

The Innovation Network in Animal Reproduction: EMBRAPA's Experience in Organizing a Research Project on Reproductive Biotechnology

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ABSTRACT

Background: In 2007 a broad Network project was proposed, aiming to organize in a more efficient way the different research and development actions related to new reproductive technologies in Embrapa. The initial proposal focused to develop new technological solutions to increase Brazilian livestock competitiveness; generate basic knowledge to support development of new technologies; to promote genetic improvement and evaluate dairy and beef animal models for the different ecosystems, to improve laboratorial infrastructure and promote capacity building; and to promote equal development of the technologies for the different livestock species. The final proposal, titled “*Innovation Network in Animal Reproduction*” was approved for the period 2008-2012.

Review: The Network Project includes research activities in animal reproduction and in the interfaces of reproduction and animal health, nutrition, and genetics. A consortium of 12 of the Embrapa units, 14 Universities, 2 International Research Centers and 5 private companies are engaged in the project. The main structure follows the general guidelines of the Embrapa's standard of network projects, being organized in 10 thematic Component Projects (CPs): CP1- Activities related to the organization of the Network, as the coordination of the CPs, financial management, promotion of meetings and workshops, and compilation of results and evaluations; CP2 – Development and evaluation of new technologies for the sanitary control of semen, oocytes, and embryos; CP3- Evaluation of nutritional strategies to improve reproductive efficiency; CP4- Development of methods to improve the quality and quantity of gametes used in assisted reproductive technologies; CP5- Development of *in vivo* and *in vitro* embryo production systems; CP6- Establishment of protocols for the isolation, culture and maintenance of cell lines aiming the production of animal clones; CP7- Establishment of alternative protocols to the production of transgenic or intragenic animals; CP8- Identification, selection, use and conservation of genetic resources; CP9- Validation and monitoring of technologies; CP10- Technological innovation.

Conclusions: The establishment of the network allowed the organization of Embrapa's different ongoing research actions in animal reproduction in a large and multidisciplinary project. As consequences, there was a larger interaction among the different research groups of the company and external partners. The proposal of collaborative research improved the scientific production of the group and also the development of products, processes, and technical information to the private sector. The technology transference and capacity building activities were strategically reorganized in line with the scope of the Network Project. A last consequence of the network was the possibility of applying for consortium research funding opportunities. The group also expects to improve scientific collaboration and to increase the relevance of R&D projects in animal reproduction, to improve the interplay with the government agencies in charge of the establishment of laws and rules for reproductive biotechnology used in livestock, and to improve their capacity of identifying and measuring the impact of the new technologies in the different livestock production systems.

Keywords: Network research, embryo technologies, R&D projects.

I. INTRODUCTION

II. THE NETWORK STRUCTURE

III. RESULTS OF THE NETWORK PROJECT

IV. FUTURE CHALLENGES AND PERSPECTIVES

I. INTRODUCTION

The development and use of new reproductive biotechnologies such as *in vitro* embryo production, nuclear transfer and sperm sorting had a deep impact in the Brazilian livestock sector in the last decade. A remarkable example of this was the increase of the bovine embryo industry, in which the country reached a leading position, accounting for about 1/3 of the world embryo transfers [1]. The Brazilian Agricultural Research Corporation (Embrapa) took part of this revolution, providing research and development solutions by its different regional centers. Besides a significant scientific contribution, publishing many studies in national and international Journals, the Embrapa's research team was also engaged in the introduction of emerging technologies in the country (OPU, cloning), in capacity building (ET and IVF courses), in the interplay with the productive sector (The IVEP Lab Network) and in the organization of scientific societies and promotion of workshops and congresses in this field (CBRA, SBTE). There was not, however, a formal instrument to coordinate the research actions developed by the different Centers and in cooperation with other institutions. Therefore, it was quite difficult to evaluate the impact of the development of new technologies on the productive sector. In 2007 a first broad Network project was proposed, aiming "To order in a more efficient way the different research and development actions related to new reproductive technologies and correlated areas". The initial proposal focused in the most important challenges 1) To promote genetic improvement and evaluate dairy and beef animal models for the different ecosystems, specially the tropical ones, and with proper sanitary control; 2) Develop new technological solutions to increase Brazilian livestock competitiveness; 3) Improve laboratorial infrastructure and promote capacity building to support the adoption of new technologies; 4) Promote equal development of the technologies for the different livestock species (bovine, ovine, goats, buffalos, equine and swine); 5) Generate basic knowledge in the field of the project to support development of new technologies for animal and

human health. The final proposal was approved in the following year to be implemented in the period 2008-2012, with the title "Innovation Network in Animal Reproduction".

II. THE NETWORK STRUCTURE

The Network Project includes research activities in animal reproduction and in the interfaces of reproduction and animal health, nutrition, and genetics, and also technology validation and promotion of their use. A consortium of 12 of the Embrapa units (Embrapa Headquarters, Cenargen, CNPGL, CNPGC, CFACT, CPAP, CPATU, CPATC, CPAC, CPAFAC, CNPC, CPPSUL), 14 Universities (public, private and from abroad), 2 International Research Centers and 5 private companies are engaged in the project. The main structure follows the general guidelines of the Embrapa's standard of network projects, being organized in thematic Component Projects (CPs). Each CP includes different activities related to each research line. The Innovation Network in Animal Reproduction includes 10 Component Projects, as described below:

CP1- Activities related to the organization of the Network, as the coordination of the CPs, financial management, promotion of meetings and workshops, and compilation of results and evaluations. The Project has a consulting committee composed of the leaders of each PC and members from other institutions, helping in the strategic decisions. This committee has meetings each semester to monitor and evaluate the project. The CP1 is also in charge of looking for funding opportunities, intellectual property and visual identity (Figure 1) and actualization of the project home page (<http://www.macroprograma1.cn-ptia.embrapa.br/biotecanimal>).

CP2 – Development and evaluation of new technologies for the sanitary control of semen, oocytes, and embryos. The activities of this CP are in the interface reproduction/animal health, and were proposed mainly focusing in the concern about the possibility of dissemination of pathogens by the use of reproductive biotechnologies, and the need to establish diagnose and control strategies. The research actions included in the CP range from pathogen molecular characterization to the development of specific diagnosis kits.

CP3- Evaluation of nutritional strategies to improve reproductive efficiency. This CP is in the

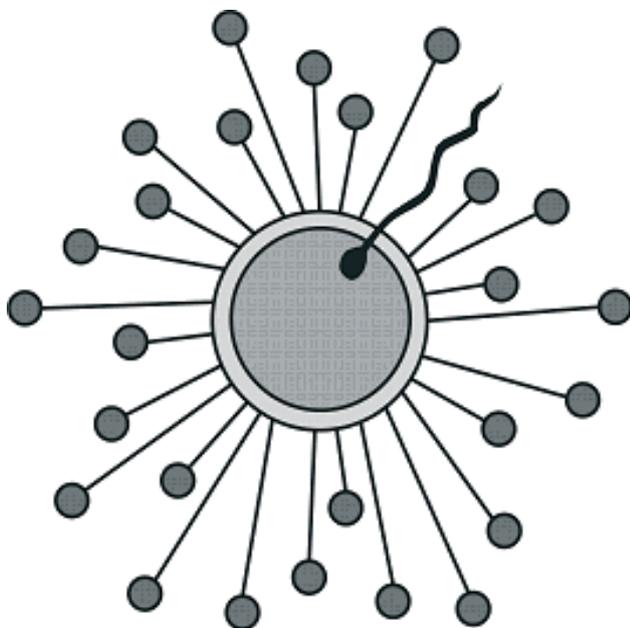


Figure 1. Logo of the Innovation Network in Animal Reproduction.

interface reproduction/nutrition and has a general aim of to evaluate the influence of nutrition and body score condition on reproductive efficiency and on the production and survivability of gametes in livestock animals. The research actions deal not only with the effects of diet quantity and quality, but also with the effects of specific components of the diet. Besides, these effects are measured from the interference with the intra-follicular environment to pregnancy rates.

CP4- Development of methods to improve the quality and quantity of gametes used in assisted reproductive technologies. This CP aims to support the improvement of *in vivo* and *in vitro* technologies by the study of farm animal gametogenesis, of gamete collection procedures and laboratory processing, and their subsequent use in artificial conditions. The relationship of environment, genetics, and folliculogenesis; the kinetics of nuclear maturation; the association of follicular development and DNA metilation; the effects of freezing on chromosome structure and cytoskeleton; the development of new procedures for sperm recovery and molecular markers of sperm fertility; and the use of sperm sorting techniques; are under study.

CP5- Development of *in vivo* and *in vitro* embryo production systems. The aim of this CP is to identify bottlenecks in embryo production systems and develop technologies to improve embryo pro-

duction, quality, and cryotolerance. The research subjects are the development of new embryo cryopreservation procedures, the improvement of hormonal synchronization and superovulation protocols, the evaluation of different approaches to improve the efficiency of *in vitro* embryo production, the development of new techniques of gamete and embryos micromanipulation, and the evaluation of gene expression patterns related to *in vitro* embryo development.

CP6- Establishment of protocols for the isolation, culture and maintenance of cell lines aiming the production of animal clones. This CP focus in the development of cloning techniques, by the establishment of stable somatic and embryonic cell lines; by the molecular study of *imprinted* genes related to cloning; and by the development of new nuclear transfer techniques.

CP7- Establishment of alternative protocols to the production of transgenic or intragenic animals. This CP aims to evaluate different approaches to the production of genetically modified cells, embryos, and animals; which could be able to express recombinant factors of interest. The effect of different chemicals in the transgene expression and alternative methods to produce transgenic embryos and animals are under investigation.

CP8- Identification, selection, use and conservation of genetic resources. This CP aims to evaluate the efficiency and impact of new reproductive biotechnologies in animal breeding programs. The project also evaluates the potential use of reproductive biotechnologies in the formation of specialized beef and dairy crossbred herds.

CP9- Validation and monitoring of technologies. This CP has a transversal character, and aims to monitor the development of animals generated with the different biotechnologies developed in the others CPs, mainly those using *in vitro* culture systems and genetic manipulation.

CP10- Technological innovation. Just like the CP9, this Project has a transversal character, and aims to promote the use of technologies generated and, or tested in the other CPs. The main strategy is to promote interplay of the research and development sector with the private activity, and generate an information network which could support large scale use and evaluation of new technologies, focusing technological innovation.

III. RESULTS OF THE NETWORK PROJECT

The establishment of the network allowed the organization of Embrapa's different ongoing research actions in animal reproduction in a large and multidisciplinary project. As consequences, there was a larger interaction among the different research groups of the company and external partners. The proposal of collaborative research and the consolidation of results improved the scientific production of the group and also the development of products, processes, and technical information to the private sector. This fact is demonstrated by the range of publications in basic and applied scientific journals, books, technical bulletins, patents and intellectual property requests [2]. The technology transference and capacity building activities were strategically reorganized in line with the scope of the Network Project. An example was the promotion of a special course in animal biotechnologies to the staff of the Agriculture Ministry. The network also converged some ongoing International Collaboration projects, as with East Timor, South Korea, Kenya and Tanzania. A last consequence of the network was the possibility of applying for consortium research funding opportunities.

IV. FUTURE CHALLENGES AND PERSPECTIVES

A network project has an increased complexity and demand a larger institutional infrastructure

and personal support. Consequently, the success of this kind of project may requires the use of new coordination strategies, use of web tools to organize information, multi-institutional contracts with suppliers, etc., and the support of innovation agencies. We expect with the formation of this network, however, to improve scientific collaboration and to increase the relevance of R&D projects in animal reproduction. Another future possibility is the increase of the use of our technological platform in areas as wildlife conservation, bio-pharmaceutical production, reduction of sanitary barriers, etc., as well as the integration with other network projects such as animal genomics.

The network may also improve the interplay with the government agencies in charge of the establishment of laws and rules for reproductive biotechnology used in livestock, allowing a better identification of the research demands of the productive sector and providing proper technical background for official decisions.

A final goal of network project is to improve our capacity in identifying and measuring the impact of the new technologies in the different livestock production systems and, consequently, to show the importance of R&D for the agribusiness and for the people.

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