 in lactation) and has a milking parlour with milking pit (*Figure 1*), the second farm has around 12 female in lactation and is equipped with a bucket milking machine (*Figure 2*), while the third farm has 8-10 female in lactation and the milking is performed manually (*Figure 3*).

We assessed the musculoskeletal risk to the upper limbs by means of the OCRA Checklist using the software "midaOCRAmulticompiti" (*Colombini et al., 2005; Occhipinti E., Colombini D., 2007*). The studied heads were in good health and far off from the calving. The tasks processes were broken down into fundamental phases (CIOSTA – AIGR methodology).

The tasks processes were broken down into fundamental work phases (CIOSTA – AIGR methodology). The examination of video films shot during the work period made it possible to deduce or confirm information about frequency, posture and the stereotypical nature of the work.

Results

The research shows that in she-asses farming workers are exposed to musculoskeletal risks due to repetitive movements and incorrect postures. Those equipped with a milking parlour with pit parlour show the same problems observed in cow farming, but the small number of head per farm makes small the connected health problems.

As concerns Farm 1, the final daily Checklist score, weighted for the net duration of the repetitive tasks is 7.60, a low but existing risks.

As regards Farm 2, the milker assuming bad postures but thank to the short milking time the final score is low, as long as the herd is less than 12 - 14 heads.

As concerns Farm 3, due to highly incorrect postures (*Figure 4*) and other factors (repetitiveness and frequency above all), the final score is a red one: 16.25 (left arm) and 18.50 (right arm).

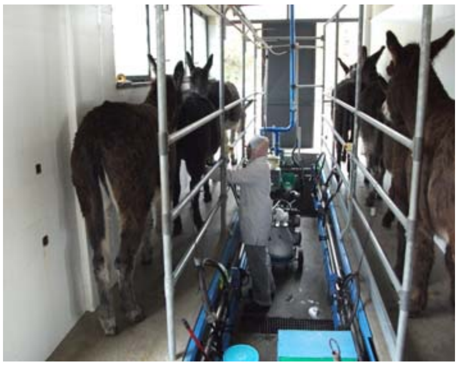

Figure 1. Milking parlour of farm 1

Figure 2. Milking in farm 2

Figure 3. Milking in farm 3

Figure 4. Uncorrected posture in farm 3

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Climate conditions in a broiler house in Molise: experimental and numerical analysis

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Abstract
Ventilation flow in livestock buildings can determine the indoor climate and air quality and so it affects the welfare of the reared animals. The experimental study was carried out in a poultry house located in Molise (Italy).
The objective of this study was to find the optimum ventilation system to improve the rearing conditions in broiler house.
Climate conditions were evaluated by mean of temperature, relative humidity and carbon dioxide concentration; the BABUC/A, connected with tree probes, the BSU102 for temperature, the BSV101 for air flow and the BSO 103.1 for CO2 concentration, was used to detect the investigated parameters; detections were measured at 3 different heights, at 20cm from ground level, 100cm and 150cm, every 10 m all along the length of building.
During experimental trials different configurations of the ventilation system were tested and even if a little influence was found on CO2 average concentration, an irregular distribution was detected due to a wrong activation of the fans in the ventilation system.

Keywords: ventilation, temperature, poultry

Introduction
To determinate animal's wellness is easy as to determinate the human's one.
Well being is " the condition of a person regarding his tries of adaptation to his habitat".
So well being can be defined the greatest reduction of uneasiness causes in the habitat were everyone lives. In the end the more pain causes are removed or avoided the more the well being increases.
In broilers breeding well being means that the animals live in a position to perform the maximum production capacity (quantity and quality) without running into so severe pathologies or mental disorders as to alter its physiologic balance.
The most of cattle breeders are careful to wealth and security of their animals. Not healthy broilers cause a smaller production, loss of time and require useless waste of money and medical treatments with less gains for the breeder.
The main elements to be considered are:
- the standard of broilers stalling
- the broilers' number
- the quantity and quality of feeding
- the method of feed-dispensing
- the micro-environmental conditions (light, temperature, noise, velocity and quality of ventilation)

In the broilers breeding the contact with gaseous emissions produced by different factors is continuous, so it is necessary an appropriate ventilation in order to discharge them. During last years a lot of broilers breeding have been industrialized.
A lot of money is saved through industrialization also thanks to skilled workers, large sized farms and an high density of broilers on quite small areas.
A deterioration of the micro-environment, brought by unhealthy air-quality owing to high concentration of gas and microorganism, often happens in such places. (Kristensen and Whates, 2000; Quaglio et al., 1998).
In the broilers breeding the microclimate (temperature, humidity, air velocity and their interaction) helps to generate a microenvironment from witch the broilers well being for the most part depends.
The microclimatic control is essential so that the broilers are in perfect health and give the best productive performances. The same environmental conditions, with the addition of broilers movements, and stalling standards, affect the quality of dust in the air. (Takai et al., 1998).
Experimental tests are carried out in the agro-zoo-technical farm (Fig. 1) belonging to Anna Faiella, placed in S. Elia at Pianisi (CB Italy).
A broilers breeding has been located in two warehouses one of them newly built. This one is able to breed 30000 heads/cycle (9500 females and 20500 males). Every cycle goes on 80 ayes: 60 to grow animals (60 for males and 35 for females) and 20 needed to the health rest.
The warehouse size is 13,00 x 14,20 metres with an inner surface of 1874,40 m^2 and an height of 2,65 m.
Inside the building 14 electric fans, that can be operated one by one, supply the change of air. These fans are set in motion by a1.0 CV three-phase engine and a fixed speed of 1400 revolution per minute (rev/min).
An impeller with 6 blades and a diameter of 1270 mm whirls at a nominal speed of 368 rev/min. Every fan has a maximum capacity of 36000 m^3/h. The cooling or pad climate system is a water cooling that uses latent heath of the water evaporation. Water circulates inside the system through a pump, goes across the delivery pipes, located in the superior part of the system, and finally is sprayed into the deflector.
The air takes up the heath useful to water evaporation and, through a panel, gets cold and humid.

Fig. 1 – A view of the broilers breeding

Fig. 2 – the two cooling systems

Two cooling systems (Fig. 2) are located on the sidewall of the warehouse near the service area: in this way the air entering through the cooling runs across the whole warehouse before being discharged outside.
Each cooling is composed of two parts: the first one is longer and located in the middle pf the warehouse. The overall length is 30 m. This division helps to restrict heating air during the transit inside the warehouse. The warehouse switches on the cooling at 27 °C and switches off at 24 °C.

Materials and methods
A multichannel BABUC/A data logger has been used for the microclimatic remarks inside the building.
The used feelers are:

- a psychrometer BSU 102 supplied with two thermometers: the first one, with a dry bulb, measures air temperature, the second one, which has a wet bulb and an hydrophilic sheath soaked in distilled water, measures the water temperature on contact with air. The psychrometer is provided with a little fan that sets up the testing at air velocity of 4 m/s.
- an anemometer BSV 101 with warm wire that measures the air velocity in every direction. The wire is platinum and is covered by a cylindrical bearing, let down during the testing so that the air flow is not obstructed. BABUC/A is able to calculate the number of the air changes, if the volume of the building is known.
- a infrared feeler BSO 103.1 to measure carbon dioxide with a range from 0 to 3000 ppm.
- To value the microclimate in the breeding, temperature, humidity, air velocity and carbon dioxide nave been measured.
- The tests have been carried out during the whole breeding cycle, every week before midday in summertime when the maximum air quantity is requested.
- The barn has been separated into 14 vertical sections and 3 measuring at the height of 20,100 and 150 cm have been taken in the middle part of each one.
- In the sections 1, 5, 9, 13 two more sets of testing on the lateral positions of the same sections have been carried out; so the values of the parameters at the different heights have been obtained for each set.
- A schedule (model) shows the points where the measuring have been taken in the cattle breeding (Fig. 3).

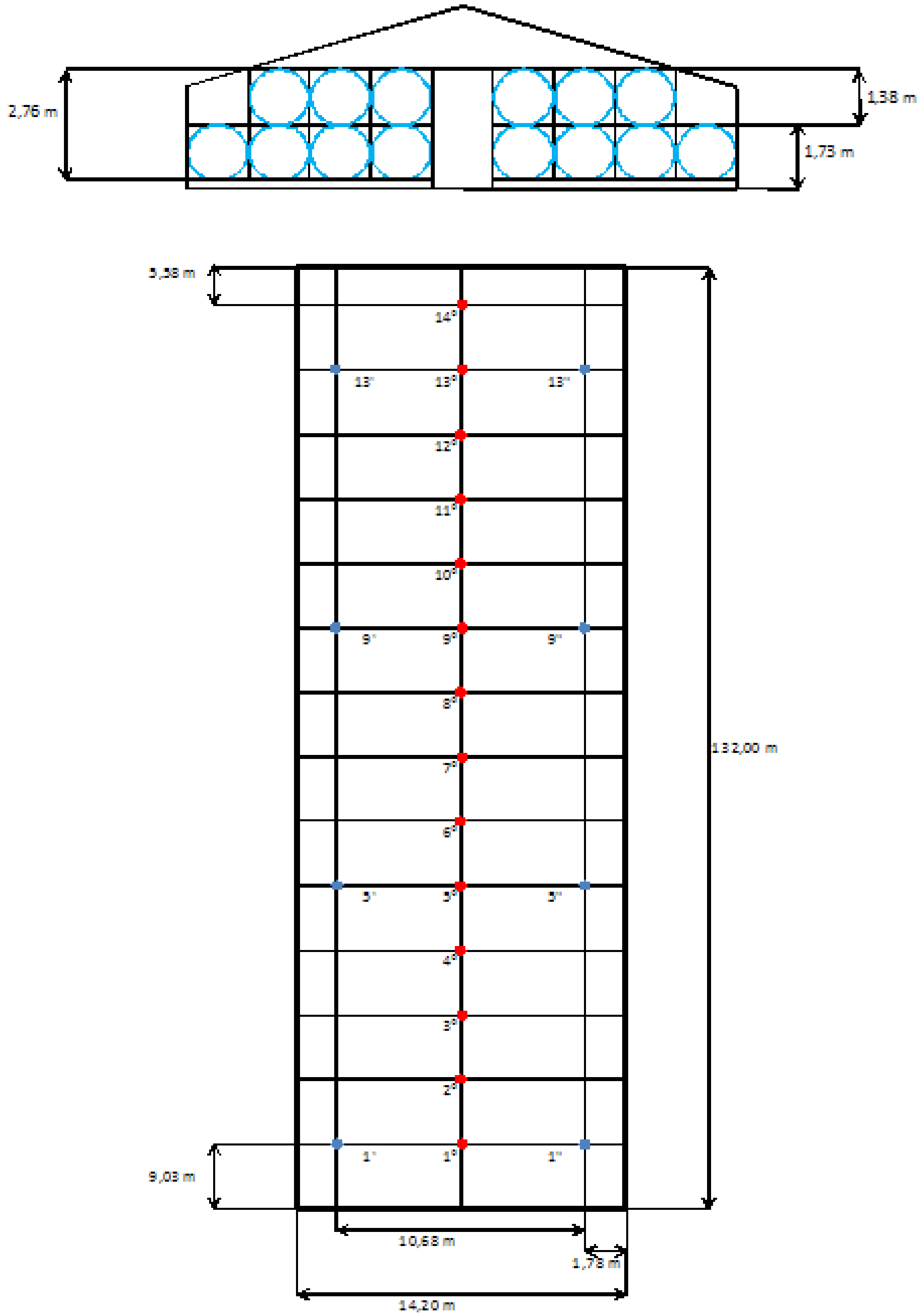

Fig. 3 - points where the measuring have been taken

Results and discussion

Each test was carried out during June 2011 for a overall length of about 1 hour and 40 minutes each, with the storage of the mean values of the measured properties. The measurements of the environmental parameters and also the number and the location of the fans have been registered in function of each test. The following graphs (Fig.4) obtained allows a first evaluation of the microclimate in the farm.

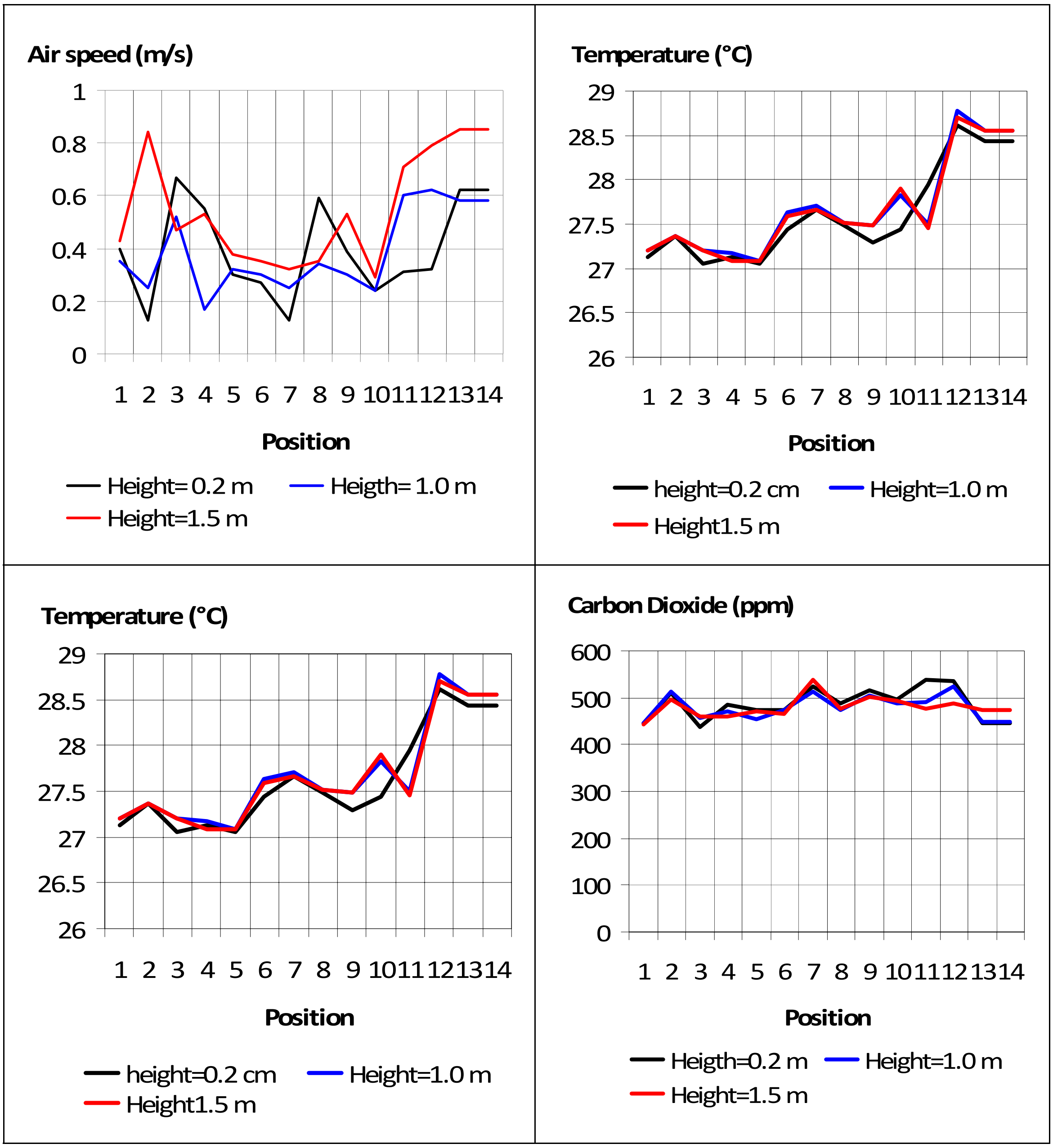

Fig. 4 – Microclimate parameters measurements

The graphs show the parameters trend considering the variation of height and length of the farm building. The air velocity mean value is higher at 150 cm from the floor with corresponding higher mean values of Humidity and Carbon Dioxide measured at 20 cm from the floor (animals height). The temperature values are higher at 100 and 150 cm from the floor respect to the values measured at 20 cm from the floor. The temperature values increase and the Relative Humidity values decrease moving towards the end of the building. This fact is due to the presence of the animals heating the air. The Carbon Dioxide concentration remains constant during the air flow. The Carbon Dioxide rate can be evaluated by mean of the following equation (rate of Carbon Dioxide which flows through a generic section in time unit):

$$\dot{m}_{CO_2} = \omega_{CO_2} \rho_a v_a A$$

where:

$\dot{m}_{CO_2}$ = Carbon Dioxide mass rate (mg/s),

ω_{CO_2} = Carbon Dioxide concentration (ppm: mg (CO2) /kg (dry air)),

ρ_a = air density (kg/m^3),

A (section) = area of the transverse section (m^2) in the point of measure,

v_a (air) = air velocity (m/s).

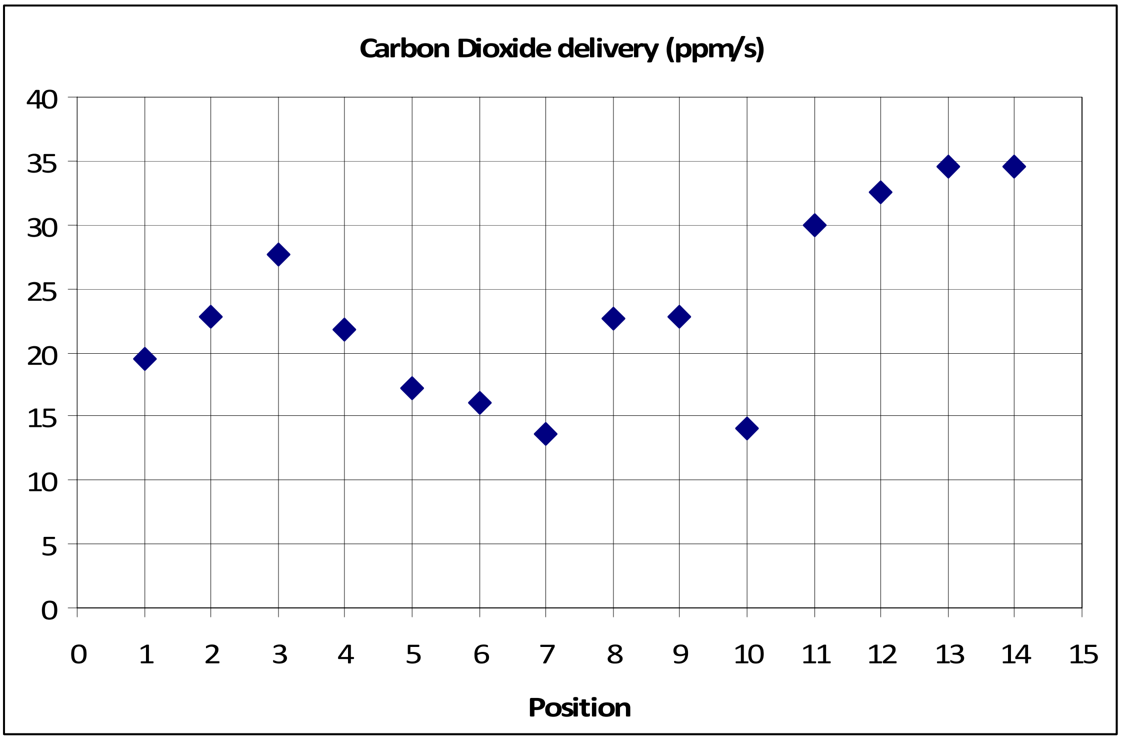

Fig.5 – Amount of carbon dioxide delivered across each measurement point

Fig. 5 shows the variation of the Carbon Dioxide rate along the air flow in the farm. The values used for the Carbon Dioxide concentration and for the air velocity were obtained from the average of the corresponding values measured at three different heights. The graph is subdivided in three parts:

- a first phase of CO2 increase, due to the animals presence without a further air change,
- a second phase of CO_2 rate decrease, during the air change and due to the cooling (in the first part of the farm(1/3)),
- a third phase of CO_2 increase (during the second inactive cooling).

The CO_2 increases linearly during the tests and shows a quite highe gradient.
The carried out tests showed a good quality of the air in the farm related with the Carbon Dioxide and the Relative Humidity. The fans put in are able to extract a high air rate causing, in some cases, a sudden variation of temperature. The values of the measured parameters, except for the temperature, are meanly included in the range considered as optimal for the welfare of the animals. The mean value of the CO_2 were calculated at three height of measure, to determine the CO_2 rate. Tests were carried out during summer when the worse conditions of microclimate are evaluated in the farm. In particular:

- The measured Carbon Dioxide never overcame the value of 800 ppm (value limit for the welfare of the animals), not even when the animals generated a higher amount of the gas. The low concentration of Carbon Dioxide and the low Relative Humidity, both due to a good ventilation, make us to think that the concentration of other polluting substances in the farm is low also in absence of specific monitoring.
- The temperature, before cooling, always were not higher than 3 °C respect to the outside temperature. The inside temperature, during cooling, lowered of 3 – 4 °C respect to the outside temperature. The temperature values measured during cooling tests ranged between 25 – 30°C, too high compared to that ones considered as optimal for the boiler growth up (range 20-21°C).
- The Relative Humidity values measured during the tests ranged between 40 and 60%. During the cooling some R.H. values are lower than that ones considered as optimal (range 60-70%) for animals. A low Humidity makes the temperature perceived by the animal not too high, partially compensating the highest tested temperature values.

During the last tests during this year (2012), (not presented in the paper), some sudden variations of temperature and R.H. were evaluated, owing to an inaccurate control of the fans and of the two cooling batteries.

Conclusions

Some conditions in the farm, regarding the environmental control, could be improved:

- A more homogeneous condition of temperature and R.H. in the farm could be reached working on a smoother ventilation and testing the cooling surface.
- The optimization of the ventilation system could be done changing the ON-OFF working with the VFD working. The VFD system guarantees a higher ventilation control and a higher energy saving.

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New technologies in the cultivation of sugar beet (*Beta vulgaris)* and their relation to yield and quality in Iraq

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Abstract

A field Experiments in tow agricultural sites were carried out to evaluate three levels of phosphorous fertilizer (60,80,120)Kg P/ha , as super phosphate and five varieties of sugarbeet seeds Three are monogerm (Vero, Rosana, Rosa) and the others, multigerm (Gitane, Monterosa) .

The results showed that the yield of root (ton/ha) increase significantly as the fertilizer increased, which gives (20.26% ,24.61%) when compared with the first level added of phosphorous fertilizer respectively and the percentage of the sugar of the root also increased as compared to the first level (0.65%,0.89%) respectively at the tow locations, the monogerm (Vero, Rosana, Rosa) also gives a high yield and the percentage of sugarand purity when we compared with the multigerm seeds and the Vero surmount to the others monogerm Rosana and Rosa at the tow locations .so the phosphorous fertilizer and the monogerm seeds of the sugarbeet will increase the quantity and the quality of the sugarbeet at the tow locations in this study.

Keywords: New, technology , cultivation ,sugar beet, yield

Introduction

Sugar beet (beta Vulgaris L) which releated to the chenopodace family is the important plants to produce sugar from its roots , sugar is consider as an consuming substance in the world . the secondary product of the industrial root is the molas and a filtered substance which used for animals nutrition and we can obtain alcohol and acetone as a sub products .

The sugar beet inter Iraq after building a factory in Mosul – North Iraq . at early in (1960) but till now there are many problem in the field to in crease the yield and the Quality and in the industrial the root in the factory . on of the measure problem is the fertilizer recommendation and the varieties which give high yield and best Quality in the Iraq conductions . specially in spring sowing ,The phosphor fertilizer consider as a power house of the plants and effects the Photosynthesis reaction to produce (ATP) . (Mangle & Armstrong 1987) .Many studied showed that the phosphate improve the Quantity and the Quality of the sugar beet(Jaszczolt 2000 , AL- rashidi 2001)

the varieties consider as the important factor witch depend on the environment of field after adapted to the condition of its growing , this study answer some Questions about the phosphate fertilization need and which varieties can we used to give a high yield with a best Quality in a spring growing we have little in formation about its growing of sugar beet in this conditions .

Materials and methods

A field experiment conducted in tow region in the Iraqi field the first in Hawiga (L1) About 90 Km east north Mosul city and the other in Rabeia (L2) about 80 Km north of Mosul city , which this tow region are famous in sugarbeet production the soil properties of this regions are showed in Table (1) Page (1982) the experiment designed as a Split plot with a randomize block in a factorial experiments the phosphate fertilizer In a three levels (60,90,120) KgP/ha in a main plot and the varieties (Vero,Rosa, Rosanna) and (Gitan, Monterosa) monogerm and multi germ respectively in a Secondary plots. The sowing in L1 and in L2 (9APril) ,(12 April) respectively by a development seed sowing model 2001 after plowling and leveling the field

The sowing seed are in the same depth 2.5 Cm , the line about 50 Meters and the Distance between lines are 30 Cm and between plants about 12 Cm the field irrigated By the sprinkler irrigation the phosphate fertilizer levels added with the sowing with the first part of the Nitrogen fertilizer as Urea 140Kg/ha , the weeds control by the Pyramine after followed the experiment till the harvest in the (28Sept.) , (4 0ct.) for the tow regions respectively , we take the weight of the root /plants and the vegetative parts

/plants and at the same time we send some samples to the Mosul sugar company to major of the quality of the roots,(total soluble salt, sugar percent .purity) then the all plots harvested for each treatment to obtain the root yield as Ton/ha , the experiment analysis by Duncan probability 0.05 to identified a significant treatments.

Table (1) physical and chemical properties of soils L1 , L2 Location under study

Properties	**Soil L1**		**Soil L2**	
	Depth Cm		**Depth Cm**	
	0-15	15-30	0-15	15-30
Texture	SL	SL	CL	CL
Available Nitrogen PPm	70.3	55.5	65.2	50.4
Available Postauim PPm	96.6	71.5	120.4	85.6
Available Phosorous PPm	4.7	3.5	22.6	15.2
Organic Meter Percent	0.47	0.14	0.97	0.63
Calcium Carbonate Percent	22.6	15.7	28.4	22.8
Ec dSm/m	2.6	2.4	3.4	2.7
PH 1:1	*7.8*	*8.1*	*8.2*	*8.0*

Result and Discussion

Sugarbeet quantity

Tab(2.3) showed the weights of the roots as Kg/plant are increase significantly with the phosphate fertilizer increase in tow regions (L1,L2)under study. increment percentage as compared to the first level of adding phosphate are (34.3%,85.5%)and (14%, 61,9%)for the tow region respectively .from this results the L1 is more response to the adding fertilizer than the L2 because the available P in the first region lower than the L2 also the temperature is higher in the growing condition than the L1.

The Vero variety gives highest weight of roots/plant in the tow regions ,so we can says this variety is the best to give a highest weight of root /plant which having high genetically properties .

From Tab(4,5) observed the dry weight roots which indicate the accumulate solid substances in the roots that reflect to the growing plants ,the phosphate fertilizer increase significantly this property when we compared to the other levels . the increment percentage (6.9, % ,41.8%),(6.5%,41.3% for the tow regions respectively we show contrasting result that Vero and Rosanna which are a monogerm varieties are suitable for these Iraqi regions .this

concerned with many researches that Monogerm having good growing properties. These results were in agreement with results obtained by Alrashidi 2001,and Abdal 2005, The Table (6,7) showed the air dry and oven dry vegetative weight of the tow regions that the phosphate increase significantly as the fertilizer increase which this result agreement with the weight of the roots /plant , the percentage increment are 9.6% ,14.9%) and (11.9% , 16.4%) when compared to the first level of phosphate fertilizer for the tow regions respectively. From this result showed the impotents of the leaves to the sugarbeet which consider a factory of the sugar production and storage in the root . the varieties in the tow region especially Vero , Rosa in the first region and the
Vero only on the second region , this results conclude the varieties of the sugarbeet play a good results to give a height yield with a good quality . from theTable (1).
For the total yield that the phosphate fertilizer give a height effect on the total yield Ton/ha as the fertilizer increase . the percentage increment as the compared to the first level 60 Kg/ha (6.5% , 10.6%) and (0.8%, 0.7%) for the tow region respectively , for this results we obtain that the L2 have a height level of available phosphate which Give no response when increasing the fertilizer more than 60Kg p/ha Vero varieties gives a high significant result in the tow regions under study , this results confirmed that the Vero varieties suitable to the Iraqi regions of the sugarebeet and this results agree with Duke (1983) , Popseca (1994) , and Abdal (2005) .

Sugarbeet Quality
Table(8,13) showed the quality of the root for sugarbeet total soluble salt percent sugar and purity moreover we measure white sugar after sending the root sample to the Mosul sugerbeet company , from the table we observed that total soluble salt ,should attach with the sugar percent to be desirable ,The treatments , for the Table (10,11) that the sugar percent increase as the fertilizer the phosphate fertilizer increase in tow regions , the increment percentage are (4.9% , 11.8%) , (3.9%, 8.4%) for the tow region receptively when compared with first level of fertilizer , these results where agreement with results obtained by Draycott (1996), Marvin (1997) and Al - Rashidi (2001) that the roots sugar percentage reach about 17% . from this result we found the Vero varieties is to surpass the all veracities growing in the tow regions under study
from the Table (12,13) it showed that the phosphate fertilizer increase the purity of the roots significantly as the fertilizer increase , the percentage increment (5.3%,14%) and (4.4%,15.8%).
for the tow region respectively as compared to the first level of the phosphate fertilizer 60Kg/Pha . this results are agreed with the result obtained by Shaker (1993) Abdal (2005). from this result found also the Vero varieties to surpass
the all varieties growing in the tow regions which certainly attributed to their
genetically properties for growing in this regions.
Tables(14,15) showed that white sugar affect by the fertilizer increase especially when compared to a first level in L1 but in L2 there are no significant between treatments all so the Vero variety is significantly as compared to the other varieties under study at the tow regions .this result agreed with Sim and Smith(1997) they showed the weight of white sugar related with phosphate fertilizers.and with Saccomani and Stevanato (2002)that they found amongem seed gave high result in white sugar than the multi germ seed.

Table(2,3) Effects of phosphate fertilizer and varieties on Weight of root Kg /plant on Tow Regions L1 ,L2 respectively

varieties	fertilizer phosphate Kg P/ ha			Effect of varieties
	60	90	120	
Vero	0.94	1.43	2.14	1.5
Rosa	0.86	0.94	1.23	1.01
Rosanna	0.98	1.3	1.67	1.32
Gitan	0.66	0.94	1.36	0.98
Montrose	0.69	0.88	1.3	0.98
Effect of Fertilizer	0.83	1.09	1.54	

varieties	fertilizer phosphate Kg P/ ha			Effect of varieties
	60	90	120	
Vero	1.22	1.62	2.36	1.73 a
Rosa	1.21	0.98	1.46	1.22 c
Rosanna	1.2	1.42	1.84	1.43 b
Gitan	0.87	0.98	1.42	1.04 d
Montrose	0.73	0.92	1.6	1.08 d
Effect of Fertilizer	1.03 c	1.18 b	1.74 a	

Table(3,4) Effects of phosphate fertilizer and varieties on dry Weight of root Kg /plant on Tow Regions L1 ,L2 respectively

varieties	fertilizer phosphate Kg P/ ha			Effect of varieties
	60	90	120	
Vero	0.41	0.52	0.64	0.52 c
Rosa	0.38	0.49	0.66	0.51 b
Rosanna	0.28	0.48	0.61	0.46 b
Gitan	0.26	0.39	0.57	0.41 a
Montrose	0.24	0.38	0.56	0.37 a
Effect of Fertilizer	0.34 c	0.46 b	0.61 a	

varieties	fertilizer phosphate Kg P/ ha			Effect of varieties
	60	90	120	
Vero	0.57	0.57	0.69	0.61
Rosa	0.51	0.57	0.59	0.56
Rosanna	0.46	0.54	0.69	0.56
Gitan	0.42	0.51	0.68	0.53
Montrose	0.32	0.42	0.62	0.45
Effect of Fertilizer	0.46	0.48	0.65	

Table(4,5) Effects of phosphate fertilizer and varieties on Weight of leaves Kg /plant on Tow Regions L1 ,L2 respectively

varieties	fertilizer phosphate Kg P/ ha			Effect of varieties
	60	90	120	
Vero	0.85	0.88	0.9	0.88 a
Rosa	0.79	0.74	0.81	0.78 a
Rosanna	0.62	0.68	0.7	0.66 b
Gitan	0.52	0.61	0.64	0.59 c
Montrose	0.42	0.51	0.58	0.5 d
Effect of Fertilizer	0.64 b	0.68 b	0.73 a	

varieties	fertilizer phosphate Kg P/ ha			Effect of varieties
	60	90	120	
Vero	0.88	0.91	0.96	0.92 a
Rosa	0.7	0.78	0.88	0.78 b
Rosanna	0.69	0.66	0.78	0.71 c
Gitan	0.59	0.68	0.69	0.68 c
Montrose	0.47	0.58	0.61	0.55 d
Effect of Fertilizer	0.67 b	0.75 a	0.78 a	

Table(6,7) Effects of phosphate fertilizer and varieties on Weight of dry leaves Kg /plant on Tow Regions L1 ,L2 respectively

varieties	fertilizer phosphate Kg P/ha			
	60	90	120	Effect of varieties
Vero	0.24	0.22	0.29	0.25 a
Rosa	0.26	0.26	0.2	0.24 a
Rosanna	0.19	0.18	0.2	0.19 b
Gitan	0.17	0.14	0.12	0.14 c
Montrose	0.16	0.11	0.13	0.13 c
Effect of Fertilizer	0.2 a	0.18 b	0.18 b	

varieties	fertilizer phosphate Kg P/ ha			
	60	90	120	Effect of varieties
Vero	0.2	0.28	0.3	0.26 a
Rosa	0.21	0.29	0.21	0.24 b
Rosanna	0.2	0.16	0.18	0.18 c
Gitan	0.19	0.16	0.14	0.16 c
Montrose	0.12	0.14	0.14	0.13 d
Effect of Fertilizer	0.18 b	0.21 b	0.19 a	

Table(8,9) Effects of phosphate fertilizer and varieties on total yield of root Ton/ha on Tow Regions L1 ,L2 respectively

varieties	fertilizer phosphate Kg P/ ha			Effect of varieties
	60	90	120	
Vero	76.4	80.22	86.2	80.94 a
Rosa	74.12	76.16	79.98	77.42 b
Rosanna	72.1	74.72	77.41	77.74 b
Gitan	68.43	72.84	76.72	72.66 c
Montrose	66.41	74.2	72.69	71.1 c
Effect of Fertilizer	71.4 c	76.03 b	79 a	

varieties	fertilizer phosphate Kg P/ha			Effect of varieties
	60	90	120	
Vero	78.69	84.69	88.92	84.1 a
Rosa	77.63	79.22	86.43	81.09 a
Rosanna	75.3	78.85	83.76	79.18 b
Gitan	78.1	78.31	80.33	77.91 b
Montrose	76.83	78.63	74.69	76.71 c
Effect of Fertilizer	77.38 b	76.71 b	82.82 a	

Table(10,11) Effects of phosphate fertilizer and varieties on percent of total soluble salt on Tow Regions L1 ,L2 respectively

varieties	fertilizer phosphate Kg P/ha			
	60	90	120	Effect of varieties
Vero	18.61	19.13	19.69	19.14
Rosa	19.77	20.49	18.03	19.43
Rosanna	20.42	20.02	19.31	19.91
Gitan	18.73	17.98	17.79	18.16
Montrose	18.4	18.77	18.7	18.62
Effect of Fertilizer	19.19	19.27	18.7	

varieties	fertilizer phosphate Kg P/ ha			Effect of varieties
	60	90	120	
Vero	20.65	20.29	18.97	19.97
Rosa	18.38	18.79	18.26	18.47
Rosanna	18.28	18.46	18.31	18.35
Gitan	17.82	17.84	17.39	17.68
Montrose	18.84	18.69	18.41	18.64
Effect of Fertilizer	18.79	18.81	18.24	

Table(12,13) Effects of phosphate fertilizer and varieties on sugar percent on Tow Regions L1 ,L2 respectively

varieties	fertilizer phosphate Kg P/ ha			Effect of varieties
	60	90	120	
Vero	14.3	15.1	16	15.13 a
Rosa	12.9	13.6	14.1	13.53 b
Rosanna	12.7	13.1	13.8	13.2 b
Gitan	11.5	12.1	13.6	12.4 b
Montrose	11.1	11.7	12.4	11.73 c
Effect of Fertilizer	12.5 b	13.12 a	13.98 a	

varieties	fertilizer phosphate Kg P/ha			Effect of varieties
	60	90	120	
Vero	14.9	15.6	16.4	15.63 a
Rosa	13.1	13.8	14.6	13.83 b
Rosanna	12.9	13.7	.14.0	12.7 c
Gitan	11.9	12.6	13.6	12.06 c
Montrose	11.5	12.1	12.6	
Effect of Fertilizer	13.04 b	13.56 b	14.13 a	

Table(14,15) Effects of phosphate fertilizer and varieties on purity percent on Tow Regions L1 ,L2 respectively

varieties	fertilizer phosphate Kg P/ ha			Effect of varieties
	60	90	120	
Vero	76.83	78.92	81.24	78.99 a
Rosa	65.25	66.36	78.2	69.93 b
Rosanna	62.17	65.42	75.34	67.64 b
Gitan	61.38	67.26	76.43	68.35 b
Montrose	60.29	62.32	66.28	62.96 c
Effect of Fertilizer	65.18 c	68.06 b	75.49 a	

varieties	fertilizer phosphate Kg P/ ha			Effect of varieties
	60	90	120	
Vero	72.13	76.85	86.42	78.46 a
Rosa	71.25	73.44	79.93	74.87 b
Rosanna	70.54	74.2	76.43	73.72 b
Gitan	66.77	70.6	78.17	71.84 b
Montrose	60.93	64.72	68.43	64.69 c
Effect of Fertilizer	68.29 c	71.96 b	77.87 a	

Table(16,17) Effects of phosphate fertilizer and varieties on white sugar on Tow Ton/Donum Regions L2 ,L1 respectively

varieties	fertilizer phosphate Kg P/ha			Effect of varieties
	60	90	120	
Vero	1.434	1.572	1.623	1.543 a
Rosa	1.321	1.342	1.463	1.375 b
Rosanna	0.689	0.884	0.962	0.912 c
Gitan	0.541	0.582	0.599	0.574 d
Montrose	0.432	0.469	0.453	0.451 e
Effect of Fertilizer	0.919 a	0.968 a	1.02 a	

varieties	fertilizer phosphate Kg P/ha			Effect of varieties
	60	90	120	
Vero	1.36	1.49	1.544	1.464 a
Rosa	1.23	1.335	1.423	1.328 b
Rosanna	0.662	0.642	0.653	1.318 b
Gitan	0.521	0.539	0.614	0.558 c
Montrose	0.432	0.536	0.611	0.526 c
Effect of Fertilizer	0.861 b	0.908 a	0.969 a	

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Hazelnuts mechanical harvesting in Calabria: preliminary trials on work productivity

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Abstract

Hazelnut or *Corylus avellana* is an important species for many Calabrian hilly territories. It represents a key cultivation for those areas where there are no alternative crops, except forestry. However, it would require high levels of mechanization, especially for harvesting, which is currently one of the most expensive processes of the productive cycle; an operation that can engrave up to 40-60% on the sale price of the product, moreover to be time consuming if carried out manually.

Since hazelnuts are fruit that tend to fall spontaneously from the trees, they are mainly harvested using gathering machines from the ground. Hazelnuts mechanical harvesting seems to be efficient even in complex situations. In the surveyed farm, they were first moved into the center of the rows using backpack blowers, and then gathered by mean of *"Jolly 2800"* harvester. Finally, they were transported to processing site where they were cleaned and dried.

The present paper intends to assess work productivity of a Calabrian farm during mechanical harvesting and preliminary post-harvest processing of hazelnuts. Operational working time and productivity assessment have been made under C.I.O.S.T.A. ranking requirements. Time measurement started when the machine was positioned at the beginning of the row ready to start gathering. The obtained results showed that such machines offer work productivity higher than manual harvesting. A significant decreasing of working times was also reached thanks to an accurate soil management that allows ground leveling and eliminates cultural residues and other impurities eventually present.

Keywords: *Corylus avellana*, mechanical harvest, work productivity

Introduction

According to ISTAT data (2011), Hazelnut or *Corylus avellana* cultivation is extended on about 69.898 ha in Italy, from which 66.192 ha produce 1.176.001 quintals, 1.122.860 quintals of them are harvested or collected.

The main important areas of production are Piemonte, Liguria, Lazio, Campania and Sicilia. In Calabria, this cultivation covers 376 ha, situated mainly in the mountainous area of Catanzaro, so that it constitutes a characteristic element of the agricultural and forestry landscape. It is an important species for many Calabrian hilly territories, and represents a key cultivation for those areas where there are no alternative crops, except forestry.

However, it would require high levels of mechanization, especially for harvesting, which is currently one of the most expensive processes of the productive cycle; an operation that can engrave up to 40-60% on the sale price of the product, moreover to be time consuming if carried out manually. According to producers, mechanical harvesting is an essential factor for the subsistence of such cultivation (Blandini *et al.,* 2007). Indeed, the necessity to reduce harvesting costs and the relative operating time, have pushed machines industries to realize diverse and ever more innovative models for harvesting from the ground (Pagano, 2008).

Hazelnuts are harvested from August 10th, and on, when the product fall down in the ground, doing one o more passages utilizing self-propelled, trained, and scoped machines. These

machines permit with little manpower a fast harvesting of hazelnuts from the ground. However, harvesting period has to be as brief as possible; in way to avoid that fallen hazelnuts could have alterations that compromise their commercialization (Ascopiemonte S.C., 2009).
The present paper intends to assess work productivity of a Calabrian farm during mechanical harvesting and preliminary post-harvest processing of hazelnuts.

Materials and methods

1. Harvesting

Trials have been effectuated during 2011 harvesting campaign (October, 2011 corresponding to the second harvesting), in a hazelnuts orchard of about 1 ha, composed mainly by shrubs of 10 to 12 years old, with a planting distances of 5x5,5m; situated in the municipality of Torre di Ruggiero, Province of Catanzaro, Southern Italy. It is a mountainous area that lies at 590 above sea level. The main cultivated varieties are "*Tonda Gentile Romana*" and "*Tonda Calabrese*".

Fig. 01: Hazelnuts orchard subject to trials.

Over the year, the crop is managed as follows:

January/ February	*March*	*April*	*May/June*	*Beginning of August*
Pruning	Fertilization with NPK	weeding and/or soil tiling	Fertilization with secondary minerals; 2nd weeding and soil cleaning	Soil cleaning and preparation for harvesting before fruit falling

Hazelnuts have been harvested by mean of "Jolly 2800" harvester from the ground. In the surveyed farm, as described by Colorio *et al.* (2011), the fallen nuts which tend to be spread over the whole orchard are usually bushed away from the tree trunks using backpack blowers (Fig. 02), so that the harvester head can get at them easily.
The crew was composed by four laborers: the harvester driver and three laborers charged to windrow hazelnuts.

Fig. 02: hazelnuts windrowing using backpack blowers.

a) Harvester description

In the Certificate n°17-008, the ENAMA (2004) describe the harvester G.F. model "Jolly 2800" as follow: It is an agricultural operating machine semi-scoped by the tractor with power takeoff (PTO) and three-point hitch at the front. It is destined to almonds, nuts, hazelnuts and chestnuts harvesting from the ground, on both, bare soil and tiled one; and their subsequent transfer, after a mechanical sorting, in bags set up on a work platform. Functioning principle of such machine is based on the presence of a rotating brush for nuts collection from the ground, set frontally and transversally to advancement direction. Moreover, the machine has separate chambers that insure the harvested product cleaning by mean of mechanical devices.

Fig.03: Hazelnuts harvester G.F. model "Jolly 2800".

b) Operational working time

The experimental plot was composed by three rows of about 119 m of length. We considered that each row constitute a replicate. Then, three rows replicates have been achieved. Time assessment taken by the observed tasks in the current study has been made under C.I.O.S.T.A. ranking requirements (Bolli *et al.*, 1987). Time measurement started when the harvester was positioned at the beginning of the first row, ready to start gathering. And it finished at the end of the last row. Time measurements concerned the following tasks:

- Effective time (necessary for harvesting) : TE
- Accessory time for moving to the second row TAV
- Accessory time for handling: TAC

After harvesting, hazelnuts have been transported to processing site where they were cleaned and dried.

2. Cleaning and drying

Once harvested, hazelnuts are passed in suitable cleaners that with the aid of air flow separate the fruit from eventual stones, dust, leaves and branches. So, hazelnuts can carry on with draying phase, in the surveyed farm, this task took 10.57,85 min for 50 kg of the harvested product.

Fig.04: Hazelnuts cleaning (in the left) and drying (in the right) devices.

Nowadays many farm that produce hazelnuts, have acquired industrial dryers having a capacity of 20-30 quintals of hazelnuts. These equipments effectuate a forced drying utilizing a hot air of 45 degrees and the continuous movement of hazelnuts, in heating phase. Hazelnuts so dried can be stored in the farm under different ways: in bulk, in jute bags, or in cases as shows Fig. 05 (Ascopiemonte S.C., 2009)

Fig. 05: Different ways to store hazelnuts.

Results and discussion

The obtained results show that the operative time TO (TO=TE+TA), in the previous conditions of trials had an average value of 3,50 h/ha which is higher than operative working time registered by ENAMA (2004): 2,61 (h/ha). The effective working time had an average value of 2,88 h/ha corresponding approximately to the results obtained by ENAMA (2,48 h/ha). The TAV, instead, had a mean value of 0,40 h/ha and accessory time for handling TAC of 0,36 h/ha, occurred just when the harvester driver had to check an eventual problem.

According to the harvested production, the value obtained during trials was about 1,30 quintals/h.

After hulling, the extracted 500 g contained 184 g of net product (hazelnuts),whose moister was of 14,5%, instead, shell moister was of 10,7 %. To be properly stored and commercialized by the time, hazelnuts must have a moisture percentage not higher than 8-10% for the shell and less than 6% for the unshelled hazelnut (Ascopiemonte S.C., 2009). The 184 g of hazelnuts contained 14 g of rotten product, and 8 g of spotted one. Therefore, from 500 g of the harvested product, the proper and usable one weighted 158 g.

Conclusion

The present paper constitutes a description of the state of art of hazelnuts mechanical harvesting in Calabria. The carried out trials have to be consolidate by more experiments including more farms and different devices for harvesting. However, it illustrated that, hazelnuts mechanical harvesting from the ground by mean of the above described harvester could be suitable to be used even in complex situations. Indeed, such machines offer work productivity 3 or 4 times higher that manual harvesting (Pellizzi, 1986); therefore a significant decreasing of working times can be reached. Prior weeding and hazelnuts windrowing in the fields allow 20% time saving in harvesting phase. Mechanical harvesting of windrowed hazelnuts increase harvested yields up to 39% and advancement speed up to 48% (Blandini *et al.*, 2007).

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