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ISPEC
12th INTERNATIONAL CONFERENCE ON AGRICULTURE, ANIMAL SCIENCE and RURAL DEVELOPMENT

DATE – PLACE
July 06-08, 2023
Ordu, TÜRKİYE

CONFERENCE PROCEEDINGS BOOK

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CONTENTS

CONGRESS ID		
PROGRAM		
PHOTO GALLERY		
CONTENTS		
Authors	**TITLE**	**Page Number**

ABSTRACTS

Özlem Önal Aşci Umut Ertürk Salantur A. Özge Şimşek Soysal	The effects of different nitrogen doses on hay yield and some quality properties in sorghum x sudan grass hybrid	2
Osman Serdar Ayşe Nur Aydin Abdullatif Ölçülü Taner Derman Işil Canan Çiçek Çimen Tuba Parlak Ak Ayşegül Pala Nuran Cikcikoğlu Yildirim	Determination of acute toxicity and biochemical parameters of chlorpyrifos (Cpf) pesticide active on Chlorella vulgaris	4
Osman Serdar Ayşe Nur Aydin Abdullatif Ölçülü Taner Derman Işil Canan Çiçek Çimen Tuba Parlak Ak Ayşegül Pala Nuran Cikcikoğlu Yildirim	Determination of acute toxicity and biochemical parameters of chlorpyrifos pesticide on navicula cryptocephala var. veneta	7
Timur Demir Ahmet Uluer Özkan Özbay Aylin Kocalmiş Nurten Özbey Gökhan Karakaya	Some physio-chemical properties of tohma stream (Malatya)	10
Kadir Kirk Tuğba Cebeci	The effects of semen collection frequency on spermatological characteristics and semen microbiology	13
Seda Arikan Fatma Akbay Zehra Korkmaz Tuğba Günaydin Eylül Nezahat Kizilyar Mustafa Kizilşimşek	The effect of cultivation of fodder peas with different ratios of barley and wheat on silage quality	15

Mohammed Mohammed Sulaiman Ebrahim	A study on the financial awareness among among undergraduate students in hodeida province in Yemen	268
Mónika Fekete Bálint Madarász Judit Forrai Zoltán Ungvári János Tamás Varga	Chronic respiratory diseases: can diet or vitamin-antioxidant supplementation help?	269
K. Meriç Uğurlutepe Hüseyin Sauk	Ergonomic analysis of tomato harvesting in greenhouse agriculture	271
Mansi Pawar Tushar Nikam Ganesh Sonawane	Animal science: a review	273
Beyza Nur Yıldız Nuray Çömlekçioğlu Büşra Yapıcı Ezgi Gürsoy Ş. Şebnem Ellialtıoğlu	The effects of in vitro colchicine applications on embryo frequency in anther culture	274
Gréta Törős József Prokisch Ferenc Peles	Optimization of unique media production for enhanced bioactivity of *Pleurotus ostreatus mycelia*	276
Rutuja Nikam Piyush Bachhav Ganesh Sonawane	Cruelty to animals: a review	277
Malik Ergin Rabia Albayrak Delialioğlu Yasin Altay Özgür Koşkan	Bibliometric analysis of lactation curves in livestock	278
Armaelis Arfani Elsa Nadiya Febriyani Muhammad Sultan Mubarok	Strategi kota pekalongan dalam pengembangan pariwisata kreatif berbasis industri batik	280
Saiqa Andleeb Summaya Yahya Abdul-Hameed Khan	Efficacy of vermi-compost on seed germination and seedling growth parameters of wheat (*Triticum aestivum* L.)	281
Kemajl Kurteshi Ilmije Vllasaku	Investigation of genotoxic effect of insecticide chromagor at fish goldfish (Carassius auratus), after 14 days of treatment	282
Charif Rania Sriti Fatima Zohra	Synthesis and characterization of a K2NIF4 structural material	283

FULL TEXTS

Gülcan Kaymak Bayram Utku Tunali Zeki Acar İlknur Ayan	Determination of forage yıeld and some morphological characteristics of some cowpea genotypes (Vigna unguiculata (L.) Walp) growed in Samsun ecological conditions	285
Mehmet Can Gülcan Kaymak Bayram Özlem Önal Aşcı İlknur Ayan Zeki Acar	Determination of the quality and nutritional content of some cowpea genotypes (Vigna unguiculata (L.) Walp) growed in Samsun ecological conditions	296

Matanat Aliyeva Aziz	Agriculture, livestock and rural development project of the turkic world and components of the 4th industrial revolution	759
Füsun Gülser Siyami Karaca Bulut Sarğın	Soil parent material and plant nutrients: exploring the linkages	778
Mehmet Altun Ustun Sahin	The effect of different irrigation practices on stomatal conductivity in silage maize grown in soil amended with stabilized wastewater sludge	788
Hasan Kuraloğlu Serap Kulaç Halil Ünal	Operating parameters in milking robots with forced cow traffic	801
Ibrahim D.G. Bashir M.B. Sabo E. Garba M.S.	Factors influencing farmer-herder conflict in ardo-kola and lau local government areas of taraba state, Nigeria	820
Gamze Kaya	Variation in stomatal density and distribution on leaves of different radish cultivars	831
Emine Nakilcioğlu	Nutritional properties of sea cucumber and its potential effects on human health	841
Hamit ISMAILI Kemajl KURTESHI	Estimation of Genotoxic Effect Of Herbicid Randap 480 EC at Goldfish (*Carassius auratus*) Through Micronucleus Test and Nucleoplasmic Bridges After 10 Day Treatment	848
Rasheed Olatunde Ajetunmobi Benjamin Ogbomena Omorojor Gabriel Semako Hojapoji	Navigating the evolving landscape: exploring emerging trends and challenges in data center security	855
Bashir, M.B Ndaghu, A.A Anonguku, I Sani, U.M	Management practices of cattle diseases and parasites among pastoralists in north-east, Nigeria	865
Stanislava Stateva	Possibilities for controlled storage and propagation in medicinal plant species	885
Ezgi Edebali Murat Emre Terzioğlu İhsan Bakırcı	Food safety and haccp applications in ice cream production	895
Büşra Turan Murat Emre Terzioğlu İhsan Bakirci	Dioxin in milk and dairy products	904
Sri Padma Kanta Mishra Deepak Bansal	Economics Of oil prices and dynamic relationship with exchange rates and stock markets under uncertainty: a literature review	914
Fatih Ahmet Aslan Hilal Tozlu Çelik	Methods and current advances in estrus synchronization of sheep and goats	922
Şükran Öztürk Öznur Ergen Akçin	Anatomical characteristics of Alchemilla sericata rchb., species, distributed in the eastern black sea region	956
Mahmut Kaplan Idris Yildiz	Determination of herbage yield, yield characteristics and silage quality of different silage sorghum genotypes	966
Ihsan Serkan Varol Ali Ünlükara Mahmut Kaplan	Changes in phenolic and antioxidant activity in alfalfa cultivars grown under different irrigation levels	974
Şeyda Çavuşoğlu Sercan Düzgün	The importance of respiration after harvest in climacteric fruit species	982

ZORUNLU İNEK TRAFİĞİ OLAN SAĞIM ROBOTLARINDA ÇALIŞMA PARAMETRELERİ[1]

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ÖZET

Robotik sağım sistemlerinin geliştirilmesinde mühendislik araştırmalarının rolü büyüktür. Ancak robotik teknolojilerin çiftliklere entegrasyonunun gözden geçirilmesi şarttır. 1996 yılı sonunda Hollanda'da ilk ticari otomatik sağım sisteminden itibaren hayvanlar sağlıklı ve kendi istekleri ile robota gelerek sağım işlemi için gönüllü olmaları sağlanmaya çalışılmaktadır. Diğer sektörlerden teknoloji transfer eden süt sağım sistemleri canlı hayvan ile çalışmanın getirdiği hassasiyetle kendini yenilemektedir. Bir işletme için iyi gibi gözüken uygulamalar bir diğerine uymamaktadır. Bu sebepten sahada yapılan ve yapılacak olan her çalışma çok değerlidir ve sistemin eksiklerini görerek kendini yenilemesini ve hızla gelişen ve değişen yeni teknolojiyi halihazırdaki sisteme dahil edilmesini sağlayacaktır. Bu çalışmada, robotik sağım sistemlerinin çalışmalarının takip edilerek robot etkinliğinin arttırılmasına yönelik sağımla ilişkili parametrelerin belirlenmesi amaçlanmıştır. Araştırma, 'zorunlu inek trafiği' tipine göre planlanmış ve Holstein Friesian ırkı 500 adet sağmal ineklerin olduğu ticari bir çiftlikte yürütülmüştür. Çiftlikte sağmal ineklerin bulunduğu ana bina, aynı çatı altında birbirinden bağımsız bölünmüş dört ahırdan meydana gelmiş ve her ahır bölümünde 2'şer adet olmak üzere toplamda 8 adet robotik sağım ünitesi vardır. Araştırmada çiftliğin bir ahır bölümündeki sağım robotlarının dört yıllık performansları incelenmiştir. Ahırdaki iki robotun karşılaştırıldığı dört yıllık denemelerde inek başına günlük sağım sıklığı ilk üç yıl ortalama 2,82 adet/gün iken, dördüncü yıl 3,06 adet/gün değerine yükselmiştir. Denemelerde ilk yıl ineklerin günlük süt verimi, sağım başına verimi ve robotta geçen süre sırasıyla 26,1 kg, 9,1 kg ve 7,2 dakika iken, dördüncü yıl bu değerler 46,6 kg, 15,3 kg ve 7,7 dakika belirlenmiştir. Robotlardaki ret sayıları ve süreleri ilk üç yıl artan seviyelerde iken (2,6-5,5 adet ve 2,2-4,9 dakika), dördüncü yıl bu değerler 2,0 adet ve 1,9 dakikaya düşmüştür. Ahırdaki robotların günlük sağım sayıları ilk yıl 145,6 adet iken, ikinci yıl bu sayı 161,3 adet ile en üst seviyeye yükselmiş, ancak üçüncü ve dördüncü yılda azalarak 157,1'den 153,0'e düşmüştür. İneklerin günlük sağım süresi aralıklarında ise 8,14 ila 8,30 dakika gibi çok az değişiklik olmuştur. Ayrıca robotların sağımdaki yüklenme oranı birinci yıl %72,3 iken, bu oran artarak dördüncü yıl %82,2'ye yükselmiştir. Bu sayede robotların boşta geçen süreleri %22,4'ten %10,8'e düşüş göstermiştir. Ahırdaki ilk yıl verilerinin düşük saptanmasına, birinci yılın işletme ve hayvanlar için daha

[1] Bu çalışma Hasan Kuraloğlu'nun Doktora tezinin bir bölümünden üretilmiştir. / This study was produced from a part of Hasan Kuraloğlu's PhD thesis.

başlangıç yılı olması sebep gösterilebilir. Dördüncü yıl verilerinin yüksek olmasına ise, çiftlik bütünündeki yüksek süt verimine sahip hayvanların bu ahır bölümüne toplanması, hayvanların çevreye uyum sağlayarak robotik sistemi tanıması sebep gösterilebilir.

Anahtar Kelimeler: Robotlu Sağım, İnek Trafiği, Sağım Sıklığı, Robot Yüklenmesi, Sağım aralığı

OPERATING PARAMETERS IN MILKING ROBOTS WITH FORCED COW TRAFFIC

ABSTRACT

Engineering research has a great role in the development of robotic milking systems. However, it is essential to review the integration of robotic technologies into farms. Since the first commercial automatic milking system in the Netherlands at the end of 1996, it has been tried to ensure that the animals are healthy and volunteer for the milking process by coming to the robot on their own free will. Milking systems, which transfer technology from other sectors, renew themselves with the sensitivity of working with live animals. Practices that seem good for one business do not fit another. For this reason, every work done or to be done in the field is very valuable and will enable the system to renew itself by seeing the deficiencies and include the rapidly developing and changing new technology into the current system. In this study, it was aimed to determine the parameters related to milking to increase robot efficiency by following the work of robotic milking systems. The study was planned according to the type of "guided cow traffic"' and was carried out on a commercial farm with 500 Holstein Friesian dairy cows. The main building, where the milking cows are located, consists of four independent barns under the same roof and there are 8 robotic milking units, 2 in each barn section. In the study, four-year performances of milking robots in a barn section of the farm were examined. In the four-year trials comparing the two robots in the barn, the average number of milking per cow per day was 2.82 milking/day in the first three years, while it increased to 3.06 milking/day in the fourth year. In the first year of the trials, the daily milk yield of the cows, the yield per milking and the time spent on the robot were 26.1 kg, 9.1 kg and 7.2 minutes, respectively, while in the fourth year these values were 46.6 kg, 15.3 kg and 7.7 minutes. determined. While the number of rejections and the duration of the robots were increasing in the first three years (2.6-5.5 and 2.2-4.9 minutes), these values decreased to 2.0 and 1.9 minutes in the fourth year. While the daily milking numbers of the robots in the barn were 145.6 in the first year, this number increased to 161.3 in the second year, but decreased from 157.1 to 153.0 in the third and fourth years. There was little change in the daily milking time intervals of the cows, such as 8.14 to 8.30 minutes. In addition, while the loading rate of robots in milking was 72.3% in the first year, this rate increased to 82.2% in the fourth year. In this way, the idle time of the robots decreased from 22.4% to 10.8%. The reason for the low data for the first year in the barn may be that the first year is the beginning year for the farm and animals. The high data for the fourth year can be attributed to the fact that cows with high milk yield in the whole farm are collected in this barn section, cows adapt to the environment and recognize the robotic system.

Keywords: Robotic Milking, Cow Traffic, Milking Frequency, Robot Loading, Milking Interval

INTRODUCTION

Today, it is more difficult to ensure sustainability by incorporating advanced technology into the agricultural sector than in other sectors. Especially as the investments in livestock enterprises increase, the suppliers serving this sector are also improving their service function not only to sell the product but also to ensure the sustainability of the complex technology This not only controls the operation of the sold product, but also provides incentives for upgrading and re-acquiring new products by introducing them to the business.Thus, technology will be more accessible and usable, especially in the dairy sector (Kuraloğlu, 2014).

Using the resources more effectively on dairy farms, it is necessary to explore the full potential of each individual dairy cow. While herd management is applied in traditional milking farms, the basic logic in precision dairy farms is that each cow should be evaluated as an individual and each cow should be managed individually. The most interesting of the precision dairy farming technologies is milking robots. The use of milking robots has increased in the United States, Canada and Australia, especially in European countries. In our country, the use of this technology is new; Since the pros and cons of milking robots compared to traditional milking systems are not fully known by the operators, they are adopted slowly. However, the increase in the need for qualified labor will increase the preference of the robotic milking system (Örs ve Oğuz, 2016).

While robotic milking systems (AMS-Automatic milking systems, VMS- Voluntary Milking Systems, RMS- Robotic Milking Systems), one of the precision livestock developments, control the process, there have also been many changes in the way the entire farm system is managed. Milking is no longer performed in certain sessions; instead, the cow can now choose when to milk on the robot and allow milking to be distributed over a 24-hour period (John et al., 2016).

There are three types of traffic regulations proposed by robotic system manufacturers in farms. The first is free cow traffic. When the cow gets up from the stall, it is free to go to the robot or the feed table. There are no sorting, gates or routing. The cow can go wherever it wants, of its own free will. Secondly, milk-first forced cow traffic. In this traffic, the feeding area and the resting areas are separated from each other. When the cow gets up from the stall, it makes the transition to the feed table through the smart gates located close to the robot. If the cow's milking

time has not come, the smart gate directs the cow to the feed table. If there is a milking permit, the cow is directed to the waiting area in front of the robot to be milked. After milking, it proceeds to the feed table. The animal can pass from the feed table to the rest area through one-way gates. The third type of traffic is the feed-first forced cow traffic. In this traffic, cows have free reach to the ration feed table with one-way gates. When cows return from the feeding area, they are controlled by a selection gate and directed to the robot if there is milking permission, and to the resting area if there is no permission (Hobbis, 2013; Rodriguez, 2012; Rodriguez, 2014).

There are many international studies on robotic milking systems. However, in Turkey, there are mostly survey-based studies that reveal the statistical figures in the enterprises, and compilation-weighted publications that examine the economic situation and reveal the differences of the system with the existing milking systems (Gonulol, 2016; Örs and Oğuz, 2016; Akar Çıkrıkçı, 2019). There are almost no studies that reveal the situation of commercial enterprises in the field and contribute to the performance of robotic systems. In this study, it was aimed to determine the 4-year performance of milking-related parameters to increase robot efficiency by following the work of robotic milking systems in a commercial farm.

MATERIAL and METHODS

Material

This research was conducted in a commercial farm established in Balıkesir province, which was planned according to the 'milk-first forced cow traffic' type. The main building, where the milking cows are located, consists of four independent barns under the same roof. There are 8 robotic milking units in total, two in each barn. In this study, four-year performances of 2 milking robots in a barn of the farm were examined.

The layout of a barn on the farm and the animal movements in the barn are given in Figure 1 (Kuraloğlu, 2022). Accordingly, when the cows want to pass from the resting area (A) to the feeding area (C), they are sorte at a pre-selection gate (5) and if there are milking permits, with the guidance of the sorting gate, the robot located in the milking room (B) (1) enters the waiting area (E) to be milked. Otherwise, it is sent to the feed area where PMR is given. The animal that is milked in the robot is left in the exit area (F). Then, with another smart separator gate combination (5), it is directed to the separation area (G) if a special treatment or treatment is required, and to the feed area if it is not. The passage from the feed area to the rest area where

the beds are located is provided by three one-way gates (6). The plans of the four barns in the enterprise are the same and they are positioned in a mirror symmetry manner.

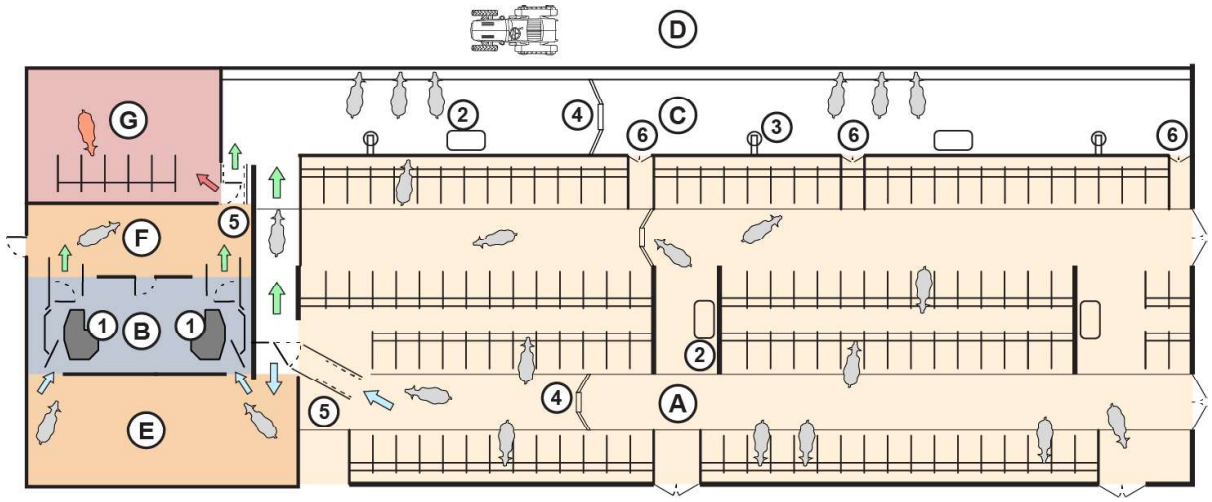


Figure 1. Layout plan and animal movements in the barn

A-Resting area, B-Milking room, C-Feeding area, D-Feeding line, E-Waiting area, F-Exit area, G-Separation area, 1-Robotic Milking System (AMS), 2- Trough, 3-Brush, 4-Manure scraper, 5-Smart gate, 6- One way gate

The barn where the research was conducted is the barn where the cows with proper udder shape and high milk yield are located. Since the barn is the easiest to observe in the farm main building, it is close to the milk room and the IT room, the robots here were chosen for research. There are an average of 102 cows in the barn. A partial mixed ration (PMR) is distributed on the farm twice a day, at 08:30 in the morning and at 17:00 in the evening. In addition to PMR, concentrated feed is given from the feed station in the robotic system according to the individual needs of the animal. The ration feed in the feed line is pushed 3 times a day. Ration feed distributed 33 kg per animal; It consists of 2 kg of straw, 3.5 kg of alfalfa, 18 kg of corn silage, 0.35 kg of vitamin and mineral mixture, 3 kg of corn flake, 0.15 kg of soda and 6 kg of concentrated feed. The total length of the feed table is 53 m. In the milk room, there is a main milk cooling tank and a buffer tank that serves during the washing and milk transfer process to tanker. Robots are automatically washed three times a day (at 03:00, 12:00 and 21:00) with alkaline detergent 3 times and acid detergent once, respectively. A washing time of a robot takes an average of 20 minutes. Imported product robotic milking systems are used in the research farm. The general view of the robotic system and some elements are given in Figure 2 (Anonymous, 2013).

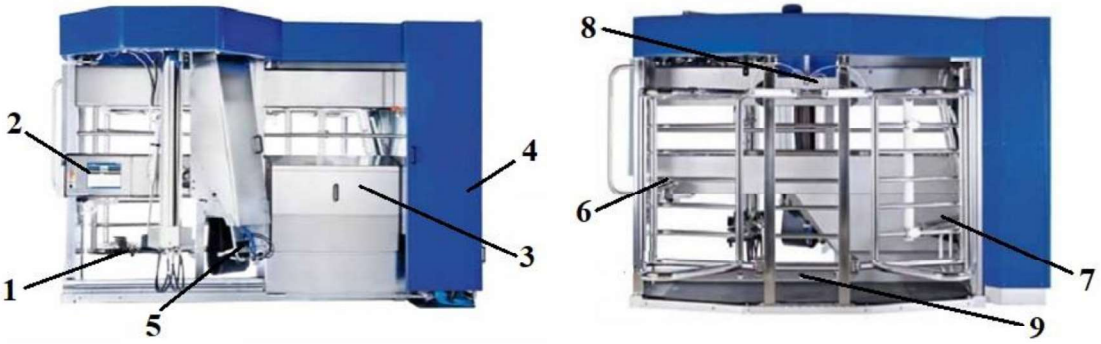


Figure 2. General view of the robotic milking system

1- Robot arm; 2- Screen; 3- Milking unit; 4- Washing system; 5- Disinfectant spray nozzle; 6- Manure gutter; 7- Bait station; 8- Electrically controlled gates; 9- Automatic foor washing

Herd management program (DelPro 4.5) is used in the robotic milking system. The software presents the information coming from all units in the farm (robotic system, automatic concentration feed station, smart gates, electronic tags, activity meters, etc.) in the form of a report on the computer. Necessary reports in the herd program are based on feeding, milking, device, activity, cow and herd monitoring etc. on the "Design Tree" selective time levels. headers can be created by the user. In this research, the report named “Group Milking” presented under the “Animal” tab of the herd management program was used. In this report, group-based data were selected between certain dates with the “User Defined” tab, and the start date and time of the visit of each animal, its group, the number of the robot on which it was milked, the name of the operation (milking, feed only, rejection, exit without milking), the total milk yield of the cow in one visit, milking time (min:h), number of milkings per day, unfinished operations, amount of milk, average milk flow amount (kg/min) were recorded. The research data were transferred daily from the herd program and analyzed in MS Excel program and analyzed in Minitab 17 program. The comparison of barns on the farm was analyzed using ANOVA and compared using the LSD test ($P<0.05$). The mean and standard deviation of the data were calculated.

Methods

The 4-year performance of two robotic systems in the barn with high milk yielding cows, which can represent the full capacity loading of the milking robots, was investigated. In order for the robot data to represent homogeneous results in the trials, 20 February-20 April of each year was taken as a basis and 60-day data were used. The milking system performance results are not individual for each robot, but are given as the average of two robots in the barn. The reason for averaging; is that the waiting area of the two robots is common. The trial period could have

been kept longer, but there has been a lot of animal movement in the barns. In addition, drying, sending to the infirmary due to illness, slaughtering, etc. For reasons, it becomes difficult to work with the same animals in the same barn.

The following basic parameters were examined in the barn (Kuraloğlu, 2022):

- Number of cows milked per robotic system (unit/robot),
- Daily milking frequency per cow (pieces/day, cows),
- Distribution of the number of milkings per cow per day (%),
- Hourly milking number distribution of the two robots during the day (unit/h),
- Daily milk yield per cow (kg/day, cow),
- Cow milk yield per milking (kg/milking, cow),
- Milk flow per cow (kg/min, cow),
- The cow's daily milking time interval (h/cow, day),
- Percent distribution of cow's daily milking time interval (%),
- Time spent on the robot during milking (min),
- Number of rejections per day,
- Daily rejection time (min/day),
- Number of milkings per day per robot (pcs/day, robot),
- Loading rates of the robot in milking, washing, idle and non-milking processes (%),
- Daily labor requirement per cow (man hour/cow, day),

While the basic parameters above can be directly obtained from the herd management program, some of them are calculated with linked equations (Castro et al., 2012; Priekulis and Laurs, 2012; Ünal and Kuraloğlu, 2016).

RESULTS and DISCUSSION

The milking characteristics obtained from two robots belonging to 4 years in the working barn are given in Table 1. As seen in the table, the number of cows milked in the barn varies between approximately 100-117, and 50-59 animals are milked per robot. It can be expected that the number of animals per robot is higher (around 65) in farms where milk compulsory cow traffic is applied first. Therefore, it can be said that the optimum herd number has not been reached.

Table 1. Milking characteristics for four years in the barn

Parameter	Unit	1st year	2nd year	3rd year	4th year
Number of milked cows	pcs/2 robots	101.8±0.43c	116.8±0.39a	110.9±0.79b	100.3±0.74c
Number of days in milk	piece	144.9±0.18	154.8±0.76	153.4±0.96	195.1±1.41
Number of lactations	piece	1±0.00	1.6±0.00	2.2±0.01	2.8±0.01
Daily milking frequency	pcs/day	2.87±0.02b	2.76±0.01c	2.84±0.02b	3.06±0.03a
Daily milk yield	kg/ day	26.1±0.17d	32.3±0.09c	33.6±0.28b	46.6±0.43a
Milk yield per milking	kg/milking	9.1±0.05c	11.7±0.04b	11.8±0.07b	15.3±0.09a
Average milk flow rate	kg/min	1.3±0.01d	1.7±0.01c	1.7±0.01b	2.0±0.01a
Time spent on the robot during milking	min	7.2±0.04b	7.1±0.02b	7.0±0.03b	7.7±0.03a
Number of rejections per day	piece	2.6±0.34b	2.7±0.34b	5.5±0.44a	2.0±0.22b
Daily rejection duration	min/ day	2.2±0.36b	1.9±0.30b	4.9±0.57a	1.9±0.29b
Number of milkings per day of the robot	pcs / day	145.6±0.92d	161.3±0.70a	157.1±0.75b	153.0±0.85c
Daily milking interval	h/ day	8.2±0.02	8.1±0.02	8.2±0.02	8.3±0.02
Daily labor requirement	worker h/ day cow	0.012	0.012	0.011	0.011

*Average values shown with lowercase letters (a,b,c,d) on the same line show the differences between years ($p<0.05$)

Daily milking frequency per animal varied between 2.76 and 3.06 (Table 1). Low milking frequency in the second year; The reason may be the feeding strategies applied and the commuting strategies of delayed animals. The fourth year value was above the limit values (2.5-2.9) for farms with first milk driven cow traffic in the literature (Ipema, 1997; Laurs et al., 2009; Castro et al., 2012, Sitkowska et al., 2015). The animals were not grouped according to their yield in the first three years across the farm. The fact that high-yielding animals were collected in the barn after grouping provided a good value of 3.06 for milking frequency.

While the daily milk yield was 26.1 kg in the first year, which is the first lactation period of the cows, it increased to 32.3 kg with an increase of 24% in the second year and to 33.6 kg with an increase of 28% in the third year. The reason for the low milk yield in the first year may be the fact that the cows are in the first lactation and the period of getting used to the robotic system of the cows and workers. It can be said that the increase in the number of herd lactations and be familiar with the robot system in the second and third years have a positive effect on milk yield. Despite the fact that the number of animals in the barn was at the lowest level (100.3 units) in the fourth year, the daily milk yield increased by 78% compared to the first year and reached

the highest level with 46.6 kg. This amount has been reached to the fact that cows with high milk yield throughout the farm are taken to this barn in the fourth year. It is an important issue to know how much extra milk will be given by animals that are milked more than twice a day. Compared to 3x milking and 2x milking, the amount of milk can increase by 20% on average. Milking 4x times can provide an extra increase of 5-10%. The additional increase in milk yield provided by stimulation of milk producing cells is associated with better feeding and better management on the farm where 3x milking is performed (Hobbis, 2013). With the grouping strategy carried out in the fourth year in the farm, feeding was done according to the expected yields of the high-yielding cows and the highest milk yield was obtained.

The increase in the daily milk yield of the cows by years has similarly increased the milk yield per milking. Accordingly, the milking yield, which was 9.1 kg in the first year, increased by 28% on average in the second and third years to 11.8 kg, and increased by 79% to 15.3 kg in the fourth year (Table 1). Milk yield increases showed that the cows were accustomed to the robot system. Controlling the robot operation from the manager to the workers in the barn, increasing the milking efficiency of the cows with increasing lactation age and adapting to the environment and knowing the system, and herd grouping have provided this improvement. Another factor affecting the yield per milking is the milk flow rate (milking flow). This value, which is related to the genetics of the animal, is also affected by environmental conditions, the care and settings of the milking system and the training of the animals. Stress is low in every animal that is well fed, welfare conditions are created, and if milking is done at the right time with the right conditions and equipment, the milking flow will increase. In the measurements made, the milk flow rate increased significantly each year (1.28, 1.66, 1.68 and 1.97 kg/min) (Table 1).

Despite the increase in the productivity of the cows in the farm, which was not grouped in the first three years, the time spent on the robot was found to be close to each other (average 7.1 minutes). The increase in milk flow of animals during milking can be shown as a reason for this. On the other hand, the significant daily milking frequency (3.1) and daily milk yield increase (46.6 kg) in the fourth year increased to 7.7 minutes, increasing the time spent on the robot by only 8%. The fact that this period does not increase is a desired situation for the entire herd to use the robot effectively. The fact that this period does not increase much in the fourth year can be shown to increase the milk flow rate from 1.3 kg/min to 2.0 kg/min at milking.

Results obtained after the first year in this study were similar to that of Castro et al. (2012) (1.44 kg/min) and Heringstad and Kjøren Bugten (2014) (1.5 kg/min) were found to be higher than the results of their research (Table 1).

The daily number of rejections and the duration of the cows in the robot are examined, the third year was the highest year with 5.5 and 4.9 minutes. In the fourth year of grouping, the least results were obtained with 2.0 units and 1.9 minutes (Table 1). The target value should be zero in the number and duration of refusals in farms that apply milk-first forced cow traffic first. In a farm with a pre-selection gate, it is impossible for a cow without a milking permit to enter the waiting area. However, sometimes manual intervention may be made by the worker due to faults of robots. On the other hand, although the cows collected from the barn are sent directly to the waiting area and leaving the milking selection to the robot, it seems like a temporary solution, it affects the robot performance negatively. However, since the intervention to delayed milking is a priority, it has been seen that the concern of robot performance can be put into the background. In addition, after the operations carried out in the separation area (special needs area) after the robots, the cows are left back to the robot waiting area instead of the feeding area. In this case, the cow without milking permit can occupy the robot.

The maximum number of milkings performed by a robot during the day was obtained with 161.3 units in the second year data. The lowest number of milkings was realized in the first year with 145.6 units. This situation can be primarily associated with the number of animals in the barn in those years (102 cows in the first year, 117 cows in the second year). On the other hand, in the fourth year with the lowest number of animals (100 cows), the robot's milking rate was expected to be the lowest, but on the contrary, it ranked third with 153.0 milkings. The grouping of high-yielding animals on the farm in this barn for the fourth year has increased the loading rate of the robots.

When the daily milking intervals in the barn were examined, values close to each other were found between 8.1 and 8.3 hours. Less commuting in only the fourth year increased the milking interval slightly (8.3 hours). While the daily labor requirement per cow was 0.012 worker hours in the first two years, it decreased slightly to 0.011 worker hours in the next two years. It can be said that cows have adapted to robotic systems over the years, reducing the labor. The ratios of the time spent by the two robots in the barn in milking, idle, washing and non-milking operations are given in Figure 3. As seen in Figure 3, the highest percentage of loading of robots

in milking belongs to the fourth year with 82.2%, and the lowest percentage belongs to the first year with 72.3%. The second and third years were found to be close to each other with 79% and 78%. The fact that the first year in the farm is the beginning of the robot operation and the animal can be shown to be low, while the fourth year's milking routine in the barn is completely left to the robot, and the time (percentage) of milking time (percentage) of high productive cows being taken to this barn may be shown to be high.

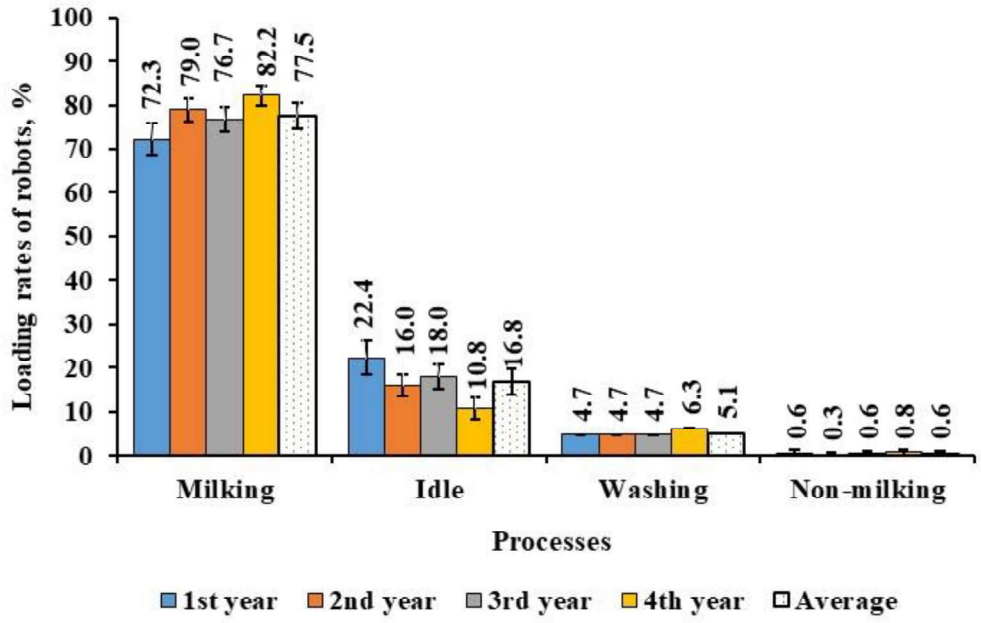


Figure 3. Rates of time spent by robots in milking, idle, washing and non-milking operations

When the idle time ratios of the robot are examined, the highest with 22.4% in the first year and the lowest with 10.8% in the fourth year. The most effective factor on idle time is the number of cows. In the barn, there are 102 cows in the first year and 100 cows in the fourth year, and the number is close to each other. However, the percentages of idle time are far from each other. This can be attributed to the wrong strategies in cow traffic, the feeding not supporting the traffic, and the animals not being trained. In the fourth year, the loading of high-yielding animals in the barn increased and the idle time percentage decreased. Laurs et al. (2009) found the rate of idle time as 19% in a study they conducted with 88 animals in a compulsory type barn. Although the number of animals in the first year of this study was 14 more than the number in the authors' study, the rate of idle time was higher than the rate given by the authors. This surplus can be attributed to the new establishment of the farm, the cows in the first lactation and the lack of training of the working staff. In general, increasing the number of cows in the barn can reduce idle time. However, increasing the number of cows is not the only factor that

will increase the performance of the robot. Cow traffic management is also important. In other words, in order to reduce the idle time in robots, animals that have not been milked should be trained instead of being held (Devir et al., 1999).

The times spent in the washing process' were the same (one wash was 20 minutes). However, when the idle time of the robot exceeds 30 minutes, the system performs a short rinse. Cleaning processes such as washing and rinsing can be changed in the system. If the number of cows that are not milked on maintenance-repair days increases, the washing process can be canceled. In the fourth year, detergent washing has been reduced to two this year, as highly productive cows keep the robots busy. When the non milking processes are examined, the fourth year is different from the values in other years with a rate of 0.8%. Because, apart from rejection, without milking and manual milking under this title, heifers are trained to the robot before calving by using the "only feed" function in the third and fourth years. This feature was not used for the first two years.

The milking rates of the cows according to the number of milkings per day are given in Figure 4. When the figure is analyzed, the distribution of milking numbers per cow is concentrated at 2x, 3x and 4x in all years. Cow milking rates, which were 1.1% and 2.2% in the first year and second year at 1x milking, decreased significantly (0.5% and 0.3%) in the third and fourth years. In the fourth year with high yielding animals, 4x milking increased significantly and reached 20.8%. Again in the same year, the rate of milking 5x times increased to 2.8%, increasing the number of milking per animal per day of the group. The daily milking frequency of 3.06 in the fourth year can explain the result of this improvement. In the fourth year, the number of milking has been increased by the barn structure created according to the yield throughout the farm. It can be suggested that barns with low robot performance improve the robot visits, with cow feeding strategy, training, and routine introduction of unmilked cows.

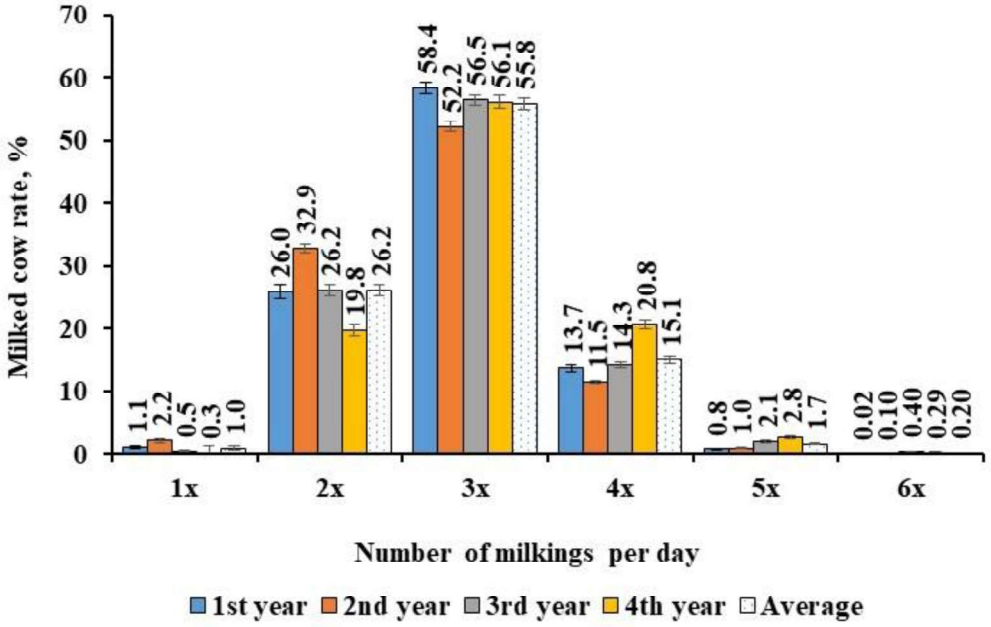


Figure 4. Distribution rates of cows according to daily milking numbers

When the distribution of hourly milking numbers of the two robots in the barn is examined in a 24-hour period, it is seen that the lowest milking number is 12,2 in the range of 00:00-08:00 hours in the average of four years, and the highest number of milking is between 16:00-24:00. It was seen that it was reached at :00 hours (Figure 5 and Table 2). The main cleaning times of the robots in the barn were changed every year. In the first year, washing was done at 03:00, 12:00 and 21:00 hours, however, the lowest number of milkings (5.8 in the range of 03:00-04:00) was determined this year. In the second year, the washing process was programmed at 00:00, 06:00 and 12:00, in the third year it was changed to 04:00, 12:00 and 20:00. In the fourth year, the washing process was reduced to two times a day and was carried out at 04:00 and 20:00. In the second and third years of the study, it was observed that the number of robot milking reached peak values (15.7 and 15.2/2 robots). However, considering that the number of animals in the barn was high in these years, it cannot be said that it was very successful. Because after the yield grouping in the fourth year, although the number of cows was the lowest in four years (100).

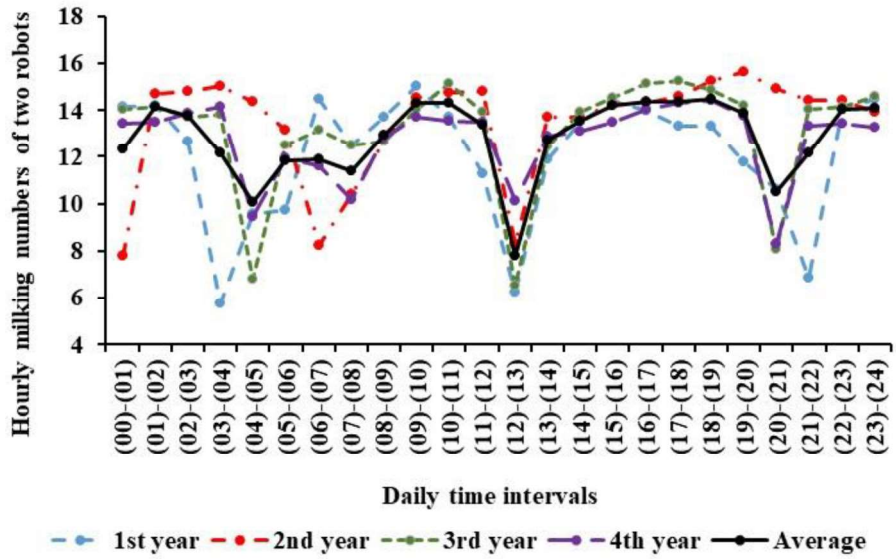


Figure 5. Distribution of hourly robot milking during a day (total of two robots)

Table 2. Summary of the distribution of the milking number of the two robots during the day

Clock-Parameter	1st year	2nd year	3rd year	4th year	Average
00:00-08:00	11.6	12.3	12.6	12.3	12.2
08:00-16:00	12.5	13.3	12.9	12.9	12.9
16:00-24:00	12.3	14.7	13.8	13.1	13.5
Smallest	5.8	7.8	6.6	8.3	7.1
The biggest	15.0	15.7	15.2	14.4	15.1
Average	12.1	13.4	13.1	12.8	12.9

It was stated in Table 1 that there was no significant difference between the visit times of the cows to the milking robot during 4 years in the barn. The milking time intervals given in the table vary between 8.1 and 8.3 hours. As it is known, one of the features of robotic milking is that cows can visit the milking robot voluntarily. This causes a large variation in the frequency of visits to the milking robot and thus milking intervals can result in high variation. For this reason, the milking time intervals of the cows in the robot visit were examined proportionally (Figure 6). As seen in the figure, approximately 92% of milkings in the first and second years were detected at the highest rates between 4-12 hours of milking. In the fourth year, this time interval was found to be the lowest with 88.8%. In the third year, the milking interval of 4-12 hours increased by 89.4%, close to the fourth year. On the other hand, the fact that 7.5% of milkings are detected on average over 12 hours in the third and fourth years may pose a problem for animal health. Since milking routines are largely left to the robot in the third and fourth years, it makes it difficult to follow up cows that are delayed in milking. In this case, human labor and initiative cause delays in the transportation of the animal. On the other hand, milking

visits under 4 hours is another problem that reduces robot performance. Because arrivals to the robot under 4 hours cause rejections. Hogeveen et al. (2001) investigated the relationship between the milking interval of the milking robot, milk production and milk flow rate on 66 cows. They found that 9.7% of milkings were shorter than 6 hours and 17.6% were longer than 12 hours. The researchers reported that the average daily milking frequency of 6% of all cows was less than two, and this was due to the cow factor and the time of the day affecting the change in the milking interval. In addition to the cow factor, the authors found that milking interval length also had a significant effect on milk production and milk flow rate. They found that the effect of milking interval on milk production per hour was greater in high-yielding cows than in low-yielding cows. It can be said that the findings of the researchers are similar to the results of this study.

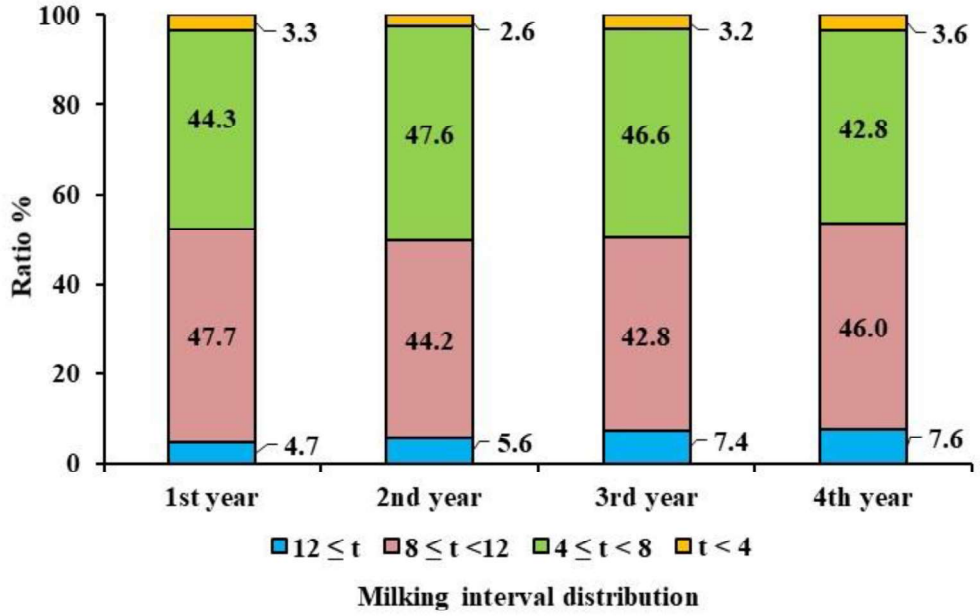


Figure 6. Distribution rates of cows in the milking interval

CONCLUSION and SUGGESTIONS

The priority of the study was to determine the effects of the processes in the first years of establishment of the commercial farm, on the robot performance. The results obtained from this study are as follows.

- Daily milking frequency, which varied between 2.76-2.87 in the first three years in the barn, reached 3.06 in the fourth year because of the grouping made throughout the farm. This showed that it is beneficial to grouping animals according to yield for more effective use of robot performance.

- Since the first year of the research was the first lactation period of the cows, the daily milk yield, milking yield and milk flow rates were found to be 26.1 kg/day, 9.1 kg/milking and 1.3 kg/min, respectively. In the second and third years, these data increased to an average of 25%, and in the fourth year, the yield increased by 78% on average thanks to the grouping. Over the years, the employees' mastery of the use of robots, the increase in the lactation age of the cows and their understanding of the system by adapting to the environment have increased the milking efficiency. The yield grouping of the herd also provided this improvement.
- While the loading percentage of robots in milking was 72.3% in the first year, increasing it to 82.2% in the fourth year is a significant improvement. This increase in rate significantly reduced the idle time of the robot (from 22.4% to 10.8%). The biggest reason for potential improvement seems to be using milking management strategies to increase the percentage of time each robot milks cows. By leaving the milking routine completely to the robot in farm management, especially the length of time spent in milking of high-yielding cows can be shown as a reason for this improvement.
- Although the number of cows milked by the two robots in the barn during the day was 13.2 in average in the second and third years, this number was reached with an average of 114 animals. Although the number of cows in the barn decreased to 100 in the fourth year, the two robots milked an average of 12.8 cows. With this year's yield grouping, milking frequency of cows, milk yield etc. It has been observed that the robot performance can be maximized due to the improvement of the robots.
- Grouping can be done in enterprises that do not have capacity problems and have more than one robotic system barn. When creating groups, milking numbers suitable for robot loading and the number of animals equivalent to them should be calculated.
- Robots must have idle time. Thus, less dominant animals are not rejected during robot visits and the desired daily milking numbers can be achieved.
- Capacity can be affected not only by the number of animals and milking, but also by milking efficiency and duration.
- Animals with bad teats and not suitable for milking should be removed from the herd. Reverse alternative solutions (such as manual tooling) should not be applied to the operation of the system.
- Animal traffic in the barn should be set up correctly, and interventions that will affect robot performance should be avoided.

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