Food and Agriculture Organization of the United Nations

19

ISSN 1810-0708

FAO ANIMAL PRODUCTION AND HEALTH

guidelines

DEVELOPMENT OF INTEGRATED MULTIPURPOSE ANIMAL RECORDING SYSTEMS

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2016

Recommended citation

FAO. 2016. *Development of integrated multipurpose animal recording systems.* FAO Animal Production and Health Guidelines. No. 19. Rome.

ISBN 978-92-5-109256-9

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Foreword

Animal identification and recording systems were historically developed by breed associations to maintain pedigree details of animals, by breeding organizations to implement genetic improvement programmes for which performance recording is a prerequisite, by livestock improvement organizations to assist farmers in the management of their herds, and by veterinary health institutions and organizations to distinguish the health or vaccination status of herds or individual animals. These programmes, however, were limited to participating farmers or to specific areas and were not implemented nationwide.

Past food and health scares, such as those caused by bovine spongiform encephalopathy, avian influenza and chemical contamination (dioxin, melamine, etc.) in the early 1990s, increased concerns about veterinary public health and food safety and quality, and resulted in enormous losses. The need to trace animals and animal products has led many high-income countries to put in place nationwide animal identification and recording systems to ensure complete traceability. Animal diseases have the potential to significantly affect international trade. For this reason, animal identification and traceability systems, which help to prove freedom from disease, are becoming a requirement for access to specific regional or international markets. As a result, many countries worldwide, including emerging economies, have put such systems in place. Furthermore, various international agreements and standards address animal identification and recording for traceability. These include the World Trade Organization Agreements on the Application of Sanitary and Phytosanitary Measures and on Technical Barriers to Trade,[1] the World Organisation for Animal Health (OIE) *Terrestrial animal health code*,[2] and the Codex Alimentarius under the Joint Food and Agriculture Organization of the United Nations (FAO) / World Health Organization (WHO) Food Standards Programme.[3] In addition, animal identification and recording systems are used in some countries to deter stock theft or facilitate subsidy payment and insurance schemes.
In 1998, FAO developed and published the *Secondary guidelines for development of national farm animal genetic resources management plans – animal recording for medium input production environment*.[4] These guidelines focus on performance recording schemes. However, as described above, several production and trade-related changes have occurred since the publication of these guidelines; in particular, a surge in the importance of animal health and traceability, which in recent times have become the main drivers of animal identification and registration. It, thus, became necessary to broaden the scope of animal recording and adopt a new set of guidelines that embody a multipurpose approach integrating animal identification and registration, live animal traceability, animal health information and perfor-

[1] See www.wto.org/english/tratop_e/sps_e/spsagr_e.htm and www.wto.org/english/docs_e/legal_e/17-tbt_e.htm, respectively.

[2] See www.oie.int/international-standard-setting/terrestrial-code/access-online/

[3] See www.codexalimentarius.org

[4] See www.fao.org/ag/againfo/programmes/en/lead/toolbox/indust/anim-rec.pdf

mance recording. FAO, through its Technical Cooperation Programme, has supported several member countries in the development of animal identification and recording systems that are compliant with international standards, and continues to do so. These projects highlight the need to adopt a multipurpose system and to develop comprehensive, practical and straightforward guidelines on how to set up and implement such a system.

The First International Technical Conference on Animal Genetic Resources for Food and Agriculture,[5] held in Interlaken, Switzerland (3–7 September 2007), called on FAO to continue its development of technical guidelines and technical assistance and its coordination of training programmes as a means to support countries in their efforts to implement the Global Plan of Action for Animal Genetic Resources.[6] At its Fourteenth Regular Session, in 2013, the Commission on Genetic Resources for Food and Agriculture specifically requested that FAO continues developing technical guidelines on integrated multipurpose animal recording systems.

The guidelines for development of integrated multipurpose animal recording systems have been prepared with the objective of helping countries to design and implement such systems and to maximize the chances that they will be sustained. These guidelines put performance recording in a more general context complementing rather than replacing previous FAO guidelines.

These guidelines focus primarily on the process rather than the methods and technologies employed (e.g. details of the equipment and measurements), as the latter are sufficiently covered by other guidelines. Where necessary, they are formulated with low or medium-input production environments in mind.

The preparation of the guidelines began with an expert meeting held in October 2011 to discuss the contents and outline. A second expert meeting was held in June 2013 to review a draft version of guidelines. A second version was subsequently discussed and revised at a third expert meeting held in June 2014.

Four workshops, held in Botswana, Chile, Morocco and Tunisia and attended by a total of 236 scientists, technicians and policy-makers from 57 countries, contributed to validating the overall outline of the guidelines, shaping the conceptual approach and integrating lessons learned from countries' experiences.

[5] See www.fao.org/ag/againfo/programmes/en/genetics/angrvent2007.html

[6] See http://www.fao.org/docrep/010/a1404e/a1404e00.htm

Acknowledgements

Fifteen experts from ten countries contributed to the preparation of the guidelines. Kamlesh Trivedi, Cuthbert Banga, Ole Klejs Hansen, Thomas Armbruster, Paolo Calistri, Gabriel Osorio, Daniel Trocmé and Graham Hamley wrote and reviewed sections. Hans Jürgen Schild, Erik Rehben, Mohammed Bahari, Japie van der Westhuizen, Omrane ben Jamaa and Ferdinand Schmitt contributed to discussions on the overall outline and/or reviewed the document. Badi Besbes, Kamlesh Trivedi and Graham Hamley provided extensive editing of the document.

In addition, other units at FAO headquarters, such as the Animal Health Service (AGAH) and the Development Law Service (LEGN), along with the Regional Offices for Latin America and the Caribbean and the Near East, and the Subregional Office for North Africa, were directly or indirectly involved in the preparation of the guidelines. In particular, the contributions of Carmen Bullon, Julio Pinto and Olaf Thieme, who each co-wrote a section and reviewed several others, were invaluable. Carolyn Benigno, Astrid Tripodi and Cesare Di Francesco peer-reviewed the manuscript, and their contribution is highly valued.

The guidelines were prepared under the supervision of Badi Besbes, with the full support of the Chief of the Animal Genetic Resources Branch (AGAG), Irene Hoffmann, and the AGAG officers Alizée Sauron, Paul Boettcher, Roswitha Baumung, Beate Scherf and Dafydd Pilling. Umberto Ciniglio and Kafia Fassi-Fihri provided administrative and secretarial support.

FAO would like to express its thanks to all these individuals and to those not mentioned here who generously contributed their time, energy and expertise.

Acronyms

AHI	Animal health information
APHIS	Animal Plant Health and Inspection Service (*United States of America*)
AR	Animal recording
AT	Animal traceability
BSE	Bovine spongiform encephalopathy
EID	Electronic identification
ELISA	Enzyme-linked immunosorbent assay
EMPRES-i	The EMPRES Global Animal Disease Information System
EC	European Community
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FMD	Foot-and-mouth disease
GDP	Gross domestic product
GIS	Geographical information system
GLiPHA	Global Livestock Production and Health Atlas
GPRS	General packet radio service
GPS	Global positioning system
I&R	Identification and registration
ICAR	International Committee for Animal Recording
ID	Identification
INAPH	Information for Animal Productivity and Health
ISO	International Organization for Standardization
IT	Information technology
LIMS	Laboratory information management system
LITS	Livestock Identification and Traceability System (*Botswana*)
NDDB	National Dairy Development Board (*India*)
NTB	Non-tariff barriers
OIE	World Organisation for Animal Health
OS	Operating system
PDA	Personal data assistant
PR	Performance recording
RFID	Radio frequency identification device
SCC	Somatic cell count
SIRA	Animal Identification and Registration System (*Uruguay*)
SOAP	Simple object access protocol
SOP	Standard operating procedure
SPS	Sanitary and Phytosanitary Measures
SRS	Software requirement specifications

TBT	Technical Barriers to Trade
UI	User interface
URS	User requirement specifications
USDA	United States Department of Agriculture (*United States of America*)
UTM	Universal Transverse Mercator
VPN	Virtual private network
WAHIS	World Animal Health Information System
WTO	World Trade Organization

Definitions

The following definitions of terms used in these guidelines are provided in order to ensure clarity for the reader. It is acknowledged that alternative definitions exist for these terms.

Animal identification means the marking of an animal, individually or collectively, by its group, with a unique individual or group identifier.

Animal registration is the process by which information on animals is captured manually or electronically, and then entered and securely stored to be made accessible to users as appropriate.

Animal identification and registration is a core functionality of an animal identification and recording system and covers both animal identification and animal registration.

Animal traceability means the ability to follow an animal, or group of animals, during all stages of its life.

Animal performance recording refers to the process by which indicators of animal performance are objectively and systematically measured, and related data including parentage, breed characteristics and related test events are collected, recorded, calculated and securely stored and made accessible to users as appropriate.

Animal health information recording refers to the process by which indicators of the health status of animal populations and related data on prevention, surveillance and outbreak management are systematically collected, recorded, calculated and securely stored and made accessible to users as appropriate.

Animal recording is a generic term that integrates animal identification and registration, animal traceability, animal health information and animal performance recording.

Premises, holdings and establishments are synonymous terms for a geographical location, and refer to any construction or, in the case of an open-air farm and/or marketplace, an area where animals are held, kept or handled.

Animal keeper is the person responsible for the day-to-day management of animals on the premises.

Animal owner is a person (physical or moral) who has a legal title or right to the animals regardless of whether he/she owns the premises on which the animals are kept.

Animal identification and recording systems consist of all or part of the integrated components of animal identification and registration, animal traceability, animal health information recording and animal performance recording, taking into account existing legislation, organization/administration, technical devices and databases.

Structure of the guidelines

The guidelines are divided into three parts: setting the scene; developing the concept; and putting the concept into practice. Each part consists of a number of sections (see Figure 1).

Part 1 is divided into two sections, which address the following objectives:

- providing background information on the potential uses of animal recording systems and explaining the rationale behind the development of these guidelines (Section I); and
- demonstrating the need for adopting a multipurpose approach and translating the latter into an integrated multipurpose system (Section II).

Part 2 comprises four sections, which develop conceptual frameworks for:

- animal identification and registration (Section III);
- animal traceability (Section IV);
- animal health information (Section V); and
- performance recording (Section VI).

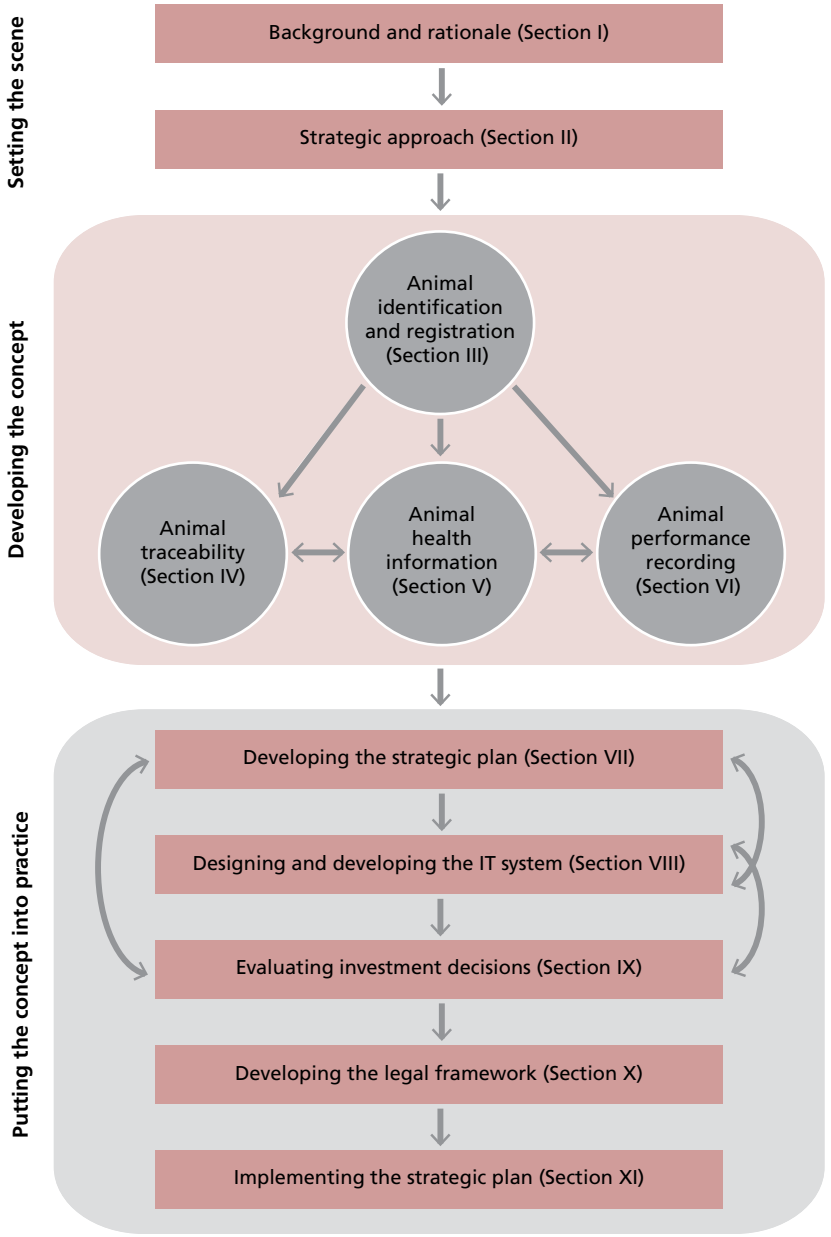
Each section introduces the introduction, objective(s) and respective conceptual framework. These describe the different options for the respective system and the requisite elements, and provide guidance on how to make the right choices for a given situation.

Part 3 is divided into five sections, respectively addressing the following objectives and tasks:

- developing a strategic plan for establishing an animal recording system (Section VII);
- procuring or developing a software application for an animal recording system, and setting up the necessary computer hardware (Section VIII);
- evaluating the costs and benefits of an animal recording system and identifying ways to ensure an equitable distribution of costs among beneficiaries (Section IX);
- developing a legal framework for an animal recording system and highlighting key policy and regulatory decisions to be made when implementing the system (Section X); and
- implementing the animal recording system based on the established strategic plan (Section XI).

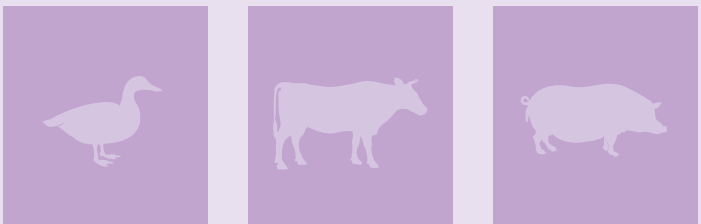
In addition to establishing the rationale and objective(s), Part 3 presents a set of tasks that need to be carried out to achieve the desired outcome. These tasks are further broken down into a series of actions. These sections have much in common. However, each section is meant to stand alone. Reading them in sequence will involve some unavoidable repetition.

FIGURE 1
The process for preparing and implementing an animal recording system



PART 1

Setting the scene



Section I
Background and rationale

INTRODUCTION

Animal recording systems are attracting worldwide interest across high-income and mid and low-income countries. In high-income countries, animal recording systems were historically developed by breed associations to maintain pedigree details of animals, by breeding organizations to implement their genetic improvement programmes, by livestock improvement organizations to assist farmers in the management of their animals, and by governments and veterinary health organizations to eradicate diseases such as brucellosis, tuberculosis and scrapie. These programmes, however, were limited to participating farmers or to areas in which certain disease risks existed, and were rarely implemented nationwide. Recent outbreaks of bovine spongiform encephalopathy (BSE or mad cow disease), foot-and-mouth disease (FMD), classical swine fever, avian influenza and other diseases, in certain high-income countries, have resulted in enormous losses in terms of the number of animals culled and destroyed, and diminished access to international markets. Many of these countries have subsequently implemented nationwide animal recording systems that facilitate the complete traceability of all animals and their products.

Most mid and low-income countries have not yet implemented animal recording systems at national or even at local levels. However, growing domestic and global demand for animal products and emerging opportunities for exporting animal products have encouraged governments and livestock organizations in many of these countries to invest in developing infrastructure and processes to improve the genetic potential of their animals, control prevalent infectious and parasitic diseases, develop traceability systems to track animals and their products, and enhance the capacity of people to adopt new technologies and systems. The essential role of animal recording in these programmes has led to increased interest among mid and low-income countries in establishing animal recording systems.

Animal recording systems developed in high-income countries are not directly replicable in mid and low-income countries due to differences in socio-economic conditions, production environments, livestock service providers, veterinary institutions, resource availability and farmers' capabilities. This section presents the background and rationale for the preparation of guidelines on animal recording focusing upon the context and needs of mid and low-income countries.

OBJECTIVES

This section has three key objectives. First, it describes the benefits and beneficiaries of animal identification and recording systems. Second, it reviews examples of systems implemented in selected high, mid and low-income countries, and highlights key points for consideration based on current and past experiences. Third, it provides an overview of

existing guidelines relevant to animal recording systems and explains the rationale behind the development of the present guidelines.

BENEFITS AND BENEFICIARIES

The primary purpose of animal recording systems is to provide information to farmers, service providers, policy-makers and so on, to enable them to make informed decisions and to implement suitable plans. Such systems benefit a variety of disciplines including: animal and public health and disease control; food safety and quality; market access, trade and economic growth; genetic improvement and productivity; and stock theft mitigation. These benefits and their beneficiaries are summarized as follows under four headings: animal traceability; animal health information; performance recording; and other benefits.

1. Animal traceability

Animal traceability forms the basis of sanitary control systems in the production of food of animal origin. It constitutes the link between animal health, public health, and food safety and quality. Traceability serves many purposes, including the following:

Food safety and quality control. A properly developed animal traceability system is a risk mitigation tool that contributes to ensuring the safety and quality of food products of animal origin. It enables a food product to be traced back to its source, throughout all stages of production. This allows action to be taken promptly and effectively to prevent contaminated or poor quality products from reaching consumers in the event of an identified risk. It may also facilitate food recall in cases of contamination in the value chain. It is important to note, however, that the scope of these guidelines is limited to the traceability of animals from birth to slaughter or death, and does not address the traceability of products along the value chain.

Value addition to products. Animal traceability can help to verify information about the attributes of a food product, such as whether the product is organically produced, the specific breed type from which the product is derived, whether good animal welfare practices have been followed or particular feeding practices applied, whether it is free from antibiotics and hormones, and whether it has been produced under environment-friendly conditions. The underlying rationale is that such products usually attract higher prices in the marketplace. A traceability system providing such *ex ante* information also benefits consumers by offering protection from fraudulent claims about specific attributes.

Export and certification. Animal traceability helps exporting countries to achieve compliance with sanitary and phytosanitary standards set by importing countries, and can provide information required for the issuance of health certificates for export.

The benefits and beneficiaries of traceability will vary depending upon the scope and comprehensiveness of the traceability system (i.e. the extent of the supply chain covered by the system and the level of detail recorded).

Traceability systems may be mandatory and controlled by government authorities or voluntary and controlled by the private sector for individual supply chain initiatives. Mandatory traceability systems are designed primarily for the purpose of consumer protection. By protecting human and animal health and reducing public costs associated with disease

outbreaks, they benefit the country as a whole. Consumers benefit from improved food safety and assurances regarding the accuracy of claims made about characteristics of the food they purchase and consume. Voluntary traceability systems benefit subsectors within the supply chain such as producers, processors, distributors and exporters. They also help to reduce exposure to risk and minimize the costs and impact of crises related to food safety and quality. Finally, traceability systems can help to strengthen regional cooperation and encourage countries to enhance their respective national veterinary services.

2. Animal health information

Animal health information recording is an essential tool for the prevention and control of diseases and the improvement of veterinary health management systems.

Disease prevention and control. A sound animal health information system provides information that enables animal health officials to define the health status of animal populations. The assessment of the population's health status is a prerequisite for planning any surveillance and control strategy and for the application of zoning or compartmentalization policies. It also plays an essential role in enabling countries to fulfil their international obligations concerning animal disease notification and facilitates early detection and rapid response in the event of health emergencies. Timely responses minimize direct and indirect losses and help to restore consumer confidence. Finally, the existence of a comprehensive animal health information system facilitates the performance of risk assessment studies.

Estimation of disease losses and management of veterinary health. An animal health information system is a useful tool for estimating disease incidence and the impact of diseases upon animal performance and mortality. The systematic collection of veterinary treatment data, laboratory data, and information on diagnostic and health-related farm management practices, and making veterinary health information available to farmers and veterinarians, can help to reduce the incidence of disease and decrease resultant animal losses.

3. Performance recording

The benefits and beneficiaries of performance recording depend upon the purpose and scope of the recording system. Performance recording serves many purposes, including those listed as follows.

Establishment of baseline animal performance levels. It is important for a country to be aware of the true productive capacity of its main livestock species in each of its major production environments and ecological zones. A nationwide animal recording system can generate statistics about livestock numbers. However, it is important to note that animal recording cannot replace a livestock census. If the system also has a performance recording component (applied to a subset of the livestock population), then it can generate useful data on production and productivity on a species basis. These data should be analysed in relation to constraints operating in the production environment. Characterization of animal genetic resources produces the same results at the breed level, allowing determination of a breed's productive capacity in its production environment. Data generated provide valuable inputs to livestock organizations, public and private decision-makers, and agricultural

planners when developing strategies and programmes to enhance national food security and increase livestock productivity.

Evaluation of production system alternatives. Information collected through performance recording provides important data for the advancement of production practices (e.g. improved feeding strategies, better healthcare options, appropriate breeds or crosses, and housing alternatives), which can contribute to improved food supplies, competitiveness in the global market, sustainable economic development, environmental conservation and social stability. Therefore, advancements in production practices benefit not just farmers who participate in performance recording activities, but also the farming community as a whole and, ultimately, the consumer. Box 1 shows how such benefits can extend to the nation at large.

Individual animal management. Individual animal performance data assist farmers in managing day-to-day farm operations, making culling decisions and planning investments.

BOX 1

Flow of performance recording benefits through the value chain: a dairy example

The concentration of white blood cells in milk, known as the somatic cell count (SCC), is an indicator of the hygienic quality of milk. While a low SCC is desirable, a high SCC is a manifestation of udder infection (mastitis). Most milk processors penalize high SCC milk and pay a premium for low SCC, as high SCC adversely affects product yield and quality.

Individual cow SCC is widely recorded in dairy recording schemes. Farmers use individual cow SCC results to carry out herd improvement interventions (e.g. withholding milk from high SCC cows, culling cows with consistently high SCC, breeding replacement stock from genetically low SCC animals) that reduce the SCC of milk sold to processors. This improves their revenue from the sale of milk, in addition to saving on costs related to high SCC, such as discarded milk, veterinary fees, and the cost of antibiotics and other therapeutics.

Selection against high SSC in milk will benefit all actors in the value chain. Farmers will own milking cows with a longer productive life, as udder infection is a major reason for non-voluntary culling. Processors buying milk will produce more and better quality dairy products (with fewer residues), for which consumers will be prepared to pay more. Distributors of these products will be exposed to fewer quality-related risks. Finally, consumers will enjoy better quality and safer products. Additionally, national food quality and safety will improve, resulting in better public health and global competitiveness. Reduced use of chemicals to treat infected cows will result in less environmental pollution, providing a benefit to the whole country. Lower udder infection also implies improved animal welfare.

Provided by Cuthbert Banga.

Systematic use of information helps farmers to enhance the productivity of animals in terms of better growth, reproduction, production, nutrition and health. However, the expected benefits from performance recording data will be modest and difficult to demonstrate objectively for small-scale farmers who have few animals. For this reason, appropriate public institutions must be able to provide support in the form of financial capacity and knowledge-building programmes to allow such farmers to realize the full benefits of performance recording.

Genetic improvement. Performance recording for genetic improvement aims to identify and mate superior animals to produce superior herd replacements or offspring for sale as breeding animals. Genetic improvement requires the maintenance of parentage records, and the recording programme must be sustained over many animal generations in a rigorously consistent manner. Performance recording for genetic improvement benefits participating farmers as well as the national livestock sector as a whole. This is because genetic improvement is permanent and cumulative – one round of selection confers improvement on all subsequent generations, while vaccination, for example, needs to be applied to each new group of animals. Subsequent rounds of selection build on previous improvements. However, annual rates of improvement are usually modest – less than 3 percent per year – compared with those delivered by management interventions such as vaccination or feed supplementation. Therefore, a support mechanism for the animal recording programme is required, at least in the initial phase, in the form of subsidized labour, equipment or other production inputs, as necessary.

Performance recording can improve the efficiency of animal food production, which – when combined with a traceability system – can lead to increased income for farmers and safer food of animal origin for consumers. Raising awareness of the multiple benefits of performance recording among the different actors in the livestock sector can help to secure their understanding, participation and contribution.

4. Other benefits of animal recording systems

Animal identification and recording can also help to deter livestock theft and prevent fraud in the payment of subsidies.

Authentication, preventing stock theft, and locating and rescuing animals in disaster-struck areas. Animal identification and recording systems can be useful in resolving ownership disputes, mitigating stock theft and helping to locate animals and return them to their rightful owners in disaster-struck areas. The extension of such systems to include storage of biological samples could help to resolve disputes through the use of molecular genetics techniques.

Managing payment of subsidies and preventing fraud. Correct payment of subsidies or taxes requires accurate data concerning animal numbers, holdings and owners. As animal recording provides such data, it can support administration processes and fraud prevention in subsidy payment schemes. It also reduces the costs associated with the application of related controls.

Animal insurance. By assigning unique identification codes to insured animals and their rightful owners, animal recording systems can ease the process of administering animal insurance schemes and mitigate fraudulent insurance claims.

STATE OF IMPLEMENTATION OF ANIMAL RECORDING SYSTEMS

Animal recording systems have been implemented in most high-income countries and in certain mid and low-income countries. The main motives for implementing such systems have been summarized above, but the specific reasons may vary from country to country. This subsection provides an overview of several animal recording systems that have been implemented in high, mid and low-income countries, and highlights the lessons learned.

1. High-income countries

Many high-income countries have implemented nationwide animal recording systems to enable access to certain markets and to strengthen consumer confidence in farm animal products. Examples include:

Australia. The mandatory National Livestock Identification System has been in place since July 2005. The system is governed by Meat & Livestock Australia and facilitates the tracing of bovines until slaughter or death, for the purposes of controlling infectious diseases and enabling market access.[7] In 2008, an animal recording system was developed for sheep. Both animal recording systems are linked to an animal disease surveillance and intelligence system that collects data from livestock markets, abattoirs, feedlots and saleyards.

Canada. A voluntary cattle recording system was introduced in Canada in 2001 and became mandatory in 2002. The system is regulated by the Canadian Cattle Identification Agency, an industry-led organization that manages individual cattle identification and traceability up to the slaughter or death of an animal. The primary purpose of this animal recording system is to facilitate the traceability of animals to control infectious diseases and enable market access.[8]

European Union. Prior to 2000, only some European Union (EU) Member States implemented national animal recording schemes. In **France**, a national scheme was launched in 1969 to establish organized breeding programmes, and was updated in 1978 to require mandatory individual identification.[9] **The United Kingdom of Great Britain and Northern Ireland** introduced a mandatory Cattle Tracing System in 1998 to identify and trace all cattle in the country, primarily for the purposes of disease control, food safety and market access.[10] The first related European Community (EC) Rule was Directive 92/102/EEC, which set out minimum requirements for the identification and registration of animals. This was followed by Council Regulation (EC) No. 820/97 to establish a system for the identification and registration of bovine animals and the labelling of beef and beef products. The regulation was replaced in 2000 by Council Regulation (EC) No. 1760/2000, which sets out the elements of the European cattle identification and registration system, and requires compliance on the part of each Member State. The primary purpose of this system is to facilitate the tracking of cattle in order to control the spread of infectious diseases and to improve management of the subsidy payment scheme.[11] The EU identification system for sheep and goats was implement-

[7] See www.mla.com.au/meat-safety-and-traceability/National-Livestock-Identification-System

[8] See www.canadaid.com and www.inspection.gc.ca

[9] See http://en.france-genetique-elevage.org/Identification-and-traceability.html

[10] See https://www.gov.uk/guidance/cattle-identification-registration-and-movement

[11] See http://ec.europa.eu/food/animal/identification/bovine/index_en.htm

ed in 2004. Since 2005, EU legislation also stipulates that meat must be identified in terms of the animal or group of animals from which it derived and the country and facility where it was processed.[12] The EU also stipulated that third-party countries wishing to export animals and products of animal origin to the EU must have in place effective animal recording systems in addition to other minimum sanitary and phytosanitary (SPS) measures.

Japan. A mandatory animal identification and traceability system for cattle has been in place in Japan since 2004. The system traces animals from birth to slaughter and tracks resultant animal products from slaughterhouses through the distribution chain to the point of purchase by consumers.[13]

The Republic of Korea. Since 2004, the Republic of Korea has operated a mandatory full traceability system, entitled the Beef Traceability System. The Ministry of Agriculture and Forestry governs the system for the purpose of controlling infectious diseases and ensuring food safety.[14]

United States of America. Since 2004, the United States of America has been implementing the National Animal Identification System, which builds on an earlier programme initiated by the Animal and Plant Health Inspection Service (APHIS) of the United States Department of Agriculture (USDA). The system is voluntary and is based upon a partnership between state and federal-level authorities and livestock industry organizations. The main purposes of the system are to enable the control of disease and the traceability of animals, and to promote market access.[15] The USDA has also formulated a new Rule on Animal Disease Traceability, which became effective in March 2013.[16] The rule stipulates that animals should be identified prior to any interstate movement. This extends to cattle, sheep, swine, horses and poultry, which must be identified individually or in groups, depending upon the species. The federal standard sets out the minimum requirements and individual states remain free to implement more stringent systems if they so desire.

Each of these countries has developed legal and regulatory frameworks to provide rules and regulations for implementing their animal recording systems. Further information on each of these systems can be found on the websites listed in the footnotes.

2. Mid and low-income countries

Animal recording systems are uncommon in mid and low-income countries due to one or other of the following reasons:

- These countries generally have few surplus animal products to export, and most food products are produced and consumed locally.
- Distribution chains are poorly developed.
- Generally, domestic consumers are unwilling to pay premium prices for animal products that are identified and traced.

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[12] Council Regulation (EC) 21/2004 (amended Regulation (EC) No. 933/2008) and Regulation EC/178/2002, respectively.

[13] See www.nlbc.go.jp/en/index.html

[14] See Lee *et al.* (2011).

[15] See https://www.aphis.usda.gov/traceability/downloads/NAIS-UserGuide.pdf

[16] See www.aphis.usda.gov/newsroom/2012/12/pdf/traceability_final_rule.pdf

- Animal productivity is low due to the low potential of local breeds and challenging production conditions.

However, increasing demand for animal products worldwide has created opportunities for many mid and low-income countries with large farm animal populations to export their animal products. As meat exporters in these countries must provide certain minimum information on the animals slaughtered in order to achieve compliance with importers' requirements, they are applying pressure on governments to develop animal recording systems for animal identification and registration, traceability, disease recording and disease surveillance. Increased demand for animal products, both domestically and globally, is also prompting governments in these countries to invest in infrastructure to enhance the productivity of animals, promote genetic improvement and protect animals against disease. Growing awareness of the value of locally adapted breeds in many mid and low-income countries is also inducing governments to initiate systematic breed conservation and development programmes, of which animal recording systems form an essential component.

Several mid and low-income countries in all regions have developed – or are in the process of developing – national recording systems. Examples of systems that have been implemented for some time are described as follows:

Argentina. In 2003, the Government of Argentina established the Animal Health Information System. The Argentinean National Health and Agroalimentary Quality Service operates the system primarily for the purpose of achieving access to the EU beef market.[17] Under this system cattle are often identified in groups. Subsequent legislation introduced mandatory identification for all calves born after September 2007, through the use of an ear tag. It is anticipated that by 2017 all beef cattle will be individually identified and traced.

Botswana. In 2004, Botswana developed and implemented an advanced livestock identification and traceability system (LITS) that satisfies EU export requirements.[18] The system incorporates stock branding in accordance with the Stock Brand Act and individual animal identification. It enabled the computerization of a number of activities, including the issuance of brand certificates, movement permits and change of ownership documentation. Botswana's LITS initially used inserted reticulorumen boluses (see Section III), but as of 2013, it began moving towards the use of radio frequency identification device (RFID) ear tags. While the primary driver for the establishment of LITS was access to the EU market, its implementation has also reduced incidence of stock theft and has improved livestock marketing payment systems and abattoir operations.

Brazil. In 2002, the Brazilian Ministry of Agriculture, Livestock and Supply created the Brazilian Bovine and Buffalo Identification and Certification System for the identification and tracing of all cattle. Although initiated as a mandatory programme, it evolved into a voluntary programme restricted to premises supplying animals to slaughterhouses that prepare meat for sale in foreign markets, in particular the EU.[19] However, some states in Brazil (e.g. Santa Catarina) are implementing a compulsory identification system.

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[17] See www.senasa.gov.ar; www.sgsgroup.com.ar

[18] See ec.europa.eu/food/fvo/act_getPDF.cfm?PDF_ID=10380

[19] See http://www.icar.org/Documents/technical_series/tec_series_15_Santiago_Chile.pdf

India. The National Dairy Development Board (NDDB) in India has developed an integrated animal recording system, referred to as the Information Network for Animal Productivity and Health (INAPH).[20] This system, which includes animal identification and registration, has been developed primarily for the purpose of performance recording (including artificial insemination, milk recording, progeny testing, ration balancing, veterinary treatment, diagnosis, testing and disease outbreaks). It can also be used to trace animals and for the control of infectious diseases. The NDDB maintains the central database, which receives data from INAPH users across the country. Users also receive all necessary information from the system to carry out their daily tasks.

Namibia. In 1999, Namibia introduced the Fan Meat Scheme, which is managed by the Meat Board of Namibia. Under this scheme, it is mandatory for commercial farms to identify each animal with an ear tag displaying a unique identification number. The Directorate of Veterinary Services is responsible for issuing ear tags and livestock movement permits. Recently, Namibia has moved from bar-coded ear tags to double RFID ear tagging in both commercial and communal production environments. Prior to 2012, the animal recording system did not cover animals in the Northern Communal Area to the north of the FMD cordon fence. Instead, they were identified using a communal branding system. During the life cycle of an animal, each farmer is required to submit a number of documents, including an animal registration card after ear tagging and a livestock termination form after death or on-farm slaughter.[21] The system was developed to satisfy standards required to export meat to the EU and South Africa. The origin of animals must be indicated on arrival at a slaughterhouse, whether they come from commercial or communal farms. The carcass is then labelled to indicate the owner, date of slaughter, abattoir at which the animal was killed and carcass weight. This information is then used to trace back any meat sold either domestically or internationally.

Uruguay. Since 1974, Uruguay has operated a group traceability system. In September 2006, the government introduced the Animal Identification and Registration System (SIRA) under Law No. 17 997 of 2 August 2006. This was followed by mandatory individual cattle traceability requirements under Decree 266/2008. The Livestock Control Office manages SIRA under the Ministry of Livestock, Agriculture and Fishery.[22]

KEY POINTS FOR CONSIDERATION

This subsection summarizes key points for consideration when implementing animal recording systems. The statements and recommendations presented here are based on lessons learned from the case studies described above, the outcomes of related symposia, workshops and expert meetings organized by FAO and its partners, and the experiences of the authors. The key points are as follows:[23]

Animal traceability, control of infectious diseases and promotion of food safety should be regarded as public goods, as they deliver benefits to farmers, consumers and the nation as a

[20] See http://www.nddb.org/resources/inaph

[21] See Fan Meat Standards for producers at www.nammic.com.na/jdownloads/Manuals/fanmeatmanual.pdf

[22] See www.inac.gub.uy/innovaportal/file/5219/1/libro_trazabilidad_ingles.pdf

[23] See www.fao.org/fileadmin/templates/raf/pdfFiles/AIR_Pretoria_Declaration.pdf

whole, irrespective of whether they take the form of a public or private sector initiative. By making local animal food producers and processors more competitive in global markets and enhancing their export capabilities, traceability not only helps to develop individual businesses, it also contributes to national economic growth and development.

Increases in animal production and productivity through breeding and improved farm management are private goods inviting private sector contributions. The identification of benefits that stakeholders derive from participation in the system requires participatory stakeholder consultations. Stakeholder buy-in is a prerequisite for economic sustainability. The public and private nature of animal identification and recording systems calls for participatory approaches and public–private partnerships for the development and operation of animal recording systems.

The participation of stakeholders is likely to increase if related benefits are clearly visible. The different uses and benefits of the system should, therefore, be explored in the planning stage through a participatory needs assessment. The benefits of participation and the disadvantages of non-participation in an animal recording system must be clearly defined and communicated to all stakeholders.

When developing a new animal recording system, it is essential to assess the underlying motivations and the prevailing conditions and production systems – and to determine what is feasible in each given situation. While countries can learn from each other's experiences, country-specific research is invaluable, as there is no one-size-fits-all model.

Any system must be adapted to the circumstances in which it will operate, including production environments and socio-economic conditions, the state of livestock service provision and veterinary institutions, levels of capability among farmers and officials, the state of communication networks and the availability of resources (both human and financial).

The development of a national animal identification and recording system requires the presence of national regulation, particularly if animal health and traceability are the primary objectives.

Countries should avoid developing regulation and an animal identification and recording system in a rush; for example, under pressure from trade partners. The development of such complex systems requires time, and compressing the process will ultimately result in additional costs.

The development of an animal recording system should be undertaken in a phased manner; it should be extended progressively to new regions, species and/or additional functionalities. However, this strategy may not always be easy to implement. For example, animal movement may lead to contact between identified animals and non-identified ones, rendering animal traceability more difficult. Likewise, it is essential to introduce a modular system that can be upgraded to cover new functions or activities incrementally.

Animal identification and registration constitute the basis of any recording system. The allocation of a unique identification number for individual animals or groups of animals, premises and owners within a country, is, therefore, a prerequisite for operating any animal recording system. Other modules or systems, such as traceability and performance recording, can be added or linked later.

Countries should follow international standards and quality protocols and use certified products to ensure quality. The International Committee for Animal Recording (ICAR) guidelines and standards can serve as a reference. International standards also allow for interoperability at regional or international levels, as certain aspects of the systems, such as theft control or breeding, require regional collaboration. The harmonization of regional regulation is another step towards improved regional collaboration.

An integrated animal recording system requires appropriate software. A number of pre-designed commercial software packages are available for purchase. Alternatively, such software may be developed locally. It is important to note that pre-designed commercial software is unlikely to offer a sufficient degree of customizability to meet all the requirements of a new animal recording system. However, developing custom software is initially a costly, time-consuming and complex process. Nonetheless, if sufficient resources and capacity are available, it is recommended that software be developed locally to meet specific needs.

The development and maintenance of a multipurpose animal recording system is complex and requires long-term commitment of human and financial resources. The importance of this should not be underestimated.

The dual nature of the public and private benefits of animal identification and recording systems has several consequences. Country experiences have shown that purely public systems are not sustainable, as implementation and operating costs are high.

Before any decision is taken to introduce an animal recording system, it is important to carry out a cost–benefit analysis of the project. However, benefits are often intangible and not quantifiable in monetary terms. The economic analysis is then limited to cost calculations and to comparing the costs of different options for the establishment of animal recording systems or schemes. The results should be communicated to stakeholders including funding agencies. Ensuring stakeholder commitment from the outset is essential for successful implementation of any animal recording project. While public funding is often essential at the outset of such projects, it is important for long-term sustainability that the system evolves so as to enable sharing of operating costs among all beneficiaries, including farmers.

Most technical problems are resolvable with the assistance of outside expertise and transferable experience. However, examples from many countries show that institutional problems are harder to overcome and have to be addressed at the national level. Issues in this category include questions of governance and rule of law, the designation of the competent authority (e.g. the Department of Livestock or the veterinary authority) and ownership of the data collected. The competent authority should be a coordinator and facilitator of the various stakeholders rather than the sole implementer of the system.

Availability of regular training and education programmes for end users is vital to the implementation and maintenance of any animal recording system. It is equally important to provide online assistance to end users to troubleshoot problems as they arise.

REVIEW OF EXISTING GUIDELINES

Many guidelines have been developed to foster standardization of animal recording systems worldwide. These guidelines are applied in high-income countries where animal recording systems have become more or less standardized. Their suitability for direct application in

mid and low-income countries is debatable given the presence of large numbers of small-scale producers and the prevalence of low and medium-input systems. This section reviews existing guidelines and their applicability in these countries, in general, and in small-scale production environments, in particular.

OIE guidelines on identification and traceability of live animals. General principles on identification and traceability of live animals and guidelines for the design and implementation of identification systems to achieve animal traceability are set out in Chapters 4.1 and 4.2 of the *Terrestrial animal health code*, published by OIE.[24] These guidelines describe the essential elements of an identification and traceability system and the logical steps to be followed when developing such a system. However, they do not provide substantial guidance on how to implement these steps, or practical examples and information on the pros and cons of the different options.

ICAR guidelines. ICAR is a worldwide not-for-profit organization that promotes the standardization of animal recording and productivity evaluation. Its aim is to promote the improvement of farm animal recording and evaluation through the formulation of definitions and standards for the measurement of traits of economic importance. The ICAR International Agreement of Recording Practices, which contains voluntary standards, rules and guidelines concerning all aspects of animal recording, is available on the ICAR website.[25] This document describes in detail the acceptable methods of animal identification and recording, and refers to these descriptions as guidelines.

The ICAR guidelines are primarily written by and for technicians who run highly developed state-of-the-art animal identification and performance recording systems. They provide good reference material on all matters relating to performance recording, including methods of animal identification, measurement, and calculation of traits and genetic evaluation. However, the ICAR guidelines do not provide direction for adapting these general principles to conditions in mid and low-income countries. ICAR has, therefore, established a Working Group for Developing Countries, one of whose primary tasks is to simplify and adapt relevant sections of the ICAR guidelines to suit the low and medium-input production systems of these countries.

FAO secondary guidelines: animal recording for medium-input production environment. In 1998, FAO developed and published the *Secondary guidelines for development of national farm animal genetic resources management plans – animal recording for medium input production environment* (hereinafter referred to as the FAO secondary guidelines).[26] They provide a comprehensive description of the benefits and beneficiaries of performance recording, the planning and conduct of performance recording schemes, and provide stepwise and detailed guidance on the institutional and operational organization of such schemes, and the utilization of resulting information, with a special focus on medium-input production systems.

Since the publication of the FAO secondary guidelines, a number of developments have occurred in the fields of livestock production and trade. These include a surge in the

[24] See www.oie.int/international-standard-setting/terrestrial-code/access-online

[25] See www.icar.org/pages/recording_guidelines.htm

[26] See www.fao.org/AG/AGAInfo/resources/en/pubs_gen.html

importance of animal health and traceability, which has become one of the main drivers of animal recording. It has, therefore, become necessary to consider performance recording in the more general context of national animal recording and to establish linkages with animal identification and registration, traceability and animal health information.

In conclusion, there is a need for new guidelines that support countries in the development of integrated multipurpose animal recording systems that integrate animal identification and registration, animal traceability, animal health information and performance recording. These guidelines should have a practical focus and be used to support decision-making when implementing sustainable animal recording systems, drawing on lessons learned from past and current experiences. There is also a need for guidelines that afford greater consideration to low and medium-input production environments within low-income countries (the common characteristics of such production environments are summarized in Box 2).

BOX 2

Adapting animal recording systems to the low-input production environments of developing countries

When implementing animal identification and recording programmes in the low-input environments of developing countries, it is inadvisable to apply the same standards and guidelines used in the high-input production environments of developed nations. The following factors, characteristic of the low-input production systems of developing countries, should be considered when implementing animal recording technologies in such environments:

- **Low external inputs.** Low-input production systems are characterized by limited capitalization or purchasing of external inputs. Animal production is typically low cost and mainly dependent upon local animal genetic resources. The use of external inputs may be virtually non-existent (e.g. subsistence-based pastoral systems), which makes it difficult to implement costly technologies.
- **Limited access to resources.** Resources such as land, feed, water, finance and services in general are scarce in low-input environments in developing countries. The situation with respect to feed supply is exacerbated by the continual loss of pasture to cropland due to increasing demand for grain.
- **Inadequate infrastructure.** Any efforts to transfer technology developed for high-input environments to the low-input environment of developing countries must take account of the general lack of infrastructure in the developing world. It is worth noting that facilities such as information communication technology systems, marketing services, transport systems, equipment and laboratories, which are vital for the proper functioning of animal recording systems, are poor or even lacking in developing countries.
- **Low knowledge and literacy levels.** According to the United Nations, 98 percent of non-literates live in developing countries, with high concentrations in South Asia, West Asia and sub-Saharan Africa. This poses a serious challenge to the implementation of animal identification and recording systems, which are highly dependent on good data collection and record-keeping.
- **Multiple uses of livestock.** Livestock generally serve a variety of purposes in developing countries. This has particular implications for the type of data to be recorded, the recording methods used and the utilization of data in performance recording.

When adapting animal recording systems to low-input production environments, it is important to consider all the above factors and characteristics and ensure that minimum conditions are met; otherwise the resulting system will not be useful or sustainable.

Section II
Strategic approach

INTRODUCTION

Section I outlined the potential benefits of an animal recording system and provided examples of animal recording systems that have been implemented in different countries. These examples and others demonstrate the need to broaden the scope of animal recording by adopting a multipurpose approach. This section introduces this approach, translates it into an integrated multipurpose system, and describes the step-by-step process of developing such a system. Subsequent sections provide detailed guidance on each individual step, and further develop the concepts and approach described here.

OBJECTIVE

The objective of this section is to describe the strategic approach to the development of an integrated multipurpose animal recording system.

THE CONCEPT OF A MULTIPURPOSE APPROACH

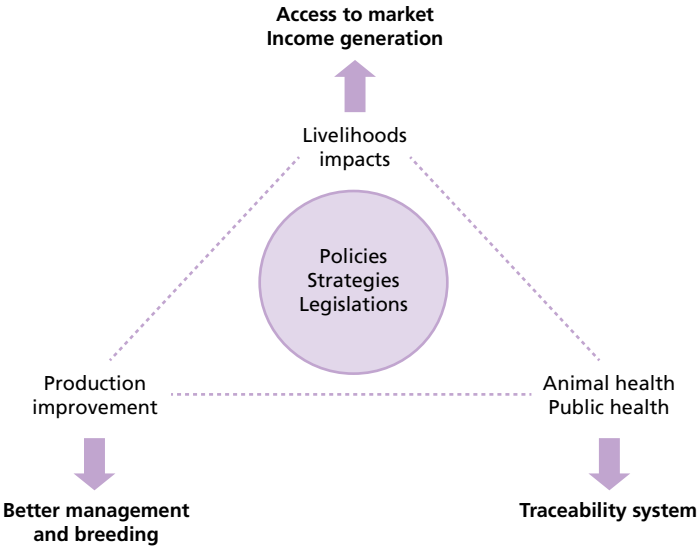
Figure 2 illustrates how animal recording serves multiple purposes in a national livestock sector. Animal recording is a prerequisite to establishing and operating a genetic improvement programme. It also contributes to animal traceability and disease control by making valuable health-related information available to veterinarians and other health professionals, enabling them to develop and implement disease prevention and control strategies. Traceability of animals and their products helps public health professionals to identify sources of risk quickly and prevent contaminated or poor quality products from reaching consumers. Implementation of animal traceability systems can enhance market access and generate larger incomes for producers and other players in the value chain. Therefore, animal recording systems are not just information systems; they are also a powerful tool for livestock development and can contribute to global demands for food security and poverty alleviation. However, for animal recording systems to be effective, they must be supported by appropriate public and private policies and accompanied by a legal and institutional framework.

MULTIPURPOSE INTEGRATED SYSTEMS

1. Components of the multipurpose animal recording system

A multipurpose animal recording system may comprise the following four components: (i) animal identification and registration (I&R); (ii) animal traceability (AT); (iii) animal health information (AHI); and (iv) performance recording (PR) (see Figure 3). The animal identification and registration component provides information to support the other three components,

FIGURE 2
Global approach to animal recording



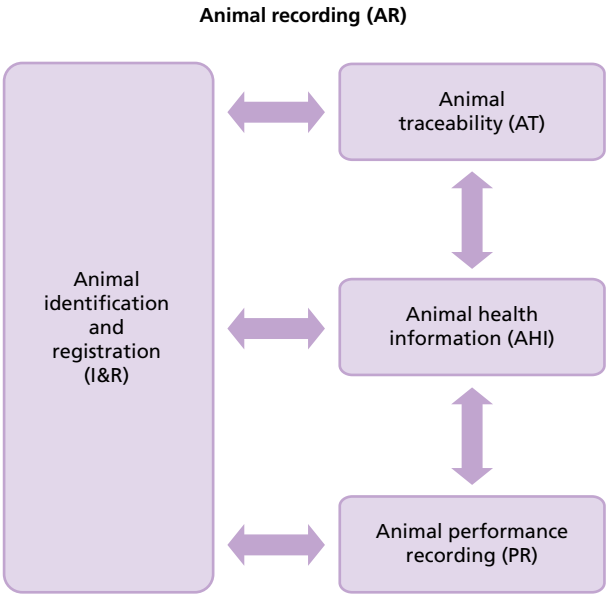
which provide additional functionalities and/or data elements in their respective fields. This structure is chosen for two reasons: it presents the system's components in a clear and simple way and it establishes the basis for building a modular system.

2. Integration and exchange among components

An animal recording system is a combination of two, three or four components, depending on the desired objectives. To be effective, each component must be developed separately, but all components must operate cohesively together. Developing an animal recording system that encompasses all components from the beginning of its operation may not be feasible due to financial or other constraints. In such circumstances, it will be necessary to prioritize the development and implementation of those components that are most critical to meeting national requirements. Less critical components may then be developed at a later stage and integrated into the existing animal recording system.

In countries where little or no action has been taken to develop an animal recording system, it may be preferable to develop a fully integrated system from the outset, if necessary resources are available. In such cases, the recommended approach is to design an integrated system that incorporates all components within one central database, even if the components are implemented in stages. The components of such an animal recording system are referred to as "modules". The use of a single central database considerably reduces the cost of implementing and maintaining the system and facilitates rapid flow of communication, which allows action to be taken quickly.

FIGURE 3
An integrated animal recording system with animal identification and registration as the core component



It is likely that in many countries a number of disconnected single or multipurpose information systems will already be in place. These systems may have databases in different locations and may be operated by different institutions. It would be costly and impractical to merge such systems. In such circumstances, one possible solution is to establish linkages between these different systems, enabling the databases and applications to: (i) export and import data (details on the technology are given in Section VIII); and (ii) generate reports and carry out analysis by pulling data from other databases. The different components of the animal recording system with their respective databases are referred to as "sub-systems". It is important to remember that only the animal identification and registration subsystem should allocate animal and premises codes, which should then be provided to all other subsystems. For example, veterinary data concerning vaccinations, treatments, testing, disease surveillance and herd health management can be linked to individual holdings and animals if the different subsystems are harmonized and communicate with one another. The development and integration of different animal recording subsystems should ensure that data only need to be collected and entered once. It should also enable all participating organizations using the different subsystems to access the common data for their own purposes.

THE PROCESS FOR DEVELOPING AN ANIMAL RECORDING SYSTEM

These guidelines have been prepared to provide users with step-by-step guidance on how to develop and implement a strategic plan for an animal recording system (see Figure 1). The process is broadly divided into two parts:

1. Developing the concept; and
2. Putting the concept into practice.

1. Developing the concept

There are different ways to set up each of the animal recording system components. To account for these differences, the guidelines first develop a conceptual framework for each component. Sections III, IV, V and VI develop the conceptual frameworks for animal identification and registration, animal traceability, animal health information and performance recording, respectively. They describe the consequences of the different solutions and provide rationales for making the right choices for a given situation.

Animal identification and registration. Animal identification and registration refers to the identification and registration of premises, keepers and owners, and animals. Section III presents these elements and describes the relevant data to be collected. It describes the options available for the identification of animals and gives guidance on choosing the method of animal identification that best fits the objective. The development of an animal identification and registration system requires appropriate information technology (IT), policy, legislation and institutional support. Their importance in the establishment and operation of an effective animal identification and registration system is also highlighted.

Animal traceability. In these guidelines, animal traceability refers to the ability to access the history of an animal or a group of animals throughout its life cycle. In essence, this refers mainly to animal movement traceability. Section IV reviews the multiple objectives of an animal traceability system, identifies the elements of such a system and the different options for tracing an animal or a group of animals, and describes the data to be collected or provided in each case. These guidelines will help users to select the most appropriate type of animal traceability system and its constituent components, based on the set objectives.

Animal health information. Animal health information systems fulfil different objectives, including support for notification of animal diseases according to legislation and the priorities of veterinary services. The systems support disease monitoring and risk management by providing data that can assist the development of disease prevention and control measures. Section V describes the main elements of an animal health information system and provides guidance on correctly evaluating the elements characterizing such systems. It also provides key recommendations for developing an animal health information system.

Performance recording. Performance recording involves the objective and systematic measurement of various indicators of animal performance. Data such as the physical characteristics of animals, parentage and relevant events, may also be collected. The FAO secondary guidelines provide a comprehensive description of the benefits and beneficiaries, and the planning and conduct of performance recording schemes. Section VI does not explore the same ground as that covered in the above-mentioned guidelines; instead, it places performance

recording in the more general context of national animal recording, highlighting the linkages between performance recording, animal identification and registration, traceability and animal health information. This section reviews the multiple objectives of performance recording, examines the different types of performance recording systems and the elements of such systems, and describes the data to be collected or provided in each case. Examples, based mainly on dairy recording, are given for the purposes of illustration.

2. Putting the concept into practice

Based on the conceptual framework developed in Part 1 and Part 2 of the guidelines, Part 3 provides guidance on how to prepare and implement an integrated multipurpose animal recording system. The related activities are divided into three steps:

1. Developing the strategy;
2. Developing the legal framework; and
3. Implementing the animal recording system.

2.1 Developing the strategy

The development of the strategy involves an iterative process that consists of three steps: preparing the strategic plan; designing and developing the IT system; and evaluating investment decisions. If the cost estimates exceed the availability of funds, the strategic plan and the IT system must be re-examined and modified, and the costs and benefits re-estimated. This iterative process is continued until the cost of implementing the identified activities matches the available funds (see Figure 1).

Preparing the strategic plan. A strategic plan should define the objectives and scope of the animal recording system; identify the participating stakeholders and their needs; select the type of system and define its elements; specify the rules and procedures for data collection, storage, processing and reporting; and state the IT requirements needed to develop the software application and build the IT infrastructure. It should also define the legal and institutional support required, and present a detailed implementation plan. Finally, the strategic plan should stipulate human resource requirements and include a budget that specifies identified funding sources. Section VII provides guidance on how to conduct a country situation assessment and prepare such a strategic plan. The latter is common to all animal recording system components, but specificities are given where required.

Designing and developing the IT system. The IT system enables users to capture, validate, process and store data, and to generate and transmit relevant reports to the same or other users for decision-making and planning. The IT system has two components: a software application and a hardware infrastructure. Section VIII provides guidance on procuring or developing a software application for an integrated multipurpose animal recording system and on setting up the required computer hardware. It focuses, in particular, on the preparation of user requirement specifications, which can have a major impact on the success of the development process. It also provides guidance on how to issue calls for tender for IT companies and develop and test the software.

Evaluating investment decisions. Developing a national animal recording system requires significant investment, not only to develop and implement the system, but also

to ensure its maintenance. A cost–benefit analysis facilitates decision-making about such investment. The cost–benefit analysis involves: (i) estimation of costs; (ii) estimation of benefits; and (iii) evaluation of the cost–benefit relationship.

Estimation of costs involves identifying all cost items and determining a unit cost for each cost item. The estimation of benefits involves identifying and quantifying the benefits. The analysis of the cost–benefit relationship should ideally be undertaken in economic terms. When this is not possible, alternative criteria should be elaborated. Section IX provides a clear breakdown of the costs and benefits of an animal recording system (in particular, animal identification, registration and traceability systems) and discusses the cost–benefit relationship. It also identifies ways to reduce costs and to distribute costs equitably between the main beneficiaries.

2.2 Developing the legal framework

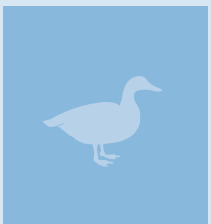
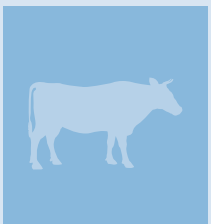
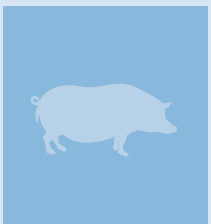
Implementation of an animal recording system must be supported by a suitable legal framework. To achieve this, it is first necessary to undertake a detailed analysis of existing relevant legislation in the country, including its scope and the extent of compliance. It is then necessary either to update existing legislation so as to support animal recording activity or develop new legislation for this purpose. During this process it is important to consider the desired scope of the animal recording system and whether compliance ought to be voluntary or mandatory. The latter will depend not only upon the desired outcome, but also upon whether the country has sufficient resources to operate a mandatory system. Section X provides guidance on developing a legal framework to support an animal recording system.

2.3 Implementing the animal recording system

Before the animal recording system is rolled out over a wide area, it should be implemented as a pilot project over a smaller area to test its functionalities. The implementation activities, whether in the pilot area or in the extended area, can be divided into three phases: the preparatory phase; the execution phase; and the maintenance phase. Once implementation has reached the maintenance phase, independent evaluations of the system must be carried out at regular intervals to ensure compliance with the standard operating procedures. The main activities to be carried out in each phase are described in Section XI.

PART 2

Developing the concept

Section III

Animal identification and registration

INTRODUCTION

Animal identification and registration (I&R)[27] form the core component of any animal recording system (Figure 3). This section describes a conceptual framework for I&R that focuses on the identification and recording of premises, keepers and owners, and animals. Part 3 of these guidelines addresses the development and implementation of a strategic plan for building an I&R system and describes how to put the conceptual framework into practice. The process for developing an I&R system is similar to that used for developing animal traceability, animal health information or performance recording systems. Therefore, these processes are addressed together later in these guidelines.

OBJECTIVE

The objective of this section is to describe the elements of an I&R system and to provide guidance on how to choose the most suitable method of animal identification.

DEVELOPING THE CONCEPTUAL FRAMEWORK

I&R involves the identification and registration of premises (sometimes referred to as establishments or holdings), the identification and registration of keepers and owners, and the identification and registration of animals. This section considers these elements and describes the data to be collected for each one. It also specifies the options available for the identification of animals and determines the criteria to be considered when selecting a method of animal identification. The development of an I&R system requires IT, policy, legislation and institutional support.

1. Identification and registration of premises

The term "premises" refers to a geographical location and/or area where animals are permanently kept, such as a home, farm or feedlot, or a place where animals are temporarily handled, such as a market, abattoir, test centre, dip tank, common shearing shed or grazing pasture. Premises can also be mobile; for example, a truck, train or ship. In these guidelines, the terms "premises", "establishment" and "holding" are treated as synonymous. In order to establish geographical traceability, each premises should be identified by a unique premises code. The premises code remains assigned to a specific geographical location even when the herd, herd keeper or herd owner move to another

[27] This acronym is used throughout this section only, to facilitate ease of reading.

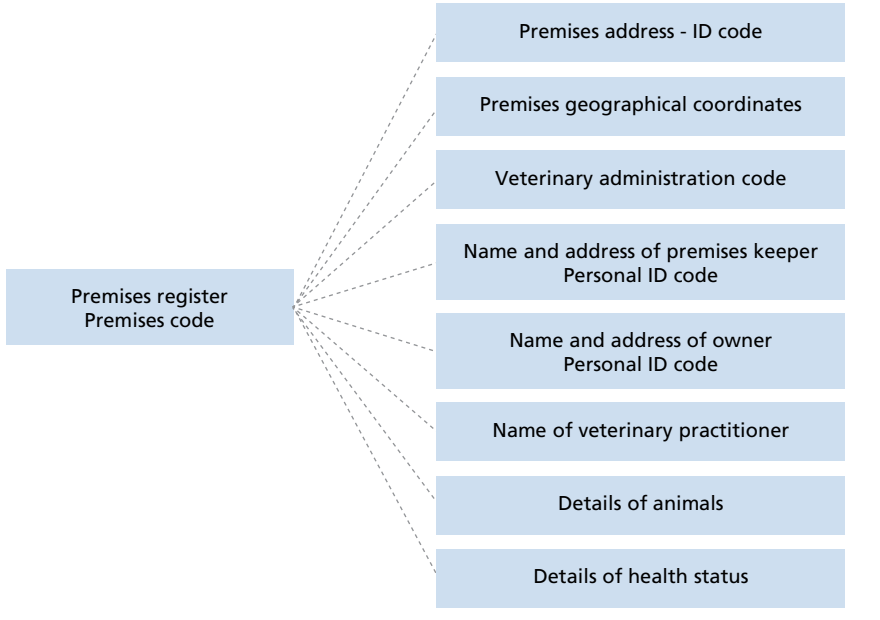
location. Therefore, the premises code identifies the geographical location and not the ownership. If the animal owner has more than one farm, each location must have a unique premises code. Premises codes must be linked to animals, and keepers and owners.

All premises must have a premises register that contains the premises code, the address with a location code, geographical coordinates of the premises, jurisdiction of the veterinary administration code, name and address of the keeper with the personal ID code, name and address of the owner with the personal ID code, name of the veterinary practitioner, and further aggregated parameters on animals kept on the premises (see Figure 4). This summary of animals includes details on animal species, production types (e.g. dairy or beef), defined groups (e.g. cows, heifers, bulls) and information on the health status of all animals on the premises.

The schematic presentation of a premises register shown in Figure 4 is relevant both to manual and to computerized systems. In a manual system, the premises register should include all the data specified above, so as to allow visiting inspectors access to all details concerning the premises, including those related to the owner and keeper. However, in the case of a computerized system with a centralized database, there is no need to store all these details in the premises register. Instead, most of this information can be accessed by linking the premises table with other tables in the database that store details of keepers and owners, animals and the jurisdiction of the veterinary administration.

When all animals of a particular species in a geographical location (such as a village) are kept in a manner that allows them to mix freely during daytime; for example, by grazing

FIGURE 4
Schematic representation of a premises register



in a common area or drinking from a common watering source, they may be treated as a single epidemiological unit coming from one premises. This applies even if the animals return to individual households for milking in the evening and are owned by different persons. In such circumstances, the premises code would be the same for all animals of that particular species in that particular geographical location.

2. Identification and registration of keepers and owners

The keeper is the person responsible for the day-to-day management of animals on the premises. The owner is the legal owner of the animals, regardless of whether he/she owns the premises on which the animals are kept. Very often, the owner is also the keeper. A keeper may be responsible for more than one herd (on more than one premises) belonging to one or more owners. Likewise, an owner may possess more than one herd (on more than one premises), each having the same or different keepers. Identification and registration of both keepers and owners are essential. Dealers and transporters are a special group of temporary animal keepers, and must also be registered.

A register that records data on keepers and owners should be established in the database. This register should contain the names, addresses and other contact information of the keepers and owners, so as to enable the authorities and other users of the database to contact them quickly if necessary. When individuals or corporations are already registered in other public databases, such as a national register of persons or any other existing register, their identification codes in such databases may be utilized to identify them as animal keepers or owners in the register (see Figure 5).

When establishing both the premises register and the keepers and owners register, the following points need to be considered:

- The premises address is identified by a unique village/location ID code.
- Keepers and owners are identified using unique personal ID codes.
- The person responsible for the animals at the premises is registered as the keeper, regardless of whether he/she is the owner.
- Even if the keeper and the owner are the same person, they should be specified separately. The register can include a "person" table for both keepers and owners, with a "type" column indicating owner and/or keeper.

3. Identification and registration of animals

Regardless of whether animals are identified individually or by group, they need to be identified with a device and identification code (ID code) appropriate for the species and the purpose for which it is applied. For example, if the purpose is to demonstrate ownership of a community's animals, a brand may suffice. For some species, such as pigs and poultry, it may be sufficient to identify animals with a group code representing the premises of origin and to register all group movements. For others, such as cattle, a unique lifetime identification code may be required for each animal to record its movements or control its performance.

The ID code links the animal to the premises where it is kept (see Figure 5). When identifying an animal, certain data must be collected and maintained at the premises and on

the database. The options available for uniquely identifying animals and the minimum data to be recorded during the registration process are described as follows.

3.1 Developing a unique identification numbering system

ID codes should preferably be numeric. In principle, ID codes should be kept as short as possible while remaining nationally unique for a turnover period of at least ten generations (approximately 50 years for cattle). In animal breeding, where pedigree information is recorded, a longer turnover period is required. Short and simple ID codes are easy to remember and to handle. However, animal ID codes often contain further information such as herd number and region. The inclusion of such extra codes as part of the animal ID code can provide useful information, such as the origin of the animal. However, although this makes such information easily and immediately available, it also makes the ID code longer and considerably reduces the number of possible ID codes. It also renders the management of ID codes more complex and expensive and requires storage of a larger number of identification devices.

ISO 11784 is the established international standard for the structure of ID codes. The structure was developed for use in electronic identification worldwide, but is also applicable for non-electronic ID codes. The basic structure is an individual animal ID code consisting of the country code followed by a 12-digit number. The country code is a two-digit alpha code for traditional individual identification (visual tags) and a three-digit numeric ISO 3166 code for electronic identification. This enables the format of identification devices to be harmonized worldwide. In most cases, the last digit of the 12-digit number is used as a check digit (see Box 3 for an example).

BOX 3

Algorithm to calculate a check digit

In a 12-digit number, the check digit is a function of the preceding 11 digits. It is used to prevent entry of a false animal ID code. When the animal ID code is read, the algorithm is applied to calculate whether the check digit is correct. If any digit is incorrectly typed, the check digit will not match the calculation and the software will prompt a message that the animal ID code is wrong. The correct ID code may then be entered to ensure that the correct data is applied to the correct animal.

Let us assume a tag number is 291024654871, where 2 is the first digit, 9 is the second digit and 7 is the eleventh digit. The last digit is the check digit; this is derived from the first 11 digits as follows:

The first digit is multiplied by 11, the second by 10, the third by 9 and, finally, the eleventh by 1. The total sum of these numbers is then divided by 9. The remainder of this sum is taken as the check digit.

For the above tag number, the check digit is 1, which is derived as follows:

$(2 \times 11 + 9 \times 10 + 1 \times 9 + 0 \times 8 + 2 \times 7 + 4 \times 6 + 6 \times 5 + 5 \times 4 + 4 \times 3 + 8 \times 2 + 7 \times 1) / 9) = 244 / 9 = 27$

and the remainder is 1.

FIGURE 5

Schematic representation of relationships between keepers, owners and premises

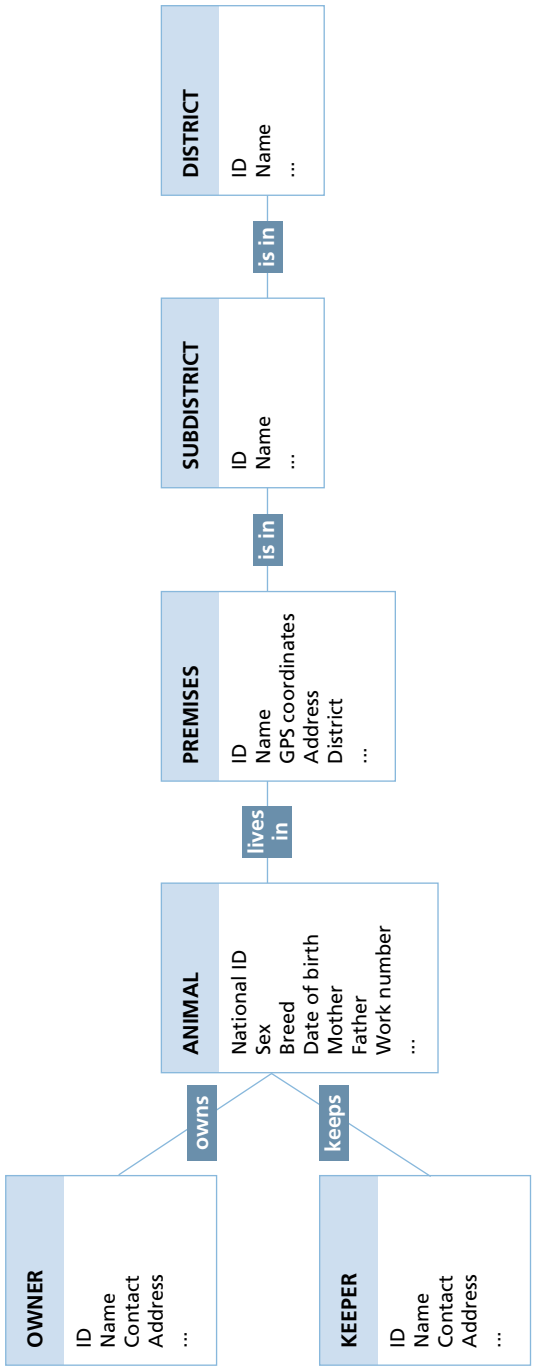


FIGURE 6
An example of a tamper-proof test, showing reusable tags (left) and non-reusable tags (right)

Note: The numbers on the tags correspond to the test codes and not to animal ID codes.
Provided by Ole Klejs Hansen.

3.2 Identification devices

Different identification devices, such as tattoos, tags or electronic devices are used for identifying animals, depending on the code structure and the animal species. Typically, the mode of identification is easily visible to the human eye. In some situations, however, visible identification is supplemented by electronic identification (e.g. electronic ear tags, ruminal boluses and chips). In the case of animals identified individually with ear tags, it may be useful to use a larger font for a number of digits (e.g. the last five digits) that can serve as a relevant working number for the animal.

Identification devices should be tamper-proof or at least tamper-evident. Tamper-proof means that the devices cannot be opened without destroying the locking mechanism in such a way as to prevent reuse (Figure 6). Tamper-evident means that the devices cannot be opened and reused without leaving clear indications such as marks or scratches. In addition, identification devices should not pose risks to animal welfare at any time during the lifetime of the animal.

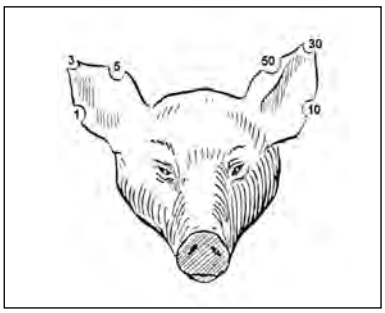
A national system may use more than one type of identification device. Available identification devices are described as follows:

Drawings, descriptions and photographs. This method of identification is often used to identify stud animals of certain breeds, and can be used for breeds where individual animals have distinctive colours and markings. In countries where an animal identification system is absent, descriptions can be used to identify animals on most documentation that accompanies them in the event of sale or transfer of ownership. For example, an animal may be described as being red with a white blaze.

Hot branding (large stock). This method of identification has been in use for centuries to prove ownership and protect against theft. One criticism of the use of hot iron branding

relates to its effect on animal welfare. Additionally, under certain circumstances, it is possible to change characters in brands, making them potentially unreliable. As hot branding cannot ensure individual animal identification, it is not a reliable tool for the implementation of precise movement recording and control systems.

Freeze branding. A freeze brand can be applied through the use of liquid nitrogen (-196° C) or by placing the branding iron in a methylated spirits (alcohol) bath that is cooled down to -40° C by using solidified carbon dioxide. The frozen iron is then placed on the shaven skin and held in place for at least 30 seconds. Freeze branding is slower, more expensive and less reliable than hot branding. In addition, the supply of liquid nitrogen is limited in many places.



Ear notching. Ear notching is a code used for identifying animals based on notches in the rim or holes in the animal's ear, but here, too, animal welfare is an issue. Several systems are in use and the notches have different meanings in different systems. The example shown here is a simple system with six notches of different value, where a maximum of three notches per ear are needed to reach any total value up to 99. The animal shown has an ID number of 99. In this system, a hole in the middle of the animal's left ear could denote 100 and a hole in the middle of the right ear could denote 200, and the system would be able to provide ID codes up to a maximum number of 399.

Because of the low number of combinations possible in any ear-notch system, ear notching is not able to provide unique codes for national animal identification schemes, and, in many cases, will not even be able to provide unique identification for all animals in a herd. In order to understand the notch code, it is necessary to know which coding system was used at the time of identification.

Tattoo. Tattooing is a system where codes are tattooed on the animal's ears or body in such a way as to be easily visible. Tattoos can provide unique identification for a larger number of animals than ear notching. If the animal has one tattoo with the premises code and another tattoo with an individual animal ID code within the premises of origin, this method might provide a sufficient number of digits for national unique individual animal identification.

Tattoos are often considered to be an easy and cheap identification method. However, the technique has to be carried out with a high degree of accuracy to ensure that the tattoo can be easily read. Using complicated codes or allowing persons without sufficient training to apply tattoos poses a significant risk to the effectiveness of an identification system. Additionally, it can be difficult to read tattoos on animals with dark skin or thick hair, or animals that are covered in dirt. Often tattoos are not readable from a distance,

which means that it is necessary to catch each animal to verify its identity. Finally, the cost of character needle blocks is often underestimated. It is necessary to have as many sets of blocks as there are digits in the ID code, which adds considerably to the cost.

Ear tags. Ear tags are metal or plastic tags applied to an animal's ear. Plastic ear tags are highly visible and easy to read at a distance, allowing them to hold sufficient digits for national unique ID codes. In official identification programmes, authorities must set requirements for durability, fraud resistance, readability and animal welfare. Internationally agreed test procedures for the quality of plastic tags are available from a number of sources, including ICAR. Information about ICAR-approved tags can be found on the ICAR website.[28]

Plastic tags are currently the most commonly used method of identification. Although cheap, one drawback is the risk of loss (the loss rate should not exceed 5 percent per year). The use of two identical plastic tags per animal, one in each ear, enables identification even if one tag is lost, as the probability of losing both tags is extremely low.

I&R systems commonly use laser-printed plastic ear tags. However, in some cases the ID code is written on the ear tag with a special marking pen. A one-dimensional or matrix barcode can be printed along with the number on the plastic tag, allowing the number to be read by an electronic scanner. This method eliminates human error in reading and recording tags. However, under certain conditions (e.g. extensive farming systems), particularly where humidity is high, barcodes may become obscured by dirt, making them unreadable by electronic scanners.

Ear tags can be removed and replaced easily. For this reason, it is important to ensure that ear tag numbers are granted by the appropriate information system. It is also important to control the distribution and traceability of ear tags and to ensure that only official ear tags that can be easily authenticated are used. It is, therefore, advisable to distribute pre-printed ear tags displaying a special symbol, such as the logo of the competent authority, and to record the distribution and use of pre-printed ear tags in the central database.

Metal ear tags are generally smaller than plastic tags and can often only be read at close range. It may also be necessary to clean tags before reading them, as the tags and any engraved figures can easily be obscured by dirt.

Under certain circumstances the use of ear tags or notching may not be possible, for example with earless animals or in areas where social conditions prohibit the puncturing of ears.

Electronic ID. Visible identification is often supplemented by electronic identification (EID), also referred to as RFID. The electronic device, which can be programmed with an identification code, consists of a low frequency passive transponder that can be contained inside injected chips and built into ear tags or a ruminal bolus (see Figure 7). The transponder can be read with an electronic reader.

[28] See www.icar.org/pages/certified_eartags.htm

FIGURE 7
Examples of electronic devices:
a chip for injection (left) and an ear tag and ruminal bolus (right)

The passive transponder is activated by a radio-magnetic field, applied using an electronic reader (scanner). Once activated, the transponder starts transmitting the unique ID code stored on the microchip. In addition to read-only EIDs, read–write EIDs are also available, which allow the user to include additional data, such as the animal's date of birth, dam ID, sire ID, birth weight and last calving date.

The two main advantages of EIDs are that they minimize the effort and amount of physical handling required to record an animal, and reduce the risk of human error in reading the devices. The main disadvantage is the cost of purchasing the EIDs and reading devices. EIDs have mainly been used to identify pets and some horse breeds, but a growing number of countries are beginning to use EIDs for farm animals.

Microchip implants. The use of intramuscular and subcutaneous microchips in farm animals poses a problem for the meat industry. For security reasons, the chip should be collected at the slaughterhouse. Compliance with this measure creates higher costs for the slaughterhouse, especially as microchips can migrate inside the body. In some instances, microchip implantation can also cause abscesses.

Bolus. A bolus containing a microchip can be placed inside the rumen with a special introducer. This method can only be used in ruminants over three months old. However, in contrast to implants, a bolus does not present a risk of migration or abscesses. The bolus is removed from the rumen at slaughter. Although it is theoretically possible to reuse boluses, there is a logistical problem of reallocating microchip numbers that have already been used.

EID devices should comply with international standards, and can be tested for performance and conformance through reference to ISO 24631 (see Box 4). Approved devices can be found on the ICAR website.[29]

Iris and retina scan, and nose prints. These techniques consist of taking digitally codified scans or prints and analysing them using special software. However, they are rarely used due to the cost and difficulty of obtaining scans or prints of an acceptable quality.

[29] See http://www.service-icar.com/tables/Tabella1.php

BOX 4

ISO standards for conformance and performance of electronic identification devices

ISO 11785: This international standard specifies how a transponder is activated and how stored information is transferred to a transceiver (scanner).

ISO 24631: This international standard provides the means of evaluating the conformance and performance of ISO 11784 and ISO 11785 transponders. Manufacturers should provide a copy of the original test report or ICAR performance test certificate, to allow national authorities and users to verify that minimum requirements have been satisfied.

Minimum requirements for EID tags used in sheep and goats can be set in electrical units as follows (EU legislation):

- minimum activation field strength: max. 1.2 A/m;
- modulation amplitude: min. 10 mV at field strength 1.2 A/m.

Minimum requirements for EID tags used in cattle, providing a higher reading distance than for sheep and goat tags, are:

- minimum activation field strength: max. 0.6 A/m;
- modulation amplitude: min. 10 mV at field strength 0.6 A/m.

Other ISO standards used to provide animal identification codes:

ISO 3166 prescribes codes for the names of countries, dependent territories and special areas of geographical interest.

ISO 11784 defines a code structure for country codes or manufacturer codes and animal ID codes. If the transponder has a country code, it is the responsibility of that specific country to ensure the uniqueness of the transponder identification code. If a transponder has a manufacturer code it is the manufacturer's responsibility to guarantee the uniqueness of the code.

DNA analysis. This bio-identification method also enables the identity of a particular animal to be proven beyond any reasonable doubt. The use of tissue-sampling ear tags and DNA analysis in suspicious cases an be a good means of preventing animal theft and fraud.

3.3 Important considerations for selecting an identification device

An animal should have one unique ID code that is used for all animal recording systems, including animal traceability, animal health information and performance recording. All organizations that use or may wish to use I&R should, therefore, be involved in the discussion.

The choice of an appropriate identification device depends on the desired objectives, animal species and production environment(s), cost, existing animal welfare regulations and so on. Hot branding of large stock and tattooing of small stock remain a good method for achieving group identification and preventing theft. Laser-printed ear tags with a controlled production and distribution system are most frequently used for individual identification and traceability.

Where theft is a problem, boluses may present a good solution. However, the choice of identification method may be restricted by cost and/or animal welfare regulations. While the cost of EIDs is decreasing, it is still necessary to consider reader costs, bearing in mind that an electronic reader is not required for every animal keeper. The use of EIDs and visual ear tags can also be combined. Table 1 summarizes key issues related to the use of various identification devices.

3.4 Registration of animals

The data collected during registration of an individual animal should include the ID code, date of birth, dam ID and breed. Certain additional data may be collected for the different components of the recording system. For example, details of animal movements, including the date, are required for animal traceability systems; and health status and individual restrictions are required for animal health information systems (see Figures 3, 5 and 8).

A computer-based system is essential for I&R. It should have a built-in audit function that automatically checks for missing or inconsistent data, and alerts the staff responsible for ensuring that animal keepers, abattoirs and other relevant stakeholders comply with record-keeping requirements and correct reported errors.

FIGURE 8
Schematic presentation of an animal register (and its links to the premises register)

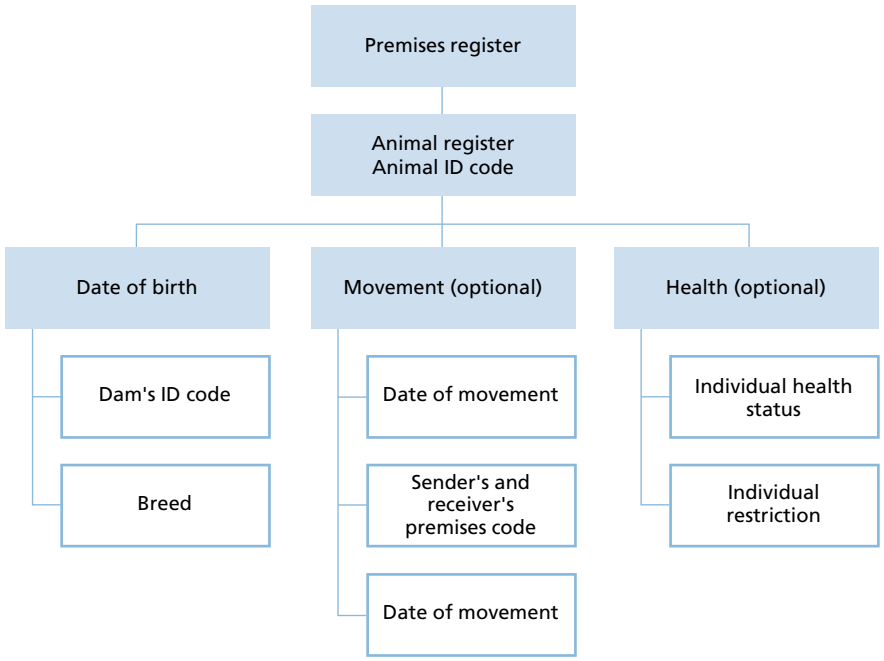


TABLE 1
Advantages, challenges and costs of various types of animal identification

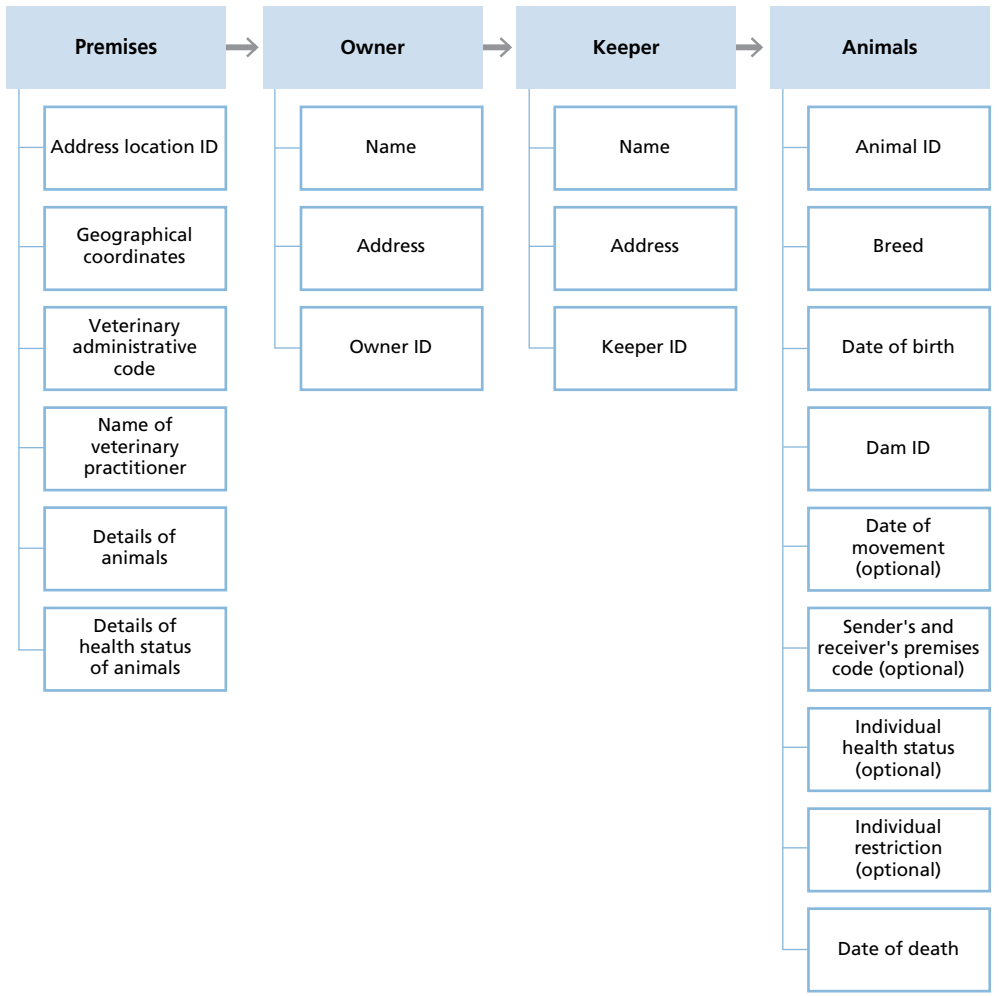
ID device type	Advantages	Challenges	Costs
Ear notch	• Easy application • Tamper-evident	• No global standard for value of notches • Low number of ID codes • Difficult to read from a distance on hairy animals • Animal welfare	• Device is cheap • Labour cost for reading and registration is high
Tattoo	• Tamper-evident • High number of ID codes	• Application must be done very carefully to ensure that the tattoo remains readable • Difficult to read from a distance on hairy, dark or dirty animals	• Medium cost device • Labour cost for reading and registration is high
Metal ear tag	• Easy application • Tamperproof • All ID codes are possible • Low loss rate	• Difficult to read from a distance • Animal welfare issues can arise due to sharp edges	• Device is cheap • Labour cost for reading and registration is high
Plastic ear tag	• Easy application • Easily readable • All ID codes are possible • Barcode possible	• Many marketed products are not tested (certified) for fraud resistance, durability, readability or animal welfare • Loss rate may be a problem in rugged environments	• Device is relatively cheap • Labour cost for reading and registration is low
Electronic plastic ear tags	• See plastic ear tags	• See plastic ear tags • Only tags tested for electronic conformance and performance should be used	• Device is more expensive • Enables automatic reading and handling of animals
EID boluses for ruminants (only possible with low frequency tags, ISO 11785)	• All ID codes are possible • Tamperproof • Loss rate is independent of environment • Enables automatic reading and handling of animals	• Cannot be applied until the animal has reached a minimum age • No visual identification unless in combination with external ID device	• Device is more expensive • Disposal costs
Injectable chips (only possible with low frequency tags, ISO 11785)	• All ID codes are possible • Tamperproof • Loss rate is independent of environment	• Application is complicated and often not accepted by slaughterhouses • No standard for injection site • Low read distance • No visual identification unless in combination with external ID device • Difficult to collect the chip at the slaughterhouse • Fragile (in glass capsule)	• Device is more expensive

A simple paper-based system is possible if the animal keeper reports recordable events to the competent authority within a few days. These data must then be entered into the centralized database as quickly as possible. All relevant events, such as animal movements, births or deaths, should be reported as soon as possible.

3.5 An integrated view of I&R systems

The I&R process consists not only of the identification and registration of animals but also of premises, keepers and owners (see Figure 9).

FIGURE 9
Animal identification and registration: an integrated view



As explained in Section II, there are two main options when implementing an animal recording system. Under the first option, the I&R component constitutes a core module within a single central database of a fully integrated system, which includes the other modules – animal traceability, animal health information and/or performance recording. Under the second option, I&R constitutes a core subsystem for all other subsystems. In the latter case, one organization is responsible for maintaining the I&R database, with all other organizations that implement specific animal recording subsystems extracting data from the I&R database to their own database. This approach establishes linkages between the different subsystems, allowing the databases and applications to export and import data elements through the use of the XML file protocol. This is referred to as system interoperability.

Section IV
Animal traceability

INTRODUCTION

The development of animal traceability (AT)[30] systems has grown in importance worldwide over the last two decades. The main drivers have been protecting animal and public health, ensuring food safety and quality, and facilitating market access and trade. Section I of these guidelines describes these drivers and the potential benefits of AT systems in detail. A summary is provided in Subsection 1 of this section, which reviews the objectives of an AT system. Countries, regions or organizations that develop effective AT systems are not only better prepared to ensure safe and quality food for their consumers and guarantee public and animal health, but also have a comparative advantage in enhancing their exports of animal products. Importing countries that have implemented an effective AT system often require that their trading partners establish an equivalent system. Sanitary and phytosanitary measures (SPS) along with AT requirements are increasingly becoming major non-tariff barriers (NTB) to international trade in animals and products of animal origin.

This section describes a conceptual framework for AT, with a primary focus on animal movements. The process for developing an AT system is similar to that used for animal identification and registration, animal health information or performance recording systems. For this reason, these processes are discussed together in Part 3, which describes how to put the conceptual framework into practice.

While delineating the conceptual framework, this section reviews the multiple objectives of an AT system, describes the elements of such a system and the different options for tracing an animal or a group of animals, and outlines the data that should be recorded in each case.

OBJECTIVE

The objective of this section is to describe the types of AT systems and the requisite elements that should be developed, taking into account the local situation and the objectives for which the systems are being implemented.

DEVELOPING THE CONCEPTUAL FRAMEWORK

The International Organization for Standardization (ISO) defines traceability as "the aptitude to find the history, the use or the localization of an entity by means of recorded identifications".[31] In the context of ***animal production***, traceability refers to the ability to access the history of an animal or a group of animals throughout the course of its life.[32] In the context of ***animal health***, it refers to an animal's location and movements, its health status (including its history of vaccinations and disease testing), and the ability to access the history of other animals that it has come

[30] This acronym is used throughout this section only, to facilitate ease of reading.

[31] ISO 8402:1994

[32] The OIE Terrestrial Animal Health Code defines animal traceability as "the ability to follow an animal or group of animals during all stages(s) of its life".

into contact with during its life cycle. In the context of ***food safety***, it is a risk-management tool that enables identified risk to be traced back to its source in order to prevent food contamination and to respond promptly and effectively to prevent contaminated food reaching consumers.[33] In this case, traceability refers to the ability to trace animal products along the value chain. These guidelines, however, focus on the traceability of live animals. Following slaughter, there is a need to implement a separate product identification and traceability system linked to the AT system. When developing an AT system, it is, therefore, essential to identify the desired objectives of the system before defining its individual elements.

1. Objectives of an animal traceability system

An AT system can serve several objectives, including, but not limited to, the following:

- Enhancing risk management procedures:
  - enabling risk managers to trace identified hazards (e.g. transmissible animal diseases and zoonoses, antimicrobial residuals) back to their source;
  - assessing the potential spread of these hazards, thereby enabling effective control.
- Protecting public health:
  - identifying, tracing and controlling animal movements, particularly concerning the possible spread of zoonoses;
  - identifying, tracing and recalling unsafe foods (and feeds) at any stage of the food production and distribution chain.
- Improving animal health services:
  - improving disease surveillance and control (epidemiologic investigation);
  - ensuring the inspection and certification of animal health.
- Capturing trade opportunities (World Trade Organization Agreement on Sanitary and Phytosanitary Measures [WTO SPS Agreement]):
  - facilitating trade certification and access to markets with higher safety and quality standards.
- Ensuring fair practices in food trade (World Trade Organization Agreement on Technical Barriers to Trade [WTO TBT Agreement]):
  - minimizing the exercise of deceptive practices and fraud in the marketplace, and reducing the instance of unsubstantiated product claims (geographic indication, food quality, etc.).
- Mitigating stock theft:
  - facilitating the identification of rightful owners, resolving ownership disputes and discouraging livestock theft.
- Facilitating the operationalization of animal insurance, subsidy and compensation payment schemes.

[33] The Codex Alimentarius Commission (CAC) guidelines CAC/GL 60-2006 define traceability as "the ability to follow the movement of a food through specified stage(s) of production, processing and distribution".

2. Elements of an animal traceability system

The key elements of an AT system are:

- unique identification of individual animals or groups of animals, and the premises where animals are kept, reared, housed or gathered;
- registration of identified animals, premises, owners and keepers;
- recording of the movement of animals between premises, as well as animal births, deaths or losses; and
- collection and reporting of information.

The chart presented in Figure 5 is used here again to illustrate these elements, with the addition of a module describing the data elements for recording the movements of animals from one premises to another (Figure 10).

As animal movement requires veterinary certification, the AT system should record or facilitate access to sanitary information provided by the animal health information component (see Section V).

As shown in Figure 10, an animal identification and registration system is a prerequisite for a functional AT system; the latter cannot exist in isolation. In practice, the two systems will be fully integrated. They are addressed here separately in order to present the multipurpose (and modular) concept in a clear and simple manner. Readers who are unfamiliar with animal identification and registration are advised to first read Section III, which provides detailed guidance on this topic, before reading this section.

Depending on the objectives and scope of an AT system, the level of implementation is determined by the extent (e.g. number of districts or regions covered), level of detail (e.g. individual or group traceability), frequency and clarity of the above data elements and system functionalities.

3. Types of traceability system

AT systems can be categorized according to:

The extent of the value chain covered. Systems can be classified as follows:

- An AT system involves the traceability of the animal from the farm to the abattoir lairage. All animal movements and events during rearing, production and marketing are recorded.
- A product traceability system facilitates traceability from the abattoir, or meat or dairy processing plant, to the point at which the consumer purchases the animal product.
- A full traceability system extends across both segments of the value chain and is generally referred to as "traceability from farm to fork".

These guidelines address only live animal traceability. As mentioned, the traceability of products follows a different logic and involves a different set of techniques.

The type of data capture and management system. An AT system may be paper based, computer based or a combination of both. A simple paper-based traceability system only supports single-tier traceability. It addresses movement to and from the premises that maintains the record. The movement information is maintained locally on the farm or in a local extension, veterinary, police or administration office. In order to compile a complete record of movements for an animal or animals, it is necessary to trace each separate movement. This can

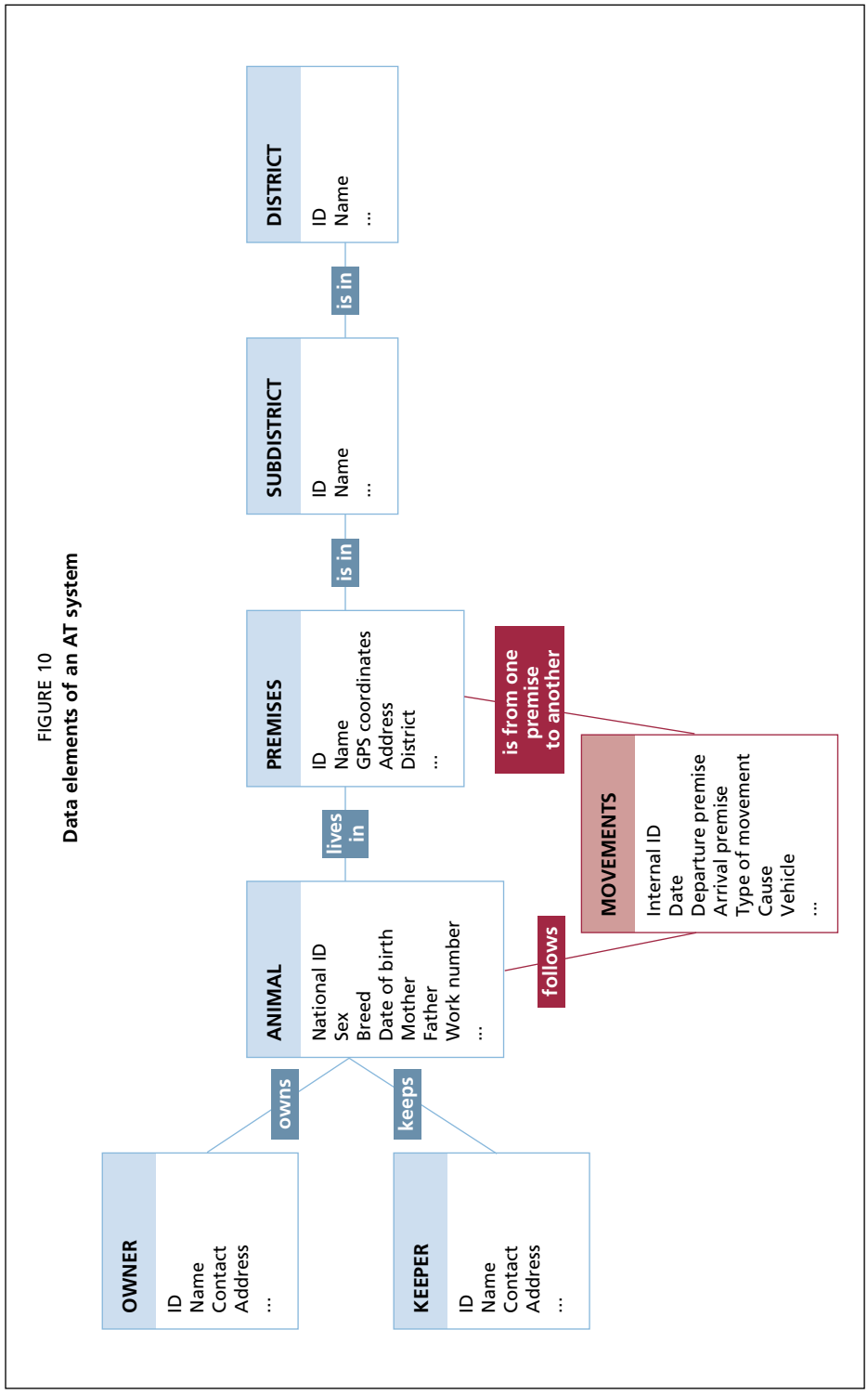


FIGURE 10
Data elements of an AT system

be time-consuming and may prevent a timely response if a disease risk is detected. In the case of chronic animal diseases that are not zoonotic, a delay in response pending the availability of movement-tracking results may be acceptable. However, a computer-based AT system capable of capturing and mapping all recorded data elements and animal movements is required if the objective is to trace susceptible animals within 24 to 48 hours (e.g. when managing highly contagious diseases such as FMD or avian influenza). Box 5 summarizes the various systems for tracking movements between premises.

The type of identification system. Animals may be identified and traced individually or in groups (e.g. the herd or a group of animals from a specific geographical location such as a village). Such groups constitute an epidemiological unit.

For all AT systems, the amount of information that is centrally available and accessible depends upon the number and disaggregation of data elements concerning animals, premises, and owners and keepers. A minimum traceability system would require the identification of animals when they leave their premises (e.g. farm or village) and the recording of movements on paper. In such cases, the database may only store information on premises (locality, animal keeper and annual census) and indicate the relation between farms, rather than enabling full traceability of individual animals.

4. Tracing animal movement

Animal movement occurs when an animal leaves a premises and enters a new one. Several AT systems, especially for large ruminants, trace and control movements by issuing an individual movement ID card on which all animal movements are recorded. In the European Union, individual animal movement ID cards are mandatory for cattle, sheep and goats (Figure 11 provides an example of a cattle passport). An individual animal movement ID card must provide the minimum following information:

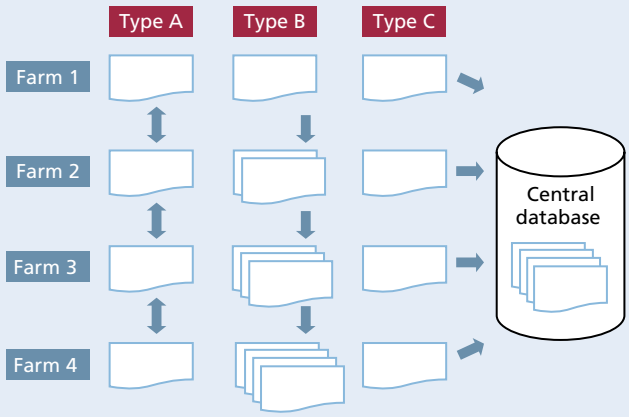
- animal ID;
- colour(s);
- sex;
- year or, if known, date of birth;
- location of birth (premises ID).

Additional information may be added depending on the objective. Examples include the sire ID, dam ID (important for tracing vertically transmitted diseases such as BSE), the health status and vaccination history of the animal, and information concerning treatments.

Whenever the animal is moved, movement details are recorded on the movement ID card. Data that must be recorded at the time of movement include the ID of the sending premises, the date of departure, the ID of the receiving premises and the date of arrival. Additional data can include the type of movement (e.g. leased in, leased out, sold, purchased, recovered from loss or theft, sent to slaughterhouse, exported or imported) and, if used, vehicle ID. In some countries, data regarding birth, on-site slaughter and death are also recorded (in a movement register), as identification, registration and traceability form part of a fully integrated system.

BOX 5

Tracking movements between various premises



Type A system

In this type of system, each link (premises) in the production chain receives relevant information from the preceding link, i.e. the premises from which the animal has been supplied. The amount of information communicated remains small. Each link has to trust the quantity and quality of the data transmitted by the previous link and must maintain a record of this information. Type A is used to ensure traceability in the food chain and enable businesses to identify at least the immediate supplier of the product in question and the subsequent recipient. With regard to animal identification and traceability, a movement permit or movement certificate are typically used to record movement from one farm to another. When an animal's movements have to be traced back, a special investigation is conducted to re-establish all links in the chain.

Type B system

In this type of system, each link receives relevant data about all previous links from the last one. Compared to the type A system, tracking and tracing is much faster in the event of an emergency. Each link in the chain receives all prior information, enabling control over completeness of data. A typical example of a Type B system is an animal passport, which remains with the animal through its lifetime and records all its movements, thus allowing these movements to be traced back when necessary.

Type C system

In this type of system, each link provides the relevant data to a central identification and traceability database, which accumulates information concerning all movements in the lifetime of the animal. Tracking and tracing can be carried out rapidly. The information system provides traceability information not only on the animal itself, but also on animals that came into contact with it.

Provided by Ferdinand Schmitt.

FIGURE 11
A sample cattle passport issued by the Government of the United Kingdom of Great Britain and Northern Ireland

A system based on an individual movement ID card is only feasible for larger animals (e.g. cattle and horses) and when identification and registration are based on individual animal identification. It is not practical when the number of individual animals and the speed of population renewal hamper the implementation of a comprehensive individual animal identification, as in the case of sheep and goats. In such cases, veterinary services often issue a group movement permission paper, which can be useful in the event of trace-back and trace-forward investigations.

A traceability system based on individual movement ID cards (animal passports) must specify the maximum period within which a movement card for newborn animals must be

issued (e.g. within one month of birth). Similarly, the system must stipulate the maximum period for recording a movement on the movement ID card (e.g. within three days of the movement). The movement ID card accompanies the animal throughout its life, and should be returned to the designated authority on the death, slaughter or exportation of the animal.

In the case of animal imports, the animal identification record from the exporting country should be stored in the database and linked to the animal identification record assigned in the importing country. Similarly, in the case of animal exports, the animal identification record from the exporting country should be provided to the veterinary authority in the importing country.

5. Control of animal movement

Animal movement control is essential to an animal traceability system. If controls and incentives are implemented, movement reporting will increase. Incentives (e.g. subsidies, drought season support) should benefit only herds that comply with all animal identification and traceability obligations. Controls should be performed at different places and stages, notably at the farm (to control death, theft and losses), during transportation (by road police) and at livestock markets and slaughterhouses. Only animals in compliance with regulations should pass controls and be accepted. Control in livestock markets can be improved by providing adequate infrastructure (e.g. a fence around the site and a single entrance) and ensuring the presence of a market operator, veterinary inspections or an authorized veterinarian.

The passage of animals through livestock markets brings large numbers of animals into contact with each other. In the event of a contagious disease outbreak, such contact threatens the entire population. Therefore, all livestock markets must be incorporated into the animal identification and traceability system, regardless of their official status. To avoid conflicts with existing legal veterinary provisions, non-official livestock markets must either be officially approved or closed within a reasonable time period; otherwise, the central database will not reflect the actual situation. However, this approach is not easy to implement, as official approval requires appropriate sanitary conditions. Moreover, strict controls may lead to the emergence of new informal markets elsewhere, preventing local administrations from levying market taxes. Instead, as a short-term solution, records from non-official markets may be entered into the system under the category "Other".

6. IT infrastructure

An AT system is effective only if it is supported by an integrated IT system that captures data and provides information to all stakeholders in the shortest possible time. Section VIII provides detailed guidelines on establishing an IT infrastructure and developing a software application for an integrated information system that covers all components of the animal recording system: animal identification and registration; animal traceability; animal health information; and performance recording.

The main resources required for the central infrastructure include: a database server to host data; a web server to host web-based applications; a data warehouse server to produce

specific reports; and high-speed connectivity. The structure of the IT network will depend on how the data are captured and generated, which can take one of the following forms:

- Information is collected on paper and entered into the database via desktop or laptop computers;
- Data are gathered in the field and entered via smartphones/personal digital assistants (PDAs) into a local database, which is synchronized periodically with the central database; or
- A combination of the above two forms are used, depending on the species and/or production system.

A suitable and user-friendly software application is necessary to capture, validate and retrieve data and reports through different platforms such as smartphones/PDAs, netbooks, tablets, laptops, desktops and so on. The installed application should support transmission of the required information to various users (e.g. governments, veterinary authorities, livestock producers, service-providing organizations, livestock markets and slaughterhouses) in various formats (e.g. print output, e-mail, PDF files, HTML pages, smartphone/PDA and mobile) and as various outputs (e.g. as alert messages, operational reports, review reports, graphs, analytical reports and statistical summary reports).

Section V
Animal health information

INTRODUCTION

The primary objective of any animal health information (AHI)[34] system is to collect, manage and systematically analyse data in order to generate appropriate information for various stakeholders along livestock food value chains. These data may be used to support the decision-making process in relation to diseases prevention, eradication or control, and may support the design, development and management of surveillance programmes.

A wide variety of disease drivers (e.g. increased intensification of livestock production, global trade, animal movement and climate change) are facilitating the emergence of new diseases and creating endemic problems. This poses new challenges for the prevention, control and eradication of animal diseases and makes the tasks of AHI systems more complex. Conversely, the evolution and availability of new technologies, such as mobile devices, bioinformatics and geographical information systems, have transformed the development of AHI systems into a dynamic process that is constantly renewed to meet these challenges and the changing needs of users.

This section describes a conceptual framework for AHI systems. The development and implementation of a strategic plan for building an AHI system is addressed in Part 3 of these guidelines, which describes how to put the conceptual framework into practice. The process for developing an AHI system is similar to that used for developing animal identification and registration, animal traceability or performance recording systems. For this reason, these processes are discussed together later in these guidelines.

OBJECTIVE

The objective of this section is to describe the elements of an AHI system and provide guidance on how they may be used and integrated with other relevant systems.

DEVELOPING THE CONCEPTUAL FRAMEWORK

1. Objectives of an animal health information system

AHI systems can be used to fulfil several different objectives; in particular, facilitating the identification and notification of animal diseases in accordance with legislation and the priorities of veterinary services. By collecting accurate data, AHI systems support the monitoring and management of emerging and endemic diseases and the development of disease prevention and control measures. This subsection addresses four key objectives of AHI systems:

[34] This acronym is used throughout this section only, to facilitate ease of reading.

Supporting official animal disease notification systems. These systems focus on collecting outbreak data for subsequent notification to other information systems, such as the OIE World Animal Health Information System (WAHIS), in line with international obligations.

Supporting the management of animal health emergency systems. These systems provide information that facilitates rapid intervention in the event of a disease outbreak. Examples of utilities provided by such systems include:

- enabling online queries to animal identification and registration and traceability systems to identify and retrieve data concerning connections between premises as a result of animal movements (see Figure 3);
- facilitating epidemiological inquiries (tracing-back and tracing-forward investigations) in cases of confirmed disease outbreaks;
- defining buffer (e.g. protection and surveillance) zones around outbreaks; and
- providing a list of premises within such zones using web-based geographical information system (GIS) tools.

Enhancing animal disease surveillance and early warning information systems. These systems combine data derived from:

- animal identification and registration systems;
- animal traceability systems;
- control and surveillance activities (e.g. vaccination data, herds or animals sampled, and laboratory testing results); and
- other relevant systems, such as those targeting the incidence of human cases of zoonoses or the use of antimicrobials in food-producing animals.

Surveillance and early warning information systems are essential tools for assessing the health status of animal populations; monitoring and improving existing surveillance activities; and supporting decision-makers in planning prevention, control or eradication strategies and framing zoning or compartmentalization policies. Another objective of surveillance systems is assessment of the genetic resistance of animal populations to certain diseases (e.g. related to genetic selection programmes against scrapie). Surveillance information systems may also be used to demonstrate the absence of specific diseases in order to acquire disease-free status, in accordance with the requirements of competent institutions.

Supporting risk assessment.[35] This involves the collection of a wide range of data to facilitate a number of key actions, including:

- quantifying disease prevalence and incidence;
- estimating the probability of spread of infection through the animal trade (disease import risk analysis) and other means (e.g. vector dissemination for vector-borne diseases);
- identifying the presence of risk factors (summer grazing on common pastures, use of potentially contaminated common feed, etc.); and

[35] For a definition of "risk assessment", please refer to the OIE *Terrestrial animal health code* (available at www.oie.int/index.php?id=169&L=0&htmfile=chapitre_1.2.1.htm)

- estimating the magnitude of possible consequences for animal or human (in the case of zoonoses) populations exposed to an infectious agent.

The above-mentioned objectives are not mutually exclusive and a certain degree of overlap may be observed in practice. One important component of any AHI system is the collection and maintenance of herd health management data, which may be used to benefit diseased animals, as well as the herd as a whole. Details of herd health management are covered under performance recording in Section VI of these guidelines.

The EMPRES Global Animal Disease Information System (EMPRES-i) is an example of an AHI system.[36] EMPRES-i is a web-based application that has been designed to support veterinary services and organizations by facilitating the collation, analysis and accessibility of animal disease information. It integrates several data layers, including livestock density and environmental variables from other FAO systems, such as the Global Livestock Production and Health Atlas (GLiPHA), and data on genetic characterization of pathogens, such as those deriving from the Openflu database.[37]

Although the Internet has revolutionized the data collection and dissemination process and reduced costs, gathering and analysing data still constitute a major expenditure for any AHI system. In addition, the growth in sophistication of AHI systems has increased the need for hardware and skilled labour, further boosting associated costs.

2. Inputs and deliverables of an animal health information system

This subsection describes the data input and information deliverables of an AHI system (see Figure 12).

2.1 Input data

Data on disease cases and outbreaks. The collection of data on the occurrence of animal diseases requires a clear and unambiguous "case definition" for each disease. The OIE *Terrestrial animal health code* provides case definitions for diseases relevant to international trade.[38] National legislation and regulations may also provide case definitions for many animal diseases, especially in relation to existing surveillance activities. Specific rules and diagnostic protocols have to be defined for case confirmations, taking into account the characteristics of the diagnostic tests.[39] In some cases, a correct case definition may be difficult to obtain, particularly for asymptomatic infections in animals (e.g. emergent diseases such as Influenza A infection in multiple species, Middle East respiratory syndrome or Crimea Congo haemorrhagic fever) or when wildlife is involved.

In addition, case definition may be determined by the objectives of the surveillance system. For example, with vector-borne zoonotic diseases (e.g. Rift Valley fever, West Nile or Japanese encephalitis), where the main aim is early detection of any circulating virus for

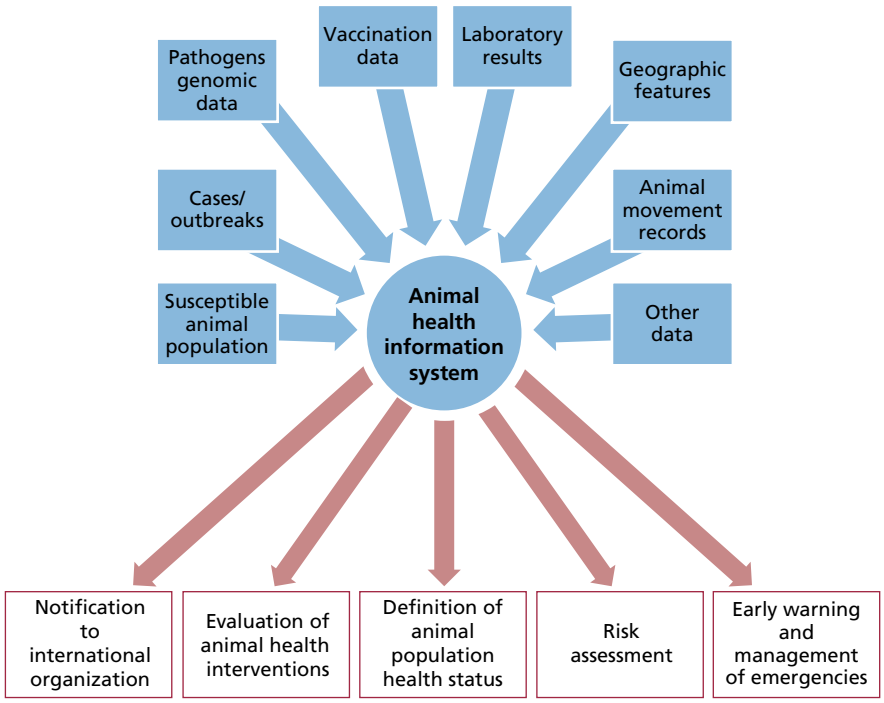
[36] See http://empres-i.fao.org/eipws3g/

[37] See http://openflu.vital-it.ch/about.php

[38] See www.oie.int/international-standard-setting/terrestrial-code/access-online/

[39] Consult the OIE *Manual of diagnostic tests and vaccines for terrestrial animals* for the characteristics of diagnostic tests and their use as confirmatory tests, especially for international trade purposes. See www.oie.int/international-standard-setting/terrestrial-manual/access-online/

FIGURE 12
Inputs and deliverables of an AHI system



prompt institution of public health protection measures, even the detection of viral genome by RT-PCR on mosquito pools may be included in the case definition.

For each suspected and confirmed case of disease the minimum data elements that must be collected are as follows:

- the disease in question (sometimes identification of the strain or subtype/serotype can be fundamental);
- the location of the disease outbreak (the ID code of premises involved, with related geographic coordinates);
- the species of animals affected (demographic data on infected premises);
- the time and date on which the disease first occurred (date of first clinical signs, date of first suspicion and date of confirmation);
- how the infection was detected and what initially raised suspicion;
- the control measures put in place to limit spread of the disease; and
- the results of epidemiological investigations to identify the origin of the infection and any other premises that may have been exposed.

In general, the geographic localization of an outbreak is demarcated by the affected epidemiology unit (farm, premises or village) where one or more cases of the disease have been confirmed. In practice, much of the data to be recorded in the event of an outbreak

may be available through an animal identification and registration system. Special situations can be identified. For example, the disease may be detected in a geographical location where animals are brought together from numerous locations (e.g. pastures or villages) or at the abattoir (e.g. contagious bovine pleuropneumonia or bovine tuberculosis). In such situations, an effective AT system and a well-established animal identification and registration system play a crucial role in identifying the premises where the animals originated and, thus, the source of the disease.

Data on susceptible animal populations. In order to identify susceptible animal populations, it is necessary to access data on the number of animals of susceptible species located in the proximity of outbreaks, within a certain radius of the outbreak area (e.g. in buffer zones) or that may otherwise have been exposed to the disease. These data are often retrievable from the animal identification and registration system. It is also important to gather data concerning the type of premises (e.g. breeding farms, fattening farms, collecting centres or animal markets), as well as data on animal densities in the areas of concern. An animal identification and registration system may provide information on animals and animal numbers subdivided by category (e.g. fattening versus breeding animals), allowing for more informed planning of control activities such as vaccination campaigns or monitoring programmes.

Data on animal movements. Data concerning the number of animals of susceptible species or other groups subject to movement may be retrieved from the animal traceability system. For practical purposes, these data are often represented in AHI systems in the form of movement networks, using the social network analysis method (Wasserman and Faust, 1994). Representing animal movement as a network of connections between premises has the advantage of promptly defining all possible infection routes in the event of an outbreak. In addition, the analysis of the animal movement network may highlight those premises that are at greatest risk of spreading infection (called "hubs" or "super spreaders") due to the number, intensity and complexity of their connections. The identification of potential "super spreaders" facilitates better planning of preventive measures, including more efficient resource allocation (see also Calistri *et al.*, 2013).

The retrieval and analysis of data on animal movements is important not only in the case of direct or indirect contact (e.g. FMD, peste des petits ruminants), but also for vector-borne diseases (e.g. Rift Valley fever) due to the possible spread of infection through the movement of viraemic animals. Systematic and timely recording of animal movement between premises is carried out by animal identification and registration and animal traceability systems.

Data on geographic features. The availability of detailed geographic data on roads, mountains, rivers, lakes and other barriers is important both for planning in-field interventions in health emergencies, and for risk assessment studies and surveillance purposes. Such data are of particular importance for vector-borne diseases when preventive action such as vaccination has to be put in place. In the context of vector-borne diseases, a range of other information, including climatic conditions (e.g. temperatures, humidity and rainfall) and environmental factors (e.g. wind patterns, soil texture, land use, vegetation cover and vegetation indexes) is useful for identifying zones more likely to be associated with disease spread or endemicity, thus facilitating the implementation of more targeted preventive action. Basic geographical layers showing the administrative subdivisions of a country (regions, provinces,

governorates, prefectures, departments, etc.) are normally available in the animal identification and registration system, together with the geographical coordinates of premises. If this is not the case, they must be incorporated into the AHI system, to support proper management of health emergencies. Data concerning geographic features complement those concerning the localization of farms and other places where animals are kept (e.g. pastures).

Laboratory results. The results of laboratory investigations are an essential part of any AHI system. Inclusion of these data requires the standardization of all information, including the type of laboratory methods used and the format of results (qualitative versus quantitative values and the definition of "negative" cases). Particular attention should be paid when applying the concept of "sample" (see Box 6). The inclusion of laboratory results could imply the development of an interface between the AHI system and one or more pre-existing laboratory information management systems (LIMS) where laboratory results are stored.

Genomics data. Genomics is a special area of laboratory testing. Today, the genomic characterization of pathogens is becoming increasingly relevant in the context of both animal health and food safety. The genomic characterization of pathogens may also be useful in investigating the origin of outbreaks and identifying spatial and temporal clusters of infection possibly linked to common risk factors or sources of infection. It is important to emphasize that while genomics data can provide additional material for epidemiological investigations, they cannot replace information retrieved from animal identification and registration and traceability systems. Such data are indispensable for tracing the source of an infection (based on the movement records of infected animals) and for identifying possible risk factors epidemiologically linked to the spread of a disease.

BOX 6

"Sample" definition

The World Organisation for Animal Health (OIE) *Manual of diagnostic tests and vaccines for terrestrial animals* defines a "sample" as the "material that is derived from a specimen and used for testing purposes".[1]

This definition may be sufficient for laboratory quality systems. However, it may not be sufficient for the epidemiological objectives of an AHI system, which require information on the health status of animals (both in cases of individual animals or groups of animals), premises or territories. Therefore, it must be possible to link data from each sample to its source of origin (an individual animal, a group of animals and/or premises). This may not be easy to achieve under certain conditions, for example in the case of pooled samples or when food or feed are tested. When an animal identification and registration system is implemented effectively, it can support sample management by linking the animals from which samples have been collected (e.g. barcode or ear tag or RFID) to the sample material itself (e.g. barcode of the unique tube).

[1] See www.oie.int/fileadmin/Home/eng/Health_standards/tahm/0.04_GLOSSARY.pdf

Vaccination data. Vaccination is one of the main control measures for many animal diseases. Therefore, the collection of data on vaccination activity may be essential for defining the health status of an animal population. The minimum data that should be recorded is the number of vaccinated animals within a given time period (year, month, week, etc.) and the epidemiological unit of concern (ideally each premises). Nonetheless, information on vaccination may not be sufficient to precisely quantify the proportion of the population immunized, particularly when booster doses are required. Theoretically, only the registration and identification of each individual animal that has been vaccinated would enable accurate calculation of the number of animals that have been correctly immunized. Mass vaccination activities enable veterinary services to enter a large number of premises and crosscheck the identification and movement records of each animal. There are also animal identification and recording schemes linked with specific vaccination programmes (e.g. FMD and brucellosis vaccinations).

Human cases. In the case of zoonoses, the efficacy of veterinary actions can be measured primarily on the basis of their impact on public health. The availability of updated human incidence data for specific zoonoses, including temporal and spatial distribution, is fundamental for evaluating existing control measures and developing new intervention strategies. Information on the demographics (age, gender and profession) of affected people is necessary in order to evaluate the required veterinary action properly. For example, in the case of brucellosis, the profession of a patient can indicate whether the source of infection is restricted to direct contact with infected animals during abortion or parturition (when the great majority of human cases are farmers or veterinarians) or whether a serious food contamination problem may exist.

Other data. Numerous other types of data may be included in an AHI system, depending on the overall objectives of the system. For example, data on the use of antimicrobials in food-producing animals or data on the type of feed used on the premises (e.g. for BSE or mycotoxin monitoring) may be added to the AHI system.

2.2 Deliverables of animal health information systems

Animal disease notification to international organizations. One of the main outcomes of an AHI system is the automatic production of data required by regional or international organizations for the purpose of disease notification. Each outbreak of a notifiable animal disease must be reported to the OIE-WAHIS. Specific sets of data are required by OIE for immediate notification, follow-up reports, and six-monthly and annual reports. The specific requirements of WAHIS and its dictionaries, as well as the glossary of the *Terrestrial animal health code*[40] (for the description of diseases, species, case, epidemiological unit, outbreak, slaughter/destruction, diagnostic and control methods, etc.), must be taken into consideration when developing an AHI system.

Managing and assessing the efficacy of animal health interventions. Data collected by an AHI system may be used to assess the efficacy of measures implemented by veterinary services. Comparison of actual figures (i.e. number of suspected, investigated and confirmed

[40] See www.oie.int/index.php?id=169&L=0&htmfile=glossaire.htm

cases, or the number of animals sampled, tested, slaughtered or vaccinated) with target figures allows for assessment of the efficacy of such measures and overall compliance. This approach also supports the revision of existing measures and the formulation of proposals for additional interventions. This information is also useful for performing cost–benefit and cost–effectiveness analyses of actions. Periodic evaluation of veterinary actions is essential for reviewing and modifying such actions.

Definition of animal population health status. An AHI system should be capable of producing indices and other outputs that assess the health status of the animal population within a country or specific territories. Prevalence and incidence values are essential to quantify the frequency of animal infection (and/or disease, according to the case definition). Case-fatality, mortality, abortion rates and reproductive indices are also useful tools for assessing the impact of diseases. Each of these measurements must be spatially and temporally characterized to highlight possible geographical clusters or specific temporal trends. Further outputs, such as the proportion of vaccinated or (estimated) immunized animals, may be of importance in correctly defining the health status of the population. Changes in the health status of the animal population may also indicate the efficacy or impact of veterinary actions, in terms of variation in disease occurrence and/or consequences.

When the objective of the AHI system is to support a "free status" request for a country or a zone, the system outputs must adhere strictly to the criteria used to declare the free status for that specific disease. The AHI system must provide all necessary data to fulfil the criteria, including the performances (i.e. sensitivity and specificity) of diagnostic tests employed.

Early warning and management of emergencies. One of the most valuable deliverables of an AHI system is the ability to generate accurate disease information quickly, which may then be used to alert veterinary and/or public (in the case of zoonoses) health systems and networks, enabling them to take immediate action to prevent and/or control the spread of disease. The implementation of an early warning surveillance system that enables accurately targeted surveillance actions to detect initial outbreaks requires a thorough knowledge of the epidemiology of the disease in question. The existence of an animal disease notification system able to react quickly to any indication of disease is a fundamental prerequisite for any early warning system. Furthermore, an effective early warning system should be able to integrate data coming from active and from passive surveillance actions. In this context, the rapid collection and prompt analysis of laboratory results deriving from active surveillance activities, or related to routine diagnoses of syndromic disorders, are of vital importance in the early detection of emerging health problems. The periodical analysis of mortality and reproductive data recorded in the animal identification and registration system may also be of great help in facilitating early detection of possible health emergencies.

In addition, the AHI system should be able to provide information rapidly to support and guide interventions in the event of a disease outbreak. This includes making available utilities to animal health authorities and other relevant institutions such as online queries for retrieving and identifying connections between premises due to animal movements, facilitating epidemiological inquiries (e.g. tracing-back and tracing-forward investigations), defining buffer zones (e.g. protection and surveillance) around outbreaks and providing a list of premises within such zones.

Risk assessment studies. Data collected by AHI systems also act as inputs for routine risk assessment activities. In particular, data concerning the frequency of animal infection and the results of epidemiological investigations (including surveillance activities) can be used to assess the probability of disease incursion and spread, the magnitude of possible consequences and the relative contribution of different risk factors. The need to generate data and information to support risk assessment should, therefore, be borne in mind when developing an AHI system.

3. Elements of an animal health information system

An AHI system should contain the following elements:

3.1 Data gathering

Most systems are based on the use of reporting forms to record and transmit data to local or national centres for collation via paper, mobile devices, e-mails or the internet.

Data are collected using specific reporting forms. A simple reporting form can include:

- geographical information related to location (latitude/longitude) of premises and/or epidemiological units, and delimitations of administrative units, if these do not exist in the premises register (see Section III, Subsection 1);
- temporal information related to the time at which the information was recorded, and at which any health-related activities (e.g. administration of vaccinations) took place;
- epidemiological information on the species, farming system, number of animals at risk, cases, deaths, etc.;
- laboratory information, including samples, species, date of collection and date of results; and
- action and control measures taken.

3.2 Data storage and manipulation

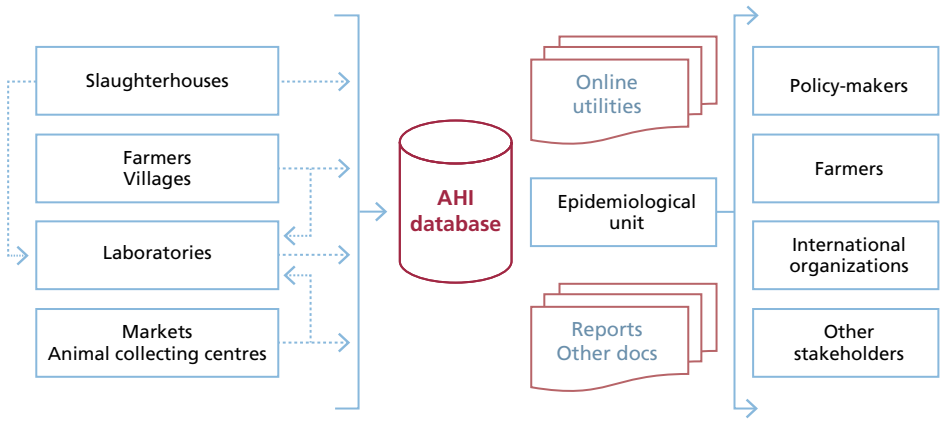
AHI systems should be able to handle a large amount of data and information. Paper-based systems are often inefficient and severely limited in the volume of information they can process. Computerized systems based on database management systems are more efficient, and are recommended, even for use in developing countries, due to their ability to store and effectively manage large amounts of data for processing.

3.3 Data flow and analysis

Veterinarians, technicians, farmers and other stakeholders, working on farms or at slaughterhouses, abattoirs or laboratories may all produce in-field data. This makes data flow a critical aspect of AHI systems. The restricted access of specific users to sensitive data needs to be taken into account when establishing the flow of disease data in an AHI system. Disease data need to be recorded and integrated following a logical sequence of steps leading up to validation and integration in the database prior to dissemination (see Figure 13).

Data analysis is required to convert data into information, which is then used to assist animal health decision-making. Data analysis may range from the simple calculation of totals and rates (e.g. mortality, incidence and prevalence) to the determination

FIGURE 13
Main data flow in an AHI system



of complicated statistical associations and the use of epidemiological risk models to predict the outcomes of interventions. The latter will need to be done by skilled epidemiologists.

3.4 Outputs/reporting

Once data have been analysed, the results must be made available to those involved in decision-making. The information has value at many different levels. Potential users include livestock owners, owner groups and cooperatives, as well as industry bodies, private veterinary services, agricultural product manufacturers, legislators, university and research organizations, trading partners, regional or international organizations, and local, provincial and national government veterinary authorities. Information dissemination can follow different channels and formats. Traditionally, periodical reports describing the results of data analyses are used to illustrate the main outcomes to policy-makers, other stakeholders and the general public. Today, data dissemination occurs increasingly via online utilities; for example, based on web-GIS solutions or interactive online reporting and charting systems.

4. Key considerations for the development of an animal health information system

A well-designed, functional AHI system should be based on clear rules and procedures. These must specify the responsibilities and duties of the different institutions and actors (public and private) involved, in order to establish an effective and efficient data quality verification system. As a general rule, those who generate the data should be responsible for their validation (as these stakeholders will possess all the necessary information to undertake the validation). The organizational structure of the institutions involved must be respected when data flows (inputs and outputs) are developed. Particular attention should be paid to these matters in cases where the information system has to collect and manage

data deriving from several competent authorities. It is crucial to ensure that the system respects data ownership and confidentiality, and that all data are stored securely.

In many countries, the execution of preventive actions (e.g. vaccination) is often assigned to private veterinarians or community animal health workers. As such, they play a crucial role in disease detection. To improve their ability to recognize clinical signs of disease, these veterinary practitioners should receive training and be targeted by communication campaigns.

Abattoirs and animal markets may also enter relevant epidemiological data into AHI systems. In many instances, these premises represent the sole feasible sampling point for monitoring programmes. Likewise, in some countries, laboratories represent the main centre for data collection and storage. Accordingly, LIMS function as a primary source of data for any AHI system. This is especially relevant when a widespread informatics infrastructure is not in place.

Careful integration of animal health information systems is also essential to avoid multiple entries of the same data. This involves standardizing both data and procedures, and requires significant effort. With regard to standardization and the establishment of common dictionaries, it is also necessary to implement a common coding system (to track the source and type of data). This represents a significant challenge for any institution. The complexity of these systems and the need for practicable, flexible and easy-to-use tools, poses particular difficulties for developers. A collaborative approach involving management experts and veterinary professionals is, therefore, crucial.

For the above-mentioned reasons, it is advisable to adopt a progressive and incremental approach when developing an AHI system, starting with the basic functionalities (e.g. notification and registration of disease cases) and progressively adding new ones. An AHI system should be integrated gradually with other existing systems (e.g. integration with a LIMS could start with the exchange of simple data files). The integration of two or more pre-existing information systems developed for different purposes requires complex analysis of the data generation process and revision of data management procedures.

Section VI
Performance recording

INTRODUCTION

The FAO *Secondary guidelines for development of national farm animal genetic resources management plans – animal recording for medium input production environment* (FAO, 1998) – referred to in this section as the FAO secondary guidelines – provide a detailed description of the benefits and beneficiaries of performance recording (PR),[41] and of the planning and conduct of PR schemes. The secondary guidelines provide stepwise and detailed guidance on the institutional and operational organization of such schemes, and the utilization of information resulting from their use. In particular, they focus on medium-input production systems.

The purpose of this section is to provide a conceptual framework for PR. It addresses key questions such as what to measure, how to measure, how to process data and how to use the results. It does not repeat details covered in the FAO secondary guidelines; instead, it addresses PR in the more general context of national animal recording, highlighting the linkages between performance recording, animal identification and registration, animal traceability and animal health information (see Figure 3).

A strategic plan for building and implementing a PR system is presented in Part 3 of these guidelines, which describes how to put the conceptual framework into practice. The process for developing a PR system is similar to that used for animal identification and registration, animal traceability and animal health information systems.

While delineating the conceptual framework, this section reviews the multiple objectives of PR, describes the different types and elements of PR systems, and specifies the data to be collected or provided in each case. Examples, based mainly on dairy recording, are given as illustrations.

OBJECTIVES

The objective of this section is to highlight the potential uses and main elements of a PR system, the potential linkages with animal identification and registration, animal traceability and animal health information systems, and key considerations when implementing a PR system. This includes giving consideration to the process of integrating a PR system into existing animal recording components, with a particular focus on national animal identification and recording systems.

DEVELOPING THE CONCEPTUAL FRAMEWORK

Performance recording involves the objective and systematic measurement of various indicators of animal performance. Data such as animal physical characteristics, parentage and relevant events may also be collected. All data are recorded, securely stored and processed

[41] This acronym is used throughout this section only, to facilitate ease of reading.

TABLE 2
Potential stakeholders in PR systems

Stakeholders	Cattle and buffalo		Sheep and goats			Poultry	Pigs
	Dairy	Beef	Dairy	Meat	Fibre		
Producers	X	X	X	X	X	X	X
Artificial insemination service providers	X	X					
Breeding companies	X	X	X	X	X	X	X
Milk-testing laboratories	X		X				
Breed associations	X	X	X	X	X		
Feed suppliers	X	X	X	X	X	X	X
Feed-testing laboratories	X	X	X	X	X	X	X
Provincial health authorities	X	X	X	X	X	X	X
Disease-testing laboratories	X	X	X	X	X	X	X
Private veterinarians	X	X	X	X	X	X	X
Farm consultants	X	X	X	X	X	X	X
Processors	Milk processors	Slaughter houses	Slaughter houses	Slaughter houses	Slaughter houses/ wool companies	Slaughter houses/egg-processing plants	Slaughter houses
Policy-makers	X	X	X	X	X	X	X

for use by various stakeholders to support decision-making, according to their objectives. The stakeholders and their needs, as well as the objectives and scope of the PR system, are described as follows.

1. Potential stakeholders and their needs

The primary stakeholders in any PR system are the producers. However, many others potentially benefit from the PR system (see Table 2). Stakeholders have specific information needs in terms of both frequency and content.

2. Objectives of a PR system

Performance recording serves a variety of purposes. It helps to build a knowledge base, such as baseline animal performance levels, best production practices and best breeding strategies. The main purposes of PR are described in Section I and are summarized here:

- **Establishment of baseline animal performance levels.** In any country, it is necessary to know the productive capacity of the main livestock types and breeds in each

major production system and ecological zone. This information, along with other statistics related to number and distribution of animals and holdings, is required for planning and investment decisions.

- **Evaluation of production system alternatives.** In cases where production efficiency and outputs do not conform to the optimum norms or baselines, PR can support the investigation and establishment of management alternatives. For example, it can be used to compare specific feeding strategies, health care options, germplasm sources, housing alternatives or other management variables.
- **Individual animal management.** PR can provide farmers with the necessary information to make decisions and take action to improve the productivity and health of their animals, enhance the quality of their products and increase the overall profit of their farm operations.
- **Genetic improvement.** Data collected through a PR system is used by breeders (farmers) and breeding organizations, governmental institutions and other agencies for the evaluation and selection of replacement stock (young animals) as future parents and the achievement of genetic progress in the target population.

3. Scope of a PR system

The scope defines the level of coverage of a PR system. This involves several factors, including:

- **Species.** Farmers keep a variety of livestock species (cattle, buffaloes, sheep, goats, poultry, pigs, etc.); however, in most countries PR systems have been implemented just for cattle.
- **Traits.** Many economically important traits can be included in a PR system. Table 4 classifies these traits into three categories: essential, desirable and additional.
- **Spread.** The geographical area to be covered by the PR system may encompass the whole country, a province, a region or a group of farms.
- **Production systems.** This comprises the type of herds (small, medium or large) and production systems (intensive, extensive or livestock–crop mixed faming) to be included.
- **Coverage.** The PR system may be restricted to farms or may include other institutions such as laboratories (feed testing, milk component analysis, disease testing, etc.), slaughterhouses and processing plants.

The choice of option will depend on the objectives and the available resources (infrastructure, financial and human), as well as on the involvement of the farmer in the decision-making process.

4. Types of PR systems

In accordance with the above-listed objectives, the FAO secondary guidelines defined four broad types of PR system:

- PR systems to establish baseline animal performance levels;
- PR systems to compare specific production system alternatives;
- PR systems for individual animal management; and
- PR systems for genetic improvement.

Table 3 summarizes the main features of these types of PR systems. The common goal of all these systems is to facilitate better understanding and control of the production process in order to increase production, enhance efficiency and sustainability of resource use, and identify opportunities to improve management. However, these systems differ with regard to their beneficiaries, and structural and organizational requirements.

The first two types of PR system listed above are essentially field survey or research activities designed to address specific questions over limited periods of time. They record information on an appropriate sample of animals, and their costs are usually covered by public funds. The two latter types represent continuous activities (lasting at least several production cycles or animal generations) that seek to utilize objective performance data at the individual animal level. Their costs are usually borne by the farmers, but public support is also required, at least in the initial phase.

A PR system designed for genetic improvement has much in common with a PR system for animal management, but there are a few key differences. First, the former focuses upon the breed as a whole, whereas the latter focuses upon the individual herd. Second, the former includes pedigree information on each recorded animal, which must be sustained over time (several animal generations). In both cases, records must be maintained in a consistently rigorous manner.

This section focuses only on PR systems for individual animal management and genetic improvement.

5. Elements of PR systems

Figure 14 shows that information recorded in an animal identification and registration system (e.g. animal, farm, keeper and owner information) will automatically be utilized by any PR system. Similarly, events such as animal movements and treatments, which are recorded in animal traceability and animal health information systems, will also be used. Animal identification and registration, animal traceability and animal health information systems are described in detail in Sections III, IV and V of these guidelines, respectively, and are mentioned briefly in this section.

A PR system can exist as an independent system. However, it functions better when part of a national comprehensive animal recording system (see Figure 3). As the different components share information (see Figure 15), this reduces duplication and results in lower incremental costs. Information need be collected only once at the animal, herd and/or farm levels.

5.1 Animal identification

As indicated earlier in this section, animal identification is necessary for most types of PR systems. However, the choice of identification method (i.e. group or individual identification), identification device and duration (i.e. temporary or permanent) depends on the specific objectives of the system. It is also necessary to relate the recorded animal to its premises (farm) in order to link performance to the environment where the animal is raised; hence, the linkage with the animal identification and registration system.

TABLE 3
Types of PR systems and their general characteristics

Characteristic	PR systems to establish baseline performance	PR systems to compare production alternatives	PR systems for animal management	PR systems for genetic improvement
Primary uses	Identifying development opportunities and challenges; helping improve strategic planning	Identifying best management practices; farmer education	Improving day-to-day farm management; farmer education	Identifying best breeding animals; improving farmer organizations; farmer education
Main beneficiaries	Government and the nation as a whole	All farmers; consumers	Participating farmers; consumers; rural communities	Participating farmers; commercial farmers; consumers; rural communities
Participants	A broad sample of farmers	A few carefully selected farmers	Initially a few farmers, with numbers to increase progressively	A number of farmers (breeders); eventually, farmers not participating in the programme may be involved in estimating the genetic gain realized in the base population
Duration	Short-term (1–5 years)	Usually a single production cycle	Continuous, across multiple production cycles	Continuous, across animal generations
Who takes the measurements?	Technical staff/field technicians	Farmers, technical staff/field technicians	Farmers, technical staff/field technicians	Farmers, technical staff/field technicians
Animal identification	None or temporary	Temporary individual or group animal identification, usually for a single production cycle	Permanent individual animal identification	Permanent individual animal identification; pedigree information
Traits to be measured	Many simple measures	Measures of animal response to production alternatives	Measured traits associated with individual animal productivity and economic return	Easily measured traits associated with the breeding goal
Data analyses	Summaries of averages and measures of variability	Appropriate comparative statistical analyses	Easily interpreted individual animal and herd summaries; benchmarking; provision of assistance and advice to interpret the results	Prediction of genetic merit; individual animal summaries; provision of assistance and advice to interpret the results

Source: adapted from FAO, 1998.

FIGURE 14
Elements of a PR system

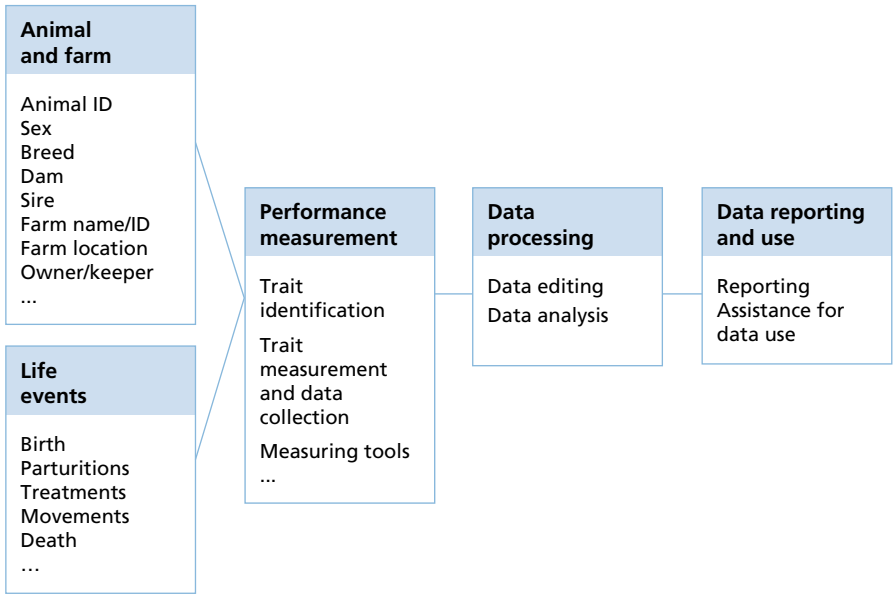
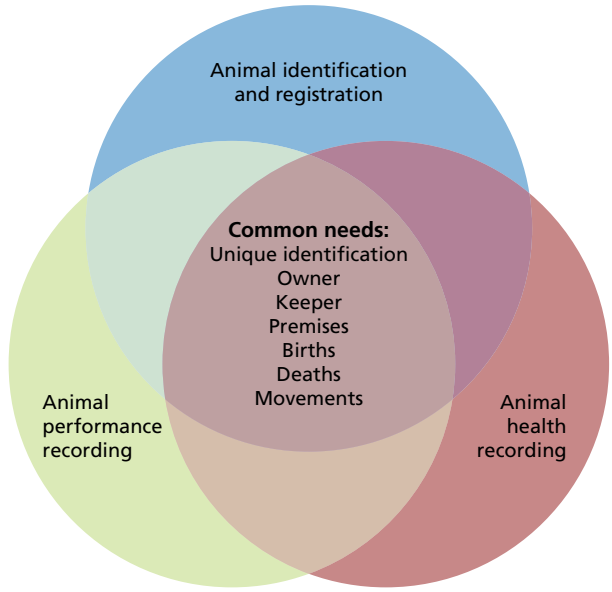


FIGURE 15
Sharing of information within an animal recording system



5.2 Performance measurement

In order to measure performance, it is necessary to define and identify the traits to be measured, specify the measurement and collection procedures, and select the appropriate measuring tools.

Trait identification

When selecting traits, it is important to choose those that support the objectives of the PR system and that can feasibly be measured on the farm. In many cases, important traits cannot be measured with ease. For example, resistance to infectious diseases can only be measured directly by exposing the animals to the disease, which is neither desirable nor possible in field conditions. In such cases, it is necessary to use correlated or indicator traits that are relatively easy and inexpensive to measure, and provide information on the traits of interest. Table 4 presents a list of measurable traits and other important information to be collected by a PR system.

Life history data that define the critical events in an animal's productive life are important for all types of PR systems. Such data are generally temporal in nature, such as dates of birth, weaning, mating, parturitions, sale, medical treatments, end of lactation and death. Measurement of these data often cannot be scheduled and must, therefore, be recorded by farmers as the events occur. If the PR system is integrated with an animal identification and registration system, much of this data can be retrieved from the latter.

The production levels of animal products (milk, meat, eggs, fibre) are an important component of overall animal value, although they are not necessarily the only important component in low to medium-input production systems. The levels of milk production at various points during lactation and the duration of lactation are the main indicators of dairy production. Body size is an indicator of meat production. Measures of body size may be taken at weaning and at marketing time. Body size at weaning provides information on both the growth potential of the offspring and the mothering ability of the dam. In low-input smallholder production systems, there is often a tendency to sell the largest individuals among animals of the same age, as they fetch a higher price, and to keep smaller ones for replacement, leading to negative selection on this trait.

Definition of quality traits must be made in relation to current and potential market requirements. Measuring quality traits is appropriate only if it leads to increased product prices or if the trait is an indicator of other important economic traits (e.g. lean animals usually have higher feed conversion efficiency).

Occurrence of disease and the need for health care can have a significant impact on animal productivity and profitability. It is, therefore, desirable to identify animals that require higher-than-normal levels of health care. This is easy to achieve in dairy production, where animals are handled and observed daily, but nearly impossible when the animals are not handled or observed regularly (e.g. in beef ranches).

Adaptation, while difficult to define, is a critical characteristic in many production systems. Adaptation is not a single trait; rather, it involves different sets of characteristics in each production environment. Therefore, measurement of adaptation must first involve identification of the most important animal stressors, including diseases, climatic conditions, endo and ectoparasites, dietary deficiencies, and seasonal feed and water shortages.

TABLE 4
A (non-exhaustive) list of measurable traits

Species or production system	Traits and properties to be recorded		
	Essential	**Desirable**	**Additional**
All systems and species **(Basis for all other production systems to follow)**	• Unique identification • Sex • Owner • Keeper • Treatment group • Culling and death • Birth date (at least estimated)	• Breed • Premises • Birth date (exact) • Dam • Sire • Birth status (single, twin, etc.) • Wean status (raised as single, twin) • Calving/lambing ease • Culling reason • Pregnancy diagnosis • Mating information (AI/natural)	• Functional (linear) traits and body measurements • Body condition (scores) • Sickness diagnoses • Fertility tests and diagnoses • Health treatment • Vaccinations • Parasite counts or scores • Parasite impact indicators (e.g. FAMACHA scores) • Recorder (technician/farmer) • Inseminator • Diagnostic and analysis laboratory • Feed intake
Dairy production • Cattle • Buffalo • Dairy goats • Dairy sheep	• Test-day milk yield • Dry-off date	• Fat percentage • Protein percentage • Somatic cells per ml • Milking times/intervals	• Milk urea nitrogen • Lactose percentage • Mastitis diagnosis • Locomotion • Body weights (calves and production animals) • Metabolic disorders • Temperament and likability • Milking speed/ease of milking • Individual or group feed intake
Meat production (ruminants) • Cattle • Sheep • Goats	• Weight at weaning • Weaning date	• Birth weight or girth circumference measure • Post-weaning weights • Dam weight at weaning of calf • Pre-slaughter weight • Scrotum circumference	• Pre-weaning weight • Dam weight after calf birth • Post-weaning growth test weights • Body measurements • Shoulder/hip height, body length, pelvic dimensions, girth circumference • Individual feed intake • Real-time ultrasound • Muscle area, subcutaneous fat, marbling • Carcass and meat traits • Grading, dressing percentage, tenderness, retail meat yield

(Cont.)

Fibre production • Sheep • Goats	• Fleece weight (8–12 months growth)	• Fibre diameter • Staple length • Clean fleece weight (8–12 months growth) • Fibre strength • Body weight • Pleat score • Kemp and undesirable fibres	• Fibre diameter variation • Percentage of fibres over/under desirable diameters • Percentage of impurities • Colour • Percentage of modulated fibre
Pig meat production	• Litter size • Litter weight	• Individual piglet weight at weaning • Number of teats • Sow weight	• Individual piglet weight at birth • Body measurements • Real-time ultrasound scanning - Muscle depth, marbling, subcutaneous fat thickness • Carcass and meat properties - Dressing percentage, drip loss, marbling, muscle yield • Stress susceptibility
Poultry meat production	• Batch weight at slaughter, mortality and feed consumption	• Individual weight at slaughter • Age at slaughter	• Individual weight at hatch and at adult age • Body conformation • Individual feed consumption • Carcass (eviscerated) weight • Weight of breast and legs • Walking ability (or other leg problems)
Egg production	• Total egg mass, mortality and feed consumption	• Number of eggs per hen • Egg weight	• Age at first egg • Shell strength (breaking force weight or specific gravity) • Shell colour • Albumen and yolk weight • Fertility and hatchability

Variation in reproduction and production parameters usually serves as an indicator of adaptability to and suitability for these conditions. Poorly adapted animals do not produce, reproduce or survive well.

In some countries, it is important to measure manure production and/or suitability as draught animals, as these have a highly significant impact on the economic output of farms, especially in mixed crop–livestock production systems.

Trait measurement and data collection

The data elements for each trait and the detailed procedures for the measurement of each data element are described in the following paragraph. Data elements are the items that must be measured and/or recorded for the respective trait. For example, if the desired trait is "conception rate", data elements that must be recorded include:

- the ID code of the female to be inseminated;
- the date and time of insemination; and
- details of the sire whose semen is used, ideally including a record of the technician that carried out the insemination.

The procedure describes how each data element is to be recorded or measured. By way of example, Table 5 lists the key data elements and the organizations and persons who could be entrusted with collecting data for a PR system in the dairy sector. A similar exercise can be conducted for any other PR system.

ICAR establishes rules, standards and guidelines for measurement of different traits in various species. The latest ICAR guidelines on recording practices, published in 2012, provide guidance on these matters. The guidelines can be used as a reference document for defining detailed procedures for the measurement of data elements for each selected trait. As these guidelines are developed by technicians who run state-of-the-art recording systems, the data elements should be tailored to the needs and existing constraints of developing countries. This is because a PR system developed for high-input production systems may not be applicable to low and medium-input production systems.

Measurement tools

The measurement tools used in PR systems vary widely in complexity and sophistication. Simple procedures and equipment are always preferable to complex procedures and sophisticated equipment, provided they allow the goals of the PR activity to be achieved. To allow the PR system to operate successfully, it is crucial that measurement tools are used in a consistent manner. A few examples are given here:

- Dairy traits:
  - Smallholders who own only a few animals may hand-milk their animals with small vessels. In such cases, measurement of milk production will have to be performed volumetrically, possibly through appropriately calibrated jars (see Box 7) or digital weighing scales. Therefore, use of milking machines is likely not to be cost-effective.
  - In some countries, it is common for milk samples to be collected from a very large number of farmers for analysis at a central milk component laboratory. Because of the logistical issues involved, this type of procedure may not always be feasible.

TABLE 5
Data sources and persons collecting data for PR systems: the dairy sector

	Trait group	Traits	Data elements	Who collects the data		
				Large herds owned by educated producers	Smallholders and large herds owned by less-educated producers	
					Service providers	Data collectors
1	Fertility	• Conception rates • Number of inseminations per conception • Service period • Dry period • Inter-calving period • Ease of calving	• Date of inseminations • Date of calving • Calving ease	• Producers	• Artificial insemination service providers	• Artificial insemination technicians
2	Production	• Lactation yields	• Test-day yield	• Producers • Milk recorders of milk recording organization/ breeding companies/ breed associations	• Milk recording organizations • Breeding companies/ breed associations	• Milk recorders
3	Quality	• Milk components	• Fat percentage • Protein percentage • Lactose percentage • Somatic cell count • Milk urea nitrogen	• Producers • Milk component laboratory	• Milk analyses laboratory	• Milk recorders • Milk analyses laboratory staff
4	Body conformation	• Body condition scores	• Measurement and scoring of all linear traits	• Breed associations/ breeding companies	• Breed associations/ breeding companies	• Body type recorders
5	Health	• Herd health traits	• Udder health: - Mastitis • Reproductive disorders: - Retained placenta - Metritis - Cystic ovary • Digestive and metabolic disorders - Milk fever - Ketosis - Digestive ruminal, abomasal and intestinal disorders • Leg and foot disorders • Infectious and parasitic diseases	• Producers (in some cases) • Government, cooperatives or private veterinarians	• Government, cooperative or herd health service providers • Private veterinarians • Disease diagnostic laboratories	• Veterinarians • Other health workers

BOX 7

Standard operating procedures for milk recording in dairy cattle – an example from India

- A specific person should be assigned the task of milk recording.
- In the case of dispersed smallholders, a milk recorder should record about five animals per day.
- First records should be taken no earlier than 5 days and no later than 25 days after calving.
- Milk recording for an animal should be done once a month, at a fixed date (± five days), in the morning and the evening. If milking is also done in the afternoon, then three milk records should be taken.
- Milk recording should be carried out using a transparent calibrated plastic jar with a sensitivity of 100 cc or using an accurate calibrated weighing machine.
- After milk recording, a milk sample should be taken for milk component analysis.
- Each animal should be recorded monthly for milk volume and milk components, 11 consecutive times or until the animal becomes dry.
- The dry-off date should be recorded.
- If an animal's milk yield drops by 20 to 50 percent of the previous recording, depending on its level of production (this percentage being lower for higher producers), or if an animal is suffering from illness, the milk yield should not be recorded. In such cases, the reason for the decreased yield should be recorded and the milk recording should be reattempted after a period of at least five days.
- If an animal is only milked once, then only that single event should be recorded and the other fields of the form should be left blank.
- The milk recorder should record the details of the recorded yield on a milk-recording card shared with the farmer.
- The Standard Lactation Yield of the milk-recorded animal should be calculated using the Test Interval Method (A4) described in Section 2.1.5.1 of the *International agreement of recording practices*, published by ICAR.

Provided by Dr Kamlesh Trivedi.

Where this is the case, establishing a dispersed milk analysis laboratory network, comprising a few small milk analysis laboratories at strategic locations within the area of operation, may be an option.

- Meat traits:
  - For poultry, small ruminants and young pigs, body weights can be obtained using mobile weight-measuring sets (e.g. a tripod, spring balance and hanging canvas sling). For bigger animals (e.g. cattle, adult pigs), mobile weighing machines (e.g. mobile facilities with load bars) work well, but their use in dispersed smallholdings can be

limited by their relatively high cost. Other indirect methods of estimating body weight, based on body measurements, should be considered. These may include simple linear and volumetric tools, such as tapes for measuring animal size with associated weight conversion tables.

- Ultrasound equipment for recording body characteristics in live animals is widely used by the breeding industry. Their use in dispersed smallholdings may be limited for logistical and economic reasons. In such cases, simple indirect measures of body characteristics, such as body scoring and palpation, can be considered, provided that the technicians undertaking such tasks are well trained.

- Reproduction traits:
  - No tools are needed for measuring these types of traits. Records of dates, numbers of offspring, offspring survival and indications of reproductive events are the most important information.
- Disease traits:
  - Enzyme-linked immunosorbent assay (ELISA)-based methods to assess antibody (in non-vaccinated animals) or hormone titres or any diagnostic procedures that involve only collection of blood or a tissue sample could be considered.
  - Scores or counts can be used to quantify resistance to ticks. Laboratory-sourced egg counts in faeces can quantify internal parasite loads.

Data processing

While animal identification and traceability is a matter of capturing, storing and reporting data, performance recording consists, to a larger extent, of processing data, and requires specific technical competence in this field.

Data errors may arise from misinterpretation of measurements and recording procedures, improper training of farmers and/or technicians, or recording errors. Data editing (to identify erroneous or fabricated data) and validation is, therefore, a crucial step in data processing. Data editing should be conducted as soon as possible after the data is recorded. It should take place on the farm and in the data-processing centre, and should include checks for reasonableness and consistency of data.

Data processing is necessary to ensure the utility of the recorded data as a management and/or selection tool. Requirements for data processing can vary widely between PR schemes, depending on the type of traits being measured and the objectives of the PR system. Depending on the PR system, it can be performed locally by the farmer or field technician or centrally by a specialized team (as in the case of genetic improvement programmes). In all cases, data should be stored in a central database, and processed and shared with the users in a timely manner.

After adjustments have been made for differences in conditions (e.g. age of the animal, season, parity, age of the dam and sex adjustments for weaning weight in calves), the results derived from the recorded data enable comparisons to be made between animals or groups of animals.

To compare the genetic merit of animals, a methodology that describes the additive genetic differences between the animals in question is usually applied. Predictions are generally based

on recorded differences between animals within groups subjected to similar treatment and environmental conditions (called contemporary groups), on the (additive) genetic relationships among all animals, and taking the genetic parameters (heritabilities and genetic (co)variances of traits) into account.

Obstacles to defining contemporary groups in PR systems may arise, however, in the case of smallholder production systems. As smallholders that keep only one or two animals cannot have contemporaries within their herds, it is necessary to consider these animals in the context of a larger animal group. One way to solve this problem is to consider an entire village (or a neighbourhood within a village) as a herd or a contemporary group. As farmers within a village often follow common management practices, genetic linkages could be established between villages by using as many common sires as possible to produce progeny in these villages. This necessitates the development of appropriate procedures for estimating genetic merit under smallholder production situations.

Reporting and use

To encourage keepers to use the results of PR systems for their management decisions (e.g. feeding, selling animals, selecting replacements and organizing mating), results must be disseminated quickly, and in a form that meet their needs.

The information needs of a dairy farmer with a large herd are different from those of a farmer with only one or two animals, as the latter knows each of the animals in question. However, approaches such as sending text alerts to carry out specific activities for an individual animal, could prove useful for smallholders, who might be busy with other duties. Such messages could include:

- likely to come in heat in one or two days;
- to be examined for pregnancy diagnosis;
- to be dried off;
- likely to calve in one week;
- lactation production abnormal;
- has subclinical mastitis;
- due for FMD/haemorrhagic septicaemia/brucella vaccination; or
- due for deworming.

Moreover, a performance report produced for all producers within a village, providing comparative performance on certain economically important traits, may be more valuable than a report produced for an individual herd. Reports produced for farmers should be simple and action-oriented, taking into account their level of education. Farmers often require guidance on how to interpret and apply the results.

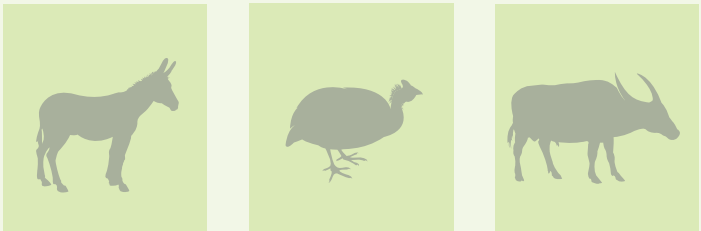
6. Considerations for the integration of PR systems

A PR system "generates" its own animal identification and registration to meet its own functional needs. Such an identification and registration system will, however, be limited to the animals recorded in the specific PR system; that is, to a species, production system, specific area (e.g. districts, provinces and states) or breed.

In the absence of a comprehensive and integrated national animal recording system, PR systems might develop independently, due to the interests of groups of keepers, breeders or regions. The absence of unique animal identification (as well as owner, keeper and premises identification) will restrict the joint evaluation of animals recorded in different systems. The challenge is to reconcile such independent PR systems with the overarching animal identification and recording system implemented on a countrywide basis.

PART 3

Putting the concept into practice



Section VII
Developing the strategic plan

INTRODUCTION

Section II describes an integrated multipurpose animal recording system composed of four components, namely: animal identification and registration; animal traceability; animal health information; and performance recording. Conceptual frameworks for these components are presented in Sections III, IV, V and VI, respectively. This section provides guidance on preparing a strategic plan for developing the integrated multipurpose animal recording system. Implementation of such a system is addressed in Section XI. A strategic plan is common to all animal recording system components, and specificities are given as needed. The user may decide to incorporate all or some of these components. However, animal identification and registration is a central component and provides data to all other components.

OBJECTIVE

The objective of this section is to provide guidance on how to develop a strategic plan for establishing an integrated multipurpose animal recording system, taking into account the specificities of its components.

TASKS AND ACTIONS FOR PREPARING THE STRATEGIC PLAN

To prepare a strategic plan to establish an integrated multipurpose animal recording system (hereafter referred to as an animal recording system), the following tasks need to be completed:

1. Conduct a study to assess the current situation in the country;
2. Identify the potential participating stakeholders and their needs; and
3. Draft the strategic plan to establish an animal recording system.

Task 1: Assess the current situation

Action 1: Assess the production systems and the value chain

To ascertain the feasibility of the animal recording system as a whole, or its individual components, it is necessary to conduct an assessment of the production systems by collecting information on:

- the number of herds and animals by species and breed, their geographical distribution, and past and future trends, if possible;
- the profiles of keepers and production systems by species and region or agroclimatic zone. Collected data may include: (i) literacy rates among keepers; (ii) herd size (categorized as small, medium or large); and, if possible, (iii) level of input (categorized as low, medium or high);
- the seasonality of births, grazing, slaughters and disease control measures. This information is useful for planning field activities; for example, determining the best period

for animal identification from the standpoint of animal health (e.g. to avoid infection after branding during the rainy season);

- the age of animals at slaughter and the number of times animals change owner before being slaughtered, the proportion of home slaughtering and the age of animals at home slaughtering (in some dairy systems, calves are home slaughtered at an early age and may not be identified);
- formal and informal animal marketing systems. If possible, map the market chains. Identify market actors (traders, operators, etc.) and collect information on market capacities and infrastructure (structures, fences, crushes, etc.) that may affect the implementation of a traceability system.
- the practice of transhumance and other migrations (e.g. for social reasons);
- the presence of private veterinarians or service providers, and their distribution; and
- the accessibility of veterinarians and other health workers or technicians, and their capacity to carry out additional animal recording services. In some countries and in low-input production zones, only government staff (e.g. livestock assistants, dip tank assistants or community animal health workers) are present and able to perform animal identification and recording activities.

Likewise, when assessing the importance of the livestock sector, the following factors should be taken into consideration:

- the livestock gross domestic product (GDP) as a proportion of overall agricultural GDP and, if possible, the contribution of the target species (or subsector) to the livestock GDP;
- food of animal origin as a proportion of the total food basket;
- the percentage of the pastoralist population in the country/territory;
- the number, size and distribution of livestock markets, slaughterhouses, dairy plants, exhibition sites and fairs;
- the level of current exports and/or potential for export;
- the level of current imports and the potential for import substitution (for countries that import a large part of their food products);
- the incidence of diseases and disease control measures likely to be improved by animal recording, in general, and animal health information and traceability systems, in particular;
- the presence of (or potential for) zoning (e.g. disease-free and commercial zones) and compartmentalization; and
- the existence of control systems, especially in countries where theft is a serious problem.

The above information will highlight various possible drivers for implementing an animal recording system. When exports are a major driver, the following tasks should also be undertaken:

- review existing policies on promoting the export of animals and animal products;
- compile a list of countries to which there are major exports of animals and animal products and their key import requirements;
- describe existing requirements and guidelines in importing countries regarding imports of animals and their products; and
- state the key requirements for obtaining a health certificate for exports and a licence for the importation of animals.

Action 2: Assess animal recording activities

Most developing countries have at least basic animal identification and recording practices, with traditional branding and marks often used to identify owners. Individual animal identification and recording systems may also exist, particularly in commercial dairy farms, government farms, feed lot operations and ranches. The temporary marking of animals when they are vaccinated is also a common practice in many countries. Information on such practices must be collected during the assessment study.

Similarly, the assessment study should identify existing schemes and programmes in which animal recording plays an important role, including the following:

- disease control and eradication programmes where animals are vaccinated;
- genetic improvement programmes where pedigree and individual animal performance records are maintained;
- productivity enhancement schemes (e.g. artificial insemination schemes) where data are maintained for individual animals; and
- subsidy schemes where livestock owners receive benefits based on the number of animals they own.

Additionally, insurance companies that insure animals and banks that extend loans for purchasing animals often have their own recording systems. It is, therefore, important to collect information on the scale and area of such operations. It is also important to verify the presence of firms that produce animal identification devices, both at regional and national levels, particularly in developing countries.

In countries where an animal recording system exists, the assessment should collect all relevant information, including the benefits realized, lessons learned, legislation adopted, institutions involved, costs incurred, funding strategies adopted, identification devices used, numbering system followed and information systems employed. Ideally, collection of this information should be supported by visits to areas where these activities are ongoing. A complete review of such systems should include an audit of the:

- IT system architecture and operation;
- software implemented;
- animal recording database;
- data capturing and management processes;
- field operations and inspections, particularly in the case of traceability and/or animal health information systems;
- organization of the responsible unit; and
- costs and sources of funding.

Action 3: Assess the institutional and legal frameworks

Assessment of the institutional and legal frameworks will focus on the institutional environment in which the animal recording system will operate, as well as existing policies and legislation related to livestock, in general, and animal recording, in particular. The assessment should include the strengths and weaknesses of institutions that may participate in the implementation of animal recording, including veterinary departments, livestock departments and extension service-providing organizations (e.g. private veterinarians, farmers' associations, breeding

organizations, performance recording organizations, meat boards, milk processors and livestock markets). It should also analyse the roles, functioning and capacities (in particular, the human resources) of such institutions.

In addition, the following should be examined:

- existing livestock and food-related legislation; in particular, legislation that may directly or indirectly affect animal identification, traceability and health;
- existing policies relating to livestock and livestock product subsidies, taxes, incentives, export promotion and import substitution; and
- existing policies related to the management of animal genetic resources, in general, and animal breeding, in particular (see also Section 10, Task 3).

Action 4: Assess the communication and information infrastructure

Information and communication channels include telephone and fax, postal services, countrywide or region-wide services (e.g. the veterinary service) and the internet. Existing channels should be identified and assessed in terms of their speed, reliability and costs. Mobile internet services (e.g. smartphones) are becoming more affordable and reliable.

Communication networks within the Ministry of Agriculture and its decentralized husbandry and veterinary services should also be assessed. It is worth noting, however, that in some countries the competent authority may be attached directly to the Prime Minister's Office. This is especially common in the case of food safety and related public health matters. A detailed description should be made, providing information on the network's architecture, accessibility (e.g. times when the servers are active), maintenance and replacement policies, and any system backups and security policies. In addition, the assessment should describe reporting procedures (if any) in place between potential partners and agencies that could support the implementation of the animal recording system.

Regional differences in telecommunication infrastructure should be assessed with a view to identifying locations with weak conditions. The assessment should describe the type of connectivity available, for example:

- full internet access (dial-up) and general packet radio service (GPRS);
- poor internet access (dial-up) and GPRS;
- no internet access (dial-up), but GPRS; or
- no internet access (dial-up) and no GPRS (or weak GPRS signal).

For each of these situations, a flexible approach can be developed. For example, data entry centres may be established at a regional level if data cannot be entered directly at source due to poor connectivity. However, IT is a dynamic sector and it is important to consider changes likely to happen in the near future and to plan accordingly. For example, the PDA, a handheld device considered the tool of choice for capturing, validating and storing limited data at source, became rapidly obsolete and was superseded by smartphones.

Task 2: Identify the stakeholders and their needs and roles

The assessment study should also identify stakeholders willing to participate in the animal recording system. Their participation will become compulsory in the case of mandatory animal identification and registration, traceability and/or animal health information

systems. The primary stakeholders in any animal recording system are the livestock owners or keepers responsible for the identification and registration of animals and the notification of events (e.g. birth, movement and disease occurrence). However, depending on the objectives and the animal recording system components, all or some of the following stakeholders may be included:

- livestock keepers or breeders and/or their associations;
- officers of animal health and production departments of the Ministry of Agriculture and/or Livestock and their decentralized offices;
- field veterinarians, livestock extension staff, artificial insemination service providers or authorized field agents;
- laboratory staff for testing disease, feed, milk, etc.;
- livestock market staff;
- hauliers/livestock traders;
- distributors and retailers; and
- abattoir and processing plant staff.

In addition, assessment of the literacy rate among keepers (see Task 1, Action 1) should be extended to some of the above-mentioned stakeholders; for example, market and processing plant staff.

After identifying the stakeholders that will implement or use the animal recording system, the next step is to ascertain their needs. These could include information and/or technical assistance. For example, large-herd owners/keepers may tag their animals themselves, but smallholders that keep only a few animals may refer this task to identification agents. Needs should be assessed through structured personal interviews and/or during a consultation workshop, which should also be used to assess the commitment of stakeholders to establishing an animal recording system in the country.

Task 3: Draft the strategic plan for establishing the animal recording system

The next step is to draft the strategic plan, based upon the information collected during the assessment study and discussions with the relevant stakeholders.

Action 1: Define the objectives and scope of the animal recording system

The objectives of the animal recording system should state in clear terms what it aims to achieve, who it intends to serve and what services it intends to offer. These objectives should align with national livestock development goals. It is necessary to discuss and agree upon these objectives with all relevant stakeholders, to ensure their willingness to participate in the development of the animal recording system and contribute to its costs. Lists of possible objectives for animal identification and registration, traceability, animal health information and performance recording systems are presented in Sections III, IV, V and VI, respectively.

The scope of the animal recording system depends upon the desired outcomes and the feasibility given the circumstances (e.g. cost, accessibility to services and responsiveness of livestock keepers). The scope should also be defined in terms of the species covered within a specific geographical area. Owing to constraints of time, available financial resources and

manageability, it may not be possible to implement a system that covers all species and geographical areas from the outset. Consequently, implementation of the system should be prioritized and subsequently expanded to cover other species and areas at a later stage. The following questions may prove useful in defining the scope of the animal recording system components:

- Should the animal identification and registration system include all livestock species or be restricted to particular species?
- Is individual identification necessary or can animals be identified by their herd or village?
- Are animals identified at birth or later in life (e.g. when they leave the community or establishment of origin)?
- Should different animal recording schemes be established for different species or different production systems?
- Should a traceability system cover the entire country or remain restricted to particular geographical zones (e.g. a FMD-free zone or a zone with commercial producers/ slaughterhouses accredited to export products)?
- Which stakeholders should be included (e.g. keepers' associations, livestock markets, slaughterhouses, product distributors and retail markets)?
- What are the priority traits for performance recording?

Answering the above questions will help to define the breadth, depth and precision of the planned animal traceability system. "Breadth" refers to the quantity of information maintained in the system for each animal. "Depth" refers to the extent of the production or supply chain covered (e.g. birth to death, meat traceability after slaughter). "Precision" refers to the level of detail stored (e.g. whether the system supports individual animal identification or less precise group identification).

Action 2: Select the type of animal recording system and define its elements

Because of their specificities, the type of system to be introduced and its respective elements are described separately for each component of the animal recording system.

Animal identification and registration. There are two types of animal identification: individual and group identification. The decision concerning which one to use should be based on the objectives and a cost–benefit analysis (see a simulation in Section IX). Once this decision has been made, it is necessary to decide upon the identification code and appropriate identification method, using the recommendations provided in Section III of these guidelines.

Animal identification and registration refers not only to identification and registration of animals, but also to identification and registration of keepers and owners, and premises. The latter is defined as a geographical location where animals are kept on a temporary or permanent basis. Premises, owners and keepers, and animals should have respective registers in the database. It is necessary to define the specific data that these registers should contain (see Section III, Figures 4, 5 and 8).

Animal traceability. Animal traceability systems, addressed in detail in Section IV, Subsection 3 of these guidelines, may be categorized according to: (i) the extent of the value chain covered; (ii) the type of data management system (paper or computer based, or both); and (iii) the type of identification system (animals may be identified and traced

individually or in groups). A decision must be reached on the type of traceability system to be implemented, taking into account the objectives and scope defined above.

As explained in Section IV of these guidelines, an animal identification and registration system is a prerequisite of a functional animal traceability system. Therefore, the elements that comprise the animal identification and registration system constitute an integral part of an animal traceability system. Other key elements of such a system include animal movement and sanitary information; the latter is normally provided by the animal health information system. It is necessary, therefore, to decide how to integrate these elements into the animal traceability system.

Animal health information. Section V describes animal health information systems with four main purposes: animal disease notification, animal health emergencies, animal disease surveillance and early warning, and risk assessment. These are not mutually exclusive; a certain degree of overlap may be observed between them in practice. It is necessary to select the type of animal health information system based upon the objectives and scope defined above.

The key elements of an animal health information system are defined in terms of data gathering, data storage and manipulation, data analysis and reporting. Subsection 3.3 of Section V describes these elements in detail. It is important to adapt these elements to suit the specific circumstances of the country in which they are being implemented.

Performance recording. Section VI defines performance recording systems that address the objectives of establishing baseline animal performance levels, comparing specific production system alternatives, supporting individual animal management and enabling genetic improvement. The main features of these systems are summarized in Section VI (Table 3). These systems have a common goal: to understand and control the production process in order to increase production, enhance efficiency and sustainability of resource use, and identify opportunities to improve management. However, they differ with regard to the beneficiaries, and structural and organizational requirements. A decision must be reached regarding the type of performance recording system to be implemented, taking into account the objectives and scope defined above.

The key elements of a performance recording system are animal identification and registration, performance measurement, data processing, and data reporting and use. A key aspect of performance measurement is identification of the traits to be measured. The following questions can help in this regard:

- What biological traits should be improved to move toward the set objective?
- Which of these traits can be measured directly on the farm, and which cannot?
- For those traits that cannot be measured directly, are there alternative traits that provide indirect information? If so, how can they be measured?
- On what basis are the relationships between the indicator traits and the traits of interest determined? For example, is the correlation between both traits estimated?
- What equipment, technical skills, infrastructure, etc., are needed to enable cost-effective recording of these traits?

Subsection 5 of Section VI describes in detail the elements of a performance recording system. As with animal traceability and animal health information, many of the data elements

can be provided by the animal identification and registration system. These elements must be adapted to the unique circumstances of each country, and must be integrated accordingly.

Action 3: Define the rules and procedures for animal recording

Before the development and implementation phase begins, all stakeholders must agree on the rules and procedures. Each of the animal recording system components is addressed separately as follows.

Animal identification and registration. Standard operating procedures should be developed for identifying and registering premises, keepers and owners, and animals. These procedures should be based on the conceptual framework described in Section III of these guidelines, while taking into account what is feasible in a given situation. For example, standard operating procedures must:

- provide a clear definition of a premises in situations where animals belonging to different owners routinely mix;
- prescribe whether a single tag or two tags must be used for individual animal identification;
- define the procedure for retagging an animal when a tag is lost;
- prescribe the numbering system to be followed;
- specify the data to be collected at the time of registering premises, keepers and owners, and animals; and
- set out rules for data entry.

Animal traceability. In addition to rules and procedures for identification and registration, it is necessary to establish rules concerning animal movement. For example, it is necessary to establish a definition for "movement", which may include events such as death, loss and theft, especially when animals are identified individually.

It is also necessary to specify which data should be registered on the animal movement ID card when issued, and which data must be recorded following movement of the animal. Section IV details the range of such data. In addition, it is important to specify the period during which a newborn animal should be issued with its movement ID card and the maximum allowable period for recording a movement on the card in the event of the animal being moved. The rules and procedures for issuing a new animal movement ID card and for returning the movement ID card to the designated authority on an animal's death or slaughter should also be clearly specified.

Animal health information system. Rules and procedures must also be established for animal health management practices (vaccination, testing, etc.), disease data gathering, data storage and manipulation, and data analysis and reporting. Further guidance on these rules and procedures is provided in Section V of these guidelines. The first step is to identify and select the animal health events or priority diseases to be recorded, through open discussion and agreement with all relevant stakeholders. Data collection is usually performed through the use of specific reporting forms or templates. It is necessary to define the content of such forms and decide upon the frequency of data collection.

Data can originate from different sources (e.g. veterinarians, technicians, keepers, and staff of slaughterhouses, abattoirs or laboratories). Planning data flow is, therefore, a critical

step in the development of the animal health information system, and one that requires specification of users' profiles, with appropriate data security settings.

Performance recording. The rules and procedures for performance recording should be based upon the recommendations given in Section VI. In particular, the following aspects should be specified:

- the data to be collected, the source, the frequency of collection and the person(s) responsible;
- the standard operating procedure (SOP) to be followed to measure each trait (Box 7 in Section VI provides a SOP for milk recording in a smallholder situation); and
- the contents of information to be sent to each stakeholder. This should be made available in various formats tailored to the needs of each type of stakeholder (alert messages, operational reports, review reports, graphs, analytical reports, statistical summary reports, etc). It is also necessary to consider how this information will be transferred (paper, e-mail, PDF files, HTML pages, smartphones/PDAs, mobiles, etc.).

Action 4: Specify the IT system requirements

Animal recording systems are reliant upon the availability of dedicated systems and technologies (hardware and software) for timely data collection, processing and reporting. The plan must specify those that fit the type of system selected, its elements and its data requirements, taking into account the findings of the assessment study, especially those related to the internet and/or mobile phone coverage. Information technology experts should be involved in determining specifications for the tools and technologies required to meet the system requirements. These include:

- the devices used for data entry and validation (e.g. handheld devices, notebooks, laptops; desktops; etc.);
- the communication network(s) used (i.e. wired or wireless network);
- the institution hosting and managing the central database;
- the data exchange protocol to be followed among the various databases;
- the software solution: either a readymade software or a newly developed application. Regarding the latter, it is important to compile a detailed manual on rules of data acceptability before designing any new software. This manual should specify the typology of each event and the person responsible for the associated data entry. The process of development and validation of the software is described in detail in Section VIII; and
- the software and central database backup protocol. This can be performed locally using a dedicated server, externally or online. For external backups, data security and data backup agreement must be considered if a different institution or company is responsible. In the absence of an automatic backup, data should be backed up manually on a regular basis (e.g. once a week).

The inclusion of GIS and mapping applications in the animal recording system (in particular, for animal traceability and disease surveillance) produces additional challenges in relation to building a standardized repository for geographical data that is fully integrated with the other data collected and stored. Detailed standards and procedures must be

specified in order to define, in the best way possible, the geolocations of premises (farms, slaughterhouses, markets, pastures, etc.). In addition, specific software applications and algorithm solutions must be considered for geographical data manipulation and analysis. Finally, appropriate technologies must be added for developing and managing georeferred data and generating a variety of geo-outputs, such as interactive web maps. It is important to ensure that the specific expertise required is available in the team tasked with developing such a system.

Action 5: Define the legal, policy and institutional support required

It is important to determine whether the provisions contained in existing legislation are adequate to ensure full compliance by keepers and other stakeholders with requirements for identification and registration of premises, keepers and owners, and animals, and notification of animal events, movements and diseases. If this is not the case, new legislation will be required. The status of the animal recording system should also be specified (mandatory or voluntary). Experiences from many countries have shown that a multipurpose animal recording system cannot be effective unless its animal identification and registration component is declared mandatory under appropriate legislation. The elements of such legislation are described in Section X.

The plan should also specify whether the provision of any existing government subsidy payments or free services to keepers will be conditional upon their compliance with particular requirements concerning the animal recording system or some of its components (e.g. animal identification and registration, animal traceability or animal health information). If such subsidies or free services do not exist, a proper incentive scheme could be proposed. Likewise, if any penalty is to be imposed for non-compliance, this should be clearly stated.

The other key area that needs to be addressed in the legal framework is the development of an appropriate institutional set up to implement the animal recording system. It is necessary to identify the competent authority that will regulate/coordinate the animal recording activities and manage the central database. The latter can delegate all or part of the activities to an implementing institution (this could be a private company contracted by the competent authority). It is crucial that the line of command is clearly defined and remains under the competent authority. If the competent authority and the implementing institution are different, their respective roles, responsibilities and relationships should be defined. For example, the implementing institution may be allocated responsibility for supplying equipment and materials, maintaining the database, training and coordinating all other participating organizations. The involvement of local organizations (e.g. keepers' associations and cooperatives or local offices of larger central institutions) will provide mechanisms for ensuring that keepers provide input to the operation of the system through regular meetings, seminars, fairs and other events. If many institutions are involved, the roles and responsibilities of each should be specified, and a governing and monitoring structure should be established (e.g. a steering committee comprised of representatives from all stakeholder groups to monitor the implementation). Likewise, an independent institutional arrangement may also be needed to implement a quality assurance scheme.

Action 6: Prepare a human resource requirement plan

The human resource plan should define the profiles needed for staff involved in:

- data collection, entry and validation;
- data analysis;
- information reporting and feedback to users;
- database maintenance; and
- IT development.

An implementation unit responsible for the operation and control of all aspects of the system must be defined (see Action 7). In order to estimate the total human resources required (e.g. number of fieldworkers, supervisors and data entry staff), the following parameters should be determined:

- number of premises that can be registered per day;
- number of animals that can be tagged and registered per day in the initial phase;
- number of new premises that can be registered per day;
- number of newly born animals that can be identified per day in the maintenance phase; and
- number of records (e.g. events to be notified) that can be entered per day.

Based on the above, the required technical, administrative and field staff should be identified, recruited and placed. A human resource development strategy should be established to ensure capacity building of personnel at all levels.

Action 7: Prepare an implementation plan

This action aims to develop a strategy for field implementation of the animal recording system. A phased approach consisting of a pilot phase and a rolling-out phase is recommended. The pilot phase aims to test the system on a limited scale. The duration of this phase may vary between three and six months. During the rolling-out phase, the entire country or identified geographical area is gradually covered. The duration of the rolling-out phase depends on the size of the country or geographical area. Irrespective of the phase, the implementation plan can be divided into three stages: preparation, execution and maintenance (see Section XI).

However, before developing the road map for phased implementation, it is necessary to identify the pilot intervention area, establish the implementation unit, and define operational roles and responsibilities.

Identify a pilot intervention region

Testing all aspects of animal recording in a small pilot area before rolling over a wider area is always a prudent strategy. The choice of pilot area depends upon the objectives and components of the animal recording system. In the case of animal traceability, the pilot area could consist of export abattoirs, a special commercial production zone, a disease-free zone, etc. The selected area should have attributes that facilitate controls between the defined zone and the territory external to the zone. Natural boundaries, such as rivers or mountains, can potentially be used when defining a zone. In the case of performance recording, it is preferable to start with a few influential and progressive keepers to maximize the likelihood

BOX 8

Animal identification and traceability system unit: job descriptions

Head of the unit

The head of the animal identification and traceability system unit reports to the director of the competent authority, and he/she is responsible for organizing and coordinating the activities of the animal identification and traceability system unit, preparing medium-term and annual work plans for the unit, and monitoring their realization. The job description may include:

General obligations:

- assigning tasks, monitoring activities and achieving the set goals;
- approving different manuals for stakeholders;
- monitoring the performance of employees of the animal identification and traceability system unit;
- maintaining regular contact with relevant departments (e.g. the veterinary department) and exchanging information and experiences;
- participating in the preparation and amendment of primary and secondary legislation and other related legal documents;
- reviewing international animal identification and traceability system-related legislation (e.g. of important meat-importing countries to suggest possible changes in national legislation);
- preparing budgets for the implementation of animal identification and traceability system activities;
- coordinating activities relating to designing, testing, implementing and upgrading the animal identification and traceability system, including specifying the requirements of the central database, other field-related hardware and software applications;
- coordinating integration of the animal identification and traceability system database with other IT systems in the veterinary department and ministry;
- communicating and promoting animal identification and traceability activities; and
- approving all documents, reports and records dealing with the animal identification and traceability system.

Specific obligations:

Continuous routine operations:

- monitoring the activities of field service providers and addressing challenges faced;
- monitoring the printing and issuing of movement ID cards and other documents produced centrally;
- managing the initial registration of new premises (establishments); and
- training field service providers and veterinary inspectors or other inspectors in charge of checking the animal identification and traceability system.

of success. It is also advisable to select keepers that operate in the same region, rather than in different regions. This will make the pilot intervention easier to operate for logistical reasons and will also favour an environment of mutual support between the keepers.

All functionalities of the animal recording system should be tested during the pilot phase. For animal identification and registration, all animals of the selected species (or all species that fall within the set objectives) in the pilot area should be included. To this end, the relevant legal authority must require mandatory participation by all relevant keepers.

At fixed intervals (yearly):

- generating statistics on animal identification and traceability activities (annual report on identification, registration and traceability containing, *inter alia*, the number of establishments, animals, inspection controls and imposed measures and penalties);
- establishing risk criteria and carrying out risk analysis for inspection control; and
- preparing annual plans for inspection of field service providers and keepers.

Help desk operator

- supplying online and on-the-spot support to system users (field service providers, veterinary inspectors and border inspection posts);
- analysing system functionality/effectiveness;
- preparing presentations for stakeholders; and
- organizing training courses and preparing operating manuals for end users.

Logistics operator

- procuring hardware and software; and
- coordinating and monitoring the ordering, contracting and delivery of animal identification and traceability materials and equipment (e.g. farm registers, movement ID cards, ear tags, applicators and IT equipment), and managing the stock.

AITS administrator

- registering new establishments and confirming changes to establishment information;
- updating the central establishment register with data on new establishments, closures and changes in ownership;
- granting privileges in the case of new private field service providers;
- organizing the maintenance of hardware, software and electronic field devices (if any);
- proposing improvements;
- following up on inspection control of field service providers and keepers;
- putting in place backup procedures; and
- generating reports.

IT administrator

- administrating the IT system;
- installing remote support software with field service providers or other regional units;
- troubleshooting hardware and software usage issues;
- granting system accounts, privileges;
- correcting errors encountered;
- setting up and changing the system parameters, whenever required;
- following up on maintenance contracts with software and hardware suppliers; and
- coordinating testing activities.

Establish an implementation unit

A dedicated unit should be established within the identified implementing institution to take overall control of the implementation and management of the recording system. This unit will need to combine several skills – management, logistics, training, help desk and IT. A set of job descriptions for key members of an animal identification and traceability system unit is presented in Box 8. These job descriptions can easily be adapted to fit the requirements of implementation units for animal health information or

performance recording systems. Members of the unit may have multiple responsibilities, but responsibilities should not be shared.

Define operational roles and responsibilities

Operational roles and responsibilities for data and information transmission to and from the central database are summarized here for different actors:

Keepers report identified animals, movements and deaths, and request material such as ear tags and animal movement ID cards. Events can be notified by means of specific forms, oral communication or phone calls. Keepers may also conduct performance measurements and recording. If this is the case, it is important to ensure that they understand the objectives and the operational rules and procedures, that they have the requisite skills to accurately record data, and that they receive appropriate support in recording data and interpreting results.

Livestock technicians/veterinarians identify and register premises, owners and keepers, and animals; measure animal performance; report ear tag change, movements, deaths and so on to regional/district offices or directly to the central implementation unit (central database). Where there is a shortage of public livestock technicians/veterinarians, service providers (e.g. private veterinarians, breeders' associations and farmers' cooperatives) can be contracted to conduct these tasks. Livestock technicians/veterinarians or service providers should preferably be physically located in close proximity to participating premises. This limits the costs of travel and promotes a close working relationship between livestock technicians, veterinarians and keepers.

Regional/district offices provide the first level of support to livestock technicians/veterinarians or service providers. They enter slaughter data (if the abattoirs lack direct database access or do not generate electronic batch files to be sent to the central database); effectuate changes of premises, animal attributes and movements; and deal with requests for printing of movement ID cards or other documents. Regional offices may exist in larger countries and in places where field service providers do not directly enter the data.

The central implementation unit is responsible for managing the system as a whole, including:

- training keepers, technicians and professionals of participating organizations;
- verifying questionable premises;
- distributing data collection forms, animal movement ID cards or any other official forms;
- supervising orders for ear tags (or other identifiers);
- supplying required equipment and materials to regional offices and field units;
- checking invoices for services (if partially paid by the government); and
- operating a help desk and providing a second level of support. See, for example, the job description presented in Box 8.

Inspectors/auditors prepare annual plans for the inspection of premises, animals and animal movement recording at all premises including farms, slaughterhouses and so on. Inspectors/auditors also carry out inspections of randomly selected premises.

Other institutions that participate in implementing the animal recording system may include the following:

- ear tag manufacturers, which provide ear tags for animal identification;

- veterinary labs, which test samples, the results of which can be directly transmitted to the central database;
- slaughterhouses, which provide notification of all animals that have been slaughtered;
- livestock markets, which provide notification of all animal movements;
- border inspection posts, which provide notification of all livestock imports and exports; and
- research institutes, which help to define performance measurements, analyse the data, interpret the results, and use them for improvement of breeding or husbandry practices.

The list of roles and responsibilities should be adapted based on the objectives and/or components of the system, and the particular conditions of the country in question.

Prepare a road map for phased implementation

A roadmap for the implementation of a national animal recording system is presented in Section XI, Table 16. It comprises three phases – preparation, execution and maintenance.

Action 8: Develop a monitoring and evaluation mechanism

A monitoring and evaluation tool should be developed to ensure stakeholder compliance with the standard operating procedures laid down for implementing the animal recording system. Ideally, this mechanism should be based on a risk analysis and should include indicators to assess the level of implementation in the field. For example, the mechanism should check selected premises to ensure that all newborn animals are identified and registered, that all deaths and movements are reported, and that no animals are kept or moved without an official identification number within the stipulated time frame.

The prevalence of animal recording practices should not only be checked on farms, but also at other premises such as seasonal grazing areas and village pastures, traders' holdings, livestock markets, fairs, exhibition sites and slaughterhouses.

Action 9: Prepare a budget and secure funding

A detailed budget (organized by activity and by year) should be prepared for the planned period. All assumptions made and the assumed unit cost parameters should be stated clearly. It is also necessary to identify the sources of funds and the contributions made by different stakeholders. A detailed description of these aspects is presented in Section IX.

Section VIII

Designing and developing the IT system

INTRODUCTION

The previous section described a strategic plan for developing an integrated multipurpose animal recording system composed of four components, namely animal identification and registration, animal traceability, animal health information and performance recording. A key element of the strategic plan is the development of an IT system that supports the activities of each component. This IT system will enable users to capture and validate data, process and store data, and generate and transmit relevant information to the same or other users for decision-making and planning. It should accurately mirror field activities and workflows. The IT system has two components: a software application and a hardware infrastructure. The nature and scope of the IT system to be developed will vary depending upon the specific objectives of the animal recording system. Nonetheless, there are many commonalities in the workflows, rules and procedures followed (otherwise known as "business processes") and the technical designs employed. This section describes these commonalities.

OBJECTIVE

The main objective of this section is to provide guidance on procuring or developing a software application for an integrated multipurpose animal recording system, and setting up the necessary computer hardware. In particular, it aims to guide the user on how to:

- define all relevant requirements concerning software and hardware;
- call IT companies for tender; and
- develop and test the software.

TASKS AND ACTIONS FOR DEVELOPING THE IT SYSTEM

The standard process for the development of an IT system is described briefly in Box 9. This section focuses particularly on the first phase, the preparation of user requirement specifications (URS), as this greatly affects the other phases and the success of the development process.

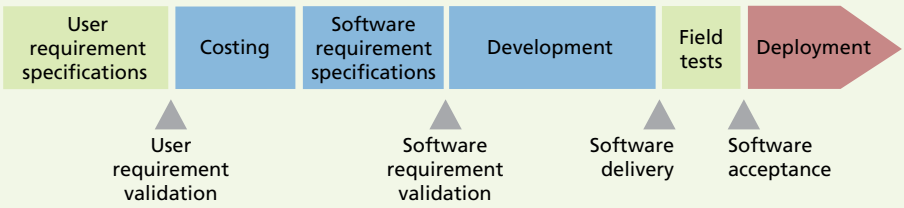
The following tasks need to be undertaken in order to prepare the URS and develop the IT system:

- establish an IT project group responsible for the preparation of the URS;
- organize preparatory field visits and interviews of key stakeholders;
- define the objectives and scope of the IT system;
- provide a general description of the required software;
- describe, in detail, the functionalities of the software;

BOX 9

Standard process for the creation of an IT system

Figure A: Simplified project timeline for the development of an IT system



In order to implement an IT system to support an animal recording system, the project group should adopt a standard IT project methodology. This will help to establish a good partnership arrangement with the contracted IT company, and prevent additional costs that might otherwise arise as a result of misunderstandings and delays. A simplified project timeline is presented in Figure A.

The process for the development of an IT system can be divided into four phases:

1. User requirement specifications: The first phase consists of detailing stakeholders' needs in the user requirement specifications (URS) document. This phase can be divided into several steps (see Figure B). The project group is responsible for completion of this phase.
2. Development: The costing, software requirement specifications (SRS) drafting, and development (including internal tests) are undertaken by the contracted IT company. The developed software will be then installed on the platform implemented in the host data centre.

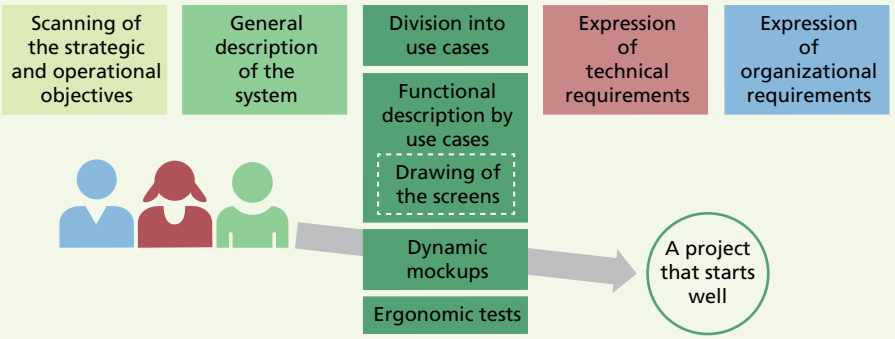
- describe the technical requirements;
- validate the URS and the mock-up;
- call IT companies for tender; and
- develop and test the animal recording IT system.

Task 1: Establish an IT project group responsible for the preparation of the URS

The IT component of the animal recording project constitutes a project in itself. As such, a project leader (preferably a livestock specialist) should be appointed and empowered to lead the IT project. A project group should be established around the project leader to assist in elaborating the functional and technical requirements in a clear and consistent manner. The project group should consist of:

- user representatives, who support the operational objectives (see the following) and contribute their core business technical skills;

Figure B: Steps for developing the URS document



3. Tests: The project group should conduct a test of the software using real data. Once testing is complete and the system is operating satisfactorily, a document called an acceptance form must be signed.
4. Deployment: Deployment should commence with a pilot phase before being rolled out across a wider area.

The whole process described above should take approximately 18 months prior to the roll-out phase:

- 6 months to design the system and approve the user requirement specifications;
- 6 to 9 months to develop the software (web and mobile); and
- 6 months for field tests and the pilot phase.

- management representatives, who support the strategic objectives (see the following) and provide their organizational and managerial skills; and
- a facilitator (a consultant or consultancy service provider) experienced in the development of this type of system, recruited to help the group prepare the URS.

It is essential to involve an IT expert who is able to define a set of highly detailed technical specifications. This person must be part of the project group. Following the URS phase, the project group usually becomes a project monitoring committee, which may also include IT persons from the contracted IT company.

Task 2: Organize preparatory field visits and interviews of key stakeholders

The information needs of stakeholders in the areas of identification and registration, traceability, health and performance recording are described in the conceptual sections earlier in these guidelines (Sections III, IV, V and VI, respectively) and defined in Section VII. At this

stage, the project group should gather detailed information on the functionalities required by the users of the IT system. In order to do this, they should visit and interview key stakeholders, and collect detailed information before they begin the preparation of the URS document.

The persons to be interviewed are livestock keepers and producers, directors or managers of concerned organizations, technicians, veterinarians and service providers who undertake fieldwork. It is necessary to interview each category of persons who will directly use the IT system. Questions to consider during the interview include:

- What is the existing situation?
- What are the needs and requirements of the stakeholders for the proposed IT system?

The first question refers to current activities and workflows of the different stakeholders, existing IT systems and infrastructures, and existing paper forms and human resources. This question is normally addressed during the preparation of the strategic plan (see Section VII, Task 1). If this has not already been done, collect all relevant information.

It is important to listen carefully to each stakeholder. If the stakeholders feel that their views are being taken into account and they realize that the system will include functionalities that serve their needs, they are more likely to participate and view the system favourably. On the contrary, if stakeholders feel that they are being coerced into adopting a rigid system, this may generate resistance. Furthermore, stakeholders usually wish to be in control of their own system and are unlikely to share governance. Nevertheless, IT systems offer different possibilities to share data and services without the need for relinquishing individual control.

For each functionality, describe the activities and workflows to be supported by the IT system. Focus on the functions required by each type of stakeholder in the field (identification technician, inseminator, performance recording technician, etc.). It is important to remember that different types of actors may require the same function.

Task 3: Define the objectives and scope of the IT system

Once the interviews have been conducted and the required information has been collected, the project group can focus on production of the URS document. This document must be comprehensible to both stakeholders and the contracted IT company.

Action 1: Define the objectives

The objectives of the IT system must serve those of the animal recording system, but also must be IT specific. Their formulation has to be precise, as they will underpin the functional design and support the post-implementation assessment. The objectives are often formulated at two different levels:

- **At strategic level**, the objectives express, precisely and concisely (in three or four clear sentences) the reasons for creating the IT system, and what is expected of it. For example, the system must enable the country to comply with EU regulations on meat exportation. This information must be specified in the URS document, which will be the only technical document provided to the IT company.
- **At operational level**, the objectives serve the strategic objectives and describe, in a systematic manner, the operational services and outcomes of the IT system. A list of three to ten bullet points is usually appropriate. For example, these may include:

TABLE 6
IT system objectives to be adopted and/or reformulated based on a country's circumstances

Strategic objectives		Operational objectives	
☐	Gather in a unique national database, under the control of _____, all information concerning premises, keepers and owners, and animals, in order to provide a livestock data management system for public and private organizations involved in animal production and health.	☐	Create an integrated web portal, available online, for all relevant stakeholders according to their privileges, that offers a wide range of services concerning: • animal identification and tag management; • traceability of movements and updated inventory; • health, disease control and prophylactics; and • milk and meat performance recording.
☐	Centralize all information concerning animal movement or transportation within the country, from birth to death, in order to trace any animal at any time, and to distribute incentives equitably. Provide an updated animal inventory of all premises to relevant stakeholders.	☐	Provide field technicians of public and private livestock organizations with a multidevice software (compliant with Android, Apple and Windows smartphones and/or tablets), for the following field activities: • premises, keeper and owner registration; • animal tagging and registration; • recording of animal movement; • animal insemination and reproduction management; and • performance recording.
☐	Provide an integrated set of relevant services and harmonized information on animals and production data to stakeholders (e.g. farmers, service-providing organizations and farm consultants), according to their privileges, in order to support milk and meat production chains and food security in the country.	☐	Create a set of standard data web services (simple object access protocol (SOAP) or equivalent), thereby enabling authorized stakeholders to interact with the central system from their own IT systems (e.g. to declare newborn calves or receive slaughter results of their animals automatically).
☐	Create a unique national set of services and unified data for disease control. Make it available by web and mobile devices in order to achieve maximum participation of public and private health organizations, veterinarians and keepers.	☐	Create a decisional and statistical data warehouse, and produce automatically each month a set of reports and statistical newsletters for the information of relevant stakeholders, including updated data about cattle, sheep, milk production, exports, etc.
☐	....	☐	....

- providing technicians with a smartphone application that allows them to identify premises and keepers, and animals;
- capturing health and production events and reporting these data to a central database; or
- providing stakeholders with an internet-based dashboard that enables them to access identification, traceability, health and production data (according to their privileges).

The formulation of operational objectives is required because it drives the project group to describe the services and functionalities that the system will provide to users. The strategic and operational objectives of the IT system may be different for each country. Table 6 identifies a number of objectives, to be adapted or completed based on the specific requirements of the country.

TABLE 7
Scope of an IT system

Main functions to be adapted based on the objectives of the IT system and the specific requirements of the country		Year 1	Year 2	Year 3	Year 4
Animal identification and registration	Registration of premises	x			
	Registration of owners	x			
	Registration of keepers	x			
	Registration of animals	x			
	Tag management	x			
	Recording of births and deaths	x			
Animal movement	Registration of movement between premises	x			
Animal health	Management of health status for animals, herds, zones		x		
	Authorization of animal movement according to health status		x		
	Management of animal controls and analyses before movements for disease eradication purposes		...		
	Registration and management of vaccination campaigns (e.g. FMD) and other preventive measures				
	Supporting animal health services				
	Disease diagnosis and testing services				
Animal breeding	Enabling performance recording				
	Supporting artificial insemination				
Farm management and nutrition	Nutrition advice – ration balancing				
	Feed and fodder sample testing services				
	Proof of ownership – reduce cattle rustling				
Administration and livestock statistics					

Action 2: Define the scope

The scope describes the list of functions and entities that the IT system will have to accommodate in order to achieve the defined objectives. As shown in Table 7, it is not necessary at this stage to provide excessive detail. Incorporating all functions into the IT system from the beginning may not be feasible due to constraints of time and financial resources. Hence, it is necessary to establish priorities, so that the functions most critical to the success of the animal recording system will be developed first, with those less critical added later. This means that the IT system has to be modular.

Task 4: Provide a general description of the required software

Action 1: Identify the actors and define their responsibilities in the IT system

Before designing the IT system, it is necessary to identify all users of each component of the animal recording system (here called functional areas). For example, users of an IT system for performance recording in the dairy production sector may include:

- dairy farmers;
- service providers such as inseminators, technicians of milk recording services and technical advisers;

TABLE 8
Actors and their responsibilities

Actors	Roles and responsibilities in the target system
Tagging assistant	Registers new animals and premises Updates paper lists of animals present at the premises Perfoms the same tasks with the mobile application
Data entry operator	Captures the identification forms Prints premises inventories, ID cards and inspection sheets Sends documents to the relevant actors Handles minor entry errors and provides reports
Field inspector	Captures ear tag allocation to, and uses by, tagging assistants Reads data entry and error reports Reads the person list, premises list and animal list for the region Reads the inspection sheet and captures corrected data Perfoms the same tasks with the mobile application
Veterinarian in charge of meat inspection	Captures the animal ID card and ear tags Captures the animal ID of slaughtered animals
Livestock market agent	Captures the movements of sold animals
Laboratory analysis agent	Captures individual analysis results
Central/state authority	Reads the person list, premises list and animal list Sends ear tag orders to manufacturers Captures ear tag series acknowledgements Captures allocation or reallocation of ear tags Assigns privileges to the relevant actors Handles errors Reads management reports
Central technical unit	Reads the person list, premises list and animal list Manages system quality Reads management reports Manages portal content
Livestock organization	Obtains datasets in real time for their zone Reads livestock reports Reads selected management reports pertaining to their level
Guest user (without authentification)	Reads public reports (maps and other information, without access to sensitive data) Enters user opinion

- geneticists implementing genetic evaluation programmes;
- operators of milk component-testing laboratories or feed-testing laboratories;
- operators of dairy processing plants;
- private veterinary practitioners; and
- nutritionists.

Users of the IT system for animal traceability may include:

- commercial farmers (small-scale farmers are not normally direct users of the system);
- tagging technicians and registrars of premises, owners and keepers, and animals;
- the animal health authority and animal health field operators;
- regional and/or central data entry operators;

TABLE 9
Data input and output interfaces

Orientation	Description	Mode	Frequency
Input →	From existing national laboratory IT system: input of blood analysis results for display in the health module of the animal recording system. The latter will ask for data in real time from the laboratory database and display it directly in its own interface (e.g. SOAP web service)	Consultation by data web service	On demand
Input →	…		
← Output	The animal recording system will produce a standard file readable by any relevant stakeholder with information on: • Premises • Owners • Keepers • Animals	Standard file transfer (XML)	Daily
← Output	…		

- slaughterhouse operators;
- field inspectors; and
- staff of the animal traceability central technical unit.

Similarly, users of the IT system for health purposes may include:

- staff of organizations implementing disease eradication, vaccination and/or testing programmes;
- private veterinarians; and
- staff of abattoirs, disease diagnosis laboratories, provincial and state veterinary health departments.

The project group should elaborate this list at the individual level rather than at the organizational level, because:

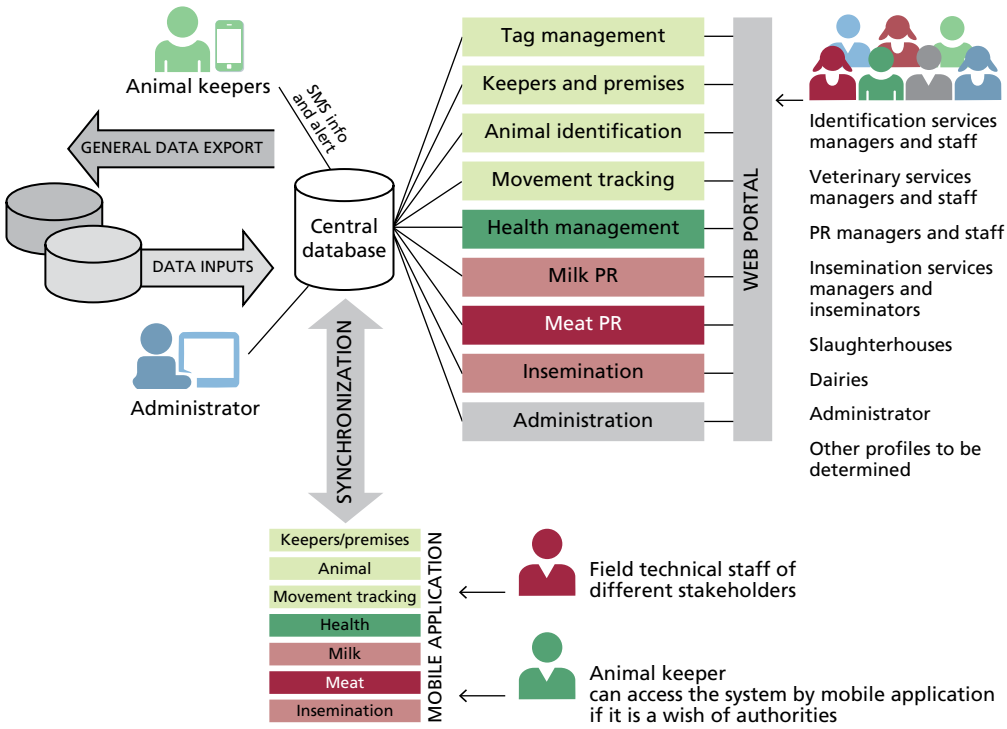
- the software is designed to be used by individuals in line with their specific tasks; and
- some individuals belonging to different organizations may have common requirements (e.g. inseminators from different organizations will have to register inseminations).

Based on the information collected, the project group will have to develop a table of actors and related responsibilities (see Table 8), where actions should strictly mirror the defined field tasks and workflows. In the software, the actors will become profiles and their roles and responsibilities will become relevant screens and functionalities.

Action 2: Describe the regulatory requirements

The URS should describe all legal requirements – both current and additional (see Section X on legal elements of the animal recording system). For example, the structure and uniqueness of the premises/owner/keeper/animal identifiers must be respected in the software. If the law requires certain mandatory details attached to declared entities, the software will have to make these details mandatory, too. The need for a review of existing national

FIGURE 16
General function chart of the target system



legislation on veterinary health, public health, livestock breeding, data management and statistics and so on, is addressed in Section VII, Task 1.

Action 3: Identify the data interfaces and data exchanges with other systems

This part of the URS document addresses data flows between systems. It does not describe the screens made for data capturing. If other IT systems are likely to exchange data with the animal recording system, the project group should attempt to find the simplest way to effect this exchange. Description of the data interfaces should reflect the example presented in Table 9.

The project group should bear in mind that data interfaces are often costly in terms of development and maintenance, especially bidirectional exchanges. This is why, in countries where few livestock IT systems currently exist, it is strongly recommended to build a fully integrated system with a single database for all functional domains.

Action 4: Draw a functional chart of the IT system

When the functional physiognomy of the IT system becomes clear, the project group can produce a representation in the form of a visual chart. Such a tool can prove highly useful in enhancing comprehension among stakeholders. Figure 16 provides an example of such a chart.

TABLE 10
First entry lines of a table of functionalities

#	Module	Name of the service	Description of functionalities	Content			Access given to the different profiles of the services											Media	
				Number of screens	Imports/exports	Number of printings	Tagging assistant	Data entry operator	Farmer	Service provider	Market agent	Vet/meat inspector	Field inspector	SD/D/State authority	Central authority	AITS tech. unit	Livestock organization	Guest user	Web screens	Mobile app
1	Keepers and premises	Capture of keepers and premises	This service allows users to capture or update the data collected in the field about keepers and their premises. Two different screens are provided for premises and keepers. The forms contain the same data as the paper forms. The design of the screen must also be compatible with the paper forms.	2			B	B		K				D	N	N			•	•
2		List of premises and print	The list displays one premises per line with the following columns: Premises ID, First name of keeper, last name, gender, phone, cooperative, hamlet, village name, village ID, block and district. Each line provides a link to further details, allowing authorized actors to update or delete information, and to enter the "keepers and premises" registration form.	1		1	B	B		K	D	D	D	D	N	N	Z		•	•
3		List of keepers in charge	This list shows persons in charge of premises registration, with their contacts and other details. The page will have an option to print the list of persons in charge of premises registration.	1		1	B	B		K	D	D	D	D	N	N	Z		•	•
4		Progress of premises census	This service provides synthesis indicators about the progress of censuses in the geographical area of the user (e.g. number of registered keepers and premises). The user filters the area by state, district and/or subdistrict, and obtains a list of villages detailing the number of keepers and premises by village.	1									D	D	N	N			•	
5		Premise closure	Here, the relevant authority can enter a date and reason for end of activity at a premises.	1				B					D	D	N	N			•	

Note: The letters in the profile columns indicate privileges: B = block, D = District, N = national, K = keepers, Z = zone or geographical area.
Source: adapted from an Indian URS document.

Figure 16 represents databases as cylinders and functionalities as rectangles. Individuals (and possibly their main activities) are also represented, with simple arrows representing their web connections or access to an application. Double arrows represent exchange or synchronization between databases, or between a database and a mobile application that has its own database.

Action 5: Establish the general table of functionalities

The general table of functionalities is a key table of the URS document. It provides the functional structure of the IT system, and will be used by the IT company to calculate the cost of the system, functionality by functionality. Each service (functionality) is described in one line, and the table often comprises 70 to 150 lines. Each line provides the assumed number of screens it will be necessary to develop to enable functionality, imports and exports, and printing. It displays the privileges for each user, and the mode(s) to be developed: on web screens and/or mobile application screens. An example of a table of functionalities is presented in Table 10.

Action 6: Describe the usage conditions and ergonomic requirements

This part of the URS document focuses on the usability of the system. The software design should be user friendly to facilitate deployment and encourage use. Several items, in particular, should be described carefully.

Mobile usage conditions:

- Requirements regarding screen size: the mobile application should adapt to screens from x to y inches: 4 to 5.5 inches for smartphones, 7 to 10 inches for tablets, and 4 to 10 inches for both).
- Size of the touchable elements (e.g. buttons, checkboxes): minimum 7 x 7 mm and preferably 9 x 9 mm for frequently used elements.
- Colours and contrasts: the contrast between text and background must be higher than a ratio of five, if the application is to be used outdoors in daylight conditions.[42]

Performance: The project group must take into account average web speeds in the country (which are often slow). If necessary, they should take speed measurements and record these in the URS document. Under normal web speed conditions (e.g. 1 megabyte per second), a professional web page usually loads in less than 5 seconds. This point should be raised in the URS to avoid misunderstanding with the IT company and to optimize the amount of data downloaded on each device. If possible, the project group should provide the relevant device specifications or select the appropriate model(s) with the IT company during the development phase.

Efficiency of service: The work sequence including the number of steps (clicks) must be optimized to meet field conditions. This point is critical for frequently used screens and may lead to non-acceptance of the software. The best way to optimize screen efficiency is to design mock-ups with the working group and request a beta version from the IT company in order to test the user interface prior to production.

[42] See W3C Guidelines, available at: www.w3.org/TR/1999/WAI-WEBCONTENT-19990505

BOX 10

Description of a functionality

The standard methodology employed to describe a functionality is as follows:

- **Purpose of the functionality.** The purpose of the functionality is to capture the premises data on a mobile application or web screen from paper copies collected by field technicians, and to display the list of premises.
- **Steps of use, navigation.** When entering a new premises or updating information, the user will check the premises list for the area to see if the premises already exists in the database. If this is the case, the user selects it, displays the details and modifies them. If the premises is not found, the user creates a new entry and the software produces an automatic premises identifier and an empty table ready for data capture. Once the premises entry is created, the user is given the option of visiting the animal registration page and declaring all animals associated with the premises.
- **Main data displayed, main data captured.**

Type of data	Premises screen	List of premises	Controls and remarks
Form number	**M**		Only if data capture is made from paper form
Date of census	**M**		If data capture is made directly by mobile, the date of census is the present date
Person in charge of paper capture	**M**		If data capture is made directly by mobile, the person in charge is the user (cannot be captured in this case)
State of the premises	**M**		Select choice from drop-down list
District of the premises	**M**		Select choice from drop-down list
Block of the premises	**M**		Select choice from drop-down list
Village name	**M**		Select choice from drop-down list
Village ID of the premises			Deduced by the system
Latitude of the premises	**O**		Kilometric latitude coordinates in Universal Transverse Mercator (UTM)
Longitude of the premises	**O**		Kilometric longitude coordinates in UTM
Organization name	**O**		Name of organization: select choice from drop-down list
Organization ID			Internal ID generated by the system
Cooperative of the premises	**O**		Name of cooperative: select choice from drop-down list of cooperatives of the district
Provider service attachment	**M**		Each premises is attached to a service provider (private or not). This attachment defines the responsibility of the service provider or the local authority regarding the premises.
Official ID of the premises			Provided by the system for every new premises – not captured separately.
Name of the premises	**M**		If owner ID has been captured, this is displayed by the system; otherwise, free text entry.
Phone #	**O**		Phone number (the system controls the format: number of digits, etc.)

Notes: = Read only; = Read-write; **M** = Mandatory capture; **O** = Optional; **Blank** = Cannot be captured.

cont.

- **Main business rules**:
  - The premises is defined by an official identifier provided by the system. This should be a location within a village, if possible with GPS coordinates.
  - At any given time, an animal either lives at a single premises or is deceased.
  - A premises can belong to a cooperative and/or an organization.
  - There is no direct relationship between a keeper and the premises. The animal constitutes the link between them. The data architecture takes into account commercial farms as well as collective premises, where animals belonging to (or managed by) different keepers live in the same place (share the same premises, but not the same keeper).
- **Screen mock-ups and documentation**. Mock-ups should be made for key screens to facilitate the functional design process for the working group. It is also useful to include existing (or mock-ups of) necessary documentation on data collection and/or entry in the URS.

Other ergonomic aspects: The portal menu (and mobile application menu, if any) should be described in detail, including system navigation (especially transverse navigation) and all elements required to guide the user (tooltips, icons, etc). The project group should also request and validate a user interface guidelines document from the IT company.

Languages: If the software is to be multilingual, this must be specified clearly in the URS, with details about the type of characters to be used (e.g. Arabic, Cyrillic, Latin). The IT company must supply an external file containing texts and labels, with the project group usually responsible for translations.

Action 7: Decide whether to build specific national software or buy existing software

The project group has to choose between two IT solutions:

- buy existing software designed by an IT company and customize or adapt it to the needs of the country; or
- recruit an IT company to develop an IT system specifically designed for the country.

Generally, the first option is less costly and time-consuming than the second. However, pre-designed commercial software is unlikely to offer a sufficient degree of customizability to meet all the requirements of a new animal recording system. Provided that sufficient resources and capacity are available, it is recommended that software be developed locally to meet specific needs. If the project group decides to buy existing software, a general table of functionalities (see Box 9) must be established before comparing offers. If the project group decides to develop a specific system, the project group will have to produce a detailed description of the functionalities of the software (see Task 5).

Task 5: Describe in detail the functionalities of the software

Action 1: Follow a standard methodology to describe the modules and functionalities

Generally, the methodology used for the software menu allocates a single functionality to each entry – for example "capture premises data". A comprehensive list of functionalities and an individual description of each one is a fundamental requirement of the URS. The IT company will need these descriptions to design the data model, business rules and screens. If the menu is too long, it may be possible to aggregate certain functionalities within sub-modules. For example, administration of the database could be regrouped under a single description (e.g. administration of stakeholders, users and services).

Action 2: Share the project vision to engage stakeholders

The project group has a central role in engaging and involving stakeholders. They should share their vision of the project by:

- preparing a simple and visual description of the IT system with charts and tables; for example, using a PowerPoint slideshow;
- creating a dynamic mock-up of the main screens of the web portal and mobile application. This is not a technical prototype and the mock-up should not be reused in the development phase;
- sharing these support materials with key stakeholders and collecting their views before finalizing the URS document; and
- organizing user interface testing with different types of end users. These ergonomic tests should employ dynamic mock-ups and use typical simple operational scenarios (e.g. declaring a new premises, a new animal, etc.). This phase is quick and easy to organize, highly instructive and can help avoid serious design errors.

Task 6: Describe the technical requirements

The technical design of the IT system is usually developed by the IT company to meet the functional requirements. For this reason, the URS document can describe only particular technical requirements. This part of the URS is, therefore, much shorter than the functional description.

1. Introduction to the technical elements of the system

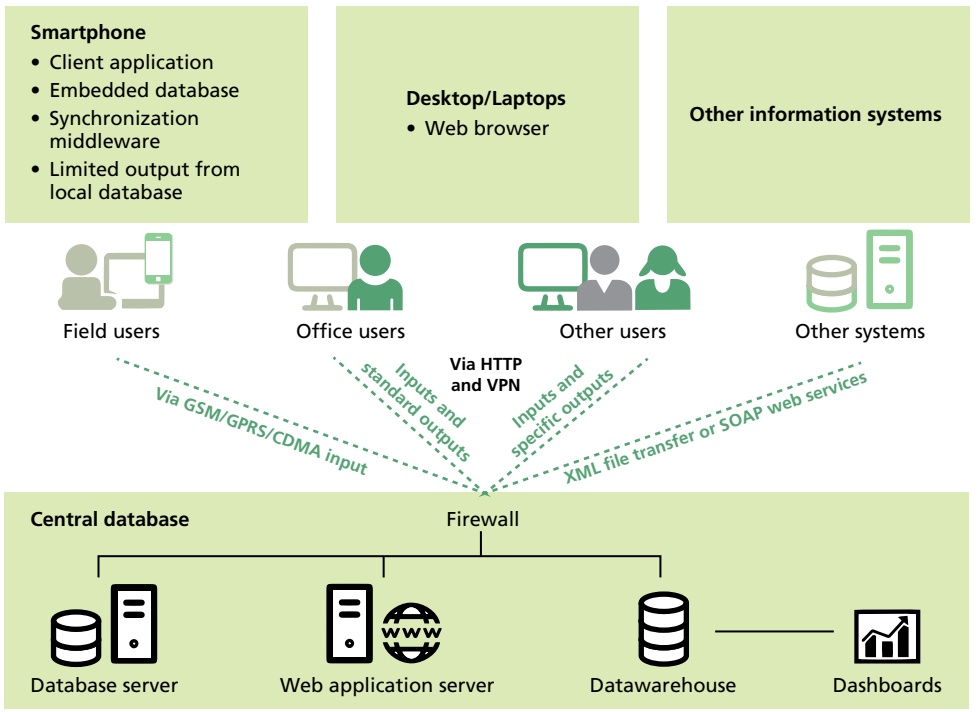
The various elements of the IT system can be divided into two main subsets (see Figure 17):

- central infrastructure to store data and provide web-based services; and
- distributed field devices for capturing data and receiving information.

1.1 Central infrastructure to store data and provide web-based services

The main resources required include a database server to host data, a separate server to host web-based applications and synchronization services, and high-speed internet access. The central infrastructure should also have well-secured data backup and recovery services. Generating complex reports and graphs often consumes many resources. Therefore, it is advisable to have an additional data warehouse server that stores data in specified formats

FIGURE 17
Technical elements of the IT system



that allow the production of specific reports and graphs required by users, if defined in the functional requirements.

For security purposes, the data stored at the data centre should be duplicated at a second site located over 30 km from the principal site. If a fire or other event should destroy the main data centre, the second site should allow the system to be restarted with a minimum loss of data, and a minimum period of unavailability. The frequency of data backup and the time to restart, known as the recovery point objective (RPO) and the recovery time objective (RTO), respectively, should be defined by the project owner, and are typically less than 2 hours (RPO) and 4 hours (RTO). The company responsible for hosting the data must commit to guaranteeing the RPO and RTO.

1.2 Distributed field devices for capturing data and receiving information

The available technologies for capturing data at field level may be divided into the following three groups:

1. Collecting data on paper and entering data through connected desktops/laptops. The central server provides functionalities via web pages, allowing various stakeholders to capture or display information, usually through a web portal that grants personalized privileges and access to specified information;

2. Entering data offline through smartphones or tablets in a local database and periodically synchronizing the local database with the central server; and
3. Enabling data exchange between the central server and other databases through XML files or web services for real-time data exchange; for example, via simple object access protocol (SOAP) or other interoperable technologies.

System access should be as widespread as possible, with connected computers supplemented by smartphones or tablets linked to local databases. This model describes the current architecture of most major IT systems. As a consequence, it is possible to use all types of devices cited for the first two groups above (e.g. tablets and smartphones in group 1 and laptops and desktops in group 2).

Collecting data on paper and entering data via desktops/laptops to produce operating reports

In this case, the fieldworker collects data on specified formats and dispatches them to a nearby workstation, where data entry operators enter the data using a web-based application into desktops/laptops connected to the central server. This approach duplicates the work of data entry, and also increases errors, adds to cost and causes delays. However, in many situations, this may be the only possible option. The web-based application provides various user interface (UI) forms to enter and validate data. It could also produce operational reports on desktops/laptops, which need to use appropriate web browsers (e.g. Internet Explorer, Firefox and Chrome).

Entering data offline via smartphones or tablets in a local database and synchronizing the local database with the central server periodically

In this case, fieldworkers are provided with smartphones or tablets. The smartphone is embedded with a custom designed client application, a local database and a synchronization middleware. The client application provides UI to enter and validate data and updates the local database. The synchronization middleware synchronizes the local database with the central database via wireless connectivity. The smartphone uses any of the available mobile operating systems (OS), such as Google's Android, Apple's iOS and Microsoft's Windows phone. When smartphones are used, data entry occurs only once, errors are rectified at the source and data updating occurs (locally) without delay. The central database is updated when the device is synchronized – a process that can be automated. Unlike the workstation approach, many fieldworkers enter the data using smartphones supplied to them. This means that numerous smartphones will have to be supplied and maintained. In addition, each fieldworker will require a user ID.

Data exchange between the central server and other databases through XML files or data web services (SOAP or equivalent)

As discussed in Task 4, Action 3, the development of a fully integrated system is preferable for countries with minimal prior experience in animal recording. However, most countries already have several single or multipurpose IT systems with corresponding databases in place. In such cases, data exchange is possible between these databases and the central

BOX 11

The National Dairy Development Board's Information Network for Animal Productivity and Health (INAPH)

The National Dairy Development Board (NDDB) of India has developed an integrated IT system referred to as the "Information Network for Animal Productivity and Health (INAPH). This information network is based on field force automation, using mobile technology (GSM or CDMA). The field technicians are provided with handheld devices (PDAs/smartphones/netbooks) to record activities in real time with proper validation, and to generate information for monitoring and control of their daily activities at the village level. The system is a Windows mobile-based application, developed using .net framework and a SQL CE database, along with mobile synchronization middleware. Field-level workers synchronize their data with the INAPH central server at Anand in the State of Gujarat using GPRS/CDMA services. The web-based version of the network is available on desktops/laptops for entering data and generating the required information. The desktop version is also developed using a .net framework. A DBMS Microsoft SQL server is set up at Anand to host data. A separate web server is maintained to host all web-based applications. The Microsoft ASP .net framework is used in developing the applications. The system also has the facility to send SMS alerts to farmers to remind them of scheduled interventions for animals (for further details on INAPH see http://NDDB.coop).

Provided by Dr Kamesh Trivadi.

server via XML file protocol or real-time technologies such as SOAP. Another option are file transfers, which may be particularly useful for external organizations not capable of implementing a web-based application. In this case, the participating organization enters its data into a specified file and transmits it electronically using internet broadband or virtual private network (VPN) to the central server. An application on the web-based server provides an FTP file service to transfer such data.

Action 1: Describe the technical requirements regarding the software

The project group should describe the following requirements in the URS:

- **Volume of data.** Provide information concerning the volume of data to be stored in the database; give approximate estimates of the number of users, premises, keepers, animals, movements, events, documents, etc.
- **Security of access.** Indicate the type of security required (encrypted passwords, password renewal, etc.). Specify whether the login and password should duplicate that of another system.
- **Functional logs.** The software should register functional logs at each step. It should be able to identify who performed each action at each step (i.e. who captured the data, when, who modified it, who cancelled it, etc.). This is essential for effective supervision

of the system and to guarantee reliable data quality. It can also help provide utilization statistics and billing files, if necessary.

- **Display optimization** for a range of screen sizes and resolutions. Require the use of an optimized presentation on the screens:
  - For a mobile application, it could be 4 to 6 inches, 4 to 10 inches or 7 to 10 inches, with resolutions starting from 480 x 800 pixels or 1024 x 600 pixels.
  - For a web portal, it could be 11 to 19 inches, with resolutions starting from 1024 x 600 pixels.
- **Compatibility of mobile application with operating systems (OS).** Require full compatibility with Android, Windows 8 and Apple, or simply compatibility with Android, if preferred. Ensure that the application will adapt to changes in the OS over time.
- **Compatibility of web services with main browsers** (Internet Explorer, Firefox and Chrome)**.** Specify the versions and require sustained compatibility.
- **Requirements regarding development technologies and architectures.** If the system is to be maintained by a local company or organization that uses one technology, the project group should demand that the IT company develop the new system with the same technology. For example, some organizations use only Microsoft or Java.

Action 2: Describe the platform and hosting service requirements

The IT system should be hosted in a data centre that guarantees a supply of key elements such as electrical supply, power generators, air conditioners, firewalls, backup systems, access to the internet and so on, as well as physical security against fire, flood and intrusion. These requirements are necessary for systems requiring high availability and security.

The project group may decide to issue a call for tender during the development phase to select a data centre. If there is no compliant data centre in the country, the system can be hosted abroad. The decision should be based, as far as possible, on technical and security concerns. For the call for tender, the project group should specify the level of service expected, including bandwidth requirements (see Table 11). Hosting the system with the IT company that developed the software, at least for the first few years, may be a good solution in terms of providing an effective response to operational needs and troubleshooting.

Task 7: Validate the user requirement specifications and the mock-up

The project group will require around six months to gather information and produce the URS. Validation of this document is a key step in the overall process. It should be undertaken in a formal manner, involving the key stakeholders and the top management of the implementing institution. Usually, the mock-ups are validated at the same time. Once validated, the URS document is used as a technical reference for the call for tender.

Task 8: Issue a call for tender

This approach traditionally consists of providing the URS to IT companies according to the country's tender regulations and procedures. It is useful to provide standard costing grids to the candidates in order to obtain comparable offers, and to understand the differences between the various solutions. The statement of full ownership of the software by the

TABLE 11
Hosting service requirements

Hours of operation of the system	**Continuous**
Hours of supervision of the system	Monday to Friday, 07.00 to 21.00
System availability percentage, monthly	99.98 percent
Response time for a page of 50 kilobytes (internal time)	2 seconds
Provided bandwidth	4 Megabytes per second
Maximum duration of service interruption during the hours of supervision	4 hours
Provision of a preproduction platform	Identical platform
Provision of a test and training platform	Yes

client should be mentioned in the tender documents, as some IT solutions might be delivered with a licence (in such cases ownership of the software is retained by the vendor).

Task 9: Develop and test the animal recording IT system

1. Organization

As indicated in Task 1, the project group and the team leader of the IT company may form a monitoring committee that will oversee the development of the software. Likewise, the project leader, the director of the implementing institution and the manager of the IT company may form a steering committee that will take important decisions about planning and budgeting during the implementation of the IT project.

2. Development phases

The software development process may involve the following sequential steps (see Box 9):

1. Preparation of the software requirement specification (SRS) document by the IT company, which involves:
   a. Specifying in technical terms all use cases, providing details of the purpose, data elements, business rules, etc. This is a very critical phase of any software development process.
   b. Providing details of the data model, business rules and technical architecture of the web and mobile software. Depending upon the complexity involved, this phase may take three to six months.
2. Careful validation of the SRS by the project group, followed by formal acceptance.
3. Provision of real datasets and scenarios for testing by the project group.
4. Development of each functional module and internal testing by the IT company.
5. Testing by the project group using different refered devices, computers and configurations. This activity could take three months. The testing should be performed prior to acceptance, and should include both a functional test of the software and a load test to verify whether the whole system (hardware and software communication lines, etc.) responds with adequate performance, including when all hypothetical users are connected to the system.

6. The IT company development team should rectify any problems that arise during the testing of the application. The final version of the software is made available to the project group after all changes have been incorporated.
7. Final acceptance of the software. Depending upon the complexities involved, the entire process may take 24 to 30 months.

The IT company and the project group need to work closely together during the development of the software. The project group should provide continuous guidance and regular feedback to the IT company. The IT company should nominate a business analyst to act as a key account manager of the IT company, and work closely with the project group. Given the comprehensive range of functionalities, the recommendation is to follow a modular software development approach, wherein the project group and the IT company development team work in a collaborative manner. Under this approach, the development team works on each module, discusses the solution with the project group and adds modifications suggested by the latter until the solution is accepted. The IT company then proceeds to the second module and repeats the procedure. As the development team finishes working on one functional module, it makes it available to the project team for testing. Thus, the process of development and testing proceeds in tandem.

Section IX

Evaluating investment decisions

INTRODUCTION

Developing a national animal recording system requires significant investment, not only to implement the system but also to ensure its maintenance. Governments should, therefore, analyse the costs and benefits of such a system before embarking on the enterprise. The analysis should also consider the implications of non-investment, such as the risk of market exclusion or increased difficulties in exporting live animals and animal products. Another potential risk is loss of competitiveness as a consequence of lower productivity per animal.

During project formulation it is important to identify the objectives and outcomes, define the strategy for achieving these goals, and estimate the budget needed to implement the strategy. The process will be iterative, continuing until a compromise is reached between the best technical proposal and the limited available resources.

These guidelines are intended to provide support to groups undertaking this process. Sections VII and VIII, respectively, describe a strategic plan for developing an integrated multipurpose animal recording system and the IT needed to support these activities. This section provides guidance on performing a preliminary cost–benefit analysis to assist decision-makers in selecting the most appropriate type of animal recording system and its components. Simulations and examples are presented to help with this exercise. The section also discusses options for making the system affordable and acceptable to all stakeholders. Particular attention is paid to animal identification, registration and traceability systems, for which some data are available.

OBJECTIVE

The main objective of the section is to provide the user with a breakdown of the costs and benefits of an animal recording system – in particular, an animal identification, registration and traceability system – with a view to identifying and evaluating ways of establishing an equitable distribution of costs among the main beneficiaries.

TASKS AND ACTIONS FOR EVALUATING COSTS AND BENEFITS

The literature on the costs and benefits of animal recording systems for livestock is scarce. Although some structured approximations of cost are available (see Table 12), it is difficult to locate information concerning the quantification of benefits. This is related to the fact that animal recording is a tool rather than an end in itself. Any benefits are, therefore, indirect and derive from outcomes of the activity for which the tool is used. Published financial analyses show variations depending on objectives, species, regions, extent of coverage, size and type of production system and level of participation of keepers, among other factors.

TABLE 12
Typical operating costs for animal identification and traceability systems

Description	Cost per newborn calf (US$)	Factors
Ear tags, storage and distribution logistics	0.30 – 1.00	Size of country, cattle density, production systems
Paper forms and preprinted products, storage, logistics	0.05 – 0.10	Identifiers, applicators, reading equipment
Animal traceability unit cost (staff members, office and administrative costs, hotline, communication, travel)	0.15 – 0.70	Specification of animal traceability schemes (workflows, degree of movement reporting, paper forms), allocation of tasks (animal keeper/ service organization)
Cost for replacement of identification devices (ear tags), including logistics	0.00 – 0.20	
Depreciation/maintenance of hardware and software, hosting of servers, internet access	0.30 – 0.50	Internet coverage, IT infrastructure
Labour cost for fieldwork: identification (tagging), movement recording and registration (data capture and data entry, including working time and transport)	0.50 – 3.00	Infrastructure, travel time, salary of service staff
Veterinary inspection and on-spot control (costs for inspectors, office costs and transport costs)	0.00 – 1.00	Application of on-spot control measures
Total costs	1.30 – 6.50	

Provided by Ferdinand Schmitt, based on data aggregated from various animal identification, registration and traceability projects (2014).

The following tasks must be undertaken to evaluate the costs and benefits of an animal recording system:

- identify and evaluate the costs;
- identify and evaluate the benefits;
- evaluate the cost–benefit relationship; and
- define the requirements for sustainability.

Task 1: Identify and evaluate the costs

Action 1: Identify the cost items for animal identification, registration and traceability systems

Any project will involve initial investments or capital costs associated with the acquisition of assets that will be used over a long period of time, and operating costs incurred on a regular basis during implementation. Capital costs may include building, equipment, IT and communication hardware, software, vehicles and so on. Operating costs are usually grouped into two categories:

Variable costs (or direct costs) vary depending on the level of activity. In the case of animal identification, registration and traceability systems, they may vary depending on the number of premises, keepers and owners, animals and animal movements recorded.

Fixed costs (or indirect costs) are recurring costs. They include staff costs (salaries and benefits), administrative costs, hardware maintenance and software operating costs, training and awareness raising, etc.

The following paragraphs describe these costs, which are briefly summarized in Table 13.

TABLE 13
Cost items for identification, registration and traceability systems

Capital costs or fixed asset costs
• Reading equipment • IT and communication hardware • Software • Vehicles
Operating costs
Variable costs Direct material costs: • Identification devices and applicators • Printing material **Fixed costs** • Staff costs • Central hardware and database management costs • Software operating costs • Administrative costs • Training and awareness campaign • Depreciation and interest

Capital costs or fixed asset costs

Reading equipment. RFID or barcode readers may have to be purchased, depending on the identification devices selected. The former are substantially more expensive than the latter. Keepers, service providers or livestock public services perform the reading, depending on the implementation plan adopted. This decision has direct implications for the number of readers purchased, and who will cover their costs.

IT and communication hardware. These items include central servers, computers, printers, telecommunication hardware (routers, modems, etc.), projectors and global positioning systems (GPS).

Software. As the software that is developed or purchased will be used for a long period of time, all costs related to its development are usually considered capital costs.

Vehicles and accessories. This refers to the vehicles and accessories needed to perform fieldwork. The quantity depends on the scope of the system, the size of the implementing organization and its territorial coverage (proximity to the keepers), and the geographic dispersion of the premises.

Some of the equipment listed above (computers, printers, readers, servers, modems, GPS, etc.) is essential for core staff ***and*** for all actors involved in system implementation (e.g. producers' associations) and in compliance enforcement (e.g. police officers).

Operating costs

Variable costs

Identification devices and applicators. The selection of identification devices is an important decision, with a wide range of options and products available of varying quality

and price. The decision should take into account the main objective of identification, the species and the type of production system. The number of identifiers required depends on the scope (fraction or whole population), rules (e.g. simple or double tagging) and the environmental challenges affecting the rate of loss. Re-identifying animals has a cost, which is often underestimated. This cost is lowest if re-identification involves the use of a new ID code. If the rules require re-identification using the same ID code, the cost is much higher. It is also necessary to consider the costs of applicators, documents, shipment of identifiers, and the cost of collection and destruction of identifiers following the death or slaughter of animals. For example, if endoruminal boluses are used, slaughterhouses may need to adapt slaughter line equipment to retrieve the bolus and avoid damage to offal grinder machines.

Printed material. Regardless of the system, a number of printed official documents will be required to guarantee the transaction, ownership and identification of animals. The cost of shipping such documents will also have to be considered.

Direct labour cost. This includes the labour costs involved in identifying and registering premises, keepers/owners and animals, and reporting animal movements. Depending upon the implementation plan adopted, keepers, service providers or field technicians perform these tasks and transmit the resulting data. This, in turn, affects the overall cost of the service, which may be subsidized, fully charged by the service provider or fully covered by the government, respectively. Even in cases where public field technicians perform these activities, the cost should be considered a direct labour cost instead of a fixed cost classified under staff costs, as this will provide an indication of the direct labour costs involved.

Fixed costs

Cost of staff. The animal identification, registration and traceability system should have a functional organizational structure that consists of a permanent central unit to manage the system, and field technical staff to undertake implementation and/or monitoring. Recruitment, assignment and/or deployment of the necessary staff are key to the establishment of such a structure. The strategic plan should provide job descriptions specifying lines of command, duration of contracts, financing and staff renewal. The staff structure may include the following profiles:

The **national programme coordinator or director** manages the permanent technical unit. This person could be a veterinarian or animal production scientist. The unit will include system developers, help desk officers and administrative officers.

System developers adapt, maintain and improve the system through the development of new functionalities.

Help desk officers must be livestock technicians with a good knowledge of the rural environment (including the lexicon of rural producers), animal identification, registration and traceability systems, and information technology. In addition, they must be personable and accessible to the public. In a well rolled-out system, it should be possible to train employees to respond to requests through reference to and in accordance with a standard help desk manual.

Administrative officers, such as secretaries and accountants, may be recruited depending on the scope of the system and the implementation plan.

Field technicians provide technical capacity in the field. Generally, each country is divided into veterinary administrative zones. If this is not the case, divide the country into farming regions according to the livestock demographic population in order to ensure full coverage. There must be at least one technician per region or zone.

Auditors or inspectors must be sufficient in number to provide at least one inspector per 50 000 animals. This number is based on traceability inspection in cattle. If the inspection also covers health and genetic items, the number is higher. It will vary for other species, depending on the items to be audited.

Data entry officers are responsible for data entry and error correction at the field and/or central level. Their number depends on system design (digital documents, paper, etc.).

When estimating the human resources needed to manage the animal identification, registration and traceability system, a number of parameters need to be considered, including population size, number of premises/establishments and identification method. An example is given in the simulation study presented in the Annex.

Central hardware and database management costs. Related cost items may include maintenance of central hardware and communication networks, maintenance and further development of software, purchase of software licenses and cost of communication and internet connectivity. When considering the cost of communication, it is necessary to distinguish between infrastructure costs (e.g. optical fibre) and communication costs (mainly wireless communication and internet connectivity). If the implementing institution owns the central hardware (and database), it becomes a capital cost and its depreciation is included under fixed costs. If the central hardware is hosted outside the implementing institution, its cost should be included under annual fixed costs.

Administrative costs. All office running costs, including courier, telephone, power supply, and network connectivity, should be considered here. If fire or theft insurance is purchased to cover assets, it should be considered a fixed administrative cost.

Training and awareness-raising costs. The awareness-raising plan should employ a communications strategy that uses all available information and communication modalities; for example, mobile phones, the internet, the press, radio and television programmes, manuals, brochures, posters and videos. With regard to monitoring, evaluation and audits, the cost of awareness raising and training should be considered a primary running cost.

Depreciation and interest. Capital costs are depreciation charges on the basis of original capital cost. If interest is due on borrowed money used for asset creation, it should be considered a fixed cost.

Action 2: Identify the cost items for other components of the animal recording system

The establishment of both integrated animal health information systems and performance recording systems require additional costs in terms of equipment (e.g. computers, data-storage servers); software for data recording, retrieval, manipulation and representation (web-based bulletin, web-GIS sites, etc.); internet connectivity; and computerized procedures for data alignment, exchange and sharing. The training costs for all involved personnel (veterinary offices, laboratories, slaughterhouses, etc.) must also be considered. If specific software is to be developed for animal health information systems and/or performance recording systems, these costs

should be regarded as capital costs. The above-mentioned costs, however, are specific to animal recording and not to various services provided under animal health or performance recording.

A major challenge in developing an integrated animal recording system is the elaboration of coherent data exchange procedures among the various databases included in the system. This implies significant additional IT work, the existence of adequate IT infrastructure, and the availability of fast and secure internet connections. The impact of system integration on single components should not be underestimated. For example, the integration of laboratory information management systems with animal identification and registration systems implies changes in internal laboratory procedures related to sample recording and labelling. This has consequences for personnel allocation and required skills. All these indirect impacts must be taken into account when assessing the whole cost of establishing an integrated animal health information system and/or performance recording system.

Action 3: Estimate the costs for various animal identification, registration and traceability scenarios

To aid with such work, three implementation scenarios and their resulting costs are summarized here:

- **Full traceability with electronic identification.** The first scenario consists of implementing an animal identification, registration and traceability system for a cattle population of 3 million head. Implementation is gradual, with individual identification of all newborn calves in each year performed before the age of 6 months. The identifiers used for this simulation are electronic ear tags and a visual (plastic) ear tag. Implementation is completed within five years, with about 90 percent of animals individually identified. Estimation of this time period is based on studies of stock evolution, which state that identification of the whole population can be achieved within five years. Box 12 discusses the advantages and disadvantages of establishing an animal identification, registration and traceability system gradually (only newborn animals) or at once for the whole population.
- **Full traceability with visual identification.** The second scenario is similar to the first; the primary change being the replacement of visual and electronic identifiers with a pair of visual plastic ear tags (without barcodes).
- **Group traceability.** This system is based exclusively on the identification of premises, keepers and owners, as well as the control of animal movements in a group. Hot branding is considered for identifying the animals. In contrast with the first two scenarios, group traceability is implemented for the whole population at once.

The main results of the simulation follow. See the Annex for a detailed description of the parameters assumed and the resulting costs.

The average cost per identified animal, or newborn calf, was US$5.30 for the first scenario, US$4.90 for the second scenario, and US$2.90 for the third scenario (see Table 14). As the third scenario does not include individual animal identification, the annual cost is normally expressed per bovine. However, to ensure adequate comparison with the other scenarios, the cost in the example is expressed per newborn calf.

TABLE 14
Average cost per newborn calf registered under three scenarios

Scenario	Total newborn calves identified	Total cost for five years (US$)	Average cost per calf (US$)
Scenario 1	2 873 304	15 228 708	5.3
Scenario 2	2 873 304	14 244 593	4.9
Scenario 3	2 873 304	8 278 018	2.9

BOX 12

Advantages and disadvantages of establishing an animal identification, registration and traceability system gradually (only newborn animals yearly) or for the whole population at once

Gradual implementation

Advantage: investments are spread over a certain number of years and the necessary human and financial resources are lower.

Disadvantage: the benefits of having in place an animal identification, registration and traceability system, prior to inclusion of the whole population, are quite limited (even null) for the initial years. For a certain number of years, identification systems or practices already in place may co-exist with the new system, with possible related additional management costs.

One way to quicken this approach is to identify and register not only newborn animals, but also those that are moved, with the exception of animals intended for slaughter. However, this scenario is not considered under the present simulation.

Whole population at once

Advantage: a unique animal identification, registration and traceability system is in place with organizational efficiencies. The benefits and additional value of having such a system in place are immediately available.

Disadvantage: a greater level of resources must be mobilized; in particular, for the initial tagging and registration campaign.

The variation in average costs among the three scenarios is due to:

- **Differences in the costs of the identification devices used.** The assumed unit cost for a pair of visual and electronic tags is US$2, whereas the cost for a pair of visual plastic ear tags (without barcodes) is US$1. In the case of group identification, the cost of hot branding is assumed to be US$0.14 (see Section III for details on the advantages and disadvantages of different identification devices).

- **Differences in staff costs.** When using visual plastic ear tags, the reading and data-processing work will require more staff (or personnel days) compared to electronic tags. It is difficult to estimate the increase in staff; however, the scenario estimates a 30 percent increase in staff costs. In the case of group traceability, it is assumed that increased fieldwork necessitates a further increase in technical staff (data entry operators and field technicians) of 30 percent compared to the visual identification system scenario. This is because each group movement is accompanied by documentation, which must be collected and entered into the traceability system.
- **Differences in operating costs.** The cost of equipment and field data collection and transfer rises with visual ear tag identification, which increases the overall operating cost. Most of the cost reduction due to the use of the plastic tag is offset by the substantial increase in operating costs. The costs of movement and ownership change, which are proportional to the number of identified animals, are the most determinant components when calculating these operating costs. In the case of group traceability, the need for field equipment (e.g. readers, the internet and other equipment) is considerably reduced. Likewise, the cost of movement control (documentation and shipment) also decreases, reducing the overall operating costs.

The IT system requirements do not vary, irrespective of the option selected (the system should be designed, implemented and ready to manage the full dataset). The choice of option should take into account the availability of resources and the possibility of combining identification and registration in-field activities with pre-existing activities such as vaccination campaigns.

Action 4: Explore options for reducing costs

As shown above, animal identification, registration and traceability systems are costly. Any action or measure that helps reduce costs should be explored. Actions or measures to take include the following:

- Train livestock keepers to ear tag their animals and complete and submit registration forms to regional or central offices, rather than sending field technicians or service providers to carry out these activities. Organizing such training through keepers' associations or cooperatives could help to reduce costs.
- Pool equipment and services. Producers' groups and associations can share joint access to equipment, training and support.
- Establish agreements with public institutions that have national coverage, such as national mail services for shipping materials (e.g. documents, identifiers and equipment).
- Use existing information and communication technologies and networks for online data entry (e.g. filling documents, registering animals, reporting movements, and updating data and correcting errors). Other options for exploration include scaling up an existing system (e.g. animal performance recording) and developing it into a national animal recording system or component of it.
- Adopt rules and procedures that reduce costs, wherever possible. For example, use of the same numbering for animal re-identification requires reprinting lost ear tags, and is thus more expensive than re-identification with a new pair of numbered tags.

However, the latter option could lead to fraudulent swapping of animal identities. These consequences must be evaluated before deciding which method to use. This also raises the issue of device quality, which greatly influences the rate of loss. It is recommended to use ICAR approved devices. Another example relates to admission to slaughterhouses and abattoirs, where the high cost of static reading equipment is offset by the gain in reading speed.

- Promote the development of regional systems that address the specific needs of each country. In areas, regions or groups of countries with similar conditions or common markets, a regional system would meet common objectives while reducing development costs.

Task 2: Identify and evaluate the benefits

Action 1: Identify the benefits of animal identification, registration and traceability systems

Benefits can be classified into primary and secondary benefits. Primary benefits include better management and control of diseases, ensuring safe and quality food. Secondary benefits may be classified according to four levels of action: market access and trade; public and animal health risk management; farm and industry management; and governance. Potential benefits under each level are listed here. The list should be adapted and completed according to the country's particular situation.

Market access and trade:

- Maintain the access and eligibility of current exports of animals and animal products (e.g. fibre, hides, skins, meat, milk and dairy products) to major markets. These are becoming increasingly demanding in terms of animal health standards and animal product safety. This does not necessarily imply an increase in prices or sales, but rather a guarantee of continuity of existing business relationships.
- Open new markets and position the animals and animal products of the region/country in more demanding markets.
- Increase the competitiveness of the livestock sector and take advantage of regional and extraregional markets for the export of live animals for fattening, slaughtering and breeding.
- Strengthen the country's image as a producer of safe animal-source food and other products.

Food safety:

- Ensure better control of biological, chemical or physical incidents affecting the safety of food of animal origin.
- Increase the confidence and assurance of consumers by certifying the origin of animal products.
- Contribute to the identification of causes of food contamination and reduce the probability of further spread.
- Facilitate rapid responses to consumer complaints or concerns.

Animal health:

- Increase the efficiency of procedures to manage endemic, exotic and emerging disease outbreaks.

- Improve the efficiency of health plans and programmes, surveillance, vaccination programmes, early response, notification systems, inspection, certification, zoning and compartmentalization.
- Improve the efficiency of veterinary in-field activities: for example, use of electronic identification enables rapid (a few minutes) registration of ID codes for sampled animals in large sheep flocks when animals are moved through a passage equipped with a static ID reader.
- Ensure the sanitary status of animals, farms, areas or regions.

Industry:

- Improve the image and value of the brand.
- Improve the management of the purchase and supply of animals for slaughter or animal products such as milk.

Farm:

- Improve the management and competitiveness of farms (breeding, animal husbandry indicators, feeding, etc.).
- Reduce the theft of livestock.

Governance:

- Provide continuous, up-to-date statistical information on the dynamics and characteristics of the sector (census).
- Facilitate the development of public policies to support the sector, and favour planning, monitoring and decision-making.
- Contribute to the organization of the sector (control of premises, livestock [cattle] population, animal movement, animal transportation, etc.).
- Improve the control of livestock smuggling and theft.

In all cases, it is necessary to ask whether the benefits can be attributed directly to the animal identification, registration and traceability system.

Benefits can be quantified when treated individually (e.g. enabling a keeper to improve the productivity of his or her herd, a breeder to produce genetically superior animals, or a group of producers to conquer a new market), but become more difficult to quantify when treated collectively (e.g. resulting in better animal health status, reduction of stock theft). In the latter case, the quantification of benefits requires the collection of detailed information and expertise to perform analyses, which may not be possible or available. To overcome this problem, it is possible to perform a qualitative evaluation of these benefits (see Table 15).

Action 2: Identify the benefits of other components of an animal recording system

The establishment of an integrated animal health information system can increase the efficiency of veterinary activities by making identification and sanitary information readily available where it is needed (e.g. for animal sample registration in laboratories, vaccination practices or issuing of certificates).

A performance recording system provides information to its users. The value of that information can be gauged by the benefits it provides to users (see Section VI, Table 2). Producers make use of this information for day-to-day management of

TABLE 15
Classification of benefits according to impact

Immediate or potential benefit	Producer	System	Society
Risks			
Animal health management	+++^	+++^	+
Incentive for good practices	+++^	+++^	+
Reputation/credibility	+>++^	+>++^	-
Market	+++^	+++^	+
Food security/human health	-	-	+++
Supply chain			
Information on quality	+++	+++	-
Better operability	++	++	-
Logistics and management of inventory	+	++	-
Coordination of supply	+	++	-
Market improvement			
Information on the individual carcass	+++	++	-
Available animal information	+	++	-
Quality check	+^	++^	+
Real-time results	+	++	-
Verification of ownership	++	+	-
Connectivity	+^	+^	-
Credibility	+^	++^	+
Government			
National system	+^	++^	+++
Sustainability of the official system	+>++	+>++	-
Synergy in collaboration over tasks	++	++	+

Note: - =insignificant, + = small, ++ = medium, +++ = large and +>++ = with future possibilities. ^ = greater if an export market exists.
Source: adapted from Hobbs *et al.*, 2007.

their animals (e.g. designing proper feeding strategies, taking preventive healthcare measures, taking culling decisions and preparing mating strategies), all of which help them to increase the productivity of their animals, reduce the cost of farm operations and, in turn, increase profits.

Service providers engage field technicians to provide services to producers, and engage supervisors and managers to supervise their operations. A performance recording system provides information to field technicians, supervisors and managers. Field technicians receive online information about their customers and the performance of their animals. This not only helps them to provide better services to producers, but also helps them expand their services. Supervisors and managers are informed of the progress of their field technicians and can aid them in designing suitable capacity-building strategies. Together, this helps service providers to provide efficient services to producers. Likewise,

breeding companies receive the breeding values of their bulls, which helps them to choose the right pricing strategies for semen doses and thereby optimize their profits.

An integrated performance recording system thus helps numerous stakeholders improve the efficiency of their operations and enhance their incomes. Overall improvement in the efficiency of operations and profit leads to expansion of the sector and the creation of more employment opportunities.

Task 3: Evaluate the cost–benefit relationship

Ideally, the cost–benefit relationship should be analysed and evaluated in economic terms (e.g. profit or return on investment). However, as explained in Task 2, Action 1, this may not be possible due to the difficulty inherent in estimating benefits quantitatively. Therefore, depending on the level of action and the objective, the animal recording system will need to be evaluated not only in terms of formal economic indicators, but also in terms of additional criteria that give consideration to less tangible outputs such as impact on public and animal health. The weight accorded to these criteria will need to be discussed and agreed upon.

It is worth remembering the following points:

- The higher the number of users of a system, the better the cost–benefit relationship. Multipurpose animal recording systems that maximize the number of users are preferable.
- Complex systems using the most advanced technology may not have a better cost–benefit relationship than simple systems using "old" proven technology. The design of the system should be driven by the objective and needs, rather than the technology. This being said, systems using advanced technologies can provide benefits not achievable by old technologies.
- The evaluation of the cost–benefit relationship can support negotiations with different stakeholders regarding how to share the costs of the system (those who benefit most should logically contribute more).

Task 4: Define requirements for sustainability

The sustainability of the system depends upon the fair distribution of costs among all stakeholders. Costs can be easily applied to animal keepers; for example, through application of a fee to the allotment of identification devices. It is more difficult, however, to apply fees to other stakeholders in the value chain (e.g. markets or slaughterhouses) or to stakeholders who want to access data but do not contribute to the system (e.g. food processors and retailers). It is important to develop different scenarios in order to reach a consensus on a mechanism for public and private contributions that will offer financial sustainability for the system. Some suggestions for cost-sharing between actors follow.

- Costs borne by the government:
  - system administration;
  - organizational structure and staffing;
  - official documentation;
  - inspections and audits;

  - software and database, and hosting; and
  - implementation campaign.
- Costs covered by producers and other actors:
  - identifiers;
  - equipment;
  - collection of movement data; and
  - labour.
- Shared costs:
  - response to customer needs (through official offices, producers associations, and other public and private institutions); and
  - distribution of documents, ID devices, notifications and re-identifications.

Legislation should specify how animal recording costs are to be shared among the various stakeholders (the government and the beneficiaries). Countries may also resort to imposing user fees on animal recording services.

The user should be aware that sustainability is not merely dependent on financial resources. It depends also on other factors addressed elsewhere in these guidelines, including:

- the development of specific legislation that, *inter alia*, clarifies the financing of the system, so as to avoid unaccounted costs in the future (see Section X for more details);
- the development of a training plan to instruct the actors involved in the implementation of the system;
- the development of a multipurpose system to maximize use and share costs among several categories of users; and
- the use of an up-to-date platform that ensures constant availability with a user-friendly interface, and avoids unnecessary complications.

Section X

Developing the legal framework

INTRODUCTION

A strong legal foundation is a prerequisite for an animal recording system. This section identifies the key considerations when formulating this legal framework, including an overview of broader legal areas that the system may interact with, key policy issues that should be taken into account, and any mechanisms that may need to be established via legislation for the system to operate effectively. The supporting legal framework must be tailored to the country in question and consider numerous factors, including legal traditions, existing relevant national legislation, available capacity to implement and operate an animal recording system, and any practices already taking place on the ground.

OBJECTIVE

The objective of this section is to provide the reader with an overview of the key steps and issues that must be considered when developing a legal framework for an animal recording system and to highlight the key policy and regulatory decisions to be made when implementing such a system.

TASKS AND ACTIONS FOR DEVELOPING THE LEGAL FRAMEWORK

The following tasks need to be undertaken in order to develop the legal framework:

- determine the purpose and scope of the animal recording system;
- consider all relevant international frameworks;
- identify all relevant areas of existing national regulatory frameworks;
- determine an appropriate national legal framework for the system; and
- develop suitable legislation.

Task 1: Determine the purpose and scope of the animal recording system

Action 1: Identify the desired purpose

The potential uses and benefits of an animal recording system are numerous, and are discussed in detail in Section I and Sections III to VI of these guidelines. The various reasons for implementing an animal recording system, referred to here as "regulatory objectives", may affect the form and content of the required legal framework. When developing animal recording legislation, the regulatory objectives of the system should be considered, as these will determine the type of animal recording system that is implemented. This, in turn, affects the required scope and elements of the supporting legal framework.

Animal recording systems that seek to provide animal health information will usually require mandatory identification and registration of individual animals and associated holdings, which will be consistently monitored and enforced. This enables the implementation of control measures to prevent the spread of animal disease. To limit the initial impact upon

livestock owners, it is strongly recommended to implement mandatory animal recording systems gradually, beginning with specific areas or species, or with a transitional period during which the system is voluntary and fostered by different means of governmental support, becoming compulsory thereafter on a set date.

If the key regulatory objective of an animal recording legal framework is animal traceability, identification and registration of animals will be crucial. This will also require records of all movements and any inputs used. Such a system should also be supported by comprehensive monitoring, inspection and enforcement measures, clearly set out in legislation.

Due to the voluntary nature of performance recording systems, details specifying suitable methods for identification, performance recording and strategic breeding may be set out in voluntary guidelines or codes of best practice, instead of in secondary legislation.

Action 2: Identify the desired scope

In addition to the key regulatory objectives, it is also necessary to consider the desired scope of the system, as this will serve as the basis for drafting legislation at a later stage. Depending upon national requirements and priorities, the animal recording system may be applied to all species or just to those traded internationally. Furthermore, the system may be implemented nationwide or simply applied within a limited geographical area. The desired scope will also depend on national circumstances and capacity. If the primary objective is conservation of genetic diversity, or international trade, then the system may only need to be voluntary and/or extend to particular species or breeds.

In any case, a good regulatory framework should be consistent with national policy and, at the same time, enable future incorporation of new animal species, geographical areas or animal recording components (i.e. animal traceability, animal health information or performance recording) into the animal recording system.

Task 2: Consider relevant international frameworks

A number of international instruments and institutions should be considered when developing a legal framework for a national animal recording system. These frameworks will play a key role in harmonizing national systems and facilitating international trade.

The World Trade Organization (WTO)

The Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement), to which all WTO members are signatories, seeks to prevent the imposition of unjustified barriers to trade between member territories, specifically with regard to the application of food, animal and plant health protection measures to international trade in these commodities. The SPS Agreement allows importing countries to implement sanitary measures considered necessary to protect humans, plants or animals from hazardous organisms potentially associated with imported commodities. However, these measures cannot be more stringent than is necessary to achieve the desired aim (i.e. protection of human and animal health), and must be fully supported by a scientific risk assessment.[43]

[43] See the WTO Agreement on Sanitary and Phytosanitary Measures (SPS Agreement), Article 2.

BOX 13

International OIE standards for the design and implementation of identification systems to achieve animal traceability

The World Organisation for Animal Health (OIE) Terrestrial Code, Chapter 4.2.3. The development of animal recording systems for animal traceability should take into account the following points:

- the desired outcomes and scope;
- the obligations of the veterinary authority and other parties;
- the organizational arrangements, including the choice of technologies and methods used for the animal identification and animal traceability;
- management of animal movements;
- data confidentiality;
- data accessibility;
- checking, verification, inspection and penalties;
- funding mechanisms (where relevant); and
- arrangements to support a pilot project (where relevant).

Source: OIE, 2012: Chapter 4.2.

When implementing animal recording legislation, it is, therefore, important to ensure that the system is no more stringent than is necessary, unless decided otherwise by the country's authorities. One way to achieve this is for the importing state to apply international reference standards, such as the OIE Terrestrial Animal Health Code (subsequently referred to as "the Code"), which is described in Section I of these guidelines.[44] National animal identification and traceability systems formulated in accordance with the Code are presumed not to constitute unnecessary sanitary barriers to trade.[45] For this reason, it is strongly recommended that reference be made to the Code when formulating related legislation. The Code includes general principles and recommendations on the design and implementation of animal identification and traceability systems (see Box 13).

Other international standards on animal identification and traceability

In addition to codes and standards formulated by the OIE, there are a number of other standards that should be considered when formulating animal identification systems. ICAR standards, while not recognized as reference standards for the purpose of the WTO SPS Agreement, are nonetheless applied widely by livestock keepers to foster harmonization of animal recording systems worldwide and, therefore, help to promote international trade in

[44] See www.oie.int/about-us/our-missions/

[45] OIE standards are specifically mentioned as international reference standards in the SPS Agreement. This is not the case for the TBT Agreement, which refers broadly to "relevant international standards". However, the Appellate Body of the WTO in the "Sardines case" (Dispute DS231) recognized Codex standards to be a "relevant international standard" under Article 2.4 of the TBT Agreement.

animals and animal products. Accordingly, it is recommended to make reference to ICAR standards when developing national animal recording systems.

Task 3: Identify all relevant areas of existing national regulatory frameworks

Before implementing animal recording legislation it is necessary to conduct a thorough assessment of the existing legal system, including all relevant legislation, constitutional provisions, and the general administrative and institutional structure. Identifying all areas of overlap or conflict with existing legislation will facilitate an informed legislative drafting process. The existing regulatory frameworks may then be amended or updated as necessary. The result of this exercise will be effective animal recording legislation that integrates smoothly with existing regulatory frameworks.

Action 1: Identify where legislative competence lies within the country

The first step before developing legislation is to understand where legislative or rule-making competence lies within the country, as this will heavily influence the scope of any animal recording legislation. In some instances, competence for legislating on animal production and animal health may lie exclusively with decentralized administrations.[46] In such cases, it may be appropriate to include traceability systems under the authority of the central government to legislate on global health protection and harmonization of trade standards. Harmonized legislation on such matters at a central level will help ensure that identification and traceability systems are consistent nationwide, thus optimizing their effectiveness.

Action 2: Conduct a legislative assessment and gap analysis

A legislative assessment should be conducted to identify all existing legislation that may impact upon an animal recording system, or require revision to permit its implementation (see Box 14). Once identified, a "gap analysis" of existing legislation should be conducted to identify any gaps, shortcomings or areas of duplication within the existing system. Any such duplication of provisions or duties risks creating confusion and increasing the administrative burden among the relevant government bodies. At this stage, the OIE Code may be used as a checklist of key elements to assess the structural integrity of the national legal framework. It is also important to take into account any responsibilities assumed at an international or bilateral level, such as international trade agreements. Such restrictions may limit the options available to the national government when implementing new legislation. Analysis of the legal framework may also reveal an existing legal basis for the implementation of an animal recording system; for example, within general animal health or disease legislation.

[46] For example, in India the power to legislate on matters relating to agriculture lies exclusively with state legislatures (Constitution of India, Schedule 7, Article 246).

BOX 14

Key regulatory areas that may require consideration or amendment when implementing an animal identification and traceability system

Animal production, health and biosecurity legislation. Regulatory areas to consider include legislation governing animal health, animal welfare, disease eradication and drug administration programmes, farm registration, transportation and housing of animals, and rules governing sustainable livestock production. A range of legislation addressing various biosecurity issues, including the control of invasive alien species, quarantine measures to prevent the spread of disease, and similar legislation, will be aided by the introduction of an animal recording system.

Transportation of livestock. Existing legislation regulating the movement of livestock may be affected by the introduction of an animal recording system, which is likely to impose more stringent recording requirements for all animal movements nationwide. This will extend to legislation governing the import and export of animals and animal genetic material (semen and embryos).

Slaughterhouse and marketplace controls. Legislation imposing controls upon slaughterhouses, marketplaces and other livestock gathering points will interact closely with an animal recording system. Introduction of the latter is likely to impose more stringent record-keeping and reporting requirements upon operators of such livestock gathering points.

Sale and distribution of animal products. The ability to trace animal products to their farm of origin is often a key requirement in the sale and distribution of animal products, especially in an international context. The introduction of an animal recording system will, therefore, greatly affect regulatory systems governing the sale and distribution of animal products.

Food safety and consumer protection. Food safety and consumer protection is a crucial aspect of food production, and requires systems for tracing food products from the farm to fork. Accordingly, an animal recording system will play an integral role, and will need to work in close conjunction with any food safety legislation.

Action 3: Assess the practical application of existing legislation and collect information from different stakeholders

It is strongly recommended to assess the content of existing legal instruments and their application in practice. If animal identification provisions already exist within the country but do not operate effectively, it is important to investigate why this is the case.

Stakeholders, especially livestock keepers, should be involved in all stages of the consultation and drafting process, starting from the early stages of the assessment. Gathering primary information from keepers on the practical impact of existing legislation will allow better understanding of existing shortcomings and regulatory needs. Stakeholder participation will help to draft legislation adapted to national circumstances and facilitate consensus

building and, at a later stage, implementation of the legislation. This approach will also facilitate a preliminary impact assessment of the proposed new legislation.

Task 4: Determine an appropriate national legal framework for an animal recording system

Action 1: Identify available capacity

Before drafting a legal framework for an animal recording system, it is necessary to ascertain whether the country has sufficient financial and administrative capacity to implement, monitor and enforce a compulsory system, and whether animal keepers are likely to have adequate financial capability to comply. In certain circumstances, a voluntary system may prove more effective than a poorly monitored and enforced compulsory system.

Action 2: Identify the appropriate legal structure

Legislation is necessary to introduce compulsory animal recording requirements, but also to harmonize the use of voluntary animal recording systems. For example, legislation may serve to harmonize animal identification methods or movement tracking and recording methods. Any draft legislation concerning animal recording systems should be compliant and compatible with the national legal framework, including constitutional provisions, existing legislation and the policy objectives of such systems and national capacities for implementation.

The form of legislation required to implement an effective animal recording system will vary according to the existing legal framework and legislative practices of the country in question, including whether its legal system is based on common law, civil law, religious law or another legal structure.

In some cases, the creation of new primary legislation may be the most suitable option, especially if the law is aimed at modifying previous primary legislation, establishing new responsibilities for existing institutions or creating a new institution with a legal mandate, introducing taxes, infringements or sanctions, or any other matter necessary according to the rule of law in the national legal system. Secondary legislation can then be used to prescribe methods of identification for specific species and to amend or update any technical details in consideration of technical advancements. Box 15 summarizes the key differences between primary and secondary legislation.

Alternatively, animal recording may be afforded a legal basis in general animal health or broader veterinary legislation. The specific details of the system could then be implemented through secondary legislation. Regardless of which model is chosen, it is important that specific details (such as approved methods of identification used in the animal identification and registration component) are present in a form that is easily amendable, thus allowing modifications to be made as technology advances. In practice, the most suitable form of legislation will depend upon the applicable national legal system and the scope of any legislation already in existence.

BOX 15

Key differences between primary and secondary legislation

Primary legislation is passed by the legislative branch of government, commonly called the Parliament or National Assembly.[1] It constitutes the highest legal authority, second only to a national constitution.

Secondary legislation is passed by the executive branch of government, in accordance with powers granted by primary legislation. The scope of any secondary legislation may not exceed the limits set out in the corresponding primary legislation. Secondary legislation is commonly used to expand upon general principles contained in primary legislation and to set out technical or detailed aspects of a legal framework, such as approved methods of animal identification. In most cases, secondary legislation is easier and quicker to amend than primary legislation, and is used as a way of introducing new standards or amendments to technical requirements.

[1] In some countries, constitutions allocate to the executive branch of the state the power to pass primary legislation in specified areas and under specified conditions.

Selection of a legal instrument will also be affected by a country's form of government. A centralized government may make decisions to which provincial, state or regional governments must adhere. In contrast, a decentralized government grants regions or decentralized territories the power to make their own decisions within given areas of law, as per the constitution of the country. Additional challenges may arise when implementing an animal recording system within decentralized or federal government systems. In this context, issues to consider include the distribution of powers between federal and state or decentralized authorities. In such a government system, it is important to find a balance that allows the implementation of a harmonized animal recording system, while respecting the semi-autonomous nature of each administrative division. The distribution of powers concerning animal health control and animal production may impact significantly upon the design and implementation of an animal recording system; specifically, whether legislative powers for matters relating to animal health and production lie with the central government or with decentralized authorities or state governments.

To achieve harmonization in cases where decentralized levels have the authority to create and implement legislation, it is important that decentralized animal recording systems comply with certain minimum coordination standards established by central government. Decentralized authorities may be closely involved in the formulation of such standards, thus encouraging and increasing their likelihood of compliance, and may retain the discretion to implement more stringent regulations than those enacted by central government.

BOX 16

Animal recording legislation and legislative traditions

In Argentina, which uses a civil law system, regulations on animal recording are contained within primary legislation published by the Servicio Nacional de Sanidad y Calidad Agroalimentaria.[1] Livestock identification and traceability in Spain, which also applies a civil law system, is implemented through a series of primary legislation (commonly in the form of Royal decrees) of the Ministry of Agriculture, Fisheries and Food and the Ministry of Health.[2]

In the United Kingdom of Great Britain and Northern Ireland, identification and traceability systems are implemented through secondary legislation enacted under the authority of the Animal Health Act 1981.[3] The rules concerning the identification and traceability of cattle in the European Union are commonly contained within EU Regulations, which are directly applicable in all Member States.[4] However, the rules relating to the identification and traceability of swine and poultry are contained within EU Directives, so Member States must approve national implementing legislation before they have legal effect.[5]

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1 Livestock identification in Argentina is regulated on a species-specific basis. For example, the identification and registration of cattle is governed by Resolución No 103/2006 "Créase el Sistema Nacional de Identificación de Ganado Bovino".

2 The primary legislation regulating the Spanish livestock identification and traceability system (Sistema de Trazabilidad Animal [SITRAN]) includes: Real Decreto 1980/1998, of 18 September, which established a system for identification and registration; Real Decreto 947/2005, of 29 July, which established a system for the identification and registration of sheep and goats; and Real Decreto 479/2004, of 26 March, which established and regulates the National Livestock Holding Database (REGA).

3 Specifically, the Cattle Identification Regulations 2007, the Sheep and Goats (Records, Identification and Movement) (England) Order 2009, and the Pigs (Records, Identification and Movement) Order 2011.

4 For example, Regulation (EC) No. 1760/2000 of the European Parliament and of the Council, "establishing a system for the identification and registration of bovine animals and regarding the labelling of beef products and repealing Council Regulation (EC) No. 820/97".

5 Council Directive 2008/71/EC "on the identification and registration of pigs" and Council Directive 2005/94/EC of 20 December 2005 "on Community measures for the control of avian influenza and repealing Directive 92/40/EEC".

Box 17 illustrates how powers and responsibilities for matters relating to livestock production and health, including animal recording systems, may be divided in practice. Regardless of which model a country chooses, a key consideration is ensuring that the legislation is sufficiently flexible to enable amendment to take account of technological advancements in the field of identification and traceability methods. To achieve this, approved identification devices and associated technical requirements, such as the construction and composition of ear tags, may be set out in easily amendable schedules or annexes to the legislation.

BOX 17

Different options for animal recording legislation

In many cases, the most suitable structure will vary between countries. For example, in the United States of America, federal legislation has been passed to create an animal recording system, and has imposed mandatory identification and traceability requirements on all animals moved interstate.[1] This federal system does not include within its scope any animals moved within the boundaries of a single state or tribal nation. Individual states and tribal nations remain free to regulate animal movements within their territories, and may choose to implement an animal recording system that is more stringent than that implemented at federal level. The competent authority responsible for implementation and management of animal recording at the federal level is the Animal Plant Health and Inspection Service (APHIS), which forms part of the United States Department of Agriculture (USDA). To enable successful implementation of these systems within each administrative division (states and tribes), APHIS must work closely with state and tribal animal health authorities.

In India, animal husbandry and agriculture are state issues, as prescribed by the Constitution of India.[2] Accordingly, control of the central government over state implementation of regulations concerning livestock health or production is limited. The federal authority responsible for matters relating to livestock health, production and wellbeing (including identification and recording) is the Department of Animal Husbandry, Dairying and Fisheries, within the Ministry of Agriculture. The role of the federal government is to facilitate coordination and provide advice and assistance (financial or otherwise) to state authorities on such matters. Most states have a Department of Agriculture and Animal Husbandry responsible for matters pertaining to animal health and production.

[1] For further information, see www.aphis.usda.gov/traceability/

[2] Constitution of India, Schedule 7.

Task 5: Develop suitable legislation

1. Key elements of animal recording legislation

Although the format and structure of legislation will vary widely depending upon national circumstances, the remainder of this section lists a number of key components often found in animal recording legislation. This list is not intended to be prescriptive, but, instead, serves as a guide to support the formulation of national legislation. The specific provisions of such legislation will vary widely according to national legislative practices, the desired objectives and the type of legislation through which the animal recording system is established. Nonetheless, in order to achieve a harmonized, consistent national approach, it is crucial that the legislation be clear and unambiguous regarding the operation of the system, and should, to the extent possible, identify the key actors and their specific roles.

1.1 Objectives

The "regulatory objective" of an animal recording system is the primary reason for which the system is established. Before implementing animal recording legislation, governments must identify the regulatory objectives that they seek to achieve.

The regulatory objectives of animal recording legislation should be clear and it should be evident how these objectives will support wider national strategies and policies relating to human health or economic development. The objectives of an animal recording system may be stated expressly, as is the case with EU legislation. In other legal systems, where the objective is not expressly stated, it may be implied by the title of the legislation or by the subject matter that it addresses. However, it is strongly recommended that the objective be expressly specified in the legislation unless this is contrary to national legislative practices.

1.2 Scope

The scope of legislation refers to the range of people, practices or activities to which it applies. When regulating animal recording systems, countries may want to identify, where applicable: the geographical areas or administrative divisions within their territory to which the law will apply, the species it will cover, and the operators that will be affected. This may vary widely in practice. For example, animal recording may only be required for the movement of specific species of livestock across administrative boundaries within a country.

It is, therefore, crucial that the scope of the legislation and any exemptions from the animal recording system are explicitly stated in clear and precise language that avoids the risk of uncertainty. For example, exemptions may be applied to persons that keep or produce animals only for personal consumption. If this is the case, it should be expressly stated in the text of the legislation.

For practical purposes, and to minimize the initial impact upon producers, governments may wish to introduce an animal recording system gradually. This may be achieved in a number of ways, including:

- specifying that an animal recording system will only apply to animals born after a specific date;
- specifying that animal recording requirements will only apply to animals that are moved between farms or establishments;
- specifying in the legislation the time frames for implementation of the system's various components, including premises registers and databases, and the coordination and distribution of tasks within the competent authority; and
- implementing a voluntary animal recording system that will evolve into a mandatory system upon a clearly specified date and, as relevant, in specified areas or circumstances (e.g. legislation may provide that animal traceability is voluntary in general, but compulsory for breeding animals or animals intended for export).

1.3 Definitions

To ensure consistency and to avoid ambiguity, legislation must clearly define all key terms and phrases and be consistent in their usage. These include, but are not restricted to, the following: "animal"; "identification device"; "holding"; "establishment"; "owner"; "keeper";

"traceability"; and "competent authority". While definitions are by no means universal, and terms may be used differently in different countries, general guidance can be found in the OIE *Terrestrial animal health code* glossary. Countries may also obtain inspiration from existing animal recording legislation in other countries and regions with a special interest in target markets.

1.4 Institutional structure

In order to set up a national animal recording system, the government will need to designate one or more entities responsible for implementing, regulating and managing activities related to animal recording, including the coordination of potential entities involved in the system, both at central and decentralized levels. When designing an institutional framework and appointing responsible national authorities, governments should consider: (i) the main purpose of the system; and (ii) the administrative and constitutional division of powers within the country.

With regard to the main purpose of the system, animal recording systems focused on health interests may need to take into consideration the roles and duties of all institutions with a health-related mandate. These systems may (immediately or progressively) extend to all animals of the same species or to different species and would, therefore, require strong coordination among the regional or local authorities responsible for farm registration, markets, slaughterhouses and animal movement control. Animal recording systems that aim primarily to facilitate animal traceability or performance recording will commonly involve government bodies responsible for animal husbandry and production.

With regard to the administrative and constitutional division of powers, it is important to consider the issue of decentralization and the allocation of responsibilities for managing an animal recording system within a decentralized or federal state. In practice, the balance of powers between centralized and decentralized government bodies, or federal and state governments, will be determined on an *ad hoc* basis, and is addressed in greater detail earlier in this section.

In any case, animal recording legislation should identify the authority or authorities with a role in setting up and implementing the system, and should clearly designate their powers and duties, as well as any coordination mechanisms to promote consistency. The key authorities should include the following:

- **National Veterinary Service ("the competent authority").** As noted above, the most suitable government body to manage an animal recording system may depend on the regulatory objective of the system, and the country's administrative structure.
- **Enforcement authorities.** In any legal framework that imposes duties or responsibilities, it is essential to ensure adequate monitoring and enforcement. In the case of an animal recording system, these functions will often be performed by employees of the competent authority or outsourced to a third party under government supervision.
- **Livestock owners, keepers or responsible persons.** In many jurisdictions, legislation distinguishes between "owners" and "keepers" of livestock. "Owner" refers to the legal owner of animals, while "keeper" implies any natural or legal person responsible for the daily management of livestock. While the apportionment of responsibilities and

liability may vary between countries, it is important that at least one party is responsible for ensuring, where deemed necessary by law, identification and registration of animals, maintenance of registers, reporting of information, accessibility to this information for inspection by the authorities, and that animals are moved in accordance with official requirements and with all required documentation.

- **Businesses that produce and procure identification tools.** Registration of these actors is recommended to promote harmonization and quality assurance in the production of identification devices. As discussed in Section III, consistency in the use of identification devices and the information they provide is crucial to achieving nationwide harmonization. Identifiers must also meet strict standards set out by the national competent authority.[47] To ensure that such standards are met, legislation can demand that businesses producing and procuring identification tools must be registered in a central database.

1.5 Allocation of responsibilities

As confirmed in the OIE *Terrestrial animal health code*, legislation should clearly delineate the obligations placed on actors involved in establishing a secure animal recording system to facilitate animal traceability and accurate disease tracking in the event of an outbreak.[48] Some actors such as slaughterhouse operators may be addressed under separate legislation, depending upon the form of legislation in place within the country; in which case, implementation of an animal recording system may require an amendment.

1.6 Methods of identification

It is crucial that animal recording legislation clearly specifies the accepted methods for identification of animals, discussed in greater detail in Section III of these guidelines. Regardless of the method chosen, required specifications for identifiers and identification methods should be prescribed in detail in a legal instrument that permits sufficient flexibility to allow changes to be made, as necessary. In many countries, this requirement is stipulated in secondary legislation, which is generally easier to amend than primary legislation.

1.7 Record-keeping, registration and databases

The maintenance of appropriate registers and the communication of relevant information are fundamental to the functioning of an animal recording system, and are addressed in detail in Section III of these guidelines. To support the recording and storage of such data, animal recording legislation should:

- clearly identify each register to be created and specify the information to be contained therein;
- identify the person(s) responsible for the maintenance of each register and set out the scope and limits of their responsibilities;

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[47] For example, see European Union "Commission Regulation (EC) No. 911/2004 of 29 April 2004 implementing Regulation (EC) No. 1760/2000 of the European Parliament and of the Council as regards eartags, passports and holding registers", Chapter 1.

[48] OIE, *Terrestrial animal health code* (21st edition, 2012), Article 4.2.3, paragraph 6.

- prescribe the record-keeping requirements, including the minimum length of time for storage of records; and
- impose an obligation on record-keepers to share this information with the relevant authorities upon request.

1.8 Management of animal movements and other events

If the animal recording system is intended to enable animal traceability, then the legislation should clearly specify:

- the accepted procedure for movement of animals;
- the information to be submitted to the relevant authority each time an animal is moved;
- the persons responsible for submitting the movement notification; and
- the prescribed time limit for submitting the movement notification.

1.9 Monitoring and inspection

To be effective, an animal recording system must be supported by legislation containing adequate monitoring and inspection provisions. In the case of animal recording systems intended to provide animal health information and promote food safety, such provisions should require announced and unannounced inspections of establishments, to determine whether appropriate records are being maintained, and whether all animals are being correctly identified and recorded.

Legislation designed to enable effective monitoring often affords inspectors a range of powers, including the authority to:

- enter and inspect facilities;
- handle and mark animals;
- require access to any appropriate records (either written or electronic);
- make copies of any records; and
- seize items that are considered necessary for investigation.

In practice, the exercise of these powers may impinge upon fundamental rights, such as the right to personal property. The government must, therefore, establish the mandate to exercise this authority under primary legislation that clearly sets out the extent and limits of these powers. Countries that have already incorporated these powers into animal health primary legislation may not need to include them in animal recording legislation.

The body responsible for carrying out monitoring and inspections may vary between countries. In federal states, either federal or regional authorities may carry out this function. In practice, the exercise of such powers will require the inspector to present appropriate documentation approved by the competent authority.[49]

[49] Inspectors in the United Kingdom of Great Britain and Northern Ireland possess a similar range of powers, the exercise of which is conditional upon the presentation of appropriate documentation (Cattle Identification Regulations 2007, Part 4).

BOX 18

Traditional traceability models and nomadic pastoralism

Pastoralism involves the frequent and often-irregular movement of livestock to fresh pastures, and is commonly practised in Central Asia and Africa. This form of animal husbandry highlights the limitations of traditional traceability models, particularly with regard to the notification of animal movements. In such cases, legislation may instead require that livestock owners notify authorities of their intended route and the expected duration of their movement, prior to departure.

Under such circumstances it is important to establish who is accountable for the identification of animals and for the notification of animal movements and other events. In some cases, animal keepers may be difficult to contact and it may, therefore, be difficult to hold them accountable. In practice, it may be more appropriate to apply joint liability to owners of establishments and local authorities.

1.10 Funding

Governments may choose to enact legislation to ensure that appropriate funding is provided for their animal recording system. The national government normally decides whether costs incurred in the operation of an animal recording system are borne (wholly or partially) by the state or fall entirely upon keepers. If financial support mechanisms are provided (see Section IX, Task 4), it is important that these are outlined in the legislation.

1.11 Confidentiality of information

The implementation and operation of an animal recording system will require the submission of potentially sensitive information, such as personal contact details, details of animals held at establishments and animal movement records. This may result in resistance to the creation of such a system. To minimize such resistance and protect the interests of all parties involved, governments must ensure that the relevant legislation contains provisions ensuring the confidentiality of any sensitive information or a reference to the appropriate data protection legislation. Due to the nature of the information provided, these provisions may need to be stricter than measures contained in pre-existing data protection legislation.

1.12 Enforcement

To ensure the effectiveness of an animal recording system, governments must ensure that the supporting legislation contains adequate enforcement procedures, and that inspectors have the necessary authority to carry out enforcement effectively. The following steps should be taken when developing an enforcement system.

Identify all violations. The first step is to decide which acts or omissions constitute a violation. All violations must be clearly identified and covered in the legislation in a list of violations. Possible violations include failure to identify and/or register an animal correctly, failure to submit notification of animal movements within prescribed time limits, and failure to register

an establishment where animals are kept. Violations may be committed by key actors, including producers and marketplace owners, or persons acting on behalf of the competent authority.

Each violation on the list must then be categorized as administrative or criminal in nature.[50] In practice, this will depend upon the gravity and potential consequences of a specific violation. Making a violation an offence and imposing criminal sanctions may serve as the greatest deterrent. However, if the violation is administrative in nature, then power to declare an act or omission as a violation will normally lie with the appropriate body and not with national judicial institutions. This may be easier, quicker and more cost-efficient from a practical perspective. Administrative violations will also require lower evidence standards and will, therefore, be easier and quicker to enforce. In contrast, higher evidence standards are required for offences and the imposition of criminal sanctions may be harder to enforce.

Identify appropriate penalties. Once the nature of a violation has been determined, it is necessary to determine appropriate penalties in terms of severity, which must be specified within legislation. This may include the issuance of a fine, the imposition of movement restrictions that prevent animals entering or exiting a particular establishment, or other measures intended to limit a producer's right to operate. Penalties must be sufficiently high to deter non-compliance, but not so harsh that they are disproportionate to the scale of the offence.

Over time, the deterrent effect of monetary penalties set out in animal recording legislation may decrease due to inflation. A number of steps may be taken to address this issue:

- Include mechanisms that enable such penalties to be updated, as necessary.
- Implement new legal instruments, as necessary, that allow penalties contained in animal recording legislation to be multiplied by a certain number, taking into account inflation or other relevant factors.
- Do not specify the exact penalty within legislation, but provide a range within which the penalty for a specific offence may fall. This will allow the responsible authority to exercise their discretion, allowing adjustment to take account of the gravity of the offence and of other factors such as inflation.
- Use innovation solutions such as linking the size of a penalty to a non-monetary indicator, like an accurate cost-of-living index.

Specify all relevant procedures. Once the appropriate penalties for violations have been determined, legislation must clearly specify the procedures that apply in the event of a violation. It is crucial that these procedures respect all basic legal rights afforded to individuals under international law and the national constitution, particularly if the violation is considered a criminal offence. Legislation must respect the right of due process and include a right to appeal any decision to a higher authority.

Incentives for compliance. In some jurisdictions, legislation may also contain incentives to encourage compliance. This may be of particular interest in the case of voluntary traceability systems, but may also help to foster compliance while implementing a compulsory identification system. To help prevent corruption, regulatory frameworks for incentive systems should define who is eligible to receive an incentive, the procedure to establish specific criteria, the reporting mechanisms and they should also calculate the amount of the incentive.

[50] A criminal violation is an offence.

Section XI

Implementing the animal recording system

INTRODUCTION

Section II describes an integrated multipurpose animal recording system composed of four components, namely animal identification and registration, animal traceability, animal health information and performance recording. Section VII describes a strategic plan for developing such a system. This section provides guidelines for its implementation.

The type of activities needed to implement the animal recording system will vary depending upon the objectives and components of the system, and the extent of these activities will vary depending upon the scope (e.g. species and geographical areas to be covered). However, the implementation process to be followed is essentially the same, and applies to both the pilot and roll-out phases (Table 16).

This section details the activities listed in Table 16, and as such provides a synthesis of the whole document.

OBJECTIVE

The objective of this section is to provide guidance on how to implement an integrated multipurpose animal recording system, based on the established strategic plan.

TASKS AND ACTIONS FOR IMPLEMENTING THE ANIMAL RECORDING SYSTEM

Before deployment over a wide area, it is advisable to test all functionalities of the animal recording system in a pilot area. This will help provide information on problems experienced during field implementation, improve the operational plan, and rectify potential errors in the software. Implementation activities during both the pilot and roll-out stages can be categorized into three phases:

1. The preparatory phase;
2. The execution phase; and
3. The maintenance phase.

The three phases and the related activities are described extensively in what follows. Once the system reaches the maintenance phase, it is advisable to perform independent evaluations at regular intervals to ensure compliance with standard operating procedures.

I. THE PREPARATORY PHASE

The preparatory phase involves the following tasks:

- setting up the enabling environment;
- deploying and training personnel;
- preparing public awareness materials;

TABLE 16
Process for implementing animal recording activities

Phase	Tasks and actions during pilot and roll-out phases
I. Preparation	1. Set up the enabling environment • Establish the legal framework • Establish the institutional framework • Establish the IT infrastructure and develop the software application 2. Deploy and train personnel 3. Prepare public awareness material 4. Field test the software application 5. Procure relevant equipment and consumables 6. Prepare the budget and cost-sharing scheme and secure the funding
II. Execution	7. Train field staff 8. Launch a public awareness campaign 9. Distribute equipment and consumables 10. Implement the animal identification and registration system • Premises census: identification and registration of premises, keepers and owners • Initial tagging: identification and registration of animals 11. Implement the animal traceability system • Record movements, thefts, losses, deaths or slaughters 12. Implement the animal health information system • Record health events 13. Implement the animal performance recording system • Record performance recording events
III. Maintenance	14. Animal recording, registration and traceability • Record new premises and changes of keepers and owners of existing premises • Record new births • Continue to record movements, deaths or slaughters 15. Animal health and performance recording • Continue to record health events • Continue to record performance events 16. Monitoring and evaluation

- field testing the software application;
- procuring relevant equipment and consumables; and
- preparing a budget and securing funding.

The preparatory phase leading up to implementation of the pilot stage may take at least one year to complete. However, the experience gained in implementing the pilot stage may significantly reduce the duration of the preparatory phase for roll-out of the system in other areas.

Task 1: Set up the enabling environment

Action 1: Establish the legal framework

A legal base is fundamental for implementation of the animal recording system. If appropriate legislation is not in place, this should be developed and implemented. The process for the development of suitable legislation is addressed in detail in Section X. The time taken to pass legislation may vary from country to country, but may take at least one year. This period may

be extended in countries with a federal governance structure. Lessons learned during the pilot phase could assist in finalizing the legislation.

Action 2: Establish the institutional framework

The government should first designate the competent authority as per the legislation, and establish a national steering committee representing the major stakeholders to oversee implementation of the animal recording system. The steering committee may form any number of technical committees to advise on technical matters, depending upon the objectives and scope of the project. For example, it may form a technical advisory committee for each of the components of the animal recording system (see Figure 18).

The competent authority either coordinates the implementation of the animal recording system and the creation of a dedicated central technical unit, or delegates this task to a coordinating institution. It is critical that the coordinating institution possesses the capability to maintain the required central servers and communication infrastructure, and to run the software application. For large countries, this scheme could be replicated at state or provincial levels, if necessary. The main responsibilities of the coordinating institution are to:

- issue detailed guidelines and prepare manuals on implementing the various components of the animal recording system for personnel at all levels;
- train the trainers of decentralized offices and field staff;
- prepare material for awareness-raising campaigns;
- field test the software application;
- migrate data from other databases;
- establish a help-desk to provide support for users nationwide;
- prepare the budget;
- procure all equipment and material such as ear tags and print products;
- carry out public awareness campaigns; and
- coordinate field activities through regional and district level teams, etc.

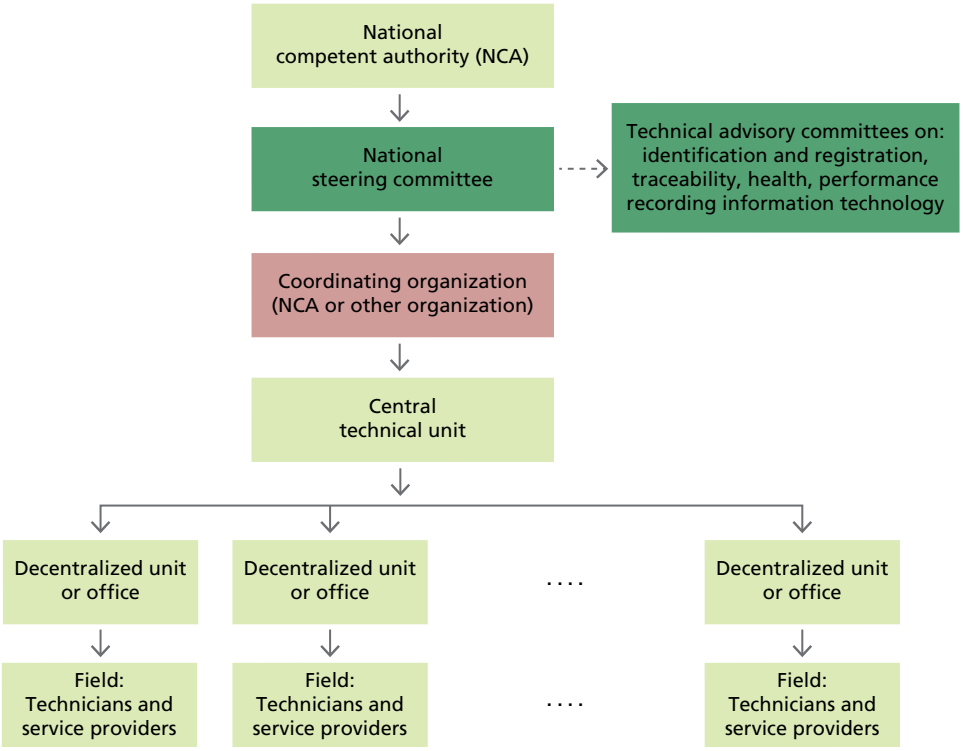
In large countries, these responsibilities could be shared between the central (national) and local (state/provincial) coordinating institutions.

Action 3: Put in place the software platform and IT infrastructure

Before initiating animal identification and recording activities in any area, it is first necessary to set up the required infrastructure for the central database and communication network to link to the central database, and ensure the software application is fully operational. Section VIII of these guidelines presents details on the development and implementation of a software application and IT infrastructure; in particular, related to the purchasing and adaption of ready-made software or the development of tailored software, as well as options for hosting the software application internally or externally. The following IT-related activities must also be carried out:

- preparing operating manuals for implementing the software application;
- training trainers for decentralized offices and service providers;
- establishing a help desk to assist users in resolving problems encountered in using the software application;

FIGURE 18
Institutional structure for implementing an animal recording system



- migrating data (if any) from other systems;
- creating a data exchange protocol using XML technology for regular data exchange with other organizations;
- creating the required master files (e.g. list of organizations; list of users within organizations and their privileges; list of registered owners, keepers and animals; list of bulls used; list of diseases; list of feed materials, etc. used for validation of data entered); and
- providing support to participating organizations to purchase required equipment and establish wired or wireless connectivity.

Task 2: Deploy and train personnel

Professionals with first-hand experience in implementing animal recording systems – or some of their components – should staff the central technical unit. If such personnel are not available locally, at least one or two key personnel could be recruited from outside the country for an initial period. The size of the central technical unit depends upon the objective and scope of the animal recording system (see the example presented in the Annex).

The coordinating institution, with the support of the central technical unit, must decide how to organize field operations and identify who will undertake the activities involved. This could include its own staff; however, service providers could also be authorized to perform field operations for a specific time period and a specific service region.

Task 3: Prepare public awareness material

Before commencing any operation, it is important to launch an awareness campaign for keepers. The campaign should explain the animal recording system, its objectives and benefits, and the related activities, and should urge keepers to participate for their own benefit and for the interests of the nation as a whole. Campaign materials should be prepared during the preparatory phase, in the form of press releases, short movies, posters, leaflets and so on. A communication strategy should also be developed based on the use of a variety of media (the press, television, radio, display hoardings, keepers' meetings, etc.).

Task 4: Procure relevant equipment and consumables

The main supplies needed for implementation of the animal recording system are ear tags (or other identification devices), applicators, readers, handheld devices/smartphones, laptops and desktops, printers, copiers, scanners, central servers and stationery. Other support equipment such as vehicles may be required in order to cope with the additional work involved or in the case of newly established units. It is important to obtain the required supplies in a timely manner and to follow standard procurement procedures to ensure competition and best value for money.

Frequent problems and proposed solutions related to procurement are:

- **Inadequate budget allocation.** If possible, prices should be checked before publishing the tender.
- **Inadequate time to complete the tendering process.** It is important to plan sufficient time to allow the whole procurement cycle to be completed and to repeat a tender if necessary (e.g. if the bids exceed the projected budget). Extended time may be required for approval of the tender dossier by the beneficiaries and possibly by donors (if any).
- **Need for additional time to prepare technical specifications**. Technical specifications must be sufficiently detailed to avoid inadequate offers, but not so detailed as to restrict the number of bidders. This is especially important, as in many cases the cheapest bid is chosen among those who fulfil the specifications. Technical specifications may also be used to preselect suppliers.

The time required to prepare a tender, invite bids, evaluate them, award a contract and finally receive delivery may be three to six months in the case of ear tags, and up to two years in the case of a software application (if new software has to be developed). Specialists should be involved in the assessment of technical details, particularly for ear tags, computer hardware and software applications. Appropriate service and maintenance provisions must be established for software applications and hardware infrastructures. Attention should also be paid to informing local companies regarding applications to tender.

Task 5: Field test the software application

Before field testing the software application, all functionalities and use cases should be thoroughly checked, both by the developer and the coordinating institution. For example, all validation checks built into the system should be tested (e.g. use of a letter instead of a number, an illogical date or a first calving age less than 15 months). The system should generate appropriate warnings and error messages to help the user (see Section VIII).

The field test will be performed across a few selected premises to test the software in real conditions with real data. During field-testing of the software application, a sufficient amount of accurate test data must be entered to simulate the workflow of the whole system and to test all functions. A procedure must also be developed to record any errors found and ensure that they are rectified. In particular, the following steps should be incorporated:

- establish test cases to test each software function;
- specify a full test to simulate complete sets of follow-up actions;
- establish load tests for both the software and hardware to ensure the system performs properly when working at full speed;
- nominate testers from central and decentralized units and other user groups;
- familiarize testers with the software application;
- evaluate test cases and modify the application on the basis of the test results.

There must be close collaboration between the technical staff of the coordinating institution and the software developers to ensure that the product fully meets users' needs.

Task 6: Prepare budget and cost-sharing scheme and secure funding

Preparing a budget for the planned activities and ensuring a long-term commitment on the part of government or donors to meet the cost of the animal recording system are essential for successful implementation. A plan for ensuring long-term funding must be developed at the outset. This should include agreement between the central and local governments concerning the sharing of costs. Sustainability of animal recording systems can only be ensured when the private sector shares, or takes over, responsibility for implementing the systems and meets part of the cost of implementation over a period of time.

II. THE EXECUTION PHASE

The activities to be executed at field level will depend on the animal recording system components (i.e. animal traceability, animal health information or performance recording, or any combination of these). Irrespective of the components included, the following tasks need to be undertaken before implementing the field activities:

- training the identified field staff;
- launching a public awareness campaign; and
- procuring and distributing the required equipment and consumables.

Once these have been completed, some or all of the following activities should be undertaken:

- implementing the animal identification and registration field activities;
- implementing the animal traceability field activities;

- implementing the animal health field activities; and
- implementing the performance recording field activities.

Task 7: Train field staff

The trained decentralized officers should, in turn, train the field technicians and/or service providers and keepers. The training programme and topics should be adapted to the needs of each category of trainees:

- Keepers:
  - objectives and benefits of the animal recording system; and
  - how to record appropriate events.
- Field technicians and/or field service providers:
  - identification and registration of premises, keepers, owners and animals;
  - obtaining a movement ID card and recording movements;
  - recording health events;
  - recording performance events;
  - data entry procedures; and
  - software training.
- District/regional centres:
  - data entry procedures; and
  - software training.
- Other stakeholders (personnel of livestock markets, slaughterhouses, breeders' associations, breeding organizations, road police, etc.):
  - data entry procedures; and
  - software training.

Training support materials can include PowerPoint presentations, leaflets, guidelines, information material about standards and various official documents. The guidelines will provide technical and operational assistance to the different actors in implementing the animal recording system. The standards may be encompassed in secondary legislation. Leaflets providing a brief overview of correct procedures, and paper forms and identifiers are issued for use by keepers, livestock markets and police, in case of traceability.

Task 8: Organize a public awareness campaign

It is important to launch the awareness campaign just before actual activities are initiated in the target area. Launching this activity too early would raise expectations at a time when the system is not yet operational, which may cause disappointment among stakeholders. Conversely, launching this activity after the start of fieldwork would leave stakeholders unprepared, possibly leading them to view the system as an intrusion into their affairs. Activities related to promotion and publicity may include:

- a press conference and press release;
- distribution of leaflets to keepers with animal recording extension messages;
- distribution of leaflets and posters to veterinary practitioners, extension offices, breeding organizations, breeders' associations, farmers' unions, etc.;
- promotional videos;

- short commercials for national and regional radio and television;
- use of billboards in target regions/areas; and
- physical meetings with keepers, traders, market agents and other relevant stakeholders.

Responsibility for managing the primary media campaign may be assigned to the coordinating institution, whereas responsibility for managing regional (e.g. village-level) campaigns could be assigned to local offices or service providers.

Task 9: Organize the distribution of equipment and consumables

Before actual field operations begin, the required equipment and consumables must reach the relevant persons. For example, all field assistants must receive the required quantity of identification devices, applicators, readers, official paper documents, handheld devices and measuring tools (e.g. flow meters, measuring jars, measuring tapes and weighing tools). Distribution of equipment and consumables must be monitored via the software application. Important official documents (e.g. movement ID cards) should be assigned serial numbers and their distribution monitored.

Task 10: Implement animal identification and registration

Animal identification and registration should be undertaken in two steps:

- initial identification and registration of premises, keepers and owners; and
- initial identification and registration of individual animals.

The two-step approach is recommended for large herds, with identification and registration of premises carried out along with their keepers and owners (preferably in combination with a mass vaccination programme) before undertaking individual animal identification and registration. In the case of smallholders, the identification and registration of premises, keepers and owners can be undertaken alongside that of individual animals, as the premises, keeper and owner of the animal may be the same entity.

Action 1: Conduct the identification and registration of premises, keepers and owners

The activities involved are as follows:

- Tagging assistants are supplied with preprinted, uniquely numbered registration forms for premises, keepers and owners.
- Tagging assistants carry out interviews with keepers and owners and complete a premises registration form for each premises in an assigned area. Section III details the information to be collected for premises, owners and keepers.
- Tagging assistants either enter the data directly into the central server via handheld devices/notebooks/laptops or send completed forms to a nearby local office where data entry persons enter the data into the central database.
- Registration of transitional premises such as livestock markets, livestock fairs and slaughterhouses can be performed by means of a file transfer if their numbers and ownership details are known in advance.

Action 2: Conduct the initial identification and registration of individual animals

The activities involved are as follows:

- Tagging assistants apply the ear tags with printed ID codes (e.g. numbers and bar-code), one on each ear. These display the same unique ID code.
- Tagging assistants complete an animal registration form for each animal. Section III details the data to be collected for each animal. Once the animal is registered in the central database, an identification document for the animal is printed and sent to the keeper.
- Tagging assistants either enter data directly into the central server through handheld devices/notebooks/laptops or send the completed forms to a nearby local office where data entry persons enter the data into the central database.

If tagging assistants encounter a premises that is not yet registered, they must register it then tag each animal and complete an animal registration form.

Initial identification and registration of animals in one geographical area may be undertaken incrementally or all at once (see Section IX, Box 12 for a comparison). If possible, the latter approach is preferable, as it facilitates rapid implementation of the animal identification component and easy identification of new arrivals (whether newborn animals or animals moved from another area). This can be undertaken in conjunction with a mass vaccination programme, if possible. During visits, vaccinators can identify and register unidentified animals in addition to newborn animals. Identification and registration can also be performed under a genetic improvement programme, with animals within a given area included in the programme.

Task 11: Implement animal traceability

An animal entering or leaving premises constitutes a movement. Registration of animal movements forms the basis of animal traceability. The functionality that allows registration of movements in the database has been implemented under Task 1, Action 3. The activities involved in recording movements include the following (see Section IV for more details):

- Keepers are issued with an individual movement ID card (i.e. animal passport), either upon request or upon provision from service providers. This document is a permanent document and remains with the animal throughout its lifetime. The minimum information contained on the movement ID card is the animal's ID, the colour(s), sex, year of birth (and exact date if known) and the premises ID of birth. The latter information may not be known at first identification, as the animal may have been transported to the premises. Alternatively, the ID of the premises where the animal has been identified can be given. Depending upon the objective, additional information may be added during the lifetime of the animal, including the sire ID, dam ID, health status and vaccination history, as well as any treatments.
- When an individual movement ID card is not used, keepers may utilize a movement permit (or other official document or form). This document is a temporary animal document and remains with the animal for one movement. It may be a document for one animal or a list of individually identified animals.
- When an animal is moved between premises, the movement details are recorded on the movement ID card. The minimum information recorded at the time of movement

(or arrival at the new premises) includes the original premises ID and the date of departure, the new premises ID and the date of arrival, the type of movement, and the vehicle ID (optional) if a vehicle is used. In the latter case, the vehicle ID could be used to check probable contacts between animals if the same vehicle has collected animals from different premises.

- It is important to specify a time limit for issuing newborn animals with a movement ID card (e.g. within one month of birth) and for recording each movement on the ID card (e.g. within three days of the movement). The movement ID card accompanies each animal on every movement throughout the course of its life.
- The ID card should be returned to the designated authority on the animal's death, slaughter or export.
- In the case of animal imports, an animal identification record from the exporting country should be kept and linked with the animal identification assigned by the importing country. Similarly, in the case of animal exports, an animal identification record from the exporting country should be provided to the veterinary authority in the importing country.

Movement reporting will increase if controls and incentives are implemented. Incentives should only benefit herds that are in compliance with animal traceability requirements. Controls should be undertaken at a number of stages – during transportation (by road police), and at livestock markets and slaughterhouses. Only animals in compliance with regulations should pass and be accepted. Controls should include unofficial as well as official livestock markets and slaughterhouses, as failing to include the former will present a risk to the whole traceability system (see Section IV for more details).

Task 12: Implement animal health information recording

Veterinarians performing on-farm activities, such as vaccination or sampling, must be equipped with paper forms or electronic devices (smartphones, tablets, etc.) for the registration of all pertinent information regarding their activities (e.g. date of intervention, control programme of concern, type of vaccine used or type of samples taken, tests requested by the laboratory) and the identification codes of animals. All data must be entered into the animal health information system, regardless of the method used on the farm (i.e. paper or electronic device). As a general rule, the person who performed the veterinary activity that produced the data should enter them into the system, as early as possible. This reduces the risk of errors due to misinterpretation, which increases significantly if the information is entered at a later date.

In the case of paper-based registration, once the national animal identification database is in place, it is advisable to use forms that are prefilled with farm and animal identification data. When samples must be taken for laboratory use, the field operators should be equipped with labels preprinted with the animal identification codes to be used for identification of samples. The prefilled forms and labels will often include barcodes to facilitate data registration at the laboratory, thereby avoiding typing errors.

In cases where smartphones, laptops or tablets are used on the farm, it may be possible to employ small portable printers for the production of labels. In addition, when animals are electronically identified, transponder readers can be connected with laptops or tablets to register automatically the codes of animals subjected to control activities.

One particular aspect of field activities within the framework of an animal health information system is the registration of information in the event of suspected or confirmed disease outbreaks. The use of smartphones or tablets on the farm will allow field operators to notify authorities of any issues quickly, and provide veterinary authorities with the required information in a timely manner.

Laboratory information management systems must be fully integrated with the animal health information system. Laboratory results are recorded in the laboratory information management system following specific procedures and using a standard nomenclature for samples and tests. This nomenclature must be compatible with that used in the animal health information system. Laboratories must be equipped with computers, servers for data storage and internet connections.

Correct implementation of an animal health information system requires detailed operational procedures for at least the main activities. Periodical evaluation of the effectiveness of these procedures and overall system performance is essential to enable prompt and appropriate corrective action.

Development of the IT platform, where all data are collected and integrated, will require significant effort. Planning and implementation of the information system and the related IT platform will involve a multidisciplinary team, comprising contributions from IT specialists and engineers, as well as epidemiologists, GIS experts and so on. Feedback from in-field veterinarians will also be crucial for the development of appropriate data management utilities, with comments passed directly to the platform developers.

Task 13: Implement performance recording

Service providers furnish a variety of services to keepers through their field technicians, who collect specific data relating to different events. For example, artificial insemination technicians collect data on artificial insemination, pregnancy diagnosis and calving. They may also register newborn calves and record the parentage. Similarly, milk recorders collect monthly yield data and send samples for analysis at milk component laboratories. The specific activities involved are as follows:

- Field technicians provide services and collect data in a specified format.
- Field technicians either enter data directly into the central database through handheld devices/notebooks/laptops or send the completed forms to a nearby local office where data entry persons enter the data into the central database.
- Field technicians provide feedback to keepers and support them in planning and decision-making.
- Service providers monitor all field operations, organize review meetings with field technicians, supervisors and managers, and take corrective action to improve the overall efficiency of services they provide to keepers.

III. THE MAINTENANCE PHASE

During the maintenance phase, initiated activities are carried forward with increased efficacy. In order to improve the overall efficiency of the animal recording system, the following specific activities may need to be performed:

- improving the performance of hardware, communication channels and software application, and reducing response time;
- incorporating changes to meet the new requirements of all stakeholders, including keepers;
- documenting the benefits of the animal recording system and publicizing success stories;
- organizing workshops to exchange experiences;
- encouraging the formation of farmers' organizations to take over animal recording activities;
- working towards making the animal recording system sustainable by ensuring the fair sharing of costs among beneficiaries, including keepers, service providers and governments (see Section IX for details); and
- organizing an independent, external, five-year strategic review of the animal recording system to assess progress, identify favourable factors and constraints, document benefits, identify opportunities, improve existing SOPs, etc.

Task 14: Conduct animal recording, registration and traceability

In the case of large herds, keepers can undertake the ongoing identification and registration of newborn animals and the recording of movements (including transfer of ownership and death). In the case of smallholders, service providers can perform these activities when carrying out periodical inventories of premises (e.g. every six months). However, it is important also to identify and register animals that leave the premises. Official veterinary staff can perform such regular inventories in conjunction with disease vaccinations, provided that the latter are repeated at regular intervals. In order to carry out periodic premises inventories, tagging assistants or field technicians must:

- be provided with prepopulated premises inventory forms for both the relevant area (e.g. village) and premises. These forms must display the premises ID and data for all live animals;
- identify and register all newborn animals, and record animal movements;
- in the case of lost or illegible ear tags, re-tag the animal and record data concerning the old and new tags; and
- upload data to the central server via handheld devices/notebooks/laptops or send the completed forms to a nearby local office where data entry persons enter the data into the central database.

If field technicians regularly visit keepers to provide other services (e.g. artificial insemination or milk recording services), such visits may also be used to undertake animal identification and registration. For such keepers, a premises inventory may be taken annually. Keepers of large herds may report the above-mentioned activities themselves via the internet or other means, as and when they take place. They may also provide their farm inventory data on an annual basis.

Operators of transitional premises such as traders, transporters, livestock markets, fairs and slaughterhouses must maintain and update the list of animals that enter and exit their premises on a daily basis. They can either upload these movements directly in the central

database via the internet, or submit appropriate paper forms to a local veterinary office where data entry staff enter the data to the central database.

Task 15: Conduct animal health and performance recording

The activities pertaining to health recording and performance recording carried out during the maintenance phase are the same as those carried out during the execution phase.

Task 16: Implement a monitoring and evaluation mechanism

A monitoring mechanism should be developed to ensure compliance with the standard operating procedures laid down for implementing the animal recording system. The mechanism should check that all newborn animals are identified and registered, that all deaths and movements are reported, that no animals are kept or moved without an official identification number, and that all new premises are identified and registered. The distribution of identification devices must also be monitored, in order to avoid misuse and to reduce the inventory of unused identification devices. Appropriate routine supervisory systems should be incorporated to check for false recording of data under animal identification and registration, traceability, health or performance recording systems. Review meetings should highlight problems encountered and take appropriate corrective action where required.

To ensure compliance with animal recording requirements, it will also be necessary to implement an independent quality control system. Once a year, spot checks should be undertaken by an independent team at randomly selected locations (e.g. villages) to check for compliance with animal identification and registration, traceability, health or performance recording requirements. In the case of animal identification, registration and traceability, inspectors should visit randomly selected farms to check whether premises, owners, keepers and animals are being correctly identified and registered, and whether births and movements (including deaths) are being correctly recorded. The inspectors must also visit selected livestock markets, livestock shows and slaughterhouses to check for compliance with regulations on reporting of animal movements. In the case of performance recording, inspectors can randomly select villages and keepers to check for compliance with rules on the measurement of different traits. For example, extra testing for milk traits can take place the day after regular testing and include milk yield as well as milk components. If the difference between regular and extra testing exceeds a specified critical percentage, the relevant farm should be subjected to further controls. Repeat testing should comprise a specified percentage of all participating farms in each year. The observations of the independent inspectors should be recorded in the system for possible use at a later date for risk analysis.

References

Calistri, P., Conte, A., Natale, F., Possenti, L., Savini, L., Danzetta, M.L., Iannetti, S. & Giovannini, A. 2013. Systems for prevention and control of epidemic emergencies. *Veterinaria Italiana*, 49 (3), 255–261. (available at www.izs.it/vet_italiana/2013/49_3/255.htm).

FAO. 1998. *Secondary guidelines for development of national farm animal genetic resources management plans – animal recording for medium input production environment.* Rome (available at www.fao.org/docrep/012/i0770e/i0770e00.htm).

Hobbs, J.E., Yeung, M.T. & Kerr, W.A. 2007. *Identification and analysis of the current and potential benefits of a national livestock traceability system in Canada*. Agriculture and Agri-Food Canada.

ICAR. 2012. *International agreement of recording practices.* Rome, International Committee for Animal Recording (available at www.icar.org/Documents/Rules%20and%20regulations/Guidelines/Guidelines_2012.pdf).

OIE. 2012. *Terrestrial animal health code (21st edition).* Paris, World Organisation for Animal Health (available at www.oie.int/international-standard-setting/terrestrial-code/access-online/).

Annex

Estimation of the costs for various animal identification, registration and traceability scenarios

This annex presents a simulation of three implementation scenarios and their resulting costs.

1. FULL TRACEABILITY WITH ELECTRONIC IDENTIFICATION

The first scenario consists of implementing an animal identification, registration and traceability system for a cattle population of 3 million head. Implementation is gradual with individual identification of all newborn calves in each year performed before the age of six months, using a pair of identifiers (electronic and visual). Implementation is completed within five years.

The following assumptions are made in order to calculate the cost of movement and changes of ownership:

Year 1: movement of 30 percent of animals born this year;

Year 2: movement of 30 percent of animals born in Year 1 and 30 percent of animals born this year;

Year 3: movement of 40 percent of animals born in Year 1, 30 percent of animals born in Year 2 and 30 percent of animals born this year; and

Year 4: movement to slaughter of 100 percent of animals born in Year 1, 40 percent of animals born in Year 2, 30 percent of animals born in Year 3, and 30 percent of animals born this year.

A public institution carries out implementation in coordination with other actors, and a service provider is responsible for collecting movement data. Table 17 summarizes the simulation parameters, which are inspired by the Uruguayan system.

The results of the simulation are presented in Table 18. As per the scenario described above, only newborn animals in a given year are identified. The cost of identification devices is then a direct function of the number of calves born (which is a function of the annual calving rate and the percentage of available cows). The unit cost for a pair of visual and electronic tags is US$2. By Year 5, it is estimated that over 90 percent of the cattle population is individually identified. For the remaining unidentified cattle, the actors can either organize a specific identification campaign or wait for their gradual decline.

The cost of vehicles and other equipment is high in the initial phase and decreases later before stabilizing (corresponding mainly to costs for fuel and maintenance and renewal). For the sake of simplicity, no discount factor (or depreciation rate) for equipment was applied. A similar approach was followed for training and awareness raising. The staff cost

TABLE 17
Simulation parameters

Demographic parameters	
Population size	3 million (with annual growth of 3 percent)
Number of target regions or areas	8
Fraction of cows	41 percent
Rate of annual calving	0.44
Identification devices	
Type of device	Visual and electronic (RFID)
Applicators	Variable amount
Equipment for field public officers	
Readers of RFID devices	65
GPS	35
Maintenance of equipment	Variable amount
Vehicles	9
Motorcycles	20
Fuel	Variable amount
Maintenance and spares, including tyres	Variable amount
Annual tuition and insurance	Vehicle taxes and insurance
Computers	50
Laser printers	25
Servers, licenses and warehouse services	2 servers and variable amount for licenses and warehouse services
Equipment for other actors	
Computers	50
Laser printers	50
Readers	60
Modems	Annual servicing
Staff	
National coordinator	1
IT specialist (deputy coordinator)	1
System developers/analysts	4
Help desk officers	4
Administrative officers	2
Field technicians	8 (1 technician per region)
Auditors (inspectors)	1 supervisor and 60 auditors
Data entry officers	20
Operations	
Central office	
Internet connectivity	30 mobile modems
Communication mobile network	Average cost of communication

(Cont.)

Collection of movement data	Cost of the service provider (US$1/animal)
Stationery and forms	Variable amount
Support materials	Variable amount
Projectors	Eight
Furniture	Variable quantity
Archive	Variable amount
Consumables	Variable amount
Field mission allowances	Average value for daily allowance
Training and awareness raising	
Promotion in radio and TV media	Variable amount
Promotion in printed media	Variable amount
Training	Variable amount
Study tours	Variable amount
Miscellaneous	1 to 2 percent

is also stable, with a slight increase due to an applied annual 3 percent salary increase. The operating costs are proportional to animal movements, which, in turn, are proportional to the number of identified animals. The unit cost for collecting movement data used was US$1 per animal movement.

The cost per identified animal or newborn calf varies around US$5. As implementation proceeds, the costs increase due to the higher reading cost. The larger number of identified animals leads to more movements and, therefore, higher costs of reading the electronic devices. If the animal is likely to be read and recorded in the central database less than three times in its entire lifetime, and machine reading is not envisaged in routine farm management operations (milking, growth rate monitoring, animal disease testing, livestock market operations), it may not be cost effective to opt for electronic identification.

2. FULL TRACEABILITY WITH VISUAL IDENTIFICATION

The second scenario is similar to the previous one, the sole change being the replacement of visual and electronic identifiers with a pair of visual plastic ear tags (without barcodes), the cost of which were fixed at half the price: US$1.

When using visual plastic ear tags, reading and data-processing work requires a larger workforce (or more personnel days). The scenario assumes an estimated 30 percent increase in staff costs, although the actual increase involved is very difficult to estimate. The number of field technicians and data entry staff rises to 10 and 26, respectively. The same percentage increase was assumed for the cost of equipment, as well as the cost of field data collection and transfer by the service provider, which rises from US$1 to US$1.30 per animal.

TABLE 18
Summary of costs of implementing a traceability system with electronic identifiers

Costs components	Year 1	Year 2	Year 3	Year 4	Year 5
			US$		
Identification devices	1 082 400	1 114 872	1 148 318	1 182 768	1 218 251
Equipment for public officers	670 700	214 450	214 450	214 450	214 450
Equipment for other actors	129 800	12 000	12 000	12 000	12 000
Staff	322 400	332 072	342 034	352 295	362 864
Operating costs	520 260	671 691	887 559	1 445 437	1 478 852
Training and awareness raising	190 000	190 000	60 000	60 000	60 000
Miscellaneous	200 000	100 000	100 000	100 000	100 000
Total cost	**3 115 560**	**2 635 085**	**2 764 361**	**3 366 950**	**3 446 417**
Annual cost per newborn calf	**5.8**	**4.7**	**4.8**	**5.7**	**5.7**

Note: The unit costs used in these simulations are taken from the analysis of the Uruguayan system, on the basis of newborns, performed by Gabriel Osorio in 2013.

TABLE 19
Summary of costs of implementing a traceability system with plastic ear tags

Investment concept	Year 1	Year 2	Year 3	Year 4	Year 5
			US$		
Identification devices	541 200	557 436	574 159	591 384	609 125
Equipment for officers	782 370	269 220	269 220	269 220	269 220
Equipment for other actors	77 600	12 000	12 000	12 000	12 000
Staff	361 400	372 242	383 409	394 912	406 759
Operating costs	670 328	843 088	1 137 366	1 862 608	1 906 048
Training and awareness raising	190 000	190 000	60 000	60 000	60 000
Miscellaneous	200 000	100 000	100 000	100 000	100 000
Total cost	**2 889 948**	**2 402 944**	**2 650 945**	**3 394 712**	**3 371 893**
Annual cost per newborn calf	**5.3**	**4.3**	**4.6**	**5.7**	**5.5**

Costs are estimated assuming the same movements and changes of ownership of animals as described in scenario 1. The resulting annual cost per newborn calf is only slightly lower than the previous case. Most of the cost reduction due to the use of the plastic tag is offset by the substantial increase in operating costs. The costs of movements and ownership changes are the most determinant components when calculating these operating costs.

TABLE 20
Summary of costs of implementing a group traceability system

Investment concept	Year 1	Year 2	Year 3	Year 4	Year 5
			US$		
Identification devices	75 768	78 041	80 382	82 794	85 278
Equipment for officers	752 320	269 220	269 220	269 220	269 220
Equipment for other actors	79 800	12 000	12 000	12 000	12 000
Staff	421 200	433 836	446 851	440 686	453 906
Operating costs	558 360	522 845	524 004	525 197	526 427
Training and awareness raising	190 000	190 000	60 000	60 000	60 000
Miscellaneous	200 000	100 000	100 000	100 000	100 000
Total cost	**2 277 448**	**1 605 942**	**1 492 457**	**1 489 897**	**1 506 830**
Annual cost per bovine	**0.8**	**0.5**	**0.5**	**0.5**	**0.4**
Annual cost per newborn calf	**4.2**	**2.9**	**2.6**	**2.5**	**2.5**

3. GROUP TRACEABILITY

This system is based exclusively on the identification of premises, keepers and owners, as well as the control of group movement. Hot branding can be recommended here as a means to identify the animals, and its costs are assumed to be US$0.14 per animal. To ensure maximum operating efficiency for such a system, the following cost variations are considered:

- Technical staff (data entry operators and field technicians) increases by about 30 percent compared to the scenario with a visual identification system, as a result of increased fieldwork. This is due to the fact that each group movement is accompanied by documentation, which must be collected and entered into the system for monitoring and traceability.
- Operating costs and support equipment and other inputs double due to the increased work arising from the collection of group data (entry of forms, movement control, auditing premises, livestock inventories, etc.).

Similarly, hardware increases by 30 percent, while the necessary field equipment is reduced (there is no need for readers, the internet and other equipment). The cost of movement control (habilitation/qualification, documentation and shipment) is estimated at US$0.5 per animal.

The results of this scenario are presented in Table 20. In the absence of individual animal identification, the annual cost is expressed per bovine. However, to ensure adequate comparison with the previous scenarios, the annual cost is also expressed per newborn calf. As expected, group identification and traceability are much less costly than full traceability. This approach could be recommended for countries with limited resources or marginal livestock sectors, with a view to evolving towards a full traceability system with individual animal identification, when feasible, taking into account market or health conditions.

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E	–	English	**	In preparation
F	–	French	[e]	E-publication
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The Global Plan of Action for Animal Genetic Resources, adopted in 2007, is the first internationally agreed framework for the management of biodiversity in the livestock sector. It calls for the development of technical guidelines to support countries in their implementation efforts. Guidelines on the Preparation of national strategies and action plans for animal genetic resources were published by FAO in 2009 and are being complemented by a series of guideline publications addressing specific technical subjects.

These guidelines on development of integrated multipurpose animal recording systems address Strategic Priority Area 2 of the Global Plan of Action – "Sustainable use and development". They have been endorsed by the Commission on Genetic Resources for Food and Agriculture.

Animal identification and recording serve multiple purposes in a national livestock sector. They are a prerequisite to establishing and operating a genetic improvement programme and facilitate the monitoring of animal genetic resources. They also contribute to animal traceability and disease control. Traceability of animals and their products helps to identify sources of risk quickly and prevent contaminated or poor quality products from reaching consumers. Implementation of animal identification and traceability systems can enhance market access and generate larger incomes for producers and other players in the value chain, and help to deter livestock theft and prevent fraud. Therefore, animal identification and recording systems are not just information systems, they are also a powerful tool for livestock development and can contribute to global demands for food security and poverty alleviation.

These guidelines adopt a broad approach to animal recording that accounts for the multiple purposes and uses, and translate this approach into multipurpose animal recording systems that integrate animal identification and registration, animal traceability, animal health information and performance recording. The guidelines describe the step-by-step process of developing such systems.

ISBN 978-92-5-109256-9 ISSN 1810-0708

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I5702E/1/05.16