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A 20-year Analysis of the Evolution of Automatic Milking Systems: Processes, Technologies and Livestock Environment

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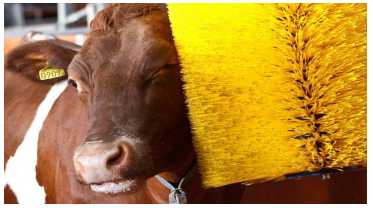
Dairy Farms – *Current and Future Challenges*

Evolution of structures

- Increase in herd size
- Increase in labor required

Change in the economic context

- Price volatility
- Timely decisions
- Traceability of livestock products



Change in rearing conditions

- Animal welfare
- Increased risk of diseases (increased surveillance)

Blow up of Information and Communications Technologies

- Advances of electronic systems (portable, autonomous, …)
- Sensors and data management (DSS, Artificial Intelligence, …)

Development of AUTOMATION In Livestock Farming

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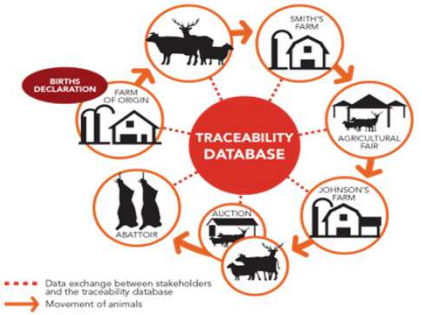
Automation in Livestock Farming

The trends to higher automation in livestock farming supports the development of systems for:

- ✓ **EFFICIENCY:** more efficient use of resources and reduction of emissions per unit of product.
- ✓ **WORKLOAD**: reduction of work-load and labor costs.
- ✓ **PREVENTION**: improvement of management in livestock housing (cow welfare)
- ✓ **CERTIFICATION**: traceability of actions, events and product quality (sanitary, nutritive, …).



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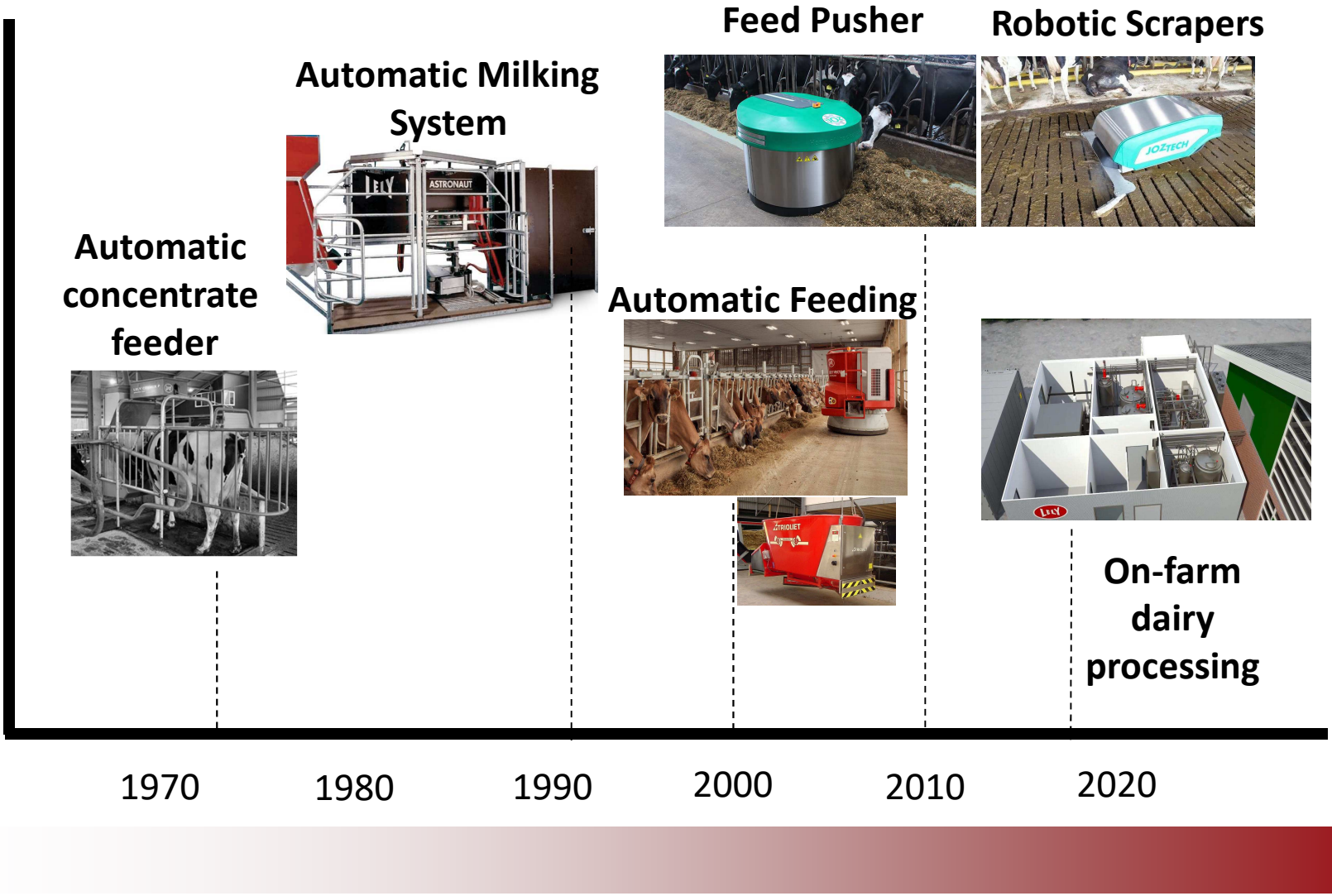
Automation in Livestock Farming

The application of automation is a growing trend in the dairy industry:



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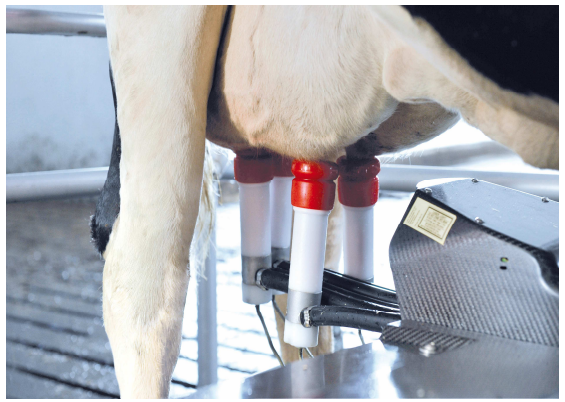
Automatic Milking Systems (AMS)

- ✓ One of the most significant technological changes in the dairy industry
- ✓ Well-established technology
- ✓ Maximise milk production and animals' welfare, thanks to the voluntary milking access
- ✓ Increase the resource efficiency and environmental sustainability of dairy farms.



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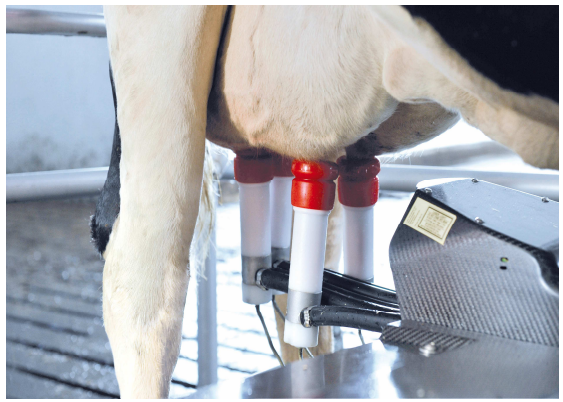
OBJECTIVES

The present study:

- Assesses the state of the art of research on AMS through a systematic review of patent trends in the last two decades (2000-2019) in order to identify research tendencies and critical gaps.

- Patents of the last 20-years were extracted from the EspaceNet database. Terms appearing in title and abstract of a total of 154 patents were processed by text mining approach



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MATERIAL AND METHODS

Data Collection and Analysis

- Patents were searched using a custom script including different synonyms used to define the AMS ("automatic milking" OR "milking robot" OR "robotic milking" OR "automated milking" OR "automatically milking")
- Filtered by publication date (2000-2019) → organised in five groups of four years: 2000-2003, 2004-2007, 2008-2011, 2012-2015, 2016-2019
- “Title” and “Abstract” were processed with the text mining process trough MS Excel and GraphPad Prism 8.0.0
- Words included in the dataset were grouped into four clusters: "Animal", "Process", "Sensors" and "Components".

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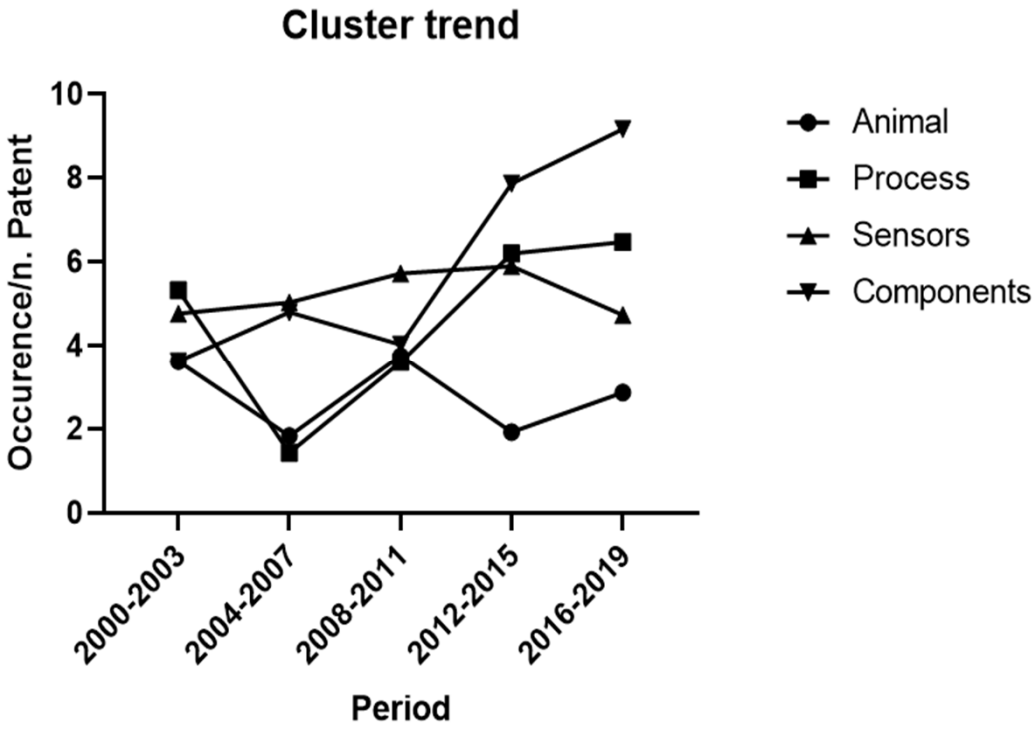
Clusters Analysis - Trends

The text mining process allowed to identify the following main clusters: Components (30%), Sensors (29%), Process (25%) and Animal (16%).



In the last 10 years, the development of sensors has been incorporated in the improvement of the process efficiency.

Meanwhile, the target of the patents moved towards the components

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RESULTS

Clusters Analysis – Words Frequencies

ANIMAL → *Animal body condition/weight*: +249% from 2000 to 2019

Animal health: +391% from 2000 to 2019

SENSORS → *Imaging techniques*: topic with the highest increase!

Model: 348 % from 2000 to 2019.

PROCESS → *Water*: +291% from 2000 to 2019.

Pulsation technologies: +65% from 2000 to 2019.

COMPONENTES → *Teat cups*: -44% from 2000 to 2019.

Milking arm : +51% from 2000 to 2019.

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CONCLUSIONS

- This study analysed the AMS patents trend over the last two decades.
- Cluster analysis showed that the AMS industry is focused on the implementation of more efficient and sustainable systems.
- The evolution of components, sensors and technologies complies both with high-quality products and ensure animal welfare.
- Topics related to the animal aspect are still underdeveloped, but their increasing trend allows to expect a progressive evolution in the animal welfare issue.

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