HIGHLIGHTS OF 28TH CLUB OF BOLOGNA MEETING

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SUMMARY

Club of Bologna, world task force on strategies for development of agricultural mechanization, at 28th annual meeting in Bologna, during its agenda, three important sessions were presented: 1st Remote machinery repair, maintenance and assistance, 2nd Agricultural machinery new technologies: challenges and limits for users, 3rd Specific mechanization: machines for horticulture. Besides Sessions, agenda comprised: Giuseppe Pellizzi Prize 2018 Award Ceremony, Report of Study Group and Programme of activities for 2019.

Keywords: *Club of Bologna, remote machinery repair, maintenance and assistance, agricultural engineering strategy, machines for horticulture*

INTRODUCTION

Club of Bologna (CoB), a world task-force on the strategies for the development of agricultural mechanization belongs, for sure, to the worldwide most important organizations in the field of agricultural and biosystems engineering. It was founded 1989 as a free and nonprofit organization, supported by Italian agricultural and earth moving machinery manufacturers association *FederUnacoma*. CoB gathers members from 31 countries and has 93 full members. Common, and most significant, CoB's activity is annual members' meetings, held alternatively in Bologna, during exhibition EIMA, and Hannover, during *Agritechnica*.

REMOTE MACHINERY REPAIR, MAINTENANCE AND ASSISTANCE

First presentation *"Product Services in the digital age (Industrie 4.0)"* was given by *E. Westkämper*, former head of Fraunhofer Inst. Manufacturing Engineering& Automation in Germany. The presentation was mainly focused on the future challenges for machine manufacturers in service and support. Future fields of action ranges from the state of the art in pure technical workshop services to web-based consulting services and finally to remote operations such as process diagnostics, process monitoring, automatic process optimization and thus up to automatic online operations. Main resume puts a focus on demands and trends of future development. All participants in the ICT framework have be involved "from cradle to grave", from resource deliverer to residue maintainers (including machinery producer and after consumer sector). Consequently, tools for life cycle assessment have to be implemented in ICT.

The main challenge for the machine manufacturer within the scope of digitization are the expansion of the product horizon from pure machine production to applied production processes in which the machines are used both regionally and in the global environment of goods and information flows. The next stages will be focused: Implementation of remote production via real-time communication. Meeting security requirements and challenges to create and secure trust. The increasing demand for Big Data Management must be adequately met in order to take account of the rapid development of sensor technologies (frequency in msec, more than 200 basic technologies available) and the need for technologies for data analysis. Big data management and artificial intelligence" have already become a key technology for the future, as a lot of data has to be retrieved from very complex systems and processes. The future research challenge must include the analysis and modelling of processes as crucial needs for future development (including high importance). To this end, the evaluation of process simulation and the development of "feedback loops and artificial intelligence" needs a learning environment of technical systems.

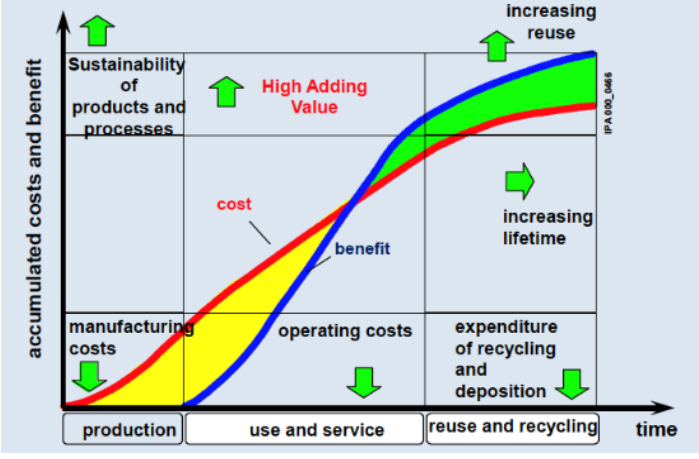

Figure 1 Sustainability of Manufacturing (Westkämper, 2018)
http://www.clubofbologna.org/ew/ew_proceedings/2018%20_S1.1_PPTX_Westkmper.pdf

In terms of costs and benefits, the manufacturing and operating costs for the use and maintenance of machines as well as the costs for recycling and deposit must be reduced. Increasing the service life is a challenge to achieve higher sustainability of products and processes and last but not least a higher added value and increased reuse.

Final statement: "The transformation of "Industrie 4.0" is a clear revolution, which will change the management and will have winner and looser in all sectors. It requires new qualification of employees, new methods of economic control and changeable structures of organisation."

F. Protano from CNH Industrial, responsible for Precision Solutions and Telematics Product Management showed an inside into the strategy for *"The Farm Data Ecosystem"*.

She presented definitions of Agriculture 1.0 up to 4.0 and what can be understood by digital farming (Figure 2).

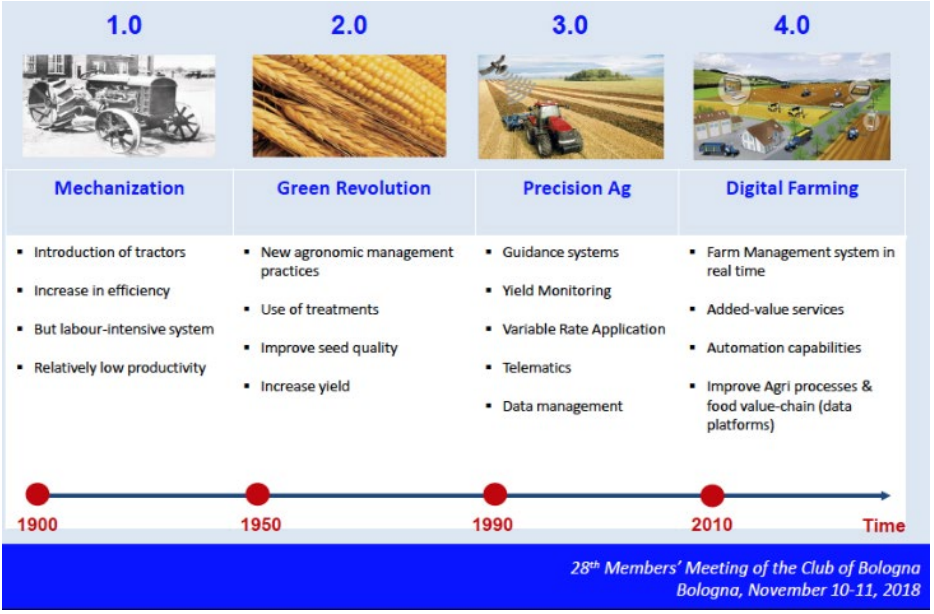

Figure 2 The agricultural Evolution (Protano, Vandecaveye, 2018)
http://www.clubofbologna.org/ew/ew_proceedings/2018_S1.2_PPTX_PROTANO_VANDECAVEYE.pdf

A clear focus was given on opportunities for Equipment Manufacturers and related strategies for operational organization between customer, dealer and manufacturer. Especially future possibilities regarding innovations in telematics connections (bi-directional communication for high density and transmission speed of online data between partners) and new infrastructures for e.g. pro-active intervention, to improve the customer service quality and the products and processes for the manufacture. "But the ultimate goal is to build the perfect vehicle." Using the combine harvester as an example (equipped with automatic steering solutions and various crop sensors, a modem on board, which allows the vehicle to be monitored in real time), the possibilities of future developments and their advantages from

the different perspectives of machine manufacturers, dealers and end customers were presented. The CNHI Agricutural Control Room, a central control room and web-based communication node between machines and all stakeholders, was presented to implement networked communication between machines, users and experts from different backgrounds online (Figure 3.)

Figure 3 The Control Room Concept (Protano, Vandecaveye, 2018)
http://www.clubofbologna.org/ew/ew_proceedings/2018_S1.2_PPTX_PROTANO_VANDECAVEYE.pdf

Several examples were given how the stored data can be used for many services from optimization of farm processes up to food traceability and documentation duties. The operational details (e.g. machine information from CAN-bus to technical support including expert knowledge online from abroad) were presented exemplary. The possibilities for an improved efficiency of the production processes were presented. For example, how to achieve proactive troubleshooting of machines in action and thus reduced repair cases and repair times or to obtain practice-relevant information for the successive further development of machines for "the next generation". "To conclude, a data-driven approach is nowadays a major factor of competitive advantage for enterprises, and especially a support for remote maintenance applications."

M. Pier (Grimme) demonstrated in his presentation *"InnoServPro: Innovative Service Products for individual and availability-oriented business models in capital goods industry"* the technical details from sensor technology to telecommunication structures in order to demonstrate the possibilities and benefits of smart farming technologies used by premium partner contractors using the example of potato harvesters. Main topic was "After sales management". To achieve an innovative service three main goals were defined: First the development of customized, availability-oriented business models; Second the development

and integration of smart components with the ability to communicate; Third a design and configuration of an information management platform to provide and exchange service relevant data. Beginning with the sensor technology using the example of a sensor which detects the load limits at the conveyer belt chains of the potato harvester (by analyzing "the process of the elongation of the conveyer belt chains in test bench trials. Results showed that the elongation increased slowly with the applied stress, and can be predicted."), the entire data transfer (from signal post processing to a prediction of the conveyer belt conditions) and telecommunication system including a predictive maintenance were presented followed by the stepwise development of a business model between manufacturer and contractor. It was pointed out very clearly that "manufacturers of industrial goods integrate several components from different component suppliers into their specific machines". A central cloud platform is obligatory due to the interconnection of component suppliers up to the machine user for cross-company data exchange (Figure 4).

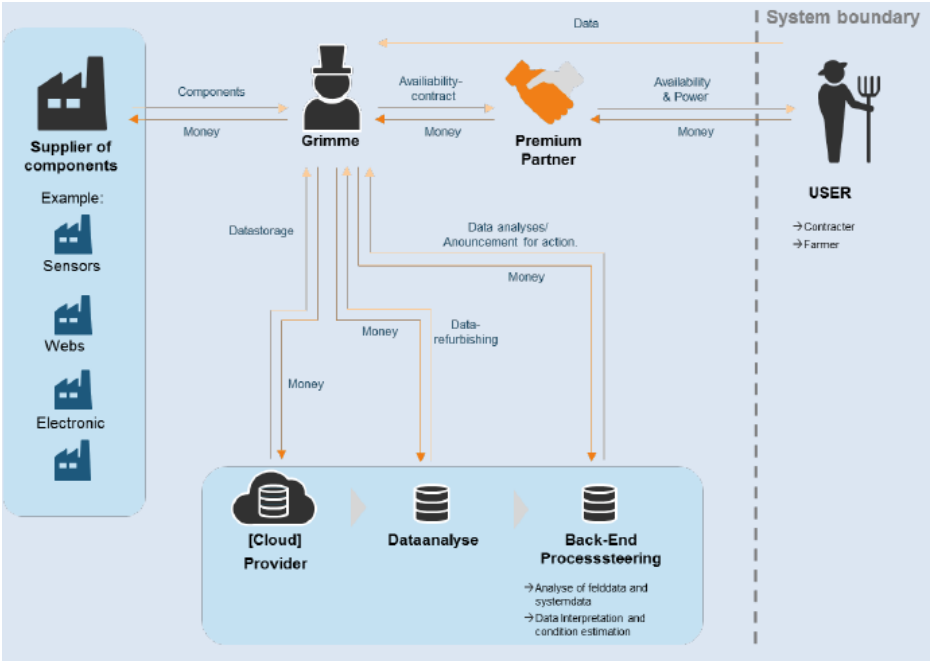

Figure 4 Value network map (Pier, 2018)
http://www.clubofbologna.org/ew/ew_proceedings/2018_S1.3_PPTX_PIER_rid.pdf

User, contractor, manufacture and component supplier are connected in a network to increase machine and process efficiency continuously.

For the future global logistic networks will be build predicting the frequency of maintenance by intelligent interfaces of machines.

AGRICULTURAL MACHINERY, NEW TECHNOLOGIES AND LIMITS FOR USERS

H. Auernhammer gave a short introduction for the Session 2., reminding audience on at Club of Bologna annual meeting during Agritechnica fair in Hanover 2017 introduced term 4.0 Agriculture.

Section started with presentation of *B. Pichlmaier* related to *trends and new technologies for agriculture and agricultural machinery.* Actual aspects of expected future development, based on complex principles of sustainability were discussed and commented. He tackled issues of machinery power and weight growth, aimed to contribute reduction of operational costs. It was concluded that the growth reached limit. Fig. 5 presented tractor operational costs as a function of engine power, and fig. 6. the same for application of future autonomous, driverless, solutions.

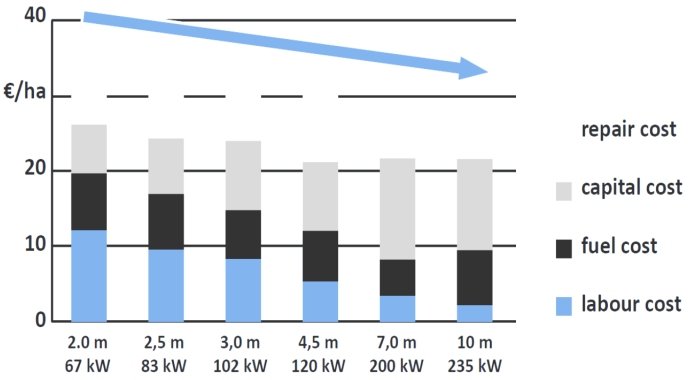

Figure 5 Operational costs versa tractor power

According to fig. 5. the power growth over 120 kW does not result in reduction of operational cost per hectare. Regarding autonomous vehicles, whose introduction is expected in the future, no labor costs, small units will have lower overall costs per hectare. This motivated author to express motto for future development: multitude instead of magnitude. Author elaborated and presented few other aspects of future technologies, like advanced controlled environment agriculture (greenhouses), robots, smart machines, new fuels (e.g. electricity) and information visualization. Very interesting, intelligent and usable presentation was finished with few messages.

Two most significant are:

- Sustainable productivity is the fundamental objective for farming. Support fresh thinking for a truly circular agricultural economy.
- Evaluate paradigm shifts: Machinery → Agronomy; Magnitude → Multitude; Complexity → Simplicity.

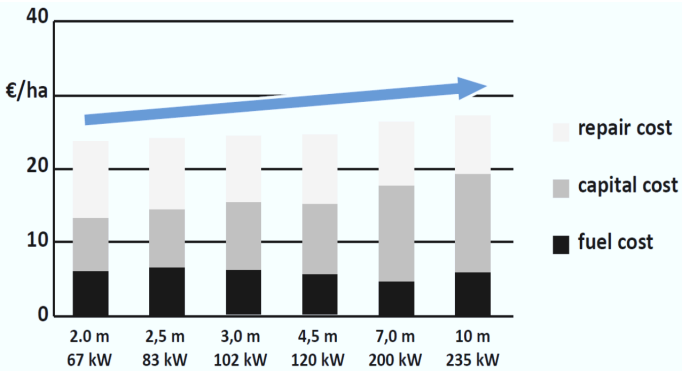

Figure 6 Operational costs versa power for autonomous, driverless, tractors

M. Shulman informed about *European Associations of Agricultural (family) Farms Copa and Cooperatives –Cogeca.* These two entities are, since merged in 1962, the biggest and most active lobby organizations in Brussels. Organization appreciates idea of "Smart Village" and is ready to accept digitization, "big-data", robotics, biotechnology, smart farming, etc., but this should be on a level to provide concrete solutions and ensure full security. In this regard EU Code of Conduct on agricultural data sharing by contractual arrangement should be usable tool. The final message of the presentation was: Innovation needs to provide concrete solutions and all farmers need to access latest technology in order to respond to dynamic markets and maintain high quality of agricultural products!

This was followed by untypical presentation of advanced farmer *J. Bosch,* who demonstrated his and other *farmer's experiences with new technologies in agriculture,* mostly related to application of IT and digitalization. He mentioned advantages of IT, but some problems as well. Most significant are those related to putting systems into operation and fighting with malfunctions. To overcome mentioned is needed between less than hour, till few months, including engagement of sellers' team. It was also mentioned the problem of coupling tractors and implements by using different stages of ISOBUS. That means, full commercial maturity of compatibility of ISOBUS is still in front of us. However, it was concluded that introduction of IT and digitalization already support agriculture, and future expectations are unlimited. Section was finalized by presentation on status in P.R. China, given by *M. Yang.* This was overview of current development and future plans, but was more like political declaration, with less concrete achievements and future outlooks.

SPECIFIC MECHANIZATION: MACHINES FOR HORTICULTURE

The future of horticulture mechanisation, by prof. Silvana Nicole, Univ. of Turine

Author emphasize several basic characteristics and future challenges of horticulture production such as: 1. High costs and low productivity, 2. Internal and external business risks, 3. Maintain product performance and quality control, 4. Threat from emerging economies with larger and cheaper labor and 5. Various risks in managing work health and safety. Besides previous, Prof. Nicole pointed out that future horticulture production needs Intelligent sensing systems, robotics and precision agriculture automation as means to reduce production

costs due to increase of productivity. Robots in horticulture are useful in nurseries and greenhouses, parks and golf courses, in the field for monitoring, serve as mechanical aids, allow high level of mechanization and can be real machines, help during post-harvest practices for picking and harvesting, grading and sorting, and packing. Harvesting fruits and vegetables proves to be a difficult problem to automate, but several companies are up to the challenge. According to prof. Nicole opinion by interconnecting crops, tools and vehicles to smart devices and sensors, farmers will soon be able to increase productivity saving money and conserving natural resources by making the right decision at the right time based on data.

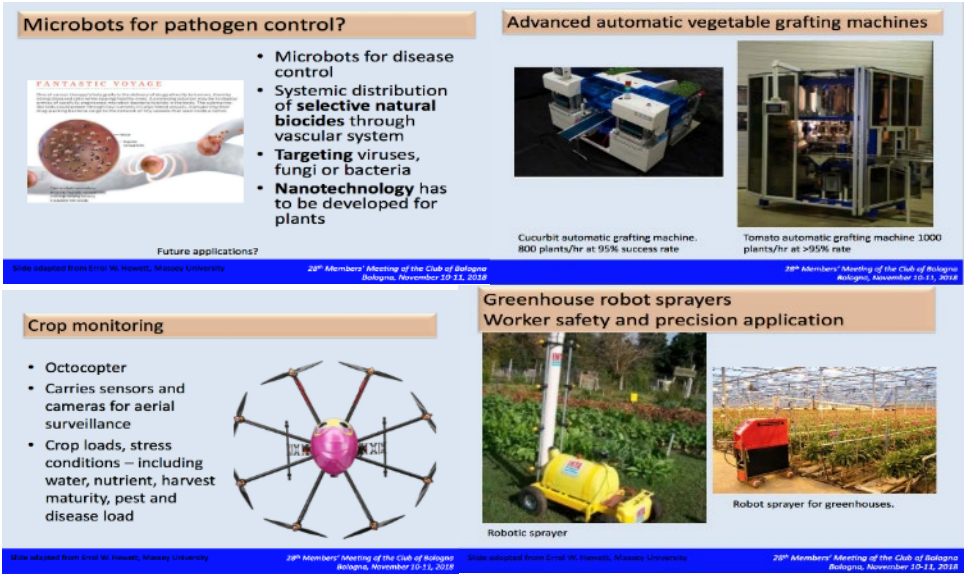

Figure 7 Pathogen monitor and control by micro robots, advanced automatic vegetable grafting machines, crops monitoring by drones and greenhouse robot sprayers (S. Nicole)

Horticulture mechanization and automation in open-field: state of the art and future perspective, by prof. Danilo Monarca from Univ. Tuscia

The author describes the machines for the production in open field, starting from the sowing and transplanting machinery and their most recent innovations (transplanters, mulchers, combined machines). After a short description of some machines for pesticide application and weed control, ample space was given to the harvesters. The distinction between product for the fresh market and for the processing industry is fundamental. For the product destined directly to the table, the use of manual and only partially facilitated harvesting yards is still very widespread (asparagus, artichoke, cauliflower), while for the productions destined for industry, harvesting operations

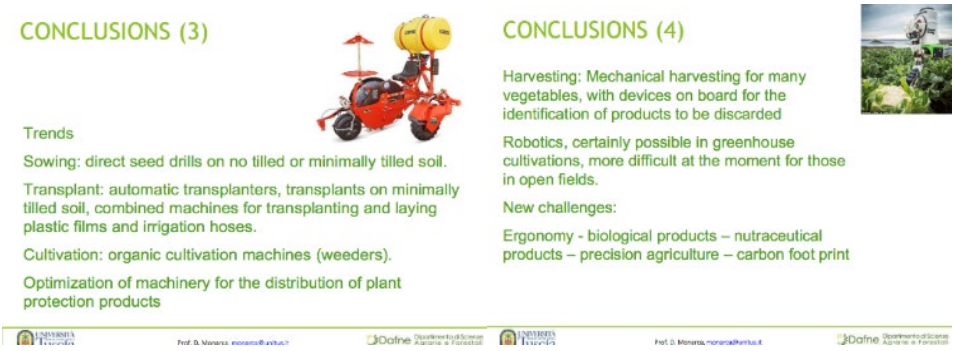

Figure 8 Final conclusions of future development and using smart machines in open field horticulture production (D. Monarca)

Automation and robotics in the protected environment, current development and challenges for the future, by Jochen Hemming, Vageningen University

The modern consumer demands guaranteed and constant quality. Moreover, there are intensified hygiene, food safety and traceability demands. Automated production and quality assessment systems can contribute to fulfill these demands. It is proven that the use of more technology in protected cultivation results in more yield, better product quality, and much higher resource efficiency. Many highly automated systems are already applied in commercial greenhouses. This includes logistics and autonomous transport of plants and harvested product in the greenhouse, spraying robots, machine vision based sorting systems for pot-plants and cut-flowers and robotic cutting, planting and grafting machines. Actual research focus on automated crop scouting (e.g. insect and disease detection), phenotyping (e.g. monitoring and predicting fruit setting) and robotic harvesting (e.g. of tomatoes, sweet pepper, strawberries). Still more research is needed to make such systems performing fast, simple and safe to use in practice. The current developments in high-tech horticulture are supported by the worldwide rapid improvements in computer hardware, software and artificial intelligence.

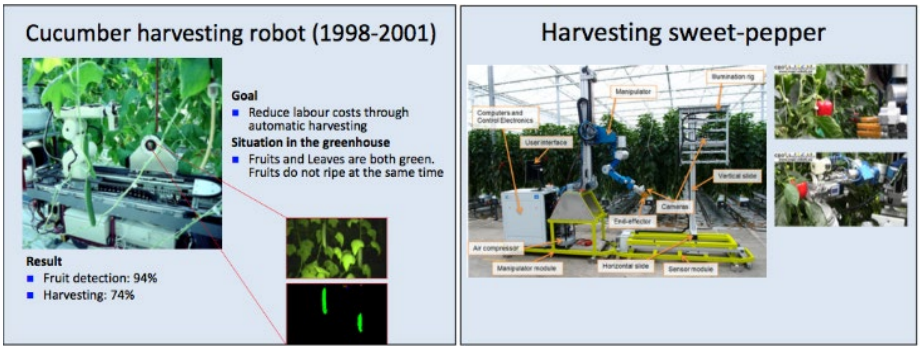

Figure 9 Some research achievements in harvesting (J. Hemming)

Equipment innovations in postharvest handling and minimally processing of fresh fruit and vegetables, by Giancarlo Colelli (University of Foggia – Italy)

Fresh fruit and vegetables are constituted by living tissues which carry on metabolic processes related to ripening and senescence. They are important for human diet as they represent an important source for bioactive compounds. Postharvest handling of these products is aimed to conditioning (cooling, grading and packaging) and to storing and/or shipping to more or less distant markets. Minimally processing is aimed to trim, wash, and cut into 100% usable product that is then packaged to offer high nutrition, convenience and value while still maintaining freshness. Despite available measures for maintaining quality of raw and processed material, degradation due to minimally processing is unavoidable, also considering that peeling, trimming and/or cutting operations are often present. In addition, other operations as washing and drying are known to cause mechanical stresses and loss of sugars and nutrients. However, the extent to which quality is compromised depends on the produce and on the processing conditions, including equipment and their operational settings.

Figure 10 Group photo of Club of Bologna members at 28th meeting, November 2018.

NOTE: All presentations and written papers are free available at web address: https://www.clubofbologna.org/en/meetings-proceedings.php