ICT in the Dairy Farming System.

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Information transfer is present wherever there are sources of information, interest to convey it and willingness to accept it. The following presents a reconstruction of the evolution of dairy farming systems and of typical information transfer at different phases of their evolution. The duration of each phase, as well as the stage reached in the present, are typical for different socio-economic systems. The latter include the range from investment extensive to intensive, size from familial to large farms, work from manual to mechanized farms, from the illiterate to the highly skilled educated farmer.

Dairy farming systems probably are the most complex of the agricultural production systems. In most other systems, involving plants and beef cattle, inputs and outputs occur a few times per year and they relate to one or two products. In contrast, the dairy system is one in which inputs and outputs are continuous: e.g. milk, births, deaths, sales or purchases of animals, feed and labor costs. The outputs of the dairy system are varied, milk, meat and surplus animals. They are the outputs of individual cows, the cost of which makes them individual production units that vary in performance. Maximizing revenue requires continuous decision making at both individual cows and herd levels, which can only be properly carried out on the basis of data evaluation, if one excludes situations in which freedom of choice is limited. This system internalized a wide range of sophisticated hardware and software, which required a large investment. The presence of such investments indicates that response to information flow is greater in the dairy farming system than in other components of the agricultural sector. This is true however only for certain categories of dairy systems and of hardware or software.

The first phase of information transfer in dairy farming systems probably is that of health control for the containment of contagious diseases, the greatest risk factor in the early stages of agricultural systems development. This is a phase of minimal technological investments in the farming sector. It is mostly evident in the nomadic and in the most extensive types of livestock farming. This phase started from detection of sick animals at the farm level, transfer of this information to the state veterinary body and subsequently vaccination of all animals or eradication of diseased ones. In this case, however, information was transferred to government bodies external to the agricultural sector and did not involve it directly. In many cases, however, disease control led to multiplication of livestock beyond the carrying capacity of the pastures, up to their subsequent destruction. This indicates the need for the creation of awareness to this problem and the acceptance of self-limitation of herd size. It is a type of information transfer that depends on the capacity to cross differences of culture.

The sedentary dairy farming systems, even the simplest of them, contain a bulk of potential information, e.g. milk production, fertility, feed production and usage, animal health, labor input, prices. The transformation of this potential into data and later into information depends on the prevalence of literacy. Conveying information by means of intuitive comprehension is much limited in its scope.

The initial phase in the creation of data was for the purpose of breeding. It was initiated by the farmers' weighing of milk and keeping of records with the purpose of selecting the more useful animals. This progressed to breeders associations setting up regular milk testing programs for determining milk quantity and composition typical for the breed. New technologies of artificial insemination and later of deep freezing bull's semen, combined with the already developed genetics to produce breeding for milk production. It required the organization of artificial insemination bodies, mostly by farmers associations and only rarely by commercial or government institutions. The efficiency of artificial insemination for producing pregnancies at the required times was linked with progress made on the farm in the detection of estrous animals. The detection of these animals was markedly improved by research, but not totally dependent on it. The advances in quantitative genetics were used by animal breeders associations to enhance progress in animal productivity. This was further improved by computerized data analysis. The role played by dairy farmers associations in this area was predominant. They initiated and supported research required for further progress and created the organizations needed for its implementation. The progress in breeding initiated by producers in culminates in international organizations serving their goals. The rate of genetic progress depends to a significant extent on the size of herds. The larger herds make possible more accurate predictions of differences in genetic potential between bulls used in the artificial insemination. This implies that farming systems of small size may see slower rates of genetic progress. Increasing farm size however may also mean disrupting social structures. It is a case, similar to that of environment conservation, in which economic efficiency may need to be compromised for the benefit of social considerations. As decisions of this nature are political, conveying information to the public about the costs/benefits of economic efficiency is required.

Another pattern of information transfer was that evident in feeding technologies and their implementation on the dairy farms. The information was initially generated by studies of animal nutrition carried out within institutional research bodies, external to the agricultural sector. It spread from them to individual farmers or to farmers' organizations. The patterns of diffusion of information in this case most typically represent the evolution of information transfer as a function of socio-economic state. The initial diffusion of information was by means of verbal communication at farmers meetings or by publications of a more popular style. The acceptance of the information provided was determined by the trust placed by farmers in the providers of information. The presence of extension services, related to universities or government bodies played a significant role in transfer of information in this domain. In the first phase it resulted in the improvement of feed rations in which individual feeds were fed. At this stage farmer's cooperatives created concentrate mixing plants, which had the economic advantage of size, and could provide concentrate mixtures at a lower cost to the farmers.

At a later stage, university research indicated the potential benefits to be drawn from the feeding of complete mixed rations. This technology required the capacity for mixing feeds and for distributing the feed mixture to the animals. The advantage of this technology was rapidly recognized by farmers. Wherever the required equipment was available to the farmers, the technology of mixing feeds and distributing complete rations was adopted by farmers. The adoption of this step was feasible on the larger farms, but economically impossible for the smaller individual farmers owing to the cost of the mixing and distributing equipment. This limitation of the smaller farms was overcome by their organizing cooperative bodies for this specific purpose, or by their turning to commercial bodies for these services. The larger mixing plants, though having an advantage of size, were unable to adapt to the diverse needs of smaller farms, which led to the creation of additional mixing plants. This niche was also filled by the surplus feed mixing capacity of the larger dairy farms. The advantage of complete rations may thus be obtained by a wide range of responses, not necessarily requiring a large farm size.

The next technological step was made possible by the advent of computers and of computer based systems. This modified dairy farming in several ways. Computer-based feeding programs became available for suggesting the least-cost feed mixtures for each category of animals in the herd. The mechanization of feeding made possible the use of data loggers, and feed offered to feeding groups was input to the herd data set, along with milk production of individual animals. This led to housing of animals by feeding groups which enabled more efficient feed utilization. Computerized milking systems enabled the storage of milk records of entire lactations on the dairy farm. The most advanced commercially developed milking systems (e.g. the Afimilk system developed in Israel) compiled information on physical activity, electrical conductivity of milk along with that on milk yield. Algorithms were created for detection of sub-clinical mastitis and made possible treatment before the evolution of the inflammation into a clinical state. Also were created algorithms for detection of estrus.

Veterinary care is another important factor in the dairy system. It involves calfhood diseases, peripartum care, mammary health surveillance, treatment of metabolic dysfunctions, detection and care of diseases. The components of veterinary care usually are performed by different organization bodies. Therefore the information associated with them may have different flow patterns, according to the distribution of components between these bodies. Mastitis control may be carried out by government bodies as part of a national health program, or by commercial bodies. Epidemic diseases control may be part of a government institution. The veterinarian visits may be used to form a herd health data base. The data on fertility, disease in its various forms from the mild infections to severe disease cases, including calfhood morbidity and mortality, mastitis, inseminations, conceptions, peripartum problems and infections, have been used to form a health data set for herd health analysis. A central health data bank may be formed within a farmer's organization, a public or a private veterinary care system. It should be noted that models of conception rate and fertility, disease and mastitis have a rather low prediction value, which limits the benefits derived of them.

Further progress in increasing production efficiency may be attained by forming an input output data bank. It includes feeds, labor, purchases, sales, and prices that may serve as an input for analysis of economic performance. Such analyses may point to herd management weaknesses requiring further consideration. These analyses may be carried out by the farmer, farmer's organizations, extension services, or commercial bodies. Such an input output data bank has been recently introduced by the dairy farmers association in Israel (the NOA software) and the inclusion of economic analysis tools in it may transform it into an unprecedented means for dairy farm management.

The feeding data set when related to the milk data set enables assessment of the efficiency of feeding on a group level. The individual cow data set created by the milking system makes possible to create a mastitis prevention program and assess its efficiency. The estrus detection data, when combined with insemination and health data may improve fertility by overall management evaluation. The five data sets, of feeding, mastitis, estrus and health and that of input/output may serve for herd management and the analysis of individual animals' performance, including a programmed culling. These may form the basis for an efficient growing herd production program, as well as for a milk quota based herd production program. It is noteworthy that

The modes of information transfer markedly changed with time. The father to son transfer of knowledge acquired from generation to generation was replaced by information transmitted verbally by bodies external to the farm. This approach was supported by extension services provided by university, government or framers' organizations, organized on a regional basis. Courses of short to medium duration, dedicated to specific subjects of particular importance made possible to overcome particular deficiencies of farming systems. On the recognition of a problem in the herd, an advisor may be called upon to analyze the situation and suggest ways of reducing or solving the causes of the problem. It still remains on the farmer to recognize the presence of a problem.

To these one may add the pollutants produced by the dairy farming systems. Reducing the formation of these pollutants, controlling their outflow to the environment, and controlling changes in the environment is a prerequisite in dairy farming systems of the industrial society. Such a control system requires its integration into the dairy farm management system.

The advent of computer networks further transformed information transfer methodologies. Information may be made available at government, university, and farmer's organizations websites. Access to information may become immediate as the need for it occurs, and may considerably reduce the time between the recognition of need for information and the access to it. The efficiency of this information transfer method depends however on the ability of end-user farmer. The farmer needs not only to recognize the presence of a problem, but also to be able to analyze the situation, to detect causes for the problem and to know where to turn for means to prevent them. It requires a farmer capable of making an efficient use of websites' resources, and of existing networks. It also requires a farmer capable of independently screening the available information for relevancy and applying the information gained. It also needs a farmer capable of critical thinking, to evaluate the efficiency of the means applied and to seek for alternatives, if needed, within a short time.

This overview of roles played by information in the course of dairy farming systems evolution, the changes in the sources of information and in the bodies that utilized it, points to a large heterogeneity of potential bottlenecks. The latter depends upon social structure, culture dependent patterns of cooperation, presence of research bodies, involvement of government institutions in the provision of extension services, and of public health care. The degree of literacy and of formal education are critical elements in determining the pattern of information flow and is impact, as are the readiness for cooperation and the degree of technological development.

The dairy farm system is one of the most complex production systems in the agricultural system. The production unit, the individual dairy farm, is too small to sustain the technologies required for its operation and the information required for its management. Government involvement in provision of services is declining and competition is increasing on a global scale. In these conditions, the dairy farming system can maintain the required efficiency by increasing cooperation in the conversion of production data into information, its transfer to central data banks, its analysis for diagnosis of limiting factors and the reduction of their impact on economic efficiency.

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