The role of veterinary research laboratories in the provision of veterinary services

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Summary
Veterinary research laboratories play an essential role in the provision of veterinary services in most countries. These laboratories are the source of new knowledge, innovative ideas and improved technology for the surveillance, prevention and control of animal diseases. In addition, many laboratories provide diagnostic and other services.

To ensure the optimal integration of various veterinary activities, administrators must understand the functions and constraints of research laboratories. Therefore, a brief discussion is presented of the following:
- organisational structures
- methods for developing research programmes
- outputs of research scientists and how these are measured
- the management of quality assurance
- funding of research.

Optimal collaboration can only be attained by understanding the environment in which a research scientist functions and the motivational issues at stake.

Keywords

Introduction
Globally speaking, the objectives of veterinary services, including research, are directed towards:
- wealth creation by improving the economic performance of livestock production in terms of improving animal health
- protection of the public against health risks posed by zoonoses, i.e., diseases transmissible to man by animals
- ensuring food safety for products of animal origin
- improvement of the welfare of production and other animals.

The role of a veterinary research laboratory in this process is twofold:
- The primary objective of research is to generate new knowledge and understanding of problems and to develop new initiatives in terms of processes, products and information. Whilst applicable to all research laboratories, this more fundamental approach particularly characterises those laboratories forming part of universities or veterinary colleges and others that have no formal relationship with national Veterinary Services.
- The second objective is to support the livestock industry by developing new strategies for disease control and supplying the technology and services required to implement them. This approach is dominant in those laboratories funded by and reporting to governmental structures, as well as those which are part of commercial companies.

Veterinary research laboratories across the world show great diversity in terms of their structures and associated functions. Some can be regarded as pure research laboratories (especially those associated with universities), but the majority are also involved in diagnostics, by developing and/or producing improved diagnostic techniques and reagents or by providing a diagnostic service. A major part of many research programmes, especially in commercial laboratories, is aimed at the development of new or improved vaccines, and as a logical consequence many laboratories are also involved in the production of vaccines. In other instances, research laboratories play a part in the quality control and registration of veterinary pharmaceuticals and vaccines. Finally, almost all research laboratories are also involved in the training of staff,
either formally in conjunction with educational institutions, or in informal practical training. As these associated activities are dealt with in preceding articles in this issue, the present discussion will focus on the research function, rather than on the research laboratory per se.

Organisational structures

Ownership and control

In most countries, veterinary research institutes were founded by the state as part of their Veterinary Services structures, most commonly under the control of their Ministries of Agriculture. In countries with a federal structure, Veterinary Services (including research laboratories) are often controlled by state or provincial authorities. In such cases, a central veterinary laboratory controlled by the federal or central government is usually necessary to support the national authority in functions such as national and international disease control programmes or import and export certification.

In many western countries there has been a tendency during recent years to separate veterinary and other research functions from central government structures and to transfer them to autonomous, semi-privatised parastatal organisations. Originally this process formed part of a governmental drive to reduce state expenditure and expected the organisations to generate external income in addition to basic core funding provided by the state. Other objectives are to improve the effectiveness and efficiency of research organisations by allowing and expecting the organisations to generate external income in addition to basic core funding provided by the state. Other objectives are to improve the effectiveness and efficiency of research organisations by allowing them greater autonomy and to effect a change in culture towards greater client orientation. Successful examples of such transitions can be found in the United Kingdom (UK), Australia, New Zealand and South Africa.

Many research laboratories form part of a veterinary college and/or university and are therefore not under governmental control. As stated above, these laboratories put more emphasis on basic research as part of post-graduate training in particular, in contrast to government-controlled laboratories where the emphasis is on more applied research.

Private companies, especially the large international pharmaceutical companies, generally have extensive research capacities concentrating on the development of new drugs and vaccines for both human and animal use. As a result of the high costs involved the tendency is, however, to contract out more research of a basic nature and concentrate on the commercial development of products.

Associations and linkages

Due to the associated functions mentioned in the introduction, most veterinary research laboratories are associated with or linked to other organisations. The most important linkage is, obviously, with government structures responsible for statutory disease control. In countries where these functions are not directly linked, structures such as liaison committees usually exist to ensure close collaboration. Such collaboration normally also exists with the human health authorities for research aimed at the control of zoonoses and at the public health safety aspects of animal products intended for human consumption, e.g., meat, milk and eggs.

Veterinary research laboratories are often closely linked to, or directly involved in, research on animal production. These two disciplines are often closely associated in smaller countries but have become separated in anglophone countries in particular. In at least one western country, The Netherlands, an attempt is presently being made to bring research on animal health and animal production together again in one institute. Areas of common interest for veterinarians and animal scientists include reproduction, growth, meat and milk production and hygiene, food safety, animal behaviour and animal welfare.

Finally, associations are usually also maintained with other research organisations in related fields. Examples are the Biotechnology and Biological Sciences Research Council in the UK, the Commonwealth Scientific and Industrial Research Organisation in Australia, the Institute for Animal Science and Health (DLO) in the Netherlands, the Institut national de la Recherche agronomique (National Institute of Agricultural Research) in France and the Agricultural Research Council in South Africa.

Internal organisation

Research institutes in the veterinary field are generally structured according to scientific disciplines, or follow a species approach. Sometimes divisions or laboratories are focused on specific diseases or functional aberrations, such as infertility, which cross the species borders. Often a mixture of the various approaches is found. A good example is the Veterinary Research Institute in Pulawy, Poland: in addition to departments for microbiology, pathology, parasitology, biochemistry, etc., it also has departments for ruminant, equine, swine, poultry, fish and even bee diseases, as well as laboratories dedicated to infertility, foot and mouth disease (FMD), tuberculosis, brucellosis and other diseases.

An inherent danger exists in the case of rigid structures based on scientific disciplines, i.e., the tendency to become isolated and lose essential interaction with other researchers. In most institutions today this tendency is countered by structuring research in terms of interdisciplinary programmes.

Specialisation

Specific needs and constraints sometimes necessitate specialised institutes. The most common example is the need for research on exotic diseases which requires sophisticated physical containment facilities where foreign pathogens can
be handled safely under strict quarantine conditions without compromising freedom from a disease in a country. The best examples are those institutions created for research on FMD, e.g., Plum Island in the United States of America, the Australian Animal Health Laboratory at Geelong in Australia and the Onderstepoort Institute for Exotic Diseases in South Africa. A related activity is research on endemic diseases with epizootic potential, for which special facilities or protected premises are required. Examples of such diseases include classical swine fever (hog cholera), porcine respiratory and reproductive syndrome, Newcastle disease and others caused by contagious agents.

Another type of specialisation which has developed in modern times is the institution dedicated to problems in developing countries, which more often than not specialises in tropical diseases. Two prominent examples are the Centre for Tropical Veterinary Medicine, which was established in 1970 at the University of Edinburgh, and the Département d'élevage et de médecine vétérinaire (Department of Breeding and Veterinary Medicine in Tropical Countries) in France, which is one of several departments at the Centre de coopération internationale en recherche agronomique et pour le développement (Centre for International Co-operation in Agronomic Research for Developing Countries), the French governmental centre for international co-operation in development-oriented agricultural research.

Research programmes

Strategies

In view of the limited human and financial resources available to most research laboratories, strategic planning of research programmes has become an essential annual task. Strategies must address both long-term and short-term needs. From a research point of view, the most important long-term strategy must be to build and maintain scientific capacity. Without the necessary scientific expertise, no research laboratory can meet the short-term needs of its clients, be they the state, the livestock industry or the private sector. A widely accepted benchmark is that at least 10% of the budget of a research laboratory should be spent on capacity building, i.e., scientific activities of a long-term nature, aimed at the development of its researchers and creation of the knowledge and skills base required for innovative problem-solving. The fact that it takes on average ten years after completion of formal education for a researcher to reach the level of expertise required for international competitiveness should be borne in mind.

Client orientation is an essential characteristic of successful research programmes. Private clients could include organisations for farmers, agricultural industries or private companies. If these clients contribute financially to research projects, their needs must obviously form the basis of the research strategy, and provision must sometimes be made for confidentiality of results.

Any strategy involving the state as a client must obviously provide support for government policies and objectives, which would traditionally include the protection of animal health and welfare and the promotion of public health through the effective enforcement of statutory and other control measures. The economic well-being of the livestock industry has become increasingly important of late, due to the increase in international trade following the General Agreement of Tariffs and Trade agreement and the subsequent formation of the World Trade Organisation. Increased trade in animals and animal products leads to greater exposure to a range of diseases, resulting in a need for more effective diagnostic techniques and disease control measures. For countries dependent on the export of animal products, the ability to prove freedom from disease becomes imperative. No better example than bovine spongiform encephalopathy (BSE) can be given to illustrate the economic havoc that an animal disease can cause, and the desperate need for research to solve the problem.

Prioritisation and criteria for determining priorities

Setting priorities remains one of the most difficult – but most essential – tasks facing research administrators. A number of sophisticated decision support systems and a variety of techniques have been developed to aid decision-makers, but in the end prioritisation remains a subjective process, dependent on personal insight, experience and a well-balanced viewpoint. A balance must be maintained between fundamental and applied research, long-term and short-term projects, between the needs of various clients and those of researchers and between scientific merit and available expertise. The danger of excessive client orientation must also be avoided.

The relative importance of various diseases will obviously differ between different countries, thus resulting in different priorities. The following five criteria used for prioritisation by the Central Veterinary Institute of the DLO in The Netherlands (CDI-DLO) will, however, find widespread application (2):

- importance for animal disease control, implying an intimate knowledge of the disease situation in a country
- contribution to the development of scientific expertise (innovation)
- the scientific quality of a research proposal
- achievability, which will take into account the availability of expertise, facilities and other resources
- relevance to the expressed needs of clients, e.g., government or industry objectives.

Socio-economic considerations

The economic impact of veterinary research has already been alluded to, not only in terms of animal production but also
with regard to international trade. The export of agricultural products is still the mainstay of many developing economies and the driving force for socio-economic development. Economic impact studies are therefore increasingly forming part of veterinary research programmes, especially in development-oriented programmes. Social structures, attitudes and economic systems are intimately linked, therefore the social implications and acceptability of the implementation of any veterinary measures have to be carefully considered, especially in developing countries (8). Furthermore, the sustainability of such measures in terms of environmental impact has to be taken into account. A special case in point is the possible effect of such measures on wildlife and, conversely, the role of wildlife as a reservoir of certain stock diseases, such as FMD or bovine tuberculosis. Ecotourism, in which wildlife is a key factor, is fast becoming a major source of income for many countries and for rural communities. Any detrimental effect on wildlife could therefore have a negative economic impact.

As a result of these considerations, research teams increasingly include non-veterinary members representing social and environmental sciences such as sociology, anthropology, economy and nature conservation. In fact, many international donors require the inclusion of such disciplines. Economic impact in terms of return on investment will be discussed in the section on 'Funding'.

Indigenous versus exotic diseases

The relative importance placed on these two categories of disease will largely depend on the situation in each country and the importance of its agricultural exports. In a country such as Australia, which is free from many animal diseases and has an important agricultural export trade at risk, strong emphasis is placed on research aimed at developing measures to prevent the importation of exotic diseases or to facilitate elimination in case of accidental introduction. In contrast, in a country such as South Africa, where many diseases are endemic, the emphasis is mainly on their control or eradication.

Emerging diseases

Newly emerging diseases, such as BSE, could have such a profound economic impact that the total research capacity of a country may need to be redirected towards its control. The same applies to a lesser extent to diseases newly introduced or reintroduced to a country, a good example of which is the recent outbreak of contagious bovine pleuropneumonia in Botswana. If the elimination of such a disease is successful, the disruption of research programmes could be temporary. If not, a more permanent reorientation may be necessary. Again, the need of the client, in this case the national economy, will be the determining factor directing the necessary research effort.

Outputs

The product of research is new knowledge. However, new knowledge in the mind of an individual is of no or little use: it must be communicated to others to be of any value. The nature of the new knowledge will determine how and to whom it will be communicated. Some results are highly theoretical and complicated and will mainly be used by other researchers in their work. This is the way in which science grows and is an essential part of scientific progress. Other results are of a more practical nature and can be used by other scientists to solve problems, provided they are aware of it. The transfer of knowledge from a research laboratory to the scientist in the field has always been, and probably will always be, problematical, and new ways of disseminating information are constantly being sought.

Publications

Printed publications have been the traditional medium of choice for the dissemination of scientific information. To accommodate the two types of readers referred to above, these publications can be broadly classified as 'scientific' and 'popular scientific' publications.

Over the years, scientific journals have developed a unique system of verification and quality assurance called peer review. All submitted manuscripts are subjected to the scrutiny of usually two or more independent experts in the field covered by the paper, and both content and presentation are critically reviewed. This process has developed into a very effective system which ensures a high scientific standard for publications in reputable journals. For this reason, the performance of a researcher is traditionally measured in terms of his number of publications in a refereed scientific journal.

To overcome the problem of highly technical information in scientific journals being inaccessible to those not trained as specialists, other publications exist at various levels of specialisation. Some cater for the public at large e.g., Scientific American, while others, such as this journal, are aimed at non-academic scientists in professional or regulatory environments or science administrators.

Conferences and workshops

While publication is the most effective way to document scientific information permanently, it is a slow process and published material does not reflect the latest developments. More immediate communication is achieved at meetings of scientists, either at more formal conferences with presentations by selected contributors or at informal workshops where the emphasis is on participation and interaction. A big advantage of such meetings is that they provide the opportunity to question and debate issues and results. It is also a much faster way of disseminating new information and is the most effective method of communication between specialists and non-specialists. The
organisation of such meetings must therefore be regarded as an important output of research laboratories.

**New technology and technology transfer**

One of the objectives of research is the development of new technology to improve production or to solve problems. Innovations are aimed at improving quality of life or preserving our environment. Such new technology can be either new products or new techniques. In veterinary science, the emphasis is usually on new or improved drugs and vaccines and on better diagnostic techniques or reagents. Most of this new technology leads to improved disease surveillance and disease control. Some laboratories have the ability to exploit new discoveries themselves by producing and marketing such products. Others would regard information about the new technology as their main output, which must then be transferred in the various ways available to anyone interested in its utilisation.

**Information services**

A library is often only seen as a source of scientific information for the researcher. Libraries can, however, play a much wider role in facilitating communication between various role players and in technology transfer. Newer developments in electronic communication can be harnessed very effectively to improve on the traditional media, as this combines the best characteristics of the printed and the spoken word. The services that their libraries deliver should therefore form part of the output of research laboratories.

**Quality assurance**

Every research laboratory should strive towards excellence in its field of activity and provide the best possible service to its clients within its budgetary and other constraints. Various mechanisms can be used to enhance performance and ensure quality standards, including peer review at various levels, performance evaluation of researchers and support staff, competitive bidding for research grants, inter-institutional collaboration and science audits.

**Peer reviews**

Reference has already been made to the use of peer review to ensure high standards in scientific publications, the main research output. Peer review can also be used very effectively at other levels. For example, research proposals can be evaluated by experts before implementation and all research projects or programmes can be reviewed on a regular basis by the same or other peers. Usually annual progress reports are required, which can be evaluated as part of the review process.

In many western countries and in international research organisations, research institutes and laboratories are also evaluated in toto at regular intervals (usually five years) by panels of experts. These reviews are convenient opportunities to bring about policy changes and to adapt programmes to market needs.

Peer reviews are less well established in the East, where the principle of open criticism is foreign to many cultures, but are being introduced gradually (9).

**Performance evaluation of research staff**

Although practices vary widely, some form of performance evaluation of researchers and support staff exists in most organisations. It can take the form of a rigid, formal system coupled to promotion, or a less formal system oriented towards human resource development. The modern trend is towards an objective-based self-motivational system in which the employee and his supervisor jointly decide on targets and objectives and the performance rating is based on the achievement of these objectives. Many organisations evaluate performance using a well-developed peer review programme. The researcher must present his/her accomplishments every three to five years to a review panel which will evaluate performance. The results of such reviews can be used for tenure and promotion/demotion recommendations.

Whatever the system used, scientific publications are the primary product of research and the quality and quantity of publications are therefore the main criteria used to evaluate the performance of researchers.

**Competitive bidding**

One mechanism widely used to enhance the quality of research is competitive bidding for external funding. Researchers prepare detailed research proposals which are then submitted to a funding body that allocates research grants based on the merit and relevance of proposals. The principle is that the best proposals will receive funding, or in some cases the best applicant. While excellent in theory, the success of a competitive bidding system depends on an efficient and effective peer review system and the availability of sufficient experts to perform the evaluation. A negative aspect is the amount of time that senior researchers in particular have to spend writing grant proposals.

**International linkages**

International organisations and international networks play an important role in maintaining high standards of research. Few laboratories possess sufficient expertise in all the fields they cover, and only through collaboration with other laboratories and experts can top-quality results be obtained. Teamwork is today the rule rather than the exception. Realising this, most donor organisations and international agencies, such as the World Bank, the Food and Agriculture Organisation (FAO), the World Health Organisation (WHO) and the European Union (EU) actively promote international networking and often their financial support for a research project depends on it.
Performance audits

In many countries, formal financial audits also include performance audits. This is especially the case in public institutions where governments have the duty to ensure that taxpayer money is used in the most efficient way and is spent on matters of public concern. A set of criteria is usually compiled for each organisation and is used in reporting to the auditors. For a research laboratory, such critical performance indicators can include the following:

- the number of scientific publications per researcher
- the level of participation in scientific meetings, international conferences etc., by researchers
- the number of conferences and/or workshops organised
- external recognition of scientific expertise, e.g., awards, invitations and requests for peer reviews received
- the number of research grants and contracts obtained
- the scientific services delivered, e.g., diagnostic specimens handled
- the level of technology transfer (talks, demonstrations, use of electronic media)
- the sale of products
- support for national objectives
- the training of staff, number of bursaries awarded, courses attended, etc.

Funding

Sources

Many veterinary research laboratories are fully or partially funded from government sources, either directly or indirectly. Governments sometimes take the view that public funds should provide for infrastructure and long-term research aimed at capacity building, but that clients must pay the direct costs of research that they require. Government agencies can also be clients for this purpose. Other sources of funding are research grants and research contracts, as well as income derived from services rendered and products sold. International donor organisations are a common source of contract or grant funding. University and commercial laboratories are less dependent on (or even independent from) public funding, and are partially or exclusively supported by the private sector. Again, it is crucial that a balance be maintained between long-term and short-term funding. Care should always be taken not to become too dependent on clients or donors, who usually have short-term needs. Funding must always be available for long-term research in order to build and maintain scientific expertise.

Priorities and economic impact assessment

Funding priorities are obviously closely associated with the scientific prioritisation discussed above. However, funding agencies or clients often have priorities of their own which may be different from pure research priorities. This is common in the case of developmental programmes, and compromises must often be sought. Generally speaking, the economic impact of a problem and/or the potential economic impact of a research project is a compelling argument for obtaining a high-priority rating. Economic impact studies are therefore fast becoming a prerequisite for success in the competition for funds. The objective of impact assessment is to optimise research resource allocation and its benefits to the public (1).

Return on investment

Increased pressures on budgets world-wide have led to reduced research funding, and consequently many attempts have been made to provide funding agencies with evidence that the cost of research programmes is justified by the benefits derived (7). The most convincing argument for any investor is a substantial return on his investment. Several studies have therefore been conducted to determine the economic benefits of agricultural research (3, 4, 5, 6, 10). In most of these studies, an increase in production was used to measure return on investment. Satisfactory results were obtained for the return on investment in total agricultural research, with figures ranging from approximately 10% to 40% calculated in various countries. However, a low rate of return (5%) was obtained for livestock research relative to other agricultural sectors, mainly because possible decline in productivity in the absence of research was not taken into account. This severely effects the cost-benefit analysis of veterinary research, which is primarily aimed at preventing losses and not at increasing production.

In a recent study, the return on investment in veterinary research and disease control in South Africa was re-examined (11). Available historic data on losses caused by three cattle diseases (FMD, rinderpest and anthrax) were used as a model. The conclusion of this study was that the rate of return of animal health research in South Africa is in excess of 36%.

Role of international organisations

The extremely important role played by international organisations such as the Office International des Epizooties (OIE), the FAO, the WHO, the EU, the World Bank and the International Atomic Energy Agency, as well as regional organisations, in promoting research has already been referred to in various sections of this article. In summary, these organisations play an essential role in initiating, funding and co-ordinating regional research programmes involving a number of countries. Such programmes stimulate collaboration, aid development and provide training where needed. Crisis situations, such as outbreaks of epizootic diseases, can be handled to the benefit of a whole region. Standardisation and quality assurance of veterinary products
and services, including research, play an important part in facilitating regional and international trade in animals and animal products and are therefore important functions of international organisations. In this way, an important contribution is made to economic development on a global scale.

Conclusion

Veterinary research laboratories are an essential part of the veterinary establishment in most countries. Many laboratories are not only involved in pure research but also support their animal health authorities in terms of diagnostic services, standardisation and quality control, import and export certification, etc. However, their main function is to create new knowledge and to use this knowledge to develop new technology. To do this effectively an infrastructure and funding is needed, part of which must be directed towards developing scientific expertise. History has shown that this investment in research has given handsome returns in terms of prevention of economic losses caused by animal diseases.

Rôle des laboratoires vétérinaires de recherche dans la prestation de services vétérinaires

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Résumé

Les laboratoires vétérinaires de recherche jouent un rôle essentiel par les prestations qu’ils fournissent, dans la plupart des pays, aux services de santé animale. Ces laboratoires sont à l’origine de découvertes scientifiques, d’idées novatrices et de progrès technologiques utiles pour la surveillance, la prévention et la prophylaxie des maladies animales. De plus, nombre d’entre eux offrent des services de diagnostic et d’autres prestations. Pour assurer la meilleure intégration possible entre les différentes activités conduites dans le domaine vétérinaire, les responsables doivent bien comprendre les fonctions et contraintes des laboratoires de recherche. Aussi l’auteur examine-t-il, succinctement, chacun des points suivants :

– les structures et l’organisation,
– les méthodes visant à améliorer les programmes de recherche et développement,
– les résultats des travaux menés par les chercheurs et leur évaluation,
– la gestion de l’assurance qualité,
– le financement de la recherche.

On ne peut parvenir à une collaboration optimale qu’en connaissant parfaitement le milieu dans lequel opèrent les chercheurs et leurs motivations.

Mots-clés
Función de los laboratorios veterinarios de investigación en la prestación de servicios veterinarios

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Resumen
En la mayoría de los países, los laboratorios veterinarios de investigación desempeñan un papel fundamental en la prestación de servicios veterinarios. Dichos laboratorios son fuente de nuevos conocimientos, ideas innovadoras y tecnología perfeccionada para la vigilancia, prevención y control de enfermedades animales. Por añadidura, muchos laboratorios ofrecen, entre otros, servicios de diagnóstico. Para asegurar un nivel óptimo de integración entre las diversas actividades veterinarias, es preciso que los responsables públicos entiendan el cometido y las limitaciones de un laboratorio de investigación. Por tal motivo el autor describe los siguientes aspectos:
- estructuras organizativas,
- métodos de elaboración de programas de investigación,
- rendimiento de los investigadores y sistemas para medirlo,
- gestión de la garantía de calidad,
- financiación de la investigación.
Tan sólo comprendiendo el entorno en el que trabaja un investigador y la importancia de ciertas cuestiones ligadas a su motivación será posible alcanzar cotas óptimas de colaboración.

Palabras clave

References