



Global livestock production systems



Photographs on cover:

Woman: ©FAO/Tariq Tinazay

Man: ©FAO/Jose Cendon

Pigs: ©FAO/Klaas Dietze

Global livestock production systems

Authors

Timothy Robinson¹

Philip Thornton²

Gianluca Franceschini¹

Russ Kruska²

Federica Chiozza¹

An Notenbaert²

Giuliano Cecchi¹

Mario Herrero²

Michael Epprecht¹

Steffen Fritz³

Liang You⁴

Giulia Conchedda¹

Linda See³

¹ Food and Agriculture Organization of the United Nations (FAO)

² International Livestock Research Institute (ILRI)

³ International Institute for Applied Systems Analysis (IIASA)

⁴ International Food Policy Research Institute (IFPRI)

Recommended citation

Robinson, T.P., Thornton P.K., Franceschini, G., Kruska, R.L., Chiozza, F., Notenbaert, A., Cecchi, G., Herrero, M., Epprecht, M., Fritz, S., You, L., Conchedda, G. & See, L. 2011. *Global livestock production systems*. Rome, Food and Agriculture Organization of the United Nations (FAO) and International Livestock Research Institute (ILRI), 152 pp.

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations (FAO) concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO in preference to others of a similar nature that are not mentioned. The views expressed in this information product are those of the author(s) and do not necessarily reflect the views of FAO. The designations employed and the presentation of material in the maps do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal or constitutional status of any country, territory or sea area, or concerning the delimitation of frontiers. The word "countries" appearing in the text refers to countries, territories and areas without distinction.

ISBN 978-92-5-107033-8

All rights reserved. FAO encourages the reproduction and dissemination of material in this information product. Non-commercial uses will be authorized free of charge, upon request. Reproduction for resale or other commercial purposes, including educational purposes, may incur fees. Applications for permission to reproduce or disseminate FAO copyright materials, and all queries concerning rights and licences, should be addressed by e-mail to copyright@fao.org or to the Chief, Publishing Policy and Support Branch, Office of Knowledge Exchange, Research and Extension, FAO, Viale delle Terme di Caracalla, 00153 Rome, Italy.

Contents

Abbreviations and acronyms	v
Compound abbreviations for livestock production systems	viii
Foreword	ix
Acknowledgements	xi
Summary	xiii
1 Introduction	1
WHY MAP LIVESTOCK PRODUCTION SYSTEMS?	1
BACKGROUND AND OUTLINE	3
2 Agricultural systems classifications	5
A BRIEF REVIEW OF SOME CLASSIFICATION SYSTEMS	5
MAPPING GLOBAL AGRICULTURAL PRODUCTION SYSTEMS: BETWEEN THEORY AND PRACTICE	9
TOWARDS A STEPWISE METHODOLOGY FOR CLASSIFYING AND MAPPING LIVESTOCK PRODUCTION SYSTEMS	10
3 Mapping global livestock production systems	13
METHODOLOGY, DEVELOPMENTS AND CURRENT STATUS	13
ACCURACY OF GLOBAL LAND COVER MAPS: IMPLICATIONS FOR MAPPING LIVESTOCK PRODUCTION SYSTEMS	18
4 From potential to actual production systems: accounting for crops, livestock and other livelihood options	27
INTEGRATING MODELLED LIVESTOCK AND CROP DISTRIBUTIONS	27
<i>AD HOC</i> EXTENSION OF THE MAPPED LIVESTOCK PRODUCTION SYSTEMS CLASSIFICATION	40
5 Accounting for intensive livestock production	43
MAPPING INTENSIVE LIVESTOCK PRODUCTION SYSTEMS	45
MAPPING AREAS WITH POTENTIAL FOR INTENSIFICATION	45
MAPPING INTENSIVE PRODUCTION BASED ON SMALLHOLDER DISTRIBUTIONS	49
MAPPING INTENSIVE PRODUCTION BASED ON LIVESTOCK DENSITIES	53
CONCLUSIONS AND DISCUSSION ON INTENSIFICATION	58

6	Linking livestock production systems to rural livelihoods and poverty	61
	LIVESTOCK SYSTEMS AND POVERTY IN UGANDA	61
	AGRICULTURAL SYSTEMS AND POVERTY IN VIET NAM	69
	LIVELIHOOD ANALYSIS AND LIVESTOCK PRODUCTION SYSTEMS IN EASTERN AFRICA	77
7	Applications of global livestock production systems	83
	ALLOCATING PROJECTED LIVESTOCK PRODUCTION DATA BY SYSTEM AND REGION	83
	MAPPING METHANE EMISSIONS FROM AFRICAN LIVESTOCK	87
	MAPPING THE BENEFITS FROM TRYPANOSOMOSIS CONTROL IN EAST AFRICA	91
	DISTRIBUTION OF RURAL POOR LIVESTOCK KEEPERS	94
8	Conclusions and future developments	105
9	References	107
10	Appendices	115
	APPENDIX A	
	Countries grouped under the 2010 World Bank developing regions and country income groupings	117
	APPENDIX B	
	Livestock production systems and estimated numbers of rural poor livestock keepers in the East Asia and Pacific (EAP) region	121
	APPENDIX C	
	Livestock production systems and estimated numbers of rural poor livestock keepers in the Eastern Europe and Central Asia (EECA) region	125
	APPENDIX D	
	Livestock production systems and estimated numbers of rural poor livestock keepers in the Latin America and Caribbean (LAC) region	131
	APPENDIX E	
	Livestock production systems and estimated numbers of rural poor livestock keepers in the Middle East and North Africa (MENA) region	137
	APPENDIX F	
	Livestock production systems and estimated numbers of rural poor livestock keepers in the South Asia (SA) region	141
	APPENDIX G	
	Livestock production systems and estimated numbers of rural poor livestock keepers in the Sub-Saharan Africa (SSA) region	145

Abbreviations and acronyms

AAT	African Animal Trypanosomosis
ADF	African Development Fund
AEZ	Agro-Ecological Zone
AGA	Animal Production and Health Division of the Food and Agriculture Organization
AVHRR	Advanced Very High Resolution Radiometer
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Center for Tropical Agriculture
CIESIN	Centre for International Earth Science Information Network
CSA	Central and South America
CWANA	Central and West Asia and North Africa
EA	East Asia
EAP	East Asia and the Pacific
EECA	Eastern Europe and Central Asia
ERGO	Environmental Research Group Oxford
ESAP	East and South Asia and the Pacific
FAO	Food and Agriculture Organisation of the United Nations
FPU	Food Producing Unit
GAUL	Global Administrative Unit Layers
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographic Information Systems
GLC	Global Land Cover
GLIMS	Global Livestock Impact Mapping System
GLiPHA	Global Livestock Production and Health Atlas
GLW	Gridded Livestock of the World
GPW	Gridded Population of the World
GRUMP	Global Rural-Urban Mapping Project
HIC	High Income Countries
IAASTD	International Assessment of Agricultural Science and Technology for Development
IFPRI	International Food Policy Research Institute

IGAD	Intergovernmental Authority for Development
IGBP	International Global Biosphere Project
IIASA	International Institute for Applied Systems Analysis
ILRI	International Livestock Research Institute
IMPACT	International Model for Policy Analysis of Agricultural Commodities and Trade
IPCC	Intergovernmental Panel on Climate Change
ISCBD	Interim Secretariat for the Convention on Biological Diversity
LAC	Latin America and the Caribbean
LCCS	Land Cover Classification System
LDPS-2	Livestock Development Planning System, Version 2
LGP	Length of Growing Period
LID	Livestock in Development
MAAIF	Ministry of Agriculture, Animal Industries and Fisheries (Uganda)
MEA	Millennium Ecosystem Assessment
MENA	Middle East and North Africa
MERIS	Medium Resolution Imaging Spectrometer
MLCCA	MODIS Land Cover Classification Algorithm
MODIS	Moderate Resolution Imaging Spectroradiometer
NAE	North America and Europe
NCGIA	National Center for Geographic Information and Analysis (USA)
NEMA	National Environment Management Agency (Uganda)
NPA	National Planning Authority (Uganda)
NRP	National Rural Poverty line
OIE	World Organization for Animal Health
PLK	Poor Livestock Keeper
PNN	Probabilistic Neural Network
PPLPI	Pro-Poor Livestock Policy Initiative
SA	South Asia
SC-UK	Save the Children-United Kingdom
SEA	Southeast Asia
SIDA	Swedish International Development Cooperation Agency
SPAM	Spatial Production Allocation Model
SPOT	Système Pour l'Observation de la Terre
SSA	Sub-Saharan Africa
SSCCSE	Southern Sudan Centre for Census, Statistics and Evaluation
TLU	Tropical Livestock Unit

UBOS	Uganda Bureau of Statistics
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USA	United States of America
USGS	United States Geological Survey
VHLSS	Vietnam Household Living Standards Survey
WANA	West Asia and North Africa
WRI	World Resources Institute

Compound abbreviations for livestock production systems

L	Livestock only production system
M	Mixed, crop-livestock production system
C	Crop only production system
G	Grassland-based
L	Landless
R	Rainfed
I	Irrigated
HYP	Hyper-arid
A	Arid and semi-arid tropics and subtropics
H	Humid and sub-humid tropics and subtropics
T	Temperate and tropical highlands

e.g. LGA = Livestock only, grassland-based, arid and semi-arid tropics and subtropics

Foreword

The global livestock sector is rapidly changing in response to globalization and growing demand for animal-source foods, driven by population growth and increasing wealth in much of the developing world. The rapid rate of urbanization seen in many countries is not only linked to growing affluence but also gives rise to changes in people's food preferences; usually tending towards greater convenience and higher standards of safety. As well as the many benefits and opportunities associated with rapid sector transformation and growth, they are also associated with social, environmental and public health risks. Moreover, there is a growing appreciation that the livestock sector needs to operate in a carbon-constrained economy, resulting in increasing competition for land and water resources, and growing pressure for the sector to be managed cleanly, safely and sustainably. But there are huge differences in the ways in which livestock are kept in different places and what their roles are. We need to develop a good understanding of the differences among production systems if we are to be able to help poor livestock keepers take advantage of the rising demand for animal-source foods, help livestock keepers adapt to a changing and more volatile climate; minimize the risk of disease emergence and spread, not only among livestock but also in people; and to help all livestock keepers mitigate greenhouse gas emissions via a wide range of options.

This book has grown out of a long-standing collaboration between the Food and Agriculture Organization of the United Nations (FAO), and the International Livestock Research Institute (ILRI). It emerged from a meeting of international organizations held at the Earth Institute at Columbia University in 2004, at which FAO and the Consultative Group in International Agricultural Research were charged with closing a gap in our understanding of the distribution of agricultural production systems. The book took further shape following a workshop convened by FAO in Bangkok in 2006, during which the custodians of many of the key datasets needed to produce maps of global livestock production systems were brought together with experts and researchers in agricultural production systems. It brings together the results of several years' of activity by FAO and ILRI, along with colleagues from the International Food Policy Research Institute, the International Institute for Applied Systems Analysis and many other organisations not explicitly linked to the production of the book.

The book provides a stock-take of where we are with livestock system classification. It presents the most up to date maps of global livestock production systems and provides revised estimates of the number of poor livestock keepers, globally, within the different production systems. It proposes alternative approaches to mapping production systems that are explicitly linked to livelihoods, and reviews the ways in which intensive production can be accounted for. Several examples are presented of how systems' information can be of value. It also underscores the areas that need further development. The FAO and ILRI continue to work jointly on several of these.

Samuel Jutzi

Director

FAO Animal Production and Health Division

Carlos Seré

Director General

International Livestock Research Institute

Acknowledgements

The work described in this book has been contributed to by many organizations, but emerges in particular from a long-standing collaboration between the Animal Production and Health Division (AGA) of the Food and Agriculture Organization (FAO) and the International Livestock Research Institute (ILRI). This work has in large part been carried out under the Pro-Poor Livestock Policy Initiative (PPLPI), and the authors would particularly like to acknowledge the support and encouragement that has been received from Joachim Otte, Jan Slingenbergh and Samuel Jutzi.

Marius Gilbert has made some very helpful suggestions, particularly in relation to the section on intensive livestock production. Laura D'Aiotti, Valentina Ercoli, Elisa Palamara and Giuseppina Cinardi assisted in preparation of much of the data presented here.

Together with some of the authors, Sonya Ahamed, Jeroen Dijkman, Hubert George, Andy Nelson, Joachim Otte, Henning Steinfeld and Robert Zomer participated in a PPLPI-funded meeting in Bangkok (April 2006), that focused on global livestock production systems and contributed to the development of this publication.

Funding for the FAO contribution to this work has mainly come from the PPLPI (GCP/INT/804/UK), supported by the United Kingdom Department for International Development. Specifically, Timothy Robinson, Gianluca Franceschini, Federica Chiozza and Michael Epprecht were funded under the PPLPI. Giulia Conchedda was funded through the AGA regular programme, which has also contributed to Timothy Robinson's involvement in this work. Giuliano Cecchi was also funded by FAO, within the framework of the Programme Against African Trypanosomosis, in particular through the project 'Pro-poor integrated packages to enhance policy and decision making against the African animal disease burden in sub-Saharan Africa' (GCP/RAF/442/IFA), supported by the International Fund for Agricultural Development.

Philip Thornton, Russ Kruska, An Notenbaert and Mario Herrero were supported by ILRI. For some activities since January 2010, Philip Thornton has been supported by the Climate Change, Agriculture and Food Security Program of the Consultative Group on International Agricultural Research. The work of the Spatial Production Allocation Model at the International Food Policy Research Institute is partly sponsored by the National Basic Research Program of China (973 Program: No.2010CB951502) and the Bill and Melinda Gates Foundation (Harvest Choice project).

The work of Steffen Fritz and Linda See was supported by the International Institute for Applied Systems Analysis and by the EuroGEOSS project, funded by the Seventh Framework programme of the European Commission.

Some of the authors, and those already mentioned, contributed to developing the applications presented at the end of this volume. In this regard, we would like also to acknowledge the inputs provided by: William Wint, Alexandra Shaw, Raffaele Mattioli, Mark Rosegrant, Maria Fernandez, Anushree Sinha, Jacqueline Alder, Helal Ahammad, Charlotte de Fraiture, Bas Eickhout, Jorge Fonseca, Jikun Huang, Osamu Koyama, Abdallah Mohamed

Omezzine, Prabhu Pingali, Ricardo Ramirez, Claudia Ringler, Scott Robinson, Detlef van Vuuren, Howard Yana-Shapiro and Robin Reid.

The artwork in this publication was directed by Claudia Ciarlantini. Fabio Ricci and Simona Capocaccia were responsible for desktop publishing.

Summary

One of the datasets that is becoming increasingly important for priority-setting and targeting by organisations with a mandate for agriculture and agricultural research for development is a spatial agricultural systems classification that provides not only detailed information on the distribution of crops and livestock in different places, but also information on how they are produced and how the various elements interact.

There is considerable spatial heterogeneity in the determinants of rural poverty, and development interventions increasingly need to be targeted at relatively small groups of people, calling for a finer grain in the definition of intervention domains than has been available in the past. Despite the continued development of sophisticated spatial analysis methods and tools, and improving availability of global, spatial datasets, there are still considerable constraints to the development of high-resolution data on livestock, crops, population, climate, land cover and land use to develop useful systems maps that can meet the requirements of a wide variety of potential users.

A short historical review is given of some of the global agricultural systems classifications that have been proposed. A systems classification based on three levels of increasing complexity is presented, and this is used as an organising framework throughout the book. Level one in the classification describes potential livestock production systems and relies on a simple set of global datasets that is continually being updated. Despite its simplicity, this classification system, like many others, relies on land cover data. Problems of uncertainty in all the land cover products currently available persist, although there are several on-going efforts to address these. Level two moves from potential to actual livestock production systems, and attempts to account for other livelihood options in addition to the specific combinations of crops and livestock that people depend on. Level three addresses issues relating to the intensity and scale of production, to incorporate information on management practices, moving from what is done to how it is done.

The relationships between livestock production systems, rural livelihoods and poverty are investigated using case studies at country and regional levels for Uganda, Vietnam and the Horn of Africa, using statistical clustering, artificial neural networks, and livelihood zone analysis.

Four examples of the application of livestock production system classification schemes and maps are then presented: allocating projected livestock production data by system and region for global integrated assessment modelling; mapping methane emissions from livestock in Africa now, and in the future; evaluating the benefits arising from control of African animal trypanosomosis, a serious disease of cattle transmitted by the tsetse fly, in East Africa; and estimating the numbers and distribution of poor livestock keepers, globally.

Further advancements in systems classification and mapping are sorely needed, particularly in relation to level three and the higher-input systems, for these are the areas where changes are occurring most rapidly and where most information is needed on the implications that intensifying systems may have for livelihoods, poverty alleviation, animal

diseases, public health and environmental outcomes. Validation of systems mapping products remains a critical constraint, although meta-analyses and expert evaluation, such as the use of geo-wiki systems, may well provide relatively easy and affordable solutions for global validation in the future. There are considerable challenges ahead, if the global population is to be fed sustainably and healthily in 2050 and beyond. Classifying and mapping global agricultural production systems is not an end in itself but a necessity if we are efficiently to evaluate different technology and policy options and effectively to target where they may be applicable.