Animal Production and Health Section

A Historical Review
1964-2014

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IAEA

Joint FAO/IAEA Division
of Nuclear Techniques in Food and Agriculture

The Animal Production and Health Section of the Joint FAO/IAEA Division

a historical review (1964-2014)

On the Occasion of the 50th Anniversary of the
Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture

A joint programme of the
Food and Agriculture Organization of the United Nations
and the
International Atomic Energy Agency

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Contents

Foreword

The Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture (NAFA) was established in 1964 as part of an agreement between FAO and IAEA to promote food and agriculture through nuclear technological means. This included atomic (stable isotopes), nuclear (radioactive tracers) and nuclear related and nuclear derived technologies.

The Animal Production and Health Section (APH), one of the five sections of NAFA, has celebrated a historic 50 years in 2014. Since its inception in 1964, the APH has conducted numerous activities and has had a long series of technical successes. Two of the best known achievements were the Section’s development and establishment of the radioimmunoassay platform that measures progesterone to monitor reproductive performance and improve fertility of livestock, and the Section’s unique contributions towards the eradication of rinderpest through the development and distribution of validated and standardized ELISA kits, and the provision of training, and a laboratory quality assurance programme to IAEA and FAO Member States.

APH has evolved over the years, and is still dynamically changing, to offer maximum assistance to Member States to overcome constraints and to achieve the sustainable intensification of animal production in an environmentally safe, clean, and ethical way. Atomic, nuclear, nuclear related and nuclear derived technologies play an important role towards achieving these goals. In general, APH identifies new areas of interest based on needs to improve efficiencies, and, to control threats to animal production and health. To this effect, several platforms, assays, diagnostic kits, and technical procedures have been developed and transferred to Member States, supported by expert technical backstopping and guidance from our Animal Production and Health Laboratory.

The IAEA and the Joint FAO/IAEA Division are very grateful to all APH staff that had efficiently worked throughout this period, to not only meet programme goals but for attaining the highest level of success achieved. Thanks and appreciation are also given to all scientists, experts and institutions that have contributed with their technical support in the developing, validation and transfer of laboratory techniques and methodologies to Member States and in facilitating the implementation of on-site training and training courses.

I want to thank all our counterparts for their loyalty and inclusive support in the past and we trust on their continued support in the future.

Sincerely yours,

Qu Liang
Director NAFA

Abbreviations and Acronyms

AAHL	Australian Animal Health Laboratory
Ab	Antibody
ABC	Agricultural Biotechnology Center
ABL	FAO/IAEA Agriculture & Biotechnology Laboratory
ABTS	2,2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid)
ADRI	Animal Diseases Research Institute, Quebec, Canada
AFR	African Renaissance Fund
AFRA	African Regional Cooperative Agreement for Research, Development and Training Related to Nuclear science and Technology
ASF	African swine fever
ASFV	African swine fever virus
Ag	Antigen
AGAH	Animal Health Service, FAO
AGES	Austrian Agency for Health and Food Safety
AI	Artificial insemination
AIDA	Artificial Insemination Database Application
AnGR	Animal genetic resources
APHL	Animal Production and Health Laboratory
APH	Animal Production and Health Section
APO	Associate Professional Officer
APU	Animal Production Unit (former name of APHL)
ARCAL	Regional Cooperative Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean (Acuerdo Regional de Cooperación para la Promoción de la Ciencia y Tecnología Nucleares en América Latina y el Caribe)
BATAN	Centre for Application of Isotopes and Radiation, Indonesia
BDSL	Biological Diagnostic Supplies Limited
BMC	Uppsala Biomedical Centre
BPA	Buffered plate antigen test
BUL	Blood urea nitrogen
CBPP	Contagious bovine pleuropneumonia
CDVS	Community-based Dairy Veterinary Services
c-ELISA	Competitive ELISA
CFT	Complement fixation test
CGIAR	formerly the ‘Consultative Group on International Agricultural Research’
CIPAV	Fundación Centro para la Investigación en Sistemas Sostenibles de Producción Agropecuaria, Colombia
CIRAD	International Centre for Agronomical Research for Development
CM	Consultants Meeting
CPF	Country Programme Framework
CaPV	Capripoxvirus
CL	Corpus luteum
CRA	Coordinated Research Activities
CRP	Coordinated Research Project
CSI	Chief Scientific Investigator
CSIRO	Commonwealth Scientific and Industrial Research Organisation
ČSSR	(Former) Czechoslovak Socialist Republic
CTVM	Centre for Tropical Veterinary Medicine, UK
CVL	Central Veterinary Laboratory
DGGE	Denaturing gradient gel electrophoresis

DNA	Deoxyribonucleic acid
DPC	Diagnostic Products Corporation
DRC	Democratic Republic of the Congo
EDI	ELISA Data Interchange
EEC	European Economic Community
EIA	Enzyme immunoassay
ELISA	Enzyme-linked immunosorbent assay
EMPRES	Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases
EOS	Economic Opportunity Survey
EPTA	United Nations Expanded Programme of Technical Assistance
EQA	External Quality Assurance
EQC	External Quality Control
FAO	Food and Agriculture Organization on the United Nations
FMD	Foot-and-mouth disease
FMDV	Foot-and-mouth disease virus
FRET	Fluorescence resonance energy transfer probes
FRG	Federal Republic of Germany
GIS	Geographic information system
GLIDMaS	Genetics Laboratory Information and Data Management System
GLP	Good Laboratory Practices
GREP	Global Rinderpest Eradication Programme
GTPV	Goat pox virus
GTZ	Gesellschaft für Technische Zusammenarbeit
HPAI	Highly pathogenic avian influenza
HPLC	High-performance Liquid Chromatography
IAEA	International Atomic Energy Agency
IAH	Institute for Animal Health (currently the Pirbright Institute, UK)
IBR	Infectious bovine rhinotracheitis
i-ELISA	Indirect ELISA
IEMVT	Institut d'elevage et de médecine vétérinaire des pays tropicaux
IFS	International Foundation for Science
IHA	Indirect haemagglutination test
ILRAD	International Laboratory for Research on Animal Diseases
ILRI	International Livestock Research Institute
IQC	Internal quality control
ITS	Internal transcribed spacers
ISO	International Organization for Standardization
ISSN	International Standard Serial Number
JPO	Junior Professional Officer
LAMP	Loop Mediated Isothermal Amplification
LAT	Latex agglutination test
LIMA	Livestock Information Management Application
LPBE	Liquid-phase blocking ELISA
LPS	Lipopolysaccharides
LSD	Lumpy skin disease
LSDV	Lumpy skin disease virus
M	Virus matrix protein
Mab	Monoclonal antibody
MOU	Memorandum of Understanding
NA	Department of Nuclear Science and Applications
NACA	Research Contracts Administration Section
NARS	National Agricultural Research Systems
NIRS	Near Infra-Red Spectroscopy
NSP	Non-structural proteins
N	Nucleoprotein

NVSL	National Veterinary Services Laboratories, Ames, Iowa, USA
ODA	Overseas Development Administration of the United Kingdom
OIE	World Organisation for Animal Health
OPD	Ortho-phenylenediamine dihydrochloride
OUA-IBAR	Organization of African Unity – Inter-African Bureau for Animal Resources
PACE	Pan African Program for the Control of Epizootics
PANAFTOSA	Centro Panamericano de Fiebre Aftosa, Brazil (Pan American Centre for Foot and Mouth Disease)
PARC	Pan African Rinderpest Campaign
PAT	Buffered plate agglutination test
PCMF	Programme Cycle Management Framework
PCR	Polymerase Chain Reaction
PD	Pregnancy diagnosis
PEG	Polyethylene glycol
PMO	Project Management Officer
PPR	Peste des petits ruminants
PPRV	Peste des petits ruminants virus
PRA	Participatory rural appraisal
PRR	Pattern recognition receptors
PUI	Peaceful Uses Initiative
QA	Quality assurance
QC	Quality control
QTL	Quantitative trait locus
R&D	Research and development
RaMP	Research and Management Platform
RBPT	Rose Bengal Plate Test
R&D	Research and development
RC	Research contract
RCA	Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology for Asia and the Pacific
RCM	Research Coordination Meeting
RFLA	Restriction fragment length polymorphism
RH map	Radiation hybrid map
RI	Department of Research and Isotopes
RIA	Radioimmunoassay
RNA	Ribonucleic acid
RP	Rinderpest
RT	Real-time (Real-time PCR)
RUSITEC	Rumen simulation technique
RVF	Rift Valley fever
RVL	Regional Veterinary Laboratory, Benalla**,** Victoria, Australia
SADC	Southern Africa Development Community
SAF-ARF	South African 'African Renaissance Fund'
SAREC	South Asian Rinderpest Eradication Campaign
SAREC	Swedish Agency for Research Cooperation with Developing Countries
SAT	South African Territories
SF	United Nations Special Fund
SIA	Stable Isotope Analysis
SID	Serum Information Database
SIDA	Swedish International Development Authority
SNP	Single nucleotide polymorphism
SOP	Standard Operating Procedure
SPeRM	Semen Processing Records Management
SPPV	Sheep pox virus
SVA	Swedish National Veterinary Institute

T3	Triiodothyronine
T4	Thyroxine
TACF	Technical Assistance and Cooperation Fund
TAD	Transboundary animal diseases
TC	Technical Cooperation projects
TC Pride	Project Information Dissemination Environment
TCF	Technical Cooperation Fund
TO	Technical officer
UK	United Kingdom
UMMB	Urea Molasses Multi-nutrient Blocks
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USA	United States of America
USAID	United States Agency for International Development
USAMRIID	U.S. Army Medical Research Institute of Infectious Diseases
VIC	Vienna International Centre
VFA	Volatile fatty acids
VNT	Virus neutralisation test
WAREC	West Asian Rinderpest Eradication Campaign
WHO	World Health Organization

Executive Summary

The Joint FAO/IAEA Division, a coordinated effort between the IAEA and the FAO, was established on 1 October 1964 to mobilize the talents and resources of both organizations to contribute to sustainable food security and food safety by use of nuclear techniques and biotechnology.

The mandate assigned to the Joint FAO/IAEA Division proved to be a wide spectrum of successful technologies that have enormously contributed to food security and food safety around the world. The first tasks of the Animal Production and Health Section (APH), one of the current five sections of the Joint FAO/IAEA Division, were technique oriented and focussed on training courses and technical assistance in a few Technical Cooperation (TC) projects funded by UNDP and other funding organizations. However, in the 1960's, the number of professional staff was very limited.

The initial activities addressed animal health problems, especially those related to parasites, and animal nutrition, mainly on the analysis of non-protein nitrogen in animal feeds. The first Coordinated Research Project (CRP) started in 1966 aiming at evaluating the use of isotopes and radiation on the control of parasitic diseases in domestic animals.

The emphasis of APH activities moved at the end of '80s from basic and pure basic disciplinary research to on-farm multidisciplinary solutions and improvements. The APH laboratory (APHL) initiated its activities in 1984 and the first Unit Head was nominated in 1990. There was a substantial increase in external funding after 1990, especially from the Dutch and Swedish governments that allowed the recruitment of technical officers (TOs,) regional experts and the implementation of several CRPs. Around 1995 professional staff at APH were composed by nine TOs plus the Section Head and the Unit Head and the Section was implementing six CRPs. In addition, APH had the largest number of active TC projects and achieved the largest number of TC expert missions of its existence on a year basis. Furthermore, 16 highly qualified experts on sabbatical leave supported either the day-to-day activities or conducted specific tasks in the period 1984–1999.

Efforts to combine research contracts under CRPs with TC projects allowed counterparts to conduct specific and focussed research that was technically supported by a group of experts (i.e. agreement holders) while receiving additional support through larger funding for equipment, training, and visit of experts. In the period 1990–1999, 24 CRPs were implemented on developing feed supplementation strategies (e.g. the urea-molasses blocks, use of non-traditional animal feeds), on the applied use of the RIA technique for monitoring ovarian activity for improving productive and reproductive efficiency of livestock, and on the development, validation and the use of the nuclear-related ELISA technique for animal disease diagnoses (e.g. rinderpest, brucellosis, trypanomosis, foot-and-mouth disease [FMD]).

All RIA and most ELISA diagnostic tests were produced or assembled at APHL and delivered to Member States in the format of a 'kit' (a small box containing all standards, reagents, chemicals and quality control samples needed to run the test). These kits were technically backstopped by an external quality assurance (EQA) programme also conducted by APHL staff for nearly 12 years where millions of unit assays were shipped every year. In this context and as an example, the contribution of APH through the validation and distribution of rinderpest kits was crucial for the eradication of the disease, a world-wide programme conducted by FAO with strong support of IBAR/OAU in Africa.

The external review of the Section by a panel of six consultants in 1996, despite its support to the on-going problem solving approach using RIA and ELISA, provided recommendations that introduced important changes in direction in the next few years, and therefore supporting work on newly emerging areas that have the potential for future applications (e.g. PCR, molecular and gene-based technologies). The transition of the new technologies were facilitated by a series of activities such as

the FAO/IAEA International Symposium on ‘Applications of Gene Based Technologies for Improving Animal Production and Health” held in Vienna in 2003, followed by three interregional training courses held in 2004 and 2005 to train scientists from developing countries on the molecular techniques used in the fields of animal nutrition, genetics and disease diagnosis. In addition, three CRPs were initiated during 2003–2006, dealing with rumen molecular techniques for predicting and enhancing productivity; characterization of small ruminant genetic resources aimed at selection for parasite resistance; and validation of a PCR technique for the rapid diagnosis of Rift Valley fever (RVF). Nevertheless, support to RIA and ELISA continued through TC projects.

In this new phase, APH obtained important extra-budgetary contributions from donors for the expansion of APHL activities, implementation of regional and interregional training courses, and for the development and strengthening of African regional and national laboratories and the development of the VETLAB Network (previously the Joint FAO/IAEA Division’s Rinderpest Network).

In the last 14 years, CRPs in animal production have dealt with the development of assays for measuring tannins in plants, rumen molecular techniques for predicting livestock productivity, use of enzymes for improving the utilization of fibrous feeds by ruminants, genetic characterization of small ruminants, and genetic variation on gastro-internal parasitism in small ruminants. CRPs in animal health have dealt with molecular techniques for differentiate vaccinated animals from FMD infected animals, PCR and ELISA techniques for the diagnosis of Trypanosoma, RVF, peste des petit ruminants (PPR), FMD and avian influenza, use of irradiated vaccines in the control of transboundary animal diseases (TADs), use of stable isotopes to trace bird migrations associated to the epidemiology of avian influenza, and on monitoring veterinary drug residues in livestock and livestock products.

Throughout the 50 years of APH existence, programmatic activities were developed based on IAEA Member States needs in the fields of animal nutrition, animal reproduction and breeding and animal health and on what can be done by using nuclear and nuclear related technologies. APH always sourced advice from experts, research centres and international organizations to plan the projects, to prioritize activities in relation to the existing resources both in terms of staff and budget and to change direction according to results, needs and the introduction of new technologies. Consultant Meetings were one of the main mechanisms of getting advice, guidance and realistic direction, as well as proper designed projects and relevant lines of research.

Over the 50 year period, APH was managed by 9 section heads and the work was done by 25 TOs supported by numerous experts, consultants and administrative staff. Among major activities, 11 international symposiums were conducted, 55 CRPs were implemented involving scientists from 104 countries, 60 consultants meetings were organized, 430 TC projects were implemented, 379 being national projects in 95 Member States. In terms of capacity building, 130 regional and interregional training courses were conducted since 1986 where 2 166 professionals and technicians were trained, 1 075 expert missions were undertaken to 99 MSs (since 1990), and 1 237 fellowships were granted (since 1980) for 1-4 month training in specialized laboratories around the world.

IAEA and FAO, Partners in Nuclear Applications for Food and Agriculture

The International Atomic Energy Agency (IAEA) was created as a specialized agency within the United Nation system in Vienna in 1951. The IAEA Unit of Agriculture, within the Division of Isotopes in the Department of Research and Isotopes (RI) was established in 1959 to conduct research on nuclear techniques in food and agriculture. This work was further expanded by the IAEA Laboratories that opened in September 1961 at the Austrian Nuclear Research Centre (Studiengesellschaft für Atomenergie, ÖSGAE), at Seibersdorf, a village 35 km south-east of Vienna.

The Food and Agriculture Organization of the United Nations (FAO) was created in 1945 and moved its headquarters to Rome, Italy in 1951. FAO created an Atomic Energy Branch in 1957 within its Agriculture Department.

The IAEA Headquarters at the Vienna International Centre, Austria

The programmatic similarities of FAO and IAEA on the peaceful use of nuclear techniques in food and agriculture created overlapping and duplication of efforts, and therefore, discussions started between the two organizations to join efforts that led to the establishment in 1964 of the now Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. It was decided to base the Joint FAO/IAEA Division at the IAEA Headquarters in Vienna, especially due to the existence and work done by the IAEA Laboratory which was already doing research in agriculture, and to the existing research contract programme offered by IAEA.

The Joint FAO/IAEA Division has been headed by four Directors. Mr Maurice Fried from the United States (1963–1983), Mr Björn Sigurbjörnsson from Iceland (1983–1995), Mr James Dargie from United Kingdom (1995–2005) and Mr Qu Liang from China (2005–date of publication).

Joint FAO/IAEA Division
of Nuclear Techniques in Food and Agriculture
50 years, 1964–2014

50th ANNIVERSARY: 1964–2014 & Beyond
Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture

Established on 1 October 1964, the FAO and IAEA created the Joint FAO/IAEA Division as a strategic partnership in order to mobilize the talents and resources of both organizations and hence to broaden cooperation between their Member States in the peaceful application of nuclear science and technology in a safe and effective manner to provide their communities with more, better and safer food and agricultural produce while sustaining natural resources.

Fifty years later, this FAO/IAEA partnership still remains unique, with its key strengths based on interagency cooperation within the United Nations family. It is a tangible joint organizational entity with a fusion of complementary mandates, common targets, a joint programme, co-funding and coordinated management. It entails close cooperation, greater efficiency and shared approaches, and geared to demand-driven and results-based services to its Members and to the international community at large.

Nuclear applications provide added value to conventional approaches in addressing a range of agricultural problems and issues, including food safety, animal production and health, crop improvement, insect pest control and sustainable use of finite natural resources. Over the past 50 years, this partnership has brought countless successes with distinct socio-economic impact at country, regional and global levels in Member States.

During the past 50 years the mission of the Joint Division has proactively evolved to embrace the adaptation to and mitigation of climate change and the adverse effects of globalisation, to increase biodiversity and to further contribute to agricultural development and global food security. Today, both FAO and IAEA strive to mobilize commitment and concerted action towards meeting the Millennium Development Goals and the Sustainable Development Goals through appropriate use of nuclear and related technologies for sustainable agriculture and food security.

Ren Wang
Assistant Director-General
FAO

Daud Mohamad
Deputy Director General
IAEA

Joint statement of FAO and IAEA on the occasion of the 50th Anniversary of the creation of the FAO/IAEA Division of Nuclear Techniques in Food and Agriculture (1964–2014)

The Humble Beginning of the Joint FAO/IAEA Division and its Associated Laboratory

Atoms for Food

The name of the Joint FAO/IAEA Division changed several times since its creation in 1964:

1964	Joint FAO/IAEA Division of Atomic Energy in Agriculture
1966	Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture
1980	Joint FAO/IAEA Division of Isotopes and Radiation Application of Atomic Energy for Food and Agricultural Development
1985	Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture
1989	Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture

The Joint FAO/IAEA Division focussed its activities into six fields. Each Section had a corresponding Unit in the Agricultural Laboratory, with the exception of the Food Preservation Section. These were:

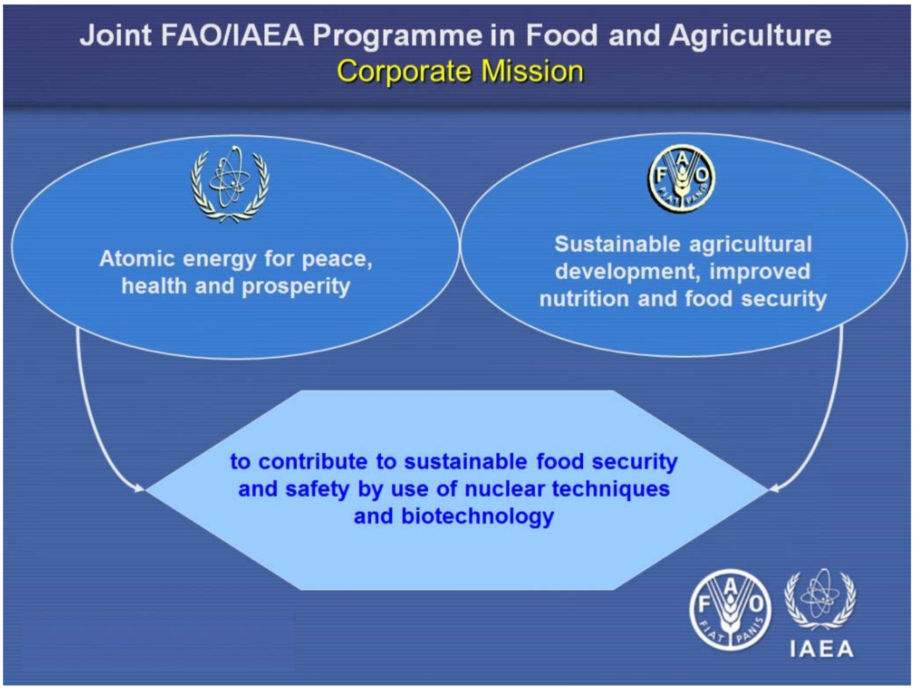
Field of activity	Section	Unit
– Soil Fertility, irrigation and crop production	– Soil Fertility, Irrigation and Crop Production	– Soil Science
– Plant breeding and genetics	– Plant Breeding and Genetics	– Plant Breeding
– Insect eradication and pest control	– Insect and Pest Control	– Entomology
– Pesticide residues and food protection	– Agrochemicals and Residues	– Agrochemicals
– Animal production and health	– Animal Production and Health	– Animal Production
– Food preservation	– Food Preservation	

The laboratory activities started with three units, namely Soils, Plant Breeding and Entomology units while Agrochemicals and Animal Production units were established in 1982 and 1984 respectively. These units and several other laboratories of the Department of Research and Isotopes (currently, the Department of Nuclear Science and Applications [NA]) depended administratively (i.e. staff management) on the Division of Research and Isotopes, which later became the Agency's Laboratories (Division), and programmatically on the Joint FAO/IAEA Division. This resulted in an adjunct between activities and staff administration. The convergence between programmatic activities

and staff was completed in 2011 with the alignment of line function of staff administration and programmatic activities under the Joint FAO/IAEA Division with the respective laboratories (units) adopting the name of the sections. The Laboratory' heads therefore now report in all maters to the respective Section's heads Section Heads as their line function.

The current sections are:

- Soil and Water Management & Crop Nutrition
- Plant Breeding and Genetics
- Animal Production and Health
- Insect Pest Control
- Food and Environmental Protection



MECHANISMS OF IAEA TECHNICAL SUPPORT TO MEMBER STATES

Technical support offered by the Joint FAO/IAEA Division and its sections is open to all IAEA and FAO Member States. The various programmatic and science delivering mechanisms are in principle the same since the inception of the Division, however, the administration procedures, budget assignment, and formalities have changed and matured over the time and mostly towards the benefit of project counterparts and transparency in the use of funds and resources.

Coordinated Research Projects (CRP)

The IAEA's Coordinated Research Activities stimulate and coordinate the undertaking of research in selected nuclear fields by scientists in FAO and IAEA Member States. The Research Contracts Administration Section (NACA) under the IAEA Department of Nuclear Sciences and Applications is the administrative body for Coordinated Research Activities (CRA). Most of the CRA are carried out under Coordinated Research Projects (CRPs), which bring together research institutes in both developing and developed countries (usually 10 to 15 scientists) to network on a specific research topic for a period of approximately 5 years.

The Animal Production and Health Section assist Member States to improve livestock productivity through:

- **Efficient use of locally available feed resources,**
- **Adequate management practices and efficient reproductive and breeding programmes, and**
- **Development of proactive disease prevention and control measures**

using atomic, nuclear, nuclear derived and nuclear related technologies

CRPs, initially named as 'Coordinated Research Programmes' were renamed to 'Coordinated Research Projects' in 1997 as the term 'programme' in Agency jargon was used in a much broader sense at Departmental level. CRPs are unique in the United Nations System.

The IAEA's CRA started its activities in 1958 and the first CRP started in 1960. Around $3 million were awarded to CRA in the period 1958–1963, $9 million in 1974–1983, $22 million in 1989–2005, and thereafter nearly $30 million for every period of 5 years (or close to $8 million per year).

The objectives of CRA are to provide opportunities to scientists in developing and developed countries to work together in solving a problem of common interest, to assist developing countries in building their research capability and technology use confidence, to encourage the acquisition and to promote the dissemination of knowledge and new technologies. Based on this, CRPs focus on problems of significant regional or global problem, with (1) high potential of technology transfer, and (2) where solutions cannot be achieved at optimal levels by individual countries. Nearly 75% of the CRPs are concentrated on topics in nuclear sciences and applications where the Joint FAO/IAEA Division is responsible for a large part of it.

The CRA programme is normally funded from the IAEA Regular Budget. Specific projects may also be financed by extrabudgetary contributions. The awards given under research contracts are rarely large and the institutes are expected to bear a significant part of the costs of the project. An average award in 2008 was about €5900 per year. Research contracts in early '90 were usually $5000 per year. Contracts are awarded for one year and renewed based upon the presentation of a satisfactory research progress report.

Improving dairy production in the tropics through better feeding, adequate reproductive management and control of infectious diseases has been the main objective of CRPs

CRPs are initiated by IAEA technical staff in response to Member States' needs and priorities. Once the CRP is approved, the scientific community is invited to submit proposals. Three types of contracts are awarded: (1) Research contracts (RC), usually to scientists from

developing countries. They receive research grants once a year in cash and/or supplies; (2) Agreements, to scientific experts to provide technical advice and support to RC holders; and (3) Technical Contracts for the provision of technical services to achieve the goals of the CRP. In addition, an IAEA Technical Officer (TO) is assigned as the scientific secretary of the CRP and liaises, coordinates and supervises the research work.

Within the lifetime of a CRP there are several Research Coordination Meetings (RCM). All CRP participants are invited to participate in at the Agency's cost in Vienna or elsewhere at the beginning, mid-phase and at the end of the project to harmonize and discuss research protocols and evaluate research findings. The results are freely available to Member States and the international scientific community through IAEA publications or other relevant scientific journals.

There were between 106 to 133 active CRPs per year in the period 2000–2012 with a mean of 1040 research contracts and 615 agreements (8.4 contracts and 5 agreements per CRP). The number of contracts, agreements, and CRPs were relatively similar over this period.

The CRP mechanism has proven of high value to address specific problems that can be solve through integrated research groups conducting common working protocols under various environments, production systems, climatic conditions and disease prevalence determining that results can be applied to most country's conditions. A large number of techniques, methods and protocols have been evaluated and validated under this system.

Technical Cooperation Projects (TC)

The technical cooperation (TC) programme run by the Department of the Technical Cooperation is the main IAEA mechanism to assist Member States to build, strengthen and maintain human and institutional capacities for the safe, peaceful and secure use of nuclear technologies in support of national development priorities. In general, TC projects contribute to the attainment of national development goals by providing expertise in fields where nuclear techniques offer advantages over other approaches, or where nuclear techniques can usefully supplement conventional means.

Many international experts have participated as agreement holders in CRPs, lectured in training courses and conducted expert missions under TC projects. Photo: Agreement holders of CRP D3.10.18 lecturing in a TC RLA/5/028 training course in Valdivia, Chile in 1995

The TC programme is funded through the Technical Cooperation Fund (TCF), which is sustained through Member States' annual voluntary contributions, payments of National Participation Costs for each project, as well as through extra-budgetary contributions, including government cost-sharing and in-kind contributions.

The programme focuses on various fields of activity where nuclear technology can be one of the key elements in providing support of sustainable socioeconomic development. These fields include human health and nutrition, agriculture and food security, management of water resources, environmental protection, radiation technology and industrial applications, energy planning and nuclear power, and the promotion of safety and nuclear security. Together with capacity building, the programme offers networking, knowledge sharing and partnership facilitation, delivered through fellowships, scientific visits, meetings, workshops and training courses, provision of expert advice and procurement of equipment. TC activities are programmed according to the needs of four geographical regions: Africa, Asia and the Pacific, Europe (which includes Central Asia) and Latin America.

APH, through CRP and TC projects has focused its capacity building, research and technology transfer efforts on ruminants (cattle, buffalo, sheep and goats) as they provide greater economic support to smallholders in developing countries. *@IAEA*

The TC programme is unique in the United Nations system, as it combines specialized technical and development competencies. It is a useful mechanism that facilitates the transfer of know-how.

Certainly, project proposals must address an area of real need in which there is a national programme enjoying strong government commitment and support. Projects are approved in a 2-year cycle and projects last for 2 to 4 years during which support can be provided for expert missions, fellowships, workshops, training courses, and equipment. A typical TC project involves an array of stakeholders and has a strong component for capacity building.

Fellowships provide academic, research or practical training to scientists and technicians in their respective fields of expertise in suitable institutions abroad for periods ranging from one month to a year, and even for longer periods. Scientific visits are awarded for 1 or 2 weeks to qualified counterparts to broaden their scientific or managerial capability and to become acquainted with new technologies. The visit of internationally recruited experts provides valuable on-the-spot in-country training, for periods usually lasting 1 or 2 weeks, and sometimes for longer periods.

The length of the training period has been reduced over the years, and currently, most of the fellowship training in the field of animal production and health ranges from 1 to 3 months. Due to the building of local or 'in-the-region' proficient laboratories, the selection of training host institutes in developed countries moved slowly over time to support host institutes within the region in order to support regional partnerships and the use of local resources and facilities. Also, experts were usually recruited based on the expertise and without considering their country of origin, so it was common to send European, North American and Australian experts all over the world for 2 to 4 months. However, the growing availability of highly qualified professionals in developing countries made it possible to recruit them for expert missions to support TC projects in their respective regions. Currently, all experts should be recruited within their regions unless the expertise is not available in the region.

An important component of TC support is related to the provision of equipment and material for the establishment or enhancement of national development activities in Member States. When complex equipment is provided, the project usually includes the visit of an expert to train the staff in the operational and technical aspects of the instrument.

The TC Programme has evolved with time and experience. The initial TC projects were mainly funded by the United Nations Expanded Programme of Technical Assistance (EPTA), the United Nations Special Fund (SF) and the United Nations Development Programme (UNDP) and external donors to fit various purposes, from funding a regional expert for e.g. one year in a particular country, to training courses, procurement of equipment, and to strengthen the development of research institutes. Years later, the programme got more focussed and the Technical Assistance and Cooperation Fund (TACF) started becoming more targeted. The TACF in early 1980' accounted for 20 million dollars per year, 30 million in 1986, 45 million in 1990, and close to 60 million by 2000. The TCAF received 55 million euros (approximately 75 million dollars) as voluntary contributions in 2012, but the TC Programme received an additional 11.5 million euros as extra budgetary funds.

Project counterparts of a Myanmar TC project in animal production with the IAEA expert in 1996

At the same time, in 1990 the TC Programme began to help Member States to develop their own project management and evaluation capabilities to improve partnership and sharing of responsibilities in the implementation and impact of the projects. In 1992, the concept of the 'Model Project' was introduced e.g. projects that were obtaining extraordinary results or had significant impact on the end-users. By 1995, 23 Model Projects were identified and were highlighted to encourage others to achieve the expected results in their projects. In 1997 the TC Programme introduced the Country Programme Framework (CPF) that each Member State has to prepare focused on agreed national development need priority. In 2002, TC started applying quality criteria to the planning and monitoring of projects, called 'central criterion' which includes relevance, ownership, sustainability, effectiveness, and efficiency. A project meets the central criterion if it addresses an area of real need in which there is a national programme with strong government commitment and support.

TABLE 1. TC PROJECTS COMPLETED IN THE PERIOD OF 1974 TO 2010 BY THE JOINT FAO/IAEA DIVISION AND THE ANIMAL PRODUCTION AND HEALTH SECTION

Period	Joint FAO/IAEA Division (n)	Animal Production and Health Section	
		n	%
1976–1980	36	11	30.6
1981–1990	252	51	20.2
1991–2000	515	154	29.9
2001–2010	318	103	32.4
Total	1121	319	28.5

The proportion of the total TC Programme disbursements in projects conducted by the Joint FAO/IAEA Division has been relatively consistent. For example, in 2000–2002 was close to 17% while from 2004 to 2012 was 11–15%.

Based on data retrieved from PCMF – TC PRIDE application available for in-house use (http://pcmf.iaea.org/Default.aspx?tabid=77), the Department of Nuclear Sciences and Applications (NA) implemented and completed 4102 TC projects in the period 1976–2010 where 1121 projects (27.3%) where under the responsibility of the Joint FAO/IAEA Division. Of this, 28.5% of TC projects were conducted by technical officers of the Animal Production and Health Section (APH). The number of completed TC projects per period is shown in Table 1. It is worth to mention that the smaller number of projects in the period 2001–2010 was due to a number of on-going projects by 2010 but completed over the next few years.

ANIMAL PRODUCTION AND HEALTH SECTION HEADS

Table 2 shows the list of section heads of the Animal Production and Health Section (APH). The first Head was Per-Göran Knutsson in 1965. Then, the section was headed by five other professionals in six continuous mandates of 2–3 years each, until James Dargie came into the office in 1982. Since then, section heads stayed in office for longer periods. In all cases, the Section Head was an IAEA staff member as opposed to other sections in the Joint FAO/IAEA Division where they have been or are FAO staff.

Photo credit: O. Perera

Workshops and training courses have been a useful mechanism of TC projects for the transfer of technologies

In the case of the Animal Production and Health Laboratory (APHL), between 1984 and 1990 the Unit was supervised by several consultants or experts on sabbatical leave, usually for a one year-period. The first Unit Head was Peter Wright from Canada (1990–1995), followed by Mark Robinson from United States (1995–1999). Adama Diallo from Mali (2000–2007, and 2009–onwards) is the current Laboratory Head.

TABLE 2. LIST OF SECTION HEADS OF THE ANIMAL PRODUCTION AND HEALTH SECTION

Period	Section Head	Country
1965 –1968	Per-Göran Knutsson	Sweden
1968 –1970	Gerald Ward	USA
1970 –1972	Hugo Höller	FRG
1972 –1974	John E. Vercoe	Australia
1975 –1978	Leon Hopkins	USA
1978 –1980	John E. Vercoe	Australia
1980 –1982	Bruce Joung	Canada
1982 –1995	James Dargie	UK
1995 –2002[a]	Martyn Jeggo	UK
2003 –	Gerrit J. Viljoen	South Africa

[a] Oswin Perera (Sri Lanka) was Acting Head for nearly one year

First Steps of the Animal Production and Health Section

(Phase 1: 1964–1984)

THE INITIAL PHASE

Information related to the early stages of APH is partially hidden or lost in the archives of the IAEA, and the staff who paved the road and provided the technical inputs are gone. Nevertheless, reports prepared by Fried (1977), Lamm (1994), Sigurbjörnsson and Lamm (1997), and Suschny (1997) partly documented the initial steps of the APH.

In the early sixties there were some international efforts in showing research results on the use and advantages of radioisotopes for understanding the physiology of livestock and for improving the digestibility of forage and crop residues. On this respect, the *International FAO/IAEA/WHO Conference on the Use of Radioisotopes in Animal Biology and the Medical Sciences* was conducted in Mexico City in 1961, with emphasis on mineral metabolism, lactation, ruminant metabolism and general animal physiology. The following year the IAEA Unit of Agriculture implemented an international training course on the *Use of Radioisotopes and Radiation in the Animal Sciences*, held at Cornell University, United States (USA), also in coordination with FAO. Other training courses were held in Argentina and India on the same line.

IAEA efforts to promote international cooperation on nuclear applications in the animal production field were hampered by the lack of an animal scientist as staff of the Unit of Agriculture. The first activities were guided by Lars-Eric Ericson, Sweden (1962–1964), whose primary responsibility was food irradiation. Fortunately, he and others in the Unit received a long-term external guidance and technical support by Johannes Moustgaard (Denmark). He took part in and advised on appropriate uses of isotopes and radiation as research tools in various fields of animal science.

The Unit of Agriculture in 1963 convened a panel of experts in Vienna to consider the production and utilization of radiation attenuated vaccines against helminthic diseases. The recommendations of the panel led to the development of widespread research in the practicality of such vaccines.

Soon after the establishment of the Joint Division in 1964, the initial six sections were created and P. Knutsson was designated as Section Head on APH. He was assisted by L.A. Black (1965) and Frederick W Lengemann (1966–1967), both on sabbatical leave secondments. The proactive initiative of J. Moustgaard and his continuous collaboration with APH was crucial for implementing several

technical meetings, training courses, CRPs and assistance to TC projects. The first duty travels took place to the former Yugoslavia, India and Brazil, mainly undertaken by J. Moustgaard in support of the existing TC projects.

THE GROWING PHASE

Staff

APH was manned by a limited number of staff in the first 'growing' years after its creation (Table 3). A frequent turnover of section heads (9 in 17 years) clearly affected the planning and structuring of long-term activities. In addition, the section head on duty only had the occasional support of one professional (mostly on sabbatical leave) at any given time until 1978.

J. Dargie was the first appointed TO[1] in 1978 and he returned to the IAEA as Section Head in 1982. L.-E. Edqvist became the second TO on board in 1983 and stayed for several years. Soon after him, several TOs started joining the Section.

TABLE 3. PROFESSIONAL STAFF IN THE ANIMAL PRODUCTION AND HEALTH SECTION DURING THE PERIOD OF 1964 TO 1984

Position	Staff	Country	Years in duty	
Unit Head in charge	Ericson, Lars Eric	Sweden	1962	1964
Section Head	Knutsson, Per-Göran	Sweden	1965	1968
	Ward, Gerald	USA	1968	1970
	Höller, Hugo	FRG	1970	1972
	Vercoe, John	Australia	1972	1974
			1978	1980
	Hopkins, Leon	USA	1975	1978
	Young, Bruce	Canada	1980	1982
	Dargie, James	UK	1982	1995
Technical Officer	Dargie, James	UK	1978	1980
	Edqvist, Lars-Eric	Sweden	1983	1987
Sabbatical	Black, L.A.	USA	1965	1965
	Lengemann, Frederick	USA	1966	1967
			1976	1977
	Kallfelz, Francis	USA	1977	1978
	Giacintov, Pavel	ČSSR	1978	1979
	Czerkawski, Julian	UK	1983	1984
	Jayasuriya, Noble	Sri Lanka	1984	1985
Associate Professional Officer	Hamel, Hans	FRG	1974	1977

MAJOR PROGRAMMATIC ACTIVITIES

International Symposiums

[1] It is worth to mention that all professional staff supervising technical work was named as 'technical officers' until about 2005 when this term refers to TC activities only. However, for the purpose of this publication this term has been used in the broad sense to reflect a professional staff.

Six symposiums were organized and implemented in the first 20 years of the APH life (Table 4), most of them in coordination with other sections of the Joint FAO/IAEA Division.

The symposium in 1964 focussed on studies of milk secretion, the role of trace elements in certain metabolic processes and the influence of environmental factors in animals. The symposium in 1967 reviewed the importance of nitrogen with discussions on animal physiology and nutrition, soil science and plant physiology, as well as on plant breeding and protein quality; while the symposium in 1972 mainly addressed factors affecting environmental adaptation and the interrelationship between the producing animal and its ecosystem.


Photo credit: C. Galina

Project team of TC MAR/5/007 and IAEA Expert in Quatre Bornes, Mauritius, in 1994

J. Moustgaard played an important role in organizing the 1976 symposium in Vienna. It dealt with methods used to increase efficiency of animal production and to combat parasitic diseases. Papers were devoted to the soil-plant-animal relations in animal nutrition, trace elements in animal nutrition, Ca, P, Mg and protein metabolism in livestock, control of parasitic infections and to animal endocrinology with special emphasis on the radioimmunoassay (RIA) technique.

The following two symposiums (1979 and 1981) dealt mainly with parasites. The first in 1979 was mainly related to immune responses, pathophysiology, parasite viability and host-pathogen relationships as applied to babesiosis, anaplasmosis, trypanosomosis and leishmaniasis, while the second in 1981 focused on nuclear techniques for the study of parasitic infections of man and livestock and progress in the application of these techniques to chemotherapy, diagnosis, epidemiology, immunology and the pathology of such infections. Special attention was paid to major diseases such as schistosomiasis, malaria, trypanosomosis, filariasis, and leishmaniasis.

TABLE 4. INTERNATIONAL FAO/IAEA SYMPOSIUMS ORGANIZED BY THE ANIMAL PRODUCTION AND HEALTH SECTION (PERIOD 1964–1984)

Year and location	International FAO/IAEA Symposium on
1964, Prague	Use of Radioisotopes in Animal Nutrition and Physiology
1967, Vienna[a]	Use of Isotopes in Studies of Nitrogen Metabolism in the Soil-Plant-Animal System
1972, Athens	Use of Isotopes in Studies of the Physiology of Domestic Animals with Special Reference to Hot Climates
1976, Vienna[a]	Nuclear Techniques in Animal Production and Health as Related to the Soil-Plant-Animal System
1979, Vienna[b]	Isotopes and Radiation Research on Animal Diseases and Their Vectors
1981, Vienna[c]	Nuclear Techniques in the Study and Control of Parasitic Diseases of Man and Animals

[a] Jointly organized with the Soil Fertility, Irrigation and Crop Production Section and the Plant Breeding and Genetics Section.
[b] Jointly organized with the Insect and Pest Control Section.
[c] Organized by the IAEA Division of Life Sciences and cosponsored by the Joint Division and the United Nations Environmental Programme.

Coordinated Research Projects (CRPs)

The concept of coordinated research was born in 1962 and the first CRP in the Joint FAO/IAEA Division was implemented by the Soil Fertility, Irrigation and Crop Production Section. APH was the third section to implement CRPs. The list of 13 CRPs implemented by APH in the period 1964–1984 is shown in Table 5.

The first CRP was launched in 1966 dealing with the pathogenic effects and control of parasitic diseases in domestic animals. It was based on the attenuation of the virulence of helminthic larvae by irradiation as a means of producing a vaccine against worm infections that presented a serious health problem in animals and man, especially in developing countries. Two years later, a second CRP on diseases caused by trace mineral deficiencies was initiated. In 1973, a third CRP on animal parasitology and immunology was launched to study the effect on parasitic diseases on livestock such as schistosomiasis, sleeping sickness (trypanosomosis), East Coast Fever and other gastro-intestinal parasites.

TABLE 5. COORDINATED RESEARCH PROJECTS IMPLEMENTED BY THE ANIMAL PRODUCTION AND HEALTH SECTION IN THE PERIOD 1964–1984

Starting year	CRP Code	CRP Title
1966	D3.20.01	Use of Isotopes and Radiation in Studies on the Etiology, Effects and Control of Parasitic Diseases in Domestic Animals
1968	D3.20.02	Trace Element Metabolism and Disease in Animals of Agricultural Importance
1972	D3.10.01	Use of Tracer Techniques in Studies on the Use of Non-Protein-Nitrogen (NPN) in Ruminants
1973	D3.20.03	Isotopes and Radiation in Animal Parasitology and Immunology
1975	D3.10.02	Water Requirements of Tropical Herbivores Based on Measurements with Tritiated Water
1976	D3.10.05	Use of Isotopes to Diagnose Moderate Mineral Imbalances in Farm Animals
1977	D3.20.04	Use of Isotopic Techniques in Research and Control of Ticks and Tick-borne Diseases
1978	D3.10.03	Use of Nuclear Techniques to Improve Domestic Buffalo Production in Asia (RCA)
1978	D3.10.04	Use of Radioimmunoassay and Related Procedures to Improve Reproductive Performance of Domestic Animals
1982	D3.10.06	Isotope-aided Studies on Non-Protein Nitrogen and Agro-Industrial By-products Utilization in Ruminant Nutrition with Particular Reference to Developing Countries
1982	D3.10.07	Optimizing Grazing Animal Productivity in the Mediterranean and North African Regions with the Aid of Nuclear Techniques
1982	D3.10.09	The Application of Radioimmunoassay to Improve the Reproductive Efficiency and Productivity of Large Ruminants
1982	D3.20.05	Use of Nuclear Techniques in the Study and Control of Parasitic Diseases of Farm Animals

The first CRP on animal nutrition started in 1972 using the analysis of the stable isotope ^{15}N on studies of non-protein nitrogen (e.g. urea) supplements to feed ruminants. A second CRP in this field started in 1975 aiming to assess the water requirements and metabolism of livestock reared under various environments, especially in the northern and dry regions of Africa.

In total, five CRPs were implemented in this period addressing disease problems, especially related to parasites, and eight CRPs on animal production, where five focussed on animal nutrition, mainly on the analysis and utilization of non-protein nitrogen, and three focussed on the use of RIA as a tool to understand the reproductive physiology of cattle and buffaloes.

Photo credit: N. Jayasuriya

Opening ceremony of the 1st RCM of CRP 'Use of Nuclear and Colorimetric Techniques for Measuring Microbial Protein Supply from Local Feed Resources in Ruminant Animals' held in Yogyakarta, Indonesia in 1996

PROGRAMMATIC ACTIVITIES IN SUPPORT TO THE TECHNICAL COOPERATION DEPARTMENT

Technical Cooperation Projects

A TC project was quite different in the early days of the Joint FAO/IAEA Division. They were mainly funded by the UNDP until the end of the 70'.

The objectives of these projects were quite variable. Some relatively small TC projects aimed at providing funds for organizing training courses or for the recruitment of experts (e.g. as regional experts based in Vienna or in a particular country and supporting in the field to neighbouring countries), as well as for the provision of equipment. On the other hand, there were also so-called large-scale field projects funded by UNDP and from extra budgetary sources (e.g. Swedish International Development Cooperation Agency [SIDA]). In these cases the budget could be close to 1 million dollars for a project of 3 to 5 years.

Large-scale field projects were implemented, as an example in the former Yugoslavia (1962–1966), India (1968–1974, 1978–1982), Brazil (1972–1981), and Indonesia (1978–1988, 1988–1993). In all cases, these projects were multidisciplinary and usually involved soil fertility, mutation plant breeding, and animal production.

Detailed information regarding all TC projects conducted by APH before 1974 could not be obtained, however, data from 58 TC projects between 1974 and 1984 was rescued. These projects were implemented in 30 countries (19 in Africa, 17 in the Asia & the Pacific, 15 in Latin America and 7 in Europe). Institutions in Ecuador, Egypt, Iceland, Malaysia, Sri Lanka, Sudan and Turkey had three or more TC projects during this period. It is worth to indicate that 33 of these projects were completed by 1984 and the other 25 projects were completed between 1985 and 1992.

The average lifespan of these projects was 4 years with a budget of about \$73 000 per project. There were however, large variations in duration as well as in budgets. For instance, six projects lasted for only 1 year with budgets ranging from \$1500 to \$7000, and on the other end 10 projects lasted for 7 to 11 years with budgets ranging from \$80 000 to \$680 000. The total expenditure on the 58 projects was \$5 465 000.

Of the 58 TC projects, 38 focused on animal production (nutrition, feed resources, feeds digestibility, chemical composition of feeds, dairy production, milk yield, hormone analysis, radioisotopes in animal nutrition and reproduction), 6 on animal health (parasites, irradiated vaccines, nuclear techniques for disease diagnosis) and 14 included both production and health components.

Training Courses

Interregional training courses in the early stages of the Joint FAO/IAEA Division were more frequently organized than in the current era. The first of these courses implemented by APH was in 1964 and records show a total of 14 training courses on various aspects of livestock production and health until 1984. In addition, there were some other courses where applications of radioisotopes in agricultural research were jointly conducted with other sections and APH staff participated as lecturers.

Participants of a workshop on the Regional TC RCA RAS/5/035 project in Mymensingh, Bangladesh, 2002

These training courses were held in various Member States. Unlike the other Sections of the Joint FAO/IAEA Division, none of these courses were conducted in the agriculture laboratory. The average number of participants per training course was 18 and the proportion of participants per region (Africa, Asia, Latin America, and Europe) was usually similar.

Regional training courses were initiated only in 1980 and were technically assisted by APH staff or through the recruitment of experts from developed countries.

Fellowships and Scientific Visits

Participants of the 2nd RCM of the Interregional CRP D3.10.23 ´Integrated Approach for Improving Small Scale Market Oriented Dairy Systems´ in Asunción, Paraguay in 2003

Information related to fellowships and scientific visits is quite obscure for this period. Partial data show that 56 fellowships and 8 scientific visits were implemented between 1979 and 1984 for scientists from 16 Member States.

Individual fellowship training lasted on average 7.7 months but it ranged from 1 to 16 months. The most frequent host countries for training were USA (19), United Kingdom (UK) (18) and Australia (8). In the case of scientific visits, 2–3 week tours comprised of one (1), two (2) or three (4) European countries. Only one scientific visit was done in the USA.

Moreover, 48 of the individual training and scientific visits were in the field of animal production and 16 on animal health.

PUBLICATIONS

Publications of research findings, laboratory manuals, proceedings of advisory group meeting or expert panels were always encouraged. A list of 24 books and manuals published by APH in the first 20 years is shown in Table 6. All of them were priced publications with the exception of the IAEA-TECDOC published in 1982. None of them have been digitalized and are no longer available for purchase; however, they can be obtained as loans in a printed format from the IAEA Library.

TABLE 6. LIST OF BOOKS AND MANUALS PUBLISHED BY THE ANIMAL PRODUCTION AND HEALTH SECTION IN THE PERIOD 1964–1984

Year of publication	Title
1964	Production and Utilization of Radiation Vaccines Against Helminthic Diseases. STI/DOC/10/30
1965	Radioisotopes in Animal Nutrition and Physiology. STI/PUB/90
1966	Radioisotopes and Radiation in Dairy Science and Technology. STI/PUB/135
1967	Isotopes and Radiation in Parasitology. STI/PUB/181
1969	Trace Mineral Studies with Isotopes in Domestic Animals. STI/PUB/218
1970	Isotope Techniques for Studying Animal Protein Production from Non-Protein Nitrogen. STI/DOC/10/111
1970	Isotopes and Radiation in Parasitology II. STI/PUB/242
1971	Mineral Studies with Isotopes in Domestic Animals. STI/PUB/293
1972	Isotope Studies on the Physiology of Domestic Animals. STI/PUB/309
1972	Tracer Studies on Non-Protein Nitrogen for Ruminants. STI/PUB/302
1973	Isotopes and Radiation in Parasitology III. STI/PUB/328
1974	Laboratory Training Manual on the Use of Nuclear Techniques in Animal Parasitology: Immunology and Pathophysiology. STI/DOC/10/160
1974	Laboratory Training Manual on the Use of Radionuclides and Radiation in Animal Research. STI/DOC/10/60/3
1974	Tracer Techniques in Tropical Animal Production. STI/PUB/360
1975	Tracer Studies on Non-Protein Nitrogen for Ruminants II. STI/PUB/389
1976	Nuclear Techniques in Animal Production and Health. STI/PUB/431
1976	Tracer Studies on Non-Protein Nitrogen for Ruminants III. STI/PUB/455
1979	Laboratory Training Manual on the Use of Nuclear Techniques in Animal Research. STI/DOC/10/193
1981	Isotopes and Radiation in Parasitology IV. STI/PUB/572
1982	Laboratory Training Manual on the Use of Nuclear Techniques in Animal Parasitology. STI/DOC//10/219
1982	Use of Tritiated Water in Studies of Production and Adaptation in Ruminants. STI/PUB/576
1982	Nuclear Techniques in the Study of Parasitic Infections. STI/PUB/596
1982	The Use of Isotopes to Detect Moderate Mineral Imbalances in Farm Animals. IAEA-TECDOC-267
1983	Nuclear Techniques for Assessing and Improving Ruminant Feeds. STI/PUB/636

The Three Programmatic Pillars

(Phase 2: 1984–1999)

THE PROGRAMME OF WORK

Programmatic activities were developed based on major needs of IAEA Member States in the fields of animal nutrition, animal reproduction and animal health and based on using nuclear and nuclear related technologies. APH was always keen in getting advice from experts, research centres and international organizations (e.g. World Health Organization [WHO], World Organisation for Animal Health [OIE], and CGIAR [formerly the 'Consultative Group on International Agricultural Research']) to plan the projects, to prioritize activities in relation to the existing resources both in terms of staff and budget and to change directions according to results, needs and the introduction of new technologies.

In addition to cattle, buffalo and small ruminants, special attention has been placed on pigs and poultry, especially for the control and diagnosis of transboundary diseases. In addition, research on camels and camelids for improving the knowledge on their reproductive physiology has been undertaken through CRPs and TC projects

Consultants Meetings were one of the main mechanisms of getting advice and getting balanced and realistic direction, well-designed projects, and relevant lines of research. APH staff did an excellent job in developing and adapting RIA kits for measuring hormone levels in body fluids and Enzyme-linked immunosorbent assay (ELISA) kits for disease diagnosis. Many of these assays were developed by specialized institutes and scientists who assisted APH to evaluate, adapt, validate and transfer them to make sure that these products were performing as needed by laboratories in developing countries.

Emphasis of APH activities moved away from basic and pure disciplinary research done at the end of '80s into on-farm multidisciplinary studies looking for solutions and improvements in livestock productivity. During this period, there was substantial increase in external funding, especially from the Dutch and Swedish governments that allowed for the recruitment of TOs, regional experts and the implementation of several CRPs and laboratory work at the laboratory. On the other hand, the frequent turnover of staff had to be handled in the best way to prevent affecting the projects.

Initial efforts of IAEA and APH in the transfer of know-how and technology were in line with the provision of long-term training, basic and specialized equipment coupled with the assistance of on-site experts for several weeks. However, due to limited resources and the increasing number of projects, the technical assistance in terms of budget had to be rationalized, and therefore, to help ensure that the right kind of encouragement was offered to staff of national animal production and veterinary research institutes to stay 'on the job', modest levels of funding over an extended period coupled with opportunities for short-term 'top-run' training was provided.

APH team is known by the nickname 'the animals'. Certainly, there were obvious reasons for that nickname, but what is true was the animal herd behaviour of the team in IAEA Headquarters in the '90. Each early morning, at somebody's shout in the B09 corridor, all the 'animals' met and went one floor down to the coffee machine, grasped a cup of coffee and went back to the corridor, to the small APH library, and had the 10–15 minutes coffee-break, partly talking nonsense, partly work-related discussions. Then, around noon, the same procedure, similar shout/call/moo and all the 'animals' herding towards the cafeteria and having lunch and coffee together.

Great golden times!!!

The 'old' APH Team

Frequent Section meetings were held either in the VIC or in the laboratory. There, programmatic issues were fully discussed, especially those related to the Programme of Work and Budget. In addition, TOs used to present the status of individual TC Projects and CRPs under their responsibility, and decisions were taken about TOs duty travels, recruitment of experts, venues for training courses, RCMs, workshops, etc. This enabled all APH staff to be aware of the current and planned activities of the Section, the successes and constraints of the existing projects and APHL activities.

Strong and successful efforts were made to combine research contracts under CRPs with TC Projects so that CRP research contract holders were able to conduct specific and focused on research, technically supported by a group of top scientists (i.e. agreement holders) while receiving support through larger funding for equipment, training, and visit of experts via TC Projects. In this period, most research contract holders participated in National and Regional TC Projects. APH also received an IAEA award for this accomplishment.

The Section contributed to the identification and evaluation of the nutritional value of a wide selection of conventional, non-traditional, and unconventional animal feeds, including shrub and tree foliage, fibrous and tanniferous plants, and agricultural and industrial by-products. Hundreds of these potential feed resources were tested using isotopic techniques in laboratory and field trials where these feeds have partially or totally substituted by traditional feed components. One of the simple, low-cost 'technologies' was the urea-molasses multinutrient blocks, an inexpensive method of providing a range of nutrients required by both the rumen microbes and the animal, which may be deficient in the diet, and were widely used in Asia and parts of Latin America. Similarly, feeding strategies suitable for the various phases of the productive life of farm animals were developed through applied research conducted in almost every developing country.

Participants of the 2nd RCM of the CRP D3.10.16 in Mexico City (1991)

The Section played an important role in the understanding of the reproductive physiology of large and small ruminants by the monitoring of reproductive hormones using the RIA technology in the early '90. This technique, in conjunction with field protocols for sampling, collection of behavioural and biological data, and the use of computer software applications developed by the staff of APH, proved enormous advantages in the better understanding of the reproductive physiology of livestock species, in identifying and ameliorating limiting factors affecting reproductive efficiency (in high-input-high-output dairy production units, medium scale farms using modern technology, small-scale livestock farms and pastoral farms), in providing diagnostic tools for ensuring proper timing for artificial insemination (AI), for monitoring ovarian cyclicity, identifying anoestrus and non-pregnant females, and in assisting AI centres and AI service providers on management and human errors on AI, efficiency of inseminators, failures in heat detection and fertility of sires.

The Section had an important contribution in developing and validating enhanced diagnostic tools, using nuclear and nuclear related techniques that were transferred to Member States for the prevention, control or elimination of important infectious diseases (e.g. rinderpest, foot-and-mouth disease [FMD], trypanosomosis and brucellosis). These diagnostic tools were used, in connection to worldwide health programmes of WHO, OIE, CGIAR Centres and other FAO divisions to apply improved techniques and strategies for disease diagnosis and surveillance. For example, APH played an important role in the global rinderpest eradication campaign through transfer of technologies, improvement of laboratory infrastructure and staff proficiencies, and the provision of methodology and operational guidance.

In the first years of the 'kit era', the focus was on the development, field testing and validation and on the theoretical principles behind them. Later, activities focussed on problem solving and their application for improving milk yield, animal fertility and for animal health monitoring.

STAFF

J. Dargie headed the Section for nearly 13 years (1982–1995) as IAEA staff, before becoming the Director of the Joint FAO/IAEA Division as FAO staff. APH under his leadership enjoyed a growth and success in terms of defining, strengthening and consolidating the three major programmatic pillars of the Section, in improving and focussing the 'coordinated work' within CRPs, in establishing proper pathways and linkages between host institutes for both CRPs and TC projects, in obtaining substantial contributions from external donors and in getting a cadre of high qualified professionals (TOs, regional experts, consultants, sabbaticals, associate professional officers [APO] and junior professional officers [JPOs]) working together as a team with the only purpose of improving livestock productivity and food security in Member States.

Unit Head M. Robinson, APHL staff, and trainees at the entrance of Seibersdorf Laboratories (1999)

M. Jeggo initiated his activities at APH as Regional Expert (1986–1992) and then became an IAEA staff (1992–1995). He became the successor of Jim as Section Head and took the reins of APH from 1995 until 2002 when he moved to Australia as Director of the Australian Animal Health Laboratory, Geelong. During his mandate, Martyn had to battle for keeping the Section strong because the reduction of contributions from external donors. Also, he faced an *External Review of the Section and Laboratory Activities* conducted by a group of external experts on what was achieved with focus on future directions. The results of this evaluation marked severe programmatic changes as re-prioritization of areas and identification of new avenues forcing the reallocation of existing resources and the seeking of additional resources.

P. Wright joined APH from Agriculture Canada in 1990 as first Head of the Animal Production Unit at Seibersdorf. Peter's main interest was the use of the ELISA technique for disease diagnose and quality control (QC). His contribution in the lab and especially on the Brucella ELISA kit and related CRPs and TC projects was remarkable. He re-structured the laboratory and supported all APH areas.

M. Robinson, virologist and expert on the polymerase chain reaction (PCR) and molecular technologies, spent a sabbatical leave from the Agricultural Research Service (USA) at Seibersdorf and then replaced Peter as Unit Head. He initiated and fully supported the FAO/IAEA quality

assurance programme and was a key person in preparing the *OIE Quality Standard and Guidelines for Veterinary Laboratories: Infectious Diseases*.

During this period, several professionals left their mark on APH and provided valuable contributions to the Section as staff (Table 7). Among them, W. Richards, one of the pioneers in the Section with a great deal of experience in tropical agriculture was in charge of Latin American projects on animal production until he became in 1991 Section Head of the Agriculture and Biotechnology Laboratory at Seibersorf. 'Wyn' was very supportive of the development of the progesterone RIA kit and his transition to the 'self-coating' progesterone kit, the nutrition metabolite kits and all aspects related to QA and quality assurance (QA) of FAO/IAEA kits.

O. Perera, from the University of Peradeniya, Sri Lanka, smoothly and efficiently promoted the use of the progesterone RIA, contributed to current knowledge of livestock reproductive physiology and assisted in the reproductive improvement of cattle and buffalo across Asian countries and elsewhere during his two-terms as TO and in multiple expert assignments.

TABLE 7. PROFESSIONAL STAFF IN THE ANIMAL PRODUCTION AND HEALTH SECTION DURING THE PERIOD OF 1984–1999

Position	Staff	Country	Years in duty	
Section Head	Dargie, James	UK	1982	1995
	Jeggo, Martyn	UK	1995	2002
Unit Head	Wright, Peter	Canada	1990	1995
	Robinson, Mark	USA	1996	1999
Technical Officer	Richards, Wyn[a]	UK	1986	1991
	Ooijen, Camille	Netherlands	1987	1992
	Plaizier, Kees	Netherlands	1987	1992
	Perera, Oswin[b]	Sri Lanka	1988	1995
			1997	2004
	Garcia, Mario	Peru	1990	1997
	Moreno-Lopez, Jorge	Sweden	1990	1995
	Wilson, Trevor	UK	1990	1992
	Jeggo, Martyn	UK	1992	1995
	Geiger, Roland	Germany	1992	1998
	Crowther, John	UK	1995	2009
	Dwinger, Ron	Netherlands	1995	2000
	Nanda, Singh	India	1996	1998
	Colling, Axel	Germany	1997	2002
	Makkar, Harinder	India	1998	2005
Regional Expert	Richards, Wyn	UK	1985	1986
	Jeggo, Martyn	UK	1986	1992
	Jayasuriya, Noble	Sri Lanka	1994	1996

[a] Moved to Agency's Laboratories Division as Section Head of the IAEA Laboratories, Seibersdorf
[b] Two periods

K. Plaizier and C. Oijeen joined the Section in 1987 as part of a large programme funded by the Dutch Government to improve livestock production in Africa. Kees and Camille took the leadership of African projects on animal reproduction and disease diagnosis respectively, conducting on-site country visits, implementing training courses and supervising TC projects and CRPs for six years. In 1995 the Government of The Netherlands agreed to further support activities on trypanosomosis, and under this

initiative, R. Dwinger joined the Section, mainly dealing with African projects on Tryps and working together with D. Rebeski (Germany) in the APH laboratory on the development of various ELISA tests for antigen detection using monoclonal antibodies.

M. Garcia, veterinarian from San Marcos University, Peru was not only responsible for Regional ARCAL TC projects, national TC projects and CRPs in Latin America, but also enhanced the QC Programme of progesterone RIA kits and developed computer applications for in-house use and for monitoring cattle reproductive performance (e.g. AIDA, AIDA Asia, AIDA Africa). After leaving the IAEA he continued supporting APH through expert missions, consultancies and lecturing at regional training courses.

Laboratory work as part of the training course on immunoassay and related techniques in livestock reproduction and nutrition under Regional TC project RLA/5/018 in Martinez de la Torre, Mexico in 1991

The experience and knowledge of J. Moreno-Lopez on the control of animal diseases and his relationship with national veterinary authorities in Latin America was crucial on his position as TO for the control of livestock diseases in the region under the programme funded by the Swedish International Development Authority (SIDA). During his time as TO, APH had a large Regional ARCAL TC project and the largest number of TC projects on animal health in Latin America.

R. Geiger spent some time as APO in the Section until he replaced Martyn as Regional Expert for Africa. Roland took an active and key participation in the rinderpest eradication programme led by FAO and OIE, through the supervision and implementation of CRPs, TC projects, training courses and on-site country visits. At the end of his contract, he was transferred to PARC (Pan African Rinderpest Campaign) Headquarters in Nairobi, Kenya.

J Crowther, from Pirbright Laboratories and a world leading authority on ELISA in veterinary diagnose joined APH in 1995 as FAO staff and stayed until his retirement in 2009. John was responsible for the introduction of ELISA platforms in Member States through TC projects and training courses. Most of his activities were conducted in Asia and Eastern Europe. His charismatic personality and leadership on two of APH symposiums and in two PCR methodology books were remarkable.

A. Colling, as Roland, through support of the Government of Germany, joined the Section as APO in 1995. His fluency in Spanish and knowledge on ELISA allowed him to take on board the supervision of related projects in Latin America. As TO in 1997, Axel took over the coordination of the External Quality Assurance (EQA) Programme assisting disease diagnostic laboratories in developing Member States on instituting quality management procedures and work towards accreditation.

S. Nanda replaced Oswin to continue the technical support to Asian countries. His expertise on on-farm research and on ways for improving reproductive performance benefited the Section. After his departure he eventually got the position of the Animal Husbandry Commissioner of the Government of India.

Sixteen scientists on sabbatical leave (Table 8) supported programmatic activities of APH during this period; either assisting projects from IAEA headquarters and on-site country visits or on hands-on laboratory activities at Seibersdorf' Laboratories. Among them, only four were closely related to animal disease diagnosis while the expertise of the rest was on livestock nutrition, reproduction and breeding. Besides, nine consultants, mainly for support work on development, adaptation and validation of laboratory techniques were recruited for periods ranging from six months to two years (Table 9).

Some of the experts, either on sabbatical leave or as consultants were particularly interested on APH activities and joined the Section as TOs (e.g. N. Jayasuriya) or unit heads (e.g. P. Wright, M. Robinson) at some point in time. Also, some of them participated in expert missions under TC projects to provide on-site technical advice to project counterparts and/or participated as agreement holders in CRPs.

TABLE 8. PROFESSIONALS ON SABBATICAL LEAVE THAT JOINED THE ANIMAL PRODUCTION AND HEALTH SECTION DURING THE PERIOD OF 1984–1999

Sabbatical	Country	Year
Jayasuriya, Noble	Sri Lanka	1984
Nachreiner, Ray	USA	1985
Mather, Ed	USA	1987
Robertson, Hamish	Canada	1987
Murphy, Bruce	USA	1988
Hamilton, Robert	UK	1988
Owen, Emir	UK	1989
Sharp, Dan	USA	1989
Yilala, Kassu	Ethiopia	1989
Bryant, Michael	UK	1990
Meirelles, Cyro	Brazil	1994
Folman, Yeshay	Israel	1995
Robinson, Mark	USA	1995
Goodger, Bill	USA	1997
Till, Ray	Australia	1997
Ezeokoli, Dan	Nigeria	1999

TABLE 9. CONSULTANTS IN THE ANIMAL PRODUCTION AND HEALTH SECTION DURING THE PERIOD OF 1984–1999

Name	Country	Initial year
Wright, Peter	Canada	1987
Adachi, Anne-Marie	Canada	1989
Fadly, Aly	USA	1989
Galina, Carlos	Mexico	1990
Kelly, Walter	Canada	1991
Nielsen, Klaus	Canada	1993
Abeygunawardena, Abey	Sri Lanka	1995
Jacobson, Richard	USA	1995
Sutherland, Susan	Australia	1995

Finally, 15 APOs, funded by their governments supported APH programmatic activities during this period, usually for one year but sometimes for up to two years. Among them, Axel Colling, Roland Geiger, Andrea Gervelmeyer, Dierk Rebeski and Hermann Unger from Germany, Anita Erkelens, Wicher Holland, Barbara van der Eerden and Eugene van Rooij from The Netherlands, and Vittorio Cagnolati, Giovanni Re, and Francesco Castrignano from Italy. Also, Stefan Oschmann (FRG), Mark

Eisler (UK), Ernst Nilsson (Sweden), Helder Louvandini (Brazil) and Thomas Ndegwa (Kenya) joined the Section at various times. As indicated, three of them became TOs of APH during their professional careers (Axel, Roland and Hermann).

APH technical and secretarial staff have been fundamental components of the APH structure (Table 10). Among the staff at Seibersdorf, M. Lelenta is a pioneer at APHL with more than 25 years of service. Mamadou is the living memory of the laboratory, and has participated in all the R&D work under the guidance of three unit heads, and countless experts and consultants throughout the years. Thousands of kits, reagents, QA panels and pieces of equipment have passed through his hands on the way to APH project counterparts.

TABLE 10. TECHNICAL AND SECRETARIAL STAFFS IN THE ANIMAL PRODUCTION AND HEALTH SECTION DURING THE PERIOD OF 1984–1999

Activity	Staff	Country	Period	
Secretary	Odinius, Camilla	Austria	1980	1998
	Heymann, Margaret	Ghana	1988	1991
	Just, Dagmar	Austria	1991	1992
	Leon, Rosario	Peru	1991	2003
	Ilundain, Adriana[a]	Argentina	?	1998
	Klinghofer, Rusiah	Austria	1995	1999
	Schellander, Roswitha	Austria	1998	DP[b]
	Schirnfofer, Anna[1]	Austria	1999	2004
Laboratory technician[a]	Lelenta, Mamadou	Mali	1988	DP
	Rogovic, Beate	Croatia	1985	2002
	Peiris, Lal	Sri Lanka	1990	1991
	Varecka, Roland	Austria	1991	1993
	Hoffmann, Cynthia	USA	1992	1995
	Dargie, Marina	Croatia	1992	1993
	Jakupciak, John	USA	1993	1993
	Winger, Eva	Austria	1993	DP
	Haas, Herbert	Austria	1995	2001
	Benkhadra, Elmuetassem	Austria	1997	2002

[a] At APH Laboratory in Seibersdorf
[b] Date of publication

B. Rogovic was a long-standing member of the team at Seibersdorf. ‘Beata’ was a major contributor to the development of the solid-phase progesterone RIA technology during the 1980s and was working on assays for veterinary drug residues before her retirement in 2002.

E. Benkhadra was also a key player on the development of the solid-phase progesterone RIA. ‘Ben’ also participated as lecturer and in the supervision of laboratory work in several regional training courses in Asia and Africa.

On the secretarial side, C. Odinius was in the IAEA for some 33 years and she ‘headed’ the Section in her particular way for nearly 20 years. It is valid to say that she has ‘seen out’ three section heads and has ‘taught and managed’ over 25 TOs. Her archiving style was well-known and appreciated by all APH.

EXTERNAL REVIEW OF THE SECTION

A panel of six consultants conducted an external review of the Joint FAO/IAEA Division on Animal Production and Health during a five day period in September 1996 (The first external review was conducted in 1988).

The panel found that the Section was achieving good results, largely through the dedicated work of well-qualified scientific and technical staff making good use of their unique capability to contribute to the design and implementation of nuclear based technologies modified for use under tropical conditions.

The use of bulls as draught power for pulling carts and ploughing the soil has been and still is a common practice in many rural areas (left photo: Cambodia; right photo: Paraguay)

The panel supported the current and new focus on problem solving using technologies transferred during the 1986–1996 period (principally RIA and ELISA) along with the extensive use of internal quality control (IQC) schemes and EQA Programme to monitor success.

— *In animal reproduction and nutrition*

The panel considered the development, introduction and widespread distribution of RIA kits for progesterone determination an outstanding success. The technology provided project counterparts the capacity to measure the impact of nutritional interventions on key reproductive parameters in several species under a wide array of environmental and managerial regimes. The reproduction work was well conducted, provided significant outputs being utilized by end-users, and was contributing to enhanced productivity, particularly in dual-purpose (dairy/beef) systems in the tropics and sub-tropics. Good science has been translated into good practical outcomes.

The panel considered that some of the earlier nutrition work improved the knowledge of ruminant nutrition and of the nutritional quantity and availability of a range of forage species; however, was too much focussed on basic science and less on production outcomes (growth, reproduction, milk production).

The panel recommended that future activities should be concentrated on R&D support for dairy production and the application of better procedures for AI. It also discouraged planned CRPs on aquaculture, pasture development, and nutrition and reproduction of draught animals.

— *In animal health*

The experts considered the development, distribution and utilization of ELISA kits for diagnosis of major epizootic diseases including rinderpest, FMD, trypanosomosis and brucellosis as a major achievement over the period 1998–1996. A notable feature of these developments activities was

the integration with national and regional eradication and/or monitoring disease control programmes in Africa, Asia and Latin America, as well as integration with the OIE.

Another key feature was the close linkages established with research laboratories in developed countries for development and validation of the ELISA platform technology. This was conducted with a sound scientific basis, utilized new or emerging technologies which was well validated, and was applied in scenarios where significant epidemiological inputs by FAO/IAEA staff contributed to the overall planning and subsequent success of disease control programmes.

The panel considered that control and eradication of major enzootic diseases assisted by the development of additional ELISAs and other technologies (e.g. PCR) should be an important part of future APH activities. Also, the panel considered that drug residues in food should be included in the Section agenda.

Participants of the training course on radioimmunoassay in animal reproduction, one of ARCAL III activities in Maracay, Venezuela in 1986

— *In training*

Training programmes for both laboratory-based and field-base studies has greatly enhanced the overall effectiveness of the Section and had improved the skills and knowledge across a number of disciplinary areas in most regions. Several universities, research centres and others were identified and efficiently used, besides the facilities at APHL, for providing valuable training. The panel however, considered that contacts with institutions within the CGIAR should be improved.

MAJOR PROGRAMMATIC ACTIVITIES

International Symposiums

APH aimed to implement international symposiums at approximately five year intervals in order to discuss technical issues of global importance in the field of animal production and health. In this context, three international symposia organized by the Section were implemented between 1984 and 1999 (Table 11). These events differed from previous symposia as they only covered topics related to animal production and health and were conducted without the involvement of other sections of the Joint FAO/IAEA Division.

The production of meat, milk, wool and other animal products is substantially lower in tropical zones as compared to temperate ones due to high environmental temperatures, seasonal variation in quantity and quality of feeds, restricted water supply, and higher prevalence and incidence of diseases. On the other hand, several indigenous livestock breeds not only can survive but produce acceptable amount of animal protein. For the better understanding of the relationship between animals and their environment, the Joint FAO/IAEA Division supported research on feed digestibility, utilization of poor quality feedstuffs, reproductive efficiency and resistance to diseases.

The symposium of 1986 reviewed the various ways by which nuclear and other methods could be used to evaluate and improve animal nutrition, reproduction and disease control under various environmental conditions prevailing in the developing world. In this symposium, the main topics under animal nutrition were related to the role of tracer techniques for nutrition studies, feeding strategies for better utilization of crop residues, and manipulation of rumen fermentation. In the field of animal reproduction, the topics were hormone determination for understanding the reproductive

physiology, effects of environmental constraints on reproductive efficiency and genotype-environment interactions on reproductive performance. On animal diseases, the topics were on disease diagnostics using radio- and immunoassays, mechanisms of immunity to viral, bacterial and parasitic infections, recombinant deoxyribonucleic acid (DNA) technology in diagnosis and vaccination, genetic resistance to disease-causing organisms and interactions between disease, nutrition and reproduction.

TABLE 11. FAO/IAEA INTERNATIONAL SYMPOSIUMS ORGANIZED BY THE ANIMAL PRODUCTION AND HEALTH SECTION (PERIOD 1984–1999)

Year and location	FAO/IAEA International Symposium on
1986, Vienna	Use of Nuclear Techniques in Studies of Animal Production and Health in Different Environments
1991, Vienna	Nuclear and Related Techniques in Animal Production and Health
1997, Vienna	Diagnosis and Control of Livestock Diseases using Nuclear and Related Techniques "Towards the 21st Century"

Nearly 150 scientists from 45 countries attended the symposium. Apart from invited conferences, there were 81 papers presented orally or as posters. Many participants from developing countries were supported through donations from the British Council, the Italian Department of Cooperation for Development, the International Foundation for Science (IFS), the Overseas Development Administration of the United Kingdom (ODA), the Swedish Agency for Research Cooperation with Developing Countries (SAREC), the Swedish International Development Authority (SIDA), and the United States Agency for International Development (USAID). The book *Nuclear and Related Techniques in Animal Production and Health* with the proceedings of the symposium was published in 1986.

The background and focus of the international symposium in 1991 were fairly similar to the previous one in 1986. The main issues under animal nutrition were related to the role of tracer techniques for nutrition studies, evaluation of feed resources with emphasis on protein and energy content, non-conventional feedstuffs, biodegradation of lignocellulose, macro- and microelement imbalances and the use of urea-molasses blocks. On the animal reproduction field, major topics were immunoassay techniques for hormone determination, field application of hormone data, use of recombinant DNA technology in animal breeding and discussions on a variety of production systems. On animal diseases, the topics were on disease diagnosis and surveillance by immunoassays techniques, use of ELISA and DNA probes for disease diagnosis, development of recombinant antigen-based vaccines, and epidemiological approaches for animal disease diagnosis and control.

More than 400 scientists and technicians from nearly 140 countries have been trained on nuclear and nuclear-related techniques related to animal production and disease diagnosis

The number of participants was close to 150 from over 40 countries. There were 63 papers including oral presentations and posters. Important contributions were received from the British Council,

Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia, SIDA, the Italian Department of Cooperation for Development, and the Technical Assistance Department of the Dutch Ministry of Foreign Affairs. The book *Isotope and Related Techniques in Animal Production and Health*, with the proceedings of the symposium was published in 1991.

The symposium in 1997 was quite different from the previous two, as this dealt exclusively with infectious animal diseases. The meeting attracted 120 participants, half of them from developing countries, which delivered 71 papers. In addition, nearly 36 invited speakers presented current activities and results on technologies applicable to disease diagnosis, advantages and disadvantages of monoclonal antibodies, diagnostic applications of PCR, molecular biological techniques, basic principles and new approaches for vaccines, approaches for monitoring disease control, QA/EQA/QC, information network and technologies (Geographic Information System — GIS), mathematical modelling, and socio-economic factors related to animal diseases. The event reviewed existing techniques utilized in disease control and diagnosis and how they can be placed in context for use in developing countries.

Participants of the 2nd RCM of CRP D3.10.20 on the use of progesterone RIA to improve artificial insemination programmes, held in Australia in 1997

The event revealed that a whole range of biosensors are becoming available that can provide the diagnostician and research worker with assays of unique sensitivity and specificity although a cost that may prohibit their use in developing countries for some time to come. It was also important to recognize that no amount of 'cutting-edge' technology will sustainably control or eradicate animal disease without a functioning veterinary field service. The book *Towards Livestock Disease Diagnosis and Control in the 21st Century* with the proceedings of the symposium was published in 1998.

Coordinated Research Projects

APH was very active in relation to CRPs, where 24 projects were implemented in this period. It is worth mentioning that three additional CRPs started in 1998–1999 and therefore, not included in this group. Out of the 24 CRPs, half were related to the improvement of animal production (Table 12) and the other half to the control of animal diseases (Table 13). One of the differences between them is that 6 out of 12 CRPs on animal nutrition and reproduction were interregional, e.g. research contract holders from more than one continent, whereas in the case of CRPs on disease diagnosis only one was interregional and the other 11 were regional.

APH received important contributions from donors for implementing several CRPs. Among them, the Ministry of Foreign Affairs of the Government of The Netherlands funded CRPs D3.10.12 and D3.10.15, and SIDA funded CRP D3.20.06, D3.20.11, D3.20.12, and D3.10.11.

The design, scope and implementation of CRPs were not always straightforward:

— CRPs D3.10.14 on animal reproduction research in Asia and D3.20.10 on animal disease diagnosis in Asia started as a combined CRP entitled 'Strengthening animal reproduction research and disease diagnosis in Asia through the application of immunoassay techniques'. However, due to the different approaches and large number of applications, it was decided to conduct two parallel but complementary projects. All RCMs were held jointly however.

— The CRP 'Improving the diagnosis and control of infectious and parasitic diseases of livestock in developing countries with the aid of radioimmunoassay and related techniques' funded by SIDA operated for one year with 24 research contract holders and 4 agreement holders. Then, it was separated into two programmes. One was the CRP D3.20.08 'Sero-surveillance of rinderpest and other diseases in Africa using immunoassay techniques' under the EEC-funded PARC programme and the other was the CRP D3.20.06 'Regional network for Latin America and animal disease diagnosis using immunoassay and labelled DNA probe techniques'.

— The CRP on 'Establishment of a unified approach to the diagnosis of animal diseases in Mediterranean, Middle East and North African countries through the use of nuclear and related immunoassay techniques' (D3.20.07) was planned but not funded and therefore never implemented.

The objectives, key elements and main achievements for CRPs in the field of animal production (Table 12) were:

- D3.10.08: The interregional CRP aimed to characterize productive and reproductive parameter of sheep and goat genotypes, improving the feeding, weaning and breeding practices, and controlling diseases. Data on age at puberty, seasonality of reproductive cycles, litter size, kid survival and growth rate was obtained. Also, early weaning and the use of 'male effect' were tested for improving fertility. Besides, some attempts were done to measure steroid hormones in hair and wool.
- D3.10.10: The project contributed to a marked improvement in knowledge of buffalo nutrition. It was noted that an improved body condition mediate via feed supplementation during the post-partum period may considerably shorten the anoestrus period. Low fertility of female buffalo seemed to be due unavailability of fertile bulls, seasonal fluctuations in semen quality, and wrong timing of insemination. Cheaper methods for oestrus synchronization are needed for greater effectiveness of artificial insemination. In addition, was noted the need for further studies on the epidemiology and control of diarrhoeal diseases and trypanosomosis in the buffalo.
- D3.10.11: The RIA technique for measuring progesterone in milk and blood was established in laboratories in the 13 participating Member States. Hormone determination was used to identify age at puberty, duration of post-partum anoestrus period, timing of insemination and to examine the effect of environment, management and nutrition on reproductive performance. Poor or inadequate nutrition and mismanagement were the major causes of low reproductive efficiency.
- D3.10.12: Research results contributed to increase the awareness of the scope that exists for improving the reproductive performance of indigenous African livestock. The progesterone RIA technique was transferred to all participating laboratories for the monitoring of reproductive events. Solid interactions between nutrition and reproduction were demonstrated by the use of a number of agricultural by-products (e.g. maize bran, cotton seed hulls, brewer grain, groundnut

In the fall of 1987, M Jeggo, C Ooijen and I went on a 6-week duty travel to 9 countries in North and West Africa to search for suitable participants for two new CRPs. Due to the absence of email and cell phones, communication was much more difficult then, and we hardly had any contact with the IAEA during the entire trip. When I saw one of my shoes arrive on its own on the baggage delivery belt at the first destination, I knew that things would not be easy. There were a few occasions where we arrived at an airport with no one to pick us up. In one occasion, Martyn said no worries; I know a 'centrally located' hotel. The hotel was centrally located enough, but it did not belong in any star category. Water was available for a while, but when Camille had fully shampooed, the water supply unfortunately stopped, and only returned a day later. Every night, Martyn, diligently worked on the travel report and integrated the hand-written inputs from Camille and I. We really got to know each other well during that trip, also made many excellent contacts that resulted in many research contracts and TC projects. Lack of certain technologies created travel challenges those days, but also made duty travels more of an experience.

J.C. (Kees) Plaizier, Technical officer

tops) as supplements. The CRP also contributed to establish or strengthen contacts between National Agricultural Research Systems (NARS) and farming communities and exchange of information between African institutes and institutes in developed countries.

TABLE 12. COORDINATED RESEARCH PROJECTS IMPLEMENTED BY THE ANIMAL PRODUCTION AND HEALTH SECTION IN THE FIELD OF ANIMAL PRODUCTION IN THE PERIOD 1984–1999

Year		CRP code	CRP Title	AH[a] (n)	RCH[b] (n)
Initial	Final				
1983	1989	D3.10.08	Improving sheep and goat productivity with the aid of nuclear techniques, with particular reference to Africa and Middle East	5	12
1983	1990	D3.10.11	Regional network for improving the reproductive management of meat and milk-producing livestock in Latin America with the aid of radioimmunoassay techniques (ARCAL)	6	22
1984	1990	D3.10.10	Use of nuclear techniques to improve domestic buffalo production in Asia (RCA) – Phase II	6	15
1987	1993	D3.10.12	Improving the productivity of indigenous African livestock with the aid of radioimmunoassay and related techniques	3	17
1987	1993	D3.10.13	Development of feeding strategies for improving ruminant productivity in areas of fluctuating nutrient supply through the use of nuclear and related techniques	5	18
1988	1994	D3.10.14	Strengthening animal reproduction research in Asia through the application of immunoassay techniques	3	10
1989	1994	D3.10.16	Development of feed supplementation strategies for improving ruminant productivity on small-holder farms in Latin America through the use of immunoassay techniques (ARCAL) – Phase III	5	21
1990	1994	D3.10.17	Interregional research network for improving the productivity of camelids through studies on reproduction and reproduction x nutrition studies	7	13
1992	1997	D3.10.18	Development of supplementation strategies for milk-producing animals in tropical and subtropical environments through the use of nuclear and related techniques	7	18
1993	1999	D3.10.19	Development of feed supplementation strategies for improving the productivity of dairy cattle on smallholder farms in Africa	5	14
1994	2000	D3.10.20	Use of RIA and related techniques to identify ways of improving artificial insemination programmes for cattle reared under tropical and sub-tropical conditions	5	14
1996	2003	D3.10.21	Use of nuclear and colorimetric techniques for measuring microbial protein supply from local feed resources in ruminant animals	6	11
Total				63	185

[a] Agreement holders
[b] Research contract holders

- D3.10.13: The interregional CRP mainly addressed ways of better utilizing locally available feed resources to improve the productivity of livestock in areas of high fluctuation in quality and quantity of feeds. Experiments were conducted on the use of ammonia treated straw, strategic supplementation with feedstuffs or feed additives, and on the manipulation of the animal's metabolism so that accumulated tissue reserves are used during time of shortage or high nutritional demand. Participants used both *in vitro* analytical methods and animal responses in the experiments.

- D3.10.14: The application of RIA to measure plasma or milk progesterone proved to be a useful aid in the assessment of reproductive status, facilitated the detection of cyclic ovarian activity before the observation of oestrus behaviour in cattle, buffalos and yaks. Some indigenous cattle breeds showed early resumption of ovarian activity and high annual calving rates due to their adaptation to climatic and other environmental conditions. Crossbreeding improved milk yield but depressed reproductive efficiency. Improved nutrition significantly improved reproductive cattle performance.

Participants of the 2nd RCM of the CRP on the Use of Nuclear Techniques to Improve Domestic Buffalo Production, held in Malaysia in 1987

- D3.10.16: Strategic supplementation was effective to advance puberty, to reduce post-partum intervals and to improve fertility, but the cost of it had to be considered. In these studies, the FAO/IAEA RIA kits were useful tools for the evaluation of reproductive functions. Substantial progress was made in understanding the relationship between the input of nutrients and productive and reproductive functions in livestock. Research work showed that inadequate nutrition remains a major constraint to improved productivity of ruminants in Latin America.

- D3.10.17: The aim of this CRP was to promote the study of factors affecting the reproductive efficiency of camelids in both the New and the Old Word. Measurement of reproductive hormones by RIA in conjunction with conventional clinical and production parameters was some of the components in the methodology to study the reproductive physiology and nutrition in the productivity of these animals. Unfortunately, the large diversity of experimental protocols and facilities in host institutions did not allowed a proper coordinated research and therefore the CRP was terminated soon after the first RCM.

- D3.10.18: The standardized research protocol used in this interregional CRP was invaluable for identifying nutritional and management constraints in dairy and dual-purpose cattle production systems. This included the use of progesterone RIA for evaluating reproductive status and identifying breeding problems, selected nutritional metabolite determinations for identifying nutritional constraints, and the measuring of body condition at key times around calving. Poor feeding management in terms of availability of feedstuffs, low quality and quantity of feeds and deficient pasture management were the common factors limiting productivity. In addition, incorrect breeding management seriously affected reproductive performance.

- D3.10.19: The African CRP aimed to increase productivity through improved nutrition and reproductive management of cattle, and also to evaluate the usefulness of certain metabolic indicators in blood as predictors of nutritional constraints. The consolidated research protocol provided to all CRP participants allowed more integrated interpretations and comparisons across and between countries. Low body condition score at calving as an estimation of nutritional status showed high correlation with fertility. The measurement of milk progesterone using RIA was useful and beneficial in the identification of fertility constraints and breeding management problems.

- D3.10.20: The CRP successfully applied a standardized methodology and uniform approach to data recording and analysis that resulted in the generation of a unique international data set on the status of AI in cattle in 14 developing Asian and Latin American countries. Measurement of progesterone by RIA in milk samples collected at specific times in relation to AI combined with the use of the computer database AIDA and a Guide to AI Data Analysis proved to be key elements in the research work. Data from over 11 000 services in nearly 8000 cows on 1735 farms permitted a clear understanding of the major constraints and factors contributing to inefficiency of AI services. The CRP demonstrated the value of accurately identifying the management problems as a basis for implementing interventions.
- D3.10.21: The interregional CRP aimed to validate the purine derivative (PD) excretion technique for measuring microbial protein supply in ruminants. Results showed that the technique is simple to implement and is a practical method for predicting the rumen microbial protein supply in ruminants, probably with the exception of the buffalo. It is a non-invasive, simple to use and inexpensive technique which gives a good prediction of microbial outflow from the rumen. A method for the determination of urinary purine derivatives based on Near Infra-Red Spectroscopy (NIRS) was also developed during the CRP.

Just after joining IAEA in 1999 my first official travel was to Mongolia under the TC programme. On arrival in Mongolia I found that no one in the group speaks English. A dilemma faced was: *"How an advanced training could be provided without team members knowing English"*. Money was sanctioned to provide English language training to 9 team members for six months at a cost of approx. US$1000 in total. This vital step paved the way for capacity development in the country that made the state-of-the-art laboratory 'effectively operational'. The project members are now senior science managers in the country feel proud to be a part of the IAEA TC Programme and attribute their growth and achievements to it. *Common sense must prevail and the project managers and donors should look beyond short-term performance indicators.*

Harinder Makkar, Technical Officer

Similarly as for animal production, the objectives, key elements and main achievements for CRPs in the field of animal health (Table 13) were:

- D3.20.06: The CRP introduced ELISA and DNA probe technology to national animal disease research institutes in Latin America. The use of standardized reagents and protocols for the conduct of assays showed great advantages, particularly with respect to assay validation, inter-laboratory comparison of results, trouble shooting and assessment of reliability of reagents. The high number of diseases included in the programme made data comparison difficult. It was recommended to include a maximum of 3–4 diseases in future CRPs and only those that can be diagnosed with FAO/IAEA ELISA kits. An external quality control programme was also recommended.
- D3.20.08: The CRP involved the introduction and use of a FAO/IAEA ELISA kit for the detection of antibodies to rinderpest virus in cattle in order to measure the effectiveness of national rinderpest vaccination in countries involved in the PARC. Several modifications were done to the kit and to the kit protocol. Due to poor water quality in the participating laboratories, sterile water for the reconstitution of reagents was included in the kit.
- D3.10.15: The CRP promoted strong collaboration and relevant technology transfer between NARS, the CGIAR's ILRAD and the Centre for Tropical Veterinary Medicine, UK (CTVM) with respect to the diagnosis, epidemiology and control of animal trypanosomosis in Africa. This collaboration resulted in the successful transfer of highly sensitive and specific ag-ELISA for bovine and camel trypanosomosis. This technique was validated against other sensitive parasitological diagnostic techniques such as the Buffy Coat technique and Mouse Inoculation, showing greater sensitivity.

TABLE 13. COORDINATED RESEARCH PROJECTS IMPLEMENTED BY THE ANIMAL PRODUCTION AND HEALTH SECTION IN THE FIELD OF ANIMAL HEALTH IN THE PERIOD 1984–1999

Year		CRP code	CRP Title	AH[a] (n)	RCH[b] (n)
Initial	Final				
1986	1991	D3.20.06	Regional network for Latin America and animal disease diagnosis using immunoassay and labelled DNA probe techniques	3	12
1987	1992	D3.20.08	Sero-surveillance of rinderpest and other diseases in Africa using immunoassay techniques	3	17
1988	1994	D3.10.15	Improving the diagnosis and control of trypanosomosis and other vector-borne diseases of African livestock using immunoassay methods	2	12
1988	1994	D3.20.10	Strengthening animal disease diagnosis in Asia through the application of immunoassay techniques	3	10
1991	1995	D3.20.11	Immunoassay methods for the diagnosis and epidemiology of animal diseases in Latin America	6	22
1991	1995	D3.20.12	Sero-surveillance of rinderpest and other diseases in Africa using immunoassay techniques - Phase II	4	21
1993	2000	D3.20.13	To improve the effectiveness of monitoring trypanosomosis and tsetse control programmes in Africa using immunoassay and parasitological techniques	4	16
1994	2000	D3.20.14	Use of immunoassay technologies for the diagnosis and control of foot-and-mouth disease in south east Asia	3	10
1994	1998	D3.20.15	The use of ELISA for epidemiology and control of foot-and-mouth disease and bovine brucellosis in Latin America (ARCAL)	5	10
1997	2004	D3.20.17	To develop and validate standardized methods for using polymerase chain reaction (PCR) and related molecular technologies for rapid and improved animal disease diagnosis	4	10
1997	2004	D3.20.18	The monitoring of contagious bovine pleuropneumonia in Africa using immunoassay	4	11
1997	2011	D3.20.16	Rinderpest seromonitoring and surveillance in Africa using immunoassay technologies	2	20
Total				43	171

[a] Agreement holders
[b] Research contract holders

- D3.20.10: Several FAO/IAEA ELISA kits were compared to other techniques for monitoring and control of various relevant diseases in Asian countries. A competitive ELISA proved to be a suitable replacement for the agar gel immuno-diffusion test to detect antibodies to bluetongue virus, an indirect ELISA for detecting antibodies against haemorrhagic septicaemia showed 91% agreement with the IHA test and was used in cattle and buffalo samples. Also, the FAO/IAEA Brucella-ELISA kit was compared with other techniques (Rose Bengal Plate Test [RBPT], Complement Fixation Test [CFT] and a commercial ELISA) with satisfactory results.

- D3.20.11: FMD, babesiosis and brucellosis were the target diseases of this CRP. The FMD antigen detection ELISA was more sensitive and its reagents were more easily standardized and stored in relation with CFT. The FMD antibody detection ELISA (Liquid-phase blocking ELISA [LPBE]) showed a good correlation with the virus neutralization test and was recommended for sero-surveillance of the disease. The FAO/IAEA ELISA kit for the diagnosis of *Babesia bovis* was validated under the conditions of participating countries. The sensitivity and specificity of the kit was suitable for epidemiological surveys. The Indirect ELISA kit for the detection of antibodies to *Brucella abortus* could be used as screening test in strain 19 vaccinated animals but cut-off values were required for each area.

- D3.20.12: This CRP and research contract holders worked together with PARC and FAO in the control and eradication of rinderpest from Africa. The sero-monitoring confirmed that the disease was eradicated from West Africa and eight countries ceased the vaccination to get an OIE declaration of provisional freedom from rinderpest. Based on the results it was recommended that all PARC countries establish rinderpest surveillance capabilities based on the FAO/IAEA/GREP guidelines (GREP: Global Rinderpest Eradication Programme). The EQA programme for the FAO/IAEA rinderpest ELISA-based system for sero-monitoring provided assurance on the reliability of the results obtained. In addition, the Ag-capture ELISA was successfully introduced for differential diagnosis of rinderpest and Peste des petits ruminants (PPR).

RCMs, training courses and technical meetings are full of anecdotes. In this case, a minor accident in Malaysia when crossing a narrow bridge while visiting local farms. *Photo credit N. Jayasuriya*

- D3.20.13: Results showed that the application of the antibody-detection ELISA was a useful tool and most suitable to characterize trypanosomosis risk areas and to monitor over time the impact of control programmes; however, it was not appropriate for individual diagnosis or for detailed transmission studies. Different diagnostic tests might be required for specific purposes and no single test was suitable for all applications related to the diagnosis of trypanosomosis. Plates coated with denatured antigen of *T. congolense* and *T. vivax* were more reliable and robust than those coated with native antigen.

- D3.20.14: ELISA-based diagnosis and surveillance capabilities for FMD in South East Asia were established and in strong agreement with OIE initiatives for the eradication of FMD. As a result of the CRP, all participating laboratories were able to provide the necessary diagnostic support to national FMD control and eradication programmes. Also, the EQA programme and IQC procedures were established but required further support, probably from the OIE FMD Regional reference Laboratory in Thailand, established during the implementation of the CRP.

- D3.20.15: Two Latin American groups did a field validation of the Brucella and FMD ELISA kits. In the case of Brucella, an Indirect and a Competitive ELISA (c-ELISA) was compared with classical diagnostic tests (Buffered plate agglutination test [PAT], Rose Bengal, CFT, 2 Mercaptoethanol) in more than 200 000 samples in various cattle breeds, the largest serological validation exercise undertaken ever for brucellosis. The competitive ELISA II (using lipopolysaccharides [LPS] as antigen and a monoclonal antibody [Mab 84] as a competitive reagent) showed the highest sensitivity and specificity and was useful to differentiate infected from vaccinated animals. In the case of FMD, the LPBE test showed great variation in the controls between laboratories and therefore, the application of the assay for field use requires further research.

- D3.20.16: The CRP was implemented in connection with the Organization of African Unit – Inter-African Bureau for Animal Resources (OUA–IBAR) and PARC epidemiology project. The CRP succeeded in establishing a rinderpest laboratory network in Africa which was involved in the

surveillance of the disease and in the validation of new assays (e.g. pen side test, PCR). The provision of EQA panels and IQC samples was an important contribution for the trustworthiness of assay results. Two IAEA documents were published based on the CRP and related activities. An initial publication (TECDOC-1161, Table 49) described guidelines for the use of performance indicators in rinderpest surveillance programmes, and the second (TECDOC-1261, Table 49) described in detail the protocols.

- D3.20.17: The PCR technique became at that time one of the most widely exploited methods of molecular biology and therefore, the CRP aimed to introduce it in developing country laboratories to answer questions not solvable by conventional serologically-based systems for three diseases: rinderpest, PPR and Contagious Bovine Pleuropneumonia (CBPP). CRP participants were able to implement the PCR methodology in their laboratories, concluding that commercial kits were not needed for PCR, but reagents should be sent from APHL.
- D3.20.18: After rinderpest, CBPP was considered the most important animal disease in Africa. The CRP aimed to develop, introduce and compare/validate a number of serological tests for the diagnosis of CBPP. The LAT test was developed in cooperation with the Moredun Research Institute, UK and the c-ELISA in cooperation with the International Centre for Agronomical Research for Development / Animal Health & Veterinary Medicine in the Tropics (CIRAD/EMVT), France, and compared and validated together with the CFT. The CBPP cELISA was internationally validated and was recognized as an OIE approved assay for CBPP.

Participants of the 3rd RCM of CRP D3.20.20 aiming to develop an FMD ELISA for differentiating vaccinated from infected animals (Cebu, Philippines, 2004)

There were 106 agreements and 356 contracts in the 24 CRPs conducted in this period, with an average of 5.2 agreements and 15.4 research contracts per CRP in the field of animal production and 3.6 agreements and 14.3 contracts per CRP in the field of animal health.

In overall, scientists of 25 Member States participated in 106 agreements, especially from UK (22), Australia (22), France (19), USA (8), Canada (7) and Sweden (7). Besides, 11 agreements were assigned to scientists in developing countries. In relation to research contracts, scientists from 70 Member States participated in 356 contracts, especially from Brazil (14), Argentina, China and Nigeria (12 each), Chile, Kenya and the Bolivarian Republic of Venezuela (11 each), Ethiopia, Mexico, Sri Lanka and the United Republic of Tanzania (10 each), Cuba, Indonesia, Malaysia, Peru and Uruguay (9 each), and Bangladesh, Côte d'Ivoire, Ghana, Sudan and Thailand (8 each). On the other hand, 16 Member States participated with only 1 research contract.

In addition, 11 technical contracts were awarded in 8 CRPs, where 6 of them were awarded to institutions in the UK, 2 in the Netherlands and 1 each in Italy, South Africa and USA.

If looking into the details of the research contracts according to the field of activity and region of the contract holder, the following can be highlighted:

In animal production,

- Brazil (9), the Bolivarian Republic of Venezuela (8), Peru (8), Chile (8), Mexico (6), Uruguay (5) and Cuba (5) had the largest number of research contracts in Latin America; while other seven countries had 1–4 research contracts each in this period.

- China (10), Sri Lanka (8), Indonesia (7), Malaysia (7), Bangladesh (6), Thailand (6), and Viet Nam (5) had the largest number of research contracts in the Asia & Pacific region, while other eight countries had 1–4 research contracts each in this period.
- Morocco (5), Nigeria (4) and Zimbabwe (4) had the largest number of research contracts in Africa while other 18 countries had 1–3 research contracts each in this period.
- In Europe, Turkey had three research contracts wile Cyprus, Czech Republic, Portugal, and Spain had one contract each.

In animal health,

- Ethiopia (8), Kenya (8), Nigeria (8), United Republic of Tanzania (8), Ghana (6), Mali (6), Uganda (6), Côte d'Ivoire (5), Senegal (5) and Sudan (5) had the largest number of research contracts in Africa, while other 16 countries had 1–3 research contracts in this period.
- Argentina (8) and Brazil (5) had the largest number of research contracts in Latin America while other 12 countries had 1–4 research contracts each in this period.
- The Philippines had three research contracts while other 12 countries in the Asia & Pacific region had 1–2 contracts each in this period.
- Turkey was the only European country and had 2 research contracts in this period.

The ratio of research agreements and research contracts based on the region of the scientist in CRPs focussed on animal production and animal health are shown in Figures 1 and 2.

Most CRPs had 3 RCMs during the lifespan of the projects; however, 1 CRP (D3.20.15) had only 2 RCMs and 6 CRPs, mostly on animal diagnostics conducted 4 RCMs. The exception was the CRP D3.10.17 which was shortly terminated after the first RCM. There were 73 RCMs for the 24 CRPs implemented in this period. In total, institutions from 32 Member States were the venues for RCMs, of which the IAEA Headquarters was the most frequent location (10), followed by host institutes in Kenya (7), Malaysia (5), Thailand (4), Australia (3), Brazil (3), Côte d'Ivoire (3), Indonesia (3) and the Philippines (3). In many occasions, RCMs were jointly conducted or followed by other meetings related to the topic of the CRP (e.g. OIE or FAO meetings, congresses, symposiums, workshops and training courses). Generally, RCMs lasted for 5 working days.

In most cases, 3 to 5 RCMs were conducted every year; however, 1989, 1991 and 1999 were very active in RCMs where 8 RCMs per year were organized (Figure 3).

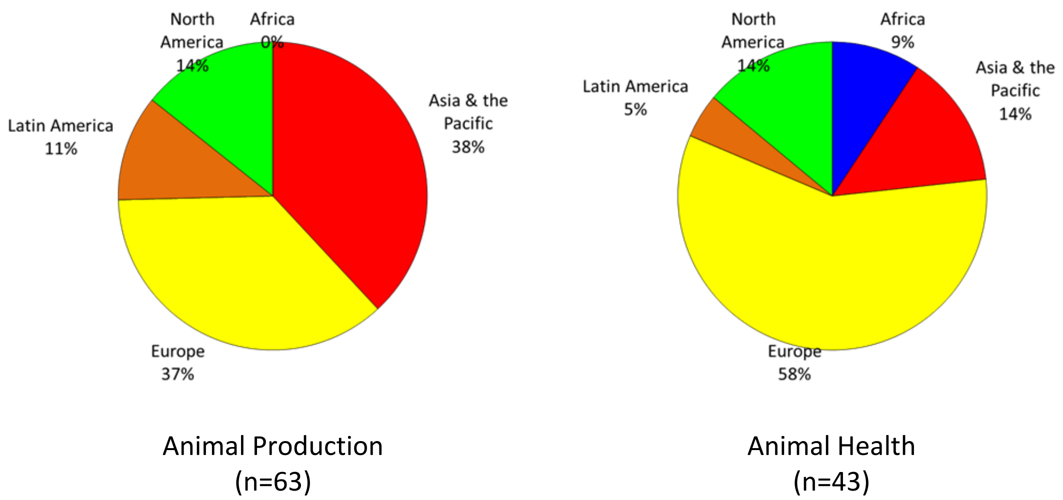


FIG. 1. Proportion of research agreements based on the region of the scientist in CRPs focussed on animal production and animal health initiated in the period of 1984–1999

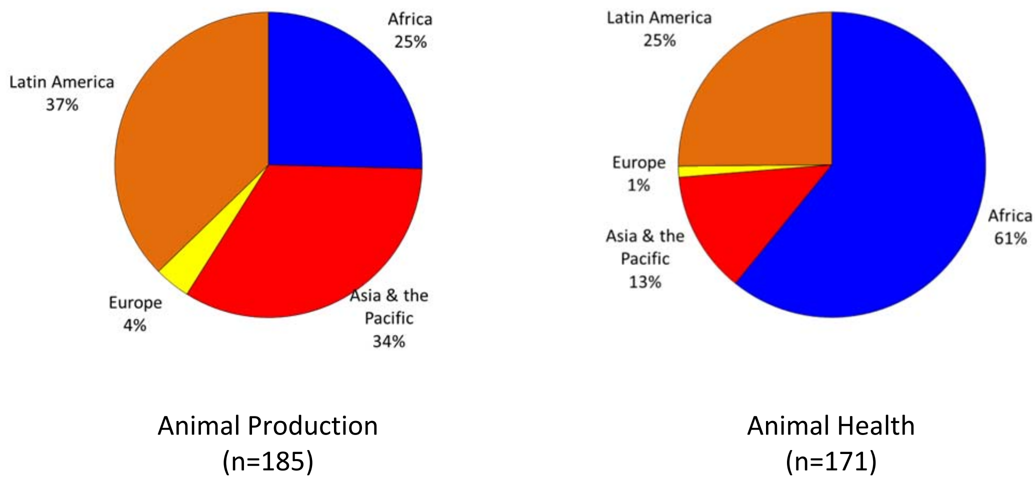


FIG. 2. Proportion of research contracts based on the region of the contract holder in CRPs focussed on animal production and animal health initiated in the period of 1984–1999

Consultants Meetings

Consultants Meeting (CM) are organized by APH to get technical advice from top experienced scientists on specific topics, especially on the state-of-the-art of advanced nuclear and related technologies and their possible applications under the prevailing conditions of laboratories in developing countries. Also, several CMs prepared the foundations for new CRPs (e.g. define work plans, research protocols) and identify potential institutions and scientists that would participate in these projects. CMs also prepared the outline and content of technical manuals and books.

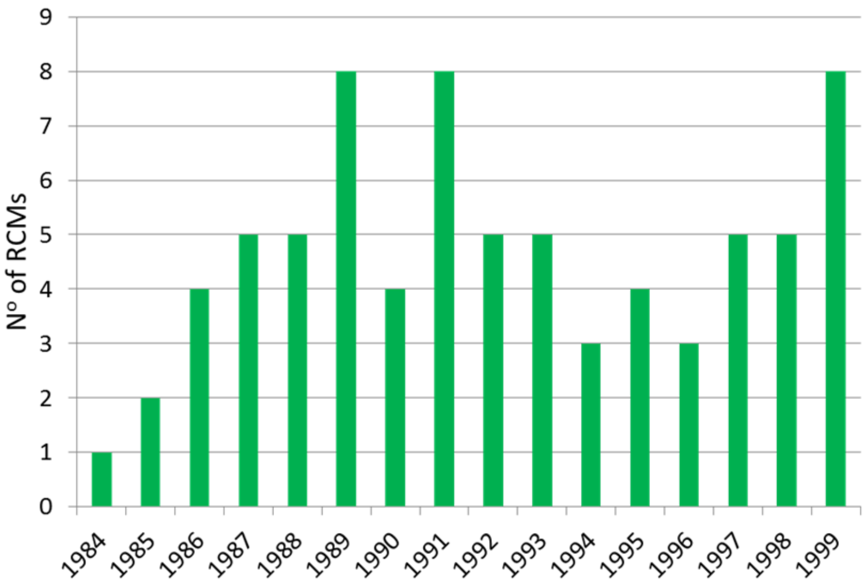


FIG. 3. Number of Research Coordination Meetings per year conducted by the Animal Production and Health Section in the period 1984–1999

TABLE 14. LIST OF CONSULTANTS MEETINGS IN THE FIELD OF ANIMAL PRODUCTION (1984–1999)

Year	Consultants Meeting on	Duration (days)
1984	Use of Nuclear Techniques in Studies on Constraints on Small Farm Pig Production in Developing Countries	3
1988	Animal Reproduction	3
1990	Biochemical Indices as Indicators of the Nutritional Status of Ruminant Animals	3
1992	Preparation of a Manual on Measuring Greenhouse Gases from Agriculture	4
1994	Progesterone Assay as a Tool for Monitoring and Improving the Efficiency of Artificial Insemination Services for Cattle	4
1995	Development and Validation of Techniques for Measuring Microbial Protein Supply in Ruminants Using Nuclear and Related Techniques	3
1995	Identifying Support Areas for Nuclear Technologies in Aquaculture	4
1997	Decreasing the Risk of Feeding Tanniniferous Plants by Optimizing their Harvesting, Diet-Mixing and Polymer Binding	3

There were 19 CMs from 1984 to 1997. The frequency of CMs varied from none (1987, 1989, 1991, 1996, 1998) to three (1990, 1997) per year. Among the CMs, 8 on animal production (Table 14), 10 were in the field of animal health (Table 15), and 1 on drug residues in food (Figure 4). CMs, depending of the nature and objectives, lasted for 2 to 5 days (Tables 14 and 15; Figure 4).

Some of the objectives, results and conclusions of the CMs related to animal production were:

- The first and only CM on pigs reared in small farms (1984) aimed at to focusing pig research using multidisciplinary approaches. Consultants selected a large number of reproductive and nutritional variables to be studied as well as vaccine quality and diagnostic methods for several viral, bacterial and parasitological diseases.

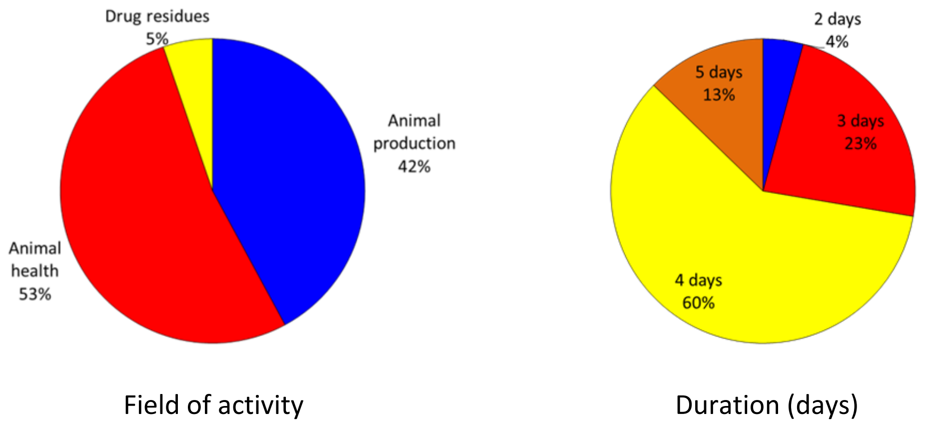


FIG. 4. Distribution of Consultants Meetings based on the field of activity and the number of working days

- The CM on animal reproduction (1988) was a key event for future research work on improving productivity of traditional livestock systems and its recommendations are still very valid. The group suggested conducting interdisciplinary research for improving reproductive performance and considering factors such as climate, nutrition, husbandry and disease. The experts suggested focusing on ruminants, including camelids, the use of RIA and enzyme immunoassays (EIA) for the determination of reproductive hormones and a strong APHL support through the development and regular supply of RIA kits to Member States.

- The CM on biochemical indices in blood (1990) discussed a number of methods for monitoring the nutritional status of ruminants and their value for assessing supplementation strategies. The group indicated that ß-hydroxybutyrate, total protein, albumin, urea, haemoglobin, phosphorous and magnesium concentrations in blood may prove to be useful indicators. These suggestions were the basis for implementing the CRP on 'Development of supplementation strategies for milk-producing animals in tropical and subtropical environments through the use of nuclear and related techniques' (D3.10.18).

Participants of a Project Review Meeting (TC RAS/5/044) in relation to integrated approaches for improving livestock productivity. The meeting was held in Jakarta, Indonesia in 2008

- The CM on greenhouse gas emissions (1992) aimed to prepare a manual for measuring these gases, primarily CH_4 and N_2O, from agricultural sources. The manual included methodologies, equipment required, sampling procedures, standards and QC, and how to conduct tracer studies using stable and radioisotope for measuring the dynamics of gas production. The manual was published as the IAEA-TECDOC-1093 *Nuclear Based Technologies for Estimating Microbial Protein Supply in Ruminant Livestock*.

- The CM on the use of progesterone RIA as a tool to monitor AI services for cattle (1994) provided the foundation for the CRP 'Use of RIA and related techniques to identify ways of improving artificial insemination programmes for cattle reared under tropical and sub-tropical conditions' (D3.10.20). The use of three milk samples collected a three defined intervals after AI plus pregnancy diagnosis by rectal palpation and the use of a fixed protocol was recommended by the group of experts, and proved to be an excellent approach for coordinated research work under CRPs.

- The CM on techniques for measuring microbial protein supply in ruminants (1995) was held to get advice on the feasibility of using nuclear and related techniques for the development and validation of techniques for such purpose. A simple method was developed through a technical contract which measures the excretion of microbial purine derivatives in the urine. The experts agreed that this method could be tested and adapted to various ruminant species and breeds. This technology was applied in the CRP 'Use of nuclear and colorimetric techniques for measuring microbial protein supply from local feed resources in ruminant animals' (D3.10.21).

- The CM on nuclear technologies in aquaculture (1995) was the first attempt of APH in this field. The meeting aimed to identify and characterize research areas where the use of nuclear technologies can improve aquaculture in developing countries. The experts agreed that the area of brood-stock management was the most appropriate as brood-stock quality makes the greatest single contribution to crop quality. The recommended technologies were DNA finger-printing, Restriction Fragment Length Polymorphism (RFLA) and DNA microsatellite. The meeting pointed out that the target region should be Southern Asia as they have the largest aquaculture production, and the target fish species should be the minor carp (*Puntius* sp). Later, one of the consultants drafted the proposal for a CRP but this was not funded mainly due to the high cost of the basic equipment for DNA technology.

TABLE 15. LIST OF CONSULTANTS MEETINGS IN THE FIELD OF ANIMAL HEALTH AND VETERINARY DRUG RESIDUES (1984–1999)

Year	Consultants Meeting on	Duration (days)
1985	Preparation of a Training Manual on Enzyme Techniques in Animal Disease Diagnosis and Epidemiology	5
1986	Animal Disease Diagnostics	2
1988	Sero-surveillance of Livestock Diseases	3
1990	Identification and Supply of Reagents for the FAO/IAEA Foot-and-Mouth Disease ELISA Kits	2
1990	International Standardization and Supply of Reagents for ELISA Kits to Detect Group Specific Antibodies to Bluetongue Virus	2
1992	ELISA Data Expression and Evaluation	5
1993	Recommended Procedures for Disease and Serological Surveillance as Part of the Global Rinderpest Eradication Programme (GREP)	5
1994	Establishment of External Quality Assurance Procedures for Use with FAO/IAEA ELISA Kits	5
1994	Plan the Research and Development Module of FAO's Global Programme for the Control and Eradication of Tsetse and Trypanosomosis in Africa	4
1995	The Application of Molecular Techniques in Animal Disease Diagnosis in Developing Countries	4
1997	Approaches to Veterinary Drug Residue Testing in Developing Countries	4

- The CM on the use of tanniniferous plants as feed resources (1997) aimed to evaluate the feasibility of a proposal for a CRP on this subject. The panel of experts suggested that the CRP focus on the validation and standardization of existing techniques to seek correlations with animal performance indicators and later on, on the evaluation of these plants as feed supplements. The CRP ‘Use of nuclear and related techniques to develop simple tannin assays for predicting and improving the safety and efficiency of feeding ruminants on tanniniferous tree foliage’ (D3.10.22) started in 1998.

Some of the objectives, results and conclusions of the CMs related to animal health and veterinary drug residues were:

- The CM for the preparation of an ELISA manual in 1985 aimed to improve the capabilities of Member States for disease diagnosis, especially using ELISA technology.
- The CM on animal disease diagnostics aimed to lay down the criteria for accepting research contract proposals on animal health and the role of APHL. The group suggested emphasizing on rinderpest, FMD, brucellosis, trypanosomosis and diarrhoeal and tick-borne diseases. They suggested the production and


Photo credit: T. Alonso

M. Garcia, Technical Officer of RLA/5/028 with training course participants in Valdivia, Chile in 1991

transfer of standardized kits and reagents rather than developing them in individual countries. This CM somehow established the basis for the next 15 years of APH activities on animal health.

- The CM on sero-surveillance of livestock diseases (1988) focussed on epidemiological approaches to serum sampling for the Pan African Rinderpest Campaign. The group prepared the booklet *Guidelines for Sero-monitoring of Cattle Conducted by PARC*.
- The CM on the FMD ELISA Kits (1990) for both antigen and antibody detection was in response of the need to support a new CRP and various TC projects in Latin America. It was decided that kit reagents should be provided from the Pirbright Laboratories and training on the use of this kits should be implemented by the Pan American FMD Centre in Brazil.
- The CM on the Bluetongue diagnostic kit (1990) was partially funded by the British Government. Data presented by scientists from Australian, Canadian, British and American laboratories confirmed that the c-ELISA was a superior test for detecting group antibodies to the virus and recommended its adoption by the OIE as the international recognized standard procedure. Experts also recommended to establish and EQA programme to ensure international standardization.
- The CM on ELISA data expression and evaluation (1992) was in response to the increased use of ELISA tests recognized by the OIEA as alternatives or additions to conventional serological tests for disease diagnosis. The consultants worked on four areas: expression of results from the samples tested, use of international reference standards, incorporation of IQC procedures, and the determination of the test threshold. The resulted guidelines were submitted to the OIE Standards Commission.

Participants of the Regional Training Course on Immunoassay and Related Techniques in Livestock Reproduction and Nutrition Research in Latin America, held in Mexico in 1991

- The CM on procedures for disease and serological sero-surveillance as part of GREP (1993) was to increase the scope of the *Guidelines for Sero-monitoring of Cattle Conducted by PARC* developed by a CM in 1988. This was considering that several PARC countries were moving towards cessation of vaccination against rinderpest, and also, that South Asian Rinderpest Eradication Campaign (SAREC) and West Asian Rinderpest Eradication Campaign (WAREC) programmes were being coordinated by GREP. The guidelines were published as the IAEA TECDOC-747 *Recommended Procedures for the Disease and Serological Surveillance as Part of the Global Rinderpest Eradication Programme (GREP)*.
- The CM on EQA procedures for FAO/IAEA ELISA kits (1994) expanded the recommendations given by a CM on ELISA data expression and evaluation conducted in 1992 and where the recommendations were adopted by the OIE. The aim of the CM was to further improve the EQA procedures for veterinary laboratories using the ELISA kits. The adoption and use of these procedures in turn would lead to 'recognition' of individual laboratories for their competence in defined assays for specific diseases. The group of experts suggested the distribution of EQC panels twice a year containing positive and negative samples.
- The CM on tsetse and trypanosomosis (1994) was convened by FAO to advice on future direction of its programme on African animal trypanosomosis. The panel of 24 experts recommended encompass the programme on three major issues: research and development, planning and management of control or eradication programmes, and policy.
- The CM on molecular techniques in animal disease diagnosis (1995) aimed to determine the applicability of PCR in developing countries. The experts recommended care on the selection of participating laboratories based on the high cost of the equipment and dedicated facilities. PCR diagnostic techniques for rinderpest, PPR and CBPP were adequate for transfer and should be initially considered. Also, it was recommended that APHL play a major role in the standardization

of the diagnostic kits. The CRP 'To develop and validate standardized methods for using polymerase chain reaction (PCR) and related molecular technologies for rapid and improved animal disease diagnosis' (D3.20.17) was implemented based on the recommendations of this CM.

- The CM on veterinary drug residue testing (1997) aimed at identifying major veterinary drugs that can affect international trade of livestock and livestock products, to determine suitable methodologies for screening and confirmatory tests for use in developing countries, and to determine appropriate sampling strategies. An outline of a CRP was drafted.

TABLE 16. NUMBER OF CONSULTANTS PER REGION IN 19 CONSULTANTS MEETINGS HELD AT IAEA HEADQUARTERS, VIENNA FROM 1984 TO 1999

Region	N° of consultants
Europe	81
Asia	17
North America	16
FAO	8
Africa	7
Latin America	4
Total	133

Participants of Regional TC RLA/5/049 with IAEA staff met in La Paz, Bolivia to discuss fascioliasis epidemiological data

Consultants are selected by the responsible TO and invited to participate at IAEA cost. The meetings usually take place at the IAEA Headquarters in Vienna. The maximum expected number of experts to be funded by the IAEA is five, but in many cases, additional experts are invited and covered by their own organizations (e.g. FAO) and institutions or through external funds allocated to APH.

The number of consultants in the listed CMs varied from 3 to 12, with an average of 6 experts. The exception was the CM to Plan the Research and Development Module of FAO's Global Programme for the Control and Eradication of Tsetse and Trypanosomosis in Africa (1994) with the participation of 24 scientists.

Most consultants were from European countries, with lesser numbers from North America (USA and Canada) and Asia (Australia) (Table 16). Member States that provided the largest number of consultants were UK (34), USA (12), Australia (11), Sweden (10), Germany (9) and France (9).

PROGRAMMATIC ACTIVITIES IN SUPPORT TO THE TECHNICAL COOPERATION DEPARTMENT

Technical Cooperation Projects

A total of 193 TC projects started in the period from 1984 to 1999 (Table 17). Among them, 162 were national projects, 25 were regional projects and 6 were interregional projects.

National TC projects were implemented in 67 Member States (24 African, 19 Latin American, 15 Asian and 9 European Member States). The Bolivarian Republic of Venezuela had the largest number of TC projects (6), followed by Côte d'Ivoire, Chile, Mexico, Peru (5 each), and Ethiopia, United Republic of Tanzania, Turkey, Argentina, El Salvador, Uruguay (4 each). On the other hand, 20 Member States had only one TC project in this period.

TABLE 17. TECHNICAL COOPERATION PROJECTS IMPLEMENTED BY THE ANIMAL PRODUCTION AND HEALTH SECTION IN THE PERIOD 1984–1999

TC projects	National	Regional	Interregional	Total
Africa	59	13		72
Asia & the Pacific	26	6		32
Europe	15	1		16
Latin America	62	5		67
Global			6	6
Total	162	25	6	193

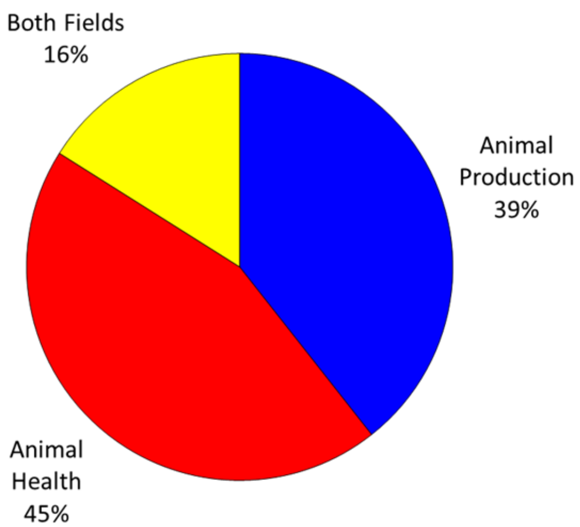


FIG. 5. TC projects that started in the period 1984–1999 according to the field of activity (n=193)

The number of TC projects associated with the field of animal health was slightly larger (n=86) than in the field of animal production (n=76). Moreover, there was a considerable number of multidisciplinary projects addressing both fields of activity (n=31), either carried out by the same host institute or with more than one institute per project (Figure 5).

The estimated duration of National TC projects varied from 1 to 6 years, with a median of 3 years; however, the actual duration of these projects varied from 2 to 11 years with a median of 5 years (Figure 6). The difference in time was usually due to allow extra time in finalizing the implementation of delayed activities (e.g. completion of fellowship trainings) and to the preparation of final reports. In most cases, the extra year did not involve major disbursements. On the other hand, some projects were extended for 1-3 years and received additional funds.

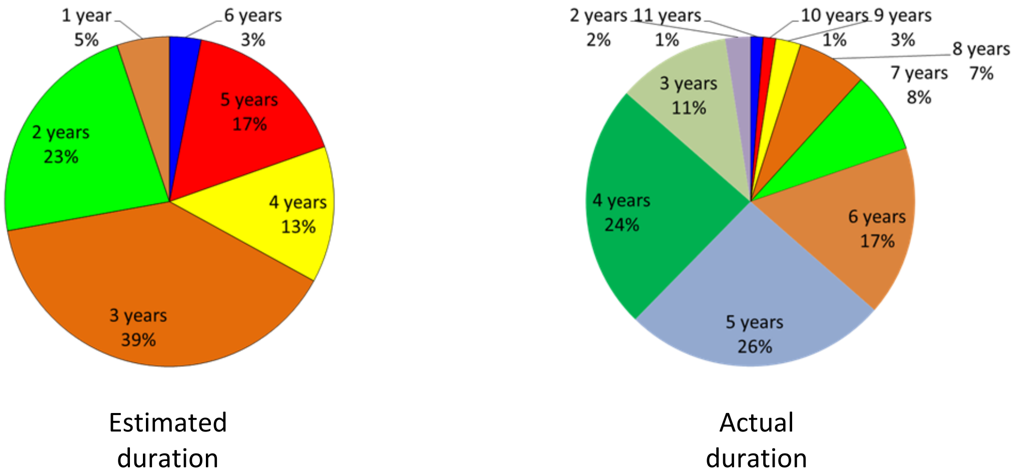


FIG. 6. Frequency of National TC projects initiated between 1984 and 1999 based on the estimated and actual duration (in years)

Regional TC projects lasted from 1 up to 9 years whereas Interregional TC projects lasted 1-2 years as they were mainly addressed for implementing interregional training courses at Seibersdorf's Laboratories.

Regional AFRA Training Workshop on Production of Standards and Internal Quality Control (IQC) Materials for Self-Coating RIA of Progesterone, held in Mauritius in 2000

The total TC budget allocated to TC projects implemented by APH in the period of 1984 to 1999 was close to €28 million. The TC budget per National TC project was quite variable, varying from close to €6000 to a small project in Madagascar in 1983–1984 to a €6 500 000 in a 4-year Ethiopian project addressed to the control of the tsetse fly with minor inputs from APH on the diagnosis and control of trypanosomosis. Most projects were in the range of €100 000 to 300 000 (Figure 7). The average budget was €183 500 and the median was €119 500, without much difference in the total budget according to regions (€107 000 per project in Europe and in Latin America to €122 000 and €131 000 per project in Africa and in Asia respectively).

Funds allocated per year per TC project varied from €16 000 to 150 000 if not considering the three largest projects in terms of funds (budgets larger than €600 000). The average amount disbursed per year per project was €48 000.

Training Courses

There were 56 training courses of which 7 were interregional and 49 were regional. Regional training courses were mostly conducted under projects supported by regional agreements (African Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology [AFRA], Acuerdo Regional de Cooperación para la Promoción de la Ciencia y Tecnología Nucleares en América Latina [ARCAL] and Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology for Asia and the Pacific [RCA]) and conducted in the regions (Table 18), whereas interregional training courses were implemented through ad-hoc Interregional TC projects.

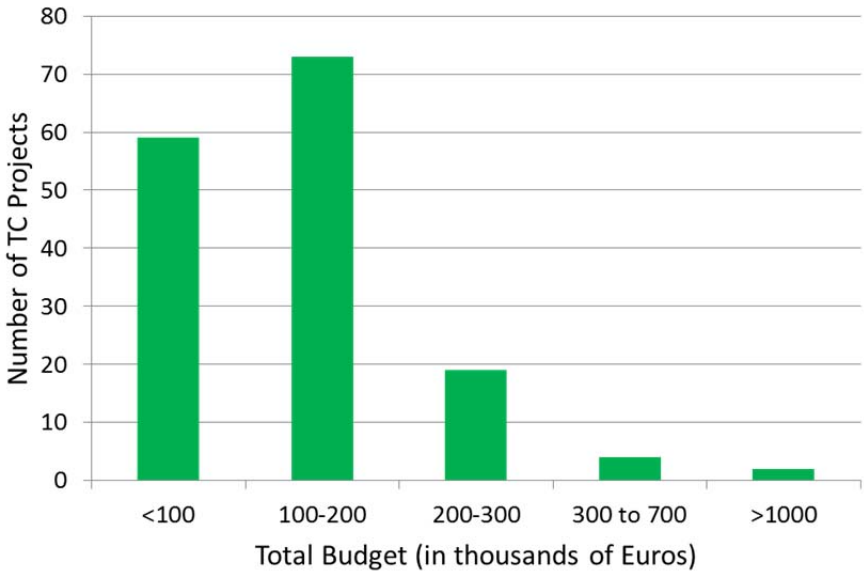


FIG. 7. Number of National TC projects initiated between 1984 and 1999 based on the total budget (in thousands of Euros)

Four interregional training courses were focussed on nutrition and reproduction immunoassay and related techniques (1985, 1987, 1991 and 1995) and two on immunoassay and molecular techniques for animal disease diagnosis (1994, 1996). All six courses were implemented at Seibersdorf's Laboratories. The seventh course was based on nuclear techniques for the determination of veterinary residues in livestock products and was held in Cyprus in 1997.

Regional training courses in the field of animal production focussed on immunoassay and related techniques in livestock reproduction and nutrition research and nutrition-reproduction interactions (n=6), on the radioimmunoassay technique including the solid phase ^{125}I-progesterone and the 'self-coating' progesterone assay (8), on feed supplementation strategies (5), on livestock data analysis (1), and on external quality control for RIA (1).

Regional training courses in the field of animal health focussed on immunoassay and molecular techniques, DNA probes and epidemiology of major animal diseases (n=8), on molecular and immunoassay techniques for the diagnosis, sero-monitoring and surveillance of rinderpest (7), on

diagnostic methods for trypanosomosis and tick-borne diseases (4), on the control and monitoring of FMD (2) and CBPP (1), on data analysis (1), on the determination of veterinary residues in livestock products (1), and on emergency preparedness and disease surveillance (1).

TABLE 18. REGIONAL TC TRAINING COURSES IMPLEMENTED PER REGION FROM 1984 TO 1999

Region	Agreement	Field of activity			Total
		Animal production and health	Animal production	Animal health	
Africa	AFRA	1	9	15	25
Asia & the Pacific	RCA	2	4	3	9
Europe	- -	-	1	-	1
Latin America	ARCAL	-	7	7	14
Total		3	21	25	49

TABLE 19. DURATION (IN WEEKS) OF TC TRAINING COURSES

Type	Duration (in weeks)				Total
	1	2	3	4	
Regional	19	11	7	12	49
Interregional	-	-	-	7	7

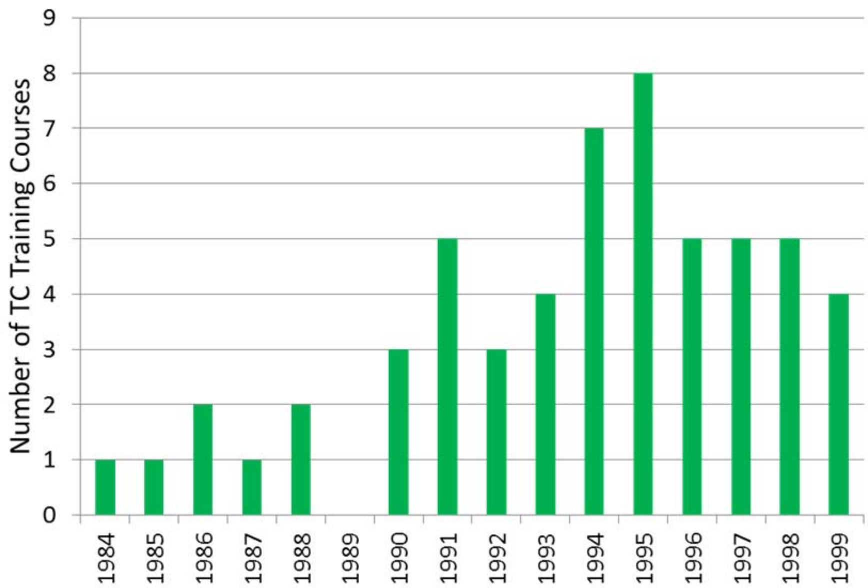


FIG. 8. Number of Regional TC Training courses per year (1984–1999)

All interregional training courses lasted for 4 weeks whereas the duration of regional training courses varied from 1 to 4 weeks independently of the topic of the course (Table 19). However, most training courses lasted for 3–4 weeks in the 1984–1990 period, 1–2 weeks in the 1990–1996 period and there was a tendency to last for one week in 1997–1999 period.

More than 50% of the regional training courses were held in African countries and only one course was held in Europe (Cyprus, 1992). The 56 training courses represented 744 working days (47 working days per year).

Few training courses were implemented before 1990. The number of courses had an steady increase since 1991 with a peak in 1994–1995 (Figure 8) coinciding with the developments of both FAO/IAEA RIA and ELISA kits and the dissemination of these techniques through regional projects and financial support from Swedish and Dutch organizations.

Training courses were conducted with the collaboration of international recognized scientists, some of them coming from developing countries where the knowledge and expertise on the prevailing local conditions could be granted. In 55 training courses (*data from the course in 1984 was unavailable*), scientists from 50 Member States participated in 228 occasions as lecturers (22 of them were local lecturers). The distribution of lecturers according to the region of origin is shown in Figure 9. Most lecturers were from developed countries (n=145). The higher proportion of African lecturers in comparison with the other developing regions was mainly due to the fact that half of the courses were conducted in Africa.

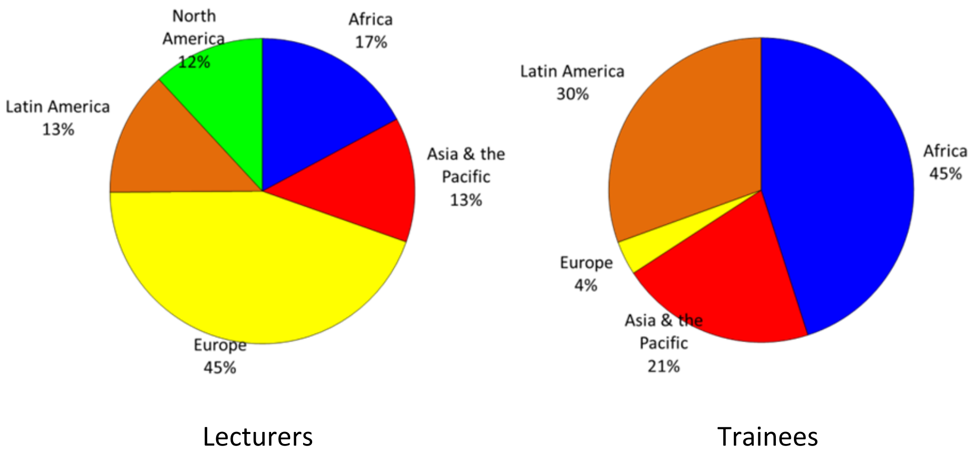


FIG. 9. Lecturers (n=228) and trainees (n=939) according to their countries of origin that participated in 55 regional and interregional training courses implemented from 1984 to 1999

Together with internationally recruited lecturers, APH TOs and APHL staffs participated as lecturers in 74 opportunities. Among them, 14 TOs participated as course supervisors, where R. Geiger was the TO in 11 courses, O. Perera in 7, N. Jayasuriya and M. Jeggo in 6 each, and M. Garcia in 5 courses.

There were 939 course participants from 107 countries in the 55 regional and interregional training courses. Of these, 45% of them were from African countries and 30 and 21% from Latin American and Asian countries (Figure 9), which was in close relation to the number of training courses implemented in each region.

About location, 176 trainees out of 939 (18.7%) were local participants and 763 participants (81.3%) travelled from their countries to the host country. On average, there were 13.9 trainees from abroad

and 3.3 local trainees per training course. Furthermore, there were 7 courses, mainly workshop training courses, with 4 to 7 participants on very specific subjects and 10 courses with 20 or more participants.

In Africa, most trainees were from the United Republic of Tanzania (n=28), Ethiopia and Kenya (26 each), Ghana (25), Sudan (23), Zambia (20), Egypt and Nigeria (18 each), Mali and Morocco (17 each), Côte d'Ivoire and Senegal (16 each), Uganda and Zimbabwe (15 each), Cameroon (14), Algeria and Tunisia (12), Niger (11), and South Africa (10).

In Latin America, most trainees were from Mexico (n=32), Chile (25), Argentina (23), Colombia, Cuba and the Bolivarian Republic of Venezuela (21 each), Brazil (20), Uruguay (19), Peru and Paraguay (15 each), and El Salvador and Panama (14 each).

In Asia and the Pacific, most trainees were from Viet Nam (n=21), Indonesia, Sri Lanka and Thailand (20 each), Philippines (13), Malaysia and Pakistan (11 each), Bangladesh (10), and China and Myanmar (9 each).

Expert Missions

Records of expert missions were not fully available or incomplete before 1990, and therefore, statistical data is only shown from 1990 to 1999. There were 676 expert missions in support of national and regional TC projects (Table 20) in the indicated period. The number of expert missions varied from 48 to 88 per year with a mean of 68 missions per year (Figure 10).

TABLE 20. NUMBER OF EXPERT MISSIONS ACCORDING TO THE HOST REGION (1990–1999)

Region	Number of expert missions
Europe	39
Asia	125
Latin America	252
Africa	260
Total	676

Most expert missions lasted for 10 days (62%) or more, while assignments of five days occurred in a lesser cases (17%) as shown in Figure 11. In most cases, experts trained project counterparts on the use of RIA and ELISA techniques and related equipment, in laboratory data interpretation, and in the application of the techniques in support of field activities related to improved feeding, better reproductive efficiency or control and surveillance of animal diseases.

Experts came from 50 countries, especially from UK (147 missions), Canada (59), USA (50), Australia (47), Germany (32), France (25), Mexico (25), Sri Lanka (25), Costa Rica (23), Netherlands (19) and Peru (18). Thirteen countries contributed with one expert during the studied period. In general, most experts were based in Europe (39% of expert missions); however, other regions were almost equally represented (Figure 12). Host institutes receiving experts were mainly in Africa and in Latin America (38 and 37% respectively, Figure 12) and this was principally due to the proportion of TC projects in those regions.

In relation to gender, the largest proportion of expert assignments was carried out by male experts (91%, Figure 13). Also, 58% of the missions were related to animal health activities (Figure 13) which was in line with the larger number of TC projects dealing with animal health.

The 676 expert missions were carried out by 264 experts. Among them, K. Nielsen, Canada (24 missions), K. Tounkara, Mali (16), E. Couacy-Hymann, Côte d'Ivoire (15), E. Perez, Costa Rica (14), C. Galina, Mexico (13), M. Garcia, Peru (13), N. Jayasuriya, Sri Lanka (12) and B. Ørskov, UK (12). On the other hand, 139 experts were recruited only once, 46 experts were recruited twice, while 32 and 16 experts were recruited 3 and 4 times respectively.

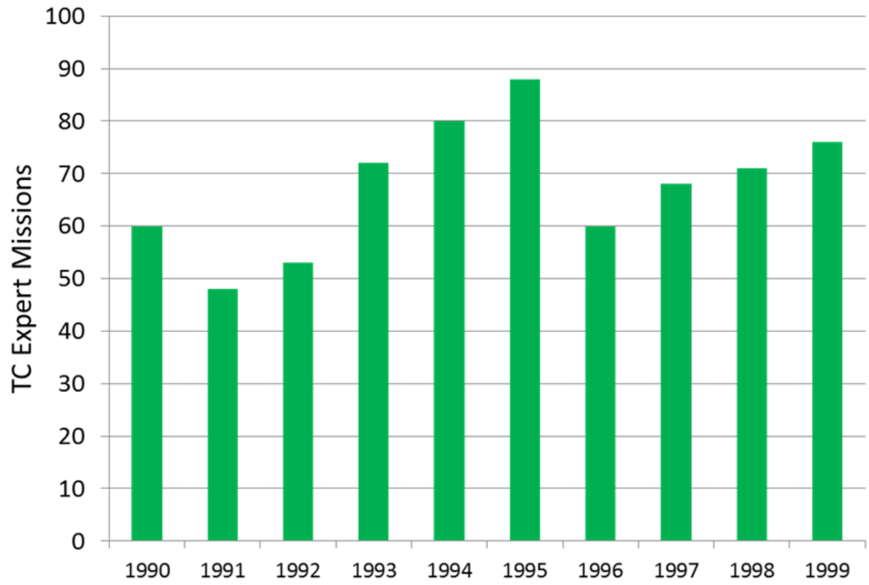


FIG. 10. Frequency distribution of expert missions in the period 1990–1999

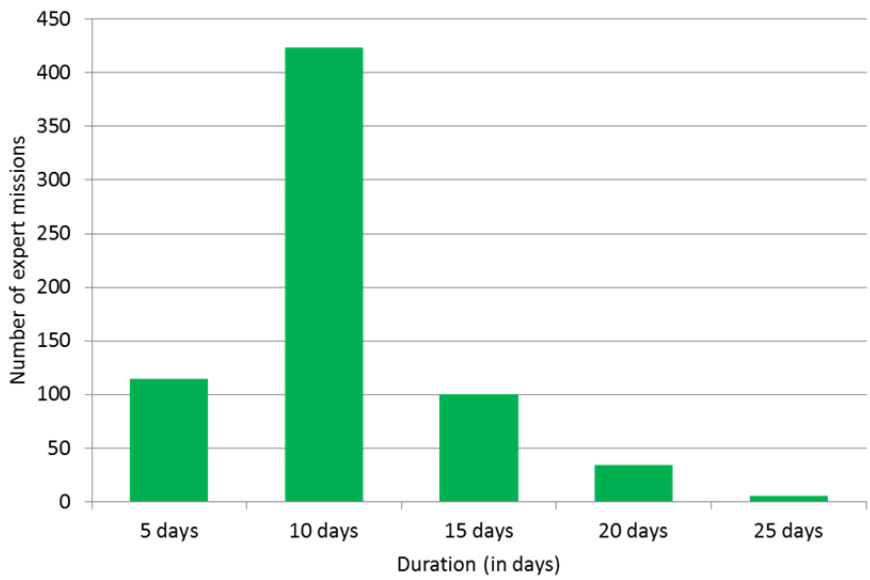


FIG. 11. Number of expert missions according to the length of the assignments in the period 1990–1999

Fellowships and Scientific Visits

There were 372 individual fellowship training and 71 scientific visits related to animal production and health awarded through TC projects in the period. Trainees came from 67 Member States. There was a clear higher number of Latin American trainees (Table 21) despite that Africa had larger number of TC projects (Table 17). The number of scientists trained per year increased through the time with a peak in 1994 (Figure 14).

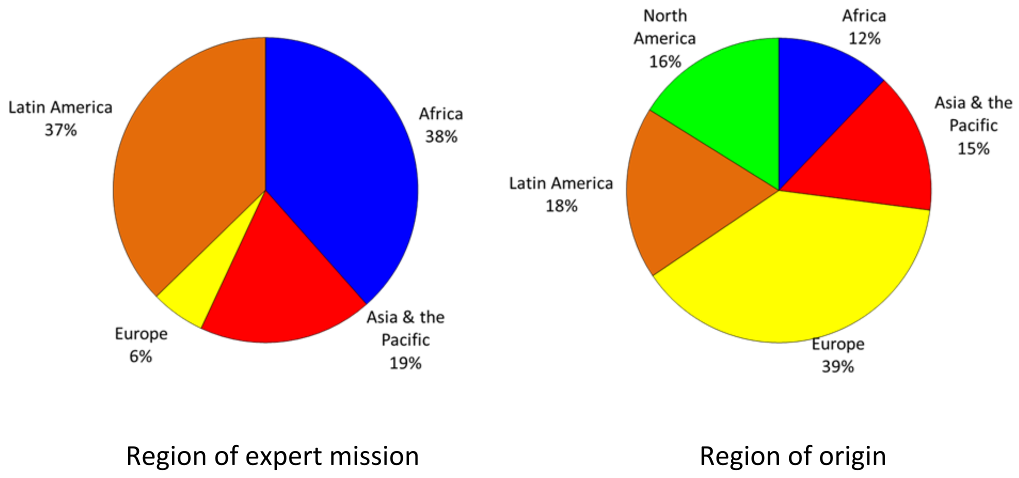


FIG. 12. Expert missions based on the region of assignment or the region of origin of the expert (n=676 expert missions)

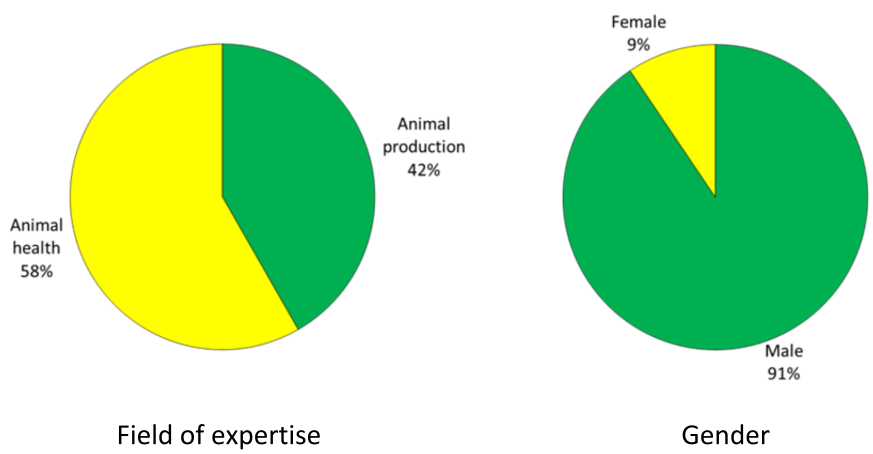


FIG. 13. Frequency of expert missions based on the gender or field of expertise of the expert (n=676 expert missions)

In the case of Latin America, the largest number of trainees came from the Bolivarian Republic of Venezuela (n=25), Chile (22), Peru (21), Mexico (16), Uruguay (14), Argentina (13) Paraguay (11), Dominican Republic and El Salvador (11 each), and Bolivia and Brazil (8 each).

In the case of Asia and the Pacific, the largest number of trainees came from Mongolia (n=16), Thailand (15), Myanmar and Syrian Arab Republic (11 each), and Indonesia (8). In the case of Africa,

the largest number of trainees came from Sudan (10), Tunisia (10) and Zambia (8), while in the case of Europe, Turkey (14), Cyprus (10) and Albania (9).

Only one or two persons from 15 Member States were trained during this period. Out of the 443 fellowships and scientific visits, 37 team members of TC projects were trained twice (2 fellows three times), especially from Latin America (18).

TABLE 21. NUMBER OF TRAINEES ACCORDING TO THE REGION OF ORIGIN

Region	Number of trainees
Asia	89
Europe	44
Africa	113
Latin America	197
Total	443

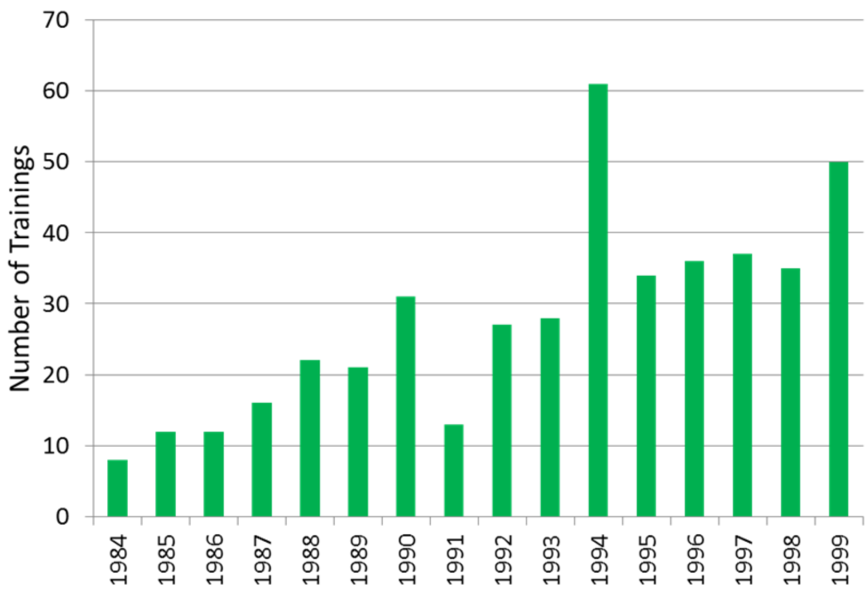


FIG. 14. Number of fellowships and scientific visits per year

The fellowship training periods varied from 0.5 to 22 months; however, most of the trainings lasted for 1 or 3 months (Figure 15). Those fellowships of 12 or more months were awarded between 1984 and 1987. The length of the training period became shorter through the years to accommodate more fellows within the existing budgets of individual TC projects. In the case of scientific visits, most of them lasted for 3 weeks; however, scientific visits of 1 and 2 weeks were common (Figure 15).

The proportion of scientists in TC projects that were trained either in topics related to animal production (mainly nutrition and reproduction) and animal health (disease control and diagnostic) were similar (Figure 16). On the other hand, 70% of the trainees were men and only 30% were women (Figure 16).

European host institutes were more utilized for training, either for fellowships (44%) or for scientific visits (39%). The most popular places were the UK (85 persons trained), France (26), and Germany and Spain (14 each). Host institutions in Latin America were also frequently utilized for fellowship training and North American and Asian host institutes for scientific visits (Figures 17 and 18). For instance, 22 persons were trained in USA, 16 in Australia, and 12 in Canada, while 20 were trained in Costa Rica, 18 in Chile, 14 in Mexico, and 12 in Argentina. On the other hand, APHL in Seibersdorf was by far the institution receiving the largest number of trainees (n=46).

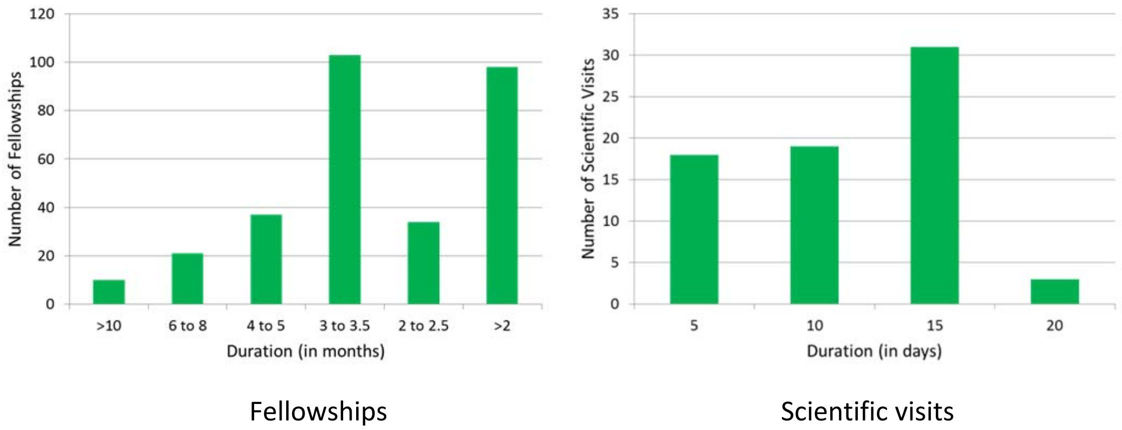


FIG. 15. Duration of the training under fellowships (in months) and scientific visits (in working days)

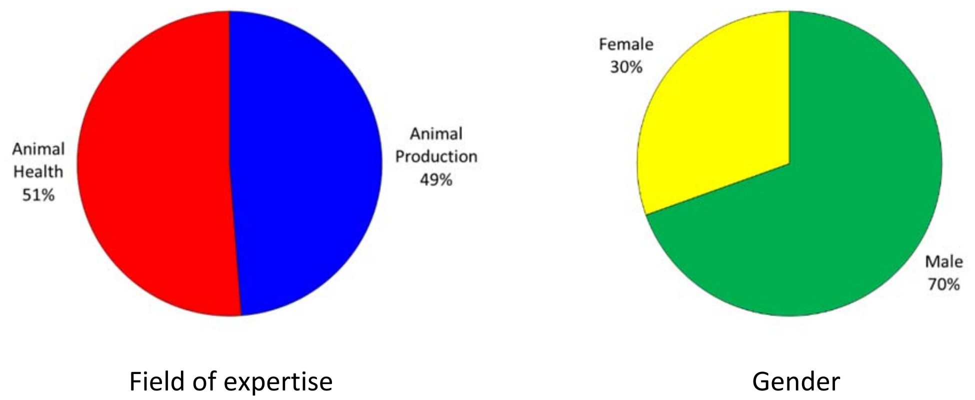


FIG. 16. Distribution of trainings (fellowships and scientific visits) based on the field of expertise and gender of the trainee (n=443)

TC Technical Meetings

Technical meetings within TC projects were uncommon in the early days (e.g. TC VEN/5/011). Nevertheless, project coordination meetings started being implemented in TC regional projects in 1993. These meetings were held at the beginning of the project to define details of work plans, at mid-term of the projects for review progress done and redefine work plans, and at the end of the projects for summarizing activities, work done and achievements. Some projects even had additional meetings during the lifespan of the project (e.g. RAW/5/004, 5 meetings). Also, some meetings were specifically organized as workshops or task force meetings to discuss specific technical topics or actions-to-do.

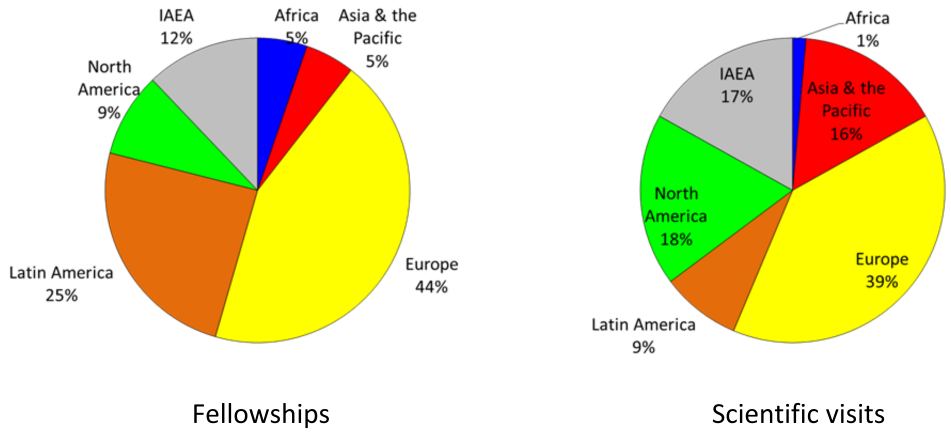


FIG. 17. Geographical distribution of host institutes for fellowship training (n=372) and scientific visits (n=71)

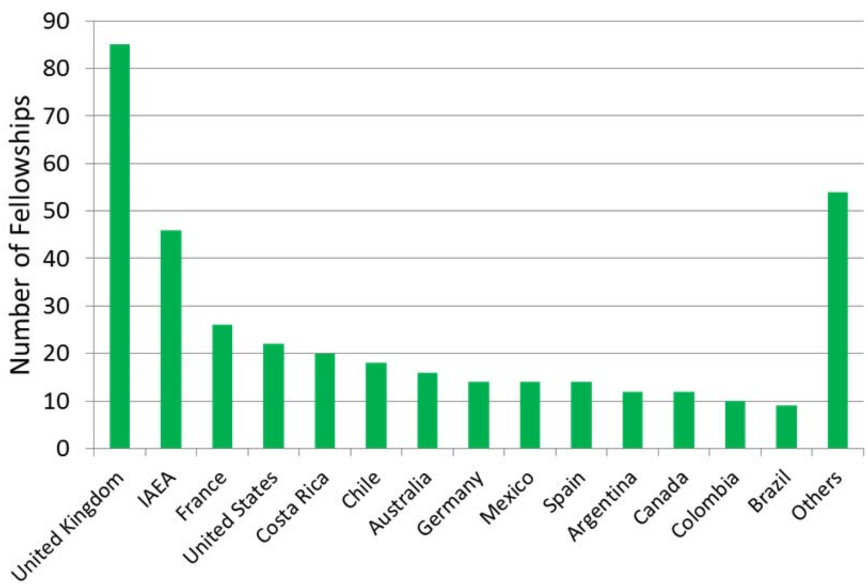


FIG. 18. Most frequent countries for fellowship training (n=372)

In the period 1993–1999, 23 technical meetings were implemented in 22 countries. Generally, these meetings lasted for one week. The average number of participants per meeting was 14, but varied from 5 to 22.

Participants in technical meetings were from 71 Member States. In addition, in all cases, TOs responsible for the projects or one professional staff from APHL participated in these meetings.

ANIMAL PRODUCTION UNIT (APU)

APHL, at that time called the Animal Production Unit (APU), was one of five laboratories within the Agriculture Laboratory at the Seibersdorf Laboratories. In turn, the Agriculture Laboratory was part of the Agency's Laboratories Division within the IAEA's Department of Research and Isotopes. As such, both the Agency's Laboratories Division and the Joint FAO/IAEA Division fall within the same Department. The function of the APU was to provide technical support to the programmes run by APH.

The IAEA Laboratory at Seibersdorf of which the Animal Production and Health Laboratory is one of the eight IAEA laboratories, that supports APH through R&D, training and technical advice to Member States. ***@IAEA***

The Unit was responsible for the standardization of techniques, reagents and protocols, to the development of quality assurance and software support systems and to the provision of assay kits to IAEA projects. The Unit was not producing reagents, but obtaining them from various commercial, government and university laboratories. The Unit was not, in most cases developing techniques but adapting and standardizing them into a kit format in collaboration with partner laboratories. The final primary objective of the Unit was to produce a quality 'kit' with a quality support system. The ultimate measure of the success was the production of reliable research and diagnostic data by counterpart laboratories participating in the projects conducted by APH in developing countries.

A tremendous amount of dedicated work which resulted in field validated kits and manuals, an extended EQC services provided to Member States and capacity building through training courses and individual training to fellows was done by a small group of APH staff with the support of experts,

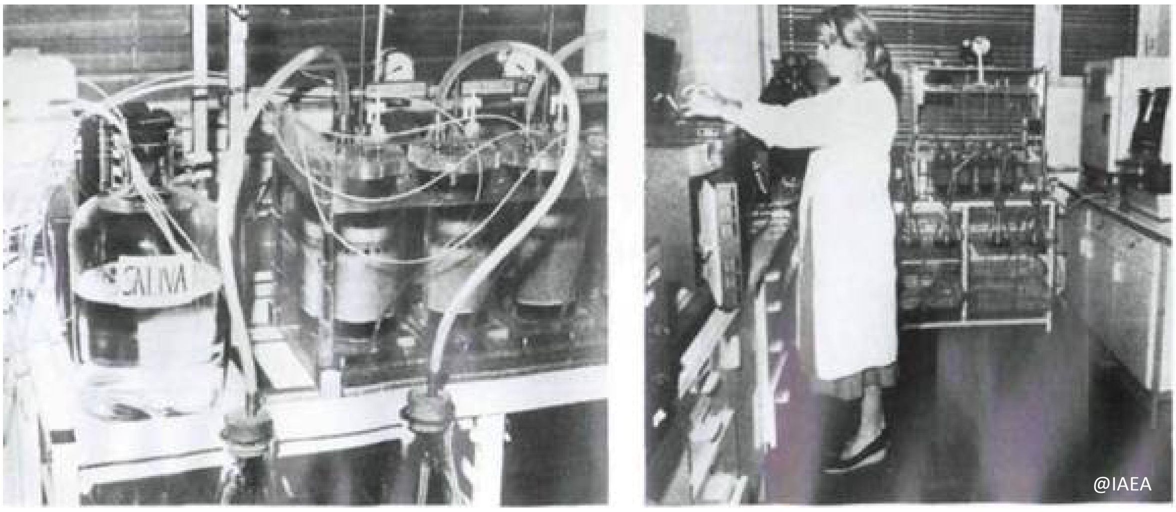
consultants, APOs and JPOs. This group managed to get an invaluable technical support from a large number of international organizations, institutes, universities, research centres and laboratories in developed and developing countries.

APU received three important endorsements in 1992 and 1993. First, the OIE designated the Unit as 'OIE Collaborating Centre for ELISA and Molecular Techniques in Animal Disease Diagnosis', then in early 1993 the IAEA and the FAO recognized the APU as the 'FAO/IAEA Central Laboratory for ELISA and Molecular Techniques in the Animal Disease Diagnosis', and later in the same year WHO designated the APU as its 'Collaborating Centre for ELISA and Molecular Techniques in Zoonoses Diagnosis'. The three designations underscored the commitment of the Unit and its staff to the international development, standardization and validation of laboratory techniques for infectious disease diagnosis.

A short description of the laboratories that were part of the APU and its activities is as follows:

The Ruminant Nutrition Laboratory

This was the first component of APHL to be established. The main activity was related to the rumen simulation technique (RUSITEC), a 4-vessel rumen simulator that allowed the evaluation of fermentation characteristics of fibrous residue-based diets, such as cereal straws, grasses and legume hays. Project counterparts sent their samples for analysis and receive data related to digestibility, production of volatile fatty acids (VFA), and microbial dry matter output.



The 'Rumen Simulation Technique' (RUSITEC), a 4-vessel rumen simulator that allowed the evaluation of fermentation characteristics of fibrous residue-based diets, used at Seibersdorf Laboratories from 1984 to 1990 for the analysis of feed samples sent by Member States

Later on, experiments were carried out on testing various dietary formulations based on urea-treated wheat straw and other sources of concentrates. Also, was shown that the RUSITEC can be used as a source of rumen liquor for the Tilley and Terry digestion studies and therefore using this *in vitro* digestibility analysis instead of using the nylon bag technique in fistulated animals. Two computer programs were developed for calculating *in vitro* digestibility by the Tilley and Terry technique and for calculating forage fibre analysis by the van Soest method.

APH support to RUSITEC ceased in 1990 to focus on field work on the response of animals to various feeding strategies. The immunoassay laboratory somehow took over the facilities and expanded his

activities on the development and validation of RIAs for measuring metabolic hormones (triiodothyronine [T3] and thyroxine [T4]) and on the development and field testing of nutritional metabolites in blood.

The colorimetric-based nutritional metabolite kits were developed and tested in collaboration with Dr Wensing (Utrecht University, Netherlands) and Dr Bamberg (Veterinary University of Vienna). Also, protocols were devised for body condition scoring, weigh-banding and faecal egg counting. The field evaluation of five nutritional metabolite kits (ß-hydroxybutyrate, total protein, albumin, blood urea nitrogen [BUN] and phosphorous) was done in seven laboratories from UK, Netherlands, Chile, Australia, Brazil, Zimbabwe and Norway. These kits and some others for major and trace minerals became available by the end of 1991 for extensive use by 18 laboratories of research contract holders from Asia and Latin America participating in the CRP D3.10.18.

The Immunoassay Laboratory

This laboratory started its operation in 1983 with the goal of developing a progesterone RIA system using iodinated tracer. At the beginning, two liquid-phase progesterone RIA systems were developed and a solid-phase using coated tubes was in the pipeline. Early plans also included developing liquid and solid RIAs for testosterone and 17ß-oestradiol, and an EIA for progesterone in blood. The laboratory was also supplying antisera for progesterone, oestradiol, testosterone and LH, and lyophilized milk and serum standards for progesterone on request.

Types of gamma counters used by project counterparts for the determination of progesterone concentration in milk and blood samples

- *The solid-phase RIA kits for milk and plasma progesterone*

  Solid-phase RIA kits were available to project counterparts in early 1986 after being tested in 12 laboratories across the world. This was a commercial kit (Diagnostic Products Corporation [DPC], USA) with standards and IQC samples prepared by the APU staff. A kit consisted of 100 progesterone antibody-coated tubes, 100 mL of buffered ^{125}I progesterone, progesterone standards in freeze-dried plasma or sodium azide-preserved skim milk, and two IQC samples. Over 250 000 and 400 000 assay units were sent to FAO/IAEA-supported projects in 1987 and 1988 respectively to over 65 projects in 40 Member States. The progesterone RIA kits allowed project counterparts to monitor reproductive status in various livestock species (e.g. cattle, sheep, goat, buffalo, camelids and yaks).

  The FAO/IAEA/DPC kits were initially distributed every second month and years later every third month to all requesting project counterparts, which in some cases were more than 70 laboratories in more than 50 countries per shipment. The reception of kits, the preparation and inclusion of QC samples and standards, and the repacking, labelling and distribution to project counterparts in so many countries by courier demanded a lot of effort and time by staff.

The inclusion of IQC samples in the kit was discontinued in 1990 when the EQC service became well established. Nevertheless, kit users were encouraged and instructed on how to prepare and use their own IQC samples. A revised protocol for the progesterone FAO/IAEA/DPC RIA kit was done in early 1993.

The progesterone RIA kit and related equipment: ^{125}I tracer, milk/plasma standards, QC samples, test tubes and tips, micropipette, single-well gamma counter, and manual. *@IAEA*

DPC changed the antibody and the tracer in 1995 affecting the FAO/IAEA RIA kit protocol. The overnight incubation caused higher maximum binding, e.g. up to 70%, so incubation was finally restricted to 3–4 hours at room temperature. As overall analysis, these kits were highly reliable and simple to use; however, created a dependence on a proprietary product from a single source and the continuous involvement of the Unit. The use of the 'self-coating' progesterone RIA kit was seen to be the best alternative.

- *The 'self-coating' progesterone FAO/IAEA RIA kit*

The initial hybridoma lines producing monoclonal antibodies against progesterone were kindly provided by Dr B. Murphy (University of Saskatchewan, Canada) and by Dr P. Booman (Research Institute for Animal Production 'Schoonoord', Netherlands). These Mab and two other polyclonal antibodies raised in rabbits at the APU were initially used in the development of the 'self-coating' kit. Later, a polyclonal antibody and a Mab developed by Agricultural Biotechnology Center (ABC), Gödöllő, Hungary, were successfully used in the development of the 'self-coating' kit.

The FAO/IAEA 'self-coating' RIA kit for progesterone in milk using the ABC Mab was field tested in 1993–1994 in collaborating laboratories in Colombia, Ethiopia, Mexico, Philippines, Sri Lanka, Viet Nam, USA, Uruguay and Bolivarian Republic of Venezuela, and later on in regional training courses in Brazil, Peru and the United Republic of Tanzania. The kit proved to be as sensitive, specific, reliable and robust as the FAO/IAEA/DPC coated-tube kit. The kit employed standard chemicals and disposables with no 'proprietary' secrets. The kit was distributed in the kit format, however, 'bulk' quantities of the monoclonal antibody could be supplied and other materials (tracer, tubes and buffers) were locally procured by counterparts. The cost per tube was cheaper than the DPC coated-tubes. It was expected that the 'self-coating' kit would enable project counterparts to continue their research work on progesterone determination after the IAEA support on TC projects or research contracts ended.

IAEA RCA Training Workshop on the production of iodinated tracer for self-coating RIA of progesterone, held in Bangkok, Thailand, in 2000

Several hundreds of these kits were used in regional training courses and shipped on regular basis to counterpart institutions in Africa, Asia and Latin America.

- *RIA kits for thyroid hormones and total oestrogen*

  In 1989, the laboratory started the validation of solid-phase non-extraction assays based on ^{125}I for the determination of thyroid hormones (T3 and T4) and the development of a total oestrogen RIA for blood samples of domestic animals (cattle, sheep, goats, camelids, buffalo and horse). The validation process was completed by the end of 1990 and kits were available for distribution to project counterparts in 1991.

  The development of a RIA kit for measuring total oestrogens in blood of ruminants was done with the collaboration of the Veterinary University of Vienna (Austria) and the University of Florida (USA).

- *RIA kit manuals*

  Manuals were prepared for all RIA kits and for the nutritional metabolite kits (Figure 19).

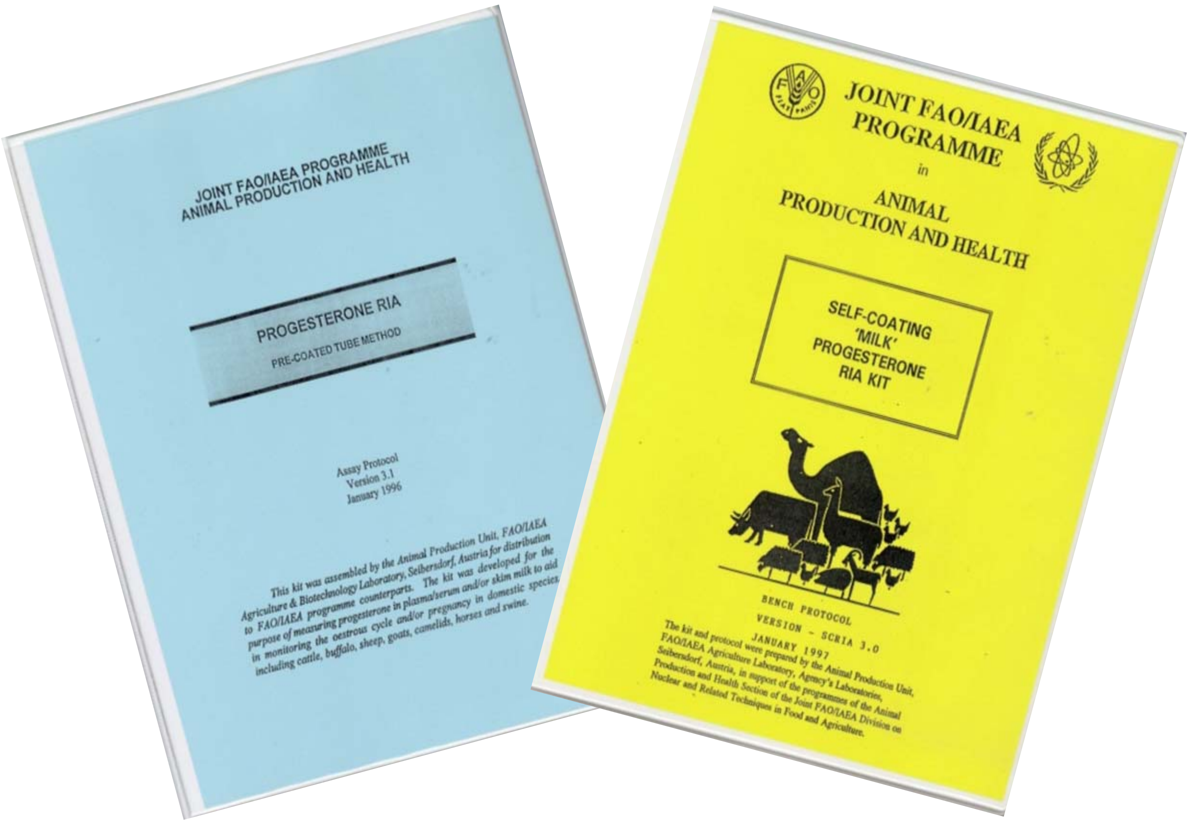


FIG. 19. Front cover of the FAO/IAEA/DPC coated-tube progesterone RIA kit (left) and the FAO/IAEA 'self-coating' progesterone RIA kit (right) manuals

- *The External Quality Control Service*

  The EQC service for RIA kits started in 1988 and was phased out in 2002. EQC samples were included in the kits and users had to report back the assay characteristics and progesterone concentration in the EQC samples. The results showed that these kits performed well under the sometimes difficult conditions found during transport, waiting period in customs and in recipient laboratories.

- *The progesterone EIA*

There were some attempts to develop an EIA for measuring progesterone in blood and milk. The research work started in 1987 with the collaboration of Drs van de Wiel (Netherlands), H. Meyer (FRG) and E. Bamberg (Austria). The field validation for the EIA kit using milk samples was done in 1988–1989 involving 11 selected laboratories in developed and developing countries and results showed high intra-assay variation.

The Disease Diagnosis Laboratory

APHL staff (M. Lelenta in the photo) with the support of experts from qualified laboratories around the world developed, adapted and validated a number of ELISA kits for disease diagnosis. *@IAEA*

In September 1986, an ELISA laboratory for disease diagnosis was implemented. In the early stages contacts were made to obtain antigens and positive and negative sera of various pathogens and procuring commercially available kits for comparison studies. One of the aims was the standardization of kits and the inclusion of all necessary reagents to analyse nearly 40 000 sera per kit; however, later on was decided to reduce the assay units to 20 000 per kit. The only equipment required by kit users was the ELISA reader and a few micropipettes.

Kits were suitable for the diagnosis of rinderpest, brucellosis, babesiosis and infectious bovine rhinotracheitis (IBR). The first kits were dispatched by mid-1987. Also, a general antibovine kit was available, and a kit for the diagnosis of Aujeszky's disease became available in 1988. Initial work on ELISA kits for the detection of antibodies against Newcastle disease virus (Dr Della Porta, Australian Animal Health Laboratory [AAHL], Geelong, Australia), avian infectious bronchitis virus and infectious bursitis virus (Gumboro disease) affecting poultry started in 1990. Collaborative work on the development, adaptation and validation of enzyme immunoassays for the diagnosis of FMD, bluetongue and CBPP started in 1990 in close collaboration with laboratories in the UK, France, Australia and USA.

In addition to the initial work on ELISA kits for disease diagnosis, developmental work was also conducted on radio-labelled DNA probes for antigen detection, monoclonal antibody production and antiserum production. Research done had some drawbacks and was limited for detecting carrier animals of Aujeszky's disease and rinderpest, and for detecting low grade of babesiosis infections. The DNA probe based on Aujeszky's disease was tested at the Uppsala Biomedical Centre (BMC), Uppsala, with the assistance of Dr J. Moreno-Lopez.

In addition, some practical applied research was done on cleaning procedures to allow the re-use of pipette tips and microtitre plates to reduce costs so as to enhance sustainability of the assays.

Several kits for the diagnosis of a number of infectious diseases were eventually developed (Table 22). A short description of the development and testing approaches for the most relevant and used kits are as follows:

- *The rinderpest kit*

The initial rinderpest kit was developed by the Institute for Animal Health (IAH), currently the Pirbright Institute (UK), in collaboration with APH. The kit was used throughout the Pan African Rinderpest Campaign. The kit protocol was improved and a new manual was prepared in 1988 and sent to laboratories in 17 countries. An EQC programme was initiated in 1990. Then, in 1991, a

new c-ELISA for rinderpest was tested by Dr J. Anderson (IAH, Pirbright, UK) aiming to replace the indirect ELISA test being used by PARC. This kit was extensively used for sero-monitoring in the PARC, WAREC and SAREC programmes. Eventually, the kit became commercially available through Biological Diagnostic Supplies Limited (BDSL) in Scotland.

In addition, work was done in collaboration with IEMVT, France (now CIRAD) in the developing and transferring a solid phase immunocapture ELISA kit (ICE) for detecting rinderpest and PPR virus antigens from animal tissues.

TABLE 22. INFECTIOUS ANIMAL DISEASE KITS AND COLLABORATORS

Disease	Test	Participant institution	Participating scientist
Rinderpest	i-ELISA c-ELISA	IAH, UK	J. Anderson
	IC-ELISA	CIRAD, France	G. Libeau
Brucellosis (*B. abortus*)	ELISA	ADRI, Canada CVL, UK	P. Wright K. Nielsen A. Macmillan
Babesiosis	ELISA	CSIRO, Australia	I. Wright D. Waltisbuhl
IBR	Kinetic ELISA	Cornell University, USA	R. Jacobson
Aujeszky's disease	ELISA	BMC, Sweden	J. Moreno-Lopez
FMD	ELISA LPBE ELISA	IAH, UK PANAFTOSA, Brazil	R.P. Kitching
Bluetongue	c-ELISA	ADRI, Canada NVSL, USA	A. Afshar J. Pearson
CBPP	ELISA		
Trypanosomosis (*vivax*, (*congolense*, *brucei*)	ELISA	ILRAD, Kenya CTVM, UK	V. Nantulya A.T. Luckins
Rift Valley Fever	ELISA	WHO USAMRIID	J. Meegan T. Ksiazek
Enzootic bovine leukosis	ELISA	SVA, Sweden	
Porcine pseudorabies	ELISA	SVA, Sweden	
Haemorrhagic septicaemia	ELISA	RVL, Australia	R.B. Johnson
Newcastle	ELISA	AAHL, Australia	T. Della Porta
Calf diarrhoea	ELISA	Moredun Research Institute, UK	

- *The Brucella kit*

The initial kit changed the OPD substrate to ABTS in 1988 after field testing to reduce the high background experienced by several users. Later, the test was compared with other serological tests (e.g. CFT) and was used in a collaborative project in EEC countries under the coordination of the Central Veterinary Laboratory, Weybridge, UK. The contributions of Drs Peter Wright (Animal Diseases Research Institute [ADRI], Quebec, Canada) and Alistair Macmillan (Central Veterinary Laboratory [CVL], Weybridge, UK) in terms of technical advice and reagents were crucial for the enhancements of the test.

Bench work at the Central Veterinary Laboratory in Lilongwe, Malawi searching for harmful pathogens using the ELISA technique

The kit was reformulated after a WHO/FAO/IAEA Working Group meeting in Vienna in 1991 and sent for field validation in 1993 to laboratories in the UK (England and Ireland), Italy, Canada, USA, Argentina, Mali, India and China. The field trial showed that results using the indirect ELISA were equivalent or superior to the Rose Bengal, Buffered plate antigen test [BPA] and CFT, but the specificity was slightly lower than the conventional screening in the testing of vaccinated and non-vaccinated cattle. The OIE Standards Commission designated this test in 1994 as a prescribed test for *Brucella abortus* in cattle; which meant that the test joins the Rose Bengal test, the BPA test and the CFT as 'official' prescribed test for the diagnosis of bovine brucellosis for the purposes of international trade.

The Brucellosis Competitive ELISA using monoclonal antibodies for the differentiation between *Brucella*-infected from *Brucella*-vaccinated animals was evaluated and compared to other OIE prescribed tests in 1995 in five Latin American countries (Argentina, Chile, Colombia, Costa Rica and Cuba) and coordinated by Dr Klaus Nielsen (ADRI, Nepean, Canada) as part of the CRP D3.20.15.

- *The Trypanosoma kit*

The initial steps for developing an ELISA kit for detecting *Trypanosome* antibodies started in 1988 with the collaboration of the International Laboratory for Research on Animal Diseases (ILRAD), Kenya and the CTVM, UK. Facilities for tissue culture procedures were implemented in early 1988, including an animal colony for mice, rats and rabbits, were implemented at Seibersdorf Laboratories.

The kits for the diagnosis of trypanosomosis in cattle and camels were validated in 12 African laboratories in 1989, with the technical support of Drs V. Nantulya (ILRAD) and A.T. Luckins (CTVM, Edinburgh, UK). Again, additional changes in the kit protocol and kit components were done by ILRAD in 1990 and the kit together with an EQC service was ready for distribution by the end of 1990. This kit was validated in 10 research institutes in Africa and appeared mucho more sensitive than conventional diagnostic tests.

The APU established the Cell Culture Laboratory in 1993 and ILRAD supplied three Mab producing hybridoma cell lines. The cell lines produce Mabs against *Trypanosoma congolense*, *T. vivax* and *T. brucei*. Based on these Mabs for both capture and detection of antigen, several modifications were introduced to the original ELISA kit, including IQ controls. The kit was field validated in several African laboratories.

- *The Babesia bovis kit*

Drs David Waltisbuhl and Ian Wright (CSIRO, Long Pocket Laboratories, Indooroopilly, Australia) assisted APU staff in introducing several modifications to the initial kit developed in 1988. It was also expected to include a recombinant DNA product developed at CSIRO in the ELISA test to increase shelf life and freedom from non-specific background reactions.

- *The FMD kit*

The ELISA kit for detecting FMD antigen was developed by Dr R.P. Kitching (IAH, Pirbright, UK) in 1991. The FMD liquid phase blocking ELISA for antibody detection, also developed by IAH was sent for field validation as part of the CRP D3.20.15 to five Latin American countries (Argentina, Brazil, Colombia, Paraguay and the Bolivarian Republic of Venezuela). The IAH and Pan American Centre for Foot and Mouth Disease (PANAFTOSA) sent the biological components of the kit while the APU provided the additional items.

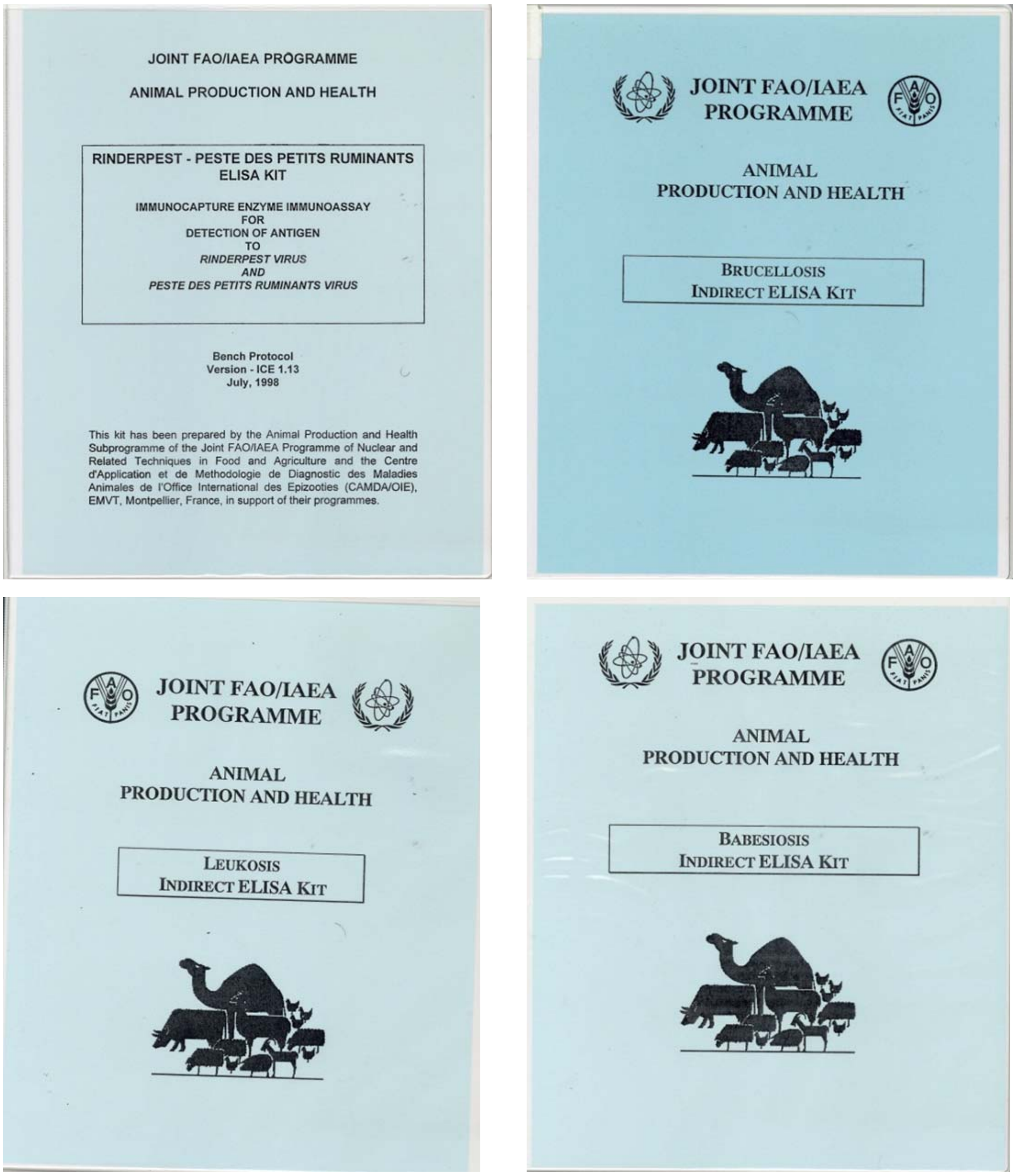


FIG. 20. Front cover of FAO/IAEA ELISA kits for the diagnosis of rinderpest virus, Brucella abortus, enzootic bovine leucosis and babesiosis in cattle

- *The Bluetongue kit*

Modifications in the existing c-ELISA kit for the diagnosis of bluetongue started after a CM held in Vienna in October 1991. Data sent from laboratories in Canada and USA were analysed and

monoclonal reagents from ADRI, Canada, and the National Veterinary Services Laboratories (NVSL), Ames, USA were used. The international standardization and validation of the bluetongue competitive ELISA was completed by 1992 and accepted by the OIE Standards Commission.

ELISA Kit Distribution

The demand of ELISA diagnostic reagents rapidly increased and went beyond the capabilities of the Unit at a very early stage, so priorities were given in 1991 to rinderpest, brucellosis, babesiosis, bluetongue, IBR and enzootic bovine leukosis antibody kits and trypanosomosis and FMD antigen kits.

In 1991 and 1992, the Unit and collaborating laboratories provided nearly 110 kits per year, which was equivalent to approximately 0.6 million test doses per year to counterparts in 75 countries in Africa, Asia, and Latin America. The most frequent kits in 1992 were for the diagnosis of *Brucella* (n=35), rinderpest (28), babesiosis (13), trypanosomosis (13), FMD (7), bovine leukosis (5), IBR (2) and haemorrhagic septicaemia (2).

ELISA Manuals

The kit manuals were continuously improved not only in the description of the kit protocols but also in the presentation (Figure 20). These booklets were prepared in a hard backed ring binder, so individual pages or groups of pages could be easily replaced in later updates.

The EQC Service for FAO/IAEA Progesterone RIA Kits

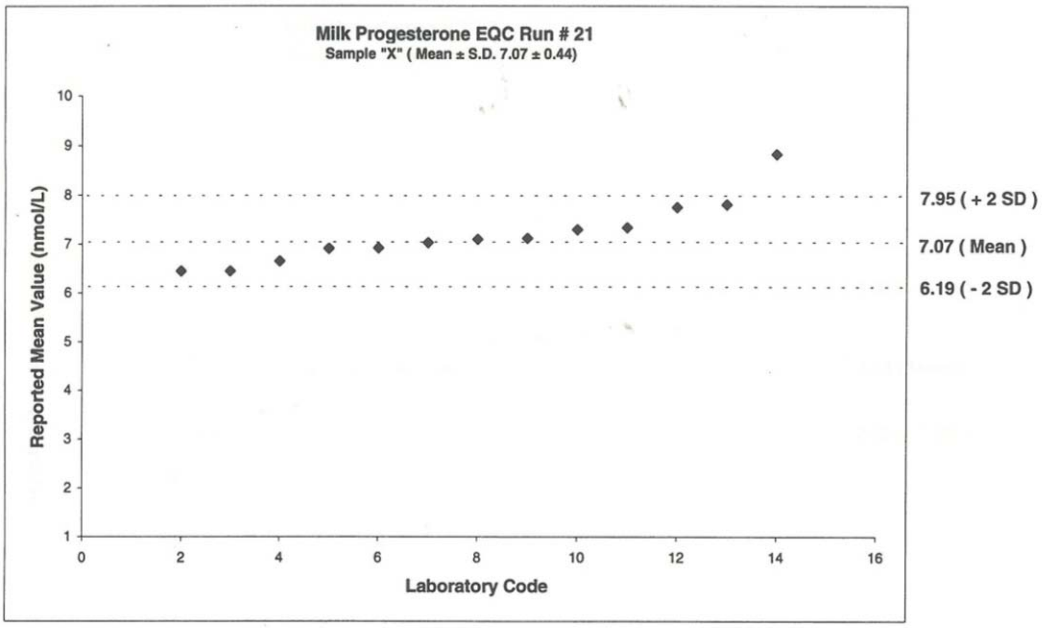


FIG. 21. Example of plotted data from an EQC exercise for the FAO/IAEA RIA Milk Progesterone Kit, showing one 'outlier' laboratory

The EQC service started in 1987. In the first exercise, only 4 of the 29 participating laboratories had outlying results. The response of kit users to EQC exercises decayed to about 60% in 1991–1992 but

recover to more than 90% by 1993. The EQC rounds were sent at least twice a year. By the end of 1999, 22 rounds were sent, data was analysed and reports were timely sent to counterparts (Figure 21).

The EQC sample set consisted of two samples (for skim milk and plasma RIA kit) that kit users had to include in an assay and sent the results back together with other assay data. Assay data and EQC values from laboratories were analysed in an Excel program developed by M. Garcia.

Responding laboratories performed within acceptable international limits and just 5–15% was 'outlier'. This accuracy illustrated the success and reliability of the RIA kit and provided assurance of consistency in the results. Based on the reporting data, users were informed about possible errors (e.g. pipetting, poor binding, aged tracer, computational errors, graphical errors). On the other hand, more errors were found on the clinical/physiological interpretation made by some counterparts than in the running of the test.

Additional QA procedures were also instituted for data interpretation, reproducibility of pipettes and the performance of gamma counters.

Participants of the Regional (AFRA) training course on molecular epidemiology and bioinformatics in TADs surveillance, held in Nairobi, Kenya in 2012

EQC Activities and EQA Programme for FAO/IAEA ELISA Kits

EQC activities for ELISA kits started in 1990 with the rinderpest ELISA kit. Counterparts were requested to analyse the EQC samples and sent back the results and the assay data.

IQC samples were introduced in all FAO/IAEA ELISA kits by 1995 to ensure that each assay was performing within defined limits. The upper and lower control limits for the reactivity of the IQC samples were the best indicators that the ELISA kits were performing well. The problem in the vast majority of cases was related to the laboratory environment (e.g. poor water quality, and improper reagent handling and storage) and not the kits themselves. The procedures for ascertaining such an assurance formed the basis of the External Quality Assurance Programme (EQAP) that was outlined by a panel of experts in a Consultants Meeting held in 1994.

The EQAP started in 1995, again with the rinderpest kit. The first batch included a panel of samples and a questionnaire sent to 23 African laboratories. Additional batches included laboratories involved in the PARC and WAREC network. Similarly, the EQAP programme involved the indirect *Brucella* ELISA kit in 1995, the FMD ELISAs (antibody and antigen detection) and the Trips ELISA in 1996; however, the latter was done only once. The list of EQAP rounds and the number of participating laboratories is shown in Table 23.

The EQAP consisted of a questionnaire to provide information about the participating laboratory, evaluation of the IQC data, and an EQC test panel of five unknown samples which were interpreted by the participating laboratory. After successful completion of two consecutive rounds of the EQAP, the individual laboratory received the FAO/IAEA recognition for their competence in performing the FAO/IAEA ELISA for a specific disease. Moreover, the EQAP assisted Member States in establishing a laboratory quality system and to implement quality standards for all laboratory activities. The EQAP also provided a mechanism for the implementation of improved Good Laboratory Practices (GLP).

The 'recognition' awarded to laboratories was an internal way of recognizing the good performance of laboratories using the FAO/IAEA ELISA kits and was different from the 'certification', 'accreditation' and ' compliance recognition' applied by the International Organization for Standardization (ISO) and other groups.

TABLE 23. IMPLEMENTATION OF THE EXTERNAL QUALITY ASSURANCE PROGRAMME (EQAP) ON FAO/IAEA ELISA KITS FROM 1995 TO 1998

ELISA kit	N.º of participating laboratories				Remarks
	1995	1996	1997	1998	
Rinderpest					
○ Competitive Ab	23	29	29	28	Africa and West Asia
Brucellosis					
○ Indirect Ab	31	35	39	32	Worldwide
FMD					
○ Ag		10		10	South East Asia
○ Ab		10		10	
Trypanosomosis					
○ Ag		16			*T. congolense, vivax, brucei*
○ Ab				6	*T. congolense*

A document entitled *Internal Quality Control (QC) of a Competitive Enzyme-Linked Immunosorbent Assay (c-ELISA) for the Measurement of Antibodies against Rinderpest and Pest de petits ruminants (PPR) Viruses using Charting Methods* was prepared in 1997 to assist kit users.

APU started developing Standard Operating Procedures (SOPs) as part of EQAP in 1995 for every component of laboratory procedures to facilitate the accreditation and international recognition of laboratories in developing countries. The EQAP was in line with the guidelines for a total quality assurance programme for laboratories that was developed by the International Organization for Standardization (ISO), including the ISO Guide 25.

The interregional TC project INT/2/010 ‘Quality Assurance in Analytical/Diagnostic Laboratories’ was implemented in 1997 with the participation of 10 laboratories using RIA for progesterone determination and 10 laboratories using ELISA for animal disease diagnosis to assist them in improving their own quality systems. Workshops on quality assurance, assay validation and kit regionalization were organized in Mexico in 1997 (18 participants) and in Vienna in 1999 (33 participants).

The FAO/IAEA Consultants Meeting on ‘Movement Towards a Generic Veterinary Diagnostic Testing Laboratory Accreditation Scheme’ was held in 1998. The CM evaluated the work done and provided recommendations for future activities.

GPS instruments required for data collection and solid interface with OCs

COMPUTER SOFTWARE PROGRAMS AND GEOGRAPHIC INFORMATION SYSTEMS (GIS)

As part of the technical support to epidemiological capabilities, several computer programs were developed to facilitate ELISA data reading, analysis and interpretation. The support of Wicher Holland, APO funded by the Dutch Government, was fundamental in developing computer-based support packages for various ELISA kits.

ELISA Data Interchange (EDI)

The first GW-Basic program was developed in the early ’90 as a contribution by Agriculture Canada. This was re-writen in-house in 1994 using Clipper (EDI 2.1) to support all indirect and competitive ELISAs for antibody detection as well as the trypanosomosis antigen capture ELISA and the FMD liquid phase blocking ELISA for antibody titration. The ‘beta’ version was sent out to five laboratories for testing. The application had facilities for data acquisition, processing, storage and reports. EDI 2.1.1 included a patch to correct a few ‘bugs’ in the earlier version.

EDI 2.2 was compatible with MS DOS 6.22, corrected for problems related to PC connections to ELISA readers and files handling, and included modules for two additional plate readers. EDI 2.3 worked with most Labsystems/Flow or equivalent microplate reader and was ready for distribution in 1999 (Figure 22). It was a DOS program but could run in a Windows environment using the DOS prompt.

Serum Information Database (SID)

SID 1.0 was based on PANACEA data management. SID 2.0 operated within the PANDA run-time environments. Both versions were developed by PAN Livestock Services Ltd (UK) and focussed on rinderpest. Version 3.0 was field tested in 1995–1996 and modifications fitted the requirements of the Disease and Serological Surveillance database which was part of GREP. SID 3.0 was distributed in 1996 to counterparts participating in the PARC and WAREC networks.

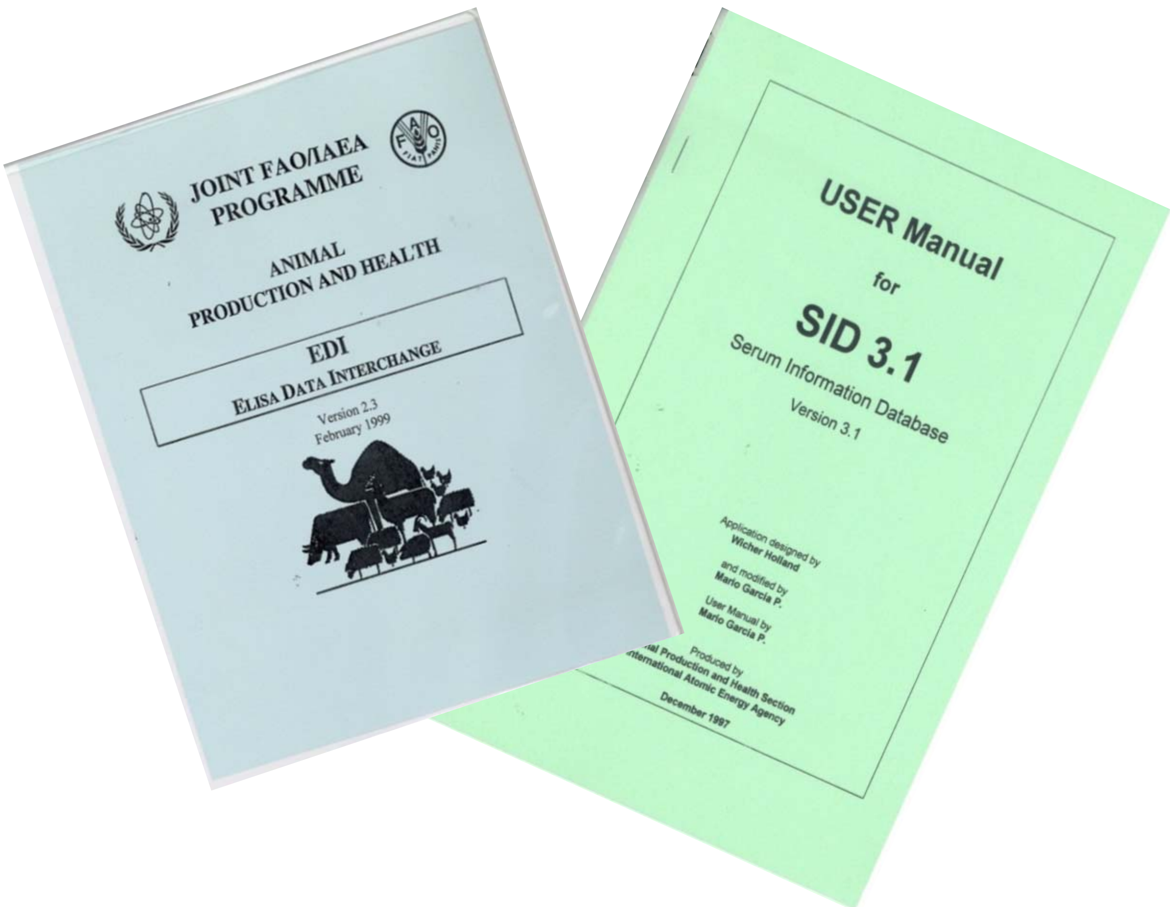


FIG. 22. Front cover of EDI 2.3 and SID 3.1 user manuals

The development of SID for brucellosis was done in 1996 and was distributed to the recipients of the Brucella Indirect and Brucella Competitive ELISA kits. A module for the surveillance of CBPP was developed to benefit CRP D3.20.18 participants.

An updated version of SID (SID 3.1) was available by the end of 1997. The new version was prepared by M Garcia and corrected minor problems and new facilities for serum bank data. It was introduced during the first RCM of the CRP D3.20.16 in Mali (Figure 22).

AIDA (Artificial Insemination Database Application)

The application was developed by M. Garcia in 1994 to assist counterparts of CRP D3.10.20 on data storage and analysis in relation to AI services. The application was based on MS Access using the experience of previous databases created by O. Perera and M. Garcia using dBase III in support of CRPs.

Data of farms, cows, semen, and AI technicians are stored and analysed to serve as a tool to evaluate the quality of the AI Service and to identify constraints that may be hampering animal fertility. Also, it served to correlate progesterone concentrations in milk/blood samples with fertility. This application, after validated by 14 AI service providers in 14 Asian and Latin American countries was available for use by any AI Centre. Years later, two applications were developed based on this one: AIDA Asia and AIDA Africa (see page 133).

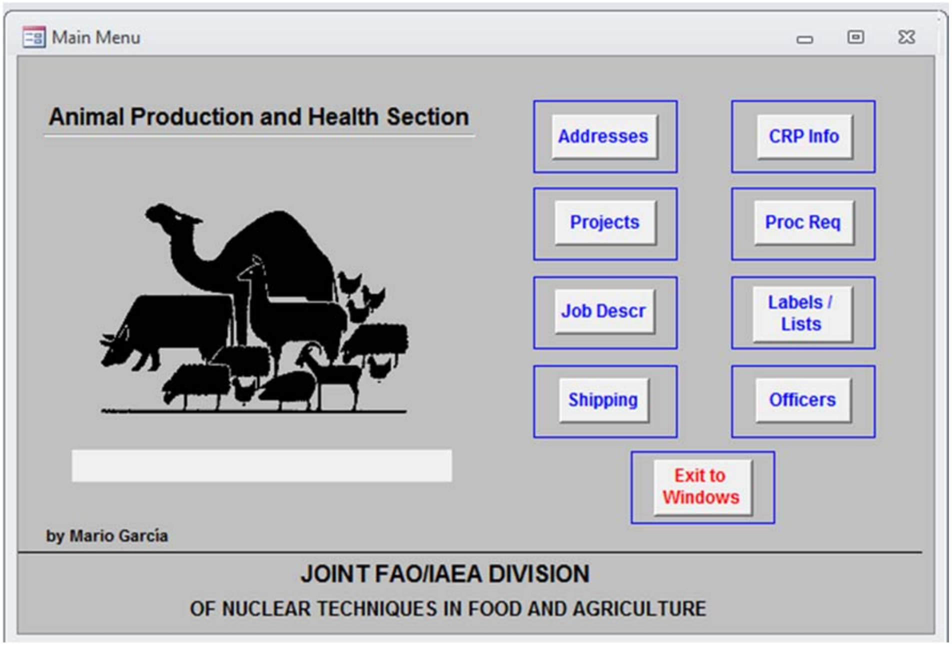


FIG. 23. Screenshot of the Main Menu of the computer application used by the Animal Production and Health Section in support to project management

Animal Production and Health Information Management Application (AIMA)

The application, developed by M. Garcia, assisted APH TOs and secretaries in the management of TC projects and CRPs. APH staff was able to store project data, prepare requests for fellowships, scientific visits, expert services and provision of equipment. In early 1990', TOs had to fill-in TC and

NACA forms and envelope labels using typewriters but APH was the only Section in the IAEA filling and printing forms and labels directly from a computer application.

In a later phase, the application included a module for the APU, so requests for shipping of kits, laboratory equipment and materials, and kit manuals were computerized and linked to the overall management of projects done by TOs at IAEA Headquarters (Figure 23).

This concept was taken by the TC Department and started developing computer applications for the administrative management of TC projects which eventually produce TC Prime and TC Pride.

AIMA was frequently updated and used until 2003 when the IAEA enforced the use of various applications across Sections and Divisions to standardize data storage.

Geographic Information Systems (GIS)

The rapidly increasing human population of sub-Saharan Africa and the population flow from rural to urban areas was creating huge changes in land use which was affecting agricultural activities, including disease distribution patterns. This was especially important for trypanosomosis control and eradication programmes. APH started a project in 1997 using GIS to integrate disease datasets on climate, land cover, tsetse flies, human population and livestock density for selected African countries.

T. Ndegwa was the APO responsible for the project. Data was collected from partner institutions (e.g. United Nations Environment Programme (UNEP), International Livestock Research Institute (ILRI), FAO) and the Tanzanian island of Unguja was selected as the first case study due to the on-going trypanosome eradication programme. A GIS training module was developed under Windows environment using ArcView v. 3.0.

Geo-referenced tsetse and bovine trypanosomosis was included from Cameroon, Uganda, and Ghana in 1998 and from Ethiopia in 1999. Un updated GIS training manual was prepared in 1999 for using ARC/INFO, ArcView for desktop mapping and IDRISI for image analysis and presentation, and several counterparts were trained on the use of these applications. Cartalinx, a spatial Data Builder, was added as companion software to GIS in 1999.

ELISA kits as the Trypanosoma kit allowed project counterparts to detect antibodies of infected animals and therefore, initiate the treatment in the early stage of the disease. ***@IAEA***

PUBLICATIONS

There were 54 publications in the 16-year period (1984–1999), which means 3.4 publications per year; however, the number and type of publications per year was quite variable (Figure 24). Three of these publications contain the proceedings of the three international symposiums held in Vienna by APH (Table 24).

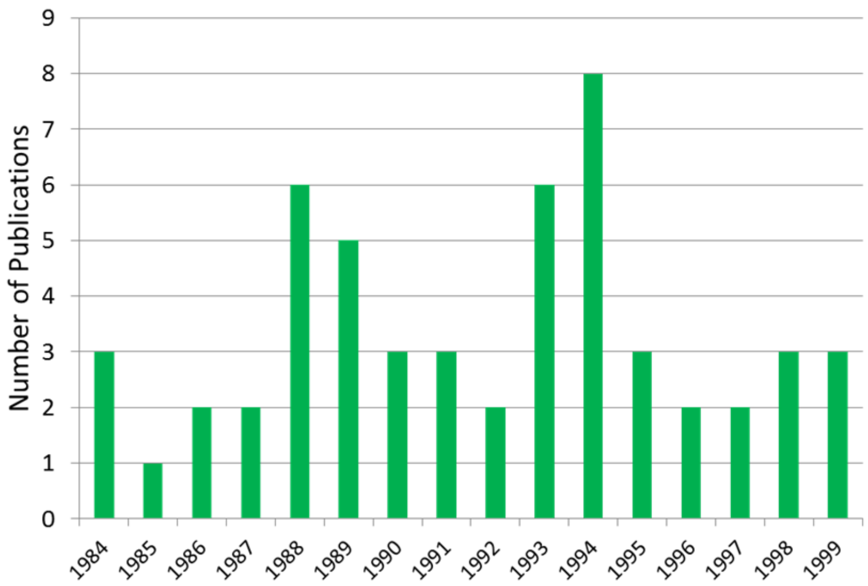


FIG. 24. Number of publications by the Animal Production and Health Section (period 1984–1999)

An important output in this period was the publication in 1999 of 11 papers in an especial issue of the journal Preventive Veterinary Medicine (Table 29), where the TO M. Garcia and the agreement holder William (Bill) Goodger were the guest editors. This publication allowed research contract holders of CRP D3.10.18 to have their papers published in a peer-reviewed journal with a better visibility within the scientific community than the standard IAEA TECDOC.

Literature search was always a difficult task for scientists in developing countries, especially due to the increasing costs of scientific journals. APH in 1987 attempted to overcome part of these difficulties with the assistance of the Vienna International Centre – VIC's Library in providing at 2-month intervals the so called 'Current Awareness Bulletin in Animal Science' which contained the table of contents of nearly 30 journals on animal science matters which were available in the library. By this mean, counterparts were informed of current papers on animal nutrition, reproduction, health, and disease diagnosis and could request reprints directly from the authors or to the VIC's Library. Unfortunately, this assistance was discontinued due to high number of requests and insufficient funds for photocopying and mailing.

Lecture on the use of Quality Control sera by the IAEA Expert, as part of a regional training course, held in Izmir, Turkey in 2012 under the Regional TC Project RER/5/016

A second attempt was done in 1990. The Joint FAO/IAEA Division, the IFS and the Department of Plant Sciences at Oxford University, UK, supported the efforts of Fundación Centro para la Investigación en Sistemas Sostenibles de Producción Agropecuaria (CIPAV) in Colombia to establish and run a computerised journal entitled *Livestock Research for Rural Development*. Any counterpart of a TC project or CRP was eligible to receive free of charge a diskette containing one volume of the journal. Also, they were encouraged to submit their papers to the journal and the TOs of APH volunteered to assist them in reviewing and editing the papers. APH support to the journal and project counterparts lasted for a few years.

TABLE 24. PROCEEDINGS OF INTERNATIONAL SYMPOSIUMS HELD BY THE ANIMAL PRODUCTION AND HEALTH SECTION FROM 1984 TO 1999

Year	Title
1986	Nuclear and related techniques in animal production and health. STI/PUB/717
1991	Isotope and related techniques in animal production and health. STI/PUB/876
1998	Towards livestock disease diagnosis and control in the 21st century. STI/PUB/1023

TABLE 25. LIST OF IAEA PUBLICATIONS IN THE FIELD OF ANIMAL PRODUCTION FROM 1984 TO 1999

Year	Title
1984	The use of nuclear techniques to improve domestic buffalo production in Asia. STI/PUB/684
1984	Laboratory training manual on radio-immunoassay in animal reproduction. STI/DOC/10/233
1994	Strengthening research on animal reproduction and disease diagnosis in Asia through the application of immunoassay techniques. IAEA-TECDOC-736
1985	Laboratory training manual on the use of nuclear techniques in animal nutrition. IAEA Technical Reports Series 248
1986	Nuclear and related techniques for improving productivity of indigenous animals in harsh environments. STI/PUB/725
1987	Isotope aided studies on non-protein nitrogen and agro-industrial by-products utilisation by ruminants. STI/PUB/748
1988	Nuclear techniques in the study and control of parasitic diseases of livestock. STI/PUB/792
1988	Isotope aided studies on livestock productivity in Mediterranean and north African countries. STI/PUB/778
1989	Feeding strategies for improving productivity of ruminant livestock in developing countries. STI/PUB/823
1990	Livestock reproduction in Latin America. STI/PUB/833
1990	Domestic buffalo production in Asia. STI/PUB/855
1990	Studies on the reproductive efficiency of cattle using radioimmunoassay techniques. STI/PUB/829
1991	Isotope aided studies on sheep and goat production in the tropics. STI/PUB/860
1992	Manual on measurement of methane and nitrous oxide emissions from agriculture. IAEA-TECDOC-674
1993	Improving the productivity of indigenous African livestock. IAEA-TECDOC-708
1993	Feeding strategies for improving ruminant productivity in areas of fluctuating nutrient supply. IAEA-TECDOC-691
1997	Estimation of rumen microbial protein production from purine derivatives in urine. IAEA-TECDOC-945
1999	Development of feed supplementation strategies for improving the productivity of dairy cattle on smallholder farms in Africa. IAEA-TECDOC-1102
1999	Nuclear based technologies for estimating microbial protein supply in ruminant livestock. IAEA-TECDOC-1093

There were 19 and 9 IAEA publications (STI/PUB, STI/DOC, TEC-DOC) in the field of animal production (Table 25) and animal health (Table 26) respectively. These publications are referred to the proceedings of CRPs, recommendations of experts from consultants meetings and descriptions of nuclear and nuclear-related techniques. Most of them are no longer available for purchase and are not in electronic format but can be obtained on loan from the IAEA Library.

Six manuals for the use of FAO/IAEA progesterone RIA and nutritional metabolite kits were prepared (Table 27). Similarly, eight manuals for the diagnosis of various diseases by the use of ELISA kits were also available (Table 28). These manuals were regularly updated and distributed to project counterparts together with the respective kits through TC projects, research contracts in CRPs and training courses. Moreover, three other publications were internally prepared on ELISA technology and on guidelines for rinderpest sero-monitoring (Table 28), and two manuals for using IAEA computer applications in support of the use of ELISA Kits.

TABLE 26. LIST OF IAEA PUBLICATIONS IN THE FIELD OF ANIMAL HEALTH FROM 1984 TO 1999

Year	Title
1984	Nuclear techniques in tropical animal diseases and nutritional disorders. STI/PUB/675
1991	The sero-monitoring of rinderpest throughout Africa (Phase one). IAEA-TECDOC-623
1992	Regional network for Latin America on animal disease diagnosis using immunoassay and labelled DNA probe techniques. IAEA-TECDOC-657
1993	Improving the diagnosis and control of trypanosomosis and other vector-borne diseases of African livestock using immunoassay methods. IAEA-TECDOC-707
1994	Strengthening research on animal reproduction and disease diagnosis in Asia through the application of immunoassay techniques. IAEA-TECDOC-736
1994	The sero-monitoring of rinderpest throughout Africa: Phase II, Results for 1993. IAEA-TECDOC-772
1994	Recommended procedures for the disease and serological surveillance as part of the Global Rinderpest Eradication Programme (GREP). IAEA-TECDOC-747
1997	Application of an immunoassay method to improve the diagnosis and control of African trypanosomosis. IAEA-TECDOC-925
1998	Diagnosis and epidemiology of animal diseases in Latin America. IAEA-TECDOC-1055

TABLE 27. LIST OF MANUALS AND GUIDELINES IN THE FIELD OF ANIMAL PRODUCTION FROM 1984 TO 1999

Year	Manual
1989	Manual for enzyme immunoassay kits for milk and plasma progesterone
1989	Analytical techniques for characterizing ruminant feedstuffs
1993	Manual for progesterone RIA kit, Assay protocol, V. 2.0
1994	Manual of self-coating milk progesterone RIA kit
1994	Manual of nutritional metabolite kit protocols
1999	Manual of Self-coating "plasma" Progesterone Radioimmunoassay (RIA)

TABLE 28. LIST OF MANUALS AND GUIDELINES IN THE FIELD OF ANIMAL HEALTH FROM 1984 TO 1999

Year	Manuals and guidelines
1988	Guidelines for sero-monitoring of cattle conducted by PARC
1988	Use of Enzyme-linked Immunosorbent Assay (ELISA) in animal disease diagnosis
1993	Manual for rinderpest ELISA kit - competitive enzyme immunoassay for detection of antibody to rinderpest virus - Bench protocol. V. RPV 1.3
1993	Manual for babesiosis indirect ELISA kit, Bench protocol. V. BBO 2.1
1994	Manual for foot & mouth disease indirect sandwich ELISA kit, Bench protocol. V. FMDAB 1.0
1994	Manual for brucellosis indirect ELISA kit, Bench protocol. V. BRA 1.3
1995	Manual for rinderpest ELISA kit - Immunocapture enzyme immunoassay for detection of antigen to rinderpest virus and peste des petits ruminants. Bench protocol. V. ICE 1.1
1995	Manual for leucosis indirect ELISA kit. Bench protocol. V. BLV 1.02
1996	Manual for trypanosomosis - Direct antigen ELISA kit. Bench protocol. V. TRP 1.3.
1996	Manual for foot-and-mouth disease ELISA kit. Liquid phase blocking EIA. Bench protocol. V. FMDAB 1.0
1997	User Manual for SID 3.1 – Serum Information Database, version 3.1
1998	The sero-monitoring of rinderpest throughout Africa. Phase III. Results for 1997
1999	User Manual: EDI – ELISA Database Interchange, version 2.3

TABLE 29. LIST OF PUBLICATIONS AUTHORED BY THE STAFF OF THE ANIMAL PRODUCTION AND HEALTH SECTION FROM 1984 TO 1999

Year	Publication
1987	Jayasuriya MCN, Hamilton R, Rogovic B. The use of artificial rumen to assess low quality fibrous feeds. Biol Waste 20: 241-250
1988	Jayasuriya MCN, Hamilton R, Sileshi Z, Jule D. The fermentation characteristics of botanical fractions of rice straw in an artificial rumen. Biol Waste 25: 303-307
1988	Jayasuriya MCN, Hamilton R, Uriyapongson DL Eskew. Fermentation of straw-based diets containing azolla (*Azolla caroliniana* Willd) using the Rumen simulation technique (RUSITEC). Biol Waste 24: 213-226
1989	Owen E, Jayasuriya MCN. Use of crop residues as animal feeds in developing countries. Res Dev Agric 6(3): 129-138
1989	Jalc D, Jayasuriya MCN, Hamilton R. The fermentation characteristics of diets containing acid-treated beech-sawdust in an artificial rumen. Biol Waste 30: 289-300
1994	Jeggo M, Geiger R, Dargie JD. Supporting African campaign against rinderpest. IAEA Bull. 36(3): 48-55
1995	Garcia M, Jayasuriya MCN, Perera BMAP. Improving animal productivity by nuclear techniques. IAEA Yearbook
1999	Garcia M, Goodger W. Development of supplementation strategies for milk-producing animals in tropical and sub-tropical environments. Prev Vet Med 38(2-3). *Special Issue*

Scientific publications in international journals were not much encouraged and therefore few publications were done (Table 29). Basically, most of them were published in 1987–1989 by N. Jayasuriya and his team in APHL on the use of the artificial rumen simulator technique (RUSITEC). Two other technical publications were printed on IAEA magazines (IAEA Bulletin and IAEA Yearbook).

Introducing Biotechnology and Gene-Based Technologies
(Phase 3: 2000 – 2014)

PROGRAMME OF WORK

Over the past twenty years the focus of APH assistance to Member States was on the establishment and application of simple and robust nuclear and related technologies to obtain answers to crucial problems facing livestock producers. These included the use of isotopic tracers and assays for feed quality and nutritional status to develop feeding strategies, RIA for progesterone measurement together with clinical methods and data management tools to improve breeding and reproduction, and the use of ELISA for diagnosing and controlling infectious diseases. These methods were adapted, standardized and proven through CRPs and subsequently transferred, established and applied on a wider scale through TC projects. Their relevance, utility and value were clearly evident from the results and reports of project counterparts. The technical results accumulated from previous years placed APH as one of the major international contributors towards the improvement of livestock productivity and livelihood of the rural community as well as in food security.

Notwithstanding, the Joint FAO/IAEA Division and APH started considering that these technologies were mature enough and that the trained personnel and resources available in developing Member States should be capable of sustaining them. Therefore, a number of actions were taken for 1 to 3 years to assist counterpart institutions to achieve the capability of using these 'mature' technologies even after the conclusion of FAO and IAEA support. For example, some of the reagents for RIA and ELISA started being produced in regional centres within the developing world and several laboratories were capable of making their own standards and quality control samples. The switch in direction was also facilitated for the turnover of staff that brought new 'brains' to the Section.

A prototype of a mobile laboratory device based on the LAMP technique for the early and rapid diagnosis of various infection diseases tested in Zanzibar, United Republic of Tanzania, in 2010

The reduction in R&D or phasing out some of the 'mature' technologies freed up some of the resources available within the Section that were moved to supporting studies on newly emerging areas that have the potential for future applications. In reviewing the current trends in livestock research in the more advanced countries, it became clear that biotechnology was very much at the forefront. In fact, the Governments of many developing countries were including biotechnology as an important component in their agenda for improving the

agricultural sector. In the livestock sphere, the advances made in genomics and the ability to manipulate genes and their expression, whether it is in animals, fodder plants or microbes, were a suitable avenue to go for improving livestock production.

These technologies were being developed and quickly adopted in the developed world creating wider gaps between the developed and developing world. Therefore, there was on obvious need for the technologies to be tested, selected and suitably adapted to meet specific needs of developing countries. This situation was somehow how APH was around 1985 when the Section moved into the young at that time RIA and ELISA techniques.

APH staff, lecturers and trainees of the regional training course on advanced molecular genetic tools, held at Seibersdorf Laboratories in 2013 (TC project RAS/5/063)

The specific biotechnological methods that would have the greatest potential for livestock production and health in developing countries, and which of these would require nuclear and related techniques were discussed and highlighted during a consultants meeting held in 2001. These concepts were also discussed with FAO, ILRI and other partners which resulted in focusing APH specific activities into those that FAO considered more relevant of support to Member States. The transition of the new technologies were facilitated by a series of activities such as the FAO/IAEA International Symposium on 'Applications of Gene Based Technologies for Improving Animal Production and Health in Developing Countries' held in Vienna in 2003, followed by three interregional training courses held during 2004 and 2005 to train scientists from developing countries on the molecular techniques currently being used in the fields of animal nutrition, genetics and disease diagnosis. Besides, three new CRPs were initiated during 2003–2006, dealing with (a) rumen molecular techniques for predicting and enhancing productivity; (b) characterization of small ruminant genetic resources aimed at selection for parasite resistance; and (c) validation of a PCR technique for the rapid diagnosis of Rift Valley Fever (RVF). Nevertheless, support to RIA and ELISA continued through TC projects.

In this period, the Section showed a trend to join two pillars of the APH programme i.e., nutrition and reproduction, into one named animal production, and moreover, adding the area of breeding to cope with DNA technologies. Besides, the veterinary drug residue testing was introduced as a new area of activity. This was emphasized during the midterm performance evaluation of APH activities where current and future activities were discussed and focused:

- Animal Production: The characterization of locally available feed and animal genetic resources and the identification and alleviation of constraints in the management of feeding, breeding and reproduction for improve the efficiency of livestock production while conserving the environment. This was done through R&D and through the transfer of the following technologies:
  - *RIAs for measuring hormones:* for identifying and mitigating constraints to efficient livestock production and improving the delivery of national artificial insemination services and providing diagnostic services to farmers.
  - *Radiolabelled and stable isotope-based feed evaluation systems:* for developing effective feed supplementation strategies using locally available feed resources, particularly those that do not compete with human food.
  - *Radiolabelled hybridization, PCR, gene expression and other molecular methods:* for characterizing rumen microbial ecology to develop and implement strategies to decrease environmental pollution from gases and excretions from livestock and for characterizing small ruminant genetic resources; also for identifying quantitative trait loci, microsatellites and genes for disease resistance and productive traits.

- Animal Health: The assessment and reduction of risk to livestock by effective diagnosis and monitoring of transboundary animal diseases and zoonoses and their use in national and international control and eradication programmes, through:
  - *Immunoassays (such as ELISAs), molecular and PCR diagnostics and other molecular techniques:* for the development, standardization and validation of veterinary diagnostic test procedures to improve national and international trade and the control of livestock diseases to improve the livelihood of the informal or small-scale farming community.
  - *Establishment of quality systems related to nuclear and non-nuclear disease diagnosis and monitoring methods*: for the development, standardization and validation of reagents and kits, the development of standard operating procedures and guidelines for their use, to establish quality assured disease control measures and to transfer technology and knowledge for use in veterinary diagnostic laboratories.
- Veterinary Drug Residue Testing: The assessment and reduction of risks to livestock products by effective screening and quantification of veterinary drug residues in animal products and promoting safety of foods, through:
  - *RIAs for measuring veterinary drug residues:* to promote safety of food of animal origin and to meet international requirements for their trade.
  - *Establishment of quality systems related to nuclear and non-nuclear methodologies:* to determine veterinary drug residues in veterinary drug laboratories.

The above activities have been complemented by tools developed for computerized data management in disease diagnosis and animal production; use of geographic information systems in management of farm resources and diseases; and distance learning through information communication technologies in the related areas.

STAFF

The IAEA 5–7 year rotation policy for TOs continued as in the previous phases (Table 30).

M. Jeggo led the APH Section until 2002 when he completed his 7-year term, the turnover policy that affects most professional staff that is not in possession of a long-term contract. Martyn, as well as Jim, despite of their background in animal health, kept a well-balanced distribution of activities among the three major pillars of the Section. However, the new wave of gene-based and molecular technologies, changes in FAO on livestock R&D priorities and requests from Member States on new areas of research urged him and his successor to strategically modify the research path of the Section.

G. Viljoen took over as Section Head in 2003 and continues in this position until date of publication. Gerrit brought the South African flavour (and the rooibos tea) to APH. He was the Assistant Director and Head of the Applied Biotechnology Division at the Onderstepoort Veterinary Institute, Pretoria before joining the IAEA. His strong interest in facilitating expertise and disease diagnostic tools to Member States has allowed the strengthening and expansion of national disease diagnostic laboratories in many developing countries and the establishment of a laboratory network in Africa. As a result, many of these laboratories trust on their own results without the need to send samples to reference laboratories for confirmation. Under his leadership, APH

Participants of a Task Force Meeting under the Regional TC project RAF/5/046 in Nakuru, Kenya in 2002

organized one successful international symposium on 'Sustainable Improvement of Animal Production and Health' in 2009 and a Scientific Forum on 'Food for the Future: Meeting the Challenges with Nuclear Applications' in 2012 among many other international scientific events.

TABLE 30. PROFESSIONAL STAFF IN THE ANIMAL PRODUCTION AND HEALTH SECTION DURING THE PERIOD OF 2000 TO JUNE 2014

Position	Staff	Country	Years in duty	
Section Head	Jeggo, Martyn	UK	1995	2002
	Perera, Oswin[a]	Sri Lanka	2002	2003
	Viljoen, Gerrit	South Africa	2003	DP[b]
United Head	Garcia, Mario[a]	Peru	2000	2000
	Diallo, Adama[c]	Mali	2000	2007
			2009	2014
Technical Officer	Dwinger, Ron	Netherlands	1995	2000
	Colling, Axel	Germany	1997	2002
	Perera, Oswin	Sri Lanka	1997	2004
	Crowther, John	UK	1995	2009
	Makkar, Harinder	India	1998	2005
	Cannavan, Andrew	Ireland	2001	2004
	Garcia, Fernando	Brazil	2003	2005
	Boettcher, Paul	USA	2005	2008
	Unger, Hermann	Germany	2005	DP
	Malek, Massoud	Canada	2006	2011
	Odongo, Nicholas	Kenya	2008	2013
	Naletoski, Ivancho	Macedonia	2010	DP
	Periasamy, Kathiravan	India	2011	DP
	Shamsuddin, Mohammed	Bangladesh	2012	DP
	Lamien, Charles	Burkina Faso	2013	DP

[a] Acting Head
[b] Date of publication
[c] Two periods

A. Diallo became the Unit Head of APHL in 2000 to lead the changes in the laboratory activities and future support to CRPs and TC projects. Adama's level of expertise in rinderpest and PPR research as well as in PCR and related technologies paved the road of the laboratory transition into molecular technologies. Activities related to R&D of nutritional metabolite kits and progesterone RIA assays, including the EQA programme on progesterone RIA were phased out and the laboratory space was reconverted into a DNA laboratory where modern equipment was installed to undertake studies on gene expression and sequencing. Adama was quite keen in attracting and obtaining extrabudgetary funds from various external donors which provided good opportunities for hiring consultants and experts to support the laboratory work and for implementing regional and interregional training courses, mainly on disease diagnostics, especially for the African region. Adama briefly left the IAEA in 2007 moving to FAO in Rome and came back for a second term in 2009.

O. Perera had an excellent understanding of multiple livestock production systems, where each species, feeding system, geographical area, and farmer's traditions influences the way animals are reared. His knowledge and expertise not only benefited the output of projects in the animal production field, but also his kind involvement with project counterparts, his gentle dedication to complete the tasks on hand including his spotless desk showed the way to other officers on how to manage research and development projects in developing countries. His work load during the last two years in the

Section were more complicated as he was acting as Section Head filling the gap after Martyn left and before Gerrit joined the team.

I was the project counterpart of a Mexican TC project when I became agreement holder of a CRP in Latin America. This dual function allowed me to expand my research endeavours in Mexico but also to share knowledge with my peers in Latin America, particularly in Costa Rica, Colombia and Uruguay, and these professional liaisons are current, even today. I spent a few months at the IAEA Headquarters in 1990 to replace Wyn Richards where I had the opportunity to increase my professional connections with colleagues in Brazil, Bolivia and Peru, forming a networking system which at least in my case, I have fond memories. Later on, I served as a "bridge of knowledge" between Latin America, Asia and Africa conducting several expert missions while strengthening my relation with IFS. After several years of international assignments I could verify that the transfer of knowledge should be preferentially south-south. Unfortunately this premise so much publicized in essence is very poorly implemented.

Carlos Galina, IAEA Expert, Mexico

J. Crowther, as indicated earlier, joined APH in 1995 as FAO staff and stayed until his retirement in 2009. John was responsible for the introduction of ELISA platforms in Member States through TC projects and training courses.

H. Makkar is a molecular microbiologist born in India. He joined APH from the Centre of Agriculture in the Tropics and Subtropics, University of Hohenheim, Stuttgart, Germany. Harinder is a non-stop writer of scientific papers and books, and this was clearly shown during his stay in Vienna. As a scientist, he was very keen in developing and validating laboratory techniques and methodologies for estimating microbial protein supply in ruminants using purine derivatives. Also, his research and major activities in CRPs and TC projects were focussed on the measurement of tannins in trees and plants and on the use of tanniniferous tree foliage for feeding ruminants. He was honored with Honorary Professorship by universities in China and Mongolia. He is currently working at the Animal Production and Health Division of FAO in Rome.

A. Cannavan has a vast experience in testing and analysing residues that can be found in livestock products. He took over the existing projects in this field, initiated the CRP on 'Development of Strategies for the Effective Monitoring of Veterinary Drugs Residues in Livestock and Livestock Products in developing Countries' (D3.20.22) and implemented a series of interregional training courses with the financial support of FAO on the screening and confirmatory methodologies for veterinary drug residues. He left APH in 2004 to take over the position of Unit Head of the Agrochemicals Unit at Seibersdorf were he continued backstopping these projects.

F. Garcia came from the São Paulo State University (UNESP), Aracatuba, Brazil and joined the Seibersdorf team for three years. The genetic laboratory was implemented under his technical support, the CRP on genetic characterization of small ruminant breeds in Asia (D3.10.25) was initiated under his command, and several fellows were trained in the laboratory under his guidance. His laboratory in Brazil is part of the IAEA Collaborating Centre in 'Animal Genomics and Bioinformatics'.

Participants of a TC RAF/5/046 Training Workshop held in Entebe, Uganda in 2000

P. Boettcher, geneticist from USA, was working at the Institute of Biology and Biotechnology in Agriculture in Italy on the development and application of statistical approaches to the analysis of genetic traits in both livestock and humans, with an emphasis on traits related to health. He took over the supervision of the CRP on genetic characterization of small ruminant breeds in Asia as well as TC projects in animal reproduction. Paul

left the APH Section to take a position at FAO on the Livestock and Genetic Resources Section. Close cooperation between Paul and APH exists until today.

H. Unger initiated his involvement with APH as a German APO in 1986 where he spent three years in Seibersdorf. He undertook several IAEA expert missions for TC projects in Africa and worked several years for a Gesellschaft für Technische Zusammenarbeit (GTZ) project in Cameroon before becoming a TO. His vast expertise in diseases diagnostic tests includes diseases such as trypanosomosis, rinderpest, FMD and CBPP, the use of tissue culture-based diagnostic tests and the establishment of animal models to study immunological aspects following influenza and RVF infections. He has adapted and validated a prototype of a mobile laboratory apparatus for the early and rapid diagnosis of various infection diseases (PPR, Newcastle disease, Avian Influenza H5N1, FMD, CBPP) based on the Loop Mediated Isothermal Amplification technique (LAMP-PCR). His skills and interest on electrical/mechanical machines, tools and gadgets has been an added value to his scientific expertise in solving and helping project counterparts in installing and repairing scientific equipment.

M. Massoud continued the work initiated by Fernando in the laboratory. His expertise in both statistical/quantitative and molecular genetics was applied on the on-going projects on molecular and quantitative genetics. He initiated the animal gene-bank at Seibersdorf collecting DNA material provided by project counterparts and trainees from cattle, small ruminants and alpacas. He assisted in the preparation of the initial proposal for the CRP on 'Genetic Variation on the Control of Resistance to Infectious Diseases in Small Ruminants for Improving Animal Productivity' which was later fine-tuned during a Consultants Meeting.

Project counterpart of TC project ANG/5/010 with extension officers and a farmer on Wako-Kungo, Angola

N. Odongo, livestock nutritionist, is a Canadian citizen born in Kenya. He was a visiting scientist at Agriculture and Agri-Food Canada, in Alberta, Canada before joining the IAEA for five years. His expertise on animal nutrition and utilization of feed resources for improving livestock productivity was widely applied in the on-going CRPs and TC projects. His efforts on the use of fibrous forages to feed ruminants while reducing greenhouse gas emissions from livestock were quite successful and several papers have been published in scientific journals by him and his research contract holders, including a special issue at the Animal Nutrition and Feed Technology journal (*Exogenous enzymes in animal nutrition — Benefits and limitations*) in 2013.

I. Naletoski, the former head of the Serological and Molecular Diagnosis Laboratory of the Faculty of Veterinary Medicine, Saints Cyril and Methodius University of Skopje, Macedonia, joined the APH team in 2010 as FAO staff member. He brought to the Section his expertise in the control of animal diseases, in particular the development and use of molecular and serological tools for the study, diagnosis and epidemiology of livestock diseases. He is involved in the use of stable isotopes to trace bird migrations in relation to the epidemiology of avian influenza. He received an IAEA Team Award for his participation in a multidisciplinary team for the monitoring of radioactive food contamination after the Fukushima Daiichi accident in Japan, where he developed a compact data-collection and data-reporting system that was approved and used for further analysis by UNSCEAR.

K. Periasamy, geneticist born in India, has first-hand knowledge of molecular techniques for the identification of genetic markers and on bioinformatic software for gene-related data analysis. He has a vast experience on the genetic characterization of livestock genetic resources, including large-scale gene expression profiling of livestock tissues of economic importance using microarray technology. He has re-structured the genetic laboratory and the livestock gene-bank in Seibersdorf, and based on

that, he has been able to supervise individual training and organize training courses on genetic characterization of indigenous livestock breeds using DNA markers.

M. Shamsuddin is the latest TO on board. Mohammed has first-hand experience on nuclear techniques for studying reproductive physiology of large and small ruminants, for identifying limiting factors affecting reproductive efficiency and productivity and for testing and validating remedial procedures under small farmer conditions in developing countries. He led a national and successful project in Bangladesh for delivering veterinary services to smallholder dairy farms called the Community-based Dairy Veterinary Services (CDVS). His expertise on artificial insemination and reproductive biotechnology in large and small ruminants is being efficiently utilized in a large number of TC projects dealing with artificial insemination in both cattle and small ruminants.

C. Lamien, molecular biologist from Burkina Faso joined APHL as a consultant in 2006 and then became a TO under the FAO umbrella in 2013. He is responsible for the development of e-learning modules, including interpreting phylogenetic trees and its application to disease diagnosis that was produced in connection with FAO and the Swiss Institute of Bioinformatics.

Twenty one consultants were hired during the period January 2000 to June 2014 (Table 31), for periods varying from 6 months to several years (usually with 1–3 month breaks in case of consultancies longer than 2 years). R. Geiger, X.B. Chen, A. Schlink, O. Perera and M. Garcia assisted APH in headquarters with the management of projects and various activities of the Section while the others worked in the laboratory on specific research areas. Tony Luckins initially worked in the laboratory with the trypanosome studies and later in Headquarters.

TABLE 31. CONSULTANTS IN THE ANIMAL PRODUCTION AND HEALTH SECTION DURING THE PERIOD OF 2000 TO JUNE 2014

Name	Country	Initial year	Final year[a]
Tounkara, Karim	Mali	2000	
Geiger, Roland	Germany	2001	2003
Bodjo, Charles	Côte d'Ivoire	2005	
Chen, X.B.	China	2005	
Adombi, Caroline	Burkina Faso	2006	DP[b]
Lamien, Charles	Burkina Faso	2006	2013
Schlink, Anthony	Australia	2007	
Garcia, Mario	Peru	2008	DP
Kolodziejek, Jolanta	Poland	2008	
Luckins, Tony	UK	2008	2011
Perera, Oswin	Sri Lanka	2008	
Berguido, Francisco	Panama	2009	DP
Fuga, Linda	Albania	2009	
Slawinska, Anna	Poland	2010	
Leykun, Esayas	Ethiopia	2011	DP
Dundon, William	Ireland	2012	DP
Kangethe, Richard	Kenya	2012	DP
Settypalli, Bharani	India	2012	DP
Wade, Abel	Cameroon	2012	

[a] Consultants without specified final year where hired for 6 to 12 months
[b] Date of publication

Consultants working in the laboratory were mainly funded through extra budgetary funds. C. Bodjo, F. Berguido, C. Adombi and W. Dundon focussed on the development of a PPR specific ELISA and

related immunological studies, C. Lamien is working on the phylogenetics of pathogens and in the developing of e-learning modules, B. Settypalli is developing technologies for multiple animal diseases, A. Wade worked on the molecular epidemiology of ASFV strains, R. Kangethe is working on the development of irradiate vaccines for the control of typanosomosis, and E. Leykun is working on Capripoxivirus. Furthermore, J. Kolodziejek, L. Fuga and A. Slawinska assisted M. Massoud on the genotyping of livestock DNA samples.

Rice straw is an important crop residue widely used as cattle feed and its digestibility can be improved by adding urea (Cambodia, 2013)

Philip Vercoe, from the Faculty of Natural and Agricultural Sciences, University of Western Australia, spent a sabbatical year at APH providing technical support to projects in the nutrition field. In addition, three cost-free experts joined the APH family at Seibersdorf: Wu Xu, from China, worked for a year in 2012 with K. Periasamy on fine-tuning some DNA techniques, and presently, Jenna Achenbach from USA is supporting the work on ASF and avian influenza and Daojin Yu from China on PPR.

Two JPOs, funded by their governments, participated in various activities of APH. Victor Mlambo from Zimbabwe spent a year at APHL validating tannin determination assays in food and feed under the supervision of H. Makkar. Kathrin Schaten spent three years assisting APH on animal health projects in Latin America and Africa. She was also a key element in the organization of the International Symposium on Sustainable Improvement of Animal Production and Health held in Vienna in 2009.

TABLE 32. TECHNICAL AND SECRETARIAL STAFF IN THE ANIMAL PRODUCTION AND HEALTH SECTION DURING THE PERIOD OF 2000 TO JUNE 2014

Activity	Staff	Country	Period	
Secretary	Leon, Rosario	Peru	1991	2003
	Reiter, Roswitha	Austria	1998	DP[b]
	Just, Dagmar	Austria	1991	1992
	Piedra-Cordero, Svetlana	Romania	2003	DP
	Dimailig, Len	Philippines	2009	2010
	Fesus, Eszter	Hungary	2011	2012
	Schirnhofer, Anna[a]	Austria	1999	2004
	Lorenz, Anne Marie[a]	USA	2005	2006
	Makovicki, Kyoko[a]	Japan	2007	2009
	Swodoba, Elizabeth[a]	Austria	2009	2011
	Mletzko, Joanna[1]	Poland	2011	DP
Lab technician[a]	Lelenta, Mamadou	Mali	1988	DP
	Rogovic, Beate	Croatia	1984	2002
	Winger, Eva	Austria	1993	DP
	Haas, Herbert	Austria	1995	2001
	Benkhadra, Elmuetassem	Austria	1997	2002
	Kist, Alla	Russian Federation	2003	2004
	Pestana, Ericka	Peru	2005	2008
	Pichler, Rudolf	Austria	2011	DP

[a] At APH Laboratory in Seibersdorf
[b] Date of publication

TO N. Odongo and invited experts to the Consultants Meeting on the use of enzymes and nuclear technologies to improve the utilization if fibrous feeds, held in Vienna in 2010

As expected, the technical and secretarial support to the APH (Table 32) was a vital factor for the accomplishment of the objectives and activities planned. Among the staff at Seibersdorf, the valuable contribution of M. Lelenta and B. Rogovic was already described. E. Benkhadra was a great contributor to the development and validation of the assays for hormone determination and for the establishment of the QA system for progesterone RIA. He also participated as a lecturer in regional training courses. E. Winger has participated in the development of assays and cell culture related to the diagnosis of trypanosomosis. Most recently, R. Pichler has been contributing with his expertise on the development and validation of techniques for DNA analysis.

Two secretaries were brave enough to stay with the 'animals' for several years. Rosario Leon accompanied APH for 12 years until she moved to the Soil Section, just few steps away crossing the corridor. Roswitha Reiter is and has been the 'living memory' of APH since 1998. She is fully aware and capable of solving and speeding all sorts of administrative procedures and to contact the right people at the right time.

MAJOR PROGRAMME ACTIVITIES

International Symposiums

Two international symposiums organized by APH were implemented between 2000 and 2014 (Table 33). Both events covered the wide range of fields of research that are part of the overall work plan of APH and focussed not only on what is the current knowledge on animal production and health but also provided a vision of potential future areas of interest.

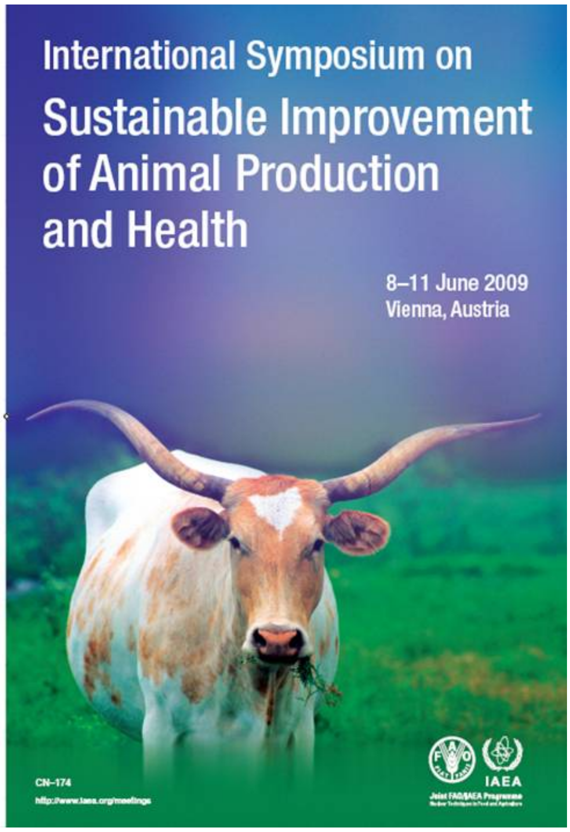
The first symposium was held in October 2003 and lasted for five days under the scientific supervision of Harinder. The meeting revised the role and future potential of gene-based technologies for improving animal production and health, possible applications and constraints in the use of this technology in developing countries and their specific research needs. Apart from the scientific objectives, there was a particular interest for APH to confirm the approaches taken when changing direction of APH into DNA technologies.

TABLE 33. FAO/IAEA INTERNATIONAL SYMPOSIUMS ORGANIZED BY THE ANIMAL PRODUCTION AND HEALTH SECTION (PERIOD 2000–2014)

Year and location	FAO/IAEA International Symposium on
2003, Vienna	Applications of Gene-based Technologies for Improving Animal Production and Health in Developing Countries
2009, Vienna	Sustainable Improvement of Animal Production and Health

The symposium coincided with the 50th anniversary of the discovery of the double helical structure of the DNA by Watson and Crick. The focus of biotechnological research in the early 2000 was on issues and problems of significance for livestock producers and consumers in the developed world. In order to address the problems facing livestock owners in developing countries and to fully realize the benefits from gene-based technologies, there was a need to identify, characterize and apply appropriate technologies in and for these regions; and therefore the importance of the symposium.

The symposium comprised a plenary session and four thematic sessions, covering animal breeding and genetics, animal health, animal nutrition and the environment. The number of participants reached 130 from 60 Member States. The scientific information presented was of a nature that elicited much excitement regarding the potential application for gene-based technologies, particularly in those fields that have matured more, notably in animal disease diagnostics and therapeutics, rather than in animal production. The timing of the symposium was opportune in the face of various recent disease epidemics and continuous debate on the 'livestock revolution' that is expected to address global food requirements and influence trading patterns.



Poster of the International Symposium on 'Sustainable Improvement of Animal Production and Health' held in 2009

The second symposium of this phase was held in June 2009 and lasted for four days under the scientific supervision of Gerrit and Kathrin. The event was attended by nearly 400 participants from about 100 Member States of the IAEA and FAO and also included the active participating of several international organizations.

The symposium addressed five areas: Interactions among nutrition, reproduction and genotype; Effects of nutrition, reproduction and environmental factors on animal productivity; Transboundary, emerging

and zoonotic diseases; One-health; and Achieving food safety and security in the 21st century. On these topics, 24 keynote speakers presented, queried, and argued the current situation and the expected research needs to cope with increasing world demands on food quantity and quality. Also, research results support by nuclear and nuclear related techniques as well as using other methodologies were exposed through 53 oral presentations and 163 posters displays.

The symposium proved to be an important platform for the scientific community to report not just valid and key technical results but coherent research and applied work conducted by the IAEA and FAO through links and partnerships with other UN organizations as WHO and OIE as well as with other international agricultural and research centres, in cooperation with Members States.

The presentations revealed that the coming world food crisis has three important factors to consider: the end of inexpensive energy era (and beginning of expensive inputs), global climate change, and global resources depletion including mineral fertilizers, irrigation water, soil fertility, and land use. Research work is highly needed to solve or alleviate much of these problems, and certainly the IAEA contribution with the development and application of nuclear and nuclear related techniques are utmost relevant; however, it is important to differentiate the target audience for application of nuclear techniques as the users in many cases are different from beneficiaries — but both of these are members of a much larger value chain. Research is highly needed but the results and its application in large scale has to be balanced, as proper evaluation and consideration to public needs, beliefs and cultural heritage are different within countries, regions and continents.

Scientific Forum

APH co-organized the 2-day Scientific Forum on ‘Food for the Future: Meeting the Challenges with Nuclear Applications’, held during the IAEA General Conference of 2012. The Forum focused on the multitude of challenges faced by farmers in many developing countries due to fragile food and agriculture environments.

Invited speakers presented their views on:

- *Increasing Food Production*. The need to produce 70% more food between now and 2050 to satisfy the demand of a population in excess of 9 billion people. The intensification and diversification of more and higher quality food in a climate-smart and sustainable manner whilst protecting the environment is critical to smallholder farmers and is the key to poverty reduction and increased food security.

Groups of panellists of the Scientific Forum on ‘Food for the Future: meeting the challenges with nuclear applications’ held in Vienna in 2012

- *Ensuring Food Protection*. Global food insecurity is inherently linked to pests and diseases that harm or kill livestock and crops, as well as people working in rural agricultural areas. The losses caused by diseases and pests at both the pre- and post-harvest levels average 30–40% of agricultural outputs, making returns on agricultural investments in land, seeds, water, fertilizer, animal feed, labour and other inputs correspondingly inefficient. In addition, the world is currently facing an unprecedented increase of invasive animal and plant diseases and pests that threaten food security by causing serious losses in production and by necessitating costly control measures, including the escalating use of increasingly expensive pesticides. Outbreaks of secondary pests, the development of resistance of pests to pesticides and the increasing threat of

zoonotic diseases to public health cause serious barriers to national and international trade and major losses in export revenues.

- *Enhancing Food Safety*. The development of systems for the control of chemical contaminants in food, the application of traceability systems to identify and manage emerging food safety problems and trends, and the provision of information on food origin and authenticity can help ensure food safety throughout the entire food production chain. In addition, food irradiation is a proven and effective post-harvest treatment to improve food safety and maintain quality through the reduction of bacterial contamination and for the control of insect pests in agricultural commodities, without the need for chemicals or additives.

The Scientific Forum highlighted the substantial capabilities in nuclear sciences and technologies that the Joint FAO/IAEA Division has established in numerous Member States.

Capacity Building through Projects Funded by APH Regular Budget and External Donors

Most training courses conducted by APH are through TC national, regional or interregional projects; however, in this period, various governments and international organizations funded R&D activities to APH. Among them, Conflutech Project of the European Commission, EBR, FAO, USDA project ‘Identify’, Peaceful Uses Initiative (PUI), Rinderpest Sequestration, and South African ‘African Renaissance Fund’ (SAF-ARF), contributed with funds which could be used, and depending of the donor, for hiring staff, procurement of equipment and training in order to achieve specific tasks.

The financial support of external donors allowed the implementation of 24 training courses of which 12 were interregional, 10 regional and one national (Table 34); the latter in Pakistan in 2013 on the diagnosis of viral diseases.

TABLE 34. TRAINING COURSES IMPLEMENTED BY THE ANIMAL PRODUCTION AND HEALTH SECTION FROM 2000 TO JUNE 2014 THROUGH THE FINANCIAL SUPPORT OF EXTERNAL DONORS ACCORDING TO THE SUBJECT AND COUNTRIES INVOLVED

Subject	Interregional	Regional	National	Total
Animal production	2	3		5
Animal health	7	7	1	15
Drug residues	3			3
Total	12	10	1	23[a]

[a] Some records of activities conducted under some projects supported by external donors were not available so these figures may be underestimated

Among the regional and interregional training courses, there were:

– Four courses outsourced by APH to the Onderstepoort Veterinary Institute, South Africa on molecular and PCR diagnostics in 2002, 2004, 2005 and 2006.
– Four courses on molecular methods applied to diagnosis and surveillance of transboundary animal diseases (TAD) and zoonotic animal diseases at APHL (2011 and 2012), Uganda (2011), and Cameroon (2012).
– One training workshop on PPR and CCPP diagnosis in the United Republic of Tanzania (2013).

- Three training workshops on molecular methods for the quantitation of rumen microorganisms and on measurement of methane emission from ruminants in Australia (2004), Switzerland (2005) and USA (2007).
- Two training courses on molecular methods in animal breeding and genetic characterization in Kenya and APHL (2004).
- Three courses on screening and confirmatory methodologies for veterinary drug residues funded by FAO and conducted at APHL (2003), South Africa (2003) and Australia (2004).

Participants of the 3rd RCM of the CRP (D3.20.23) on Veterinary Surveillance of Rift Valley Fever at the Vienna International Centre, Austria in 2009

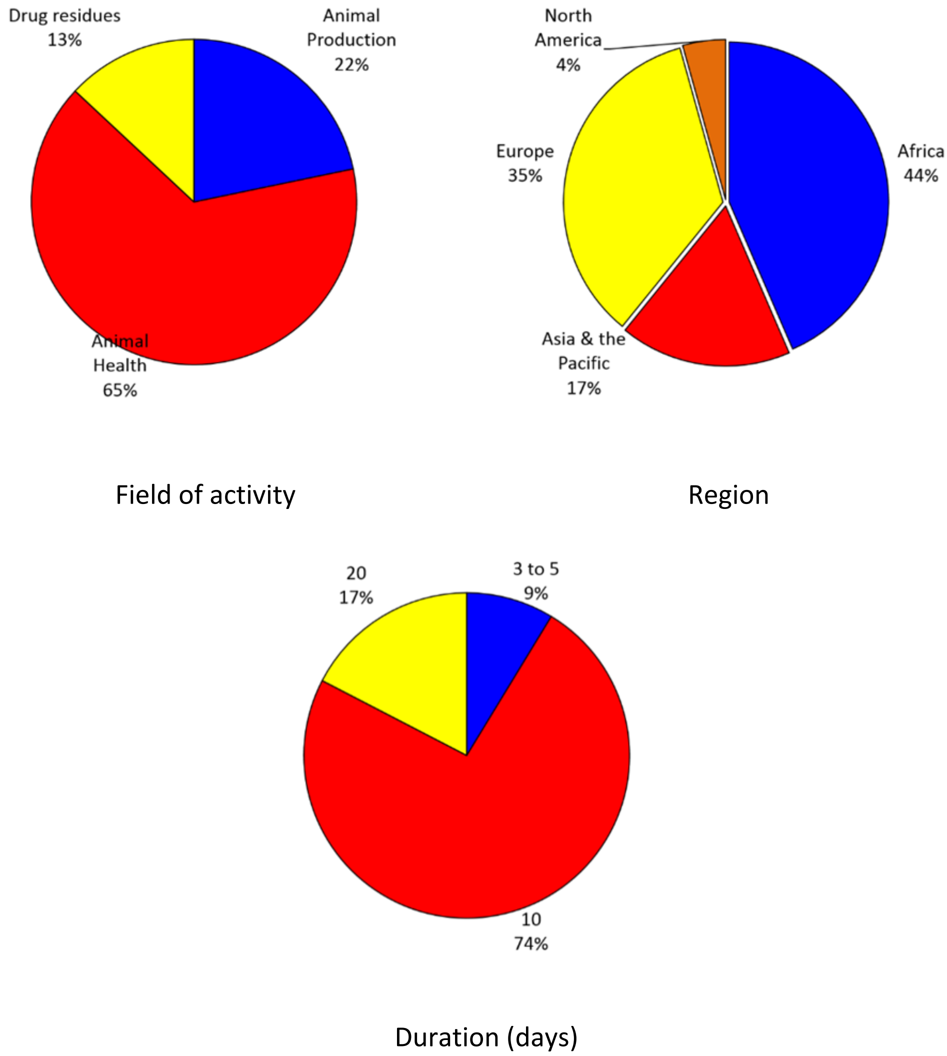


FIG. 25. Proportion of training courses (n=23) conducted by the Animal Production and Health Section in the period 2000–June 2014 through the financial support of external donors, according to the field of activity, region and duration (in days)

Most training courses dealt with animal health issues (15/23) and were held in Africa (9/23) (Figure 25) to fulfil the objectives of agreements with donors. Also APHL in Seibersdorf was used as a venue for these courses in six opportunities (the other two locations in Europe were the Russian Federation and Switzerland). The courses generally lasted for two weeks (74%); however the four courses on molecular and PCR diagnostics lasted for four weeks (Figure 25).

The frequency of these courses and workshops varied across the years depending of the availability of projects funded by external donors or the planning of specific tasks in the programme of work and budget of APH. Most of them were implemented between 2003 and 2007, and then between 2011 and 2013 (Figure 26).

Eight TOs were responsible for the implementation of these courses. Among them, the three courses in drug residues were supervised by A. Cannavan, the courses on animal health by G. Viljoen, C. Lamien and A. Diallo, the courses on rumen molecular techniques by H. Makkar and P. Boettcher, and those on animal genetics by O. Perera and F. Garcia.

All regional and interregional courses were conducted with the collaboration of international recognized scientists and IAEA personnel, plus local scientists. In these courses, scientists from 19 Member States and TOs from FAO and IAEA participated in 149 occasions as lecturers (64 of the lecturers were local). Usually, most of the course lecturers are internationally recruited; however, in this period, the three courses on 'PCR and Molecular Diagnostics' conducted in South Africa (10, 10 and 13 lecturers) and the course on 'Diagnosis of Avian Influenza' conducted in Australia in 2007 (15 lecturers) were entirely conducted by local lecturers.

The distribution of lecturers according to the region of origin is shown in Figure 27. Most lecturers were from Europe. The high proportion of African lecturers was due to courses conducted in South Africa by local lecturers.

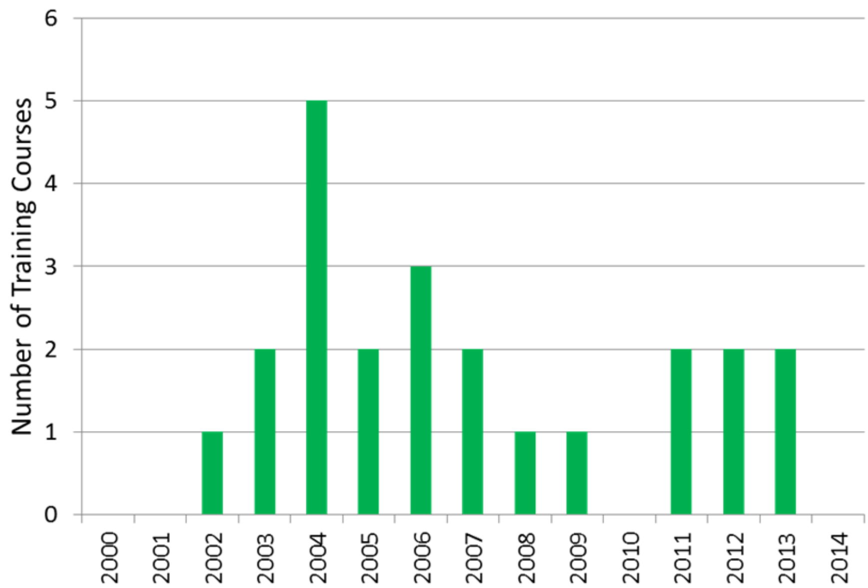


FIG. 26. Number of training courses per year conducted by the Animal Production and Health Section through the financial support of external donors in the period 2000 to June 2014

There were 331 course participants from 97 countries in the 22 regional and interregional training courses. On this, 53% of them were from African countries and 24, 17 and 6% from Asian, European and Latin American countries (Figure 28). Only 29 course participants were from the host countries and the rest (91.2%) travelled from their countries to the host country. On average, there were 13.9

trainees from abroad and 3.3 local trainees per training course. The number of participants per course varied from 5 to 28.

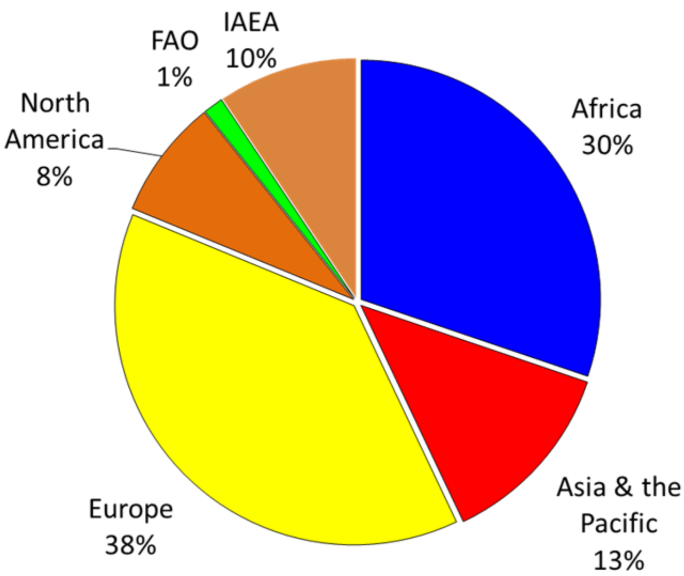


FIG. 27. Lecturers (n = 149) in 20 regional and interregional training courses implemented from 2000 to June 2014 according to the region or international organization of origin

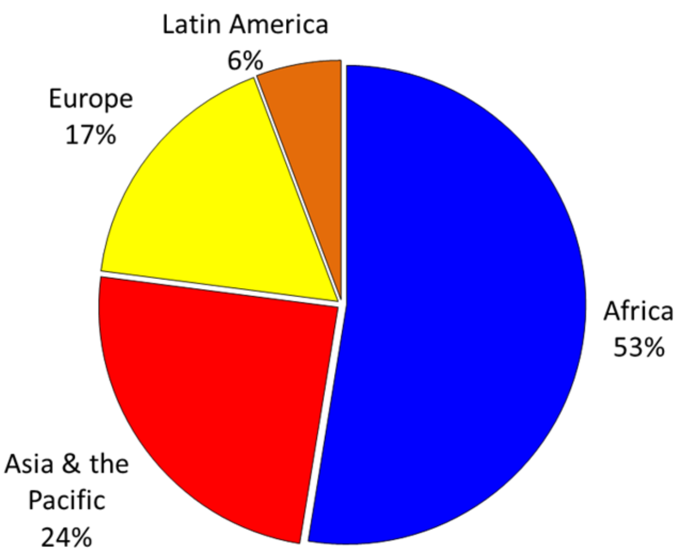


FIG. 28. Trainees (n=331) that participated in 22 regional and interregional training courses implemented from 2000 to June 2014 according to their country of origin

In Africa, most trainees were from Uganda (n=12), Ethiopia (11), Kenya and Nigeria (10 each), Botswana, Cameroon and South Africa (9 each), Senegal and United Republic of Tanzania (8 each), Democratic Republic of the Congo (DRC) and Zambia (7 each), Egypt and Sudan (6 each), Angola, Burkina Faso, Ghana, Mali, and Namibia (4 each).

In Asia and the Pacific, most trainees were from China (10), Mongolia (9), Indonesia (8), Viet Nam (7), Thailand (6), Bangladesh and Sri Lanka (5 each), and India and Islamic Republic of Iran (4 each).

In Europe, most trainees were from the Russian Federation (7), Turkey (6), Bulgaria and Poland (4 each), whereas in In Latin America were from Brazil (4), and Colombia and Cuba (3 each).

Coordinated Research Projects

There were 17 CRPs implemented in the period 2000–2014; fewer than the 24 CRPs implemented in the period 1984–1999 mainly due to the fact that none of the CRPs in this period were supported by external donors and therefore were entirely funded through the IAEA Regular Budget. The reduction of CRPs basically affected the animal production component of the APH (6 as compared to 12).

Out of the 17 CRPs, six were related to the improvement of animal production (Table 35) and 11 to the control of animal diseases (Table 36). The major differences of these CRPs in relation to the previous period were the major focus on health activities and that most of them (n=14) were interregional. One CRP focussed on animal production in general (milk yield, fertility, feeding and diseases), two in genetic characterization, three in animal nutrition, and 11 in animal disease diagnosis and control.

Participants of the 3rd RCM of the CRP 'Integrated Approach for Improving Small Scale Market Oriented Dairy Systems' held in Edinburg in 2006

Participants of the 1st RCM of the CRP on 'Genetic Variation on the Control of Resistance to Infectious Diseases in Small Ruminants for Improving Animal Productivity' held in Vienna in 2011

In addition to the above CRPs, three CRPs were announced but had to be cancelled due to other priorities based on the existing funds:

- The CRP on 'Improvement of animal productivity in developing countries by manipulation of nutrition *in utero* to alter gene expression' was designed and planned to start in 2005.
- The CRP on 'Development of modern technologies and systems to aid field side rapid diagnosis and surveillance of transboundary livestock diseases of livestock and man' was designed and planned to start in 2007.
- The CRP on 'Early and rapid diagnosis and control of animal trypanosomosis' was planned to start in 2012.

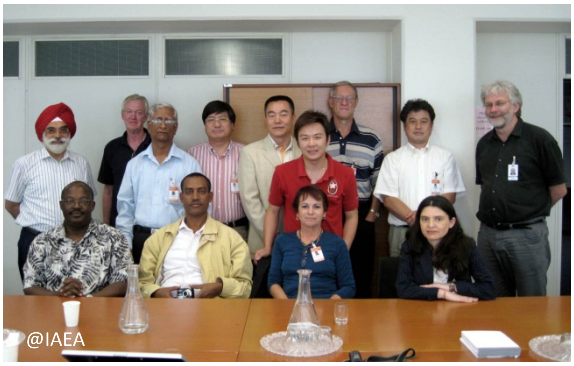
TABLE 35. COORDINATED RESEARCH PROJECTS IMPLEMENTED BY THE ANIMAL PRODUCTION AND HEALTH SECTION IN THE FIELD OF ANIMAL PRODUCTION IN THE PERIOD 2000–2014

Starting year	CRP code	CRP Title	AH[a] (n)	RCH[b] (n)	Final year
1998	D3.10.22	Use of nuclear and related techniques to develop simple tannin assays for predicting and improving the safety and efficiency of feeding ruminants on tanniniferous tree foliage	4	9	2004
2001	D3.10.23	Integrated approach for improving small scale market oriented dairy systems	4	10	2006
2003	D3.10.24	Development and use of rumen molecular techniques for predicting and enhancing livestock productivity	6	10	2010
2004	D3.10.25	Gene-based technologies in livestock breeding: characterization of small ruminant genetic resources in Asia	2	9	2010
2010	D3.10.26	Genetic variation on the control of resistance to infectious diseases in small ruminants for improving animal productivity	5	14	2015
2010	D3.10.27	The use of enzymes and nuclear technologies to improve the utilization of fibrous feeds and reduce greenhouse gas emissions from livestock	4	11	2015
Total			25	63	

[a] Agreement holders
[b] Research contract holders

The objectives, key elements and main achievements for CRPs in the field of animal production (Table 35) were:

- D3.10.22: The initial CRP title was 'Decreasing the risk of feeding tanniniferous plants by optimizing their harvesting, diet-mixing and polymer binding'; however after a Consultant Meeting held in 1997 the objectives and research protocols were modified. The implemented CRP aimed to refine and standardize nuclear, chemical and biological assays for measuring tannins in plant material and validate the usefulness of these techniques for predicting animal performance. A manual containing methodologies for the analysis of tannins recommended by the consultants was published and used by the RC holders. The final results of the CRP were published as a special issue of the journal Animal Feed Science and Technology (2005, Vol. 122).



Research contract and agreement holders and FAO and IAEA staff attending the final RCM of CRP D3.10.24 on rumen molecular techniques for predicting and enhancing livestock productivity, held at VIC, Vienna in 2009

- D3.10.23: The objectives of the CRP were to determine the most important factors in specific selected dairy production systems, to customize intervention strategies in an integrated manner and clearly demonstrate through cost benefit analysis that this multidisciplinary approach was superior to dealing with only one constraint. In Phase I, a participatory rural appraisal (PRA) to

identify the constraints and an Economic Opportunity Survey (EOS) were conducted with the active participation of farmers. In the second phase, a relevant factor in each study was selected and a technical intervention was implemented to remedy the constraint.

- D3.10.24: The CRP aimed to reduce methane emissions from livestock and divert the energy being lost in methane production towards increasing livestock production thus enhancing the efficiency of production and reducing environment pollutants. As a result, an *in vitro* gas production test for screening of plants containing secondary metabolites, a Real-time PCR to enumerate rumen microbes, a denaturing gradient gel electrophoresis (DGGE) for studying rumen microbiota diversity, and a technique for measuring protozoal activity by ^{14}C were standardized and used in the studies. In addition, two book/manuals were published and over 50 papers were published in peer reviewed journals.

Participants of the 2nd RCM of the CRP 'Development of Molecular and Nuclear Technologies for the Control of FMD' held in FAO, Rome in 2013

- D3.10.25: The regional CRP for the Asia region aimed to the phenotypic and genotypic characterization of several sheep and goat breeds in line with the FAO's Global Plan of Action for Animal Genetic Resources. Samples from 40 sheep and 60 goat breeds in eight countries were analysed using mitochondrial DNA and microsatellite DNA markers. A training course was held at the beginning of the project at ILRI, Kenya to provide training in molecular methods for assessing genetic diversity and hands-on on animal sampling, DNA preparation and storage, biodiversity analysis, and identification of genes by quantitative trait locus (QTL) mapping. A second training course in 2009 was held in Beijing, China (sponsored by the Chinese Government) for data interpretation.

- D3.10.26: The on-going project is a follow-up of the previous CRP. It aimed to develop capacity in developing countries in the use of molecular and related technologies, to collect phenotypic data and DNA samples from goat and sheep breeds with history of infectious disease (gastrointestinal parasitism) resistance, and to provide data for the identification of genetic markers associated to infectious disease resistance. Two experiments were planned, an artificial challenge to quantify the relative resistance to gastrointestinal parasites, and a field trial to quantify the relative resistance to gastrointestinal parasites. DNA samples were sent to APHL for sequencing so data analysis and interpretation will be done during the final year of the project.

The efficient utilization of feed resources has been a major task in the research and development work of the Animal Production and Health Section

- D3.10.27: The objective of the on-going CRP is to improve the productive performance of livestock by improving the efficiency of locally available fibrous feed resources while protecting the environment. In the initial phase, RC holders *in vitro* tested commercial fibrolytic enzymes to identify two to four best-bet candidates and optimum dose ranges for further evaluation in animal trials. The final RCM will take place in 2015; however, there have been an impressive number of publications (one book on nutritional strategies in animal feed additives and more than 12 papers in peer-reviewed journals), including a special issue on the journal Animal Nutrition and Feed Technology (2013, Vol. 13).

TABLE 36. COORDINATED RESEARCH PROJECTS IMPLEMENTED BY THE ANIMAL PRODUCTION AND HEALTH SECTION IN THE FIELD OF ANIMAL HEALTH IN THE PERIOD 2000–2014

Starting year	CRP code	CRP Title	AH[a] (n)	RCH[b] (n)	Final year
1998	D3.20.19	Assessment of the effectiveness of vaccination strategies against Newcastle disease and Gumboro disease using immunoassays-based technologies for increasing farmyard poultry production in Africa	7	13	2004
1999	D3.20.20	The use of non-structural protein of foot-and-mouth disease virus (FMDV) to differentiate between vaccinated and infected animals	6	15	2004
2000	D3.20.21	Developing, validating and standardising methodologies for the use of PCR and PCR-ELISA in the diagnosis and monitoring of control and eradication programmes for trypanosomosis	5	11	2006
2002	D3.20.22	The development of strategies for the effective monitoring of veterinary drugs residues in livestock and livestock products in developing countries	3	15	2006
2005	D3.20.23	Veterinary surveillance of rift valley fever (RFV)	3	11	2011
2006	D3.20.24	Control of contagious bovine pleuro-pneuomia	3	12	2011
2006	D3.20.25	Coordinate a CRP for the early and rapid diagnosis of emerging diseases (focus on avian influenza)	5	12	2011
2007	D3.20.26	The early and sensitive diagnosis and control of Peste des petit ruminants (PPR)	4	11	2012
2010	D3.20.28	Development of molecular and nuclear technologies for the control of foot-and-mouth disease (FMD)	4	11	2015
2010	D3.20.29	The use of irradiated vaccines in the control of infectious transboundary diseases of livestock	4	12	2014
2012	D3.20.30	Use of stable isotopes to trace bird migrations and molecular nuclear techniques to investigate the epidemiology and ecology of the highly pathogenic avian influenza	2	7	2017
Total			46	130	

[a] Agreement holders
[b] Research contract holders

As for CRPs on animal production, a short description of key elements and main achievements in CRPs in the field of animal health (Table 36) are mentioned:

Zambian cattle farm assisted by the project team of TC ZAM/5/028 through improved feeding and artificial insemination

- D3.20.19: The objective of the CRP was to improve village poultry production and to decrease medication costs by controlling Newcastle and Gumboro diseases. The research protocol included field trials on various vaccination strategies taking into account differences in management, poultry breeds, vaccine type and logistic constraints. Vaccination notoriously reduced mortality in village chicken and supplementary feeding as an adjunct to scavenging proved to be cost-effective.
- D3.20.20: The CRP aimed to improve the effectiveness of national and international FMD control and eradication campaigns through the application of an assay able to distinguish antibodies due to vaccination from infection. Several systems to assess antibodies against FMD in these types of animals were evaluated. The results showed insufficient data to recommend assays as being 'fit for purpose' for many of the epidemiological needs for FMD testing for antibodies; however, it was recommended to continue evaluating a Competitive Non-structural Protein (NSP) assay.
- D3.20.21: The CRP focused on the development and validation of a PCR-ELISA for the diagnosis and surveillance of trypanosomosis. The test aimed to identify trypanosomal DNA (*T. vivax*, *T. brucei* and *T. congolense*) in blood samples. DNA samples were sent to APHL for analysis. The ELISA for *T. congolense* seemed to be the most promising; however, specific protocols that fit the OIE guidelines for the specific detection of trypanosomes were not designed due to insufficient validation data.
- D3.20.22: This CRP was advertised in 1997 but started in 2002 after the appointment of an expert on drug residues in animals and animal products as TO (A. Cannavan). The initial proposal was re-evaluated and focused on the development of sampling procedures, the application of screening technologies such as ELISA and RIA, post-screening methods such as High-performance Liquid Chromatography (HPLC), and approaches towards laboratory accreditation. Three components were of common interest for CRP participants: chloramphenicol, nitrofurans and ß-agonists. ELISA, RIA and HPLC methods were developed.
- D3.20.23: The CRP aimed to support countries in risk of major RVF outbreaks to gain the capacity for a quick diagnosis. A RT-PCR and PCR sequencing for early detection of virus and the evaluation of existing ELISAs were the major components of the project. Also, the harmonization of SOPs and the introduction of QA procedures for the techniques involved. The IgG and IgM ELISA platforms were implemented and validated, serological procedures were harmonized, and protocols to perform RT-PCR, isothermic PCR (idLAMP) and PCR-sequencing were developed.

Crossbred heifer as a result of the artificial insemination programme conducted by the Centre Régional Bambui, Institut de Recherche Agricole pour le Developpement (IRAD), Cameroon

- D3.20.24: The CRP aimed to improve the capabilities of Southern Africa Development Community (SADC) countries on the monitoring of CBPP infection by use of PCR and agglutination technique and the validation

of c-ELISA and Indirect ELISA (i-ELISA) for the diagnosis of the disease. The first test was found to be a good epidemiological test for prevalence studies but had some problems in identifying vaccinated cattle as positive. The LppQ ELISA based on the lipoprotein named LppQ was seen as the better test due to its ease of handling, but missed out chronic infections. On the other hand, there was a good prospective the use of the LAMP test.

- D3.20.25: The CRP aimed to develop sensitive, specific and rapid early detection technologies including penside or hand-held systems to detect and or confirm harmful pathogens present in animals before the onset of disease, in animals in the 'disease carrier' status or in very low numbers in animals or populations of animals to respond to harmful animal disease events, and those of zoonotic nature, in a timely way. Among the technologies variations of RT-PCR were evaluated.
- D3.20.26: The objective of the CRP was to develop, validate and transfer to Member States sensitive, specific and rapid tests for the diagnosis of PPR. The RT-PCR assays developed at CIRAD and at APHL proved to be very sensitive. Also a LAMP-PCR test showed to be highly sensitive, in comparison with commercial serological kits that have cross-reaction with rinderpest antibodies. In addition, some reports indicated that PPR virus (PPRV) was recovered from infected camels and therefore is needed the sequence these strains for the understanding of the current change in the geographical distribution of PPRV lineages.
- D3.20.28: The on-going CRP is focussing on methods and seeking to provide internationally acceptable guidelines for procedures by which the ability of an FMD vaccine to induce the production of protective antibodies in cattle can be evaluated without the need for animal challenge experiments. The use of P1 amino acid sequences together with virus neutralisation tests (VNTs) and r-values, structural data and mathematical modelling is being developed for SAT (South African Territories) type viruses to predict antigenic matching. Another group is optimizing the VNT results to predict protection against the vaccine strains used in the region.
- D3.20.29: The on-going CRP aims to develop techniques for irradiated vaccines against *Trypanosoma evansi, Theileria annulata*, *Ichthyophthirius multifiliis*, *Brucella abortus*, *B. melitensis*, *Fasciola hepatica*, *F. gigantica* and *Haemonchus contortus*. Preliminary results shown that irradiated doses for the attenuation of the pathogens are much lower than doses used in the past.
- D3.20.30: The objective of the on-going CRP is to establish a scientifically justified platform for non-invasive monitoring of wild bird migrations and evaluation of their role in the long range transmission of avian influenza viruses. The principle of evaluation is based on the difference in the ratios of stable isotopes in feathers at different geographical locations. This phenomenon is intended to be used in combination with the detection of avian influenza viruses in faecal samples and determination of the bird species using DNA barcoding technique in faecal samples.

Participants of the training course on molecular diagnostic for transboundary animal diseases (Regional TC Project RAS/5/060) held in Langzhou, China in 2012

There were 71 agreements and 193 contracts in the 17 CRPs conducted in this period, with an average of 4.2 agreements and 11.4 research contracts per CRP and without relevant differences in number of participants between CRPs in the animal production and animal health fields.

In overall, scientists of 26 Member States participated in 71 agreements, especially from UK (9), USA (8), Australia (7), Germany (6) and Netherlands (6). Besides, 14 agreements were from developing countries, a much higher proportion than in the period 1984–1999.

In relation to research contracts, scientists from 69 Member States participated in 193 contracts, especially from China (14), South Africa (8), Argentina, Brazil, and Sri Lanka (7 each), Burkina Faso, Kenya and Pakistan (6 each), Ethiopia, Mexico, Sri Lanka and United Republic of Tanzania (10 each), Cuba, Indonesia, Malaysia, Peru and Uruguay (9 each), and Bangladesh, Côte d'Ivoire, Ethiopia, Indonesia and Thailand (5 each). On the other hand, 12 Member States participated with two research contracts each and 28 Member States participated with only one research contract each.

Thirteen out of the 17 CRPs included technical contracts in the programmes. There were 48 contracts of this type (3.7 contracts per CRP), where 7 of them were awarded to institutions in Germany and 4 each in Australia, Austria, Kenya and USA. It is also worth to mention that 15 technical contracts (31.3%) were awarded to institutions in developing countries.

The frequency of research contracts according to the region of the contract holder was as follow:

– African countries had the largest participation in number of research countries in CRPs (33.7%), where South Africa (8), Burkina Faso and Kenya (6 each), Cameroon, Sudan, United Republic of Tanzania and Uganda (4 each) had the largest number of research contracts in Africa while other 22 countries had 1–3 research contracts each in this period.
– China (14), Sri Lanka (7), Pakistan (6) Bangladesh, Indonesia and Thailand (5 each), and India, Islamic Republic of Iran and Viet Nam (3 each) had the largest number of research contracts in the Asia & Pacific region, while other 10 countries had 1–2 research contracts each.
– Latin American countries had a reduced participation in CRPs in this period, where Argentina and Brazil (7 each), and Peru and Uruguay (3 each) had the largest number of research contracts, and other 8 countries had 1–2 research contracts each.
– In Europe, Turkey had 6 research contracts wile Bulgaria, Cyprus, Georgia, Malta, Russian Federation, and Tajikistan had one contract each.

The ratio of research agreements and research contracts based on the region of the scientist in CRPs focussed on animal production and animal health are shown in Figures 29 and 30. The proportion of agreement holders from North America was higher and from Asia & the Pacific was lower in the animal production field as compared to the period 1984–1998. In the case of the animal health field, the proportion of agreement holders from Africa and Europe increased at the expense of less number of experts from North and Latin America (see Figure 1).

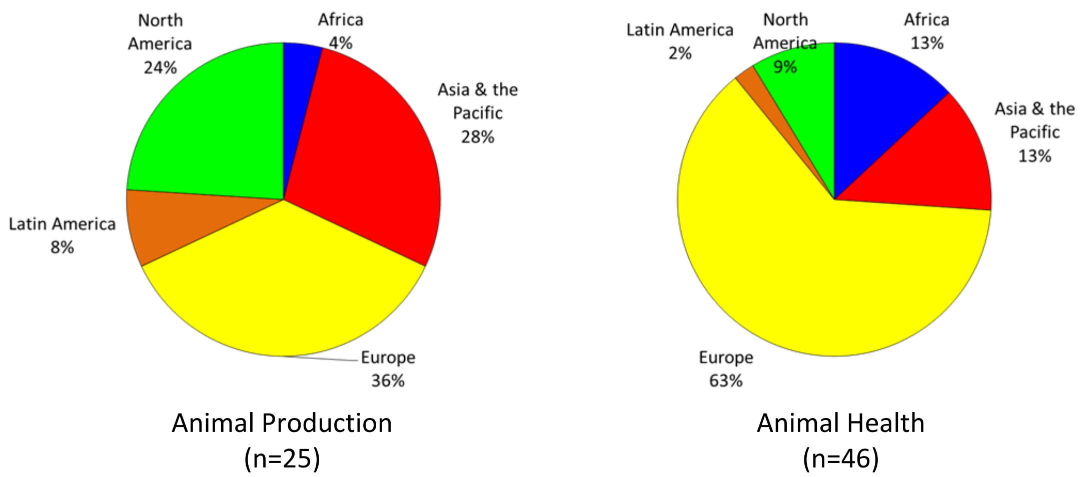


FIG. 29. Proportion of research agreements based on the region of the agreement holder in CRPs focussed on animal production (n=6 CRPs) and animal health (n=11) initiated in the period of 1999 to 2012

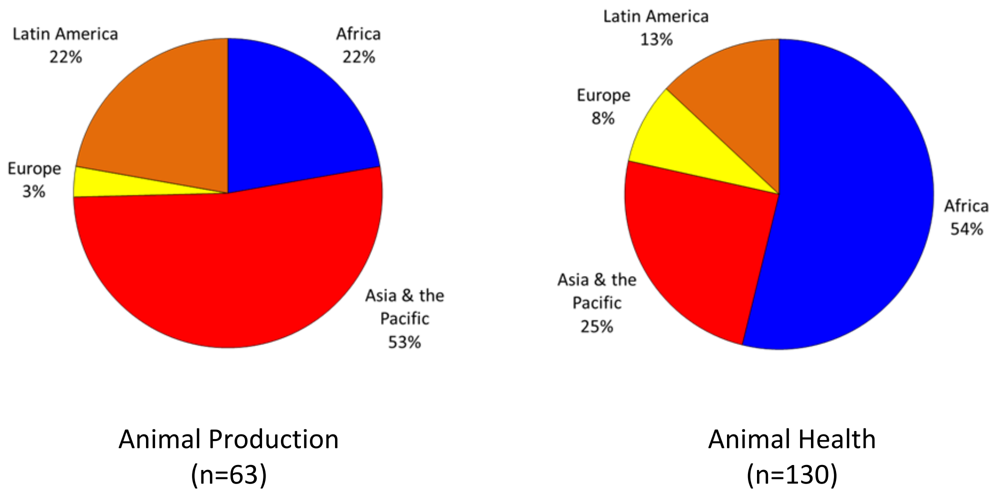


FIG. 30. Proportion of research contracts based on the region of the contract holder in CRPs focussed on animal production (n=6 CRPs) and animal health (n=11) initiated in the period of 1999 to 2012

The proportion of RC holders from Latin America substantially decreased in the animal production field while higher proportion of contracts was awarded in the Asia & the Pacific region. Likewise, in the field of animal health, the proportion of RC holders from Latin America and Africa decreased while higher proportion of contracts was awarded to Asian and European scientists.

Three RCMs per CRP were held in most cases; however, two CRPs (D3.10.23 and D3.20.19) had 4 RCMs during the lifespan of the projects. There were 47 RCMs under the 17 CRPs implemented in this period, but has to be considered that five on-going CRPs had only implemented two RCMs and the third ones are planned for 2015.

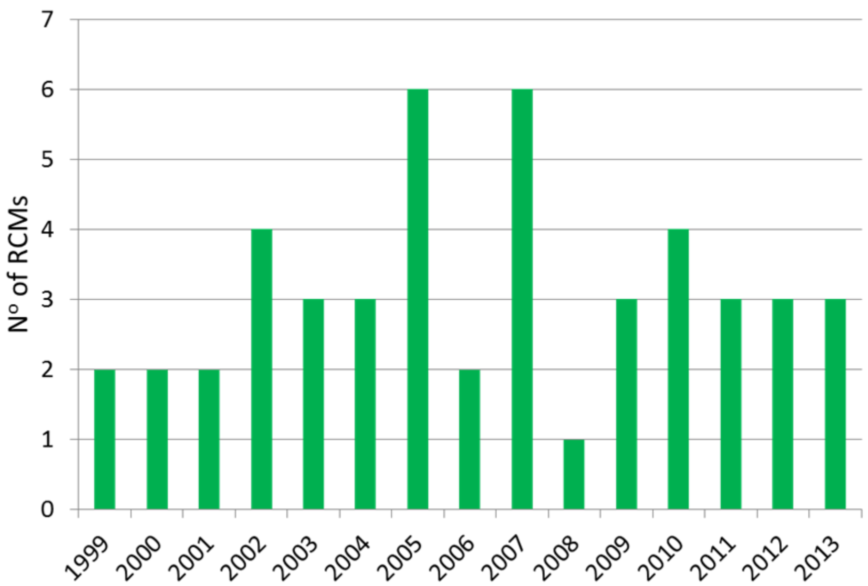


FIG. 31. Number of Research Coordination Meetings per year conducted by the Animal Production and Health Section in the period 1999 to June 2014

In total, institutions from 24 Member States and the IAEA and FAO headquarters were the venues for RCMs. Most RCMs were conducted at IAEA (13), followed by host institutes in Brazil (4) and in FAO Headquarters (3), Indonesia, Kenya, South Africa and United Republic of Tanzania (2 each). Generally, RCMs lasted for 5 working days but five of them run for 4 days and one for 3 days.

The distribution of RCMs was fairly balanced, having 2 to 3 per year. The larger number of RCMs in 2005 and 2007 were compensated by a low number of RCMs in the following year (Figure 31).

Consultants Meetings (CM)

CMs were organized by APH to get technical advice from world leading scientists on specific topics, especially on the state-of-the-art of advanced nuclear and related technologies and their possible applications under the prevailing conditions of laboratories in developing countries. Also, several CMs prepared the foundations or revise preliminary research protocols for new CRPs and identify potential institutions and scientists that would participate in these projects. CMs also were assembled for the preparation of the outline and content of technical manuals and books.

There were 40 CMs from 2000 to June 2014. There were two CMs per years from 2000 to 2006. As of 2007 there was a clear move to a higher number of CMs per year, having 4 in 2007 and 2009, and 6 in 2010 (Figure 32). Among the CMs, there were five on topics covering the whole spectrum of activities conducted by APH (Table 37), 10 on animal production (Table 38), 24 on animal health (Table 39), and one on drug residues in food (Figure 33). As compared with the number of CMs in the period 1984–1999, the number of CMs in this period was twice but again addressing all aspects related to the APH mandate.

CMs, depending of the nature and objectives, lasted mainly for 3 to 4 days (80%, Figure 33). An exception case was a CM on animal nutrition in 2000 that lasted for 10 working days. Seventeen TOs were the scientific secretaries of the 40 CMs, among them I. Naletoski (n=6), N. Odongo, H. Unger and G. Viljoen (5 each).

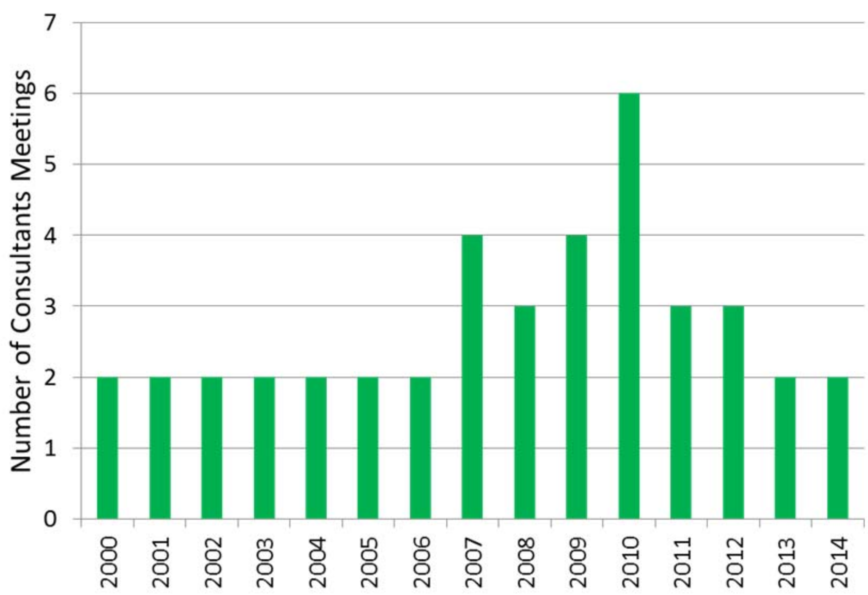


FIG. 32. Frequency of Consultants Meetings organized by the Animal Production and Health Section between 2000 to June 2014 (n=40)

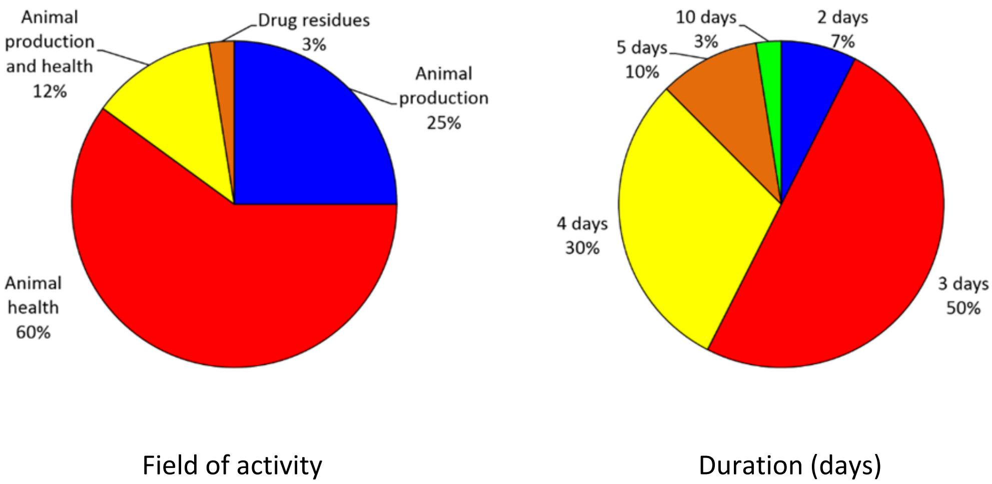


FIG. 33. Distribution of 40 Consultants Meetings based on the field of activity and the number of working days (period 2000 to June 2014)

TABLE 37. LIST OF CONSULTANTS MEETINGS COVERING THE WHOLE SPECTRUM OF ACTIVITIES UNDER ANIMAL PRODUCTION AND HEALTH (2000–2014)

Year	Consultants Meeting on	Duration (days)
2001	To Discuss and Make Recommendations on Significance, Suitability and Potential Applications of Gene-based Technologies for Improving Livestock Production in Developing Countries	4
2007	Preparing the Symposium in 2009	5
2008	Training and Capacity Building for Research Workers in Animal Production and Health in Developing Countries	3
2010	The Role of Livestock on Climate Change and Mitigation Strategies	3
2010	The Effect of Climatic Change on Animal Production and Health – Way Forward	3

Participants of the Training Workshop on 'Classical and Molecular Veterinary Virology' held in 2011 at Seibersdorf Laboratories, Vienna

Zambian inseminators participating in a national training course under TC project ZAM/5/028 (Lake Kariba, Zambia, 2013)

TABLE 38. LIST OF CONSULTANTS MEETINGS IN THE FIELD OF ANIMAL PRODUCTION (2000–2014)

Year	Consultants Meeting on	Duration (days)
2000	Identification of Research Needs for Quantification of Nutrient Budget and Flows in Integrated Crop/Livestock Systems with a Focus on Conservation and Sustainability Issues in Developing Countries	10
2005	Research Needs for Improvement of Livestock Productivity in Developing Countries Through Manipulation of Nutrition in utero, and to Identify Future Areas of Research in Animal Nutrition	4
2007	CM to define Joint Activities between the Animal Production and Health Section in Vienna and the Animal Production and Health Division in Rome	4
2007	Radiation Induced Mutations in Grain Crops to Improve Straw Digestibility for Ruminant Livestock	4
2008	Screen Plants and/or Plant Products for Impact on Animal Production, Health and the Environment	4
2009	Biology and Nutrient Requirements of Livestock during Compensatory Growth and Restricted Periods of Growth	3
2010	Genetic Variation on the Control of Resistance to Infectious Diseases	4
2010	Use of Enzymes and Nuclear Technologies to Improve the Utilization of Fibrous Feeds and Reduce Greenhouse Gas Emission from Livestock	3
2012	How to Detect and Quantify Inefficient Use of Nutrients in Livestock Production Systems: the Role of Nuclear and Isotopic Techniques	3
2014	Early Pregnancy Diagnosis in the Bovine Using Nuclear and Molecular Techniques	3

The largest number of consultants were based in European institutions (48.7%), followed by North American (20.4%) and Asian (16.2%) institutions (Table 40).

Some of the objectives, results and conclusions of CMs covering the whole spectrum of activities under the mandate of APH were:

- The CM on gene-based technologies for improving livestock productivity (2001) aimed to identify suitable areas that can be addressed by the APH, as well as to develop a framework for the FAO/IAEA International Symposium ‘Applications of gene-based technologies for improving animal production and health in developing countries’ planned for 2003. The experts concluded that the model used in the developed world focus resources in large specialized institutes and therefore, a suitable model has to be identified to harness this technology for developing countries. Also, recommended to initiate activities with characterization of the gene pools of livestock, microbes and forages. Four areas were identified for future research:
  - Development and use of rumen molecular techniques for predicting and enhancing productivity,
  - Improvement of animal productivity in developing countries by manipulation of nutrition *in utero* to alter gene expression,
  - Gene-based technologies in livestock breeding,
  - Improvement of tests for ASF diagnosis and molecular epidemiology analysis of the disease.

TABLE 39. LIST OF CONSULTANTS MEETINGS IN THE FIELD OF ANIMAL HEALTH (2000–2014)

Year	Consultants Meeting on	Duration (days)
2000	Developing Standardized Training Material to Assist Member States to Establish Quality Systems for Veterinary Diagnostic Laboratories	5
2001	Preliminary Establishment of GREP Guidelines for the Global Sero-surveillance for Rinderpest Disease in 2003	4
2002	Guidelines for Validation and Certification of Diagnostic Assays for Animal Infectious Diseases	3
2002	Plan a Workshop for Policy Makers/Senior Officials under the Project ‘Strengthening Capacities for Implementation of Codex Standards, Guidelines and the Recommended International Codes of Practice for Control of the Use of Veterinary Drugs’	4
2003	Define Technical Guidelines and Standing Operating Procedures for the Surveillance and Testing of Rinderpest as Part of the Global Rinderpest Eradication Programme	3
2003	OIE Validation and Certification of Diagnostic Assays for Infectious Animal Disease	4
2004	Early Warning Devices and Tools for the Early and Rapid Detection of Animal Diseases	5
2004	Education to Improve the Quality of Research from Developing Countries	5
2005	Molecular Techniques Applied to Foot-and-Mouth Disease Diagnosis and Surveillance	3
2006	Standards, Referencing and Validation	4
2006	Devices and Systems for Early and Rapid Detection of Animal Diseases, Early Response to Emerging Diseases	3
2007	Foot and Mouth Disease (FMD) Research Being Undertaken	4
2008	Early Warning Devices and Tools to Diagnose Known and Unknown Emerging Diseases	4
2009	The Socio-Economic Impact of Disease Prevention	3
2009	Irradiated Vaccines and their Potential for Use in the Control of Livestock Diseases	3
2009	Stable Isotope Analysis (SIA) as a Means of Tracing the Migratory Movement of Waterfowl Involved in the Spread of Highly Pathogenic Avian Influenza (HPAI)	3
2010	The Use of Stable Isotopes in the Tracing of Wild bird Movements and Correlation with Occurrence of Avian Flu	3
2010	Develop a Roadmap for the Implementation of Modern OIE Principles and Methods of Diagnostic Test Validation	4
2011	Upcoming Technologies for Early and Rapid Diagnosis of Infectious Diseases	3
2011	Use of stable isotopes and DNA barcoding in tracing migratory pathways of wild birds, potential carriers of highly pathogenic avian influenza virus	2
2012	Advanced Technologies for Rapid Detection and Characterization of Existing and Emerging Vector-borne Pathogens of Livestock	2
2012	The Application of Good Laboratory Practices in Molecular Testing of Multiple Diseases in Veterinary Laboratories	3
2013	Development of Diagnostic and Tracing Technologies Used for Livestock Pathogen Detection	3
2013	Advances in Development of Early Warning Tools for Detection of Vector Borne Diseases of Animals, Including Zoonoses – Focus on Vectors	3
2014	Development of irradiated vaccines: current status and future applications	2

TABLE 40. NUMBER OF CONSULTANTS PER REGION IN 37 CONSULTANTS MEETINGS[1] FROM 2000 TO JUNE 2014

Region	N° of consultants
Europe	129
North America	54
Asia	43
FAO	15
Africa	11
Latin America	9
Total	265

[1] Data from other three CMs was unavailable

- The CM on preparing the FAO/IAEA International Symposium (2007) defined an outline of subjects for inclusion in the sessions and identified plenary speakers to be invited.
- The CM on training and capacity building for research workers (2008) outlined relevant approaches and gave an overview of the success of programmes, which were based on open source platforms. The experts agreed that any level scientist could benefit of the learning packages if considering that much research is bad planned and poorly made in inappropriate areas and that this situation is maintained through poorly trained and quality controlled supervisors. It was also agreed that training at all levels is vital for the development of quality scientists.
- The CM on 'The role of livestock on climate change and mitigation strategies' and the CM on 'The effect of climatic change on animal production and health – the way forward' were jointly held in 2010 to review the challenges and opportunities of the intersection between livestock production systems and global climate change, to discuss how livestock production systems can adapt to climate change and to identify strategies to mitigate greenhouse gases emissions from livestock, and to demystify some of the myths and misconceptions about livestock production and global warming, some of them as a result of a previous FAO book. The experts agreed on publishing a book providing state-of-the-art information on climate change and livestock production and health. The structure of the book was prepared and potential authors were identified; however, the book was cancelled because FAO was preparing another publication on this subject.

Milk and yogurt producer with his family at his dairy farm in Madagascar (2014)

Some of the objectives, results and conclusions of CMs related to animal production were:

- The CM on nutrient dynamics (2000) had the participation of staff of the Soil Section, and aimed to review the livestock systems and their environment, considering overgrazing, deforestation, soil and water pollution and emission of greenhouse gases. The experts devised a proposal for a CRP entitled 'Integrated Nutrient Management to Improve Productivity and Sustainability of

Ruminant/Cropping Systems in Tropical Africa and Asia' to enhance animal and crop production through improved feeding strategies for ruminants. The proposal did not materialize in a CRP.

- The CM on improving livestock productivity through manipulation of nutrition *in utero* (2005) aimed to discuss technical possibilities and developed the foundations for a CRP on 'Managing the Maternal Environment to Enhance Lifetime Health and Performance of Offspring and Improve Profitability of Livestock Production Systems'. Later on the CRP was advertised but never implemented.
- The CM on joint activities between FAO (AGAP Service) Rome and IAEA (APH) (2007) aimed to identify and increase joint collaboration in animal nutrition, reproduction and breeding between the two institutions. The experts suggested four major areas of common interest: animal identification and recording as it is a topic of critical importance for livestock production in developing countries; analysis of stable isotopes due to vast number of potential applications in the fields of animal reproduction, nutrition and health; characterization of local populations of animal genetic resources (AnGR), involving phenotypic information and genotypic markers; and the use of agro-industrial by-products as animal feeds.
- The CM on animal nutrition (2007) aimed to plan a potential CRP on 'Radiation Induced Mutations in Grain Crops to Improve Straw Digestibility for Ruminant Livestock'. The panel of experts decided to envisage the implementation of a CRP on strategies to develop a 'proof of concept' that food-feed crops can be selected for improved productivity and better nutritive value for livestock using mutation breeding and complementary biotechnologies, and this can be done using two crop residues as a model. The CRP proposal was considered of low priority and therefore not supported.

> For me, the most memorable and enjoyable time while working at APH was the morning coffee breaks, or should I say 'tea' breaks. All participants were exposed to the magic nectar known as 'Rooibos'. These breaks were an opportunity to put work aside and connect on a personal level. They were also incredibly instructive. That being said, with colleagues from the UK, India, South Africa and Australia, I practically learned more about cricket and rugby than I ever did about radio immunoassays and radiation hybrid mapping. Although most of the banter was playful and happy, it was also a time to share the sad times and exchange moral support. One of the colleagues was afraid of flying, but could not avoid an upcoming trans-Atlantic flight. The colleagues were more than willing to provide calming moral support as well as practical tips to make the flight; for example, Gerrit explained that the primary key to safety was to choose a good airline and to disembark immediately if you found yourself sharing the cabin with goats and chickens, even if they were in cages. And then there was the contribution of Roswitha. Being an Austrian native, she always knew about the local holidays, the special treats with which they were associated and the best places to procure such treats. Needless to say, those 20 to 30 minutes were always time well spent.
>
> **Paul Boettcher, Technical Officer**
>
> 

- In the CM on the screening of plants and plant products for impact on livestock productivity (2008), the experts discussed the advantages of certain extent plants with secondary compounds as part of livestock diets. In addition, the panel recommended the implementation of two CRPs. The first on 'Bioactive Plants and Plant Products to Improve Productivity and Health of Ruminants in Developing Countries', to screen candidate local plants for activity against enteric methane production and helminths. The second on 'Identification of Under-utilized Plants and Plant Products to Improve Fish Productivity and Health' to move away from fishmeal as the primary source of protein in fish diets. Limited funding impeded in a later stage the approval of the proposed CRPs.
- The CM on animal nutrition (2009) aimed to develop a CRP proposal to investigate the biology of the digestive system and nutrient requirements of livestock during compensatory growth and restricted periods of growth and how to take advantage of the compensatory growth to maximize output. The experts devised a proposal for a CRP entitled 'Use of the Compensatory Growth

Phenomenon to Improve Livestock Productivity in Regions with Fluctuating Quantity and Quality of Available Feed Resources'. The proposal received low priority and was therefore not supported.

- The CM on genetic resistance to infectious diseases (2010) aimed to review the work plan and to devise SOPs and recommendations for the CRP on 'Genetic Variation on the Control of Resistance to Infectious Diseases in Small Ruminants for Improving Animal Productivity' (D3.10.26). The experts recommended conducting an initial phase for the phenotypical evaluation of resistance to gastrointestinal parasites of sheep and goat breeds by an artificial challenge trial with a fix dose of *Haemochus* larvi and a field trial with natural infection. Then, a second phase would involve genotyping strategies, validation of single nucleotide polymorphism (SNP) markers, gene sequencing, use of low density SNP panel, and data analysis.

Myanmar producer delivering feed to his animals (2010)

- The CM on the use of enzymes to improve digestibility of fibrous forages (2010) aimed to revise the methodologies and experimental protocols of the CRP on 'The Use of Enzymes and Nuclear Technologies to Improve the Utilization of Fibrous Feeds and Reduce Greenhouse Gas Emission from Livestock' (D3.10.27). The experts agreed to implement a first phase to be devoted to the evaluation of at least one of the core forages (i.e. rice straw, sorghum and/or maize stover, tropical grass, and Lucerne hay as a control) with up to 10 candidate enzymes (those evaluated in a related technical contract) at four recommended dose rates (none, low, medium, high). The second phase should involve *in vivo* evaluation of best-bet candidate fibrolytic enzymes to determine effects on animal productivity.
- The CM on feeding strategies (2012) aimed to discuss the nutrient use efficiency in livestock production systems on how to detect and quantify inefficient use of nutrients in different livestock production systems, how to close this efficiency gap to maximize resource use, and the role for nuclear and isotopic techniques. The experts highlighted the importance of having feed inventories for developing supplementation and conservation strategies, the need to promote forage production by using good quality seeds and good agronomic practices, and better understanding of the rumen ecology using e.g. 454 pyrosequencing and DGGE techniques.
- The CM on early pregnancy diagnosis in the bovine using nuclear and molecular techniques (2014) aimed to get acquainted on current status of scientific information in relation to pregnancy-

Bos indicus **cattle and its crosses with** ***Bos taurus*** **breeds are the foundation for livestock production in many tropical countries. They have the ability to produce and reproduce in harsh environments and are more resistant to ticks and tick-borne diseases**

associated molecules, and to develop a CRP proposal on this subject. The experts considered that the development, adaptation and validation of a biomarker-based approach involving nuclear and molecular techniques for pregnancy diagnosis at a very early stage of the gestation are realistic under the prevailing conditions of cattle/buffalo production systems in developing countries. The proposal received low priority and therefore not supported.

Some of the objectives, results and conclusions of CMs related to animal health were:

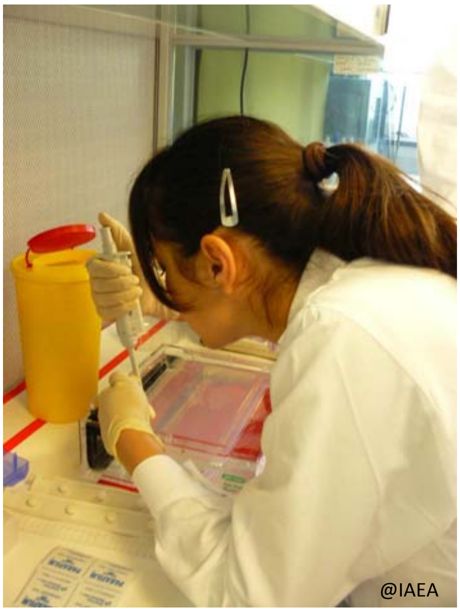
- The 2nd CM on developing standardized training material to establish EQA systems (2000) aimed to prepare generic documents in accordance with the new OIE Standard from which laboratory QA coordinators can develop their own material.
- The FAO GREP CM on rinderpest lineage 2 (2001) aimed to review the possible problems encountered with African Lineage 2 rinderpest virus infections and offer solutions and guidance for regulatory veterinary authorities and laboratories. The main concern was that the test may not measure antibodies against the lineage of virus as efficiently as compared to those from the vaccine strain. The experts drew on the data of key workers engaged in studies of morbillivirus epidemiology, pathogenesis and immunology.

Project team of TC PER/5/029 with Dr Jianlin Han, expert on animal genetics, visiting alpaca farms in the highlands of Peru in 2009

- A CM on guidelines for validation and certification of diagnostic assays for animal infectious diseases was held in 2002. The OIE Manual described 'The principles of diagnostic assay for infectious disease' but the term 'validated assay' could be misinterpreted; besides, the manual limited their application to international trade without considering any other situation. Therefore, the CM aimed to examine the possibilities for defining the requirements for testing based on 'fitness for purpose'. The experts identified eight purposes for animal disease diagnosis and indicated the assay characteristics needed for each one.
- A CM to plan a workshop for policy makers and senior officials under a FAO Project on use of veterinary drug residues was held in 2002. The expertise of the consultants was on risk analysis, maximum reside levels, drug registration, marketing authorization, and control and surveillance of drug residues. The experts supported the proposal of holding a workshop to strengthen the awareness of policy makers and public health officials on the importance of the control of veterinary drug residues, and then, to conduct three 2-week training courses targeted to 'middle management' staff in national laboratories.
- The CM in support of GREP activities (2003) defined technical guidelines and SOPs for the surveillance of rinderpest in Africa in connection with the OIE pathway.
- The CM on assay validation processes and procedures to guide the certification of animal disease diagnostic tests by the OIE in 2003 was a follow-up of a similar CM held in 2002 to produce a template and guidelines that will underwrite the development of an assay validation dossier for submission to the OIE.
- The CM on early warning devices and tools for early and rapid detection of animal diseases (2004) aimed to determine current and future technologies useful for early warning of the occurrence of pathogens and toxic agents affecting animal's health, potentially endangering public health and food security. The experts concluded that use of these tools was critical to the success of an early warning alert and disease system, that RT-PCR was currently the genetic amplification device of choice, that direct detection methods were becoming more available and should be the method of

choice in the medium to long term, and that proficiency reference standards should be developed, characterized and catalogued.

- The CM on education to improve the quality of research (2004) aimed to find mechanisms that allow CRP and TC project counterparts a better understanding of problems related to their research work. The extension of technology into real impact is in the hands of individuals and groups who should be able to identify, plan and implement work to a common end for national and regional interests.
- The CM on molecular techniques applied to FMD (2005) aimed to evaluate current and prospective methodologies for the diagnosis of the disease. Molecular based tests may offer advantages but at that time, molecular based assays were not validated beyond stage 1 or 2 of OIE guidelines. Various protocols were collected and assembled for a future IAEA publication in the OIE Review to aid laboratories interested in molecular methods.
- The CM on standards, referencing and validation assays (2006) was aimed to examine the current process and make recommendations for changes and improvements, especially on consideration of the progress on kit certification by OIE, and various aspects related to standards for serological and molecular tests for livestock diseases. Discussions focussed on the needs for reference materials in biological situations; IQA aspects, external comparison of tests at various levels; can EQA be achieved made in different ways?; standards for antigen and nucleic acid detection assays; and analytical sensitivity vs. diagnostic sensitivity.
- A 2nd CM on early warning devices and tools for early and rapid detection of animal diseases was held in 2006 to evaluate progress and recommend future direction in the development of tools used for detection of transboundary animal diseases, including zoonotic agents. It was concluded that gene amplification technology has demonstrated value and warrants further expansion of multiplex capabilities, miniaturization, speed, portability, and ruggedness.



Participant of a training course at Seibersdorf on the use of molecular techniques for the diagnosis of avian influenza (2009)

- The CM on research being undertaken on FMD (2007) aimed to ensure that research conducted under various programmes on FMD are coordinated and built on each other to avoid duplication and competition and to ensure the maximum use of available resources. The meeting discussed topics involving the improvement of more conventional methods and products for FMD control as well as ‘novel’ approaches. In addition, vaccines, immunology, communication and harmonization were identified as relevant research areas. The experts recommended a new CRP to continue the coordination of FMD research for its progressive control.
- A 3rd CM on early warning devices and tools for early and rapid detection of animal diseases was held in 2008 as follow-up of the previous two meetings. The experts agreed that APH should continue to aid in coordination of global efforts to develop, deploy, and support the use of early warning technologies for detection of animal and human pathogens or toxic agents that threaten the safety of the world’s animals, food supply, and public health.
- The CM on the socio-economic impact of disease prevention (2009) aimed to identify methods to measure it and to measure the impact of international organizations on the global community.
- The CM on irradiated vaccines for the control of livestock diseases (2009) aimed to examine vaccine technology in relation to radiation. The consultants suggested considering *Trypanosoma evansi* and *T. vivax*, *Theileria annulata*, *Dictyocaulus vivaparus*, *Schistosoma bovis* and *S. japonicum*, *Fasciola gigantica* and *Haemonchus* as potential pathogens for inclusion in the

irradiated vaccine project. Also, some viral vaccines where irradiation can lead to safer and more efficient products as in the case of RVF.

- The CM on the use of stable isotopes for traceability of migratory birds involved in the spread of avian influenza (2009) aimed to discuss the use of stable isotope analysis (SIA) to determine migratory connectivity in wild water fowl and the implications for understanding the role of wild birds in the dissemination of highly pathogenic avian influenza (HPAI) viruses and to provide the basis for a CRP on this topic. The experts suggested to liaise with the Animal Health Service in FAO (AGAH) in developing the programme, and to consider countries in regions that are known ‘hotspots’ and countries that are on migratory wild bird flyways. Samples should be based on feathers.

Trained laboratory personnel in Cameroon collecting samples for disease control

- The CM to develop a roadmap for the implementation of modern OIE principles and methods of diagnostic test validation was held in 2010. The meeting was jointly organized by APHL as OIE Collaborating Centre for ELISA and Molecular Techniques in Animal Disease Diagnosis and the OIE to develop a module-type course manual based on the OIE concept, to develop an implementation plan for regional training courses and workshops, and to identify regional laboratories and individuals, who could serve as trainers. A framework for a training manual with key elements was produced, which included a description of the target audience, identification of 10 training modules and a proposal to conduct these training courses.
- The 2nd CM on the use of stable isotopes to trace wild bird movements in correlation with the occurrence of avian influenza was held in 2010. Further discussions on the proposal for the CRP ‘Use of Stable Isotopes to Trace Bird Migrations and Molecular Nuclear Techniques to Investigate the Epidemiology and Ecology of the Highly Pathogenic Avian Influenza’ were conducted. The bar-headed goose was recommended by the experts to be used as a focal species for the CRP as this species was significantly impacted by HPAI H5N1. The consultants also recommended not only measure the deuterium isotope in keratinous tissues but other stable isotopes (strontium, lead, sulphur, etc.), heavy metals, and trace elements. The proposed CRP was approved in 2011 (D3.20.30).
- The CM on upcoming technologies for early and rapid diagnosis of infectious diseases (2011) aimed to present the latest technologies for detection of TADs and to discuss the level of their validation and harmonization. Among them were the multiplex diagnostic platforms for protein or DNA/RNA detection. The experts outlined some approaches on how to implement these technologies in Member States to improve animal health.
- The 3rd CM on stable isotopes and DNA barcoding in tracing migratory pathways of wild birds related as carriers to avian influenza viruses (2011) aimed to evaluate the possibility of applying two technologies (stable isotopes and DNA barcoding to simultaneously determine the bird species and the presence of the virus in faecal samples) to establish epidemiological linkages between long range migration of wild birds and spread of the virus at different stopover points of wild migratory birds.
- The CM on applying GLP (2012) aimed to discuss the applications of appropriate molecular diagnostic technologies and platforms suitable for veterinary testing laboratories with minimum resources, recommendations on practical implementation of GLP conditions, the multidisciplinary approach, core facility and sustainability in veterinary diagnostic and testing laboratories of Member States.

- The CM on advanced technologies for rapid detection and characterization of existing and emerging vector-borne pathogens of livestock (2012) focused on the use of next generation sequencing, metagenomics in detection of animal pathogens, luminex and DNA chip-based assays, and microarrays.
- The CM on early warning tools for detection of vector borne diseases of animals, including zoonoses (2013) aimed to discuss available and feasible solutions for ASF, blue tongue, and West Nile fever and others. Trapping vectors and evaluation of the epidemiological risk to transmit disease (number of vectors per unit geographical surface, vector differentiation and techniques for pathogen detection in the vectors and vector mapping) have been shown as a weak point in the surveillance systems of many Member States.

Hands-on in laboratory work to strengthen technical capabilities of scientists from developing countries has been the main issue in APH training courses

PROGRAMMATIC ACTIVITIES IN SUPPORT TO THE TECHNICAL COOPERATION DEPARTMENT

Technical Cooperation Projects

A total of 163 TC projects started in the period 2000–2014 (Table 41) as compared to 193 projects in the period 1984–1999. Among the 163 projects, 143 were national projects, 16 were regional projects and one interregional. In comparison with the previous period, the number of national projects in Africa increased by 54%, while the number of national projects in European and Latin American countries decreased by 60 and 73% respectively. On the other hand, the number of national projects in the Asia & Pacific region showed no changes.

TABLE 41. TECHNICAL COOPERATION PROJECTS IMPLEMENTED BY THE ANIMAL PRODUCTION AND HEALTH SECTION IN THE PERIOD OF 2000 TO 2014

TC projects	National	Regional	Interregional	Total
Africa	93	15		98
Asia & the Pacific	27	6		33
Europe	6	3		9
Latin America	20	2		22
Global			1	1
Total	143	16	1	163

National TC projects were implemented in 61 Member States (35 African, 10 Asian, 6 European and 10 Latin American Member States). These figures show a switch to a larger spectrum of African countries (35 vs 24 countries in the previous period) and a significant reduction of countries that benefitted from TC projects in the other regions, especially in Latin America (10 vs 19 countries in the previous period).

Mongolia had the largest number of TC projects (7), followed by Myanmar (6), Angola, Burkina Faso, Cameroon, Eritrea and Sudan (5 each), and Benin, DRC, Côte d'Ivoire, Kenya, Mali, Sierra Leone and Uganda (4 each). Twenty five Member States had only one TC project in this period.

The number of TC projects associated to the animal health field was 56% of the total number of projects; however, there were 12% of projects with both production and health components (Figure 34). The proportion of TC projects associated to the field of animal health increased as compared with the previous period (from 45 to 56%) while decreased the proportion for TC projects dealing with animal production and for projects with both components.

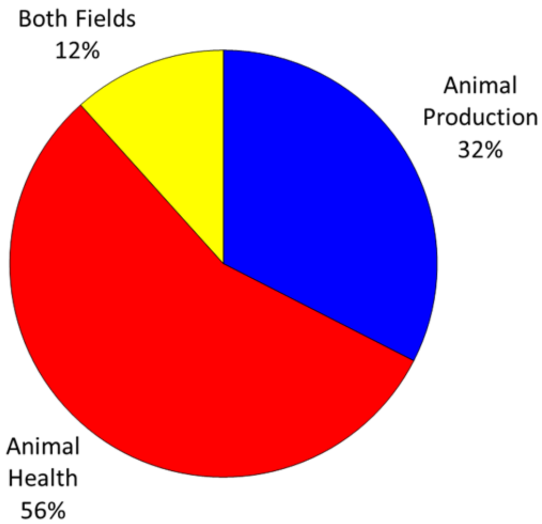


FIG. 34. TC projects that started in the period 2000–2014 according to the field of activity (n=163)

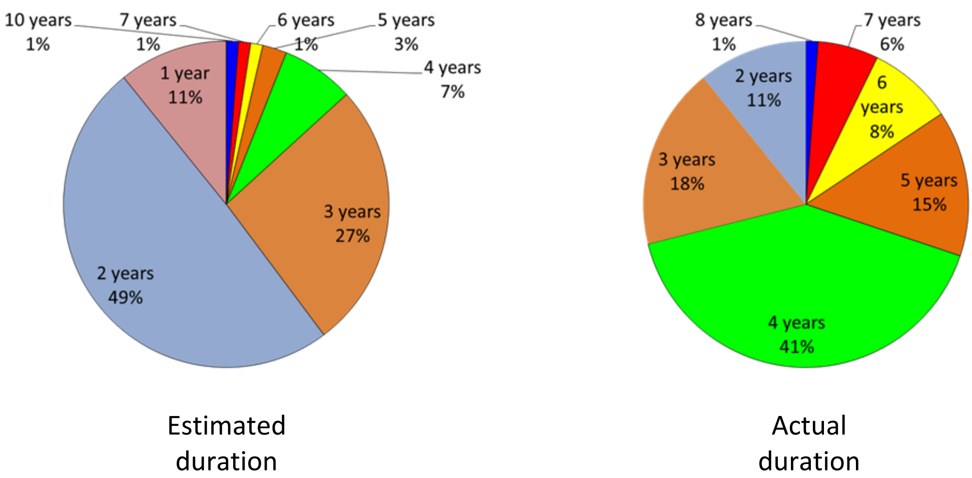


FIG. 35. Frequency of National TC projects initiated between 2000 and 2009 (completed TC projects in the period 2000–2014) based on the estimated and actual duration (in years)

The estimated (approved) duration for most National TC projects varied from 1 to 4 years, shorter average duration as compared to the period 1984–1999, which is in line with the current policies of the IAEA TC Department of reducing the duration of the projects to two years. On the other hand, the

actual duration of the projects that were completed in the period (83 out of 143 projects) varied from 2 to 8 years with a mean and a median of 4 years (Figure 35).

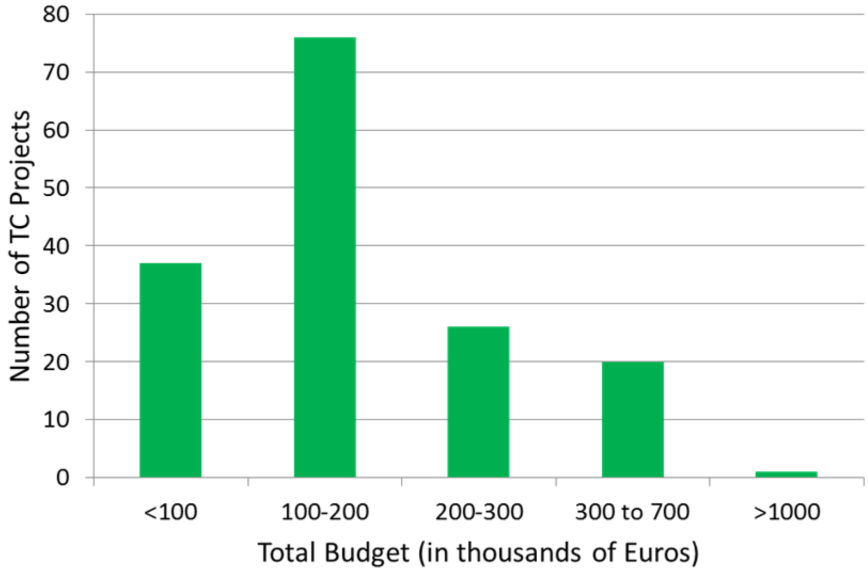


FIG. 36. Number of National TC projects initiated between 2000 and 2014 based on the total budget (in thousands of euros)

The total TC Budget allocated for TC projects implemented by APH in the period of 2000 to 2014 was close to €30 million. The TC budget per National TC project was quite variable, varying from close to €17 000 000 to projects in Eritrea (2000) and Thailand (2012) to a €1.7 million in a 7-year AFRA regional project to provide assistance to OAU/IBAR PACE programme for the control and eradication of major livestock diseases. Most projects were in the range of €100 000 to 200 000 (Figure 36). The average budget was €188 500 and the median was €154 000, without much difference in the total budget according to regions (€167 000 per project in Europe, €179 000 per project in Latin America, €183 000 per project in Africa and €212 000 per project in Asia).

The budget per project was relatively larger than in the period 1984–1999, and more projects were in the range of €100 000 to 300 000 and less projects with less than €100 000.

Training Courses

There were 73 training courses of which 52 were regional and 21 were national. Regional training courses were conducted under projects supported by regional agreements (AFRA, ARCAL, RCA and ARASIA) and the exception being Europe as there is no such type of agreements with the IAEA (Table 42). There were more training courses in Asia and the Pacific region and fewer courses in Latin America in the field of animal production as compared to the period 1984–1999. In the case of animal health, the difference was the implementation of courses in Europe (n=8). Nearly 50% of the training courses were held in African countries. On the other hand, there were no interregional training courses under the TC programme in this period.

Regional training courses in the field of animal production focussed on:

- Artificial insemination and strategies for improving reproductive performance (n=7)
- Animal nutrition, including rumen microbial protein, quantification of tannins, methane emission (n=4)

- Data collection and data analysis for breeding improvement (n=3)
- Preparation of reagents, tracer and QC samples for radioimmunoassay (n=2)
- Immunoassay and related techniques in livestock reproduction (n=1)
- Participatory approaches (n=1)
- Genetic characterization of livestock (n=1)

Regional training courses in the field of animal health focussed on:
- Molecular techniques for disease diagnosis (n=7)
- Early and rapid techniques for animal disease diagnosis (n=7)
- Molecular techniques for the diagnosis of fasciolosis (n=5)
- Rapid diagnosis of avian influenza (n=4)
- Bioinformatic and genomic tools for disease control (n=4)
- QA in veterinary diagnosis laboratories (n=3)
- Transboundary animal disease surveillance (n=2)
- Risk analysis for transboundary animal diseases (n=1)

TABLE 42. REGIONAL TC TRAINING COURSES IMPLEMENTED PER REGION FROM 2000 TO JUNE 2014

Region	Agreement	Field of activity		Total
		Animal production	Animal health	
Africa	AFRA	7	16	23
Asia & the Pacific	RCA/ARASIA	12	4	16
Europe	- -	0	8	8
Latin America	ARCAL	0	5	5
Total		19	33	52

Out of the 52 regional training courses, one lasted for three weeks (in 2004), 18 for two weeks and 33 for one week, totalling 360 working days (25 working days per year). The total number of regional training courses was quite similar to the period of 1984–1999 (52 vs. 49); however, the average duration of the training courses was much shorter and therefore the total number of working days was close to half.

Participants of the training course on classical and molecular veterinary virology, held in Seibersdorf, Austria in 2011
Course supported by extra-budgetary funds (US-AID tripartite Identify project)

The number of regional training courses per year was fairly constant, e.g. 4, with a trend to increase in the last two years (Figure 37).

National training courses under TC projects were rarely recorded as formal courses and therefore were unaccounted. Usually, experts visiting project sites were requested to provide a series of lectures or project counterpart organize a local course where the main speaker was the TC expert. The TC Department and APH found that local courses offered great opportunities to disseminate knowledge and to facilitate hands-on laboratory experience to groups larger than just the project

teams, and the cost was a fraction of the standard regional training courses. National training courses were then widely encouraged.

A total of 21 national training courses were recorded in 15 Member States (Table 43, Figure 38), especially in Eritrea (n=4), Mongolia (3), Bolivia and Sudan (2 each). Among these, 16 courses focused and animal disease diagnosis, epidemiology and control, and 5 on artificial insemination. Courses lasted 1 (n=6) or 2 weeks (n=14); however, one national course lasted for 3 weeks in Mongolia in 2002.

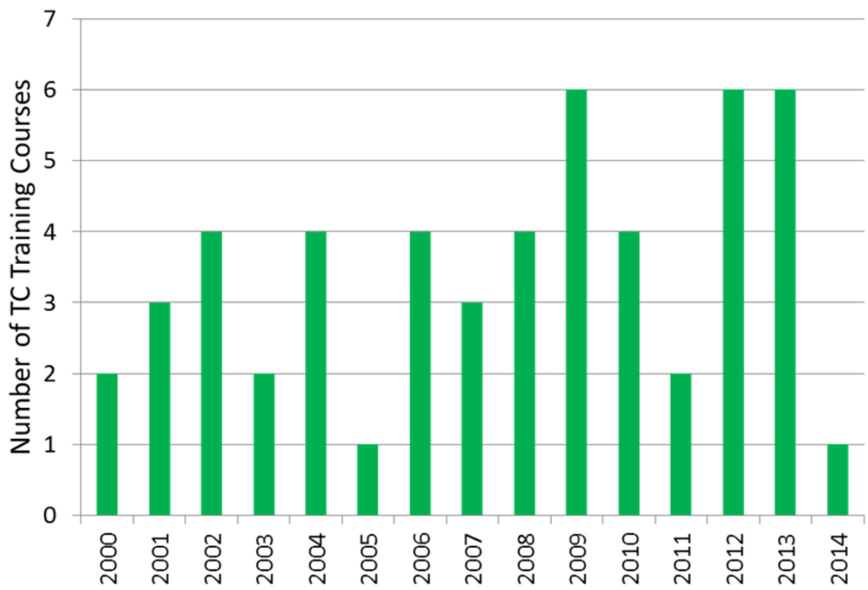


FIG. 37. Number of Regional TC training courses per year (2000 to June 2014)

TABLE 43. NATIONAL TC TRAINING COURSES IMPLEMENTED PER REGION FROM 2000 TO JUNE 2014

Region	Field of activity		Total
	Animal production	Animal health	
Africa	4	7	11
Asia & the Pacific	2	4	6
Europe	0	1	1
Latin America	0	3	3
Total	6	15	21

International recognized scientists were recruited by the IAEA as lecturers for both regional and national training courses. The host institutes also nominate local scientists with vast experience on course topics as local lecturers.

In 52 regional training courses, scientists from 42 Member States and the IAEA participated in 206 occasions as lecturers (18 of them were local lecturers and 30 were IAEA staff – TOs and APHL staff–). Figures and proportions were rather similar to the period 1984–1999, with the exception of IAEA staff level of participation as lecturers (1.34 vs. 0.75 IAEA staff per course in the periods of 1984–1999 and 2000–2014, respectively).

The distribution of lecturers according to the region of origin is shown in Figure 39. Out of the 162 recruited lecturers, 103 were from developing countries and 57 from developed countries. The rate of lecturers from developing countries was much higher in this period (63.9%) than in the period 1984–1999 (51.2%).

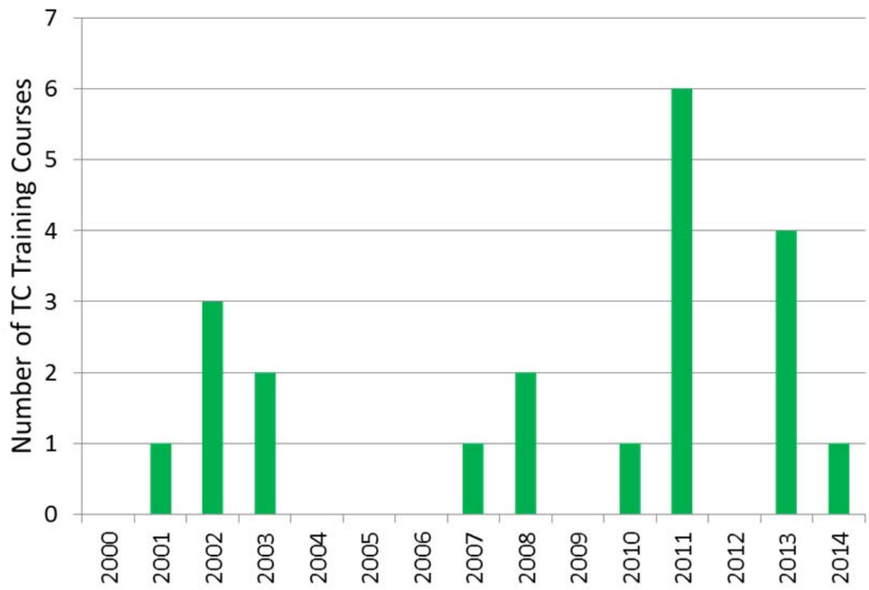


FIG. 38. Number of National TC Training courses per year (2000 to June 2014)

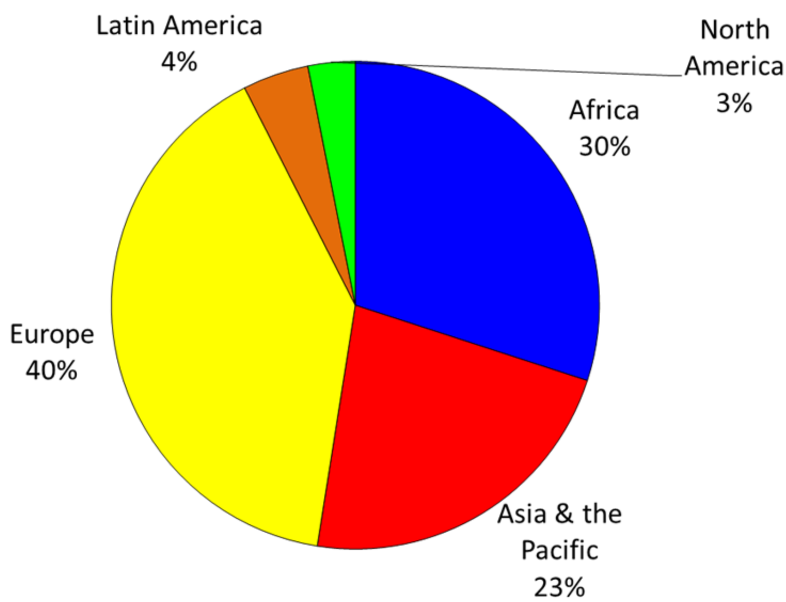


FIG. 39. Lecturers (n=160) in 52 training courses according to the region of origin (Note: IAEA lecturers are not included)

When considering both regional and national training courses, 17 TOs participated as course supervisors, where H. Unger was the TO in 17 courses, O. Perera and G. Viljoen in 6 courses each, M. Garcia and J. Crowther in 6 courses each, and I. Naletoski in 5 courses.

There were 896 course participants from 96 countries in the 52 regional training courses and 448 trainees from 13 countries in 21 national training courses. The distribution of course trainees according to the region of origin is shown in Figure 40. The proportion of African trainees was similar but the proportion of Asian and European trainees was higher at the expenses of Latin Americans as compared to the period 1984–1999.

In regional training courses, 166 trainees out of 896 (18.5%) were local participants. On average, there were 14.0 trainees from abroad and 3.0 local trainees per regional training course. These numbers and rates were similar to those in the period of 1984–1999. The average number of trainees per course was 17.9.

In national training courses, the average number of trainees per course was 21.3. The lowest number of participants was 10 in six courses. Also, there were three courses with 45–52 participants.

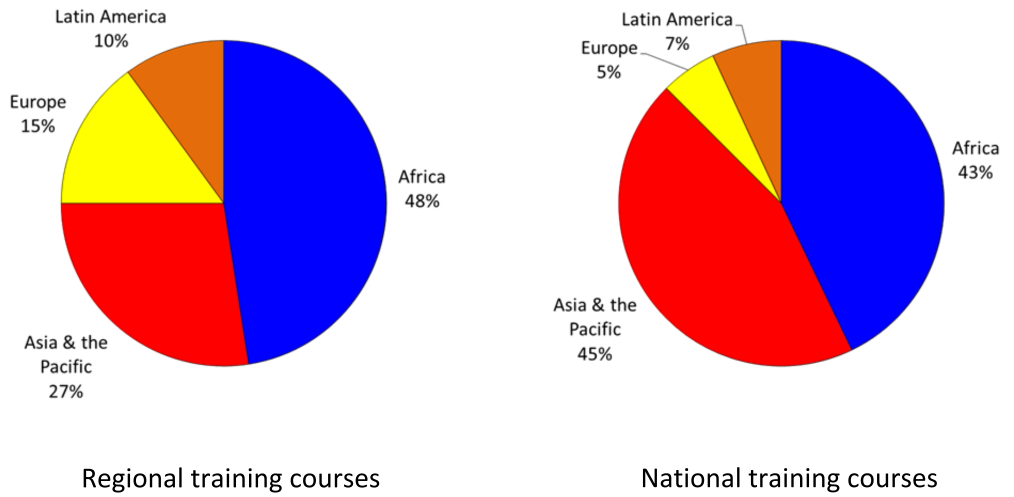


FIG. 40. Proportion of trainees in regional (n=896) and national (n=448) training courses according to their countries of origin that participated in 52 regional and 21 national training courses implemented from 2000 to June 2014

The largest number of persons trained per country when considering both regional and national training courses were:

- In Africa: from Mozambique and Sudan (n=50 each), Eritrea (47), Zambia (39), Madagascar (33), Uganda (28), Ghana (26), Sierra Leone (25), Egypt (21), Botswana, Kenya, Mali, and Morocco (20 each), Cameroon (19), United Republic of Tanzania and Zimbabwe (18 each), Burkina Faso (16), Niger (15), Algeria, Angola and Tunisia (12 each), Senegal (11), and Ethiopia (10).
- In Asia and the Pacific: from Mongolia (n=100), Pakistan (64), Yemen (62), Indonesia (28), Myanmar (22), Iraq (20), Thailand (17), Jordan and Sri Lanka (15 each), Bangladesh (14),

Viet Nam (13), China and Malaysia (12 each), India (11), Philippines (10) and Syrian Arab Republic (8).

- In Europe: from Tajikistan (n=28), Bulgaria (19), the former Yugoslav Republic of Macedonia (12), Turkey (11), Bosnia and Herzegovina (10), Albania, Croatia and Montenegro (9 each).
- In Latin America: from Bolivia (n=38), Peru (19), Cuba (13), Argentina and Uruguay (12), Mexico (11) and the Bolivarian Republic of Venezuela (6).

Expert Missions

There were 391 expert missions in support of national and regional TC projects (Table 44) in the period 2000 to June 2014. The number of expert missions varied from 6 to 66 per year with a mean of 26 and a median of 19 missions per year (Figure 41). The number of expert missions in the 14 year period was much less than in the previous 9 year period (1991–1999). The proportion of experts visiting African and European institutes was rather similar but expert missions to Asia and Latin America were reduced by 50 and 75%, mainly due to the less number of TC projects in those regions.

TABLE 44. NUMBER OF EXPERT MISSIONS ACCORDING TO THE HOST REGION (2000–JUNE 2014)

Region	Number of expert missions
Europe	34
Asia	63
Latin America	64
Africa	230
Total	391

Most expert missions lasted for 5 (55%) and 10 working days (36%), while longer assignments were less frequent (Figure 42). Expert missions were shorter as compared to the period 1990–1999. The aim of the visits were usually to train project counterparts on the use of molecular techniques and related equipment, in laboratory data interpretation, and in the application of the techniques in support of field activities related to improved feeding, better reproductive efficiency and on the control and surveillance of animal diseases.

Staff of the Agence nationale de développement de l'élevage (Bangui, Central African Republic) evaluating the ovaries of a cow as part of the training conducted by the IAEA Expert N. Slimane

Experts came from 57 countries, especially from UK (42 missions), Mali (28), USA (25), Germany (21), South Africa and Tunisia (20 each), France and Kenya (17 each), Côte d'Ivoire and Netherlands (13 each), Sri Lanka and Uruguay (11 each), and Australia, Cameroon and Peru (10 each). Fourteen countries contributed with one expert mission during the studied period. In general, most experts were based in Europe and Africa (35 and 34% of expert missions respectively); however, other regions were almost equally represented (Figure

43). Host institutes receiving experts were mainly in Africa (59%) while other regions were equally supported (Figure 43). The proportion of expert mission to Africa and the proportion of African experts were larger as compared to the period 1990–1999.

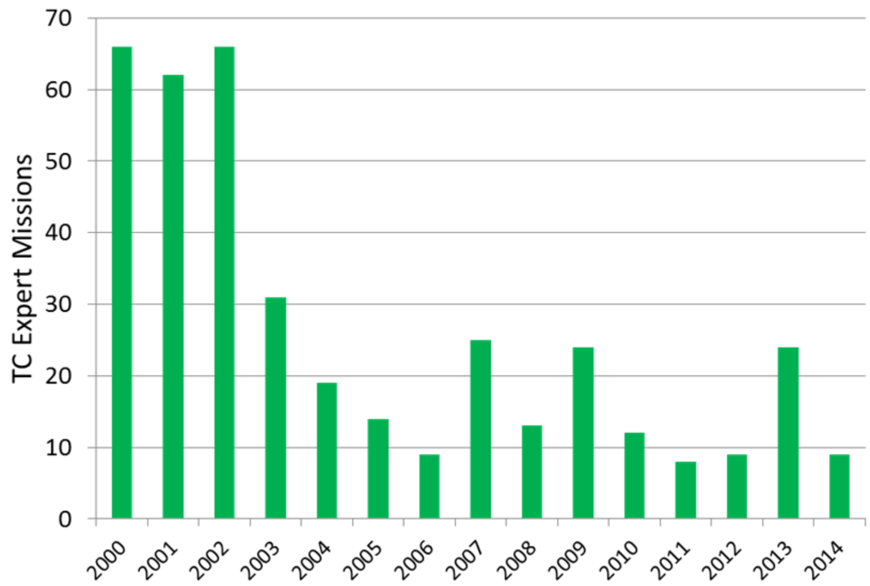


FIG. 41. Frequency distribution of expert missions in the period 2000 to June 2014

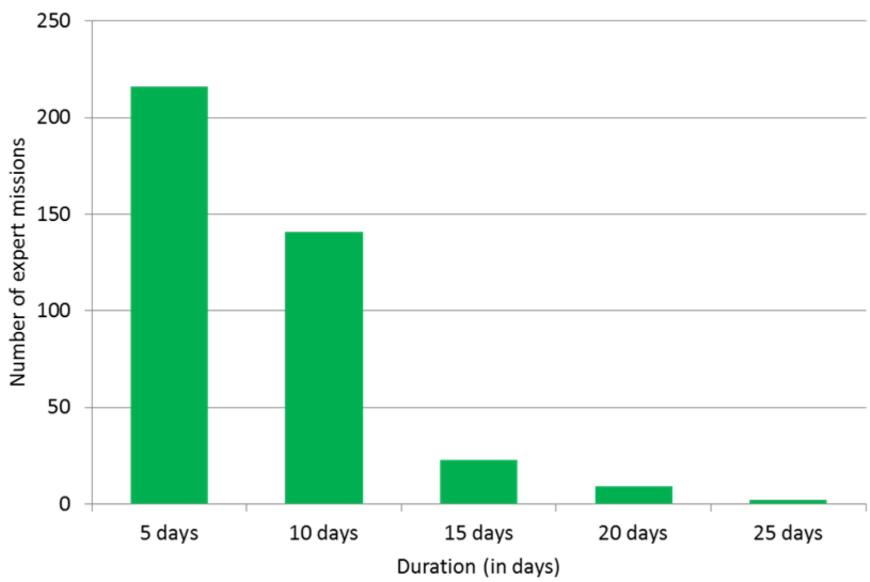


FIG. 42. Number of expert missions according to the length of the assignments in the period 2000 to June 2014

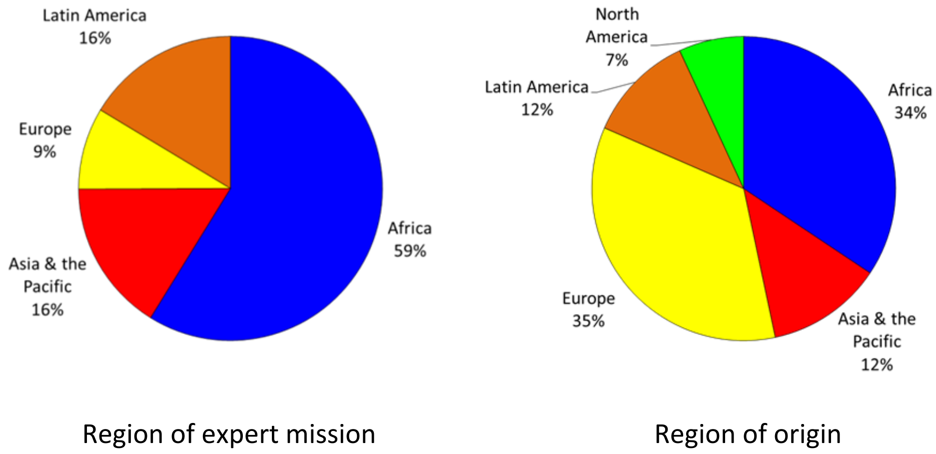


FIG. 43. Expert missions based on the region of assignment or the region of origin of the expert (n=391 expert missions)

The largest proportion of expert assignments was carried out by men (89%, Figure 44). Also, 60% of the missions were related to animal health activities (Figure 44) which was in line with the larger number of TC projects dealing with animal health. These figures were similar to those in the period 1990–1999.

The 391 expert missions were carried out by 224 experts. Among them, K. Tounkara, Mali (25 missions), N. Slimane, Tunisia (17), E. Couacy-Hymann, Côte d'Ivoire (13), R. Geiger, Germany (9), M. Garcia, Peru (8), and H. Bayemi, Cameroon and D. Cavestany, Uruguay (6 each). On the other hand, 158 experts were recruited only once (70.5% of the missions) and 40 experts were recruited twice.

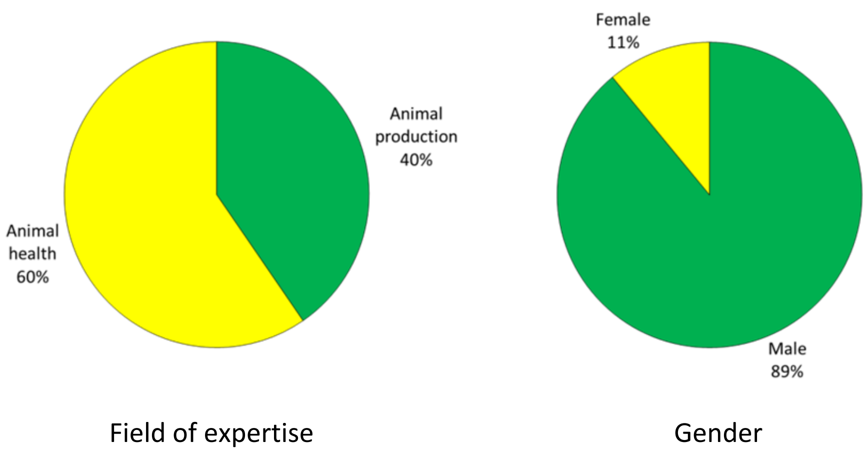


FIG. 44. Frequency of expert missions based on the gender or field of expertise of the expert (n=391 expert missions)

Fellowships and Scientific Visits

There were 627 individual fellowship training and 112 scientific visits related to animal production and health awarded through TC projects in the period (Table 45), which means 68.5 and 57.7% larger

number of fellowships and scientific visits than in the period of 1984–1999. The number of scientists trained from African countries had a 4-fold increase while the number of Latin Americans decreased by half in this period, which correlated with the number of TCs per region.

Trainees came from 72 Member States:

- In the case of Africa, the largest number of trainees came from Burkina Faso (41), United Republic of Tanzania (38), Sudan (27), Cameroon (23), Botswana (22), Kenya (21), Angola, Central African Republic and Mali (19 each), Uganda (18), Niger and Sierra Leone (17 each), Algeria (16), Benin (15), Mauritania and Zambia (14 each), DRC (13), Namibia and Zimbabwe (12 each), Morocco (11), Ethiopia, Madagascar and Mozambique (10 each), and Eritrea and Nigeria (9 each).
- In the case of Asia and the Pacific, the largest number of trainees came from Mongolia (38), Myanmar (18), Indonesia (13), Yemen (11), Sri Lanka (9), and Bangladesh (8).
- In the case of Latin America, the largest number of trainees came from El Salvador (30), Peru (15), Bolivia (11), and Honduras (9).
- In the case of Europe, the largest number of trainees came from Bulgaria (9) and Bosnia and Herzegovina and Tajikistan (7 each).

The Italian Expert Dr Maria Dattena showing the procedure for artificial insemination in ewes during the Regional RAS/5/063 training course, held in Sidi Thabet, Tunisia in 2012

Out of the 739 fellowships and scientific visits, 64 persons were trained twice, 9 were trained trice and 2 were trained in four opportunities. The number of scientists trained per year substantially decreased from year 2002 till 2005; and since then, the number of individual training per year varied from 40 to 80 without a clear pattern (Figure 45).

TABLE 45. NUMBER OF TRAINEES (FELLOWSHIPS AND SCIENTIFIC VISITS) ACCORDING TO THE REGION OF ORIGIN

Region	Number of trainees		Total
	Fellowships	Scientific visits	
Asia	92	24	116
Europe	40	10	50
Africa	412	62	474
Latin America	83	16	99
Total	627	112	739

The fellowship training period varied from 0.5 to 14 months; however, most of the trainings were for 1 or 3 months (Figure 46). In the case of scientific visits, most of them lasted for 2 weeks. The duration of training periods was shorter than in the period of 1984–1999.

Figure 47 shows the proportion of trainings in relation to the field of expertise and the gender of the trainee. The ratio of scientists that were trained either in topics related to animal production (nutrition, reproduction and breeding) and animal health (disease control and diagnostic) reflected the ratio of TC projects dealing with these two disciplines. Besides, there was a substantial increase in the ratio towards animal health as compared to the period 1984–1999. On the other hand, there was a slight increase in the proportion of female trainees.

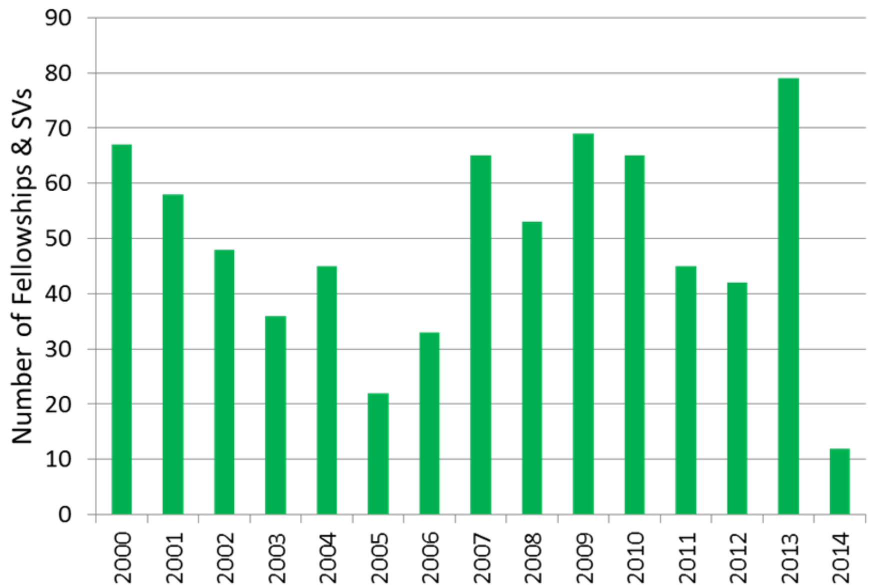


FIG. 45. Number of completed fellowships and scientific visits in the period 2000 to June 2014

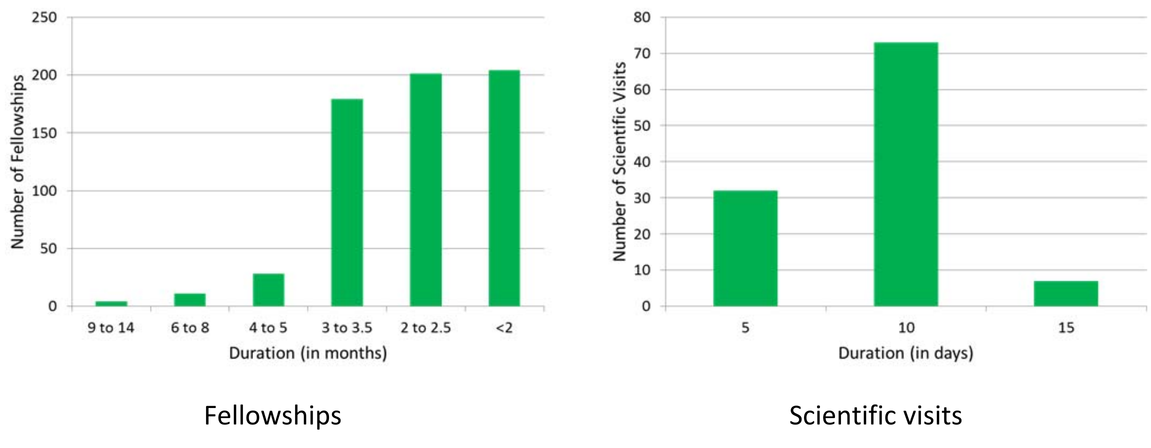


FIG. 46. Duration of the training under fellowships (in months) and scientific visits (in working days) in the period 2000 to June 2014

IAEA TC policies related to host institutes emphasized in the last 15 years that training should preferably be carried out within the region of the trainee unless suitable expertise is unavailable. Based on this, a different geographical scenario was observed in this period as compared with the period of 1984–1999. African institutes hosted most of the fellowship training as most TC projects were awarded to African institutes (Figure 48). Nevertheless, given the characteristics and purpose of the

scientific visits, the largest number of them was conducted in European institutes (Figure 48). It is also worth to mention that APHL received fewer percent of trainees as compared to the previous period.

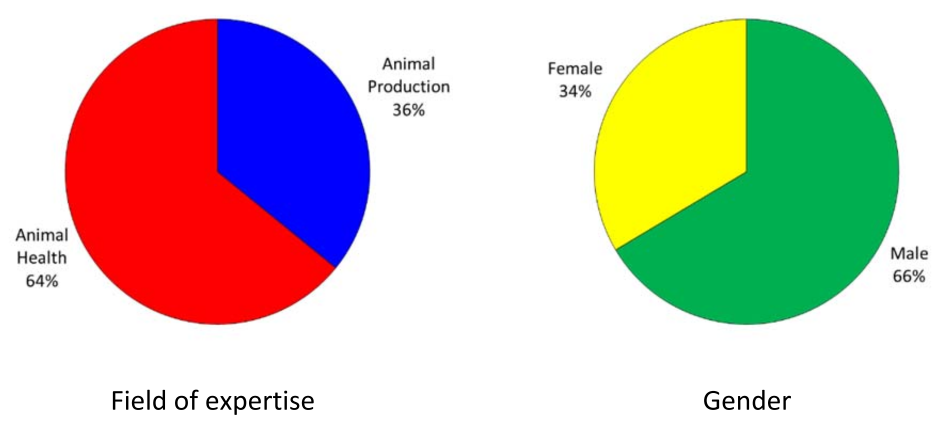


FIG. 47. Distribution of trainings (fellowships and scientific visits) based on the field of expertise and gender of the trainee (n=739)

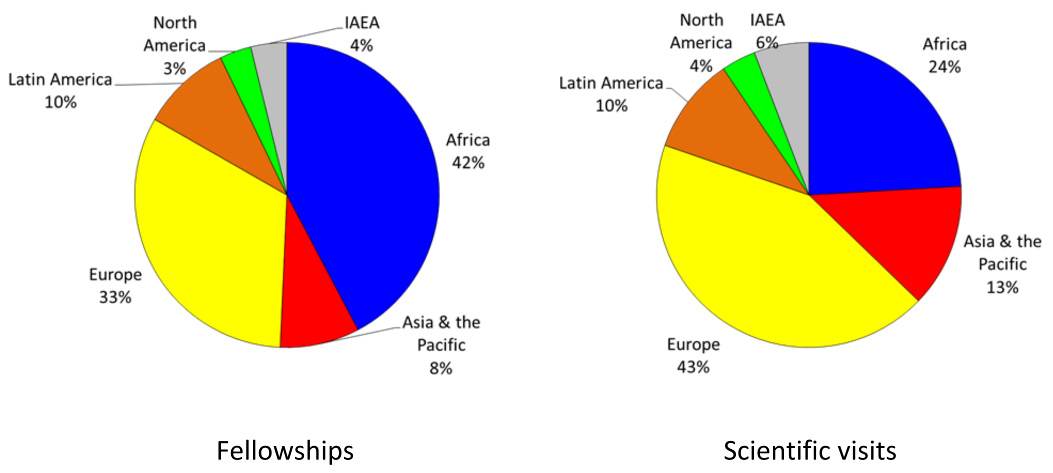


FIG. 48. Geographical distribution of host institutes for fellowship training (n=627) and scientific visits (n=112)

The most popular host institutes for fellowship training and scientific visits were in South Africa (82 persons trained), Tunisia (54), IAEA Seibersdorf Laboratories (45), France (43), UK (29), Spain (27), Kenya (18), Senegal (17), Australia, Cameroon, Germany, the former Yugoslav Republic of Macedonia, and USA (16 each), Italy (15), Brazil (14), and Côte d'Ivoire and Namibia (13 each). In the case of scientific visits, France and Italy (10 each), IAEA, UK and Tunisia (8 each), Kenya and South Africa (7 each), Sweden (6), Spain and Netherlands (5 each), and Australia, Brazil and Canada (4 each) were the most visited. Figure 49 shows the most frequent destinations for fellowship training in the period 2000 to June 2014.

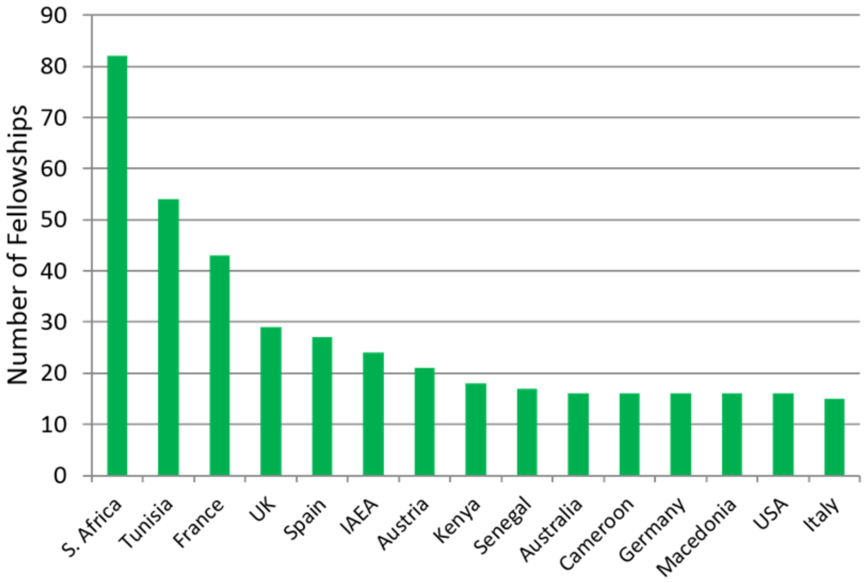


FIG. 49. The 15 most frequent destinations for fellowship training during 2000 to June 2014

Technical Meetings

Forty seven TC technical meetings for defining work plans, evaluating progress and discussing specific activities (e.g. Customization of AIDA Database, Harmonization of procedures for selection and management of artificial insemination bulls, Accreditation procedures for veterinary laboratories, Quality systems in veterinary laboratories, Biosafety training in BSL3 laboratories) were implemented in the period 2000–June 2014.

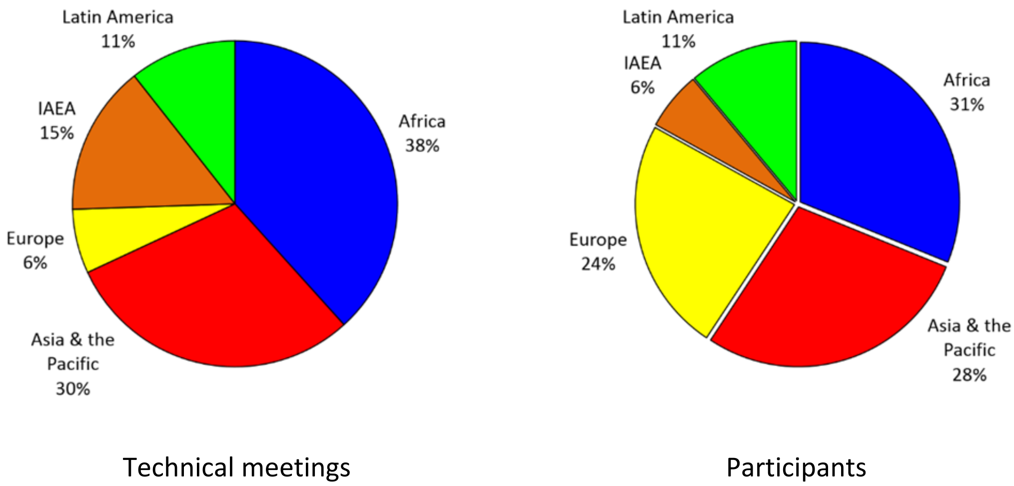


FIG. 50. Frequency of TC technical meetings per region (left) and meetings participants according to the region of origin (right)

Among the technical meeting, 42 were implemented under 17 Regional TC projects, and 5 meetings under 5 National TC projects (Botswana, Mongolia, Panama, Peru, and Sri Lanka). There was an equal distribution of meetings in relation to the animal production (n=23) and animal health fields

(n=24). Most meetings were implemented in host African and Asian institutions, and 15% of them at IAEA Headquarters in Vienna (Figure 50).

Under the Africans RAF/5/046 ‘Increasing and Improving Milk and Meat Production’, RAF/5/053 ‘Assistance to OAU/IBAR PACE Programme for the Control and Eradication of Major Diseases Affecting Livestock’ and RAF/5/057 ‘Strengthening Capacities for the Diagnosis and Control of Transboundary Animal Diseases in Africa (AFRA)’ were conducted 8, 4 and 3 meetings, respectively; under the Asians RAS/5/035 ‘Better Management of Feeding and Reproduction of Cattle (RCA)’ and RAS/5/44 ‘Integrated Approach for Improving Livestock Production Using Indigenous Resources and Conserving the Environment (RCA)’ were implemented 6 and 4 meetings respectively; and under the on-going European RER/5/016 ‘Supporting Coordinated Control of Transboundary Animal Diseases with Socioeconomic Impact and that Affect Human Health’ three meetings were implemented. Other regional projects organized 1 or 2 meetings during their lifespan.

The artificial insemination programme conducted by the National Artificial Insemination Centre (NAIC) in Arusha, United Republic of Tanzania, includes technical support to the Maasai community, where inseminators have been trained and frozen semen from local bulls is provided

A semen processing laboratory was fully established at the *Instituto Hondureño de Investigaciones Médico Veterinarias* (IHIMV), through TC project HON/5/004 in 2007–2009

The duration of these events was usually five working days; however, nine of then lasted for 2 to 4 days and one in Colombia under the TC RLA/5/046 ‘Sustainable Animal Production on Landscapes of Venezuelan-Colombian Orinoquia’ lasted for two weeks.

A total of 712 scientists participated in the 42 regional meetings, resulting in 17 participants per meeting (range: 5 to 46). In the case of the 5 national TC meetings, 129 people attended (average of 25.8 and a range of 2 to 55 participants). In most cases an IAEA TO coordinate these meetings. Among TOs, O. Perera coordinated 14 meetings, and I. Naletoski, H. Unger and P. Boettcher coordinated 6, 6, and 4 respectively.

Participants in technical meetings under Regional TC projects came from 101 Member States (Figure 50). Among them, 67 were local participants and 645 came from foreign countries. The participation of recruited experts on these meetings as resource persons was common.

- In the case of Africa, the largest number of meeting participants was from Zambia (20), Kenya and United Republic of Tanzania (18 each), Ethiopia and Uganda (15 each), South Africa (14), Sudan (13), Algeria (12), Tunisia (11), Cameroon (10), and Botswana, Burkina Faso and Ghana (9 each).
- In the case of Asia and the Pacific, they were from Thailand (25), Indonesia (24), China (20), Sri Lanka (19), Pakistan and Philippines (17 each), Viet Nam (16), Bangladesh, India, Malaysia and Myanmar (15 each), and Australia (10).

- In the case of Europe, they were from Bulgaria and Greece (12 each), Croatia (11), and Hungary, the Former Yugoslav Republic of Macedonia and Montenegro (9 each).
- Latin Americans had little participation in these meetings, where the Bolivarian Republic of Venezuela, Peru and Colombia had 8, 7, and 4 participants respectively.

ANIMAL PRODUCTION AND HEALTH LABORATORY

The Provision of RIA and ELISA kits and the EQA Programme

The FAO/IAEA EQA programme on ELISA kits evolved into a support programme to establish quality systems in veterinary laboratories. The foundation of this approach was the new 'OIE Standard for Management and Technical Requirements for Laboratories Conducting Tests for Infectious Animal Diseases' which was developed under the substantial inputs of counterparts, international expert panels and the coordination and guidance of APH.

In 2001, APHL started the re-organization of its activities to strengthen its capabilities in gene-based technologies, based on the new technical direction of APH. In this respect, it was decided to transfer the kit production to Member States and therefore, the provision and technical support to RIA and ELISA kits was dramatically reduced. Then, the EQAP activities for ELISA kits were phased out by the end of 2002. Also, the laboratory support for progesterone RIA kits (EQ samples and provision of kits) was discontinued by 2002.

Molecular and Gene-based Technologies in Support to Diagnosis of Transboundary Animal Diseases

The renovation of APHL was completed by the end of 2001 and new equipment was purchased. APHL started with gene sequencing and PCR test development for disease diagnosis, and recombinant antigen production in both bacteria and baculovirus systems in early 2002.

APH exhibition during the IAEA 2011 General Conference showing the APH contribution to the global eradication of rinderpest

The phased-out EQAP evolved into the establishment of 'Quality Systems in Veterinary Testing Laboratories', based on the OIE standard. The input of APHL included the development and storage of reference materials to be used by Member States laboratories for monitoring the performance of assays, the development and validation of assays, and the implementation of proficiency testing rounds. On this, targeted diseases were rinderpest, PPR, CBPP and trypanosomosis. One of the activities consisted in the development of standards to be used by counterpart laboratories in the implementation of their molecular assays.

The IAEA signed a Memorandum of Understanding (MOU) in 2004 with the Austrian Agency for Health and Food security (AGES) for the use of the high-security laboratory this agency is operating in Vienna. This allowed APHL to receive samples from abroad for the diagnosis of PPR, rinderpest, capripox and FMD.

- *Rinderpest-PPR diagnostic tests*

APHL started a project in the frame of the PACE programme supported by the EU, to develop new and specific Rinderpest/PPR diagnostic tests, Rinderpest and PPR marked vaccines, along with CIRAD-EMVT (France) and the Institute of Animal Health-Pirbright Laboratory (UK). The participation of APHL was to produce new monoclonal antibodies and new recombinant antigens.

The Laboratoire de Pathologie Bovine de Bingerville, with the financial support of APH, produced reference PPR anti-sera for each of the four PPRV lineages. These sera were produced in sheep, goats and cattle.

The laboratory managed to develop a DNA construct which contains two fragments of PPRV RNA genome that can be used as targets for PPR diagnosis by PCR or as RNA transcription template. The development of a standard RNA sample was foreseen to be used in the PPR PCR ring test with participating laboratories. In addition, with other partners from Africa and Europe, APHL was involved in the development of a PPR marker vaccine with its companion test. In this project, one of the work packages was the mapping of the PPRV nucleoprotein (N) to identify its interaction sites essential for its functions. After having identified two regions involved in the nucleocapsid formation, work was implemented to study the interactions between N and matrix protein M. M and different N deleted mutants were co-expressed by recombinant baculoviruses in insect cells. The study identified one region which was critical for N-M interaction.

APHL is evaluating various procedures for developing irradiated-*Trypanosoma* vaccines in Seibersdorf Laboratories, as part of technical support to CRP D3.20.29

The initial test cross-reacted with rinderpest virus antibodies, and therefore, further research work was undertaken to look for other monoclonal antibodies.

APHL started an inter-laboratories proficiency test for the application of the classical RT-PCR to PPR diagnosis in 2010 in connection with the CRP D3.20.26 'The Early and Sensitive Diagnosis and Control of PPR'. The panel of samples was composed of pathological specimens from field samples of PPRV-infected and non-infected animals in a lysis buffer to inactivate pathogens, and positive control sample of PPRV RNA. Three out of the nine participants obtained the expected results and one of them even specified the presence of a deleted amplicon.

Rinderpest was officially declared eradicated worldwide in 2011, but the surveillance of the disease will continue for many years, and therefore APHL is developing new reagents and tools for PPR specific diagnosis, in order to differentiate it from rinderpest. In addition, after having developed in 2009 a new cell line highly sensitive in PPRV isolation from pathological samples, APHL is receiving specimens regularly from Member States for the identification and characterization of PPRV strains.

- *Trypanosomosis*

APHL started to building up a bank of reference Trypanosoma DNA in support of the CRP D3.20.21 'Developing, Validating and Standardising Methodologies for the Use of PCR and PCR-ELISA in the Diagnosis and Monitoring of Control and Eradication Programmes for Trypanosomosis'. Samples were received from counterparts in Colombia, Brazil, Uganda and Burkina Faso.

Participants of a training course at APHL in Seibersdorf on PCR-related techniques for disease diagnosis

DNA samples were submitted to PCR with various sets of primers and the amplified products were cloned and sequenced. These primers allowed the amplification of the internal transcribed spacers (ITS) of ribosomal DNA.

- *Foot-and-mouth disease*

Work was done in support to the CRP D3.20.20 'The Use of Non-structural Protein of Foot-and-mouth disease Virus (FMDV) to Differentiate between Vaccinated and Infected Animals' to develop an ELISA based on the use of a recombinant FMDV non-structural 3ABC protein. For this, monoclonal antibodies were produced and one of them was selected to develop an NSP-based c-ELISA that allows the differentiation of infected animals from non-infected or vaccinated animals.

Results showed that the test was highly specific (93–100%) with a sensitivity around 84%. The performance of this test was similar to the i-ELISA developed by APHL a year earlier.

- *Capripox*

The Capripox genus is composed of three closely related viruses: goatpox (GTPV), sheeppox (SPPV) and lumpy skin disease (LSD) viruses with natural hosts being goat, sheep and cattle respectively. Most of the strains grow readily in goat, sheep or cattle although their pathogenicity may differ according to the virus origin. The epidemiology of capripox virus infections appears complex and it is not possible to clinically distinguish these virus infections.

APHL, with the financial support of the French Ministry of Foreign Affairs and in collaboration with partners in France and Africa, embarked on a project for the development of capripox diagnostic tests and for the molecular epidemiology of these viruses. The sequence of full genome length of a capripox goat strain was determined and partial sequences of gene from other strains became available.

Participants and lecturers of the Training Course on the Diagnosis of Avian Influenza Using Nuclear and Molecular Techniques, held at Seibersdorf Laboratories in 2006

Initially, a classical PCR was developed and results were not promising. Then, a real-time PCR was developed using fluorescence resonance energy transfer (FRET) probes. This test was able to distinguish isolates of SPPV from GTPV and had a high analytical sensitivity. The disadvantage of the classical FRET method is that requires the use of specialized types of real-time (RT) PCR machines which possess FRET channels. To overcome this limitation, an alternative to this method was designed in 2011 based on quencher-induced fluorescence shut down, that can be performed on any real-time machine using the known standard channels of real-time PCR machines.

Despite previous achievements in the development of a classical PCR to differentiate

SPPV from GTPV/LSDV, and two RT-PCR methods to differentiate the three capripoxvirus (CaPVs) using fluorescently labelled probes, current development is to toward real-time PCR methods based on high resolution melting and non-labelled probes to produce cost effective methods for easy adoption in veterinary diagnosis and research laboratories of Member States. The assay was proven to be well suited for genotyping and is very specific to capripoxvirus,

- *African swine fever*

  APHL initiated a study to characterize African swine fever virus (ASFV) isolates collected from different outbreaks in central and western Africa. Gene sequencing data of ASFV samples from Cameroon, Central African Republic, Chad, DRC and Senegal were analysed and compared to those of other isolates available from public databases (GenBank). The results showed that all western and central African isolates were from the ASFV genotype I and that Cameroon ASFV isolates could be subdivided into subtypes within the genotype I. The analysis also revealed that three different viral strains were involved in the recent ASF outbreaks in Cameroon. ASFV identified in two samples collected from Chad were similar to two of the Cameroon genotype I subtypes.

Rumen Microbial Fermentation

- *Tannins, polyphenols and non-starch polysaccharides on rumen microbial fermentation and microbial attachment*

  A set of experiments were carried out at APHL with the support of Mr V. Mlambo, a JPO from Zimbabwe in 2003. The ^{15}N technique was used to study the effect of tannins on rumen microbial fermentation by measuring gas production. Also, the effect on microbial protein synthesis by measuring ^{15}N enrichment in the digested bacterial pellet obtained after fermentation of ^{15}N labelled maize shoots. Polyethylene glycol (PEG) result the only additive that completely removes the adverse effect of tannins on ruminal degradation.

Hundreds of animal feed resources have been tested in nutrition laboratories supported by APH and incorporated on cost-effective diets for cattle and small ruminants

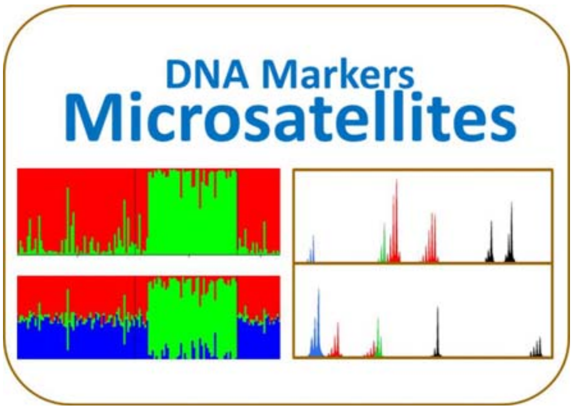
Molecular Animal Genetics

- *Sheep HapMap*

  APH in collaboration with ILRI joined the Sheep HapMap project conducted by CSIRO as part of the International Sheep Genomics Consortium in Australia. Phenotypic data and DNA samples from the African Dorper breed were provided. Samples were genotyped using the Ovine SNP50 BeadChip, a high density genotyping platform which generates genetic data from 50 000 SNP markers located across the sheep genome from high quality data. Results showed that only 19 SNP markers were out (i.e. 99.96% of SNP markers tested returned high quality data).

  The full set of genotypic data was released for public analysis in March 2009 via the International Sheep Genomics Consortium website (www.sheepmap.org). The full dataset contains information from over 2800 animals, thus it is a large dataset and consists of more than 140 million genotypic data points.

- *Construction of a goat whole genome radiation hybrid panel*



The use of molecular markers was introduced in the APHL in the early 2000

Radiation hybrid (RH) mapping is a method for producing high resolution maps that can be used for integrating linkage maps and can serve as a link across species for comparative mapping. Therefore, it is important to construct a RH panel providing a resource for rapid and large scale physical mapping of the goat genome. This will facilitate the resolution of the genetic and physical distances prior to designing strategies for positional candidate cloning of the gene(s) that are involved in economically important traits. The aims are to (1) develop and characterize a whole genome RH panel in the goat; (2) develop an initial RH map for the goat using SNP markers; (3) develop a goat RH mapping server allowing the user to map goat markers relative to a framework of previously mapped markers; and (4) provide a unique tool for the study of goat genomics and for identifying genes of important economic traits that can be used in genetic improvement programmes.

Skin biopsies were obtained from two adult Boer males, from which fibroblasts were cultured and karyotypic analyses were performed. Cells were irradiated with a ^{60}Co source. The goat fibroblast cells were fused with the hamster cells generated RH colonies. The optimization of genotyping protocols for more than 100 gene markers was completed by 2011. Apart from the candidate gene marker, about 250 microsatellite markers have been identified for mapping the goat RH panels. PCR-Agarose gel electrophoresis and Fluidic Dynamic Array system are being used for genotyping microsatellite markers on goat RH panel.

- *DNA bank for livestock characterization*

Global reference genetic repository at APHL collects, preserves, and maintains genomic DNA from distinct breeds of various livestock and poultry species including cattle, sheep, goat, chicken, alpacas, rabbits, etc. The main objective of establishing genetic repository is to encourage and strengthen the collaborative animal genetic research across different countries. The genetic repository is constantly strengthened by addition of new DNA samples sent by project counterparts around the world.

Participants in a lecture session on the Training Course on Genetic Characterization of Indigenous Livestock Breeds Using DNA Markers, held at APHL, Seibersdorf (2014)

- *Genetic variation on the control of resistance to infectious diseases in small ruminants*

APHL has been working on developing genomic tools to identify DNA markers associated with parasite resistance in small ruminants and to develop breeding strategies for improving host resistance in support to the CRP D3.10.26 ‘Genetic Variation on the Control of Resistance to Infectious Diseases in Small Ruminants for Improving Animal Productivity’.

Genetic variations within many pattern recognition receptor genes have been found to be significantly associated with genetic disease resistance of various livestock species; however,

information on genetic polymorphisms within many of pattern recognition receptors (PRR) genes is limited in sheep and goats. In the laboratory, 71 sets of primer pairs were designed to screen various selected genes. PCR optimization and sequencing for selected genes is under progress.

Genotyping assays were developed for 194 novel SNP markers identified in several candidate genes related to immune pathways, pattern recognition receptors, Major Histocompatibility Complex, etc. All the newly identified SNP markers will be tested in around 3000 phenotype recorded animals which are part of the field trial in six countries.

E-Learning

The Joint FAO/IAEA Division together with the FAO in Rome and the Swiss Institute of Bioinformatics launched in 2012 an e-learning module on ‘Phylogenetics of Animal Pathogens: Basic Principles and Applications’.

The e-learning module included an introduction to phylogenetics, tools, building and interpreting trees and finally its application to veterinary diagnostics. The aim of the application was to facilitate better management of animal diseases by preparing laboratory technicians, veterinarians and molecular epidemiologists from diagnostic and research laboratories of developing FAO and IAEA Member States, to be self-sufficient in the data analysis through the interpretation of phylogenetic trees and their relationships.

E-learning module on phylogenetics of animal pathogens

The link to the module is http://viralzone.expasy.org/e_learning/index.html

Veterinary Drug Residues

Laboratory technician analysing meat and dairy products for export at the National Laboratory for Residue Analysis, SENASA, in Tegucigalpa, Honduras (TC HON/5/005, 2009)

APHL equipped its laboratory with an HPLC to support both training and technical back-up activities for TCPs and the CRP D3.20.22 on the monitoring of veterinary drugs residues in livestock and livestock products. The initial work included the development of simplified HPLC methods for the detection and quantitation of residues of the widely used, broad-spectrum antibacterial, tetracycline compounds.

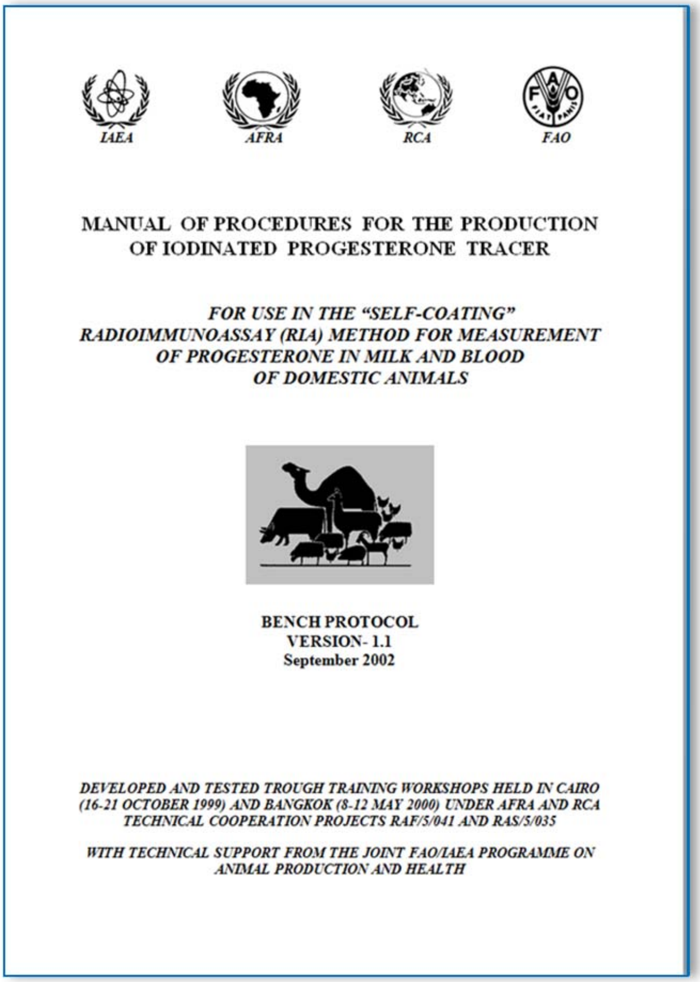
A simplified method for the measurement of chlortetracycline, tetracycline and oxytetracycline in milk was produced and an optical biosensor was evaluated to gauge its applicability to residues testing in Member States.

A series of training courses on screening and confirmatory methodologies for veterinary drug residues were held in South Africa, Australia and Seibersdorf Laboratories in 2003 and 2004, under the supervision of A. Cannavan. The work continued until 2004 when Andrew and his work moved to the Food and Environmental Protection Section, part of the Joint FAO/IAEA Division.

Iodinated Progesterone Tracer

The use of RIA for measuring progesterone in milk of dairy animals or in blood of beef animals, together with recording of data on reproductive events and production parameters, is a valuable tool that provides information both on problems in breeding management by farmers as well as deficiencies in the AI services provided to them by government, co-operative or private organizations. This allows appropriate strategies and interventions to be adopted to overcome the encountered limitations.

APH, prior to the closing of the RIA laboratory and to provide additional self-sustainability to RIA laboratories in developing countries, included training activities under on-going AFRA and RCA TC projects to develop the capability in selected laboratories within each region to produce and distribute the second critical reagent for the assay, the ^{125}I-progesterone tracer. The first of these training workshops was held in Cairo, Egypt, in October 1999 and the second, held in Bangkok, Thailand, in May 2000. As a result of these meetings and laboratory work conducted by M. Benkadra in APHL, the 'Manual of Procedures for the Production of Iodinated Progesterone Tracer' was published in 2002.


IAEA AFRA RCA FAO

MANUAL OF PROCEDURES FOR THE PRODUCTION OF IODINATED PROGESTERONE TRACER

FOR USE IN THE "SELF-COATING" RADIOIMMUNOASSAY (RIA) METHOD FOR MEASUREMENT OF PROGESTERONE IN MILK AND BLOOD OF DOMESTIC ANIMALS

BENCH PROTOCOL
VERSION- 1.1
September 2002

DEVELOPED AND TESTED TROUGH TRAINING WORKSHOPS HELD IN CAIRO (16-21 OCTOBER 1999) AND BANGKOK (8-12 MAY 2000) UNDER AFRA AND RCA TECHNICAL COOPERATION PROJECTS RAF/5/041 AND RAS/5/035

WITH TECHNICAL SUPPORT FROM THE JOINT FAO/IAEA PROGRAMME ON ANIMAL PRODUCTION AND HEALTH

COMPUTER SOFTWARE PROGRAMS AND GEOGRAPHIC INFORMATION SYSTEMS (GIS)

Geographic Information Systems (GIS)

One of the purposes of GIS is its use as a planning tool for emergency response and as a monitoring and prediction tool for disease outbreak. The GIS model to identify priority areas for tsetse control in Ethiopia was modified in 2000. Training on the use of GIS in the national rinderpest epidemiological surveillance network was conducted at PARC headquarters in Sudan in 2000.

The results of the GIS model were published in the book 'Animal Trypanosomosis: Diagnosis and Epidemiology' in 2000. A regional training course on 'The Use of GIS in Tsetse Intervention and Land-use Planning in Tsetse Free Areas' was held in Ouagadougou, Burkina Faso in 2002.

The GIS programme was phased out in 2003 based on the prioritization and change of direction in the technical programme of APH.

LabInfo

APH and EMPRES-FAO started developing this system in 1999 to assist laboratories in recording, analysing, interpreting and presenting their data for tracking and managerial purposes. It was developed in the open source model, using a database and presentation software which provided full flexibility and ease of adaptation of the various laboratories in the GREP countries.

This concept was abandoned in 2001 and this tool was integrated within the TADInfo system architecture using compatible tools, able to operate without TAD or fully integrated with TAD, in terms of data exchange.

IAEA/RCA RAS/5/035 Regional Training Workshop on Management and Utilization of Field and Laboratory Data for Breeding Support Services to Livestock Farmers (Mymensingh, Bangladesh, 2002)

TADInfo

This software was also initiated under the FAO EMPRES programme for use at national, regional or global level. The software would allow users on making decisions on disease control or eradication to be better informed through a systematic collection and multiple manipulation of reports on disease occurrence. It was foreseen that such reports will be geo-referenced to allow the full use of GIS in analysing these reports. Unfortunately, additional inputs on this software ceased together with the cancellation of the GIS activities.

Livestock Information Management Application (LIMA)

LIMA is a computer application developed in 2000–2002 by M. Garcia to store and analyse a full range of information from livestock farms. LIMA is suitable for six livestock species, i.e. bovine, bubaline, ovine, caprine, and South American camelids (alpacas and llamas) and is available in English and Spanish.

The application was developed in MS Access and Visual Basic for Applications. It is based on screen forms for data entry or editing of information and command buttons. The application contains convenient and easy-to-use data entry forms for the identification of the animal, productive records (body weight, milk yield, wool, and fibre production), reproductive parameters (heats, services, parturitions), health data (individual cases and collective preventive treatment), and economical information (farm income and expenses). Moreover, there is a wide collection of pre-defined reports for the analysis of the data, and facilities for data verification and export.

The software is updated when necessary based on request from users and can be freely downloaded from APH webpage.

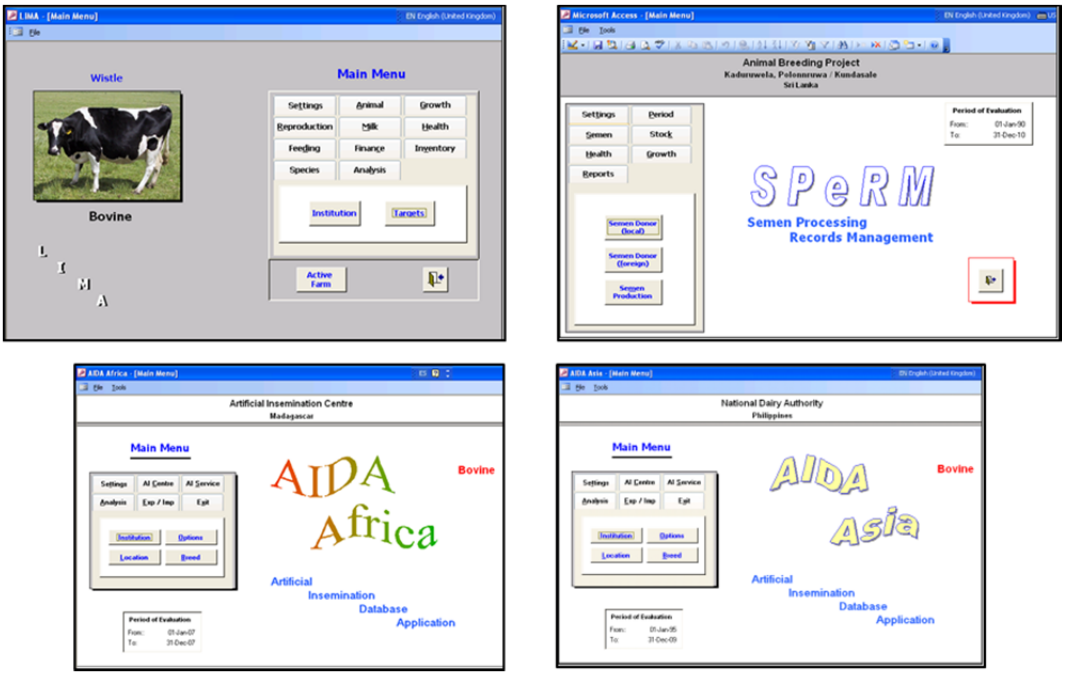
Semen Processing Records Management (SPeRM)

SPeRM is a computer application to store and analyse information from sires (bulls, bucks and rams) that are used in Semen Processing or Artificial Insemination (AI) Centres.

The need for such an application arose during a IAEA consultancy undertaken by M. Garcia under the framework of the IAEA/RCA TC project RAS/5/035 'Improving Animal Productivity and Reproductive Efficiency'. The detailed specifications for the application were determined through a

Task Force Meeting of National Consultants from five RCA Member States, organized by the IAEA and held in Kandy, Sri Lanka in April 2001.

The software is updated when necessary based on request from users and can be freely downloaded from APH webpage.



Main Menu screen of four computer applications developed by the Animal Production and Health Section to assist scientists and livestock professionals in Member States on the monitoring and evaluation of livestock farms, artificial insemination services and semen production

Artificial Insemination Database Applications (AIDA Asia and AIDA Africa)

The two computer software derived from the AIDA package developed in 1994 to assist counterparts of CRP D3.10.20 on data storage and analysis in relation to AI services. Data of farms, cows, semen, and AI technicians are stored and analysed to serve as a tool to evaluate the quality of the AI Service and to identify constraints that may be hampering the fertility. Also, it serves to correlate progesterone concentrations in milk/blood samples with fertility.

Both applications were fine-tuned on workshops with African and Asian users according to the specific needs and facilities for data collection. As in the case of LIMA and SPeRM, the two applications can be freely downloaded from APH webpage.

Laboratory Information Management System (LIMS)

The existing LIMS of the FAO/IAEA Agriculture & Biotechnology Laboratory (ABL) was based on an open-source, independent platform that consisted of a large number of customized databases designed according to the specific needs of each organisational entity within ABL. A new platform was partially developed to provide improved usability and faster application. APHL expanded its existing LIMS with some modifications and new modules. A central database inventory of laboratory chemicals, serum bank management and appropriate records, for health, reproduction and genetics

(phenotypic and genetic) data was proposed to be shared with Member States laboratories who are willing to consent to their use in research and testing at the IAEA.

Later on, this application was extended into an interactive Research and Management Platform (RaMP) to provide a more efficient and quality-assured management tool for defining, assigning and reserving tasks and activities, for monitoring progress to task and report levels at all stages and for assuring the quality of tasks and data. The new platform was a transition between traditional web application to Ajax (Asynchronous JavaScript and XML). Unfortunately, development delays, technical problems and budget constraints affected the project and a decision was taken to for an external provider for the developing of a LIMS application that can fit APHL and Member State needs.

I have had the pleasure and the honour of having learned what I know about animal production through sharing my knowledge and experiences with my colleagues, project counterparts and farmers around the world. I enjoyed every minute I spent as Technical Officer for Latin America and benefited the presence and friendship of Oswin, the best TO I ever met. Those were the years where the Section and I experienced the path between the DOS operating systems in IBM computers to the various Windows versions and related software, the path from telex and faxes to e-mail. At that time, my involvement with Asian and African counterparts was basically through the RIA progesterone EQ programme; however, after leaving the IAEA, I was involved in expert missions and training courses in many countries enlarging the number of contacts and friends and widening my understanding of production systems while providing technical support. Time spent at APH has been unforgettable, valuable and highly productive.

Mario Garcia, Technical Officer


Genetic Databases

Three databases were partially built under the supervision of M. Massoud. They were:

- Genetic Repository Bank (GRB) Database of Genetic Materials and Gene Profiling (GP) for Candidate Gene Information. The program would allow users to graphically view the location of samples with links to Google Map.
- Real-Time Databases (RT-db) for Genetic Information on Small Ruminants. The program focused on making available the genomic locations of QTLs from all known studies on small ruminants. The idea as to allow users to view graphically the positions of the QTL, filtered according to a number of criteria, such as trait name, chromosome number and statistical significance.
- Genetic Characterization Databases (GC-db) of Cattle Breeds. This was an on-line database of microsatellite genotypes for characterization of cattle, sheep and goats breeds. The program would users to compare their breeds with those of others.

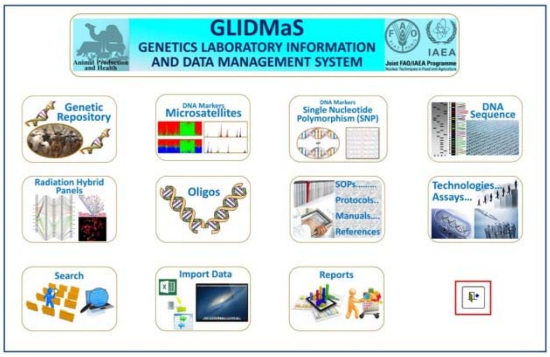
Differences in the approaches, computer languages and users interfaces were the major limitations to continue with these programs. The idea, however, was taken and K. Periasamy and M. Garcia initiated the development of a new application that can incorporate all these aspects plus few others that can be needed in a genetics laboratory.

Genetics Laboratory Information and Data Management System (GLIDMaS)

Development and transfer of bioinformatics tools to animal genetics laboratories worldwide continues to be an important strategy of APH to support FAO/IAEA Member States in managing their livestock biodiversity and improving productivity of local animal breeds.

A database application is currently being developed to assist scientists in Member States. The application tentatively named 'Genetics Laboratory Information and Data Management System'

(GLIDMaS) will allow users to manage genetic repository, genetic and genomic resources (e.g. radiation hybrid panels, oligos), DNA marker tools [microsatellites (STRs) and single nucleotide polymorphisms (SNPs)], DNA sequence data, genotype data and laboratory inventory (equipment, reagents and consumables) available in a standard molecular genetics laboratory. GLIDMaS platform will be a standalone application and will not need special software on user computers. One of the major objectives of developing GLIDMaS is to provide tools for QA and formal accreditation of genetic laboratories. The platform is also expected to support animal geneticists in managing large volumes of molecular data intended for animal selection, conservation and genetic improvement.



Reference Material Database for DNA analysis related techniques being developed by APH

PUBLICATIONS

There were 34 publications (books, book chapters, special issues in scientific journals, TECDOCs, and manuals) in the 15-year period (2000 – June 2014; Figure 51). The average number of publications per year was much less than in the period 1984–1999; however, there are a large number of papers from APH staff or project counterparts published as individual papers in peer reviewed scientific journals.

The proceedings of the two FAO/IAEA international symposiums held by APH in this period were published in a book format in 2005 and 2009 by Springer and FAO respectively (Table 46).

There were 23 publications in the field of animal production (Tables 47 and 48) and 9 publications in the field of animal health (Table 49 and 50). Most of the TECDOCs were the proceedings of final results of CRPs and workshops. All papers were technically reviewed by the responsible TO of the CRP or meeting and experts associated to APH.

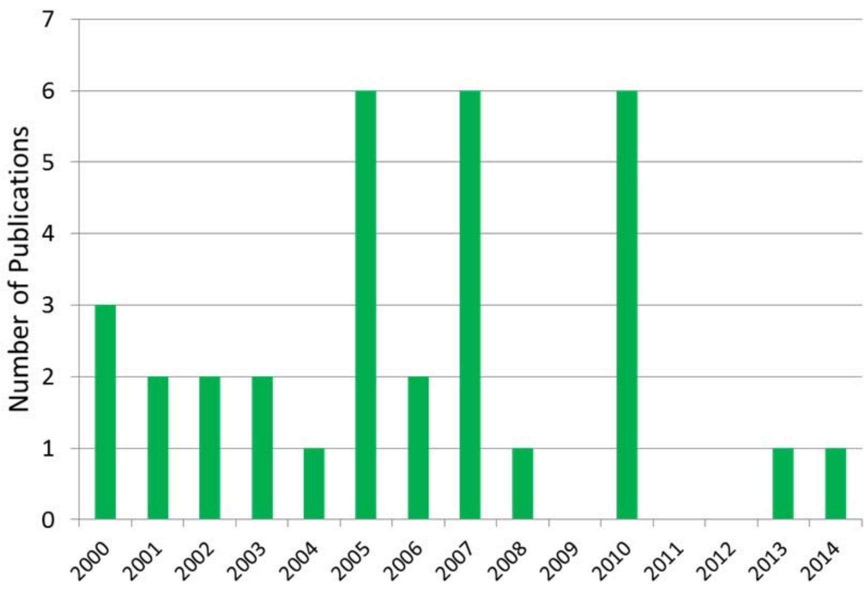


FIG. 51. Number of publications by the Animal Production and Health Section (period 2000 to June 2014)

TABLE 46. PROCEEDINGS OF INTERNATIONAL SYMPOSIUMS HELD BY THE ANIMAL PRODUCTION AND HEALTH SECTION FROM 2000 TO 2014

Year	Title
2005	Applications of Gene-Based Technologies for Improving Animal Production and Health in Developing Countries. Springer. 793 p.
2009	Sustainable Improvement of Animal Production and Health. FAO. 393 p.

TABLE 47. LIST OF IAEA PUBLICATIONS IN THE FIELD OF ANIMAL PRODUCTION FROM 2000 TO JUNE 2014

Year	Title
TECDOCs	
2001	Radioimmunoassay and related techniques to improve artificial insemination programmes for cattle reared under tropical and sub-tropical conditions. IAEA-TECDOC-1220
2002	Development and field evaluation of animal feed supplementation packages. IAEA-TECDOC-1294
2003	Guidelines and recommendations for improving artificial breeding of cattle in Africa. AFRA Document
2005	Improving artificial breeding of cattle in Africa: guidelines and recommendations. IAEA-TECDOC-1437
2005	Improving artificial breeding of cattle and buffalo in Asia: guidelines and recommendations. IAEA-TECDOC-1480
2006	Improving animal productivity by supplementary feeding of multinutrient blocks, controlling internal parasites and enhancing utilization of alternate feed resources. IAEA-TECDOC-1495
2006	Improving farmyard poultry production in Africa: interventions and their economic assessment. IAEA-TECDOC-1489
2007	Improving the reproductive management of dairy cattle subjected to artificial insemination. IAEA-TECDOC-1533
2007	Application of radioimmunoassay in improving the reproductive management of smallholder dairy cattle. IAEA-TECDOC-1571
2008	Guidelines for sustainable manure management in Asian livestock production systems. IAEA-TECDOC-1582
2010	Selection and breeding of cattle and buffalo in Asia: strategies and criteria for improved breeding. IAEA-TECDOC-1620
2010	Improving livestock production using indigenous resources and conserving the environment. IAEA-TECDOC-1640
Laboratory Manual	
2002	Manual of Procedures for the Production of Iodinated Progesterone Tracer
2003	Laboratory Manual "Quantification of tannins in tree and shrub foliage"

The four books on rumen microbiology, methane production and plant resources were authored by H. Makkar and his colleagues. The two books on PCR matters were authored by G. Viljoen, J. Crowther and their team, while the book chapter on PPR was prepared by A. Diallo (Table 50).

Three special issues containing the final results of their respective CRPs were published in scientific journals in this period (Table 48). In these cases, the TOs were designated by the journals as Guest Editors. Papers were initially reviewed by the responsible TOs and agreement holders and then were peer-reviewed by both invited and journal reviewers.

TABLE 48. LIST OF BOOKS AND SPECIAL ISSUES IN SCIENTIFIC JOURNALS IN THE FIELD OF ANIMAL PRODUCTION FROM 2000 TO JUNE 2014

Year	Title
Books	
2002	Characteristics and parameters of family poultry production in Africa. Backhuys Publishers.
2004	Estimation of microbial protein supply in ruminants using urinary purine derivatives. Springer. 212 p.
2005	Methods in gut microbial ecology for ruminants. Springer. 225 p.
2007	Measuring methane production from ruminants. Springer. 138 p.
2010	*In vitro* screening of plant resources for extranutritional attributes in ruminants: nuclear and related methodologies. Springer. 247 p.
2010	Managing prenatal environment to enhance livestock productivity. Springer. 300 p.
Special issues in scientific journals	
2005	Predicting and improving the safety and efficiency of feeding ruminants on tanniniferous tree foliage. Animal Feed Science and Technology 122(1-2)
2007	The use of participatory approaches for identifying and prioritizing the constraints to productivity on small-scale market-oriented dairy systems Tropical Animal Health Production 39(9)
2013	Exogenous enzymes in animal nutrition – benefits and limitations. Animal Nutrition and Feed technology 13(3)

TABLE 49. LIST OF IAEA PUBLICATIONS IN THE FIELD OF ANIMAL HEALTH FROM 2000 TO JUNE 2014

Year	Title
2000	Guidelines for the use of performance indicators in rinderpest surveillance programmes - a part of the Global Rinderpest Eradication Programme (GREP). IAEA TECDOC-1161
2000	Use of immunoassay technologies for the diagnosis and control of foot-and-mouth disease in southeast Asia. IAEA-TECDOC-1150
2001	Performance indicators for rinderpest surveillance. IAEA-TECDOC-1261
2007	The use of non-structural proteins of foot and mouth disease virus (FMDV) to differentiate between vaccinated and infected animals. IAEA-TECDOC-1546
2007	Developing methodologies for the use of polymerase chain reaction (PCR) in the diagnosis and monitoring of trypanosomosis. IAEA-TECDOC-1559

TABLE 50. LIST OF BOOKS IN THE FIELD OF ANIMAL HEALTH FROM 2000 TO JUNE 2014

Year	Title
2000	Animal trypanosomosis: diagnosis and epidemiology. Backhuys Publishers
2005	Molecular diagnostic PCR handbook. Springer.
2010	Early, rapid and sensitive veterinary molecular diagnostics – real time PCR applications. Springer. 210 p.
2014	Peste de petits ruminants. In: Dongyou Liu (ed). Manual of security sensitive microbes and toxins. CRC Press. 884 p.

Group photo of the staff of the Animal Production and Health Section in 2014

50 Years of Technical Support to Member States

THE SECTION

The Joint FAO/IAEA Division, a coordinated effort between the IAEA and the FAO had to develop a programme based on the corporate mission of the parent institutions, i.e. the use of atomic energy for peace, health and prosperity (IAEA) and the sustainable agricultural development, improved nutrition and food security (FAO), in order to contribute to sustainable food security and food safety by use of nuclear techniques and biotechnology.

The apparently narrow window of action assigned to the Joint FAO/IAEA Division proved to be a wide spectrum of successful technologies that have enormously contributed to food security and food safety around the world; however, the path was not always easy and the directors, section heads and the professional and supportive staff had to be creative, efficient and scientifically sound to vision major needs in the agricultural and livestock sector where relevant progress can be done and therefore develop, validate, adapt, quality control and transfer suitable and applicable technology to research centres, universities, national laboratories and farmers in general in developing Member States.

The first steps of the APH in science and technical development were basically technique oriented and focussed on training courses and technical assistance in few TC projects funded by UNDP and other funding organizations. However, at that time, the professional staff was limited to the Section Head and one expert on sabbatical, and the laboratory in Seibersdorf took 20 years to initiate its activities.

Indigenous cattle breeds and *Bos taurus* x *Bos indicus* crosses are the most common type of cattle in tropical countries, where adequate management, feeding and health care are major limitations

The initial activities addressed animal health problems, especially those related to parasites, and animal nutrition, mainly on the analysis of non-protein nitrogen in animal feeds. The first CRP started in 1966 aiming to evaluate the use of isotopes and radiation on the etiology, effects and control of parasitic diseases in domestic animals, and the second CRP on trace element metabolism and disease in livestock started two years later; nevertheless, APH managed to implement 13 CRPs by 1983. On the other hand, despite staff limitations, the Section was able to produce quite a number of books and manuals (n=24) in the first 20 years of existence.

Early and rapid diagnostic tests for TADS conducted at farm level. The LAMP-PCR in the format of a mobile laboratory is allowing on-farm diagnosis of various animal diseases (Photo: Cameroon, 2012)

The emphasis of APH activities moved away at the end of ’80s from basic and pure disciplinary research into on-farm multidisciplinary studies looking for solutions and improvements in livestock productivity. APHL initiated its activities in 1984 and the first Unit Head was nominated in 1990. There was a substantial increase in external funding after 1990, especially from the Dutch and Swedish governments that allowed the recruitment of TOs, regional experts and the implementation of several CRPs. Around 1994–1995, the staff of APH reached nine TOs plus the Section Head and the Unit Head, and was implementing six CRPs. In addition, at that time APH had the largest number of active TC projects and achieved the largest number of TC expert missions of its existence on a year basis. Furthermore, 16 highly qualified experts on sabbatical leave supported the day-to-day activities or conducted specific tasks in the period 1984–1999.

Successful efforts were done to combine research contracts under CRPs with TC projects so project counterparts were able to conduct specific and focussed research work that was technically supported by a group of experts (i.e. agreement holders) while receiving additional support through larger funding for equipment, training, and visit of experts. In the period 1990–1999, 24 CRPs were implemented on developing feed supplementation strategies (e.g. the urea-molasses blocks, use of non-traditional animal feeds), on the applied use of the RIA technique for monitoring ovarian activity in order to improve the productive and reproductive efficiency of livestock, and on the development, validation and the use of ELISA techniques for animal disease diagnosis (e.g. rinderpest, brucellosis, trypanomosis, FMD).

All RIA and most ELISA diagnostic tests were produced or assembled in the laboratory and delivered to Member States in the format of a ‘kit’ (a small box containing all standards, reagents, chemicals and QC samples needed to run the test). These kits were technically backstopped by an EQA programme also conducted by APHL staff for nearly 12 years where millions of unit assays were shipped every year. In this context and as an example, the contribution of APH through the validation and distribution of rinderpest kits was crucial for the eradication of the disease, a world-wide programme conducted by FAO with strong support of IBAR/OAU in Africa.

The external review of the Section by a panel of six consultants in 1996, despite its support to the on-going problem solving approach using RIA and ELISA, provided recommendations that introduced important changes in direction in the next few years. APH considered that these technologies were mature enough and that the trained personnel and resources available in developing Member States should be capable of sustaining them. R&D, including the EQA programme, and kit distribution from APHL were phased out by 2002. This freed up some of resources that were moved to supporting studies on newly emerging areas that have the potential for future applications (e.g. PCR, molecular and gene-based technologies).

Studies on feed supplementation strategies have resulted in improved feeding and higher livestock productive performance (Photo: Myanmar, 2009)

Recent group photo of most of APH staff with Director Qu Liang during a meeting at Seibersdorf Laboratories when presenting technical results and discussing future programmatic activities

The transition of the new technologies were facilitated by a series of activities such as the FAO/IAEA International Symposium on 'Applications of Gene Based Technologies for Improving Animal Production and Health in Developing Countries' held in Vienna in 2003, followed by three interregional training courses held during 2004 and 2005 to train scientists from developing countries on the molecular techniques currently being used in the fields of animal nutrition, genetics and disease diagnosis. Besides, three CRPs were initiated during 2003–2006, dealing with (a) rumen molecular techniques for predicting and enhancing productivity; (b) characterization of small ruminant genetic resources aimed at selection for parasite resistance; and (c) validation of a PCR technique for the rapid diagnosis of RVF. Nevertheless, support to RIA and ELISA continued through TC projects.

In this new phase, APH obtained important extra-budgetary contributions from donors for the expansion of APHL activities, implementation of regional and interregional training courses, and for the development and strengthening of African regional and national laboratories. On the other hand, there was a reduction in the number of CRPs (n=17) because all had to be funded through the APH Regular Budget.

In the last 14 years, CRPs in animal production have dealt with the development of assays for measuring tannins in plants, rumen molecular techniques for predicting livestock productivity, use of enzymes for improving the utilization of fibrous feeds by ruminants, genetic characterization of small ruminants, and genetic variation on gastro-internal parasitism in small ruminants.

CRPs in animal health have dealt with molecular techniques for differentiate vaccinated animals from FMD infected animals, PCR and ELISA techniques for the diagnosis of Trypanosoma, RVF, CBPP, PPR, FMD and avian influenza, use of irradiated vaccines in the control of TADs, use of stable isotopes to trace bird migrations associated to the epidemiology of avian influenza, and on strategies for monitoring veterinary drug residues in livestock and livestock products.

In general, throughout the 50 years of APH, programmatic activities were developed based on IAEA Member States needs in the fields of animal nutrition, animal reproduction and animal health and on what can be done by using nuclear and nuclear related technologies. APH always sourced advice from experts, research centres and international organizations to plan the projects, to prioritize activities in relation to the existing resources both in terms of staff and budget and to change direction according to results, needs and the introduction of new technologies. In addition, Consultant Meetings were one of the main mechanisms of getting advice, guidance and realistic direction, as well as proper designed projects and relevant lines of research.

STAFF

The APH Section was supervised by four directors and managed by nine section heads in its 50 years of existence. The directorship of M. Fried (1963–1983), B. Sigurbjörnsson (1983–1995), and J. Dargie (1995–2005) lasted for 10 or more years each. The current Director Qu Liang is in the office since 2005.

The first six section heads were in the office for a limited time period (2–3 years), while the last three section heads stayed for longer periods: Jim Dargie (1982–1995), Martyn Jeggo (1995–2002) and Gerrit Viljoen (2003 to present). Moreover, Jim defined, strengthened and consolidated the three major programmatic pillars of the Section, and obtained substantial contributions from external donors; Martyn initiated drastic programmatic changes to include gene-based techniques; and Gerrit has focussed his efforts on molecular technologies, especially for the diagnose of TADs.

APHL was initially manned by consultants or experts on sabbatical leave. The first Unit Head was designated in 1990 (Peter Wright). Adama Diallo, the current Laboratory Head as they are now called is in his second term of seven years (2000–2007, 2009–2015).

The Section's activities were in the hands (and brains) of 25 TOs (Figure 52) that came from 14 countries, especially from UK (n=5), Germany (3), India (3) and Sri Lanka (2). Most of them served between 5 to 7 years. The exceptions were Oswin Perera that served for two periods (1998–2005, 1997–2004), John Crowther as TO recruited by FAO and therefore not facing the IAEA turnover policy stayed in the Section from 1995 to 2009, and Mario Garcia that served for 7 years as TO (1990–1997), 8 months in 2000 as Acting Unit Head in Seibersdorf and since 2008 as a consultant based on IAEA Headquarters.

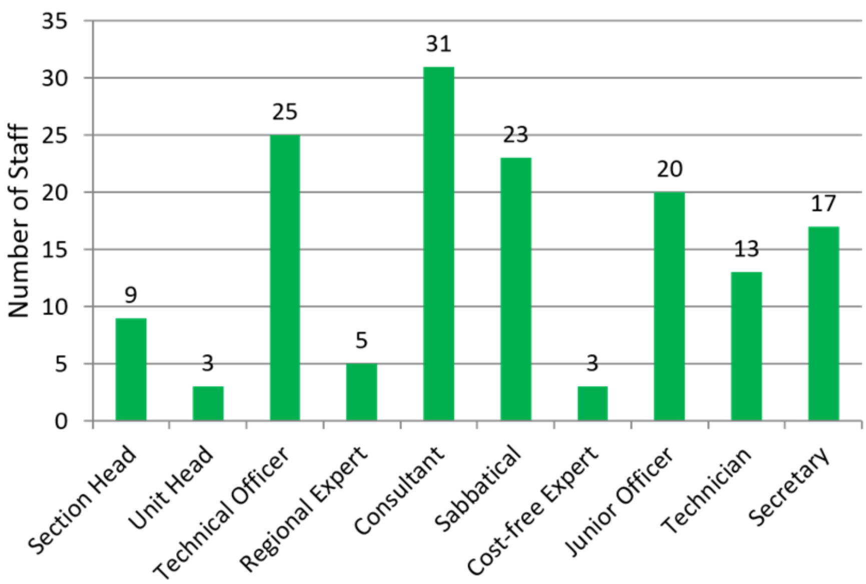


FIG. 52. Animal Production and Health personnel (n=149) according to positions in the 50 year period of the Joint FAO/IAEA Division (1964–2014)
(Some of the staffs were in more than one position)
(Only considered if worked for one year or more)

Consultants, sabbaticals, and cost-free experts provided valuable technical support to APH and alleviate the workload of TOs. Their participation varied over the years. More experts on sabbatical leave or as cost-free were recruited in the period 1990–2000 while in the last decade or so, experts were mainly recruited as consultants.

MAJOR PROGRAMME ACTIVITIES

International Symposiums

Eleven international symposiums were conducted. Six of them were implemented in the first 20 years and five in the years 1986, 1991, 1996, 2003 and 2009. These scientific events provided valuable information of the state-of-the-art of new technologies and methodologies which were effectively used for improving livestock productive and reproductive performance as well as for the control and prevention of diseases of economic important and those of zoonotic nature. However, the numerous hours dedicated by the entire APH staff in the planning and the high cost that demand the organization, including the travel and accommodation of a significant number of participants from developing countries (through TC and CRP budgets) could limit the implementation of additional international symposiums at the past intervals.

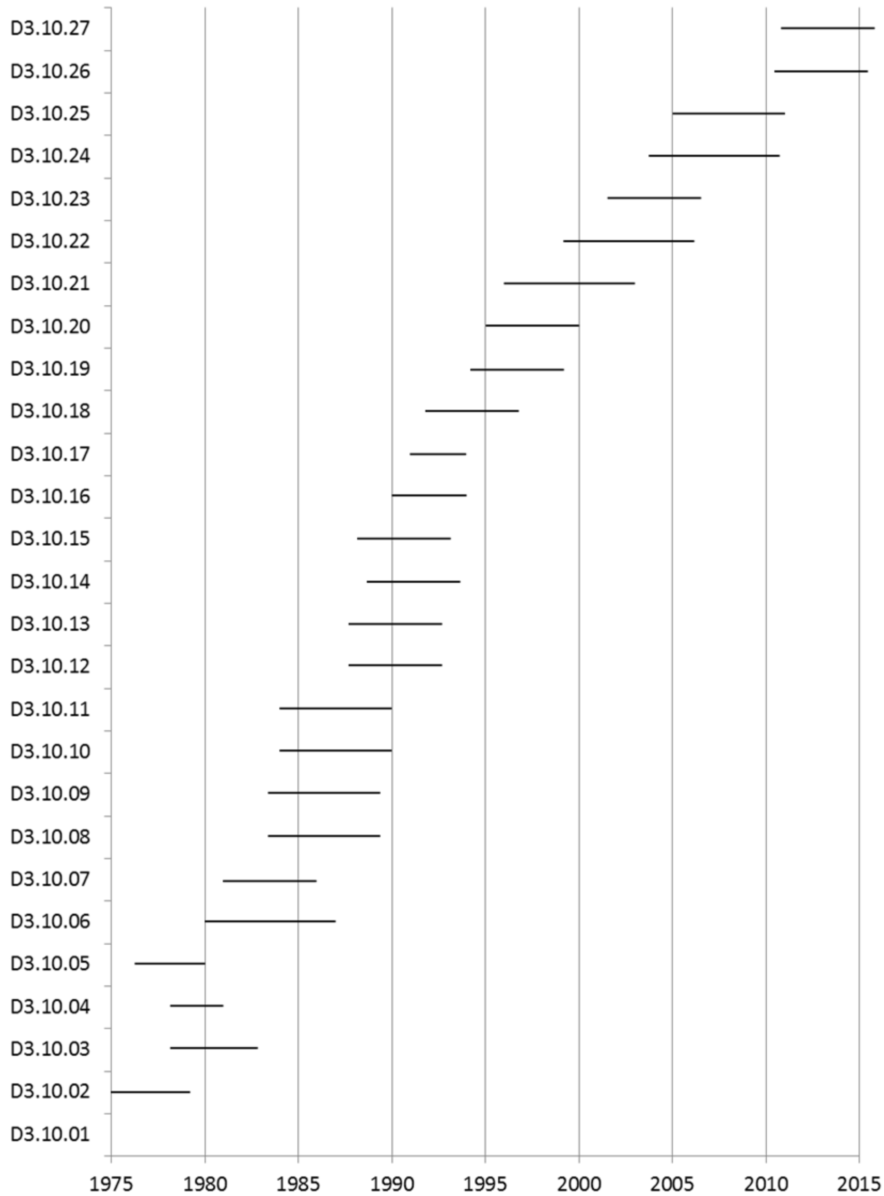


FIG. 53. Chronological distribution of Coordinated Research Projects in the field of animal production (Note: D3.10.01 was implemented from 1972 to 1976)

Coordinated Research Projects

Fifty five CRPs have been implemented in the 50 years of APH activities. On this, 27 were in the field of animal production (Figure 53) and 28 in the field of animal health (Figure 54).

In the early phase of APH, CRPs were mostly related to the control of parasite infections. In late '70 and early '80, with the creation of the nutrition laboratory at APHL, Seibersdorf, and the entry of radioimmunoassay in the scientific community, various CRPs were implemented on feeding strategies and on the use of progesterone RIA for better understanding of ruminant reproductive physiology. On the other hand, from 1995 onwards, more CRPs on the diagnosis and surveillance of various pathogens were implemented than on animal production.

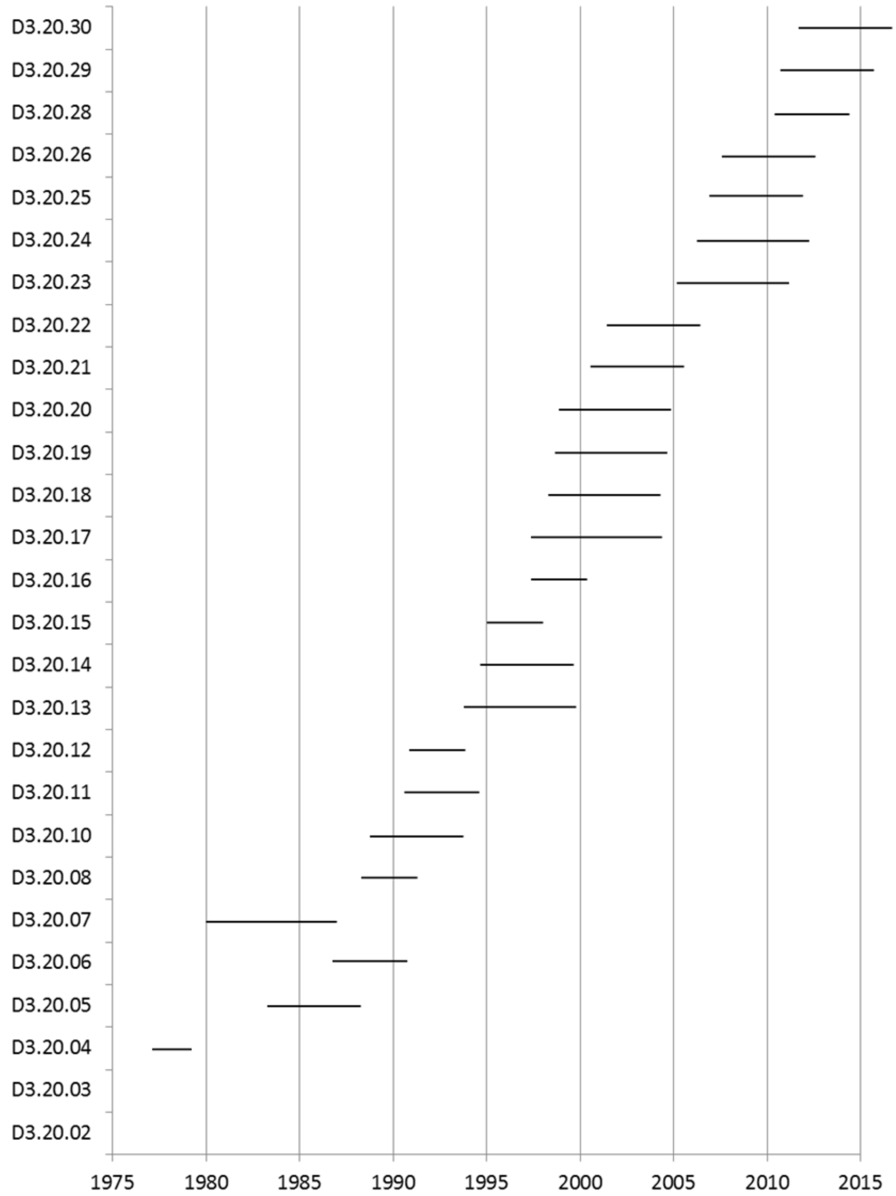


FIG. 54. Chronological distribution of Coordinated Research Projects in the field of animal health (D3.20.01, D3.20.02 and D3.20.03 were implemented in the period 1966–1976)

The highest number of CRPs running at any given time was in 1990 (10 CRPs). Besides, there were 11 CRPs running in the period 1995–2000 (Figures 53 and 54), when APH was receiving additional financial support from external donors.

Data related to CRP contracts were not available for 12 of them that were implemented in the early phase. Nevertheless, data shows that there were 837 contracts awarded when considering the latest 43 CRPs. On this, 583 were research contracts, 194 were agreements and 60 were technical contracts (Table 51), which indicated 19 participants on average per CRP. In total, 104 countries participated in one way or another in the CRP programme (36 countries in agreements, 88 countries in research contracts and 22 countries in technical contracts).

Research contracts awarded to scientists from African countries represented 43% of the total research contracts (Figure 55), while there were a similar proportion of RC holders representing Asian and Latin American countries. The participation of European institutions was circumscribed to the early phase of the Joint FAO/IAEA Division and then, in the last few years. In relation to individual countries, CSI from China (n=26), Brazil (21), Argentina (20), Sri Lanka (18), Kenya and Nigeria (17 each) and Ethiopia (16) were the recipients of the largest number of research contracts (Figure 56).

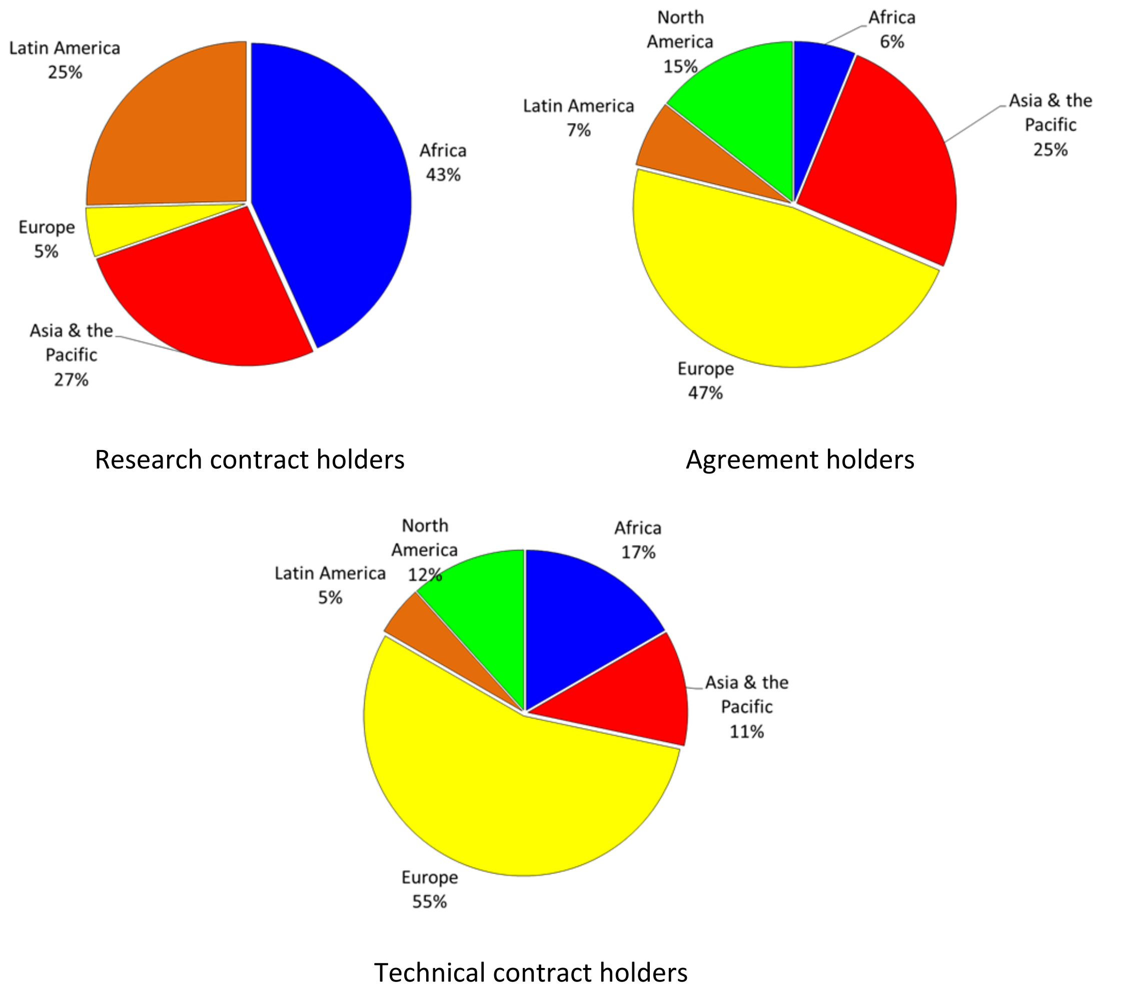


FIG. 55. CRP participants (research, agreement and technical contract holders) according to their geographical regions, based on data from the latest 43 CRPs implemented by the Animal Production and Health Section

Most agreement holders represented European (47%) and Asian (25%) institutions, while North America (Canada and USA) contributed with 15% of the total number of agreements (Figure 55). Institutions from UK (n=34) and Australia (31) received the largest number of agreement awards. Also, important technical support was received from CSI from USA, France, Canada, Sweden, Germany, Netherlands, Italy and New Zealand (Figure 56).

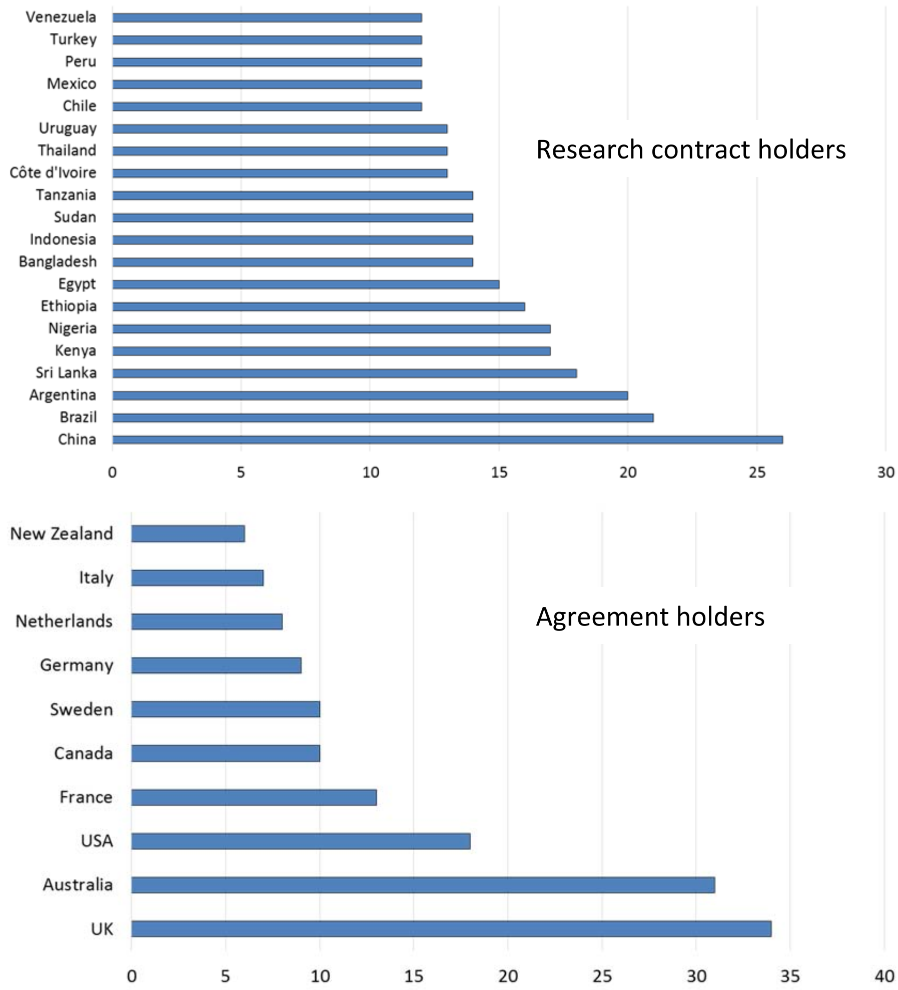


FIG. 56. Most frequent countries having institutions with research contracts and agreements as part of CRPs

TABLE 51. DISTRIBUTION OF CRP PARTICIPANTS ACCORDING TO THE TYPE OF CONTRACTS IN COORDINATED RESEARCH PROJECTS

Field of activity	Type of contract			Total
	Research	Agreement	Technical	
Animal production	271	101	28	400
Animal health	312	93	32	437
Total	583	194	60	837

Technical contracts were basically awarded for the provision of services (development of antibodies, SOPs, manuals, databases, fine-tuning of laboratory techniques, sample analysis, etc.). In some cases and depending of the type of service provided, technical contract holders did not participate in the RCMs. The number of these contracts per CRP varies from zero to several, with a trend to increase in recent CRPs.

In general, there was one agreement holder per 2.7 RC holders in CRPs on animal production whereas one agreement holder per 3.4 RC holders in CRPs on animal health (Table 51).

Consultants Meetings

There were 60 Consultant Meetings organized in the 50 years of APH activities; however, records of this type of events before 1984 were not found (Figure 57). The number of meetings per year increased, especially since 2007. The largest number occurred in 2010 (6 CMs)

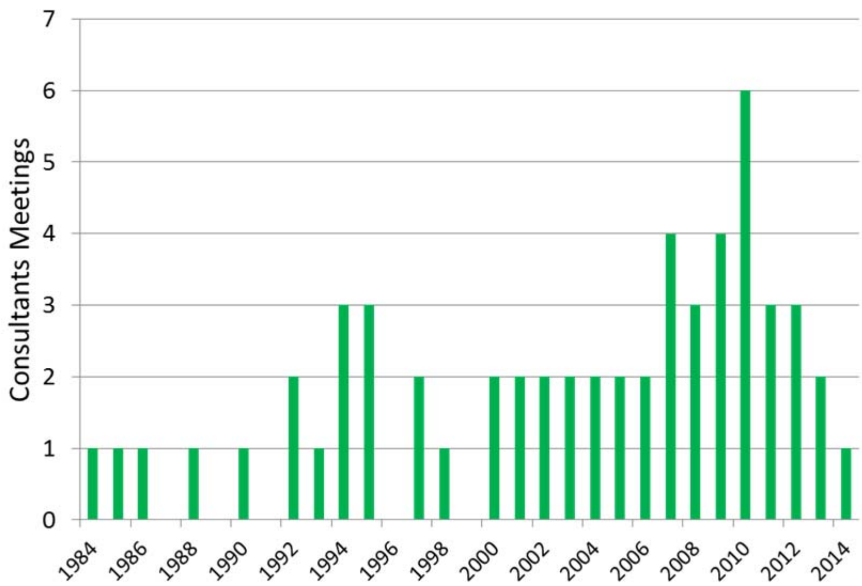


FIG. 57. Chronological distribution of Consultants Meetings from 1984 to June 2014

Participants of Workshop on Procedures for the Validation of the PANAFTOSA/FAO/IAEA FMD Antibody ELISA in Latin America, held in Argentina in 1994

Most CMs were linked to disease diagnosis and related topics (n=35) and nutrition and reproduction topics (n=18). Besides, 5 CMs covered all aspects related to the APH Section (gene-based technologies, capacity building, planning of the 2009 symposium, and the effect of climatic change on animal production and health) and two were on veterinary drug residues (Figure 58). Most CMs lasted 3 to 4 working days (Figure 59).

World leading professionals are invited to CMs in order to get the most suitable advice on their field of expertise. A total of 295 experts participated in the 60 CMs. Most of the consultants came from

institutions in Europe (53%) and North America (18%). Moreover, FAO staff members participated in several CMs (Figure 59). Experts from 45 countries have participated in CMs, where UK and USA have contributed with the largest number of experts followed by Australia, France, Sweden and Germany (Figure 60). Nevertheless, along the years the number of experts attending these meetings from developing countries has increased.

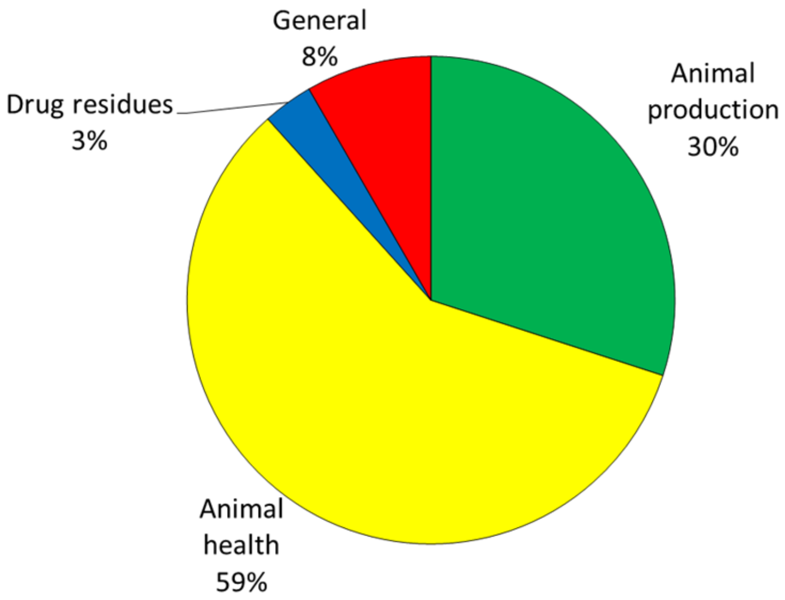


FIG. 58. Consultants Meetings organized between 1984 to June 2014 according to the main subject

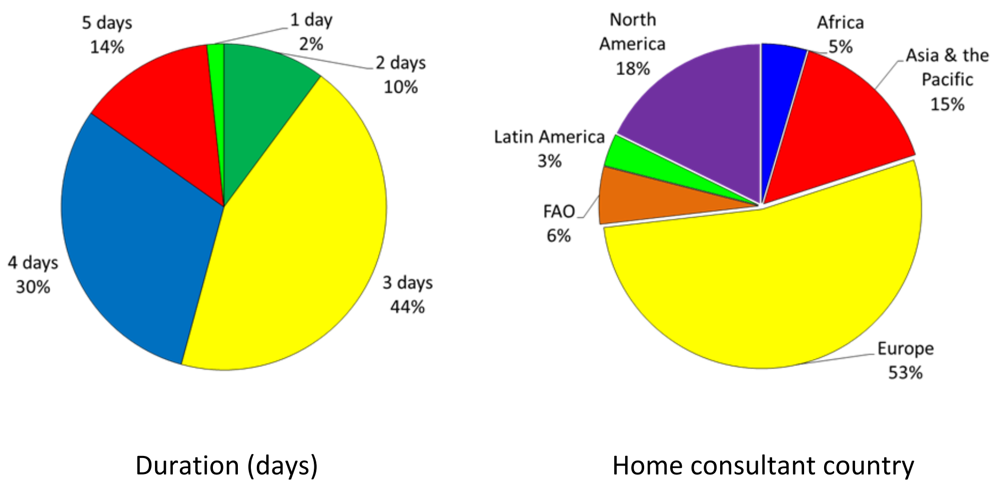


FIG. 59. Country of origin of consultants and duration (in working days) of 60 Consultants Meetings organized between 1984 to June 2014

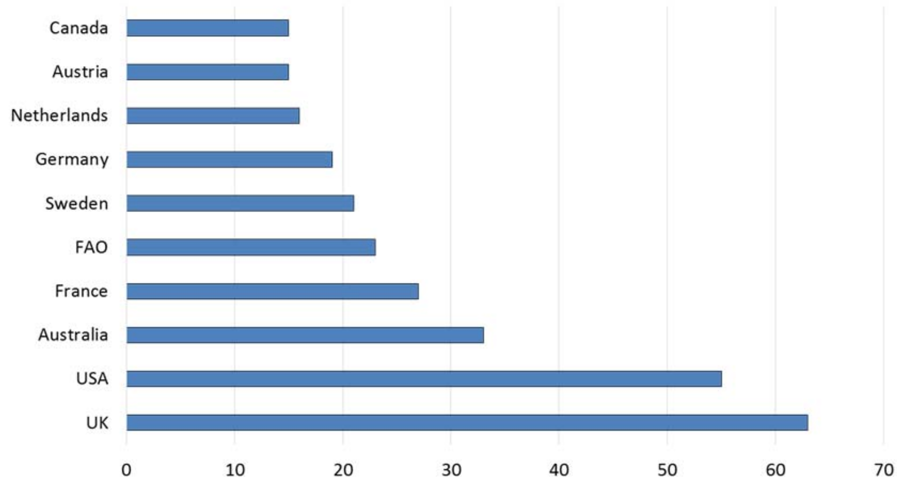


FIG. 60. Most frequent home countries of consultants attending Consultants Meetings organized between 1984 to June 2014

APH SUPPORT TO THE TECHNICAL COOPERATION DEPARTMENT

Technical Cooperation Projects

The total number of TC projects implemented by APH was 430. The number of projects per TC cycle varied from around 15 before 1990 to close to 40 in the '90s, resulting in an average of 24 projects per TC cycle (Figure 61). It is worth to indicate that only 20% of the TC projects implemented by APH lasted for 1–2 years and 48% and 29% lasted for 3–4 and 5–7 years respectively, which means that at any given time (Figure 62), APH was implementing as much as twice the number shown in Figure 61.

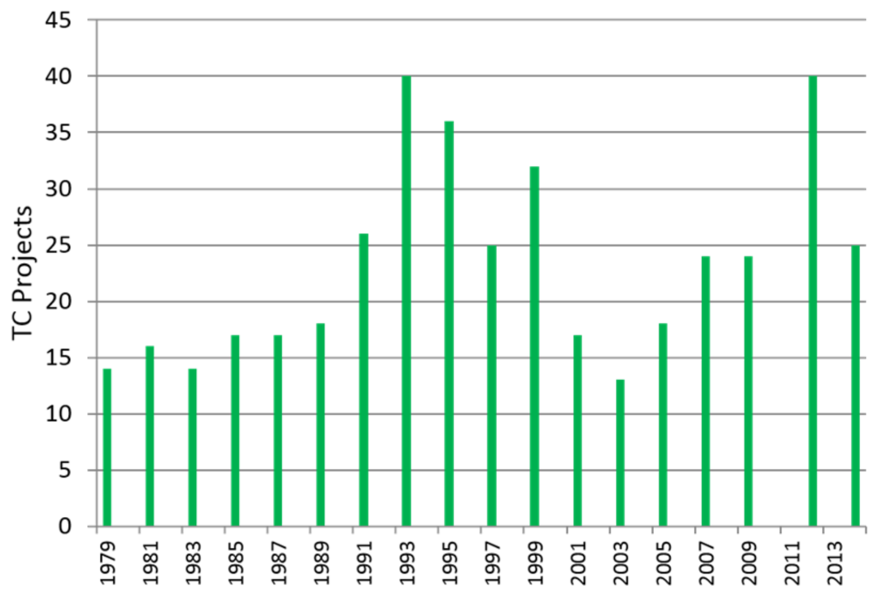


FIG. 61. Number of TC projects per TC cycle from 1970 to 2013

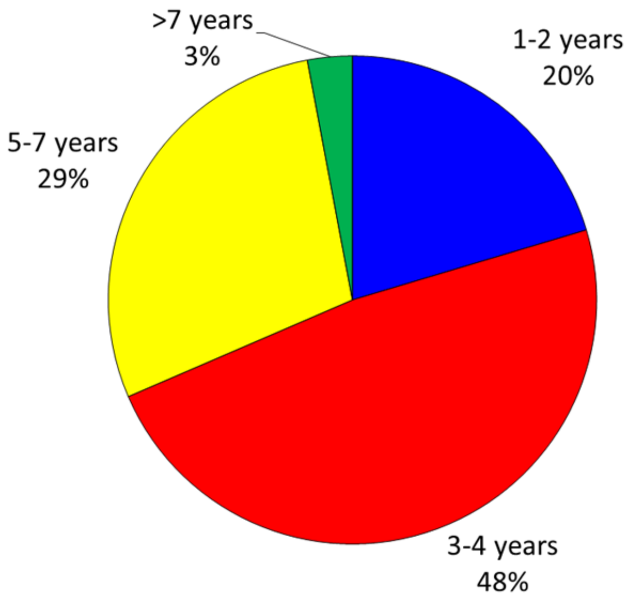


FIG. 62. Distribution of TC projects according to the actual duration (in years)

There was a significant decrease in the number of TC projects after the 1999 TC cycle, mainly due to the absence of approved projects from the Latin American region. For the 40 TC projects in the 2012 cycle it is worth to note that the 2009 cycle was extended up to three years and that could explain the increase during this cycle.

Among the 430 TC projects, 379 were national and 51 were regional projects. In both cases, the largest number of TC projects was awarded to African institutions (Figure 63). The second largest beneficiary region was Latin America for national projects (26%) and Asia & the Pacific for regional projects (30%). The number of National TC projects per country is listed in Figure 64.

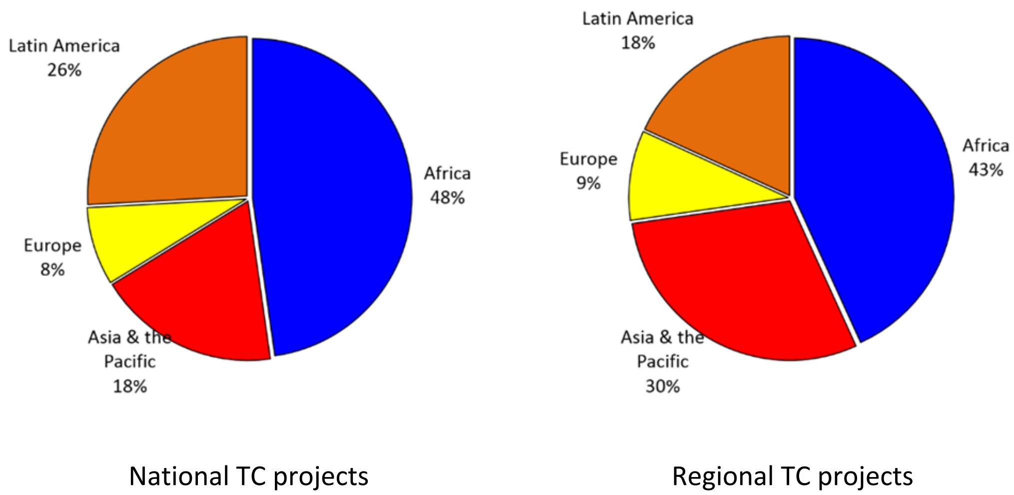


FIG. 63. Distribution of national (n=379) and regional (n=51) TC projects per region of implementation

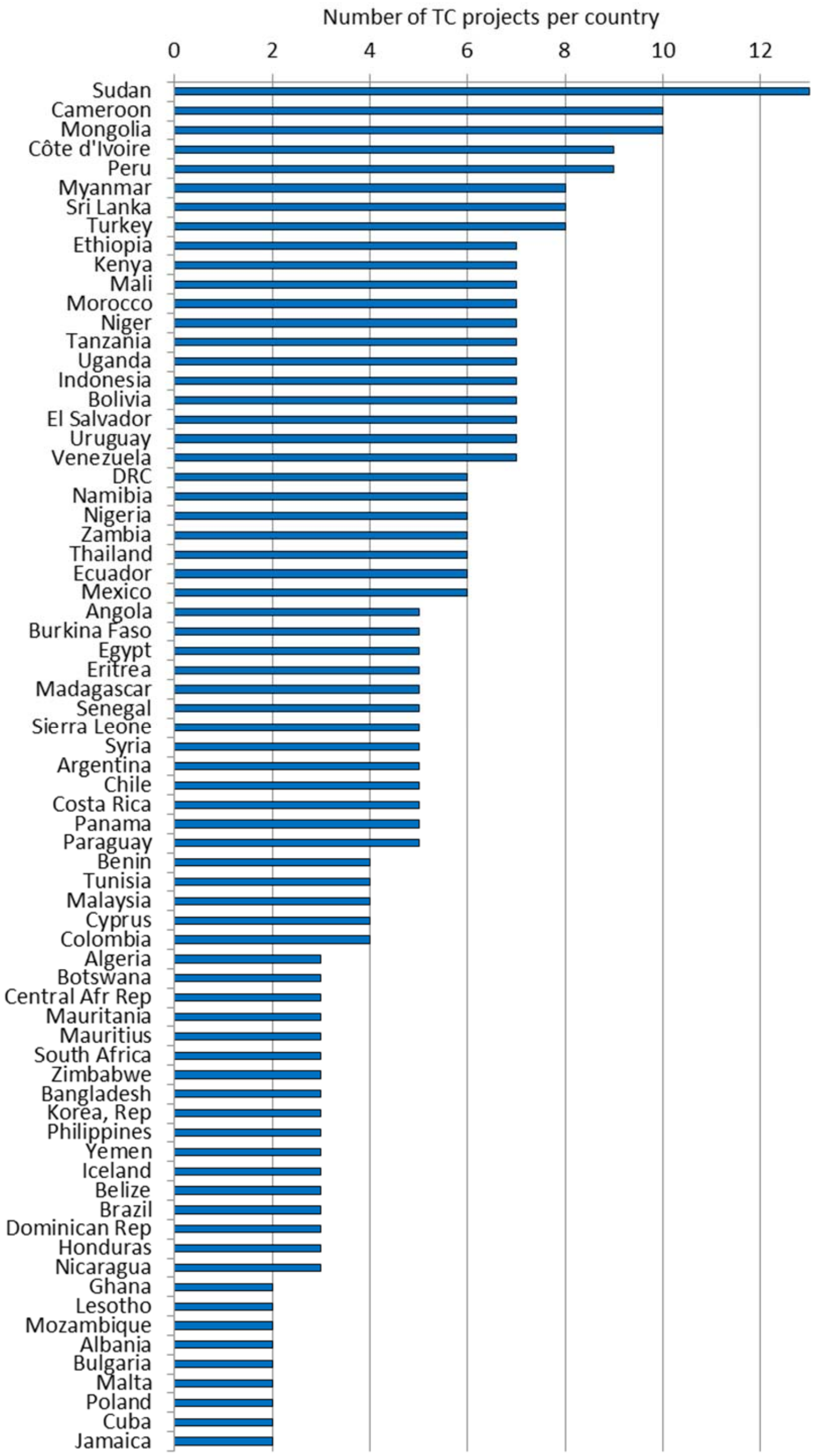


FIG. 64. Number of National TC projects per country in countries with two or more projects in the period 1979–2014

In summary, the 430 TC projects were evenly distributed between the two major subjects of APH activities: animal production and animal health. There were also 14% of the projects that had both

components, either under the same or different counterpart institutes (Figure 65). However, there were large variations across the years (Figure 66). For instance, there were higher number of projects dealing with animal production in the period 1979–1987 and larger number of projects dealing with animal health in the period 1993–2005 and again in the last TC cycle.

The occurrence of multidisciplinary projects (e.g. both production and health fields) was mainly due to the TC policy of requesting large multidisciplinary multi-institutional projects which in most cases were difficult to implement due to discrepancies on priorities between project leaders and even within TOs. It is also important to mention that some TC projects covered activities across sections of the Joint FAO/IAEA Division but those interactions have not been considered in this evaluation.

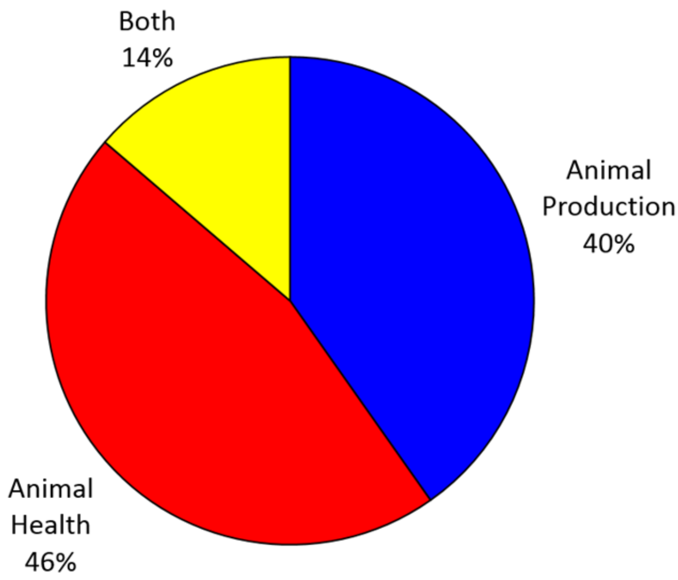


FIG. 65. Distribution of TC projects according to the main field of activity

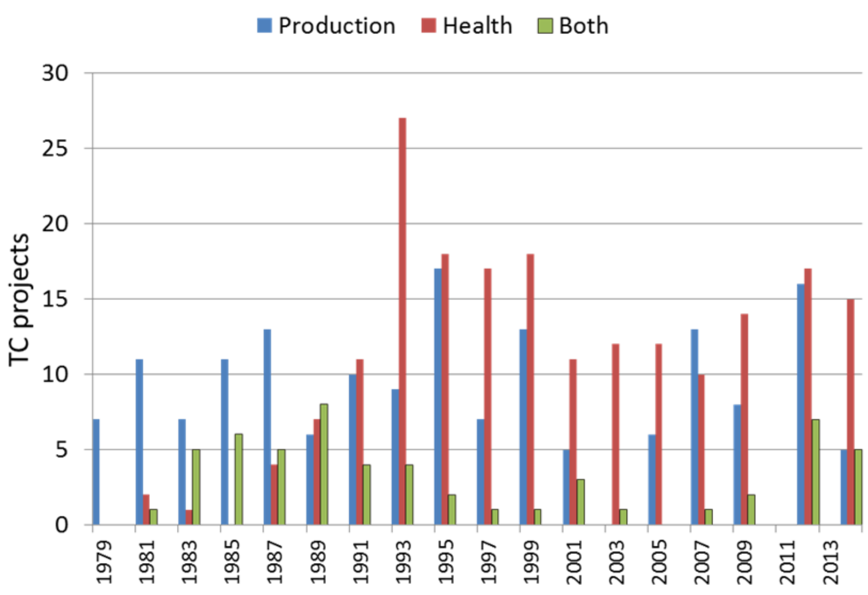


FIG. 66. Distribution of TC projects per TC cycle according to the main field of activity

CAPACITY BUILDING

Technical support to FAO and IAEA Member States was provided through TC projects; however, APH is also directly involved in capacity building through training courses, international meetings, workshops using non-TC funds such as regular budget and extra-budgetary funds.

Training Courses

IAEA records from 1986 onwards showed that 130 regional and interregional courses were implemented by APH (106 through TC projects and 24 through APH budget) as shown in Table 52. In addition, many national courses were implemented, especially during the visit of IAEA experts and TOs, but they were infrequent registered.

Regional and interregional courses were organized since the very early stage of the Joint FAO/IAEA Division. Figure 67 shows the frequency of these courses since 1986. The frequency of them varied from year to year with peaks in 1994–1995, 2004, and 2012–2013.

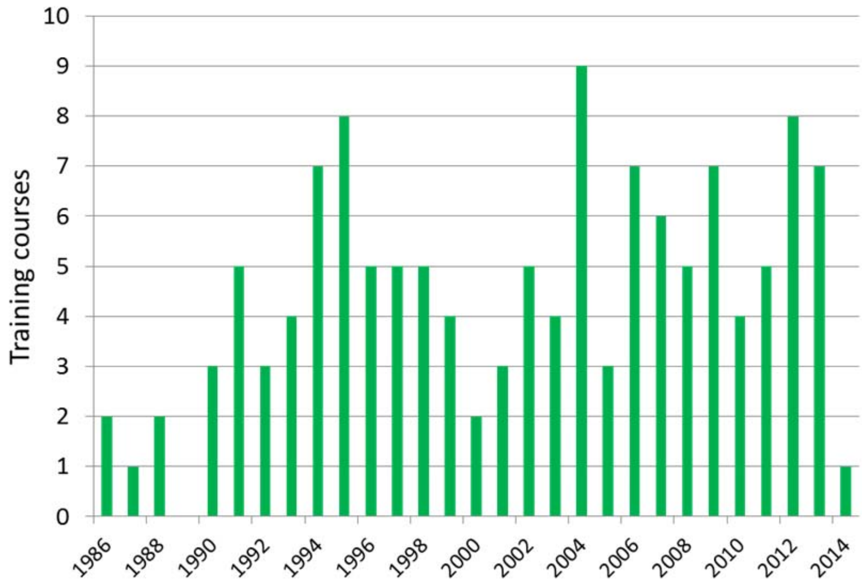


FIG. 67. Regional and interregional training courses conducted by the Animal Production and Health Section under the TC programme (n=106) and through its own financial resources (n=24) in the period 1986–June 2014

TABLE 52. TRAINING COURSES IMPLEMENTED PER SUBJECT FROM 1986 TO JUNE 2014 ACCORDING TO THE GEOGRAPHICAL COVERAGE

Subject	Interregional	Regional	National	Total
Animal production	6	43	6	55
Animal health	14	64[a]	21	99
Both subjects	0	3	0	3
Total	20	110	27	157

[a] Including three courses on drug residues

Most courses lasted for 1 or 2 weeks, however, some courses were designed for 3 to 4 weeks (Table 53). The exceptions were one regional course on the use of ELISA for the diagnosis of CBPP held in South Africa in 1995 and one interregional course held at APHL, Seibersdorf on 'on-farm' assessment of nutrition-reproduction interactions in 1995 which lasted for 5 weeks.

Data shows that there were 2166 participants trained in the 130 regional and interregional training courses (Table 54), which gives an average of 16.8 and 14.2 participants per regional and interregional training course respectively. However, due to the fact that many professionals and technicians may have participated in more than one training course, the real number of persons trained is less. The ratio of course participants per region is shown in Figure 68.

TABLE 53. DURATION (IN WEEKS) OF TRAINING COURSES IMPLEMENTED FROM 1986 TO JUNE 2014 ACCORDING TO THE GEOGRAPHICAL COVERAGE

Duration (in weeks)	Interregional	Regional	National	Total
1	1	53	7	61
2	8	39	16	63
3	0	8	3	11
4	11[a]	10[a]	1	22
Total	20	110	27	157

[a] One regional and one interregional course lasted for 5 weeks

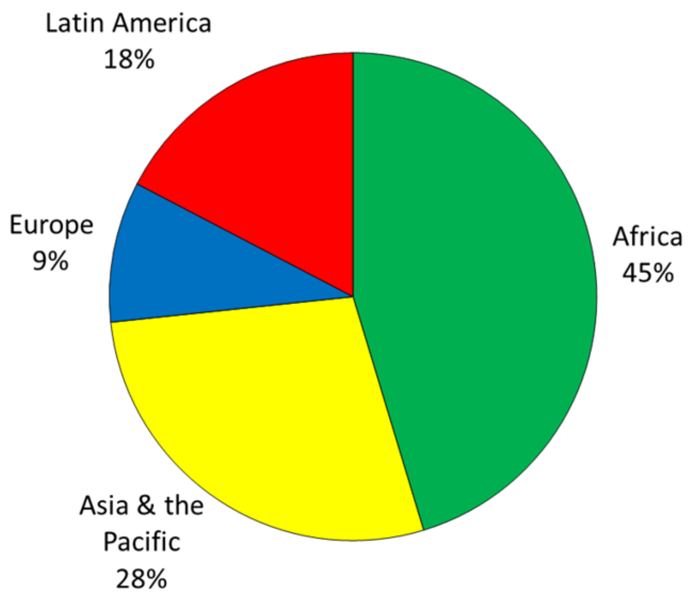


FIG. 68. Region of origin of participants (n=2681) in 159 national, regional and interregional training courses held from 1986 to June 2014

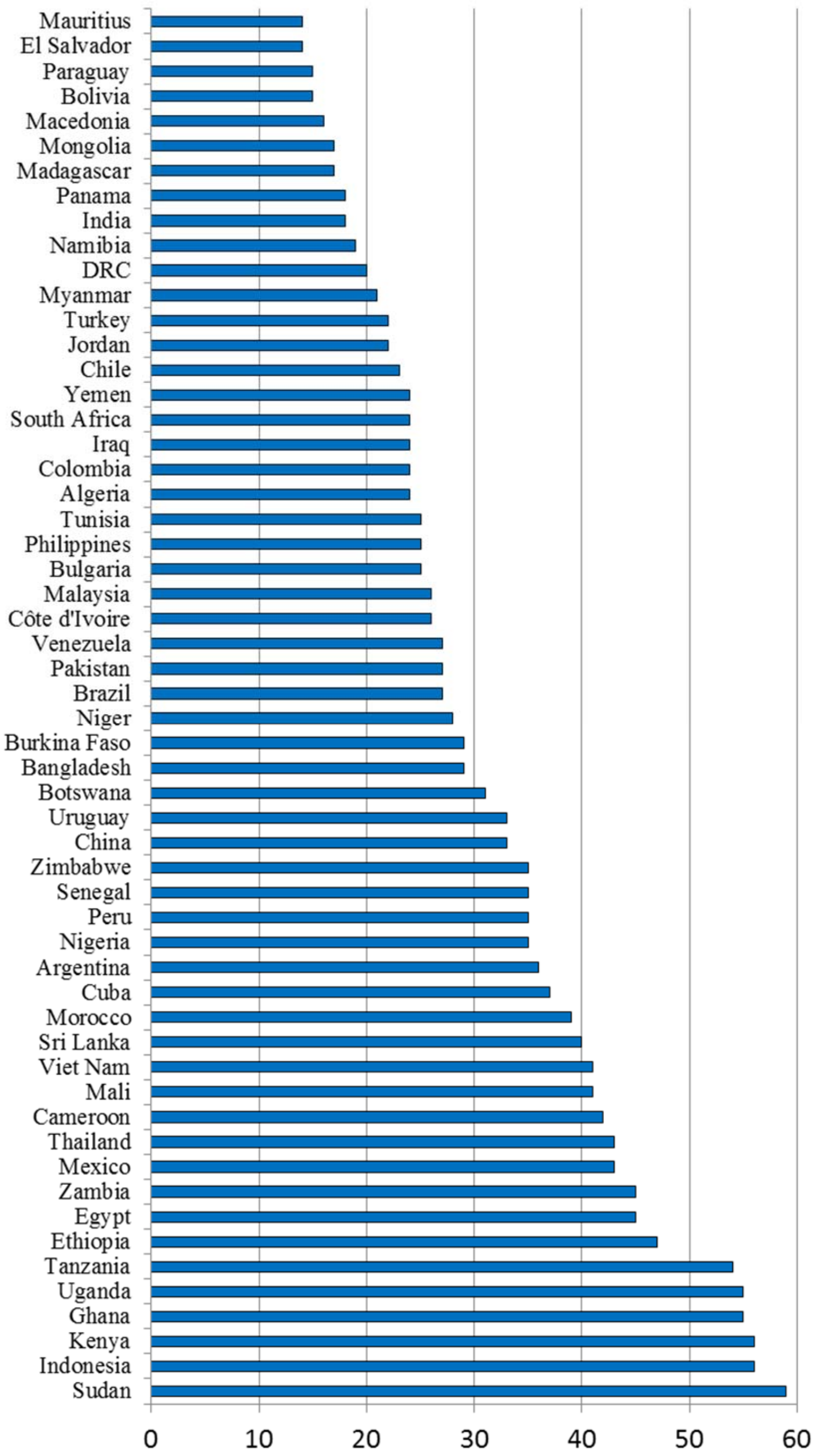


FIG. 69. Most frequent countries of origin of participants (n=2166) in 130 regional and interregional training courses held from 1986 to June 2014

The participation of scientists and technicians from FAO and IAEA Member States was directly related to the active connection of universities, research centres and laboratories with APH through TC projects and CRPs. Personnel from 133 countries have participated in regional and interregional

training courses. More than 40 participations per country in these courses were granted to 15 countries (Figure 69), while nationals of 34 countries only participated 1, 2 or 3 times in these courses.

TABLE 54. NUMBER OF PARTICIPANTS IN TRAINING COURSES IMPLEMENTED FROM 1986 TO JUNE 2014 ACCORDING TO THE SUBJECT AND GEOGRAPHICAL COVERAGE

Subject	Interregional	Regional	National	Total
Animal production	79	691	113	883
Animal health[1]	155	1120	392	1667
Production & health	-	71	-	71
Drug residues	50	-	10	60
Total	284	1882	515	2681

Expert Missions

Expert missions accounted since 1990 were undertaken by 439 world leader scientists in 1075 ocassions to 99 IAEA Member States.

The number of expert missions implemented per year varied from 50 to 70 in the period 1990–2002. Then, there was a sharp decrease of expert missions in the range of 8 to 25 per year (Figure 70).

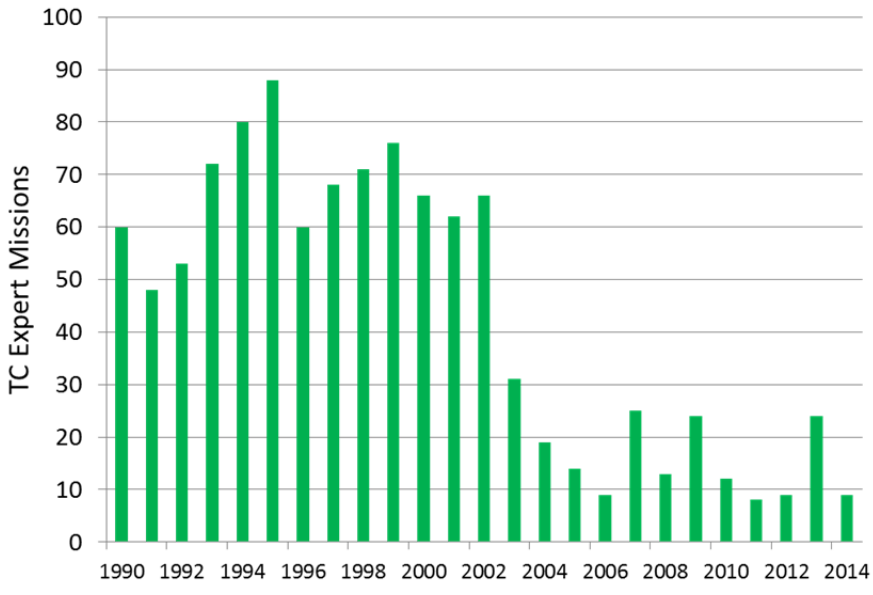


FIG. 70. Expert missions (n=1075) under National and Regional TC projects conducted in the period 1990– June 2104

On average, the vast majority of expert missions lasted for two weeks (Figure 71); however, there was a clear trend of assigning expert mission for 5 working days in the last 10 years.

In relation to the type of project, 882 expert missions (82% of the total number) were conducted under national TC projects and 193 expert missions under Regional TC projects. Most expert visits were conducted in African countries, especially under Regional TC projects (Figures 72 and 73).

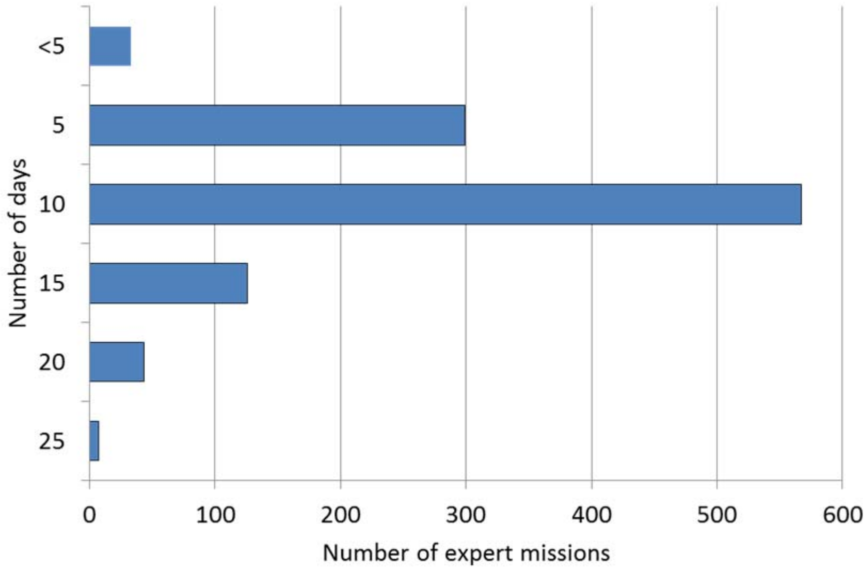


FIG. 71. Duration of expert mission (in working days) under TC Projects in the period 1990 to June 2014 (n=1075)

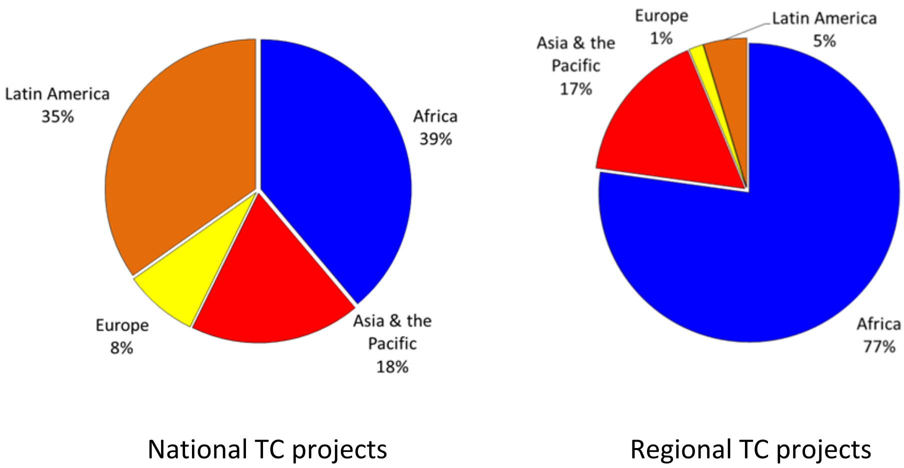


FIG. 72. Geographical distribution of target regions for expert missions under National (n=) and Regional (n=193) TC projects from 1990 to June 2014

There was a rather balanced recruitment of scientists on expert assignments according to their regions of residence (Figure 74). It is interesting to observe the large proportion of world leading professionals in their respective fields coming from developing countries. Nevertheless, a large number of experts were recruited from British institutes, but also from institutes in USA, Australia, Canada and Germany (Figure 75).

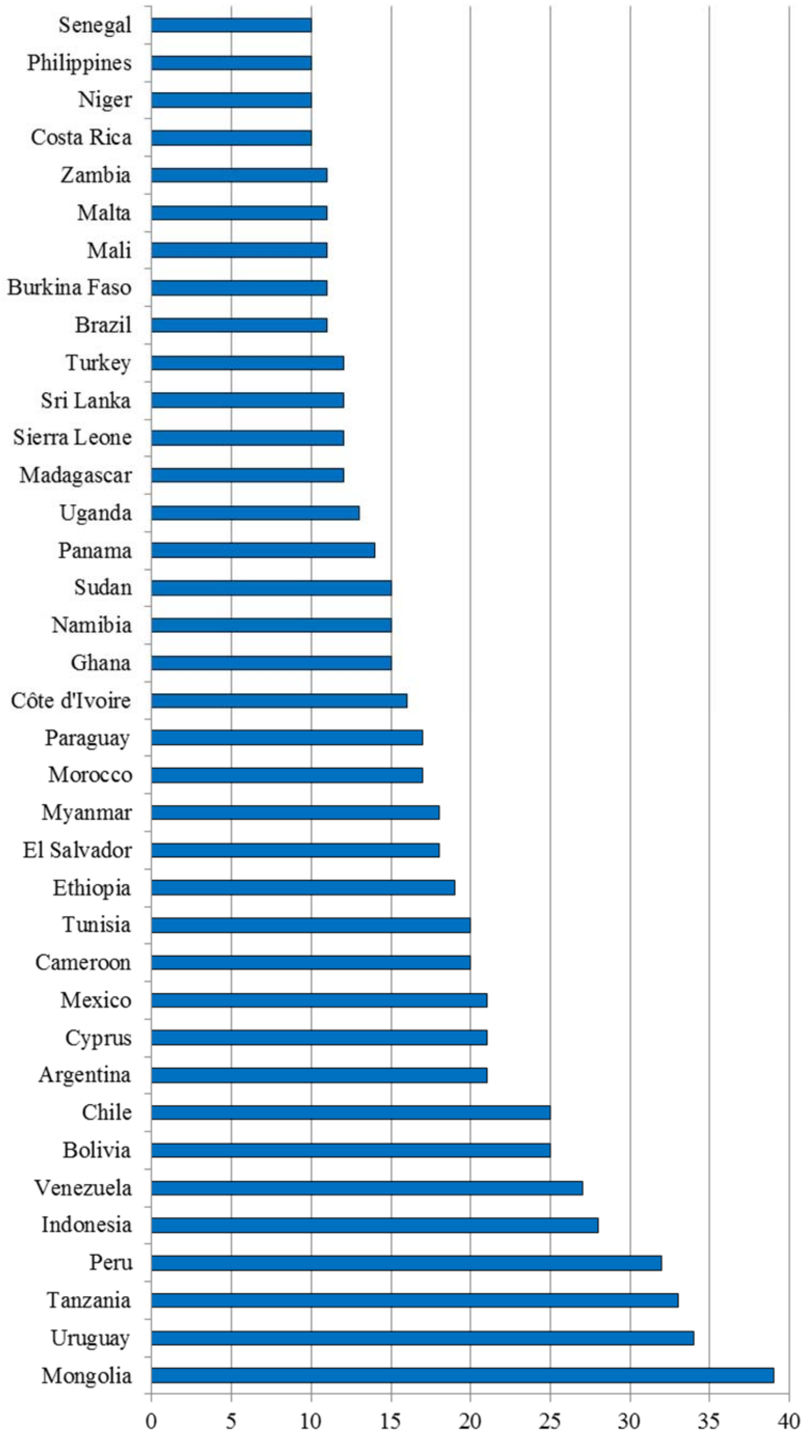


FIG. 73. Most frequent target countries for expert missions conducted from 1990 to June 2014 under National TC projects

Experts are recruited based on their knowledge and expertise for the fulfilment of specific tasks required for each expert mission. APH, through the various TOs responsible for the implementation of TC projects recruited 439 experts around the world. More than half conducted only one expert mission, 54 were recruited 3 to 5 times and 19 experts were available for 9 or more field visits (Figure 76). These figures do not include the recruitment of experts as lecturers for training courses, participation in CRPs, CMs, workshops, etc.

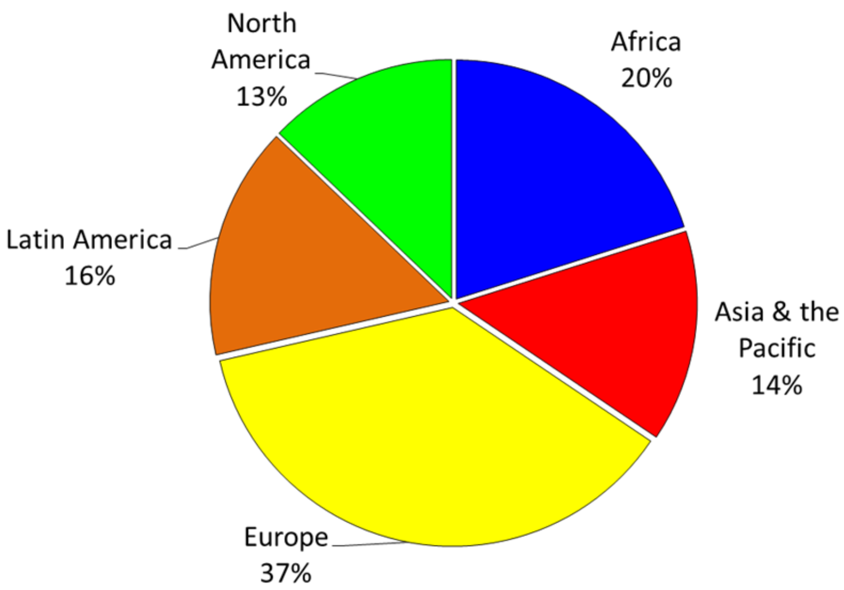


FIG. 74. Geographical distribution of scientists on expert assignments based on the country of origin (n=1075 expert missions)

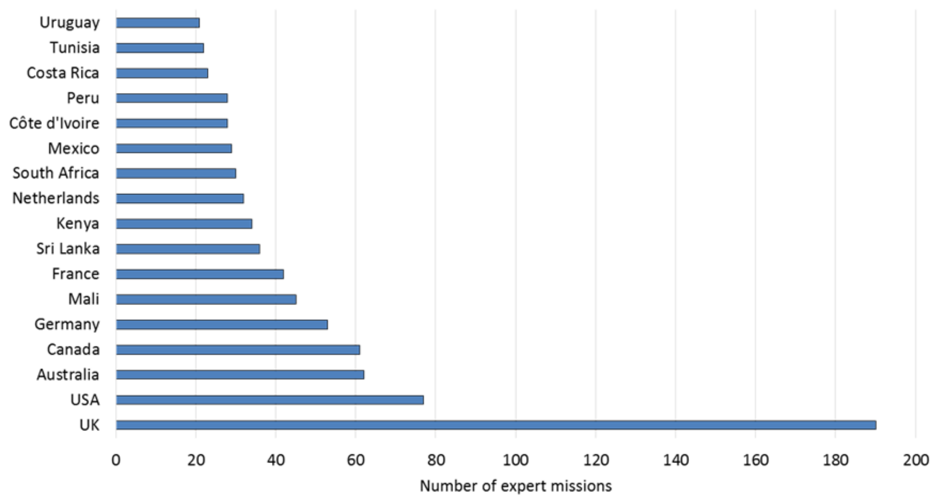


FIG. 75. Most frequent countries of origin for scientists on expert missions conducted from 1990 to June 2014 under National TC projects

Among the experts that were more often recruited, Karim Tounkara (Mali) and Emmanuel Couacy-Hymann (Côte d'Ivoire) conducted the largest number of expert missions as they were key components in the APH contribution to the rinderpest eradication programme, especially from 1999 to 2004. Klaus Nielsen (Canada) participated in the establishment and validation of the Brucella ELISA kits in Latin America from 1991 to 2003. Mario Garcia (Peru) performed several expert missions from 1998 to 2006 in Latin American, Asian and African countries on the application of RIA and the use of databases to improve the efficiency of AI services. Naceur Slimane (Tunisia) assisted the implementation of regional AFRA projects and national TC projects in Africa dealing with cattle reproductive efficiency (Figure 77).

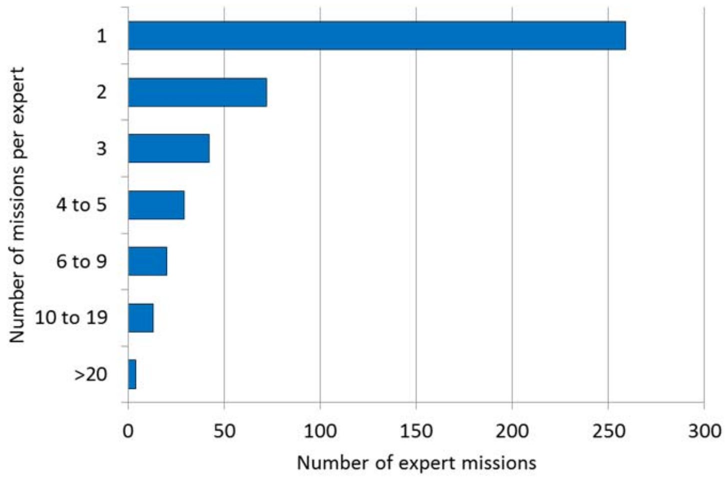


FIG. 76. Number of expert missions per expert under National and Regional TC Projects in the period 1990 – June 2014

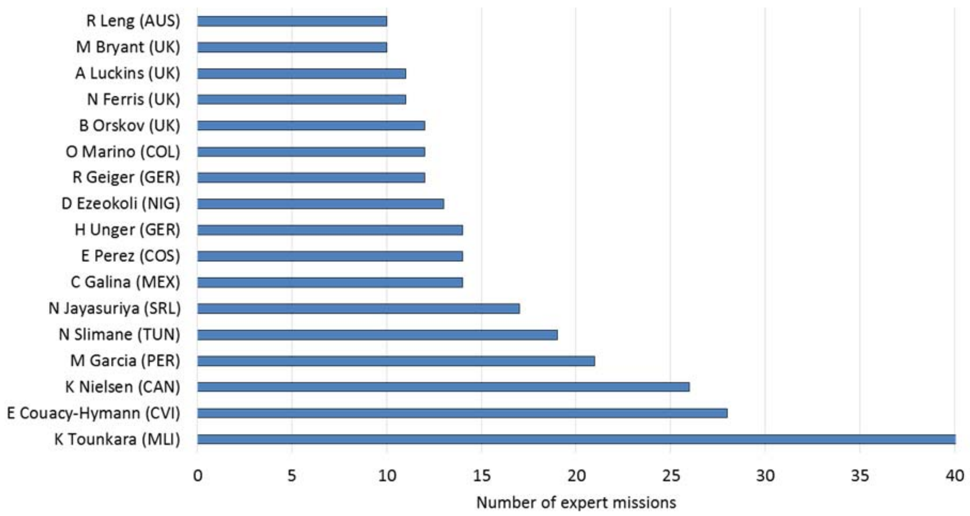


FIG. 77. Experts that have been most frequently recruited for TC expert missions under National and Regional TC projects in the period 1990 to June 2014

Expert missions related to animal health activities corresponded to 59% of the total expert missions, while 41% of them corresponded to animal production activities. Moreover, 90% of the expert missions were conducted by men scientists and 10% by female scientists.

Fellowship and Scientific Visits

The number of fellowships and scientific visits awarded under the TC Programme was 1048 and 189 respectively in the 50 years of the APH Section; however, it is possible that records earlier than 1980 are incomplete.

The number of scientists trained, either through a fellowship or a scientific visit varied from year to year without a clear pattern; however, fellowships for training abroad were awarded to 30–60 scientists per year since 1993. In the case of scientific visits, the frequency is more erratic if considering that these awards are addressed to high qualified scientists in the project team which do not require formal training and only travel for a short period to get acquainted of new technologies or discuss with their peers in more advanced laboratories. The distribution of fellowships and scientific visits per year of activity is shown in Figure 78.

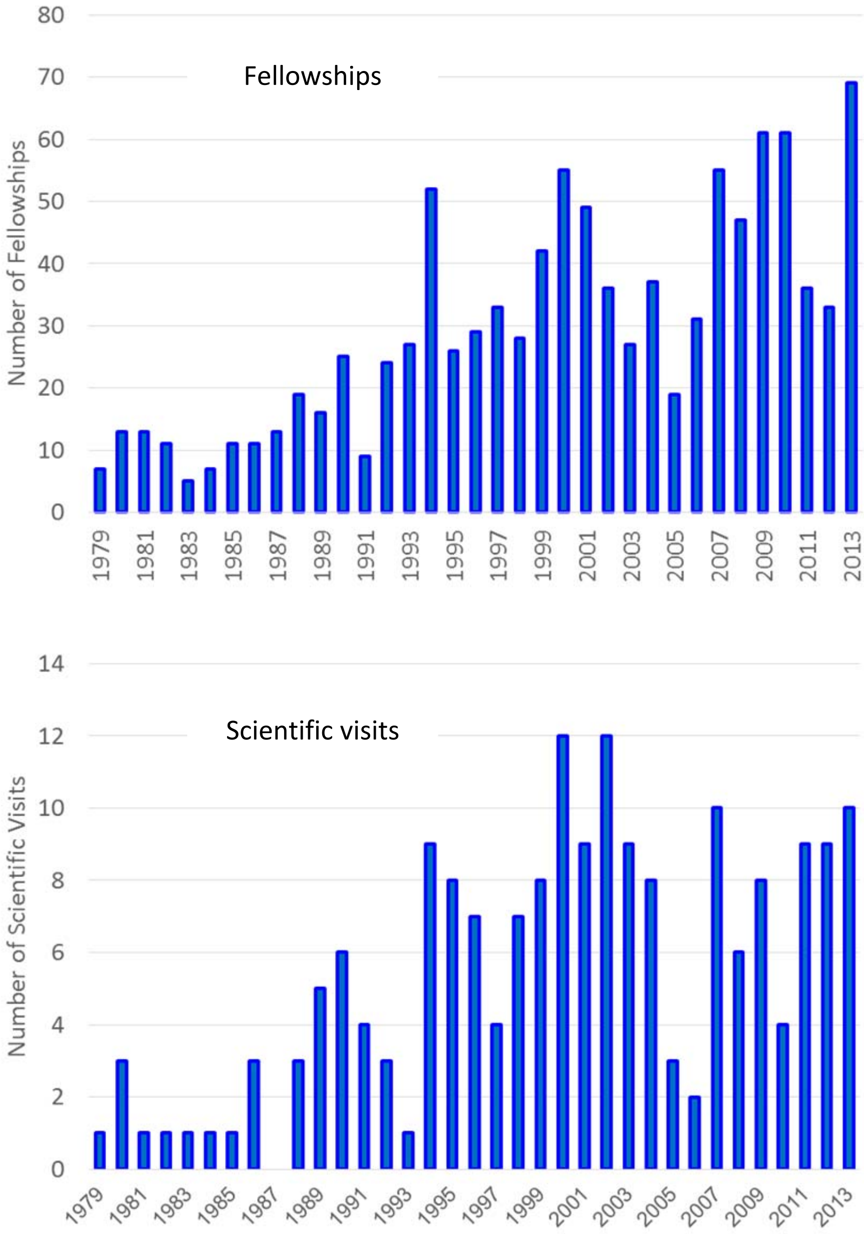


FIG. 78. Chronological distribution of fellowships (n=1048) and scientific visits (n=189) awarded to scientists under the TC programme

Host institutes for providing training are selected based on the expertise, infrastructure, equipment and facilities for training. The location of the host institute was not crucial for selection in the early years, but was always preferred to choose institutes in countries closer to the trainees; however, training

within the region of the trainee became a policy in the early 2000 in order to support regional partnership and better use of the existing TC budget. The exception was if proper expertise is not available within the region.

When pooling all fellowships and scientific visits awarded since 1979, 37 and 44% of fellowships and scientific visits were conducted in European host institutes, where APHL received 7 and 9% of the total trainees (Figure 79). This indicates the important role of the APH laboratory in providing hands-on experience and transfer of technologies to scientists from all over the world.

The preferred countries for fellowship training were the UK (n=130), South Africa (83), France (69), USA (56), Tunisia (55), Spain (41), Australia (37) and Germany (33), whereas for scientific visits, the most selected countries were UK (n=32), France (15), Sweden (14), Italy (13), USA (12), and Canada, Germany and the Netherlands (11 each). As indicated, APHL in Seibersdorf was among the most frequent recipients for training (70 fellowships and 24 scientific visits) (Figure 80).

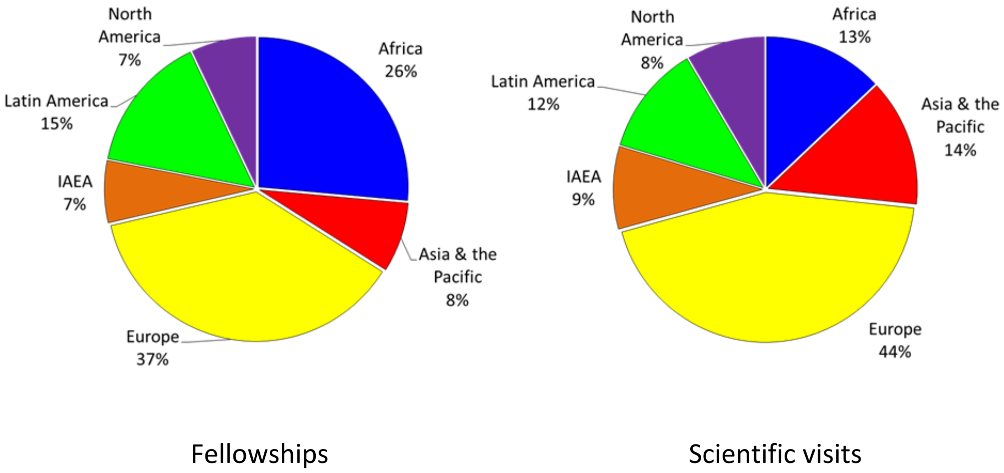


FIG. 79. Geographical distribution of host institutes for fellowship training (n=1048) and scientific visits (n=189) in the period 1979–June 2014

Thousands of livestock and animal health professionals and technicians have been trained at various levels (laboratory bench work, data processing, sample collection, pregnancy diagnosis, etc.)

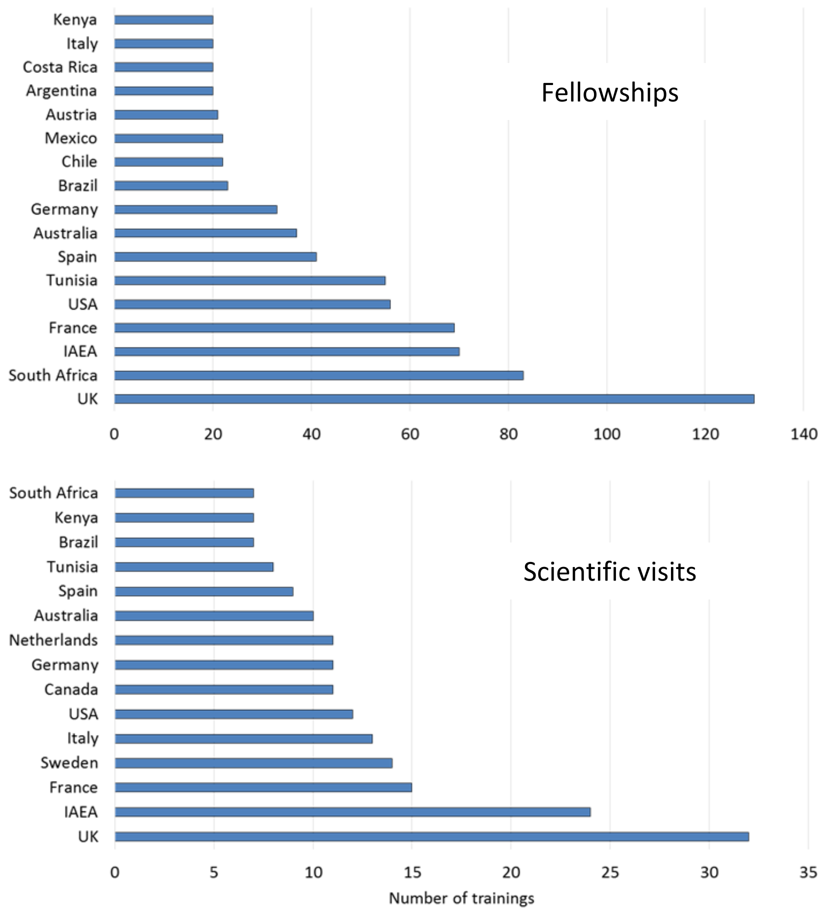


FIG. 80. Most frequent target countries for fellowship training (n=1048) and scientific visits (n=189) implemented from 1979 to June 2014 under National and Regional TC projects

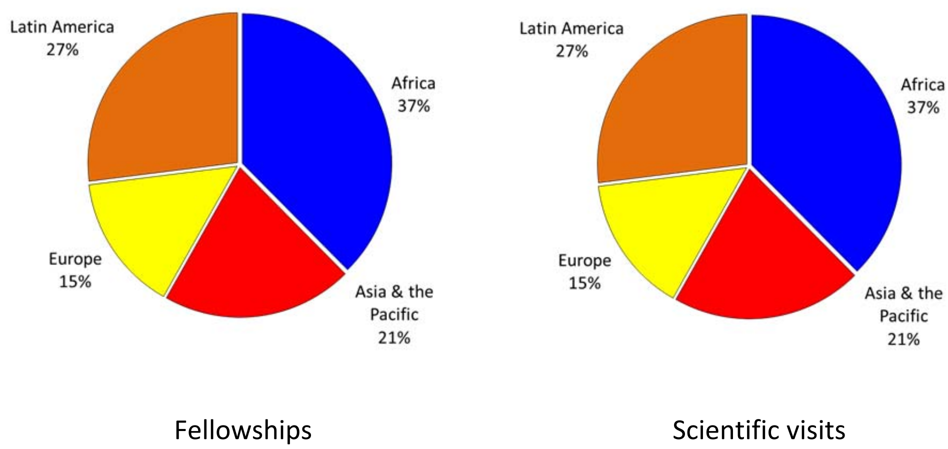


FIG. 81. Geographical distribution of trainees (fellowships [1048] and scientific visits [189]) according to the region of origin in the period 1979–June 2014 (Training at APHL is not considered in the figure)

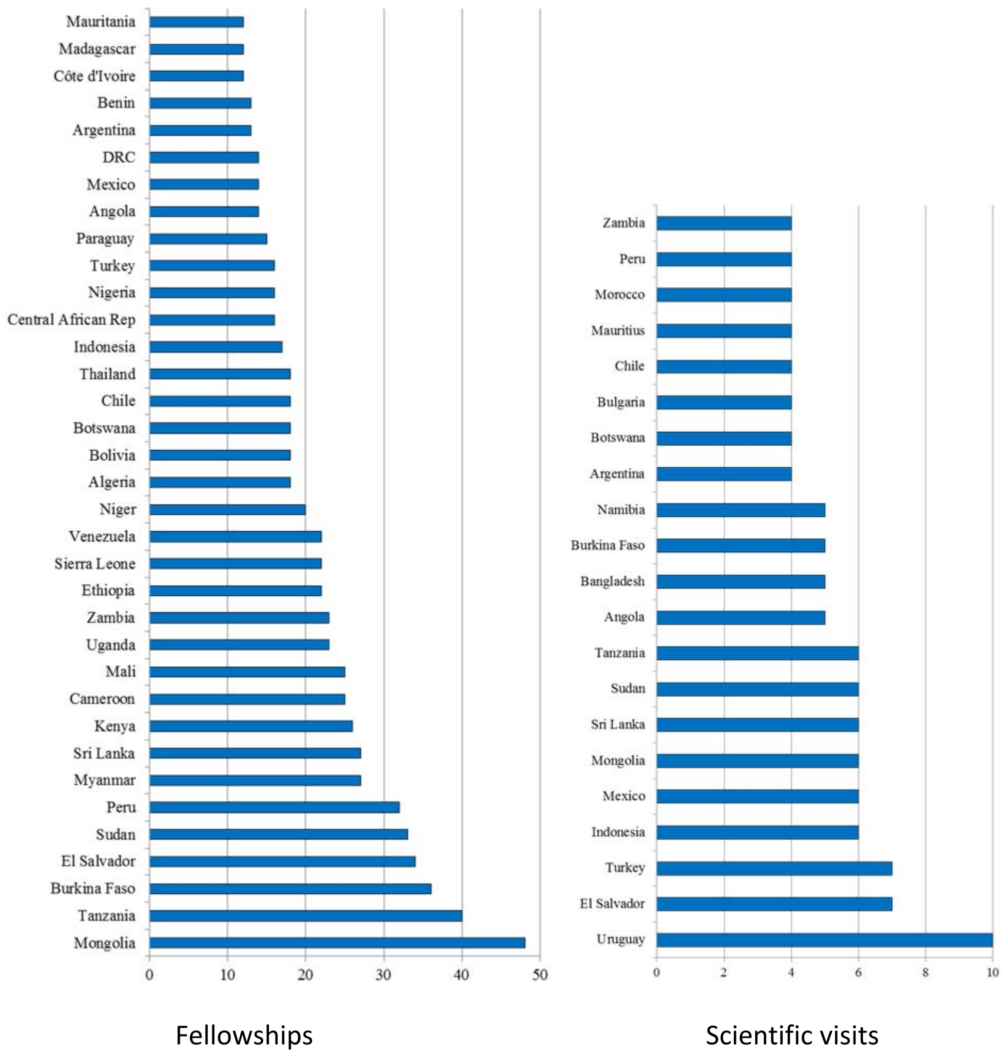


FIG. 82. Most frequent countries of origin for trainees (fellowships [1048] and scientific visits [189]) in the period 1979–June 2014

Scientists and technicians from 95 Member States have been trained in 73 Member States under the TC fellowship programme. In addition top scientists from 62 Member States were awarded with scientific visits in 50 Member States. The geographical distribution of trainees according to the region of origin is shown in Figure 81. Countries that benefitted most from the TC fellowship programme were Mongolia (n=48), United Republic of Tanzania (40), Burkina Faso (36), El Salvador (34), Sudan (33) and Peru (32), whereas countries with more scientific visits were Uruguay (n=10), El Salvador and Turkey (7 each), Indonesia, Mexico, Mongolia, Sri Lanka, Sudan and United Republic of Tanzania (6 each) (Figure 82).

The fellowship trained period varied from 1 to 3 months and most scientific visits were for three weeks, i.e. 15 working days (Figure 83). In the latter case, 2 or even 3 institutes in different countries were considered in the visit. However, the duration of the trainings has varied according to the years, as shorter period of training (1–2 months for fellowships and 1–2 week for scientific visits) were more common in the last 10 years (see Figure 46).

More fellowship trainings were implemented in the animal health field (60%) mainly due to the higher number of TC projects in that area; however, the proportion of scientific visits was similar for both animal production and animal health (Figure 84). The ratio male/female trainee was 1:2 in the case of

fellowship trainings and 1:5 in the case of scientific visits. On the other hand, out of the 1237 fellowships and scientific visits, 108 persons were trained two times, 25 were trained three times, 2 were trained four times and one person was trained five times, however, in different topics.

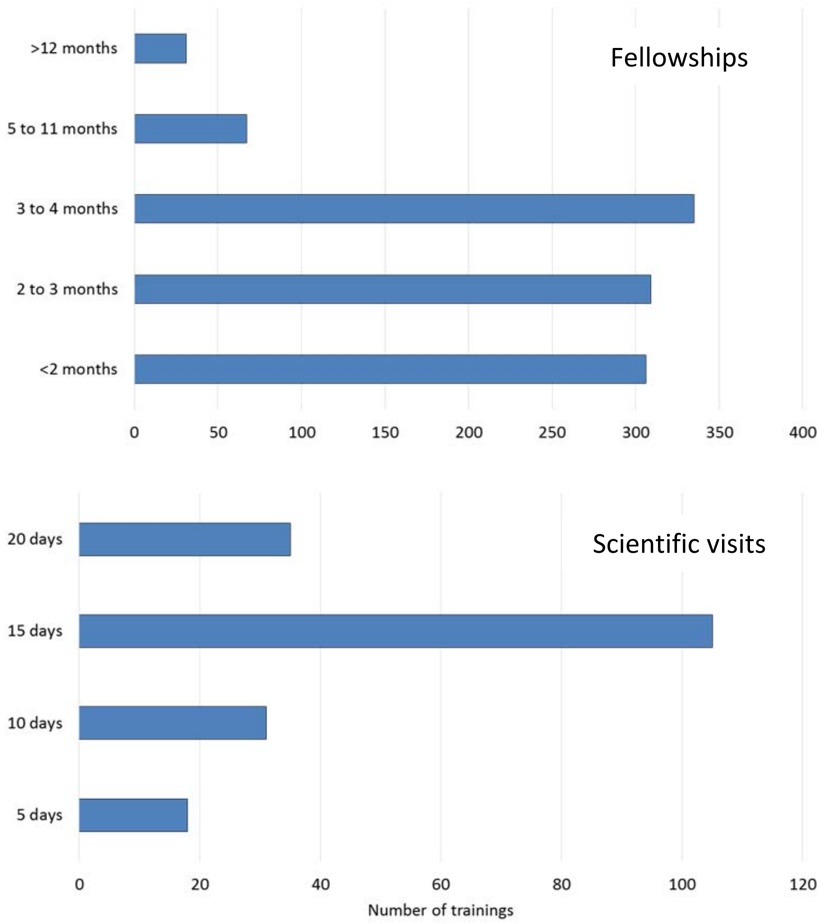


FIG. 83. Duration of fellowship training (n=1048) and scientific visits (n=189) implemented from 1979 to June 2014 under National and Regional TC projects

Duty Travels of Technical Officers

Technical officers travel to TC project sites to update work plans, advice on technical grounds, evaluate progress done, assist on data analysis and evaluate project needs. They also travel to supervise and lecture on training courses and workshops, act as scientific secretaries on technical meetings, including project coordination meetings and RCMs; however, the latter activities are not covered in this section.

Data was partially available for duty travels prior to 1991 and therefore has not been considered in the evaluation. A total of 189 duty travels were conducted by technical officers in the period 1991 to June 2014 (Figure 85).

The number of duty travels per TC project per year was nearly 0.6, which means one duty travel per project every two years. It is also important to indicate that in a few cases when projects cover two or more fields of expertise (nutrition, reproduction, health), more than one TO may visit a project during its lifetime.

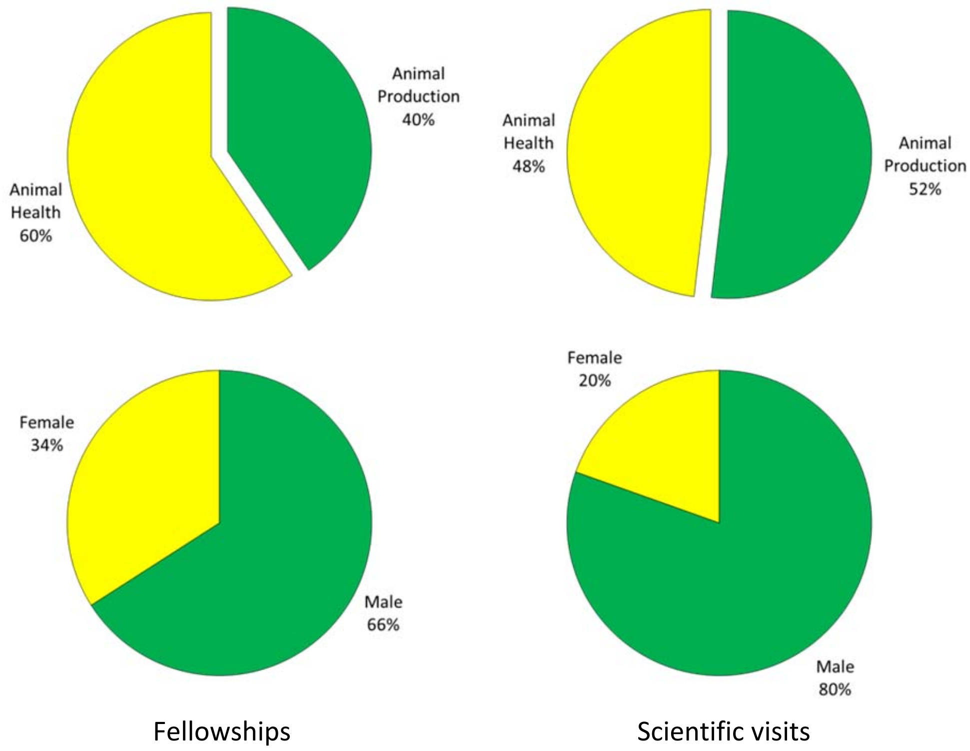


FIG. 84. Frequency of fellowship training (n=1048) and scientific visits (n=189) implemented from 1979 to June 2014 under National and Regional TC projects according to the field of expertise and gender

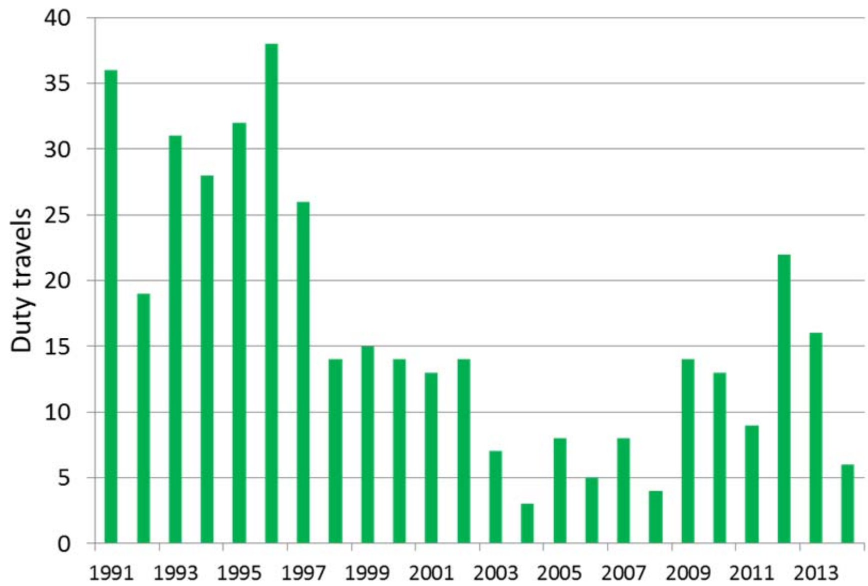


FIG. 85. Duty travels to TC project sites conducted by technical officers to monitor and supervise project activities (n=189) from 1991 to June 2014

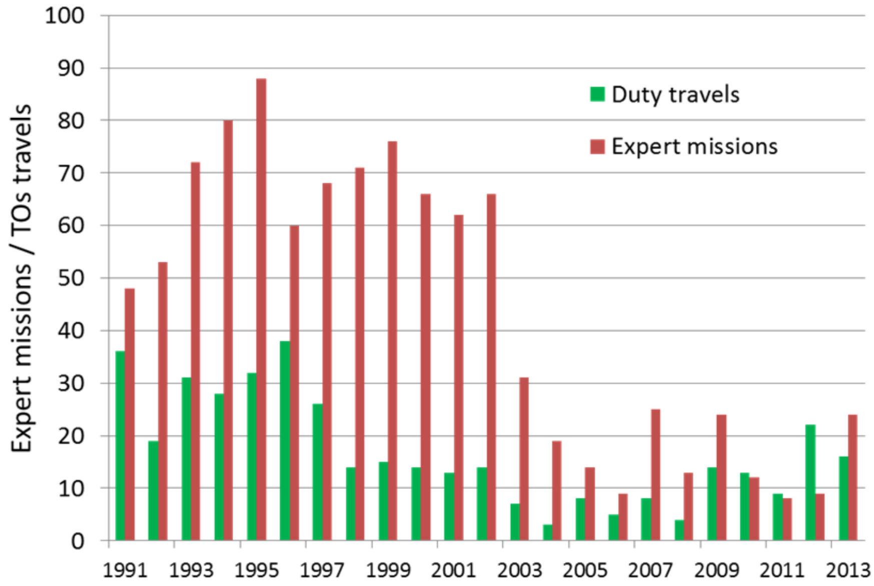


FIG. 86. Comparison between the number of expert missions and technical officers' duty travels under TC projects from 1991 to June 2014

The purpose of TO duty travels is, and should be, different from the objectives of internationally recruited experts. Usually experts spend longer time at project sites and have specific terms of reference for their missions while TOs create a working relationship with project counterparts, identify further needs in terms of equipment and capacity building, and evaluate progress done. The comparison between the number of expert missions and number of TO duty travels is shown in Figure 86.

Duty travels lasted for five or less working days; however, there were a few duty travels in the '90s that lasted for 2–3 weeks (Figure 87). The implementation of duty travels largely depends of the nature of the project, previous knowledge by the TO of the country and the host institution, and expert reports, as well as progress done by the project counterpart.

The number of duty travels by some TOs is shown in Figure 88. Duty travels are largely biased by the time spent as TO at the APH Section (*Duty travels to meetings, RCMs and training courses are not considered in the figure*).

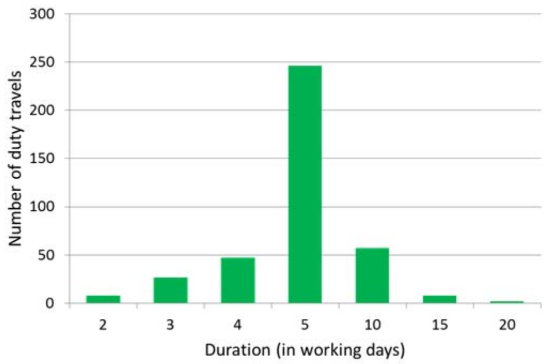


FIG. 87. Duration (in working days) of duty travels conducted by technical officers (n=189) from 1991 to June 2014

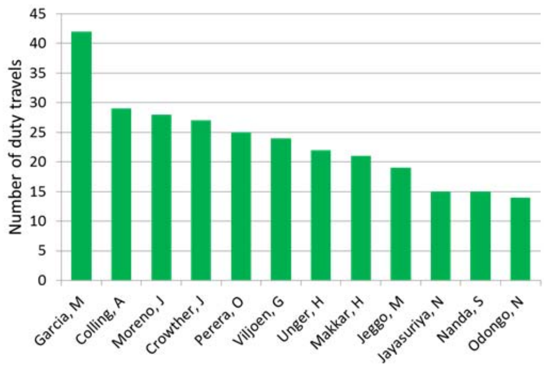


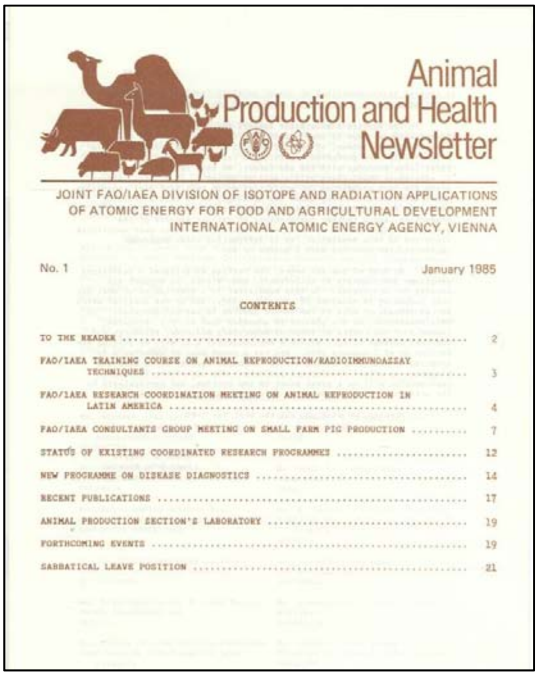
FIG. 88. Number of duty travels conducted by technical officers under TC projects from 1991 to June 2014

APH NEWSLETTER

The Animal Production and Health Newsletter has been the main source of information for past, present and future activities of the APH. The first issue saw the light in January 1984 and since then has been printed twice a year.

The content of the Newsletter has been quite consistent since its inception, as the source of information. In general, there is a message to the readers in the first pages, then the forthcoming and past events (training courses, RCMs, CMs, other type of meetings, etc.), the status of on-going CRPs, activities of APHL, list of TC projects, and publications.

The Newsletter started in a A5 format and moved to a A4 format in June 1998 using a new layout and the International Standard Serial Number (ISSN) was first applied (Issue No. 28). Then colour editions started in January 2004, (Issue No. 39) with a photo on the front page highlighting some of the activities of the Section. Colour pictures in the inner pages started with issue No. 40 (Figure 89).


Animal Production and Health Newsletter

JOINT FAO/IAEA DIVISION OF ISOTOPE AND RADIATION APPLICATIONS OF ATOMIC ENERGY FOR FOOD AND AGRICULTURAL DEVELOPMENT
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA

No. 1 January 1985

CONTENTS

TO THE READER	2
FAO/IAEA TRAINING COURSE ON ANIMAL REPRODUCTION/RADIOIMMUNOASSAY TECHNIQUES	3
FAO/IAEA RESEARCH COORDINATION MEETING ON ANIMAL REPRODUCTION IN LATIN AMERICA	4
FAO/IAEA CONSULTANTS GROUP MEETING ON SMALL FARM PIG PRODUCTION	7
STATUS OF EXISTING COORDINATED RESEARCH PROGRAMMES	12
NEW PROGRAMME ON DISEASE DIAGNOSTICS	14
RECENT PUBLICATIONS	17
ANIMAL PRODUCTION SECTION'S LABORATORY	19
FORTHCOMING EVENTS	19
SABBATICAL LEAVE POSITION	21

First issue (No. 1) of the Animal Production and Health Newsletter printed in 1984

Issue No. 29 was also the first digital issue of the Newsletter and since then all newsletters can be downloaded from the IAEA web page (http://www-pub.iaea.org/books/IAEABooks/Newsletters)

The names of the professional APH staff were initially included as signatories of the message to the readers. Then, as more staff was joining APH, in June 1990 (Issue No. 12), the 'To Our Readers' message was only signed by the Section Head and the list of staff was added as a section in the Newsletter, differentiating Headquarters and APHL staff. A photo of each staff member firstly appeared in the January 2010 (Issue No. 51) issue.

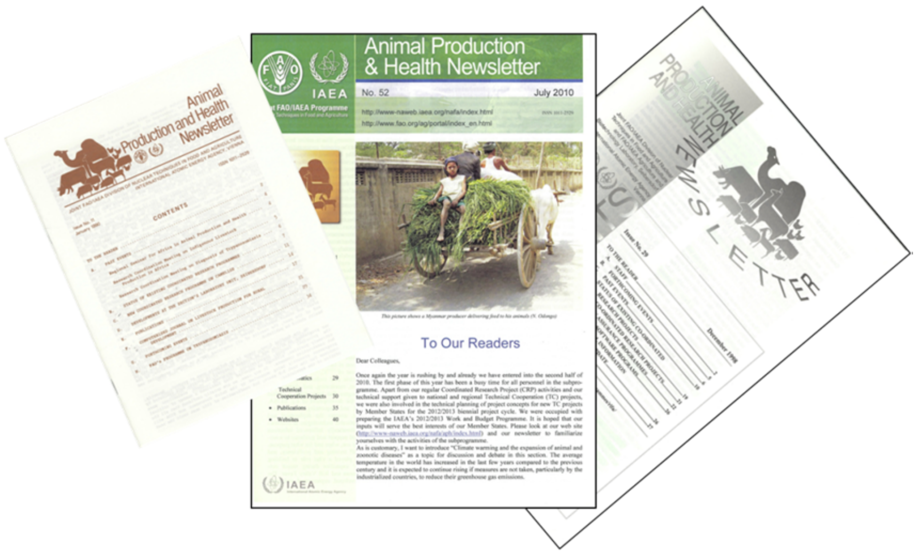


FIG. 89. Front pages of the three APH Newsletters showing the various formats along the years

The names of responsible TOs for CRPs, TC projects, training courses, and meetings were first mentioned in issue No. 30 (June 1999).

The newsletter is a free publication. Any interested person or institution can request it and his/her/its name will be added to the distribution list which is currently close to 1600 names. Everyone on this list is receiving a hard copy of the Newsletter every six months. Nevertheless, the pdf file of the Newsletter is available for free downloading in the APH webpage (http://www-naweb.iaea.org/nafa/aph/public/newsletters-aph.html).

Photographs of APH staff were printed by the first time on Issue No. 51 of the APH Newsletter (July 2010) (left). The right picture corresponds to the latest Newsletter (Issue 59, July 2014)

Major Technical and Scientific Contributions

SUCCESS STORY 1: The use of 'Urea Molasses Multi-nutrient Blocks' (UMMB) as an economical and efficient source of energy for improving feeding of dual-purpose cattle and small ruminants in developing countries


Global human population growth amounts to 75–85 million per year and most of this increase takes place in developing countries. Clearly more food of every type is required to meet the current needs and future expansion of the populations in these countries. Increasing the production and availability of animal protein in developing countries is therefore of considerable importance if the human populations of such countries are to be adequately fed.

Many developing countries have tried previously to import not only technology, but also whole entities/systems including animals, feeds and management procedures from developed countries in order to meet the escalating demands for livestock products from their expanding and increasingly urbanized populations. However, these approaches were unsuccessful, impractical or too expensive in most situations due to the different environmental conditions, culture and traditions of people and local availability of feedstuffs, especially in tropical developing countries. Central to this is finding ways of maximizing the efficiency of current livestock production systems so that all existing resources (and particularly the feeds) are used as efficiently as possible. This will require a matching of livestock production systems to the available feed resources, and here the challenge for the developing countries is not only to establish the nature, quantity and quality of the resources which are available to feed their own indigenous animals, but also to develop feeding strategies which take account of both seasonal fluctuations in feed availability and quality, and in individual animal requirements.

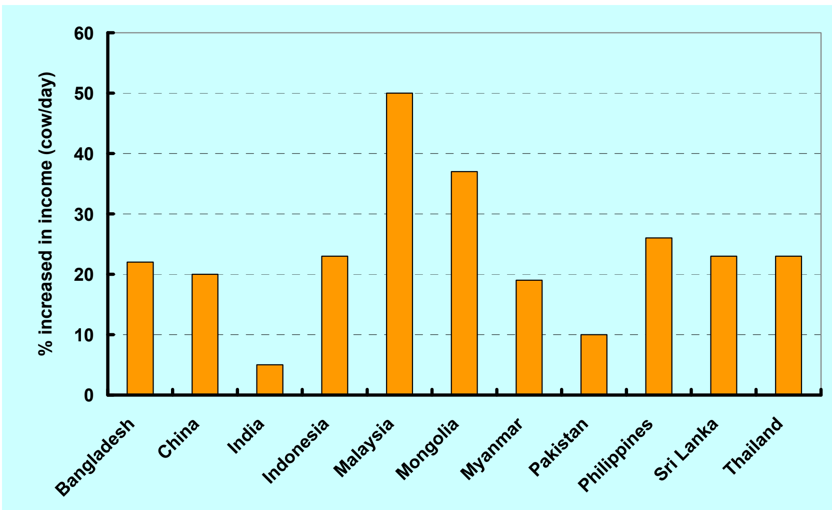

Simple way of UMMB manufacturing using local feed resources, urea and cement for use within the local community (Indonesia)

Given the enormous variations which exist in the developing world with respect to the available feed base and livestock production systems, the widespread transfer of feeding systems from dissimilar environments is unlikely to be efficient in terms of economics or productivity. Most situations will therefore have to be tailor-made for individual systems, which in turn require research and the application of research findings which take into account the circumstances of each country, climatic region and even the individual farmer.

Artisanal manufacture of UMMB (Indonesia)

A major constraint to livestock production in developing countries is the scarcity and fluctuating quantity and quality of the year-round feed supply. Providing adequate good quality feed to livestock to raise and maintain their productivity is, and will continue to be, a major challenge to agricultural scientists and policy makers all over the world. The increase in population and rapid growth in world economies will lead to an enormous increase in demand for animal products, a large part of which will be from developing countries. Future hopes of feeding the millions and safeguarding their food security will depend on the enhanced and efficient utilization of alternative feed resources that cannot be used as food for humans. In addition, a large area of land in the world is degraded, barren or marginal and the amount is increasing every year. This also calls for identification and introduction of new and lesser known plants capable of growing in poor soils, which can play a vital role in the control of soil erosion in addition to providing food and feed.

In developing countries, livestock are fed mainly on low quality roughages, including natural grazing and agro-industrial by-products, such as cereal straws/stovers, sugarcane by-products and other similar feeds, all of which contain large quantities of ligno-cellulosic material. These feeds are deficient in protein, energy, minerals and vitamins. In addition, at certain times of the year, the quality of grazing and browse deteriorates substantially due to seasonal influences, and livestock productivity consequently declines, unless supplements are offered.



Examples of economic benefit due to extra milk yield when using UMMB in dual-purpose cows fed with low-quality fibrous roughages and crop residues

The small holder farmers in developing countries have limited resources available for feeding their livestock. They are unable to select the basal feeds to suit the production requirements of their animals unlike their more fortunate counterparts in developed countries. Therefore, strategies are needed to optimize the improved utilization of vastly available feed resources such as crop residues and agro-industrial by-products, if animal production is to be maximized in these countries.

The APH Section has supported animal production research into the causes of the low level of animal productivity that exist in many developing countries and into the search for solutions. As part of these

efforts, APH gave for many years high priority to work on these aspects aiming to defining the nutritional requirements of ruminant livestock and at evaluating and improving locally available potential sources of feed in developing countries in Asia, Africa and Latin America. Technical support was given through national and regional TC projects (e.g. RAS/5/030, RAS/5/035, RAF/5/041, RLA/5/028) and CRPs (e.g. D3.10.03, D3.10.06, D3.10.07, D3.10.10, D3.10.16, D3.10.18, D3.10.19). Very often as a result of successful implementation of a CRP or a national TC project, regional projects are developed which promote the application of results emanating from a CRP or a TC project. The successful completion of the CRP on 'Use of Nuclear Techniques to Improve Domestic Buffalo Production in Asia (RCA)' and the success of four subsequent CRP's involving the development of feed supplementation strategies, lead to the development and popularization of 'Urea Molasses Multi-nutrient Block' (UMMB) technology amongst the small holder livestock farmers in in Asia and Africa.

Mechanical press for manufacturing blocks in Yangon, Myanmar (2009)

The story begins as early as 1978 when the Joint FAO/IAEA Division initiated the CRP D3.10.03 indicated above. Around the same time the IAEA initiated a project in Indonesia funded by the UNDP to develop a feed supplementation strategy for improving livestock production in the country. Animal nutritionists at the Centre for Application of Isotopes and Radiation (BATAN) of the National Atomic Energy Authority along with the staff of the Directorate General of Livestock Services (DGLS) of the Ministry of Agriculture used ^{14}C, ^{32}P and ^{15}N labelled material to measure the efficiency of rumen fermentation in buffalos fed most commonly available by-product feeds such as rice bran, cassava waste, soya bean curd, etc. Along with data obtained from measurements made using traditional methods such as digestibility, rate of passage and feed intake scientists were able to establish optimal combinations of these by-product feeds for use as supplements to available pasture and grazing. The supplements so selected were then made into blocks which could be 'licked' by animals and after testing at the research station and 'on farm' for their effectiveness on productivity and acceptance by the farmers, were made available in large scale to livestock farmers in the country.

UMMB in a cattle cooperative for sale to farmers (Naypyidaw, Myanmar, 2009)

Research carried out both at research station and 'on-farm' clearly showed the benefits of the block which was named as the 'Urea Molasses Multi-nutrient Block' (UMMB) (Tables 55 and 56). The blocks were made out of molasses (as an energy source and a source of trace minerals), urea (nitrogen source), by-product(s) (both for energy and protein sources), cement (as binding and hardening agent) and minerals/salt. The research results demonstrated the possibility of substantial increases in the productivity of milk-producing animals fed poor quality roughages. For example in milking buffaloes as well as dairy cattle under field conditions feeding of 300–500 g/day of the block resulted in increase in milk yield of 2–3 litres per animal/day. The value of the increase in yield was 2 to 3 times the cost of the supplement making it highly profitable for a small farmer owning 6–8 head of cattle/buffaloes. Similarly there was an improvement in the reproduction parameters in both cattle and buffaloes. Age at first estrous, first insemination and first calving was reduced by 2 months. Services per conception, interval from calving to re-establishment of estrous and inter-calving interval also showed a marked reduction. Experiments and field studies with goats and sheep also showed that UMMB improved growth rates, increased birth weights of off-spring and improved milk yield of dams, resulting in higher survival rates of the kids.

TABLE 55. SUMMARIZED DATA ON BENEFIT/COST RATIOS FOR APPLICATION OF UMMB TECHNOLOGY TO RUMINANTS IN INDONESIA

Livestock class	Production parameters	Benefit/Cost ratio
Beef cattle	Growth	2 : 1
Dairy cattle	Milk production and quality Lifetime reproduction Cow sale weights	4.3 : 1
Goats	Reproduction Kid survival	3.6-7.2 : 1

TABLE 56. PRODUCTIVE AND ECONOMIC COMPARISON WHEN USING UREA-MOLASSES BLOCKS AS A SUPPLEMENT FEEDING IN DUAL PURPOSE CATTLE IN MADAGASCAR (1999)

Parameter	Without UMMB	With UMMB
Mean rate of decline in milk yield (L/d)	-0.0431	+0.4531
Estimated milk production/10 weeks (L) (Initial lactation yield of 10 L/d)	686.4	838.7
Extra milk produced over 10 weeks (L)	-	152
Cost of extra milk (MF[1])	-	228 000
Cost of UMMB (MF) (Daily intake of 600 g)	-	42 000
Extra net income (MF/10 weeks)	-	186 000
Extra net income (MF/week)	-	18 600

[1] Malagasy francs (approx. 1 ariary = 5 MF)

The research results were so encouraging that the Indonesian Ministry of Agriculture took up the technology and introduced it to the farming community in the country through village dairy cooperatives. This not only lead to improved animal production in the country but also generated employment to members of the village communities.

The Indonesian success story spread into other parts of the developing world. Through national TC projects and regional TC projects such as AFRA II-17 (RAF/5/041) implemented to field evaluate feed supplementation packages for improving ruminant productivity. Various components, preparations, mixing techniques etc. were tested out to produce blocks of various sizes, consistencies and nutritive values. Immense number of feeding trials with cattle, sheep, goats and buffaloes were carried out and results in terms of growth, milk production, and reproductive performance have been recorded and proved to be satisfactory when the initial levels of growth rate, parturition intervals and milk production were low.

The technology was transferred to many developing countries, both in Asia, Africa and Latin America. In Africa the technology was promoted amongst small farmers in Sudan, United Republic of Tanzania, Mauritius, Madagascar, Zambia, Ethiopia and Tunisia. Based on the availability of feed ingredients

and the animal's requirements the composition and methodology of block production was modified. It has been reported that in many instances farmers are using locally produced UMMB as a feed supplement as well as an emergency feed during periods of fodder shortage.

The Indonesian experience has been replicated to many parts in the world where feed resources are scarce and milk yield is low. UMMB manufacture can be time consuming for individual farmers but coordinated efforts from farmers groups can make the difference

In addition to above African countries, a number of countries in Asia (such as India, Bangladesh, Viet Nam, China, Sri Lanka, Myanmar, Thailand and Mongolia) and Latin America (the Bolivarian Republic of Venezuela, Chile, Mexico, Cuba, Peru) have been actively involved in the development and/or utilization of urea molasses multi-nutrient block technology, as appropriate to individual country situations. Currently, dairy and livestock cooperatives have taken the lead in manufacturing and selling UMMB to farmers.

SUCCESS STORY 2: Use of a standardized protocol to identify factors affecting the efficiency of artificial insemination services for cattle through progesterone measurement

A multi-well gamma (left picture) and two single-well gamma counters (centre and right pictures) used by project counterparts for the determination of progesterone concentration in milk and blood samples

The monitoring of reproductive hormones, through radio-isotopic techniques such as RIA, in conjunction with field protocols for sampling, collection of behavioural and biological data, and the use of computer software applications, developed by the IAEA has proved enormous advantages for a better understanding of the reproductive physiology of livestock species, in identifying and ameliorating limiting factors affecting reproductive efficiency (in high-input – high-output dairy production units, medium scale farms using modern technology, small-scale livestock farms and pastoral farms), in providing diagnostic tools for ensuring proper AI timing, for monitoring ovarian cyclicity, identifying anoestrus and non-pregnant females, and in assisting AI centres and AI service providers on management and human errors on AI, efficiency of inseminators, failures in heat detection and fertility of sires (Figure 90).

Individual or corporate farmers, by using simple but well established and validated field and laboratory protocols, can monitor and evaluate the performance of their animals and farms. By so, animals can reach sexual maturity and first parturition at an earlier age, get offspring at a higher frequency and in return, farmers obtain higher and sustainable economic returns.

Artificial insemination (AI) is widely used for improvement of livestock production in developed countries, particularly within the cattle industry, for rapid genetic improvement. Its use in developing countries is less widespread and the results obtained are far from satisfactory. Under tropical small-farm conditions, a number of socio-economic, organizational, biological and technical factors make the service more difficult to provide and also less efficient, reducing the success rate and preventing it from being used by a larger proportion of farmers. Is this constraints can be overcome, not only would the current users of AI services benefit, but the technology would also become more widely adopted, and therefore, contributing to an increased production of milk and meat, leading to better food security and poverty alleviation.

IAEA expert N. Slimane in the field inseminating a cow during a training course in Botswana

Any attempt to improve the efficiency of AI has to be based on the understanding of the most important causes for inefficiency. The traditional methods used for this rely on accurate recording and analysis of reproductive events such as oestrus, services, pregnancies and calvings. However, this does not allow an assessment of the importance of factors such as efficiency and precision of oestrus detection by the farmers and incorrect timing of insemination.

AI technician in Morocco ready to collect a milk sample for progesterone analysis after the insemination was done in a cow (2001)

Progesterone is a hormone secreted by an active corpus luteum (CL) during certain reproductive stages such as pregnancy or the luteal phase of the oestrous cycle. This means its concentration in body fluids varies according to the reproductive status of the animal (Figure 90), and therefore, the measurement of progesterone in milk or blood allows the determination of the presence or absence of a functional CL. When progesterone is measured in samples collected at appropriate times in relation to AI, the results can be used, in conjunction with related physiological data, to evaluate more precisely the causes for poor productive performance.

Based on the above considerations, the APH Section convened a consultants meeting in May 1994 to advice on the applicability of RIA for measuring progesterone in milk of dairy cattle to identify the major causes of conception failure and reproductive wastage when AI is used under the conditions prevailing in developing countries. The consultants recommended the initiation of a CRP on this topic, and developed a comprehensive technical document including the sampling protocol and the range of information that needs to be recorded in order to obtain conclusive results. A five year CRP on the 'Use of RIA and Related Techniques to Identify Ways of Improving Artificial Insemination Programmes for Cattle Reared under Tropical and Sub-Tropical Conditions' was initiated in early 1995 with the participation of 14 countries (Bangladesh, China, Indonesia, Myanmar, Pakistan, Sri Lanka and Viet Nam in Asia, and Argentina, Chile, Costa Rica, Cuba, Peru, Uruguay and the Bolivarian Republic of Venezuela in Latin America).

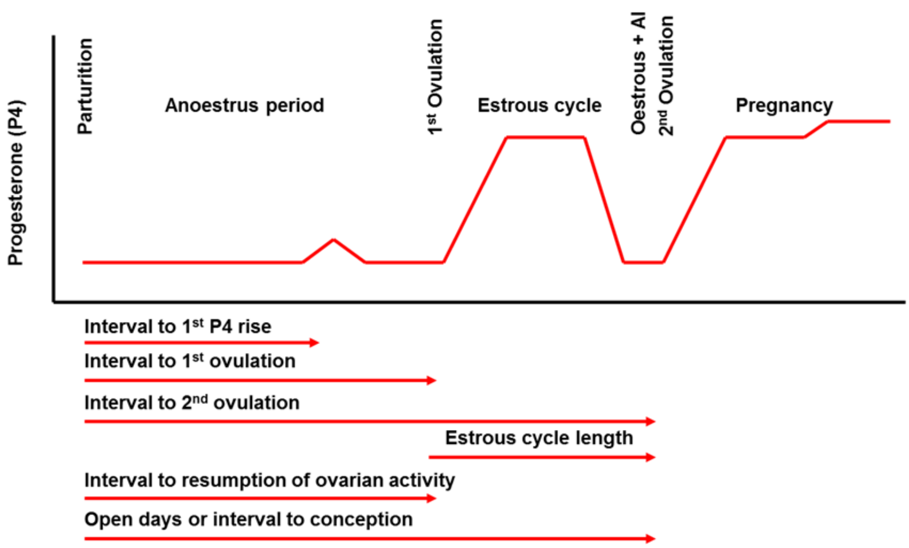


FIG. 90. Monitoring post-partum ovarian activity through RIA progesterone analysis

Research protocol

The project was focussed mainly on dairy and dual-purpose cattle and the targets farms were smallholder farms in Asia and medium to large farms in Latin America, as the farms had to be representative of the specific regions.

Technicians being trained on the artificial insemination technique in Madagascar (TC MAG/5/020) during a national training course in 2013

The programme of work considered the monitoring of a minimum of 500 cows undergoing the first insemination after parturition. Three milk (or blood) samples were collected. These were collected on the day of service (day 0) and on days 10–12 and 22–24 after service. The third sample was only collected if the animal was not observed in heat at the expected time (Figure 91).

Progesterone concentration in milk or plasma samples was measured using the FAO/IAEA RIA kits which were based on a solid-phase RIA technique employing ^{125}I-labelled progesterone as tracer. Data regarding farms, AI technicians, semen used, cow inseminated, characteristics of the heat expression and factors related to the insemination were recorded in AIDA.

Technical support

The standardized research protocol was used for all 14 RC holders and technical advice was provided by the TO, two technical contract holders and five agreement holders.

CRP participants received four times a year standardized RIA kits based on a non-extraction solid-phase assay, together with appropriate standards and the assay protocol. The laboratories were also supported by the EQA service run by APHL.

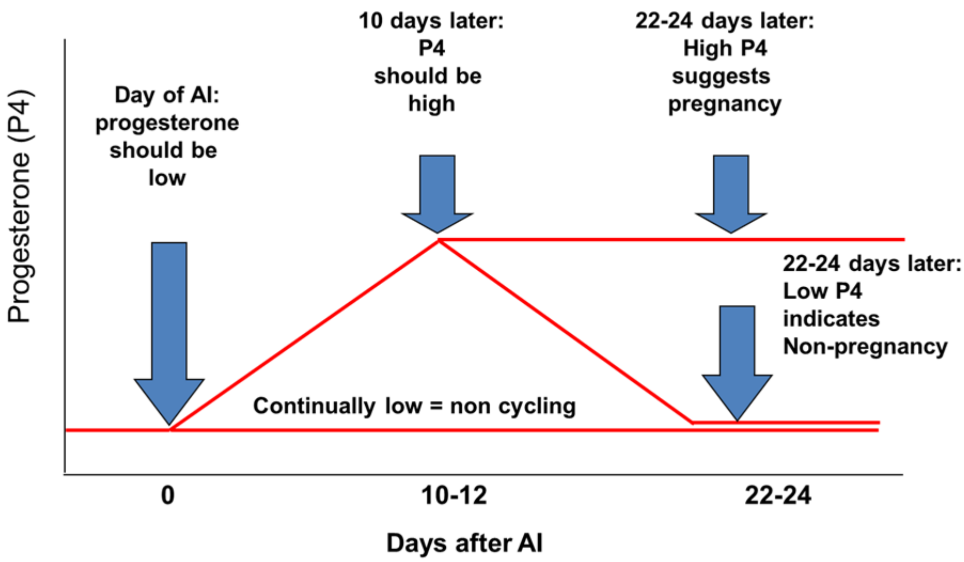
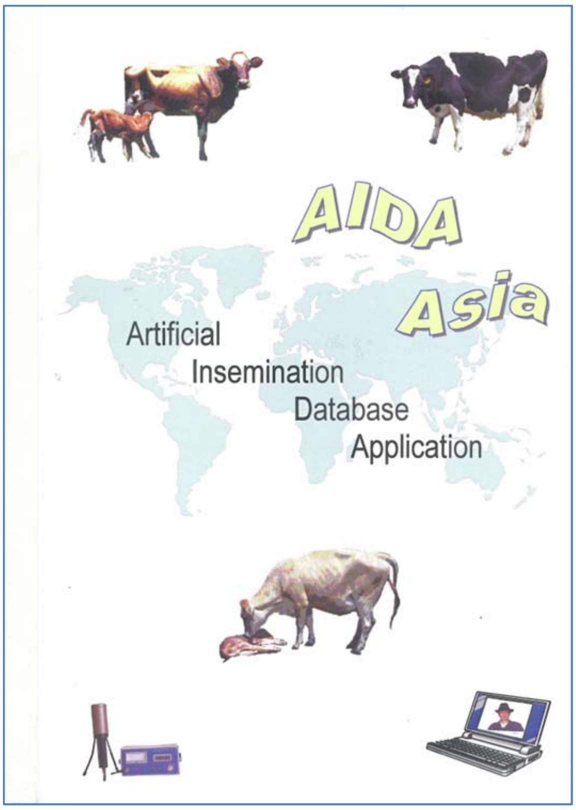


FIG. 91. Application of progesterone RIA analysis for monitoring Artificial Insemination Services

A uniform set of data recording sheets for field use, together with diskettes containing the computer database AIDA were provided and project counterparts were trained on its use during the first RCM. Thereafter, an additional set of procedures for statistical analysis of data, termed 'GAIDA' (Guide to AI Data Analysis) was developed under a technical contract and provided to RC holders.

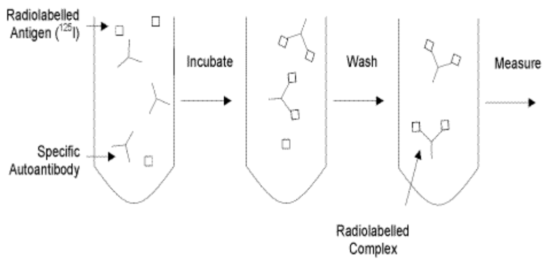


AIDA Asia, one of the APH computer applications designed for storing and analysing data for evaluating the efficiency of artificial insemination services

Characteristics of farms and AI services

The survey in the 14 countries took two years for completion and the results revealed the structure of the AI system in the participating countries, including the characteristics of farms, animals, inseminators, heat detection, and semen and sires used. Some of the most relevant findings were:

- *Farms*: Asian countries, with the exception of China focussed mostly on small-holder farms (1-2 cows), where the predominant type of animals were dairy cattle, with some dual-purpose animals. In these farms, hand milking was done 1-2 times per day using the calf for the 'let-down' of milk, and farms records were non-existent or limited to cow cards. In the case of Latin America, the study focused on medium to large farms with cattle populations ranging from 20 to 1500 dairy cows, mainly of the Holstein type. In this farms, machine-milking twice-a-day without the presence of the calf was common, and animal records were usually kept in computers or cow cards.
- *Inseminated cows*: The total number of surveyed cows in the study was 7993 from 1735 farms totalling more than 11 000 services. The mean age at service was 5.6 ± 2.3 years and parity was 2.8 ± 1.7 without major differences between countries.
- *Heat expression and AI*: The presence of mucous discharge in the vulva area was the most frequently used sign of heat expression under tie-stall Asian farm conditions; however, in farms with several animals, interactions between cows were also used as heat signs. On the other hand, in Latin American farms, the standing cow was the basic sign for AI and other heat signs were rarely accepted.
- *AI technicians*: The number of inseminators varied from 2 to 19 per country (median: 7). Inseminators in Asia were mainly employed by government AI centres whereas in Latin America the technicians were regular staff of private farms and cooperatives.



Basic steps of the solid-phase RIA technique employing ^{125}I-labelled progesterone

- *Semen*: The semen used was locally produced in most countries; however, imported semen was used in Peru and Costa Rica. Frozen straws were the most common type of semen, but pellets were user either partly (China, Viet Nam) or exclusively (Cuba). Some chilled semen was used in Bangladesh and Sri Lanka. An interesting difference was that Asian AI services used 0.25 ml straws whereas the Latin Americans used 0.5 ml straws.

- *Sires*: The number of sires varied from 7 to 68 per country (median: 25).
- *Pregnancy diagnosis (PD)*: This was done by rectal palpation usually between 80 to 120 days after the service. PD was not common in Asian countries but was a requisite in the research protocol.

Brahman bull used as semen donor at the AI Centre in Gaborone, Botswana

Reproductive performance

The overall calving to first service interval was 121.5 ± 82.1 days (median = 95 days) with large differences between countries. The shortest intervals were in Peru, Chile and Argentina, probably due to the higher genetic quality, better nutrition and management of the animals and more suitable climatic conditions for rearing Holstein-type cattle. The longest intervals were observed in indigenous cattle of Bangladesh and Pakistan (around 200 days) and in small beef farms in Indonesia (around 270 days).

The conception rate to first service ranged from 15 to 62% with a mean of 41%. Depending of the country and the farming system in place, factors like farms size, body condition at AI, easy of pipette passage, years of experience of the AI technician, degree of swelling of vulva at AI and semen source showed to be important elements affecting fertility. The inter-service interval between the first and the second service was 44.6 ± 44.4 days, which was equivalent an average of one missing heat between services.

Problems identified in the AI services

Basically, the sample on the day of service was used to verify whether the animal was inseminated during the luteal phase (i.e. incorrect timing, high progesterone values); the two-sample set (day of service and at mid-cycle) was used to verify whether the animal was cycling and had ovulated; and the three-sample plus pregnancy diagnosis strategy was used to verify whether the animal had conceived, had lost the embryo, had been inseminated while already pregnant or had been inseminated when acyclic (Table 57).

Two major deficiencies were identified through progesterone values from samples collected in more than 8500 inseminations (Table 58). AI at inappropriate times occurred in 17.3% of all services denoting serious heat detection errors at farm level. These services were performed in non-cycling cows and in cows with active CL, where most of the latter were already pregnant.

The second major deficiency was related to post-AI oestrous detection and herd management which affected 37.5% of the inseminations (Table 58). In this case, 10% of the inseminated animals suffered late embryonic death (between 16–60 days after service) but were not reported in heat until PD took place, usually 80–120 days after service. Another group representing 27.4% of the inseminated animals failed to conceive to that service but subsequent heats remained undetected until PD was performed.

Groups of crossbred Holstein cows under an artificial insemination programme in Asuncion, Paraguay (2004)

These results show that nearly half of the inseminations were associated with factors of management deficiency or human error in the farms or in the AI service, thus adversely affecting the reproductive performance of the herds and leading to low efficiency of AI services.

TABLE 57. INTERPRETATION OF RADIOIMMUNOASSAY PROGESTERONE DATA ALONE OR ON COMBINATION WITH CLINICAL INFORMATION FOR THE EVALUATION OF ARTIFICIAL INSEMINATION (AI) SERVICES USING MILK OR PLASMA SAMPLES

Nº of samples	Day of collection after AI			Pregnancy diagnosis	Interpretation
	0	10–12	22–24		
Three	Low	High	High	Positive	Pregnancy
	Low	High	Low	Negative	Non-fertilization, early embryonic mortality, post AI anoestrus
	Low	High	High	Negative	Late embryonic mortality (>day 16), luteal cyst, persistent CL
	High	High	High	Positive	AI on pregnant animal
Two	Low	High			Ovulatory cycle
	Low	Low			Anoestrus, anovulation, short luteal phase
	High	High			AI on pregnant animal, luteal cyst
	High	Low			AI during luteal phase
One	Low				AI at a time other than the luteal phase
	High				AI during the luteal phase

TABLE 58. FACTORS DETRIMENTAL TO THE ARTIFICIAL INSEMINATION (AI) SERVICE THAT WERE IDENTIFIED THROUGH THE 3-SAMPLE STRATEGY AND SUBSEQUENT PREGNANCY DIAGNOSIS

Main problem	Specific deficiency in the AI system	Population affected (%)
• Inappropriate AI probably due to wrong estrous detection		**17.3**
	○ AI in cows with active corpora lutea	6.9
	○ AI in non-cyclic cows	10.4
• Deficient estrous detection and herd management		**37.5**
	○ Cows fail to conceive, subsequent heats are unobserved and found non-pregnant at PD test	27.4
	○ Cows conceive but had late embryonic losses and are found non-pregnant at PD test	10.1

Practicability and constraints of the 3-sample strategy

The 3-sample set (milk or blood) collected at days 0, 10–12, and 22–24 in relation to the insemination, together with pregnancy diagnosis by rectal palpation, proved to be a sound strategy for evaluating the efficiency of reproductive management at farm level and the outcome of AI services. However, it is also important to point out that the system requires a large number of cows in the evaluation scheme in

order to get a meaningful set of data. The number of animals depends, among others factors, on the farming system, the genetic variability of the population, the number of variables to be considered in the analysis, and the efficiency of the sample collection.

The efficiency of non-pregnancy diagnosis based on progesterone assay at 22–24 days after AI was greater than 95%.

Milk and beef production has increased in many countries when corrective measures on cattle housing, feeding, heat detection, health care, and semen quality are implemented

Collection of the first milk sample is not a major problem as it can be taken by the inseminator. The other two samples require someone to visit the farms or have to be done by the farmers (in small farms) or farm employees (in large farms) on the exact days and from the correct animals. In the case of the latter approach, some mechanism has to be in place for delivering the samples to the laboratory.

A second constraint was that in 18.4% of the 3-sample sets of this study, at least one sample showed intermediate progesterone values (>1 or <3 nmol/L), and therefore the dataset become invalid for proper interpretation; however, and depending of the sample with intermediate values, partial interpretation can be done (Table 57). Good quality RIA laboratories can reduce this figure through accurate assay results, but other factors such as mishandling of samples can contribute to this problem.

Conclusions

The standardized methodology used across countries and the strategy of combining data from the field and laboratory, together with uniform data-entry forms and a computer database, allowed the generation of unique information regarding reproductive management and AI systems in developing countries. The methodology and approach provided a better understanding of the complex factors influencing AI programmes and, in many countries, have resulted in the first reliable assessment of the success rate of AI and the efficiency of reproductive management by small scale dairy farmers.

Red Bororo cattle in Central African Republic subjected to oestrus synchronization as a previous step for artificial insemination

The survey showed that nearly half of the services were linked to a detectable and measurable deficiency, mainly related to a human error, which

severely affected reproductive performance of cattle herds and also the quality and efficiency of AI services.

APH through national and regional TC projects has provided equipment for AI and for semen laboratories in many developing countries in Asia, Africa and Latin America

The results have highlighted the need for closer monitoring of field results by AI service providers and for better education of AI technicians and farmers. The main causes of low fertility were heat detection failure, inseminations at inappropriate time, poor semen quality, embryo mortality, seasonal influences and factors related to management on individual farms. In overall, 17.3% of cows were inseminated at an inappropriate time (range 2.8–55% among countries). Of this, 7% (1.5–18.0%) were done during the luteal phase or pregnancy and 10% (1.7–48.0%) were during anoestrus. Of the services performed at an appropriate time, 24.7% did not result in a pregnancy as diagnosed by progesterone measurement at 22–24 days (due to non-fertilization or early embryonic death). A high proportion of these cows were not submitted for further services until rectal palpation 2–3 months later, highlighting the failure of farmers to detect subsequent returns to oestrus. Of the animals diagnosed as possibly pregnant by progesterone assay, 12% were found to be non-pregnant at rectal palpation (due to late embryo mortality or persistence of luteal function).

RIA and other nuclear-related techniques can play a major role in the monitoring AI services and improving the efficiency of AI Centres in developing countries

The results clearly demonstrate the potential value of the progesterone RIA in providing diagnostic and related services to farmers in developing countries. Of the participants, 92% confirmed the feasibility of establishing a non-pregnancy diagnosis service, provided that some financial support and assay reagents were available during the initial phase to demonstrate cost effectiveness.

Additional efforts must be focused on alleviating the problems identified and can involve the following, depending on location: education of farmers on heat detection, herd management practices and better nutrition; improving the knowledge and skills of inseminators in AI practices; further research on embryo mortality, suckling practices and methods for heat induction/synchronization; improved semen handling, storage and quality control; and improved recording, evaluation of results and follow-up services to farmers by the providers of AI services.

The CRP clearly demonstrated the value of accurately identifying the management problems as a basis for implementing interventions. It already assisted in improving the performance of AI technicians and was instrumental in initiating programmes aimed at improving the dairy industry in some countries. These methodologies and protocols have been and are currently applied on a wider scale in Member States through national and regional TC projects in Asia, Africa and Latin America.

SUCCESS STORY 3: Freedom of Rinderpest: A very special success story

Rinderpest was for centuries a major cause of famine and poverty. However, by 2010, some 176 countries and territories worldwide had been declared free from the disease and field operations discontinued. In 2011 the FAO and OIE declared the disease officially eradicated from the world. This great achievement comes 30 years after the WHO declared that smallpox was eradicated, the only other viral disease to have been eliminated from the world.

In the fight to control and eliminate rinderpest, APH supported IAEA and FAO Member States through CRPs for the development, evaluation and validation of nuclear and nuclear related technologies, and through national and regional TC projects for the transfer and sustainable implementation of these technologies.

What is rinderpest?

Rinderpest (also known as cattle plague) is a highly contagious viral disease of cattle, buffalo, yak and several wildlife species, and has caused immense livestock losses throughout history. The disease is characterized by fever, oral erosions, diarrhoea, lymphoid necrosis, and high mortality.

A devastating view of the harmful effects of rinderpest in South Africa in the old days

Rinderpest was first described scientifically in Europe by Prof B. Ramazzini in 1712. It caused major cattle losses in Northern Italy until Dr Lancisi, at the request of Pope Clement XI, suggested the 'stamping-out' policy, which meant the slaughter of all infected and exposed animals in order to control the disease. This remained the procedure of choice over the next three centuries. However, the advent of steam-powered ships enabled greater international trade in livestock and accelerated the spread of infectious diseases including rinderpest. The most devastating effects of the disease were experienced in Africa in 1884, when cattle imported from India to Eritrea rapidly spread the disease into different parts of the continent, killing millions of cattle and wild animals and causing widespread starvation. Nevertheless, the stamping-out policy eventually controlled the disease.

Developing a suitable rinderpest vaccine and establishing an effective diagnostic capacity

The concept of preventing rinderpest was first attempted in the Netherlands in 1774 by using a rudimentary form of vaccination to induce immunity in at-risk livestock. The breakthrough, however, came in India in 1928 when a vaccine developed in goats was found to confer immunity in cattle. This

APH-OAU/IBAR training course on rinderpest ELISA (Garoua, Cameroon, 1992)

vaccine was used extensively in Asia and Africa but occasionally caused the disease. In 1957, advances in virology allowed for a safer tissue culture vaccine, which was developed by W. Plowright in Kenya.

This vaccine was cheap to produce and easy to assess for potency and safety. Granting life-long immunity through a single injection, it quickly became the vaccine of choice for controlling rinderpest globally. In 1990, the development of a heat stable version of the vaccine in Niger improved the efficiency of the vaccination campaign, especially in remote areas.

Historically, vaccination campaigns did not monitor the effectiveness of the intervention and thus the first major control campaign in Africa, the Joint Project 15 (JP 15), did not control the disease effectively. At this time, the assays that were used in diagnostic laboratories for rinderpest diagnosis were virus isolation, virus neutralization/immunofluorescence and antigen detection by agar gel immunodiffusion, and serum neutralisation for antibody detection. Those assays were deemed too demanding in terms of resources and technical expertise, requirements for absolute sterility, as well as being time consuming. In addition, these assays were difficult to standardize, not conducive for testing large numbers of samples that were needed for sero-monitoring of populations and surveillance activities for a disease control/eradication campaign. Due to this factors, PARC requested that the vaccination's effectiveness be monitored using serological tools based on an indirect ELISA developed in 1985. Although superior to the laborious serum neutralization assay, its only shortcoming was that a country had to validate the ELISA for its specific cattle population.

The development of a competitive ELISA in 1991 eliminated this problem and thus a common quality assurance procedure could be employed in all laboratories. In order to verify the absence of the rinderpest virus in the protected populations, an antigen detection ELISA (immunocapture ELISA) capable of screening large numbers of samples was validated and introduced to the veterinary laboratories. This monoclonal antibody (MAb) based test system used a capture antibody, which recognized both rinderpest and the PPR virus and a second MAb specific for either to differentiate between them.

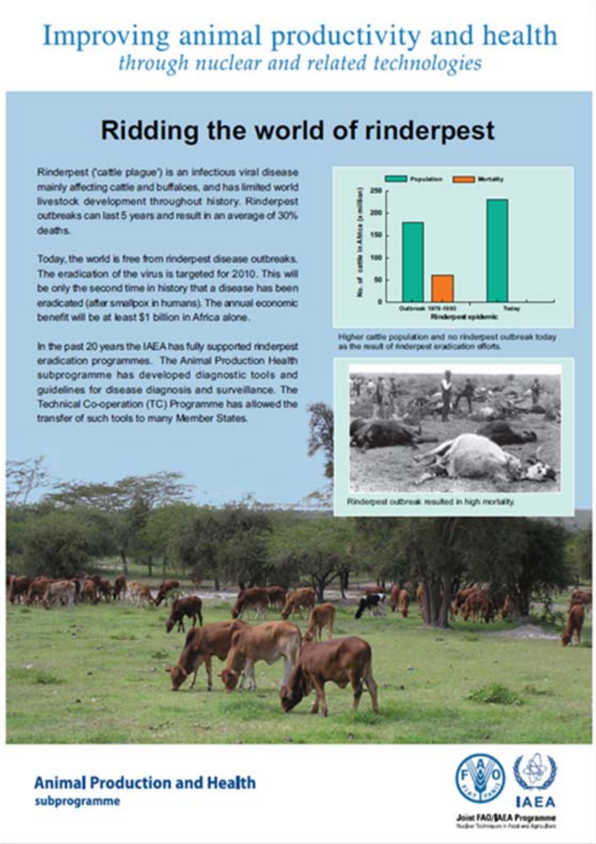
Controlling the disease by vaccination

In the 1930s, country-specific mass vaccination campaigns were used to reduce the incidence of rinderpest. The first internationally backed attempt to eradicate rinderpest from Africa - JP15, ran from 1962 to 1976 and was led by IBAR/OAU. This multi-donor campaign covered 22 countries at a cost of

Rinderpest is characterized by fever, oral erosions, diarrhoea, lymphoid necrosis, and high mortality

US $50 million. Although JP15 was highly successful in controlling outbreaks, the vaccinations stopped too early, leaving two foci of infection in Mali and Ethiopia. This led to a resurgence of the disease in the late 1970s and early 1980s. The disease quickly spread in West and East Africa and eventually over much of sub-Saharan Africa, peaking in 1983. The pandemic killed millions of cattle and wildlife and thousands of farmers and herders lost their livelihood.

PARC was initiated in 1987 by IBAR/OAU, mainly funded by the European Community. It covered 34 countries in sub-Saharan Africa with the goal to finally eradicate rinderpest from Africa. In order to ensure success PARC sought clear scientific evidence that national vaccination programmes were indeed effective and that sufficient animals were immune to the virus. Similar coordinated programmes were proposed for Asia – the West and South Asia rinderpest campaigns, respectively. The West Asia rinderpest campaign was supported by UNDP from 1989 to 1994 but left no coordination mechanism to take its place upon termination. The South Asia rinderpest campaign never materialised, although individual country programmes in Bhutan, India and Nepal achieved great success with support from the European Community. Following the success of these programmes in eliminating the virus, FAO launched GREP in 1994 in close association with OIE, IAEA and other partners to help eradicate rinderpest from the world.

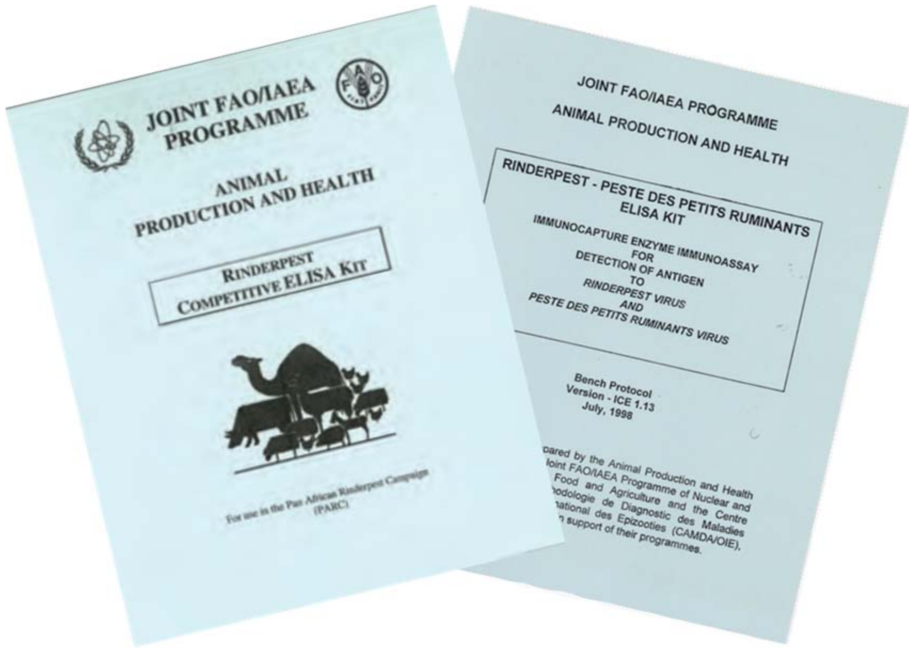


One of the APH posters printed after the last rinderpest outbreak announcing the eradication of the disease by 2010

Monitoring the efficiency of the vaccination campaigns

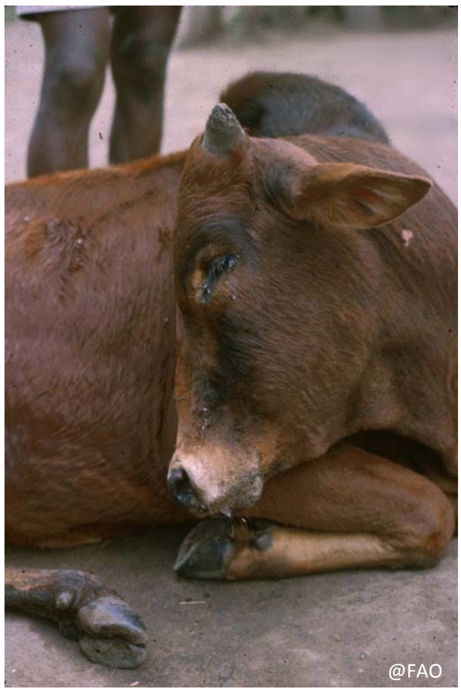
Central to the success of the rinderpest vaccination campaign was the sero-monitoring, using the internationally validated and standardized FAO/IAEA ELISA kit, which was supplied by the World Reference Laboratory for Rinderpest, Pirbright, UK and IAEA-APHL in Seibersdorf, Austria. Although vaccination was at the heart of eradication efforts, it would not have been as successful without the development and deployment of diagnostic tests to determine where the disease was, where it was spreading to, which animals were infected and/or at risk and, most importantly, to monitor the efficiency of the vaccination campaigns. Historically, an immune response to rinderpest vaccination was assessed by the virus neutralization test. This tissue-culture based test was relatively expensive, time consuming, and was not easily standardized, making it difficult to implement in many veterinary laboratories. Therefore, it was considered unsuitable for detecting antibodies to the virus in the blood samples required for monitoring vaccination campaigns or for use in epidemiological studies, and for detecting the virus itself.

APH responded to diagnostic needs by introducing ELISA tests to PARC and eventually all GREP countries, including those in West and South Asia. These nuclear related serological tests were initially developed using radioisotope labelling and tracing techniques, but were replaced with enzyme labelling and tracing to circumvent the disadvantages of the short half-life and higher technical proficiency requirements of radioisotopes. Additionally, the new generation ELISA tests could be used in relatively simple veterinary laboratories. For GREP, it was clear from the outset that the ELISA was an ideal tool for effective serological surveillance to confirm that sufficient animals were being protected by vaccination to ensure elimination of the virus from national herds.



Front covers of FAO/IAEA ELISA kits for the diagnosis of rinderpest virus

Once the assay met these international requirements, it was adapted to a kit format linked to a quality assurance programme and provided with a standardized set of laboratory equipment for routine use. These kits (separate ELISA for the detection of antibodies and immunocapture ELISA for the detection of antigen of rinderpest virus and PPR virus) were developed, standardized and validated by the APH Section working in close collaboration with Pirbright, UK and the World Reference Laboratory for PPR at CIRAD, Montpellier, France. These kits contained all the required reagents and a standardized protocol, making ELISA the prescribed test for international trade. The organizations also agreed on how to interpret the results and how these could be used to determine the effectiveness of vaccination. This required computerization of the data collected and analysis of the results.



Initial clinical signs of rinderpest include fever, anorexia, depression, and oculonasal discharge. Then, cheesy plaques appear on the gums, buccal mucosa, and tongue. Profuse diarrhoea appears before death

Contribution of IAEA to rinderpest eradication

The first step in the 20-year plus IAEA programme to control rinderpest was taken in 1986 (as part of the GREP/EMPRES programme of FAO). Consultations with veterinary officials in many developing countries, visits to national veterinary laboratories and discussions with their staff had revealed that many laboratories were simply unable to provide either the quality or level of services required to support field programmes directed at controlling livestock diseases. In 1986, the serum neutralization assay used to detect antibodies against the rinderpest virus was deemed too demanding in terms of resources and technical expertise, as well as being relatively expensive, and was slow and difficult to fully standardize. Furthermore, the

assay required collection of clinical samples, growing of the virus in tissue culture under sterile conditions, and finally identification and characterization using rinderpest virus-specific neutralizing anti-sera, also under a sterile environment. This approach required the maintenance of tissue culture which most laboratories in Africa involved in PARC did not have. Hence, another approach was needed.

Experts participating in a Consultants Meeting to develop a roadmap for the implementation of modern OIE principles and methods of diagnostic test validation

To proceed with the planned rinderpest eradication campaign, initially in Africa and later on a global level, a new approach to animal disease diagnosis was needed. Thus, following the recommendations of an international consultative group, APH changed the focus of its animal health activities and began to develop programmes promoting the new, nuclear related ELISA technology for the diagnosis, monitoring and surveillance of livestock diseases. The ELISA technology was based on the specific binding of rinderpest antibodies to inactivated rinderpest antigens that are fixed to a plastic plate. The percentage of binding between the rinderpest antigens and antibodies can be visualized by an enzymatic reaction. The more rinderpest antibodies bind to the stationary rinderpest antigens, the more enzymatic colour can be detected. The main advantages of ELISA were that there was no need to work under sterile conditions and that it had a higher throughput. This technology had a great deal to offer the diagnostician in developing countries charged with controlling rinderpest – assays were safe, relatively simple to use, low cost compared with alternatives, large numbers of samples could be tested in a short time, and the technology could, in principle, be applied both for the detection of antibodies as well as the pathogen.

ELISA was, therefore, ideally suited to meet the diagnostic needs of PARC, PACE and, later, SAREC, WAREC as well as FAO's GREP programme and its efforts in assisting countries through its vast field programme. The rapid deployment of the rinderpest ELISA was possible due to an existing prototype assay which was under field evaluation in 10 Member States participating in a CRP. ELISA kits were provided with control reagents and a protocol containing a list of the essential equipment required for conducting the assay. A strict bench protocol ensured a standard level of assay performance within and between laboratories. The protocol also described reagent preparation, handling and use, as well as details of data management and interpretation. The funding for these innovations, as well as the transfer and training in the counterpart laboratories, was covered through TC and CRP activities until commercial entities took over the production and procurement of the kits, thereby ensuring sustainability of the programme. The advent of this new tool allowed all veterinary laboratories to engage in rinderpest surveillance activities. In addition, it offered an economically viable diagnostic procedure for other diseases as well, and thus was readily implemented by the veterinary authorities or research institutes.

Celebration at the IAEA Headquarters of the declaration of global freedom from rinderpest with the participation of nearly 150 dignitaries including more than 50 ministers and ambassadors (Vienna, 20 September 2011)

The IAEA has supported the programme to eradicate rinderpest for 25 years. Figure 92

highlights major events over this timeframe. APH's contribution to the global effort included: developing a network of laboratories to diagnose the disease, organizing training workshops, supplying diagnostic kits and manuals, providing technical backstopping, producing international guidelines and technically supporting regional TC projects in Africa and Asia.

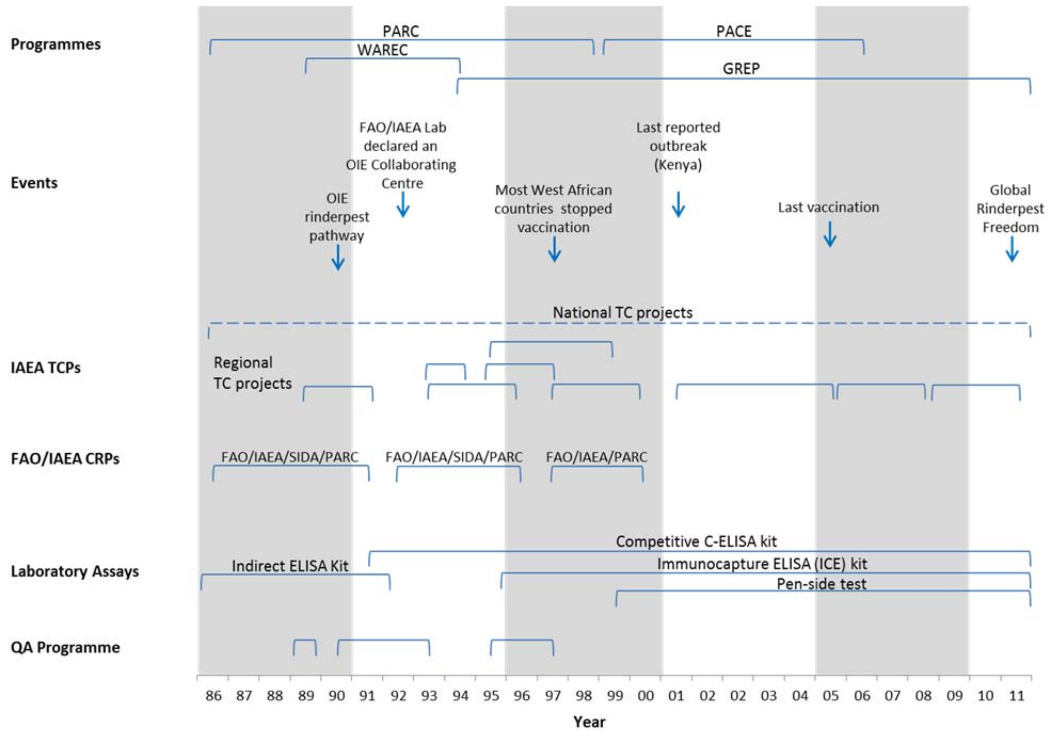


FIG. 92. Timeframes of regional and global programmes, significant milestones and FAO/IAEA support modalities for controlling and eradicating rinderpest

Support was provided to the laboratories and scientists working in rinderpest affected countries principally through CRPs and TC projects. From a funding standpoint, the total IAEA programme approximated 20 million USD (Figure 93). This long-term support was made possible not only through CRPs and TC projects, but also with financial and technical support from other organizations including Swedish International Development Agency (SIDA), FAO, OIE, the European Commission/Union, the Institute for Animal Health, UK, and the Agricultural Research Centre for International Development (CIRAD), France.

CRPs provided research contracts to scientists in veterinary laboratories in FAO and IAEA Member States, creating a network of laboratories and individuals that could test and assist in refining, validating and fully standardising the ELISA under different conditions and work situations. The first CRP (1987-1990) was funded by SIDA and was mainly concerned with the introduction and routine use of an FAO/IAEA ELISA based system for rinderpest sero-monitoring. Research contracts were awarded to 17 laboratories involved in the diagnosis of rinderpest and the CRP was augmented by a number of IAEA TC projects. This pooling of resources optimized the support to the scientists carrying out rinderpest sero-monitoring. APH took the lead in developing and distributing fully validated and standardized indirect ELISA kits and materials to all participating countries in the network, and in providing the necessary equipment and training to African laboratories and staff to ensure a uniform approach throughout PARC countries. National and regional TC projects were implemented at the request of Member States to support government efforts in strengthening and

enhancing veterinary laboratory diagnostic capabilities, training qualified staff and supporting networking and partnerships within the region.

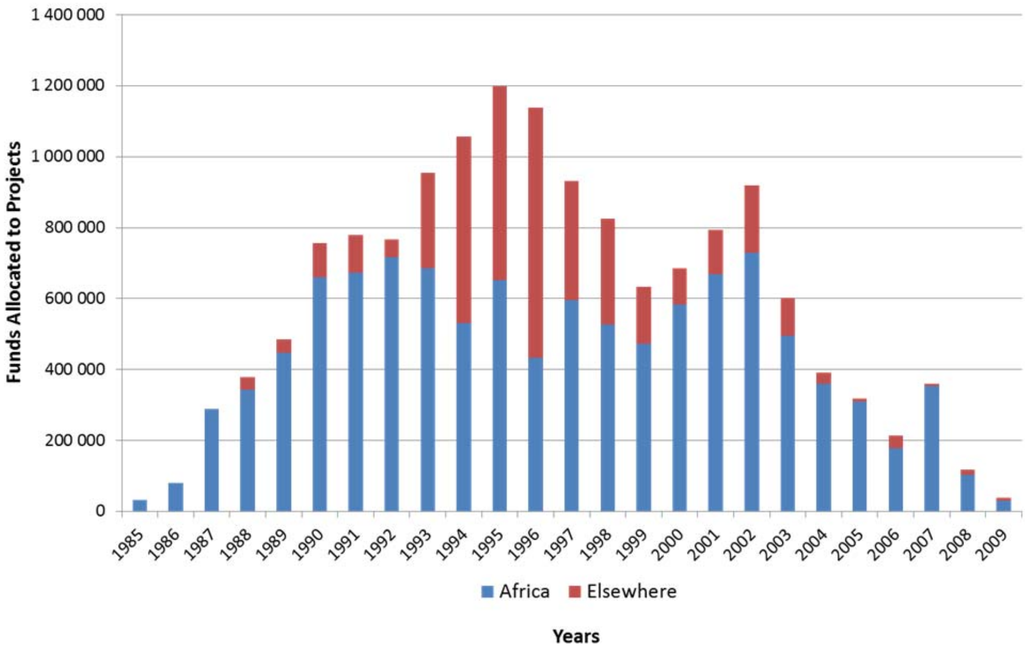


FIG. 93. A yearly breakdown of the Joint FAO/IAEA Division and IAEA Technical Cooperation funds contribution in Global Rinderpest Eradication Programme

A follow-up CRP (1991–1994), also funded by SIDA, saw the introduction of the competitive rinderpest ELISA test that was both more sensitive and that could distinguish between antibodies to rinderpest and those against the closely related PPR virus – attributes that meant it could be used as a surveillance tool within national rinderpest campaigns. The FAO/IAEA/SIDA/PARC CRP on rinderpest sero-surveillance phase II covered 17 African countries and included research agreements from Pirbright and the University of Reading in the UK and technical support from IEMVT in France. QA systems were also put in place, standardized sampling frameworks were designed, and computer software was developed for data management and analysis.

APH Section Head Gerrit Viljoen stating his remarks on the occasion of the Rinderpest Eradication Side Event during the IAEA General Conference 2011 to commemorate the FAO and OIE declaration of global freedom of rinderpest

When support from SIDA ended in 1994, the capacity to monitor national rinderpest vaccination programmes by detecting antibodies had successfully been established in 17 countries of sub-Saharan Africa. This test proved to be more robust under field conditions than the indirect ELISA. The third CRP under the auspices of an FAO/IAEA/PARC epidemiology project was funded by the European Union and ran from 1997 to 2001. Its objectives were to consolidate support for the surveillance and diagnosis of rinderpest through the sero-monitoring network, which had by that time

Proper health care coupled with adequate feeding and breeding are keys to success in animal farming

been established in 22 African countries, and to provide essential information on the epidemiology of rinderpest. Many of the institutes awarded research contracts also benefitted from IAEA support through national TC projects, and where national TC projects had ceased operation, support was provided through IAEA regional projects. One example was the large regional project in Africa which began in 1995, and throughout the duration of PARC provided regional experts, many opportunities for group and individual training courses and fellowships as well as critical laboratory equipment and infrastructure.

Similar regional projects in Asia proved indispensable for supporting GREP. In planning and implementing these projects, the high level of teamwork between counterparts and IAEA staff within the TC Department and the Joint FAO/ IAEA Division ensured that inputs of hardware, reagents and guidance on technical issues were both appropriate and timely.

It was clear that one of the most successful advances made by APH as part of its contribution to the rinderpest eradication was the diagnostic platform in conjunction with the EQA programme. Nevertheless, it was also highly relevant the formation of the laboratory network in Africa which continues today for the control and prevention of several other transboundary animal diseases (Figure 94). This network was also an ideal forum for APH to introduce and apply in the laboratories involved in the rinderpest campaign, the QA system for international acceptance of test results.

The objectives of these laboratory network structures, the first in Africa, were to:

- Improve regional and national rinderpest laboratory diagnostic capacity
- Promote consistency and rigor in methodology
- Support coordination and harmonization of regional approaches for early warning, efficient detection and early response to during rinderpest surveillance
- Enhance regional capacity and cross boundary collaborations to enable more effective responses to other transboundary animal diseases
- Build trust for enhanced transparency and mutual confidence in disease information
- Facilitate a dynamic approach for interaction between countries and enhance information sharing between national veterinary laboratories in the region

- 1986: APH incorporated ELISA into its CRP on animal health. Moreover, technical cooperation support for the efforts to eradicate rinderpest commenced in 20 national TC projects and seven regional projects in Africa and Asia to be funded over the next 25 years.
- 1987: First RCM of the CRP on disease diagnosis using ELISA includes seven projects on rinderpest.
- 1987–1990: A CRP involving 14 countries, 'The Sero-monitoring of rinderpest in Africa', using ELISA initiated by FAO/IAEA in conjunction with PARC, and with financial assistance from SIDA.
- 1991–1994: A CRP, 'Sero-surveillance of rinderpest and other diseases in Africa using immunoassay techniques, Phase II', initiated by FAO/IAEA/SIDA/PARC, establishing antibody monitoring facilities in 21 laboratories.
- 1997–2000: A CRP, 'Rinderpest sero-monitoring and surveillance in Africa using immunoassay technologies' under FAO/IAEA/PARC established in 20 African countries.
- 2001: Technical information document, 'Performance indicators for rinderpest Surveillance'.
- 2003: Technical information document, 'Definition of technical guidelines and standard operating procedures for the surveillance and testing of rinderpest as part of GREP'.
- 2011 onwards: Rinderpest virus sequestration.

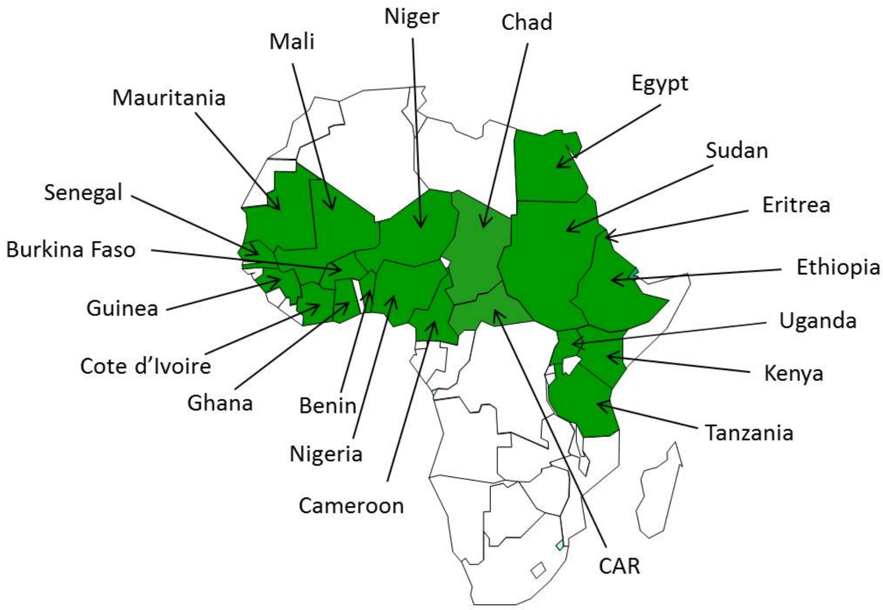


FIG. 94. Rinderpest surveillance laboratory network

As a result of the collaborative work on international standardization of the rinderpest c-ELISA and the EC-ELISA, these tests have been included in the OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals as the internationally agreed diagnostic tests for rinderpest and PPR, thereby contributing to assurance of the sanitary safety of animals in international trade. In 1992, APHL was designated as the FAO/IAEA Centre for ELISA and Molecular Techniques in Animal Disease Diagnosis and as the OIE Collaborating Centre for Application of ELISA and Molecular Techniques to Animal Diagnostic.

Animal Production and Health Section of the Joint FAO/IAEA Division - A historical review (1964-2014)

By
Mario Garcia and Gerrit Viljoen

The Joint FAO/IAEA Division, a partnership between the IAEA and FAO on the utilization of nuclear and nuclear related technologies in food and agriculture was 50 years old in 2014. This book presents a comprehensive review of activities conducted by the Animal Production and Health Section (APH), on the occasion of the 50th Anniversary of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. APH, throughout the years, and with the collaboration of experts and institutions from all over the world had to be creative, effi cient and scientifically sound to vision major needs in the agricultural and livestock sector where relevant progress can be done and therefore develop, validate, adapt, quality control and transfer suitable and applicable technologies and to build capacities in research centres, universities, national veterinary laboratories and veterinary extension services in developing Member States. The book highlights the work done by APH through the various IAEA and FAO mechanisms. The information is divided into three main sections corresponding to major programmatic changes over the years, and supported by statistical data and photos illustrating the work done.

IAEA

Joint FAO/IAEA Division
of Nuclear Techniques in Food and Agriculture

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