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Farmer Education Enables Precision Farming of Dairy Operations

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INTRODUCTION

Precision agriculture consists in the application of information technologies to production agriculture. Precision dairy farming, in our specific case, is the application of information technologies to dairy cattle farm management. The adoption of techniques of precision agriculture is conceptualized by a system approach to re-organize the total system of agriculture pursuing objectives of low-input, high-efficiency and sustainability (Shibusawa, 1998). As summarized by the Figure 1, the efficacy of the precision agriculture allows increase both the performances and the profit of the farm production processes. Bewley and Russel (2010), from a recent survey on dairy farmers opinions, suggested that many factors could limit the adoption rate of precision farming technologies. From our point of view, data reported by Bewley and Russel (2010) clearly showed that the critical point of adoption rate of precision farming technology in dairy farms is represented by farmer education.

OBJECTIVE

This work aimed to focus the role of farmer education and its constraints on precision dairy farming. It describes the causal loops involved in the success of precision farming adoption and a possible application to a specific dairy cattle production area of Italy.

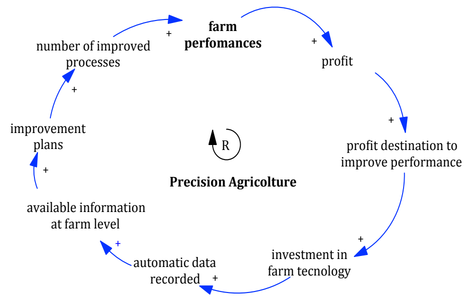

Figure 1. Theoretical role of the adoption of precision farming practices in a generic farm.

The main objectives of precision dairy farming are:
1) to avoid herd losses and in particular to avoid the medical treatments by reducing the detection time of diseases;

2) to maximize the individual cow production and its efficiency by improving management.

Precision dairy farming results in an increase of economic benefits both for the additional production and the cost reduction; furthermore it improves environmental benefits due to the reduction of input waste production cycle.

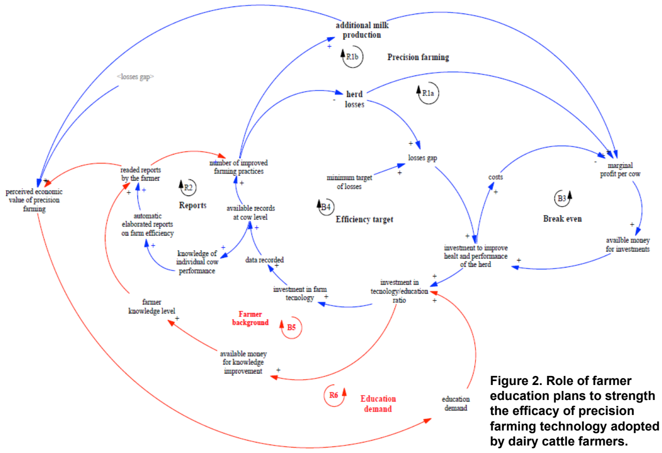

Figure 2. Role of farmer education plans to strength the efficacy of precision farming technology adopted by dairy cattle farmers.

APPLICATION

A precision agriculture project has recently been presented to the Sardinia Regional Government to increase the efficiency and the sustainability of the Sardinian Dairy cattle production system by adopting high technologies of precision farming to support the herd management (feeding, reproduction, healthy, etc.). The proposed conceptual model has been developed in order to study the adoption of precision farming practices in the area of Arborea (Province of Oristano – Sardinia - Italy). Further developments of the model must include the model translation in a stock and flow diagram and its subsequent calibration with local information. Existing information must be integrated with new information to be collected in the area of study (Table 1).

Available information	Information type and source	Farm score level	Existing info
Milk yield	Robot; daily records; monthly records; nothing	3 – 2 – 1 - 0	YES
Intake	Robot; estimated intake; nothing	2- 1- 0	YES
Reproduction	Activity + Vet. data; Activity; Vet data; calvings	3 – 2 – 1 - 0	YES
Diseases	Economic expenses; vet. data; nothing	2- 1- 0	YES
Available technology	Equipment and software in the market	From 5 to 0	YES
Potential improvement	Effect of technology on information availability	From literature	YES
Potential improvement	Effect of information on available reports	From literature	YES
Potential improvement	Effect reports on process improvement	From literature	YES
Potential improvement	Effect of improvement on farm profit	Local data	YES
Farmer background	Instruction degree	From 4 to 0	YES
Farmer background	Self learning (journals, attendance to seminars)	From 4 to 0	NO
Farmer background	Understanding of herd efficiency indicators	From 4 to 0	PARTIALLY
Farmer background	Understanding of information technologies	From 4 to 0	NO
Education needs	Cattle nutrition and reproduction	From 3 to 0	NO
Education needs	Economics and farm management	From 3 to 0	NO
Education needs	Informatics	From 3 to 0	PARTIALLY

Table 1. Example of existing and required information to study the effect of farmer education on the adoption of precision farming technologies in the dairy cattle production area of Arborea (Province of Oristano – Italy).

THE DYNAMIC HYPOTESIS (Figure 2)

We developed a conceptual model of forces driving the efficacy of precision farming techniques adopted by a certain dairy farm. The causal loops reported in Figure 2 are meaning:

Precision farming (R1): consist of a reinforcing loop based on the concepts underlined in Figure 1. It is divided in two loops (R1a and R1b) to account for the two main advantages generated by the adoption of precision farming technologies (i.e. reduction of herd losses and additional milk production, respectively). The loops show that the adopted technology allows to: increase the number of information available at cow level, improve the farming practices, obtain profits that can be in turn invested in more technology, further improve the farm efficiency.

Reports (R2): the reinforcing loop acts within the loops R1a and R1b explaining how they work. In fact, R2 tracks the information flow coming from farm equipment; thus, gathered information are commonly summarized in automatic reports; they must be read from the farmer in order to focus the practices to improve in order to get the target improvement.

Break even (B3): the balancing loop describes the effect of the cost of the adopted technology on the profitability of the investment.

Efficiency target (B4): the balancing loop describes the improvement of the efficiency allowed by the reduction of herd losses. It assumes a minimum target of losses and a gap between present and target values; due to this structure the expected reference mode of the herd losses is a goal seeking behavior.

Farmer background (B5): the balancing loop represents the bottleneck of the system. In fact, the assumption of the success of the adopted precision farming technology only works if the farmer has enough background to read automatic elaborated reports, to understand it and to get the right skills to apply adequate changes to production processes.

Education demand (R6): the reinforcing loop is activated by the loop B5. In fact, the faster the farmer increase his competence, the faster perform good report analysis and the faster perceive the potential improvement allowed by adoption of precision farming; it, in turn, stimulates the request of an higher level of education, to take even more advantages from adopted (or adoptable) technology.
In our system boundary Farmer Background (B5) represented the bottleneck of the precision farming success whereas the Farmer Education (R6) represented the possibility of escalation for the system success.

CONCLUSIONS

Recent studies clearly showed that the critical point of adoption rate of precision farming technology in dairy farms is represented by farmer education level. This work describes in a causal loop diagram the role of farmer education and its constraints on the efficacy of precision farming techniques adopted by a certain dairy farm. The paper also describes a possible application to a specific dairy cattle production area of Italy. We suppose that the increase the farmer education could enable the precision farming adoption and its efficacy both at farm and at territorial level.

ACKNOWLEDGEMENTS

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