Robots for Herd Management of Dairy Cows in Tropical Taiwan

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Dairy herd improvement (DHI) program in Taiwan

- DHI cows were 46.3% of 61,336 milking cows
- DHI herds were 32.1% of 551 dairy cattle farms
- Daily milk yield per cow was 25.1Kg in DHI farms

2018
台灣各縣市乳牛場的測乳牛群每日產乳量 (Dairy Taiwan) 最近測乳日期：2019/7/25
Average Milk Yield of Ten-tons Cows, Breeding Farm and Production Farm in Taiwan DHI Program

Milk Yield (Kg)/cow/year

Milking Year


Milking Year

Average Milk Yield of Ten-tons Cows
Breeding Farm
Average Milk Yield of DHI Farm (Dairy Herd Improvement)
Members of ICAR (International Committee for Animal Recording)

International Non-Governmental Organization (1951 Rome Italy)

2011 (in blue)

Japan
Korea
Taiwan

2019 (in yellow)
Taiwan Position on Cow Milk Production and Quality of Year 2013

Taiwan position

By Ming-Che WU at TLRI 2014/9/16
## Commodity focus

<table>
<thead>
<tr>
<th>Category</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biofuels</td>
<td>Ethanol, biodiesel</td>
</tr>
<tr>
<td>Cereals</td>
<td>Wheat, rice, coarse grains</td>
</tr>
<tr>
<td>Cotton</td>
<td></td>
</tr>
<tr>
<td>Dairy</td>
<td>Butter, cheese, milk, whole milk powder, skim milk powder, whey powder, casein</td>
</tr>
<tr>
<td>Fish</td>
<td>Capture fisheries, aquaculture</td>
</tr>
<tr>
<td>Meat</td>
<td>Beef and veal, poultry, sheep meat, pig meat</td>
</tr>
<tr>
<td>Oilseeds</td>
<td>Oilseeds, protein meals, vegetable oils</td>
</tr>
<tr>
<td>Sugar</td>
<td>Sugar, raw sugar, white sugar</td>
</tr>
</tbody>
</table>
Taiwan is the 16th

Japan is the 13th in production

Japan is the 9th in consumption

Taiwan is the 15th


Key Factors in Dairy Industry

Value

Yield

Quality

Farming Land

Dairy Policy
ICT used in dairy farming

- Milk/FTE
- Profits
- Costs

Productivity 1.0  2.0  3.0  4.0

3,800 head
3X milking per day
Global Vision for Dairy Cattle Farming by Smart Systems

What is the MOST important - **GOAL**?

Photographs, Illustrations
256 pages, 245 x 170 mm
Publisher: CSIRO
Publishing
February 2015
ISBN: 9781486301614
ACTION Scheme

Aware status: to understand what I did and how to do it better.

Core facility: to have key tools for building data banks of individual animal.

Team ready: to agree the public-private partnership and for a better breeding program.

In-time service: to view results of instrumental farming in time.

Outreach system: to assist a new keeper what he can use technique.

Niche management: to evaluate the social-economic value and outcome of smart dairy strategy.
Robotic Milking

Daily Activity of a milking cow

- 45% Lying down
- 25% Standing and socializing
- 16% Eating
- 13% Milking
- 1% Drinking

Jan Hulsen
Jack Rodenburg
Smart Technology of Top Five Robotic Applications in Taiwan Dairy Cattle Farm

Five working lines with robots in the dairy farm were designed to do smart farming as follows:

1. daily **milking** line,
2. daily **feeding** line for milking cows,
3. daily **clean up** the cow excrement and environmental clean line,
4. cycle management of **cow calving** and young **calf feeding** line, and
5. cycle monitoring of **cattle health** line for cows and heifers.

Smart Agriculture 4.0 Program for sustainable dairy farm
Dairy Industry – Milking Robots for Life Quality of Farmers

As Is
- Lack of workers to milk and feed cows
- Less use of precision farming technology in farms
- No proactive herd system for cow disease caring

To Be
- Have robotic systems in cow milking and feeding
- Have smart automatic herd management system
- Have better production efficiency and low cost

As Is
- Need milking labors
- Need labors to attach the milking cups to cows twice per day
- No sensors to record data from individual cow in 70% of herds with paper recording

To Be
- Smart Milking Robots
- Robotic milking system with milk quality sensors to replace labors. More milk production with no variation from labors in a quiet working environment.
- Robotic milking system or with rotary for relevant dairy farmers in five modes of major daily work lines, including daily milking, daily feeding, periodic cow health monitoring, periodic cow delivery and calves rearing, and daily cleaning manure environment.

Key Tech Need
- Clean space and quiet milking environment
- Smart milking and feeding robots
- Sensors for environment, body temperature and behavior
- Robotic feeding system
- Proactive herd management systems
- National milk yield data analysis
- Herd profit analysis
- Milking efficiency prediction
- Real-time sensors for cow health and milk quality
- Pipeline grading of raw milk to create values for farmer incomes and farming life quality.
<table>
<thead>
<tr>
<th>Key Tech Need</th>
<th>Robots</th>
<th>Smart Farming</th>
<th>Big Data Analysis</th>
<th>Application Needs</th>
</tr>
</thead>
</table>
|               | • Clean space and quiet milking environment  
• Smart milking and feeding robots | • Sensors for environment, body temperature and behavior  
• Robotic feeding system  
• Proactive herd management systems | • National milk yield data analysis  
• Herd profit analysis  
• Milking efficiency prediction | • Real-time sensors for cow health and milk quality  
• Pipeline grading of raw milk to create values for farmer incomes and farming life quality. |
Smart technology of top five robotic applications was for enhancement of competitiveness, sustainable development, self-sufficiency rate, and market share of dairy farms in Taiwan.

Operations of intelligent milking and/or feeding robots were introduced into 20 of cow breeding farms.

Automatic feeding robots were used effectively to maintain the performance of milking cows with the improvement of milk quality and the dairy industry capacity.
Sensors for Cow Identification and Health
Nowadays, calves are usually conceived by artificial insemination and born after a nine-month gestation period.

Cows become sexually mature of about one year, and a dairy herd calve for the first time at the age of 2.

A newborn calf weighs 40 kg, a six-month-old cow weighs 200 kg, and a fully-grown cow weighs 550 kg.

Fig. 2: Dimensions of first prototype and positioning of four Kinect-v2 sensors
ROBOT READY™ COMPONENTS

Mastitis Resistance
- SCS
- Mastitis Resistance

Mobility
- Rear Legs
- Rear View
- Overall Feet & Legs

Udders & Teat Alignment
- Front Teat Placement
- Rear Teat Placement
- Teat Length
- Udder Depth
- Overall Udder

Workability
- Milking Speed
- Milking Temperament
- Production

Culls in Robot Herds (vs other herds)
- Milking Speed: +4.1%
- Teat Placement: +6.5%
Milking and Feeding Robots

Agricultural Robot Revenue by Application Type, World Markets: 2015-2024

Source: Tractica
➢ Automatic milking and calf feeding robots were used.
➢ Intelligent robots could be used to increase precision farming with replacement of aged-labors on the five daily work lines of dairy farming.
ROBOTS FOR HERD MANAGEMENT OF DAIRY COWS IN TROPICAL TAIWAN

Robotic Systems for Dairy Cattle Farm