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COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE

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INTERGOVERNMENTAL TECHNICAL WORKING GROUP ON ANIMAL GENETIC RESOURCES FOR FOOD AND AGRICULTURE

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THE NATURE OF ECOSYSTEM SERVICES PROVIDED BY LIVESTOCK SPECIES AND BREEDS

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I. Introduction

1. The Global Plan of Action for Animal Genetic Resources (Global Plan of Action) acknowledges the contribution of livestock breeds to key agro-ecosystem functions such as nutrient cycling, seed dispersal and habitat maintenance. Animal genetic resources and livestock management systems are integral parts of ecosystems and productive landscapes throughout the world.[1]

2. The Commission, at its Fourteenth Regular Session, requested FAO to identify the nature of ecosystem services provided by livestock species and breeds kept by all livestock keepers, with special consideration to the important contributions of small-scale livestock keepers and pastoralists, and to report back to the Commission at its Fifteenth Regular Session.[2]

3. This document presents the outcomes of several activities undertaken by FAO in response to this request. More details are provided in Background Study Paper 66, *Ecosystem services provided by livestock species and breeds, with special consideration to the contributions of small-scale livestock keepers and pastoralists*.

II. Methodology

4. In 2013, in collaboration with the European Regional Focal Point for Animal Genetic Resources, the European Federation of Animal Science's Working Group on Animal Genetic Resources and the Universities of Wageningen and Milan, FAO organized a survey, targeting the Europe region, on the environmental benefits of the grazing activities of livestock breeds (European Survey). Twenty-nine responses were received. The European Survey provided an opportunity to test the methodology for a global survey on the ecosystem services provided by grazing livestock in grazing systems, which was undertaken in 2014 (Global Survey). The Global Survey attracted 120 responses, with respondents distributed across all the regions of the world. Grazing systems were chosen as the focus of both surveys because they are the systems that involve the most direct interactions between livestock and the environment, and because large numbers of poor livestock keepers and pastoralists make their livelihoods from such systems. Both surveys were accompanied by extensive literature-based research. Literature and previous FAO work were then used to assess ecosystem services provided by livestock in production systems other than grazing systems. The results of the surveys and the literature review are presented in Background Study Paper 66. The present document considers only ecosystem services that arise from the direct interaction of livestock with other components of the ecosystem.

III. Ecosystem services provided by livestock species and breeds

A. Characteristics of ecosystem services

5. Biodiversity and the services derived from ecosystems are essential to the sustained production of the food, fibres, fuels, energy and freshwater upon which humans depend for their survival. Starting from the understanding that human actions effect ecosystems and that the human species is fundamentally dependent on the flow of ecosystem services, the Millennium Ecosystem Assessment (MEA) examined how changes in ecosystem services influence human well-being, broadly defined so as to include "the basic material needs for a good life, freedom and choice, health, good social relations, and personal security." The MEA distinguished four groups of ecosystem services: provisioning services – referring to products obtained from ecosystems; regulating services – referring to benefits obtained from the regulation of ecosystem processes; supporting services – which are necessary for the production of all other ecosystem services; and cultural services – referring to non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences. Some services (particularly supporting and regulating services) are inputs to the production of others, particularly provisioning services. Many regulating services depend on landscape heterogeneity and the existence of particular landscape

[1] Global Plan of Action for Animal Genetic Resources, Part 1, paragraph 8.
[2] CGRFA-14/13/Report, paragraph 61.

elements. The Economics of Ecosystems and Biodiversity initiative subsumed supporting services, such as nutrient cycling and food-web dynamics, within the regulating-service category. However, it introduced habitat services as a separate category, in order to highlight the importance of ecosystems in the provision of habitats that, for example, allow migratory species to complete their life cycles and enable the maintenance of genetic diversity. The availability of these services is directly dependent on the state of the respective habitat.

B. Linking breed classes to production systems and land cover

6. Like other genetic resources for food and agriculture, livestock breeds are both providers of ecosystem services and, in themselves, an ecosystem service arising from, and dependent on, other ecosystem functions. Their interaction with other ecosystem structures and functions is more complex than that of plants, because of livestock's higher position in the food web, which results in conversion losses and associated environmental externalities. The provision of ecosystem services by livestock differs from one production system to another, as does the type of breed kept.

7. While there is a wealth of information on the ecosystem services provided by livestock in general, it is more difficult to find studies at species level and almost impossible to find studies at breed level. To evaluate the provision of ecosystem services at breed level, it was therefore necessary to take an indirect approach. Climate, production systems and land-cover classes were taken as proxies for breed types, as a means of estimating the numbers of animals associated with various ecosystem services, and the possible breed classes to which these animals belong. Breeds were classified according to their level of adaptedness to their production environments ("locally adapted" versus "exotic") and by their geographic distribution ("local" versus "regional transboundary" versus "international transboundary").[3]

8. FAO recently published new maps of the distribution of the most important livestock species.[4] The data are publicly available on GeoNetwork, the FAO geospatial data repository.[5] For the ecosystem service study, these livestock distributions were disaggregated by climatic zone and land-cover category.[6] All terrestrial habitats potentially suitable for livestock were included in the analysis. Mangroves, land covered by snow and glaciers, and the whole of Antarctica were excluded.

9. It can be assumed that, across all climates and regions, the breeds raised in shrub, sparse and tree-covered areas generally belong to the locally adapted, local and regional transboundary categories. It can similarly be assumed that locally adapted breeds will predominate in herb and grass-covered areas in hyper-arid, arid/semi-arid and humid climates in all regions except in Europe, where they can be assumed to occur only in hyperarid/arid/semi-arid areas. Exotic, international transboundary breeds are not usually able to thrive in harsh dry environments and tend to suffer under the high disease pressures present in humid tropical grassland and tree systems. Locally adapted breeds can also be expected to be found in mixed rain-fed systems in hyper-arid climates in all regions, whereas in Africa, they occur in hyper-arid and arid/semi-arid areas.

10. Globally, 51 percent of all sheep, 44 percent of goats, 38 percent of cattle, 21 percent of pigs and 27 percent of chickens occur in systems where it is predominantly locally adapted breeds that can thrive. In most of these low-input extensive systems, small-scale livestock keepers predominate, with pastoralists widespread in arid rangelands.

11. Locally adapted breeds are generally not used in intensive and industrial systems, as their low output of marketable products makes keeping them unviable economically. Across all climatic zones,

[3] CGRFA-14/13/4.2; 23Report: Workshop on Indicators to Measure Trends in Genetic Diversity of Domesticated Animals;
http://www.fao.org/ag/againfo/programmes/en/genetics/documents/ITWG_AnGR_6/indicator_report.pdf
[4] Robinson, T.P., Wint, G.R.W., Conchedda, G., Van Boeckel, T.P., Ercoli, V. et al. 2014. Mapping the global distribution of livestock. PLoS ONE 9: e96084.
[5] http://www.fao.org/ag/againfo/resources/en/glw/home.html.
[6] FAO. 2014. FAO Global Land Cover (GLC-SHARE) Beta-Release 1.0 Database, Land and Water Division, J. Latham, R. Cumani, I. Rosati & M. Bloise.

breeds of all categories can be found in mixed irrigated systems and in artificial/urban areas, where feed resources are better and animals are often confined. There is also a high probability of finding both locally adapted and exotic breeds in mixed rain-fed systems in arid, humid and temperate climates in all regions except Africa, where they tend to occur only in humid and temperate climatic zones. Similarly, all categories of breeds can be found in grass and herb-covered areas in temperate climates across all regions, and in Europe also in humid climatic areas. The proportions of the livestock population accounted for by locally adapted and exotic breeds in these systems vary, but generally, in all fertile, favourable environments, there is a high probability of finding exotic, international transboundary breeds. The share accounted for by cross-breeds depends largely on the level of intensification.

12. Globally, 49 percent of all sheep, 56 percent of goats, 62 percent of cattle, 79 percent of pigs and 73 percent of chickens occur in systems where both locally adapted and exotic breeds and their cross-breeds can thrive. Both small-scale and large-scale livestock keepers can be found in these higher-input systems.

C. Ecosystem services

Provisioning services

13. Provisioning services – such as the supply of food, fibres and skins – are easier to quantify and value than other ecosystem services, as most have a direct use value that has a market price. The total value of livestock production in 2010 was US$836 787 million, equivalent to 37 percent of the value of all agricultural production.[7]Mixed systems play an important role in animal source food production. However, an increasing share of global livestock production comes from intensive and industrial production systems, especially in the case of monogastrics. [8] FAO estimates that in 2010, 55 percent of the global pig population was kept in semi-intensive and industrial systems, and that 81 percent of the global chicken population was kept in industrial systems. These animals likely belong to high-output international transboundary breeds or their crosses. At global level, international transboundary breeds provide the majority of food and fibre. The other provisioning services are crucial in mixed systems with their many interactions between crop and livestock production.

14. Current economic mechanisms tend primarily to value the provisioning services provided by livestock, while largely undervaluing or ignoring cultural, supporting and regulating services, such as social functions and the maintenance of genetic diversity. Even provisioning services are not always fully accounted for. For example, milk and meat consumed in the household, rather than sold, are not fully covered in official statistics. Moreover, economic statistics do not account fully for the nutritional benefits of animal-source foods, especially for children. FAO estimates that traditional livestock systems, based mostly on locally adapted breeds, contribute to the livelihoods of 70 percent of the world's rural poor. Much of this livelihood contribution takes the form of non-marketed products and services, and often depends on the use of communal resources and ecosystem services. Smallholder's livelihoods will thus be affected if the surrounding ecosystem deteriorates.

15. Working animals play a fundamental role in agriculture and in the transport of goods and people in developing countries. This situation is likely to continue for another twenty or more years, given that the use of working animals remains widespread wherever there are significant rural populations without access to motor transport. In many mountainous or otherwise inaccessible regions, animal power is the only feasible source of energy for agricultural work and transport. It can be assumed that draught animals mostly belong to locally adapted breeds. Working animals can be both direct and indirect sources of income and can make an important contribution to households' access to food and other products and services. Direct contributions arise from the use of animals in the transport of goods and people and from the hiring out of animals to perform agricultural, carting and pack work. Indirect contributions arise when animals are used to cultivate land for crop production or

[7] FAOSTAT.

[8] Steinfeld H., Wassenaar T. & Jutzi S. (2006) Livestock production systems in developing countries: status, drivers, trends. Revue Scientific et Technique office International des Epizooties 25, 505–16.

to transport agricultural produce and farm inputs. In addition to the income-generating opportunities available to the owners of the animals, the use of animal power has a positive effect on the local economy by creating demand for local manufacture, repair and maintenance of related hardware (harnesses, carts, etc.). There are no figures for the number of draught animals in the world. However, FAO estimates that the proportion of cultivated land in developing countries cultivated by draught animals will decline from 30 percent in the late 1990s to 20 percent in 2030. [9] While draught animals are being replaced by machines in Asia, especially in Bangladesh and China, their numbers are increasing in many countries in sub-Saharan Africa.

16. Manure and urine for fertilizer and manure and methane for energy are obtained both from locally adapted breeds kept in small-scale systems and from international transboundary breeds and cross-breeds kept in intensive confined systems.

17. In developed countries, it has been suggested that less than 15 percent of the nitrogen applied to crops comes from livestock manure. In developing countries, the relative contribution of livestock manure may be high, but the extent of its use is not well documented. Manure is not captured in FAO statistics, in contrast to various types of inorganic fertilizer. It has been estimated that, in 2000, nutrients introduced in the form of manure exceeded those introduced in the form of inorganic fertilizers globally.[10] Since that time, fertilizer trade volumes have more than tripled. It is therefore possible that, by today, nutrient input from inorganic fertilizers exceeds that from manure. The proportion of manure used as fertilizer depends on the efficiency of collection, and is difficult to estimate. However, it is probably less than 50 percent in most regions. Manure is traded or exchanged for grain in many parts of the world, and this trade can generate rural employment. Manure is often more accessible to small-scale farmers than inorganic fertilizers. Access to manure can be a reason to keep animals that are not otherwise productive.

18. About 20 to 30 percent of the dietary energy contained in feed is not digested by animals and is present in their manure. Fuelwood, crop residues and animal manure are the dominant biomass fuels used in many rural areas in developing countries. In India, the country where the use of dung for fuel is most prevalent, its income-generating effect is huge. A study in one area of India found that the number of people obtaining their primary income from cow dung was half the total number of jobs in the dairy industry.[11] Methane emissions from manure amount to 300 million tonnes of CO_2-equivalent globally per year, or 16 million tonnes of oil equivalent[12] per year, about the energy use of Ireland. Such emissions can be recovered when manure is fed into biogas digesters, which are becoming more widespread globally.[13]

19. With regard to the role of genetic diversity as an ecosystem service, the greatest relevance of breeds lies in the protection of gene pools and in providing basis for improvements to food production and agriculture; this service applies across all breed classes. Livestock genetic diversity promotes food security and decreases the vulnerability of production to the effects of diseases and climatic variations. In low-input systems especially, locally adapted breeds often produce higher yields or are more resistant to diseases than breeds selected for high performance under optimal conditions. The value of animal genetic diversity depends on its influence both on mean yields and on variance of yields. Genetic improvement through selection is estimated to contribute more than 50 percent to overall productivity increases. An analysis of DAD-IS data reveals a wide range of examples of resilience and plasticity among the world's breeds, including tolerance of climatic extremes, such as hot temperatures, adaptation to poor-quality diets or to feeding in harsh conditions, and resistance to and

[9] FAO. 2003. World agriculture: towards 2015/2030. An FAO Perspective. Rome.
[10] Potter, P., N. Ramankutty, E.M. Bennett & S.D. Donner. 2010. Characterizing the Spatial Patterns of Global Fertilizer Application and Manure Production. Earth Interactions. Volume 14 (2010) Paper No. 2 pp. 1–22.
[11] Harsdoff, M. 2012. The economics of cow dung - Creating green jobs in the dairy sector in India. ILO Geneva.
[12] Tonne of oil equivalent (TOE) is a way of measuring a unit of energy for very large energy consumers such as national economies, with a base of 7.4 barrels of oil.
[13] FAO. 2013. Tackling climate change through livestock – A global assessment of emissions and mitigation opportunities. Rome; FAO 2013. Mitigation of greenhouse gas emissions in livestock production – A review of technical options for non-CO2 emissions. FAO Animal Production and Health Paper No. 177. FAO, Rome.

tolerance of specific diseases. The genetic diversity of the world's livestock thus provides a range of options that are likely to be valuable in adaptation to climate change and in meeting future market requirements.

20. Livestock serve as laboratory animals and test-organisms and are used to produce biochemical products. The "Patent landscape report on animal genetic resources" describes the range of biotechnologies and innovations that depend on livestock and animal genetic resources. [14] Animals may be the source of material used in an invention or they may be the target of an invention. The vast majority of patent references to animal breeds referred to mainstream breeds, such as Holstein cattle and Merino sheep, rather than to rarer breeds.

Regulating and habitat services

21. These ecosystem services are mostly non-consumptive, and in economic terms have only indirect use values or non-use values. Most regulating and habitat services arise from the direct interaction of animals with their environments, and are therefore related to land management practices, especially in grazing systems. Including mosaics of grasslands and low forest cover areas, grassland systems are estimated to cover about 32 percent of the world's land area.[15] In 40 countries, grasslands cover more than 50 percent of the land area.[16] Grasslands make an important contribution to the maintenance of ecosystem functions and biodiversity. In addition to providing feed for livestock, they play important roles as habitats for wildlife, in water retention and in the conservation of plant genetic resources. Grasslands are significant ecosystems in many of the world's important watersheds.

22. Most studies related to the provision of ecosystem services by livestock refer to species only. Evidence for breed-level differences is, in effect, secondary to that at species level. Overall, the effects of species and stocking densities, and of spatial and temporal livestock management, seem to have a larger effect than the specific breed used. However, there are indications that hardiness, pasturing behaviour and dietary choice play a role, in addition to the size and weight of the animals – traits that differ between breeds.[17] Such traits are particularly advantageous in the provision of services in environments that are harsh or challenging (e.g. those at high elevations or characterized by steep slopes, rugged terrain or extreme climates). Environments where the productivity of the vegetation is low require low stocking rates and breeds with low feed requirements. Particularly on dry pastures, only breeds that have low fertility and low performance can be sustained. On degradation-prone soils, the weight of the animals and their use of terrain and spatial mobility are important.

Regulating services

23. Regulating services provided by livestock can be clustered into those related to the ability of animals to convert non-human edible feed and waste into human food, those related to the impact of animals on the land in terms of soil fertility, erosion prevention and climate and water regulation, and those related to livestock's impact on land in terms of the moderation of extreme events.

24. Livestock make their most important contribution to total food availability when they use feed sources that cannot directly be eaten by humans (grass, browse, household waste, swill and crop residues). Livestock often play this role in places where crops cannot be easily grown, such as dry and mountainous areas (where high altitude or steep slopes make cropping systems impossible or where cropping systems would degrade soils) or when they scavenge on public land. In these situations, they add to the amount of energy and protein available for human consumption. Globally, grasses provide about half the biomass used by livestock, and feeds such as crop residues, cut-and-carry forages, legumes and roadside grasses make up about a quarter. In many developing countries, cereal straws

[14] WIPO 2014. Patent Landscape Report on Animal Genetic Resources. WIPO Publication No. 947/3E.
[15] FAO. 2014. FAO Global Land Cover (GLC-SHARE) Beta-Release 1.0 Database, Land and Water Division, J. Latham, R. Cumani, I. Rosati & M. Bloise.
[16] UNDP, UNEP, World Bank, World Resources Institute 2000. A guide to World resources 2000-2001. People and ecosystems – The fraying web of life. WRI Washington
[17] Hoffmann, I. 2013. Adaptation to climate change – exploring the potential of locally adapted breeds. Animal, 7:s2, pp 346–362.

and stovers are quantitatively by far the most important crop residues and comprise up to 50 percent of ruminant diets.[18]

25. When livestock are raised in intensive systems, they use carbohydrates and protein that might otherwise be eaten directly by humans to produce food containing a smaller quantity of energy and protein. In these situations, livestock can be said to reduce the food balance. Grains make up less than one-third of the biomass used by livestock.[13] The species of livestock and the production system both affect the food balance. Livestock in grazing systems consume mostly grass, whereas those in mixed systems consume a range of feeds. Monogastrics, such as pigs and poultry, naturally eat a diet that is, relative to ruminant diets, closer to that of humans. Extensive systems require animals to find a large proportion of their feed from sources that are not edible to humans, while animals in intensive systems are fed concentrate feed that includes cereals, soya and fishmeal. As locally adapted breeds tend to be kept in grassland or mixed systems, they consume more roughage than the international transboundary breeds that predominate in more intensive systems.

26. Weed control and biomass residue management were often mentioned in the responses to both surveys as roles that grazing livestock species can fulfil, particularly traditional breeds in hard-to-reach and steep areas. Livestock grazing and poultry scavenging can also prevent the spread of diseases and agricultural pests.

27. As water is becoming scarce in many regions, the regulation of water cycling and quality (water purification/filtering in soils) is an ecosystem service that directly links human populations to grasslands. The influence of livestock on water flow (natural drainage and influence of vegetation on rainfall) and on the prevention of land degradation and erosion is linked to grazing management.

28. Services related to soil fertility (maintenance of soil structure, nutrient cycling on farm and across landscapes, soil formation) and prevention of land degradation and erosion (maintenance of vegetation cover) are also related to grazing. Strategies for increasing the stock of carbon in rangelands include optimizing livestock densities, restoring soil organic matter and root biomass, rehabilitation with improved legumes and grasses, manure cycling and afforestation or agroforestry. It is estimated that nutrient cycling makes the largest contribution to the total value of all ecosystem services provided each year.[19] In soils that are low in organic matter, the organic matter provided by manure has additional value. Organic nitrogen becomes available to plants over time, so the residual effect of applying manure can be considerable.

29. With regard to climate regulation (soil carbon sequestration, greenhouse gas mitigation), FAO has estimated that improved grazing management practices in grasslands could sequester about 0.41 gigatonnes CO_2-eq of carbon per year over a 20-year period. [20] A further 0.18 gigatonnes CO_2-eq of sequestered emissions (net of increased N_2O emissions) per year over a 20-year time period, is estimated to be possible through the sowing of legumes in some grassland areas. Thus, these practices are estimated to have a combined mitigation potential of 0.59 gigatonnes CO_2-eq, representing about 8 percent of livestock supply chain emissions. FAO, the Chinese Academy of Agriculture Science, the World Agroforestry Centre and China's Northwest Institute of Plateau Biology have developed a methodology for sustainable grassland management,[21] which provides procedures for use in estimating the greenhouse gas emission reductions and/or removals brought about by the adoption of sustainable grassland-management practices in grasslands in semi-arid regions. The tool was approved by the non-profit Verified Carbon Standard, a voluntary greenhouse-gas accounting programme used by projects around the world to verify and issue carbon credits in voluntary emissions markets. This method

[18] Herrero, M., P. Havlík,H. Valin, A. Notenbaert, M. C. Rufino, P. K. Thornton, M. Blümmel, F. Weiss, D. Grace & M. Obersteiner. 2013. Biomass use, production, feed efficiencies, and greenhouse gas emissions from global livestock systems. PNAS 110 (52) 20888–20893.

[19] Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., Oneill, R.V., Paruelo, J., Raskin, R.G., Sutton, P. & van den Belt, M. 1997. The value of the world's ecosystem services and natural capital. Nature, 387: 253–260.

[20] FAO. 2013. Tackling climate change through livestock – A global assessment of emissions and mitigation opportunities. Rome.

[21] http://www.v-c-s.org/methodologies/methodology-sustainable-grassland-management-sgm.

significantly reduces the costs associated with measurement and verification, greatly facilitating the access of small-scale herders to carbon markets, and potentially helping to preserve small-scale herder livelihoods and the locally adapted breeds that they depend on.

30. With regard to services related to the moderation of extreme events (avalanche and landslide control, creation or maintenance of fuel breaks and control of bush encroachment), it seems that in particular environments (such as steep mountain ranges) where only certain species and breeds can graze, these animals fulfil the roles of guardians of intact vegetation and prevent soil erosion and avalanches if their numbers are properly managed. Both surveys found that livestock grazing is frequently used as one of the management techniques to prevent bush encroachment and maintain fuel breaks.

31. Although bees are not included in DAD-IS (except in the case of Poland's national information system), bee diversity is critical for pollination services. It is estimated that about one-third of all plants or plant products eaten by humans are directly or indirectly dependent on bee pollination.

Habitat services

32. Land-based production systems that have both plant and animal components need co-management of the various components of biological diversity, including soils, crops, rangelands and pastures, fodder crops and wildlife. The main link between livestock and the provision of habitat services is again via grazing. If animal movements are appropriately managed and regulations, including property regimes that foster sustainable land management are in place, it is likely that overgrazing can be prevented and that extensive grazing can have a positive effect on the vegetation community, associated biodiversity and other ecosystem services.

33. The most important clusters of habitat services provided by livestock are those related to the connection of habitats (seed dispersal in guts and on coats), those that support the maintenance of species life cycles of (creation or maintenance of habitat for migratory species) and those that contribute to the creation of mosaic landscapes and mini-habitats that sustain biodiversity. By moving their herds seasonally, pastoralists connect different ecosystems. There are many studies on habitat services, but they are mostly at species level. Where breeds are mentioned, they are mostly locally adapted breeds. As most habitats with high biodiversity or conservation value are located in marginal, mountainous, dry or forested areas, they are mostly grazed by locally adapted breeds.

34. In the Global Survey, 70 percent of the 120 respondents mentioned that livestock grazing takes place in protected areas. Forty percent of the grazing areas featured in the survey responses lie within IUCN categories IV, V and VI, 21 percent in categories II and III, and 9 percent in strictly protected areas (IUCN I). Although the responses may represent a biased sample, the results indicate the potential for using nature protection areas for grazing, as well as the dependence of some habitats on continued grazing. The European Survey found that most of the breeds grazing in protected areas were locally adapted or at-risk, indicating the possibility of linking breed conservation with nature conservation. Several country reports submitted as part of the reporting process for *The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture* indicate that improved collaboration between sectors and coordination between sectoral policies and programmes are needed in order to allow potential benefits of this kind to be fully captured.

35. The Global Survey found that grazing area management strategies were correlated with land ownership: herding dominating on communal lands and fencing on private lands. The level of recognition by different stakeholders of the ecosystem services provided by breeds in grasslands differed from one type of land ownership to another, with the highest frequency of positive recognition (69 percent) being in situations where the animals graze on communal lands.

Cultural services

36. Cultural services include the provision of opportunities for recreation and tourism (ecotourism, sports, shows, etc.); knowledge systems and educational values (traditional knowledge about the breed, the grazing and sociocultural systems of the area; experiences, materials or information that promote cognitive development); cultural and historic heritage (cases in which the

presence of the breed in the area helps to maintain valued elements of the local culture; cultural identity, especially for indigenous peoples); natural heritage (values associated with the landscape as shaped by the animals or associated with the animals themselves as a part of the landscape; aesthetic values, sense of place); spiritual and religious experience (religious rituals; human life-cycle events such as funerals and weddings); and inspiration for culture, art and design (traditional art and handicrafts; fashion; cultural, intellectual and spiritual enrichment and inspiration; pet animals).

37. Pastoralists and smallholder livestock keepers are guardians of animal genetic diversity.[22] In traditional livestock production systems livestock play important roles in many lifecycle and religious rituals and knowledge systems. Some of these services (e.g. those related to religious rituals) may be associated with specific traditional breeds, whereas the insurance function provided by livestock may not be breed specific. Cultural services were mentioned in 83 percent of all the responses to the Global Survey as being positively or very positively affected by the presence of traditional breeds.

38. From contributing to religious ceremonies to enhancing the cultural and recreational roles of grazing areas and attracting visitors, the cultural services provided by many livestock breeds contribute in diverse ways to their keepers' livelihoods. Livestock systems allow for agricultural activities in areas that would not otherwise be used (e.g. remote mountainous areas). These activities can prepare the ground for other activities such as tourism. The cultural services most frequently mentioned in the responses to the Global Survey were cultural, historic and natural heritage values and landscape values (22 percent each), followed by knowledge systems (20 percent), recreation (18 percent) and spiritual and religious values (17 percent). The landscape and recreational values of the grazing areas were often reported to be closely linked to the presence of livestock breeds having a positive effect on the heritage value of the region.

39. Left exposed to the vagaries of markets for provisioning services in favourable areas undergoing fast structural change, there is a risk that small-scale livestock keepers will eventually abandon agriculture and livestock production as a livelihood activity; this could result in the loss of locally adapted breeds. The popularity of some breeds is associated with their potential for use in the supply of products of designated geographic origin, i.e. those certified as having particular qualities and characteristics associated with the area where they are produced. Twenty-eight breeds reported in the European Survey were connected to 22 protected designations of origin or geographical indications.

IV. Contributions of small-scale livestock keepers and pastoralists to ecosystem services

40. It is difficult to assess the number of small-scale livestock keepers globally.[23] FAO has estimated that there are more than 500 million family farms, making up over 98 percent of global farming holdings, and that 84 percent of farms are smaller than 2 hectares (this latter category accounting for about 12 percent of global farmland).[24] Although not all family farms are smallholdings, it can be assumed that the majority of family farmers in Asia, Africa and South America are smallholders and that most keep a few livestock.

41. Grasslands and rangelands sustain the livelihoods of large numbers of vulnerable people in many parts of the world. Pastoralism, although not unique to drylands, is the only feasible agricultural strategy in many dry areas. Dryland pastoralism depends on herd mobility to track the extremely high seasonal variability of the vegetation and other resources. Precise figures are hard to come by, but nomadic and transhumant pastoralists may number between 100 million and 200 million people

[22] CGRFA/WG-AnGR-5/09/5; FAO, 2009. Livestock keepers — guardians of biodiversity. Animal Production and Health Paper 167, Rome.
[23] CGRFA/WG-AnGR-5/09/5.
[24] FAO 2014. What do we really know about the number and distribution of farms and family farms worldwide? Background paper for The State of Food and Agriculture 2014. ESA Working Paper No. 14-02. Rome.

globally. Recent estimates put the total number of pastoralists and agro-pastoralists worldwide at 120 million, of which 50 million reside in sub-Saharan Africa. [25]

42. Based on the analysis presented in Parts III B and C of this document, it can be concluded that the majority of regulating, habitat and cultural services are provided in systems, particularly grazing systems, where small-scale livestock keepers and pastoralists predominate and where mostly locally adapted breeds are kept. The large areas covered by these production systems, the importance of grasslands to biological diversity and the link between livestock grazing and nature conservation affirms the role of small scale livestock keepers as guardians of biodiversity beyond the management of their breeds. However, the extent to which small scale livestock keepers and pastoralists actually deliver these ecosystem services depends on a range of institutional factors and management practices.

43. Landless production systems and intensive mixed-farming systems provide the majority of provisioning services globally. These systems are larger scale and technology intensive.

V. Possible ways and means to acknowledge the roles of breeds and their keepers in the provision of ecosystem services

44. In the county reports prepared for *The Second Report on the State of the World's Animal Genetic Resources*, 33 percent of countries reported policies, plans or strategies for animal genetic resources management that specifically address the provision of regulating and/or supporting services. Reported measures were diverse and included incentives aimed at improving management of grazing areas (for maintenance of the ecosystem and the landscape or for fire control), management of crop residues and the supply of draught animals. Most responses indicated that the measures have had significant and positive effects in the areas targeted, with respect to the conservation of biodiversity and landscape, reduction of environmental risks (erosion, fire, avalanche) or prevention of social conflicts and improvement of working conditions. Many responses also noted that the implementation of these measures has improved livestock-keeping practices, leading to diversification of production and increases in the productivity and the economic viability of breed populations.

45. Strategic Priority 5 (Promote agro-ecosystems approaches to the management of animal genetic resources) and Strategic Priority 8 (Establish or strengthen *in situ* conservation programmes) of the Global Plan of Action highlight links between breeds and agro-ecosystems. In the words of the Global Plan of Action, agro-ecosystems "depend on human management practices, knowledge systems, cultural norms, values and beliefs, as well as social relationships and livelihood strategies." Strategic Priority 8 recognizes that encouraging the development and implementation of *in situ* conservation measures "may include support, either directly for breeders of threatened breeds, or measures to support agricultural production systems that manage areas of importance to breeds at risk, the encouragement of breed organizations, community-based conservation organizations, non-governmental organizations and other actors to participate in conservation efforts provided that such support or such measures are consistent with existing international agreements."[26]

46. The analysis presented above shows that a large share of the world's locally adapted ruminant breeds are kept by small-scale livestock keepers and pastoralists in arid climates or in grazing systems where the vegetation is of poor nutritive value, and that it is in these systems that the majority of livestock's habitat, regulating and cultural ecosystem services are delivered. These are also areas where poverty rates are high and where livestock keepers' livelihoods depend on the continued provision of diverse ecosystem services by their animals and the surrounding natural habitats. Intervention measures thus need to take into consideration the close links between ecosystem services and the livelihoods of small-scale livestock keepers and pastoralists. Labelling and the development of specific marketing chains can allow livestock keepers to valorize the originality of products linked to

[25] FAO 2006. Policies and strategies to address the vulnerability of pastoralists in sub-Saharan Africa. PPLPI Working Paper No. 37. Pro-Poor Livestock Policy Initiative, FAO, Rome.
[26] Global Plan of Action for Animal Genetic Resources, Action 2, Strategic Priority 8.

traditional production systems, regions or breeds, and thereby increase the profitability of their activities.[27]

47. Because of the dependence of poor peoples' livelihoods on the natural resource base, the United Nations Permanent Forum on Indigenous Issues, at its Seventh Session,[28] welcomed the adoption of the Global Plan of Action. It requested FAO to give priority to the Global Plan of Action's Strategic Priority 6 (Support indigenous and local production systems and associated knowledge systems of importance to the maintenance and sustainable use of animal genetic resources) and to further develop relevant approaches, including rights-based approaches and payment for services that support the custodianship of local breeds by indigenous peoples. It also recommended the provision of technical and financial support to protect and nurture indigenous peoples' natural resource management, environmentally friendly technologies, biodiversity and cultural diversity, and low-carbon, traditional livelihoods (e.g. pastoralism).

48. The Conference of Parties to the Convention on Biological Diversity has recognized the important role of indigenous and local communities in achieving the three objectives of the Convention and acknowledged the many important contributions of indigenous and local communities, including farmers and livestock keepers, to the conservation and sustainable use of agricultural biodiversity.[29]

49. Many of today's marginal areas in which locally adapted breeds thrive offer potential for nature rehabilitation and conservation. FAO has concluded that if farmers are to provide a better mix of ecosystem services, better incentives will be required. [30] In order to promote the sustainable use of such areas and improve the livelihoods of the people that manage them, the potential for introducing incentives for environmental services (IES) could be explored. Opportunities for grazing and mixed crop–livestock systems to access IES schemes are mainly driven by carbon market schemes, but also include biodiversity and water conservation and hydrological services. IES could contribute to promoting ecological and socio-economic sustainability in grazing systems and hence the maintenance of the associated breeds. For most IES programmes, the income generated from the provision of environmental benefits will remain small compared to that generated from livestock production.[30] However, improved rangeland management also leads to improved livestock productivity. Options for increasing carbon sequestration and biodiversity management through better grazing management could therefore be explored. The roles of specific breeds in such measures would need to be considered, as would the potential for integrated approaches to soil carbon sequestration, livelihood objectives, conservation of wild biodiversity and sustainable use of animal genetic resources.[31] Institutional problems, such as those related to land-use and tenure rights and secure access to resources and knowledge, would need to be resolved in order to enable the often-marginalized livestock keepers of arid and subhumid lands to partake in decision-making and develop and adopt improved rangeland management practices.

50. The Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security (Voluntary Guidelines)[32] are an important component of efforts to improve resource access for livestock keepers. They aim to promote secure tenure rights and equitable access to land and forests, as a means of eradicating hunger and poverty, supporting sustainable development and enhancing the environment. They make specific references to pastoralists, who maintain a wide range of highly adapted breeds, but whose breeds are threatened by a

[27] LPP, LIFE Network, IUCN–WISP & FAO. 2010. Adding value to livestock diversity – Marketing to promote local breeds and improve livelihoods. FAO Animal Production and Health Paper. No. 168. Rome.
[28] E/2008/43, E/C.19/2008/13 paragraph 85.
[29] Decision IX/1. In-depth review of the programme of work on agricultural biodiversity, in: UNEP/CBD/COP/9/29, page 64.
[30] FAO 2007. The State of Food and Agriculture 2007. Paying farmers for environmental services. Rome
[31] Convention on Biological Diversity (CBD) 2009. Connecting biodiversity and climate change mitigation and adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change. Montreal, Technical Series No. 41, 126 pp.
[32] http://www.fao.org/fileadmin/user_upload/nr/land_tenure/pdf/VG_Final_May_2012.pdf

lack of functioning institutions, socio-political instability and poor livestock-sector policies.[33] According to the Voluntary Guidelines, states and other parties should contribute to the understanding of transboundary tenure issues affecting communities, such as those related to rangelands or seasonal migration routes of pastoralists that lie across international boundaries.[34] A technical guide on implementing the Voluntary Guidelines in pastoral rangelands is being prepared. It should do justice to the full range of tenure arrangements in pastoral rangelands in different regions of the world, including those in industrialized countries.

VI. Guidance sought

51. The Working Group may wish to recommend that the Commission:

- Acknowledge the important contributions of all species and breeds to the provision of food, fibre, manure for fertilizer and energy, genetic resources and biotechnology innovations and to the use of primary vegetation and waste;
- Acknowledge the specific contribution of locally adapted breeds and small-scale livestock keepers and pastoralists to the provision of draught power and regulating and habitat services related to sustainable grazing and land management;
- Request FAO to improve the mapping of breed distributions, particularly in grassland-based production systems, in order to better target interventions for pastoralists and small-scale livestock keepers;
- Request FAO to improve assessment methods for ecosystem services provided by livestock, especially services related to the management of biodiversity, to develop results-based incentive systems supporting the continued provision of ecosystem services by small-scale livestock keepers and pastoralists;
- Invite countries to explore options for supporting the provision of ecosystem services through better grazing management, the role of breeds in such measures, and the potential such measures may offer for integrated approaches to livelihood objectives, conservation of wild biodiversity, soil carbon sequestration, water-related services and sustainable use of animal genetic resources;
- Invite countries to strengthen the link between breed conservation and nature conservation, and the collaboration of the agricultural/livestock sector with the environment/wildlife/forestry sector, ensuring full participation of small-scale livestock keepers and pastoralists;
- Request countries where locally adapted breeds and small-scale livestock keepers make essential contributions to ecosystem services and food security, to take appropriate measures to recognize and support them; and
- Invite countries to implement the Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security.

[33] CGRFA Background Study 50: Threats to animal genetic resources – their relevance, importance and opportunities to decrease their impact.
[34] Voluntary Guidelines, paragraph 22.2 (http://www.fao.org/docrep/016/i2801e/i2801e.pdf).