

**PEOPLE AND POLICY
IN RANGELAND MANAGEMENT
A Glossary of Key Concepts**

**Society for Range Management
and International Rangeland Congress**

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Introduction to this Book

From June 29 to July 5, 2008, the International Grasslands and Rangelands Congress (www.igc-irc2008.org) was held in Hohhot City, the capital of Inner Mongolia Autonomous Region, China. During preparation for the Congress, the International Rangeland Congress (IRC) (through the Society for Range Management, SRM) and the Ford Foundation Beijing Office cooperated to organize international authors and Chinese specialists and translators to compile a bilingual (English-Chinese) booklet for sharing with experts, scholars and friends attending the Congress.

The content of this booklet includes: (a) A brief compilation of commonly used technical terms in grassland management; (b) an introduction to 23 core concepts relating to community-based grassland management on which papers were delivered at the Congress; (c) related charts, references recommended further reading materials. Chapters 1 to 23 introduce current academic research and provide scientific reflection on the 23 core concepts. This includes summarizing experience and lessons from international grassland and grassland management and flagging existing problems or debates.

This book is suitable for reference and use by domestic and international scholars and practitioners engaged in grassland and rangeland management at home and abroad. It can also be used as an extracurricular reference resource for grassland and rangeland courses in colleges and universities.

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FOREWORD

Where one is educated and practices his or her profession defines the terminology that is used. As we gather for the 2008 International Grasslands and Rangelands Congress in Hohhot, Inner Mongolia, China, and on the associated pre- and post-congress tours from June 23 to July 12, 2008, we are going to experience the differences in definitions and terms used for grasslands and rangelands activities.

No better example of these differences in the use of terms can be found than in the name of the organizations holding this congress. Just what is the difference between grassland and rangeland? Within a given country it might be clear but between countries it is not. In the United States, for example, there are separate organizations for grassland and rangeland: the American Forage and Grassland Council and the Society for Range Management. However, in many countries, the two “disciplines” are combined within one organization as it is in the South African Grassland Society, the British Grassland Society, and the Chinese Grassland Society.

As disciplines evolve, new terms are coined to describe the work done and the implications for management. Disciplines do not evolve at the same pace in all countries around the world. While one region of the world is working on vegetation manipulation techniques, another might be working on people and policy issues while, yet another is concentrating on ecosystem monitoring and measurement procedures. It is important at congresses such as the one being held in Inner Mongolia in 2008 that there is the opportunity for researchers and managers to compare and discuss their work. In so doing, new terms are going to be voiced. In order to fully understand the progress being made in any one aspect of grassland and

rangeland work, it is important that these terms should be defined and described to allow all to comprehend the results, conclusions, and management implications of that work.

This book attempts to do just that. A number of concepts have been described and in each the terms currently used in that discipline are found. The hope is that this publication will assist us all to come to a common understanding of the terms and concepts being used in grassland and rangeland work.

We are all indebted to the Ford Foundation Beijing Office for envisioning the need for such a document to allow a better understanding of the presentations that will be made at the 2008 IGC-IRC in Hohhot. This effort would not have been possible without the contribution of the Ford Foundation.

May your grassland, or work on rangelands be monitored as sustainable.

We wish to thank all chapter authors for their generous and voluntary contributions to this volume. We hope you will be rewarded by the interest of your readers and by their application of new insights.

We also thank the 2008 IGC-IRC Congress simultaneous translators for preparing the Chinese chapter translations as a way of becoming familiar with Congress terms and concepts. We hope this will not only improve the quality and satisfaction of the Congress for all but also build capacity to continue engaging with grassland and herding issues in translation. Thanks to Bai Qiumei, Guan Yuan, Li Yong, Ma Jianbo, and Yu Shiqiang for their speedy and enthusiastic work. We also wish to thank Professors Zhang Yingjun, Rong Yuping, and their postgraduate students at China Agricultural University for translating the technical terms in Chapter One of this Glossary.

Thanks to Drs. Zhang Qian from the Chinese Academy of Social Sciences and Irene Bain from the Ford Foundation Beijing Office Environment and Development Program for editing the Chinese text at short notice. Thanks also to Irene and Yu Haiyun for formatting much of the text.

We recognize that this bi-lingual edition is only a first attempt to grapple with terms relating to grasslands/rangelands and their dependent communities. We look forward to further refinement of expressions – most importantly through their application in reality and together with grassland/rangeland communities of interest.

James T. O'Rourke
President
International Rangeland
Congress

1 TERMINOLOGY FOR GRAZING LANDS AND GRAZING ANIMALS

The Forage and Grazing Terminology Committee

As the science and industry of grazing animals has grown in recent years, there has been a parallel growth of terminology, but definitions of terms have sometimes been obscure and inappropriate, and there has been a proliferation of terms used for a single meaning or definition. Communication based on such terms results in confusion and fails to convey information. A search of the literature failed to reveal comprehensive definition of the terms used with grazing lands and grazing animals.

To resolve these problems of terminology, the Forage and Grazing Terminology Committee was organized to address the issue of usage of terms relevant to grazing animals. Although this Committee was initiated by the American Forage and Grassland Council, it was recognized from the outset that to be successful, such an effort would need to be undertaken jointly by the broad array of organizations and agencies that have an interest in grazing animals. Thus, this Committee was composed of representatives of scientific societies, agencies within the U.S. Department of Agriculture, the U.S. Department of the Interior, and other appropriate groups that have an interest in grazing lands and grazing animals. It was also recognized that such terminology would be more useful if international participation was invited and encouraged. Thus, corresponding members from Australia and New Zealand were included. This Committee was assembled with the express purpose of addressing the discrepancies in

terminology and producing a glossary of terms and definitions. Upon completion of its assignment, and publication of this Glossary, the Committee is to be dissolved.

The charge to this Committee was to develop a consensus of clear definitions of terms used in the grazing of animals. The availability of standardized terms and definitions should be of value for teaching, research, extension, industry, and production. It is hoped that it will be the standard for use by authors and editors of publications concerning grazing. In scope, it goes beyond the grazing of domestic livestock and is applicable to grazing by wild animals as well, but terms were restricted to those directly applicable to grazing by animals. Thus, terms addressed by the Committee were kept narrowly focused into four categories: 1) Terms for forages and grazing lands; 2) Management concept terms; 3) Terms of measurement, space, time or degree; and 4) Methods of grazing.

The approach of the Committee was to examine the merit, justification, and logic of each term. Common use alone did not justify the existence of a term if it was unsound in logic or was simply an alternative version of an already existing and acceptable term. Frequently, such terms have evolved in attempts to portray a concept or grazing management principle as something new and different, when in reality the term is simply a new word for an already existing and defined concept. Use of such terms causes misunderstanding and misrepresents established principles. Some terms are of value to present concepts even though the concept may not be easily documentable or measurable. Whenever possible, it has been useful to identify first the term in the broad sense, then the terms that identify the various component parts. This organization helps to establish relationships among term groups and to form the structure that can be the basis for new terms. A single, concise definition has been the objective, rather than a listing of alternatives.

As a result of the work of this Committee, a review of the literature dealing with terminology was compiled. This collection of references is in itself of value and is included in this publication.

During the preparation of this manuscript, each member of the Committee was encouraged to contact other individuals and groups to seek suggestions and to critique. Appreciation is expressed to the many individuals not on this committee, who freely offered their suggestions and encouragement.

Terminology that is clearly and concisely defined leads to meaningful communication that enhances education, science, industry, and production. The task of defining terminology is one that is never completed. Rather, it is one that must keep pace with the profession. As new concepts emerge, as techniques and methods change, and as the state of the art and science evolves, new terms will always be required and old terms will need to be redefined. A basic need for progress in the art and science of grazing animals is that, to the greatest extent possible, a common 'language' be spoken.

Work on terms in this chapter of the Glossary was funded by a grant from the Forage and Grassland Foundation, Inc., Lexington, Kentucky, U.S.A. Appreciation is expressed to the Forage and Grassland Foundation for their support of work in this chapter.

Vivien G. Allen
Chair
The Forage and Grazing
Terminology Committee
July 1991

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Members of the Forage and Grazing Terminology Committee were nominated and selected for their special competencies and for a balance of representation among geographic regions, areas of expertise, and organizational representation.

1.1 TERMS FOR FORAGES AND GRAZING LANDS

¹ Noun.

² Terms in italics are defined in this Chapter.

³ Verb.

⁴ For comparison see.

⁵ Cropland, forestland, pastureland, and rangeland provide the basis for land use mapping units.

1.1.1 Vegetation Terms

I. 1 Forage	(<i>n</i> ¹) Edible parts of plants, other than separated grain, which can provide feed for grazing animals, or that can be harvested for feeding. Includes <i>browse</i> , ² <i>herbage</i> , and <i>mast</i> . (<i>v</i> ³) To search for, or to consume <i>forage</i> (cf. ⁴ (<i>v</i>) <i>Browse</i> , I. 1. a; (<i>v</i>) <i>Graze</i> , I. 7).
I. 1. a Browse	(<i>n</i>) Leaf and twig growth of shrubs, woody vines, trees, cacti, and other non- <i>herbaceous vegetation</i> available for animal consumption. (<i>v</i>) To browse. The consumption of browse <i>in situ</i> by animals (cf. <i>Forage</i> , I. 1; <i>Graze</i> , I. 7).
I. 1. b Herbage	The biomass of <i>herbaceous</i> plants, other than separated grain, generally above ground but including edible roots and tubers (cf. <i>Herbaceous</i> , I. 3).
I. 1. b. i Forb	Any <i>herbaceous</i> broadleaf plant that is not a <i>grass</i> and is not <i>grass-like</i> (cf. <i>Legume</i> , I. 1. b. i (1); <i>Grass</i> , I. 1. b. ii; <i>Grass-like</i> , I. 1. b. iii).
I. 1. b. i (1) Legume	Members of the plant family <i>Fabaceae</i> .
I. 1. b. ii Grass	Members of the plant family <i>Poaceae</i> .

<p>I. 1. b. iii Grass-like</p>	<p>Vegetation that is similar to grass in appearance and is usually a member of the plant family <i>Cyperaceae</i> (sedges) or <i>Juncaceae</i> (rushes).</p>
<p>I. 1. b. iv Pasturage</p>	<p>Not a recommended term. (cf. <i>Forage</i>, I. 1; <i>Pasture</i>, III. 2). The recommended definition of pasture refers to a specific kind of <i>grazing management unit</i>, not that which is consumed, which is <i>forage</i>. Thus, pasturage is not a useful term.</p>
<p>I. 1. c Mast</p>	<p>Fruits and seed of shrubs, woody vines, trees, cacti, and other non-<i>herbaceous vegetation</i> available for animal consumption.</p>
<p>I. 2 Forage crop</p>	<p>A crop of cultivated plants or plant parts, other than separated grain, produced to be <i>grazed</i> or harvested for use as feed for animals.</p>
<p>I. 2. a Aftermath</p>	<p><i>Forage</i> grown following a harvest.</p>
<p>I. 2. b Residue</p>	<p><i>Forage</i> remaining on the land as a consequence of harvest.</p>
<p>I. 3 Herbaceous</p>	<p>Non-woody.</p>
<p>I. 4 Sward</p>	<p>A population of <i>herbaceous</i> plants, characterized by a relatively short habit of growth and relatively continuous ground cover, including both above and below-ground parts (Hodgson, 1979).</p>
<p>I. 5 Vegetation</p>	<p>(n) Plant life in general (Webster, 1988).</p>
<p>I. 5. a Vegetative</p>	<p>Non-reproductive plant parts, i.e., leaf and stem; in contrast to reproductive plant parts, i.e., flower and seed, in developmental stages of plant growth. The non-reproductive stage in plant development.</p>

1.1.2 Grazing Land Terms	
I. 6 Grazing land	Any vegetated land that is grazed or that has the potential to be grazed by animals. Kinds of Grazing Lands.
I. 6. a Cropland⁵	Land devoted to the production of cultivated crops. May be used to produce <i>forage crops</i> (cf. <i>Forage crop</i> , I. 2). Provides basis for land use mapping unit.
I. 6. b Forestland⁵	Land on which the <i>vegetation</i> is dominated by forest or, if trees are lacking, the land bears evidence of former forest and has not been converted to other vegetation. Provides basis for land use mapping unit.
I. 6. b. i Agroforestry	Land use system in which woody perennials are grown for wood production with agricultural crops, with or without animal production.
I. 6. b. ii Agro-silvo-pastoral	Land use system in which woody perennials are grown with agricultural crops, <i>forage crops</i> , and livestock production.
I. 6. b. iii Grazable forestland	<i>Forestland</i> that produces, at least periodically, sufficient understory vegetation that can be grazed. <i>Forage</i> is indigenous or, if introduced, it is managed as though it were indigenous (Syn: grazable woodland, woodland range, forest range).
I. 6. b. iii (1) Forest grazing	The combined use of <i>forestland</i> or woodland for both wood production and animal production by grazing of the coexisting indigenous <i>forage</i> , or vegetation that is managed like indigenous <i>forage</i> .
I. 6. b. iii (2) Silvo-pastoral	Preferred term is <i>Forest</i> grazing, I. 6. b. iii (1).

I. 6. c Pastureland	<p>Land devoted to the production of indigenous or introduced <i>forage</i> for harvest primarily by grazing. Pastureland generally must be managed to arrest successional processes (cf. <i>Pasture</i>, III. 2).</p> <p>Provides basis for land use mapping unit. Pastureland can include some grassland (I. 6. g).</p>
I. 6. d Range	<p>Land supporting indigenous vegetation that is grazed or that has the potential to be grazed, and is managed as a natural ecosystem.</p> <p>Range includes <i>grazable forestland</i> (I. 6. b. iii) and <i>rangeland</i> (I. 6. d. ii).</p>
I. 6. d. i Grazable forestland	<p>(See I. 6. b. iii. above).</p>
I. 6. d. ii Rangeland	<p>Land on which the indigenous <i>vegetation</i> (climax or natural potential) is predominantly <i>grasses</i>, <i>grass-like plants</i>, <i>forbs</i>, or shrubs and is managed as a natural ecosystem. If plants are introduced, they are managed as indigenous species.</p> <p>Provides basis for land use mapping unit. Rangelands include natural <i>grasslands</i>, <i>savannas</i>, shrublands, many <i>deserts</i>, <i>tundras</i>, alpine communities, <i>marshes</i> and <i>meadows</i>.</p>

1.1.3 Ecological land types

I. 6. e Desert	<p>Land on which the <i>vegetation</i> is absent or sparse, usually shrubby, and is characterized by an arid, hot to cool climate.</p>
I. 6. f Forestland	<p>(See I. 6. b above).</p>

I. 6. g Grassland	Land on which the <i>vegetation</i> is dominated by <i>grasses</i> (cf. <i>Pastureland</i> , I. 6. c; <i>Rangeland</i> , I. 6. d. ii).
I. 6. g. i Meadow	A tract of <i>grassland</i> where productivity of indigenous or introduced <i>forage</i> is modified due to characteristics of the landscape position or hydrology (cf. <i>Grassland</i> , I. 6. g; <i>Pasture</i> , III. 2; <i>Pastureland</i> , I. 6. c; <i>Rangeland</i> , I. 6. d. ii). May be characterized as: hay meadow, native meadow, mountain meadow, wet meadow, or other designations.
I. 6. g. ii Prairie	Nearly level or rolling <i>grassland</i> , originally treeless, and usually characterized by fertile soil.
I. 6. g. iii Savanna	<i>Grassland</i> with scattered trees or shrubs; often a transitional type between true <i>grassland</i> and <i>forestland</i> , and accompanied by a climate with alternating wet and dry seasons.
I. 6. g. iv Steppe	Semi-arid <i>grassland</i> characterized by short <i>grasses</i> occurring in scattered bunches with other <i>herbaceous vegetation</i> and occasional woody species.
I. 6. h Marshland	Flat, wet, treeless land usually covered by water and dominated by marsh <i>grasses</i> , indigenous rushes, sedges, or other <i>grass-like</i> plants.
I. 6. i Range	(See I. 6. d above).
I. 6. j Shrubland	Land on which the <i>vegetation</i> is dominated by shrubs.
I. 6. k Tundra	Land areas in arctic and alpine regions devoid of large trees, varying, from bare ground to various types of <i>vegetation</i> consisting of <i>grass</i> , <i>forbs</i> , sedges, dwarf shrubs and trees, mosses and lichens.

1.1.4 Miscellaneous Terms

**I. 7
Graze** (v) To graze. The consumption of *forage in situ* by animals (cf. *Browse*, I. 1. a).

This verb should be used in the active form with the animal as the subject. The verb should not be used in the passive voice so as to imply that a person is the subject or actor; i.e., cattle graze; people do not graze cattle.

**I. 8
Mob** See *Mob grazing*, IV. 16.

1.2 MANAGEMENT CONCEPT TERMS

**II. 1
Grazing land
management** The manipulation of the soil-plant-animal complex of the *grazing land* in pursuit of a desired result.

The definition may be applied to specific kinds of *grazing land* by substituting the appropriate term, such as *grassland* in place of *grazing land*.

**II. 2
Grazing
management** The manipulation of animal grazing in pursuit of a defined objective.

**II. 2. a
Controlled
grazing** Not an acceptable term. See *Grazing management*, II. 2; *Grazing method*, II. 3; *Grazing system*, II. 4; *Rotational grazing*, IV. 24; *Rotational stocking*, IV. 25.

'Controlled grazing' has sometimes been used erroneously to describe increased *grazing management*. The 'control' imposed is a matter of level or degree and is better described in terms of *grazing management* and *grazing methods*.

<p>II. 2. b Extensive grazing</p>	<p><i>Grazing management</i> that utilizes relatively large land areas per animal and a relatively low level of labor, resources, or capital (cf. <i>Intensive grazing management</i>, II. 2. c).</p>
<p>II. 2. c Intensive grazing management</p>	<p><i>Grazing management</i> that attempts to increase production or utilization per unit area or production per animal through a relative increase in <i>stocking rates</i>, forage utilization, labor, resources, or capital (cf. <i>Extensive grazing management</i>, II. 2. b).</p> <p>Intensive grazing management is not synonymous with rotational grazing. Grazing management can be intensified by substituting any one of a number of <i>grazing methods</i> that utilize a relatively greater amount of labor or capital resources.</p>
<p>II. 2. d Holistic resource management</p>	<p>Not a recommended term.</p>
<p>II. 3 Grazing method</p>	<p>A defined procedure or technique of <i>grazing management</i> designed to achieve a specific objective(s).</p> <p>One or more <i>grazing methods</i> can be utilized within a grazing system.</p>
<p>II. 4 Grazing System</p>	<p>A defined, integrated combination of animal, plant, soil, and other environmental components and the <i>grazing method(s)</i> by which the system is managed to achieve specific results or goals.</p> <p>Descriptive common names may be used; however, the first usage of a <i>grazing system</i> name in a publication should be followed by a description using a standard format. This format should include at least the following information: number, size, kind, slope,</p>

erosion status, and soil classification of land units; number, kind, sex, size, and age of livestock; duration of use and non-use periods for each unit in the system; *grazing method*(s); type(s) of *forage*; and geographic location and elevation; type of climate, mean annual and seasonal temperatures, and precipitation.

II. 5 Rest	To leave an area of <i>grazing land ungrazed</i> or unharvested for a specific time, such as a year, a growing season, or a specified period required within a particular management practice (cf. <i>Rest period</i> , III. 20; <i>Ungrazed</i> , II. 7; Syn: Spell).
II. 6 Stockpiling forage	(v) To allow <i>forage</i> to accumulate for grazing at a later period. Forage is often stockpiled for autumn and winter grazing, after or during dormancy or semi-dormancy, but stockpiling may occur at any time during the year as a part of a management plan. Stockpiling can be described in terms of <i>deferment</i> , III. 13 and <i>forage accumulation</i> , III.10.
II. 7 Ungrazed	(1) The status of <i>grazing land</i> that is not grazed by animals. (2) The status of plants or plant parts that are not grazed by animals (cf. <i>Rest</i> , II. 5) .

1.3 TERMS OF MEASUREMENT, SPACE, TIME, OR DEGREE

1.3.1 Terminology of Area

III. 1 Grazing management Unit	The <i>grazing land</i> area used to support a group of grazing animals for a <i>grazing season</i> . It may be a single area, or it may have a number of subdivisions (cf. <i>Paddock</i> , III. 1. a; <i>Pasture</i> , III.2).
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III. 1. a Paddock	A grazing area that is a subdivision of a <i>grazing management unit</i> , and is enclosed and separate from the other areas by a fence or barrier (cf. <i>Grazing management unit</i> , III. 1; <i>Pasture</i> , III. 2).
III. 2 Pasture	(1) A type of <i>grazing management unit</i> enclosed and separated from other areas by fencing or other barriers and devoted to the production of <i>forage</i> for harvest primarily by grazing (cf. <i>Grazing management unit</i> , III. 1; <i>Paddock</i> , III.1. a; <i>Pastureland</i> , 1. 6. c); (2) See <i>forage</i> , I. 1.

1.3.2 Terminology to Compare Animals

III. 3 Animal unit	<p>One mature non-lactating bovine weighing 500 kg and fed at a maintenance level, or the equivalent, expressed as (weight^{0.75}), in other kinds or classes of animals (cf. <i>Standard livestock unit</i>, VI. 1).</p> <p>The use of <i>animal unit</i> in a publication should be followed by a description using a standard format. This format should include at least the following information: kind (species and breed), class, sex, size, age, and physiological status of livestock.</p>
III. 4 Forage intake unit	<p>An animal with a rate of <i>forage</i> consumption equal to 8 kg dry matter (DM)/d.</p> <p>Assuming that one <i>animal unit</i> has a dry matter intake rate of 8 kg/d (NRC, 1984), any animal may be represented as a certain fraction or multiple of the animal unit, based solely on its rate of forage intake per day. An animal which has a forage intake rate larger or smaller than 8 kg DM/d will have an animal-unit-equivalent which is a proportionate fraction or multiple of one animal unit (adapted from</p>

Scamecchia and Kothmann, 1982).

The use of *forage intake unit* in a publication should be followed by a description using a standard format. This format should include at least the following information: forage species and cultivar, stage of growth, plant height, and *forage mass*.

1.3.3 Land-and/or Forage-to-Animal Relationships

III. 5
Carrying
capacity

The maximum *stocking rate* that will achieve a target level of animal performance, in a specified *grazing method*, that can be applied over a defined time period without deterioration of the ecosystem.

Carrying capacity is not static from season-to-season or year-to-year and may be defined over fractional parts of years. The 'average' carrying capacity refers to the long-term carrying capacity averaged over years, whereas the 'annual' carrying capacity refers to a specific year.

III. 6
Forage
allowance

The relationship between the weight of *forage* dry matter per unit area and the number of *animal units* or *forage intake units* at any one point in time; a forage-to-animal relationship. The inverse of *grazing pressure*.

May be expressed as *forage mass* per *animal unit* or *forage intake unit* (forage mass/animal unit at a specific time).

This definition can be appropriately altered to be specific to *herbage* or *browse* by substituting these terms in place of *forage*.

III. 7 Grazing pressure	<p>The relationship between the number of <i>animal units</i> or <i>forage intake units</i> and the weight of forage dry matter per unit area at any one point in time; an animal-to-forage relationship.</p> <p>May be expressed as <i>animal units</i> or <i>forage intake units</i> to <i>forage mass</i> (animal units/forage mass at a specific time).</p>
III. 8 Stocking density	<p>The relationship between the number of animals and the specific unit of land being grazed at any one point in time (cf. <i>Stocking rate</i>, III. 9).</p> <p>May be expressed as <i>animal units</i> or <i>forage intake units</i> per unit of land area (animal units at a specific time/area of land).</p>
III. 9 Stocking rate	<p>The relationship between the number of animals and the <i>grazing management unit</i> utilized over a specified time period (cf. <i>Stocking density</i>, III. 8).</p> <p>May be expressed as <i>animal units</i> or <i>forage intake units</i> per unit of land area (animal units over a described time period/area of land).</p>

1.3.4 Terminology Referring to Measurements of Forage

III.10 Forage accumulation	<p>The increase in <i>forage mass</i> per unit area over a specified period of time.</p> <p>This definition can be appropriately altered to be specific to herbage or <i>browse</i> by substituting these terms in place of <i>forage</i>.</p>
III. 11 Forage mass	<p>The total dry weight of <i>forage</i> per unit area of land, usually above ground level and at a defined reference level (cf. <i>Available forage</i>, III. 11. a; <i>Herbage</i>, I. 1. b).</p>

	This definition can be appropriately altered to be specific to <i>herbage</i> or <i>browse</i> by substituting these terms in place of <i>forage</i> .
III. 11. a Available forage	<p>That portion of the <i>forage</i>, expressed as weight of <i>forage</i> per unit land area, which is accessible for consumption by a specified kind, class, sex, size, age, and physiological status of grazing animal (cf. <i>Forage allowance</i>, III. 6; <i>forage mass</i>, III. 11).</p> <p>Not a preferred term. <i>Forage</i> is a defined entity (I. 1). That which is 'available' for grazing is hypothetical but has value as a concept. This term often is used erroneously for <i>forage mass</i>, III. 11.</p>
III 11. b Available pasture	<p>Not a recommended term (cf. <i>Available forage</i>, III. 11. a; <i>pasture</i>, III. 2).</p> <p>Pasture refers to a specific type of <i>grazing management unit</i>, not to that which is consumed.</p>

1.3.5 Terminology Referring to Time

III. 12 Animal unit day	<p>The amount of <i>dry forage</i> consumed by one <i>animal unit</i> per 24-hour period.</p> <p>Animal unit day is used to express the quantity of forage intake for a period of time and may be extrapolated to other time periods, such as week, month, or year (cf. <i>Animal unit</i>, III. 3; <i>Forage intake unit</i>, III. 4).</p>
III. 13 Deferment	<p>The postponement or delay of grazing to achieve a specific management objective (cf. <i>Deferred grazing</i>, IV. 5, <i>Rotational deferred</i>, IV. 23).</p>

A strategy aimed at providing time for plant reproduction, establishment of new plants, restoration of plant vigor, a return to environmental conditions appropriate for grazing, or the accumulation of forage for later use.

<p>III. 14 Grazing cycle</p>	<p>The time elapsed between the beginning of one <i>grazing period</i> and the beginning of the next <i>grazing period</i> in the same <i>paddock</i> where the <i>forage</i> is regularly grazed and rested.</p> <p>One grazing cycle includes one <i>grazing period</i> plus one <i>rest period</i>.</p>
<p>III. 15 Grazing event</p>	<p>The length of time that an animal <i>grazes</i> without stopping (cf. <i>Grazing period</i>, III. 16).</p>
<p>III. 16 Grazing period</p>	<p>The length of time that grazing livestock or wildlife occupies a specific land area (cf. <i>Grazing event</i>, III. 15).</p>
<p>III. 17 Grazing season</p>	<p>(1) The time period during which grazing can normally be practiced each year or portion of each year. (2) On U.S. public lands, an established period for which grazing permits are issued.</p> <p>It may be the whole year or a very short time span and is normally a function of <i>forage mass</i> and climate. In this context, the <i>vegetative</i> growing season may be only a part of the <i>grazing season</i>.</p>
<p>III. 18 Period of occupation</p>	<p>The length of time that a specific land area is occupied, whether by one animal group, or by two or more animal groups in succession (cf. <i>First-last grazing</i>, IV. 6, Forward <i>creep grazing</i>, IV. 9, <i>Period of stay</i>, III. 19).</p>
<p>III. 19 Period of stay</p>	<p>The length of time that a particular animal group occupies a specific land area (cf. <i>First-last grazing</i>,</p>

IV. 6, Forward *creep grazing*, IV. 9, *Period of occupation*, III. 18).

'Period of occupation' and 'period of stay' differentiate between the total time a specific land area is utilized and the time that a particular group of animals is using said land area. The term is useful in describing grazing methods such as first-last grazing. The 'period of occupation' is the total time that a specific land area is utilized and may involve several different groups of animals moving through in sequence, as in *first-last grazing* or in migrations. It differs from *grazing period* in that grazing may or may not be involved. (Example: feeding hay on pasture in winter when ice prevents grazing). The 'period of stay' defines the fractional part of the 'period of occupation' that any one of the two or more animal groups occupy the specified land area. It constitutes only a part of the *period of occupation*.

III. 20 Rest period

The length of time that a specific land area is allowed to *rest* (cf. *Rest*, II. 5; Syn: Spelling period).

1.4 METHODS OF GRAZING

IV. 1 Alternate stocking

The repeated *grazing* and *resting* of forage using two *paddocks* in succession.

IV. 2 Continuous grazing

Not a recommended term because animals do not graze continuously. If used it is synonymous with *Continuous stocking*, IV. 3.

IV. 3 Continuous stocking	A method of grazing livestock on a specific unit of land where animals have unrestricted and uninterrupted access throughout the time period when grazing is allowed (cf. <i>Rotational stocking</i> , IV. 25; <i>Set stocking</i> , IV. 28).
	The length of the grazing period should be defined.
IV. 4 Creep grazing	The practice of allowing juvenile animals to graze areas that their dams cannot access at the same time.
IV. 5 Deferred grazing	The <i>deferment</i> of grazing in a non-systematic rotation with other land units (cf. <i>Deferment</i> , III. 13).
IV. 6 First-last grazing	A method of utilizing two or more groups of animals, usually with different nutritional requirements, to graze sequentially on the same land area. (Syn: leader follower, preference follower, top and bottom grazing. First-last grazing is the preferred term).
	If more than two groups of animals are grazed sequentially, this would be described as 'first, second, and last grazing.'
IV. 7 Fixed stocking	Not a recommended term. See <i>Set stocking</i> , IV. 28.
IV. 8 Flip-Flop grazing	Not an acceptable term (cf. <i>Alternate stocking</i> , IV. 1).
IV. 9 Forward creep	A method of <i>creep grazing</i> in which dams and offspring rotate through a series of <i>paddocks</i> with offspring as first grazers and dams as last grazers. A specific form of <i>first-last grazing</i> (cf. <i>First-last grazing</i> , IV. 6).

IV. 10 Frontal grazing	A <i>grazing method</i> that allocates forage within a land area by means of a sliding fence that livestock can advance to gain access to ungrazed <i>forage</i> .
IV. 11 High intensity grazing	Not an acceptable term (cf. <i>Grazing management</i> , II. 2; <i>Intensive grazing management</i> , II. 2. c). This is a relative concept that is best described in terms of <i>grazing management</i> and <i>grazing method</i> .
IV. 12 Intermittent grazing	A method that imposes grazing for indefinite periods at irregular intervals.
IV. 13 Leader-follower grazing	Not a recommended term. See <i>First-last grazing</i> , IV. 6.
IV. 14 Low density grazing	Not an acceptable term. This is a relative concept that is best described in terms of <i>grazing management</i> and <i>grazing method</i>.
IV. 15 Mixed grazing	Grazing by two or more species of grazing animals on the same land unit, not necessarily at the same time but within the same grazing season.
IV. 16 Mob grazing	In the management of a grazing unit, grazing by a relatively large number of animals at a high <i>stocking density</i> for a short time period.
IV. 17 Multispecies grazing	Not an acceptable term. 'Multi' refers to 'many', while this grazing method most often employs only two animal species. Thus, 'mixed' more accurately describes this method of grazing (cf. <i>Mixed grazing</i> , IV. 15).

<p>IV. 18 Non-selective grazing</p>	<p>Utilization of <i>forage</i> by grazing animals so that all <i>forage</i> species and/or all plants within a species are grazed (cf. <i>Mob grazing</i>, IV. 16).</p> <p>Non-selective grazing is generally attempted by using high <i>stocking rates</i> or high <i>stocking densities</i> during short time periods. In practice, non-selective grazing is achieved rarely.</p>
<p>IV. 19 Preference-follower grazing</p>	<p>Not a recommended term. See <i>First-last grazing</i>, IV. 6.</p>
<p>IV. 20 Put-and-take stocking</p>	<p>The use of variable animal numbers during a <i>grazing period</i> or grazing season, with a periodic adjustment in animal numbers in an attempt to maintain desired sward management criteria, i.e., a desired quantity of forage, degree of defoliation, or <i>grazing pressure</i>.</p>
<p>IV. 21 Ration grazing</p>	<p>Confining animals to an area of <i>grazing land</i> to provide the daily allowance of <i>forage</i> per animal (cf. <i>Strip grazing</i>, IV. 30).</p>
<p>IV. 22 Rest-rotation grazing</p>	<p>Not a recommended term (cf. <i>Rotational stocking</i>, IV. 25).</p>
<p>IV. 23 Rotational deferred</p>	<p>Systematic rotation of <i>deferment</i> among land areas within a grazing management unit.</p>
<p>IV. 24 Rotational grazing</p>	<p>Not a recommended term. If used it is synonymous with <i>Rotational stocking</i> (IV. 25).</p>
<p>IV. 25 Rotational stocking</p>	<p>A <i>grazing method</i> that utilizes recurring periods of grazing and <i>rest</i> among two or more <i>paddocks</i> in a <i>grazing management unit</i> throughout the period when</p>

	<p>grazing is allowed (cf. <i>Continuous stocking</i>, IV. 3).</p> <p>The lengths of the grazing and of the rest periods should be defined.</p> <p>Words such as 'controlled' or 'intensive' are sometimes used in an attempt to describe the degree of <i>grazing management</i> applied to this <i>grazing method</i>. These words are not synonyms for <i>rotational stocking</i>.</p>
IV. 26 Seasonal grazing	<p>Grazing restricted to one or more specific seasons of the year.</p>
IV. 27 Sequence grazing	<p>The grazing of two or more land units in succession that differ in forage species composition.</p> <p>Sequence grazing takes advantage of differences among forage species and species combinations, grown in separate areas for management purposes, to extend <i>grazing seasons</i> enhance forage quality and/or quantity, or achieve other management objectives.</p>
IV. 28 Set stocking	<p>The practice of allowing a fixed number of animals on a fixed area of land during the time when grazing is allowed (cf. <i>Variable stocking</i>, IV. 32).</p>
IV. 29 Short duration grazing	<p>Not an acceptable term.</p> <p>A subjective term that can best be described in terms of: <i>Grazing methods</i>, II. 3; <i>Grazing periods</i>, III. 16; <i>Rest periods</i>, III. 20.</p>
IV. 30 Strip grazing	<p>Confining animals to an area of <i>grazing land</i> to be grazed in a relatively short period of time, where the paddock size is varied to allow access to a specific land area (cf. <i>Ration grazing</i>, IV. 21).</p>

Strip grazing may or may not be a form of rotational stocking, depending on whether or not specific paddocks are utilized for recurring periods of grazing and rest (cf. *Rotational stocking*, IV. 25).

IV. 31 Top and bottom grazing	Not an acceptable term. See <i>First-last grazing</i> , IV. 6.
IV. 32 Variable stocking	The practice of allowing a variable number of animals on a fixed area of land during the time when grazing is allowed (cf. <i>Set stocking</i> , IV. 28).

1.5 BIBLIOGRAPHY

During the development of this chapter of terms and definitions, a search and review of the literature was conducted in an attempt to collect and evaluate previously published terms and their various definitions. While by no means all-inclusive, this collection of references may be one of the more exhaustive listings currently available and would be of use to anyone wishing to review this subject. In the current publication, definitions are referenced if they were used verbatim as they appear in the original reference. All other definitions have been developed or revised by the Forage and Grazing Terminology Committee.

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1.6 APPENDIX: STANDARD LIVESTOCK UNITS

VI. 1 Standard livestock unit (SLU)

A Standard Livestock Unit to measure stocking rate in grazing.

Studies is a non-lactating bovine weighing 500 kg. Using the 0.75 power of body weight for conversion within animal species and the 0.90 power between sheep and cattle, the SLU can be derived for animals of different liveweights. The SLU for pastures grazed by goats can be calculated using the conversion factors for sheep (see Minson and Whiteman, 1989).

Table 1 shows factors for converting the number of grazing animals of different species and weight into standard livestock units (500 kg non-lactating bovine).

Table 1: Factors for Converting the Number of Grazing Animals of Different Species and Weight into Standard Livestock Units (500 kg non-lactating bovine)

Sheep		Cattle	
Liveweight (kg)	Livestock (units)	Liveweight (kg)	Livestock (units)
10	0.038	100	0.30
20	0.063	200	0.50
30	0.086	300	0.68
40	0.106	400	0.84
50	0.126	500	1.00
60	0.145	600	1.15
70	0.163	700	1.29

**VI. 2 Utilized
metabolizable
energy (UME)**

The amount of metabolizable energy (ME) grown as forage that is eaten by grazing animals. The UME may be expressed either per animal on a daily basis [megajoules (MJ) per head] or per unit area over a specified time period [gigajoules (GJ) per hectare]. UME is a measure of output from a forage system based on the estimated energy requirements of animals and the energy value of forage. It is calculated as the sum of ME requirements for maintenance and production of the classes of livestock involved, less the ME value of all feed supplements provided from outside the area and augmented by the ME value of any conserved herbage made on the area but unused (see Baker, 1982).

2 PASTORALISM AND PASTORALISTS

Jonathan Davies *

Extensive production of herbivorous livestock on rangelands is frequently referred to as pastoralism (Blench, 2001) and is one of the most important economic activities of the rangelands, enabling people to inhabit vast regions that are generally unsuitable for crop cultivation. Yet the very features of the rangelands that make livestock production the most suitable livelihood also impose many constraints on livestock systems and present interesting challenges for sustainable development. Although pastoral systems around the world share many characteristics, they also have important differences and there is no clear consensus on the definition. This chapter presents some of the reasons for the disagreement over how to define extensive livestock systems and the practitioners of extensive livestock production, and attempts to bring clarity to some of the associated terms that are used to describe key features of pastoral systems. The chapter also sketches out some of the shared characteristics of different pastoral systems around the world.

Pastoralism is practiced throughout the world, from the Asian Steppe to the Andean regions of South America and from the mountainous regions of Western Europe to the African Savannah. It is practiced on an estimated

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25% of the world's land area, provides 10% of global meat production, and supports an estimated 200 million pastoral households and many more mixed agropastoral households. Pastoralists manage herds of nearly a billion camelids, cattle, sheep and goats, in addition to yaks, horses, reindeer, and other ungulates (FAO 2001).

Pastoralism is essentially an adaptation to environmental uncertainty, which is a feature of many of the world's rangelands. In these areas rainfall is often hard to predict, in terms of both when and where it falls. Pastoralists have adapted to this uncertainty by developing flexible and opportunistic strategies, including herd mobility and variable herd sizes that allow herders to track the unpredictable availability of resources, a high degree of social organization and control that enables the spreading of risk and the pooling of resources, the herding of multiple livestock species and the production of multiple livestock goods and services.

2.1 MOBILITY

Mobility has been avoided in the description at the start of this chapter since mobile pastoralism is considered to be a subset of pastoralism, in which herd mobility is a central management strategy, typically associated with the use of common property (as well as private) resources. However, mobile pastoralists are possibly the greatest subset of pastoralism, and their approach to livestock production entails many unique and important features that make pastoralism particularly well adapted to the sustainable management of rangelands.

There are many types and degrees of pastoral mobility, which may vary according to environmental conditions, or according to the stage of a household's life cycle. For example, mobility can be highly regular, following a seasonal pattern, using clearly demarcated corridors between well-

defined pasture areas that have been fixed for centuries, or it can be comparatively random, opportunistically following the rains and seldom the same from one year to the next. Livestock movement can be driven by seasonal climate patterns, periodic climatic shocks, by the need to access key resources (e.g., salt pans) or to evade seasonal diseases, or for political and economic reasons (Niamir-Fuller 1999).

The term Nomad is often used to describe pastoralists, yet this term has different connotations in different languages, sometimes indicating the absence of any permanent home and other times synonymous with transhumance, or seasonal movement of livestock between distinct resource areas (such as wet and dry season pastures, or high and low altitude zones). Truly nomadic pastoralism is extremely uncommon, and most forms of mobile pastoralism employ transhumant movements of different scales.

The term mobile pastoralism is sometimes used to differentiate certain livestock systems from 'ranching', which is often considered as an extensive livestock system in which land ownership is more individualized and livestock mobility (other than paddock grazing) is not a deliberate management strategy. However, these definitions are also not universally applied, and ranching systems in the United States and Australia often have elements of communal land ownership and managed seasonal migration.

2.2 THE ENVIRONMENTAL LOGIC OF PASTORALISM

Since many rangelands are also drylands, they are characterized by patchiness of resources, and livestock mobility is critical to enabling the most efficient use of these resources. In parts of Sub-Saharan Africa, for example, the driest areas often have vegetation of the highest quality (in terms of the proportion of vegetable protein), but access to these areas is

restricted by the availability of drinking water. Livestock use these pastures when they can and then retreat to adjacent 'dry season reserves' where water sources are permanent, even though pasture quality there may be lower, and the incidence of diseases higher. Access to these reserves, whether they are annual dry-season pastures, or contingency reserves for periodic drought, is vital to the successful functioning of pastoral systems.

Most pastoral systems function on the principle that livestock graze, often very intensively, and then move on, allowing vegetation a period of recovery. Efforts to 'improve' pastoral systems, by providing infrastructure such as boreholes that enable livestock to graze for longer in one area, have often devastated rangelands environments by replacing intensive, periodic grazing with sustained, often low-level, grazing. Similarly, rangelands have been degraded where the dry season reserves have been converted to other land use, restricting livestock movements and creating sustained grazing pressure in other areas.

Pastoralists usually have a rich knowledge of their rangeland environments and elaborate institutions that enable them to apply that knowledge to sustainably manage their resources. Pastoral rangelands are not unregulated and open access, as assumed in the tragedy of the commons,¹ but are governed by intricate rules, regulations and relationships that can mitigate against degradation. Where pastoral land has become degraded, it is usually a combination of weakening of these customary management institutions, loss of key resources patches that comprise the pastoral system and restrictions on pastoral mobility (Niamir-Fuller 1999, Scoones, 1995).

¹ An economic theory put forward by Garret Hardin in 1968 to explain degradation of open access resources.

2.3 PASTORALISTS

Pastoralism is an ancient form of human activity and pastoralists have a diverse array of cultures, ecological adaptations and management systems that are under continuous change. Pastoralism is frequently associated with a particular group of producers – for example, the Maasai or the Bedouin – so that it is often very hard to dissociate the system from the practitioners. For many people, pastoralists are not practitioners of a livestock production system so much as an ethnic group, and indeed this is the view of the UN High Commissioner for Human Rights with regard to the pastoralists of Africa (African Commission of Human and Peoples Rights. *Report of the African Commission's Working Group of Experts on Indigenous Populations/Communities*).

A widely used definition is that pastoralist households are those in which at least 50% of household gross revenue comes from livestock or livestock-related activities (Swift, 1988). However, such a definition fails to capture important features of pastoral systems and can “define out” many practitioners of pastoralism who have significant other sources of income, whether temporary (seasonal) or permanent. It is therefore common to include other criteria for defining pastoral systems, such as the use of common property and private resources, the practice of mobility, the use of family labor, or husbandry of a mixture of indigenous and crossbred livestock breeds. It is therefore easy to see why confusion arises over who exactly is a pastoralist.

The term Nomad is often used to imply pastoralist, but in some countries the word has taken on a pejorative connotation where it is used to imply vagrancy, and since a nomad is thought of as a person without a home, it can be used as an excuse for acquisitioning land. Mobility of pastoralists, however, is a vitally important feature since it has important implications for

the way they interact with government and the way they access services. However, mobility is not a defining feature of pastoralists even in mobile pastoral systems, since extensive transhumant stock movements do not automatically demand movement of the entire household. In some pastoral communities, mobility of the household is essential since the system depends on significant household labor inputs, as in the case of many dairy systems. However, other pastoralists are finding that there are ways to combine the economic and environmental benefits of livestock mobility with the social and economic benefits of maintaining a fixed homestead.

2.4 IS PASTORALISM IN DECLINE?

Numerous books and reports have been published over the years that predict the decline or demise of pastoralism in different parts of the world, and these claims are given credence when pastoral societies face hardship and famine in the wake of drought or blizzard. Yet such claims need to be looked at more critically, since they fail to consider that mobile pastoralism is also practiced in some of the world's most technologically advanced and industrialized economies. Indeed, in some of the wealthiest countries, mobility of pastoralists is increasing as governments have relaxed restrictive policies in recognition of the environmental services that mobile pastoralism provides.

Over recent years there has been a rise in government investment in mobile pastoralism for the sake of capturing the positive environmental externalities of the system. Simultaneously, pastoralists are boosting their livestock incomes by exploiting niche markets, for example organic products or high value fibers, and supplementing their livelihoods through income from tourism and other ventures that capitalize on the environmentally friendly nature of their production system. At the same time, the rapidly growing global demand for livestock products is creating

burgeoning market opportunities that many pastoralists can and do exploit. Globally pastoralism is far from in decline, but it is certainly changing greatly in the face of globalization, climate change, and other global phenomena. Indeed, pastoralism would not have survived as long as it has if it did not have deeply embedded adaptive capacities. Yet change in pastoral systems should not necessarily be perceived as a decline in pastoralism, particularly where changes are being made willingly by informed and empowered pastoralists. Pastoralism still has an important role to play in the sustainable management of the rangelands, even though there remains a fervent debate about how to develop pastoral systems most appropriately.

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3 NON-EQUILIBRIUM RANGELAND DYNAMICS

*David D. Briske **

During the past 15 years, the rangeland profession has adopted alternative procedures for rangeland evaluation that include state-and-transition models, thresholds, and rangeland health. The need for alternative evaluation procedures originated from the inability of the traditional Clementsian based method of range condition and trend analysis (range model) to account for the entire spectrum of vegetation dynamics that occurred on rangelands. The primary limitations of the traditional rangeland model centered on whether: (1) vegetation dynamics are best characterized as continuous and reversible or as discontinuous and non-reversible change; (2) variables such as fire and weather play an equal or greater role than grazing in vegetation dynamics; (3) vegetation dynamics possess more than one stable plant community or state on individual ecological sites (e.g., soil/climate-based land units).

The introduction of state-and-transition models provided an alternative procedure that could overcome these limitations, including the description of multiple stable states. These models and the associated threshold concept were based on non-equilibrium theory that was developed during the 1970s. Non-equilibrium ecology is founded on the assumption that ecosystems possess a limited capacity for internal regulation and that their

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behavior is less predictable than those of equilibrium systems when modified by disturbances.

This is in contrast to equilibrium ecology which is founded on the assumption that ecosystems possess a substantial capacity for internal regulation that contributes to predictable and directional ecosystem dynamics. The fundamental difference between these two theories of ecosystem behavior is that equilibrium systems are assumed to return to their pre-disturbance state following a disturbance (i.e., possess a single stable state) while non-equilibrium systems may stabilize in an alternative stable state after being disturbed (i.e., multiple stable states are possible).

State-and-transition models describe the set of alternative stable states that represent the known or anticipated ecosystems that individual ecological sites may support. Each state contains one or more community phases representing ecological variability within the limits of the state. Variation among community phases may be associated with natural events (e.g., succession or disturbances) or human activities (e.g., land management and development) independently or in combination. Individual states are separated by thresholds that can be induced by natural and/or human events. Thresholds represent irreversible transitions between stable states that can only be reversed with the application of management or restoration activities. Thresholds identify the limits of ecosystem resilience and the point at which the ecosystem begins to reorganize around a different set of organizing processes or feedbacks resulting in the occurrence of an alternative state. Threshold recognition and prediction is necessary for managers to prevent the occurrence of undesirable states and to promote the occurrence of desirable states.

It is now recognized that evaluation procedures must be able to measure and interpret continuous, reversible and discontinuous, non-reversible dynamics because both patterns occur and neither pattern alone represents the entire spectrum of ecosystem dynamics on all rangelands. Continuous and reversible vegetation dynamics prevail within stable states while discontinuous and non-reversible dynamics occur when thresholds are surpassed and one stable state replaces another (Figure 1 below).

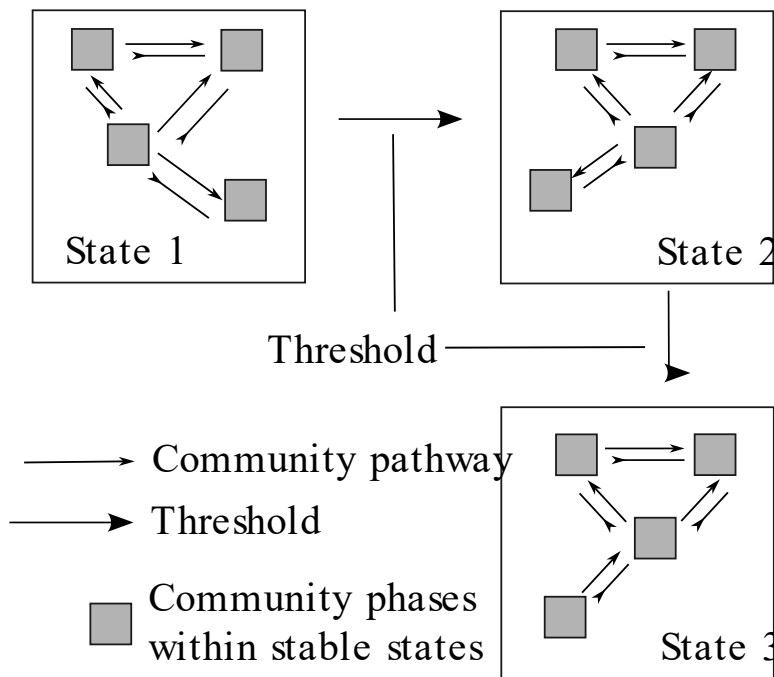


Figure 1: Illustration of a conventional state-and-transition model

Figure 1 depicts three stable states (large open boxes) and four community phases (small solid boxes) within each state. Transitions among community phases within states are reversible, but those between states are not, without management intervention (i.e., a threshold has been crossed).

The introduction of non-equilibrium ecology also required the development of alternative procedures to evaluate ecosystem function. The presumed correlation between communities with various combinations of species composition and ecosystem function was weakened by the potential occurrence of multiple stable states. Rangeland health is currently defined as, "the degree to which the integrity of the soil, vegetation, water and air as well as the ecological processes of the ecosystem are balanced and sustained". Ecological integrity describes, "the maintenance of the functional attributes characteristic of a locale, including normal variability". Current rangeland health evaluations are based on 17 indicators organized into three categories of ecosystem function: (1) soil and site stability, (2) hydrologic function, and (3) integrity of the biotic community. The variables within these three categories are intended to provide a point in time assessment of ecosystem function relative to a predefined reference state.

3.1 KEY TERMS AND CONCEPTS

Non-equilibrium system: ecosystem characterized by limited internal self-organization and the potential to express two or more stable states following disturbance.

Ecological resilience: the amount of change or disruption that is required to transform a system from being maintained by one set of mutually reinforcing processes and structures to a different set of processes and structures (i.e., alternative stable states).

Feedback mechanisms: ecological processes that enhance (negative) or decrease (positive) ecosystem resilience.

States: a suite of plant community phases occurring on similar soils that interact with the environment to produce persistent functional and structural attributes associated with a characteristic range of variability.

Community phases: unique expressions of individual states induced by either natural processes or management actions. i.e., within state variation.

Thresholds: boundaries between states resulting from an irreversible change of one or more primary ecological processes that must be actively restored before return to the previous state is possible.

Triggers: biotic or abiotic variables or events that initiate threshold-related processes.

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4 LANDSCAPE LEVEL OF ANALYSIS

*Lynn Huntsinger * and Paul Starrs ***

For rangeland scientists, the landscape is part of an ecological hierarchy of scale where plant communities and small vegetation patches are smaller, and regions and the global ecosystem are larger, than the landscape scale (Figure 2).

Processes that shape landscapes include human activities and environmental factors such as weather and topography. Range and wildlife management, pastoralism, ranching, and other range-based forms of livestock production usually require management and analysis at the landscape scale. Rangeland scientists commonly look at the interactions between environment, vegetation, animal, and human activities that shape rangeland characteristics and potential. This might include the impacts, and drivers, of the movement of livestock or wild herbivores through diverse vegetation and climatic zones, or the way that plant communities are distributed in relation to geologic substrate, elevation, and hydrologic flow.

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It could also include the relationship between political or jurisdictional boundaries and fire occurrence, wildlife abundance, grazing activities, or type conversion.

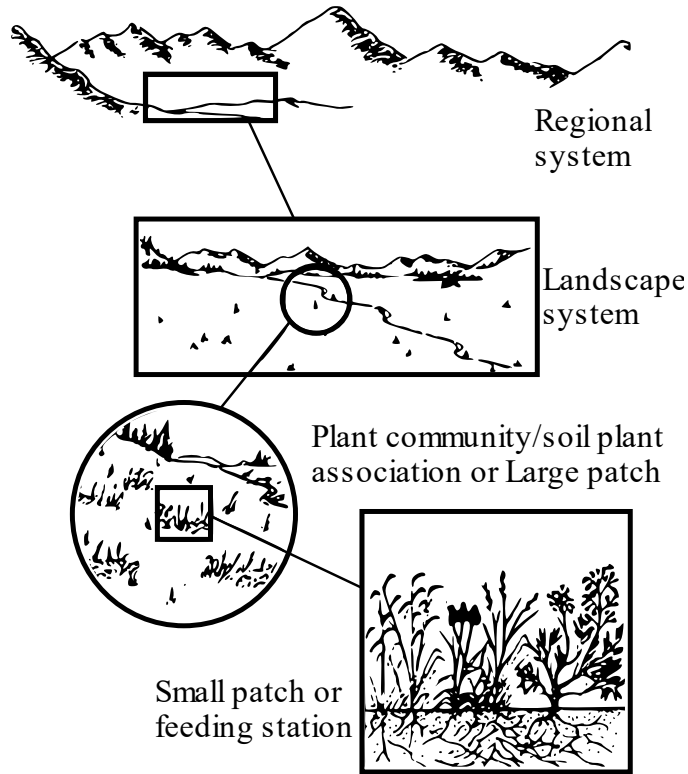


Figure 2: An ecological hierarchy encountered by large herbivores while foraging (Sneft et al., 1987)

Scales are defined by rates of foraging processes and ecosystem processes. Boundaries between units at each scale are determined by animal behavior.

Paintings, sketches, and repeat photography have long been used to study changes in landscape pattern over time. Data collected from plots and/or transects distributed across a landscape or a landscape gradient can also be used to capture or illustrate such patterns. More recently developed methodological approaches for studying landscape pattern and processes include aerial photography, remote sensing, simulation models, and, since 1990, Geographical Information Systems (GIS), with associated development of powerful quantitative methods to examine the interactions of patterns and processes. GIS and other geospatial scientific technologies allow analysis of the underlying spatial relationships in ecosystems and landscapes (Figure 3) use digitized information and geo-referencing to create and analyze map layers linked to precise locations on the surface of the earth. However, results are limited by the availability of accurate data and limited understanding of ecosystem processes.

The spatial aspects of a social or natural system (location, amount, distance, adjacency, isolation, fragmentation, heterogeneity, and other patterns of things) impact the function of the system. The effects of “patchiness”, the pattern and distribution of plant communities or habitat, may have great effect on the potential of a landscape for species conservation, watershed, livestock production, and/or resilience to fire. The influence of the adjacency of one type of vegetation, habitat, or land use to another is an additional type of pattern studied in a landscape-level analysis. Spatial data in the form of maps are almost always needed because they provide information about pattern. The simplest form of Geographic Information System, and one that is still extremely useful in many situations, is overlaying maps drawn on transparent material on top of one another to examine the patterns of overlap that occur. Today’s computer-based GIS use digitized information and geo-referencing to create and analyze map layers linked to precise locations on the surface of the earth.

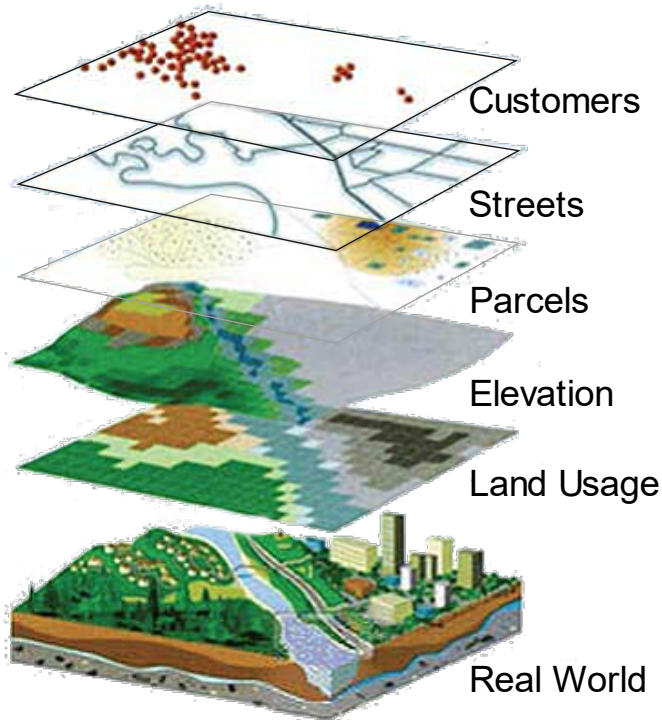


Figure 3: Geographic Information Systems

GIS is the entry, editing, storage, query, retrieval, transformation, analysis, display and printing of geospatial data. The key point behind GIS is that all data is georeferenced, which means that it is located by means of geographical coordinates with respect to some reference system. This allows for the integration of geospatial data from many sources (e. g., a GPS unit, downloaded data from online, and scanned maps), many scales (e. g., from a single site, to the entire region and on up to the entire globe), and many formats (e. g., points, lines, polygons, imagery, 2D data, 3D data, temporal data, and databases and spreadsheets). GIS and other geospatial technologies can help analyze spatial relationships at the landscape scale so that we may manage and plan for ecosystem changes.

The second major component of landscape-level analysis, “process”, requires use of the best available information about ecosystem function and change. A major focus of rangeland science is on how vegetation develops and changes in response to biotic and abiotic influences. A lack of understanding of what shapes the pattern of vegetation – for example, leaving out fire history where it is a major driver of vegetation change – will lead to unreliable results. States and transitions models draw on the state of knowledge of the process of vegetation change and can be incorporated into a landscape-level analysis used to predict the outcomes of factors such as climate change, land use, weather, and even policies. The type and rates of transitions, and the proportions of states, are simulated across the landscape for various scenarios. This is successful only if the processes and drivers of vegetation change are correctly represented in the original, site-specific states and transition models.

Traditional pastoral and ranching institutions often provide herds access to forage resources at the landscape scale. Forage and water resources are widely scattered in arid rangeland, and quality and abundance varies temporally and spatially. Management in common has allowed pastoral herds to use resources as they become available spatially and temporally through landscape-scale and regional herd movements and migrations, similar to migrations of wild herbivores. Regular patterns of seasonal movement by people and livestock, such as transhumance, remain part of ranching systems in many areas where access to resources at the landscape scale is still possible. Understanding the ecological rationale of such production systems and their relationship to the environment requires landscape level analysis of the functioning of social institutions as well as grazing patterns and environmental characteristics.

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5 KEY CONCEPTS IN AGROFORESTRY

Linda H. Hardesty * and *Linda M. Lyon* **

Agroforestry is deliberately growing or retaining trees or shrubs with crops and/or forage. Agroforestry practices exploit positive ecological and economic interactions, minimize undesirable interactions, and protect or enhance the sustainability of natural resources for the people who use them. Most current agroforestry systems are based upon the traditional practices of indigenous people from around the world.

There are three types of agroforestry systems. Agrosilviculture involves woody plants with crops grown below the canopy or between rows or clusters of trees. In some cases, understory crops are only used until the tree canopy closes or woody plants are managed to limit competition with the understory over a longer period. When fields include deep rooted woody hedges between rows of more shallow-rooted crops (alley cropping), the trees or shrubs provide soil nutrients and organic matter, shelter for crops and products such as fuelwood, green manure, fruits, medicines, gums, or fiber.

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Silvopasture is combining desirable trees or shrubs with forage for livestock. Woody plants provide shelter, and sometimes forage, while woody plants gain nutrient enrichment from manure and reduced competition from understory vegetation. Examples include cultivation of scattered timber tree species in a pasture and close planting of dense woody plants for use as live fencing.

Agrosilvopasture combines woody plants, livestock and crops. A Brazilian example is production of carnauba palms (*Copernicia prunifera*) and perennial cotton (*Gossypium hirsutum*) with beans, corn and pumpkins. Livestock grazing (cattle, sheep and goats) after the crops are harvested stimulates branching of browsed cotton plants, removes weeds, and integrates coarse crop residues into the soil while livestock benefit from the forage and shade.

In many regions, fuelwood scarcity can be addressed with agroforestry. For example, intercropping leguminous woody plants provides fuelwood, nitrogen for the intercropped species, and prunings as feed for animals or green manure. Many woody species will sprout from the stump (coppice) when cut and rapidly regrow, providing a continuing supply of fuelwood without replanting. Strategically located groups of woody plants can act as shelterbelts, protecting livestock, fields, and homes from the sun and weather damage while providing easily accessible fuelwood, and other products.

Plant species selection is critical in agroforestry systems. The compatibility of plant species depends on potential competition for resources such as light, soil moisture, and possible chemical or microbial interactions. Allelopathic, anti-quality or toxic substances from plants can harm an agroforestry system unless those plants have been selected to discourage weeds, browsing or pests. The physical arrangement of the plants must be

considered throughout the life cycle of each species. Young trees may root at the same soil depth as crops but as they mature, their roots move deeper into the soil allowing the trees to draw upon deeper water and nutrient pools than crops can reach. The depth of the soil and rooting pattern of the plants must match to avoid problems such as tap-rooted trees blowing over when planted in shallow soils. The canopy of overstory species must often be managed through pruning, lopping and coppicing to control the shape and productivity of the woody plants. Similarly, evergreen, deciduous or even deciduous species with a particular phenology can be selected to best allocate site resources.

A critical, often contentious issue is the choice of native or exotic plant species. Research (Msangi and Hardesty 1993) has shown that a preference for exotic species may cause land managers to overlook native species that are actually superior to popular exotics. While livestock and many crops have been domesticated to fill particular niches in a wide range of environments, other exotic species may threaten future biodiversity and productivity. Exotic species can displace natives, or support pathogens and pests harmful to native species and crops. Recently, some long-established exotic species previously considered harmless have become aggressive invasives. Subtle shifts in climate or CO₂ concentration have been associated with such changes; thus, global climate change may exacerbate the risks of choosing exotic species.

Livestock are a critical element in many agroforestry systems, rapidly recycling plant material into soil nutrients, and consuming crop residues such as corn stover that humans cannot eat. Many spatial arrangements are possible. Livestock can be enclosed in a pasture with live fencing of unpalatable shrubs that are not browsed (e.g., *Euphorbia* spp.). Trees may be grown in an open arrangement with forage in the understory. It is also possible that the animals are not in the same area as the woody plants and

feed is cut and carried to them. This is common when milking animals confined near the household where forage is not present. Agroforestry systems may be fertilized with manure from confined or free-ranging animals. When animals are not confined, it is important that they are selected and managed to prevent damage to woody plants or crops by trampling, browsing, or fouling.

Growing trees for timber or fruit requires years of investment before there is a marketable product. Well-designed agroforestry systems can provide early returns from forage, meat, and/or crops. Multiple crops diversify risk and income opportunities. The season when each element must be planted, tended, cultivated or harvested is also an important consideration. For example, in the Northwestern United States, sheep are raised in cherry orchards. Grazing reduces the need to spray herbicide or mow understory vegetation; animal waste provides nutrients and sheep consume fallen fruit and abscised leaves. Clearing the orchard floor reduces habitat for overwintering pathogens and pests. The sheep consume high quality forage nurtured by the irrigation and fertilizer provided for the trees, while benefiting from their shelter. However, agricultural labor is scarce in this region and labor demands may overlap if sheep are lambing when the orchard needs frost protection, or when repeated application of pesticides required to export fruit requires moving sheep in and out of the orchard frequently. Some orchardists have eliminated labor problems by selling access to forage to sheep producers rather than raising their own sheep, thus dividing the labor burden (Wilson and Hardesty 2006).

The social complexity of agroforestry systems cannot be overlooked. Trees or their products may be owned by someone other than the landholder. An example is a mango tree bordering a rice paddy. If the farmer has no tenure right to the tree, it cannot be pruned or cut to reduce shading of the rice. Nor can the farmer harvest the fruit. In the case of multiple products, one

person may have a right to fuelwood, another to fruit and a third to the nuts, all from the same tree. An apparent resistance to agroforestry may be driven by land and tree tenure concerns that are not readily apparent.

Growing woody species is a long-term commitment of resources. Successful agroforestry requires detailed knowledge of numerous plant, and possibly animal species, their interactions with each other and with their local environment.

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5.2 RELATED VOCABULARY (IN ORDER OF USE)

Sustainability: The ability for future generations to live and use natural resources unimpaired by current generation's use.

Canopy: The top level of vegetation of a plant community that has several layers of vegetation. Usually refers to a tree.

Green manure: Green vegetation applied to the soil to build fertility.

Understory: The lower layers of vegetation in a layered plant community, below the canopy or overstory.

Prunings: Small branches, twigs and foliage cut from a woody plant to modify its shape. To prune is to cut this material from the plant.

Allelopathic: Compounds naturally produced by a plant that inhibits growth of other plants nearby.

Anti-quality: Compounds naturally produced by plants that reduce the ability of herbivores to digest plant material.

Browsing: Animals eating vegetation from woody plants.

Tap-rooted: A root system composed primarily of a single, strong, deep root (e.g., a carrot).

Overstory: The upper layer in a layered plant community.

Lopping: Cutting some major branches from a tree or shrub. Removes more than pruning.

Evergreen: Green foliage is present all year.

Deciduous: Green foliage is only present for part of the year.

Phenology: The seasonal pattern of growth and development of a plant.

Exotic: Not native to the present region.

Biodiversity: The range of species and genetic variability within species that characterize an area.

Unpalatable: Has sensory characteristics (e.g., scent, texture) that allow something to avoid being eaten.

Diversify: To add more different species, parts or products.

Over-wintering: Surviving cold winter conditions.

Pathogen: An organism that causes disease in another species.

Pest: An undesirable organism that consumes or damages something.

Frost: Freezing temperature.

Tenure: Customary or legal right to property or product.

6 RANGELAND INDIGENOUS KNOWLEDGE

Sabine Homann *

Rangeland indigenous knowledge refers to nomadic land use, where people move with their animals in response to the shifting availability of water and feeds, or pastoral economies, where people derive most of their income from extensive livestock production. Such production systems are predominantly found in semi-arid Africa and the Middle East as well as the cold plains of northern Europe and Asia.

6.1 DETERMINANTS OF RANGELAND IK

Indigenous knowledge (IK) is unique to a given culture or society. It can be defined as the collective experience and skills of users and user groups in close interaction with and often restricted to a specific natural, cultural, social and/or economic context. It is dynamic, influenced by both local creativity and experimentation as well as contact with the outside and thus develops by adaptation to contextual changes and integration of new elements into proven ways of doing things. IK entails intimate information of ecological and social processes and, as such, it is the communities' base for decision-making and communication pertaining to their livelihood activities.

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Rangeland IK is primarily determined by the temporal and spatial variability of natural resources. It provides livestock keepers with flexible rangeland management strategies, as they are able to match their animal nutritional requirements to unpredictable rainfall and patchy distribution of fertile soils and vegetation. In semi-arid Africa, livestock keepers exploit abundant rangeland resources after the rains and manage to cope with scarcity in feed and water resources during dry seasons and periodic droughts. Rangeland management principles based on IK are strategically extensive, tailored for conditions with relatively low natural potential and high production risks and with difficult accessibility to markets, inputs, and services. These result in opportunistic management as the most appropriate form of land use and take the form of herd mobility, herd diversification, and flexible stocking rates as key strategies.

The production objectives of livestock keepers also shape their IK and management strategies. Often the primary production objective is to ensure survival and reduce risk. Livestock keepers therefore maximize the use of natural resources on a large scale. Enhancing flexibility in spatial resource management promotes resilience against external shocks (droughts, epidemics, conflicts) and livestock keepers can subsequently adapt better to seasonal or longer-lasting changes. Livestock keepers also emphasize reproduction, which is reflected in the high proportion of females in the herds (< 60%). In semi-arid Africa, livestock keepers combine large stock (cattle/camel) for milk, draft power, and insurance, with small animals (goats/sheep) as assets that can be quickly liquidated.

Rangeland IK is not equally distributed within communities. In many cases, men are responsible for large stock and therefore hold more IK in this regard. Young men are better positioned to generate ecological IK, as they herd the animals and are therefore in closest contact with rangeland conditions. They are supposed to share this information with the older men,

who typically make decisions on rangeland management issues. Women deal more with small animals (sheep and goats) and milking animals and are thus closest to observe the animals' daily condition. These roles as carriers of IK are not static. For example, Somali men are often absent in the rural setting and women then become more involved in herding.

6.2 TECHNICAL RANGELAND IK

Rangeland IK comprises various technical components:

- **Rangeland condition monitoring and evaluation:** Livestock keepers have sound ethnobotanic knowledge. They use various rangeland condition indicators (e.g., invading and decreasing plant species, plant populations and composition, soil conditions, salt licks, climate forecasting, wildlife) or livestock condition indicators (milk production, reproduction rates, animal body condition, animal behavior, animal feces) to assess current rangeland conditions as well as long-term trends. Other factors in indigenous rangeland condition scoring include disease outbreaks, proximity to cropping areas, territorial boundaries and relations with adjacent communities (alliance, peace). For example, the Ethiopian and Kenyan Boran pastoralists have scouts who evaluate rangeland conditions regularly and pass this information to traditional decision-making bodies.
- **Rangeland management:** Based on the information gathered on rangeland condition, livestock keepers respond by fine-tuning temporary herd movements. They change their seasonal grazing directions towards areas with better grazing (rotational grazing), declare resting periods for those areas under high grazing pressure and susceptible to degradation (deferment), and

preserve areas for critical periods (reserves). For example, the Fulani in West Africa regulate daily herd movements and shift camps regularly to avoid overuse. Some Fulani groups even overgraze deliberately and then let that area rest for a long time. The Kenyan Masai or the Boran control stocking densities and shift the number of grazing animals according to estimates of temporarily available grazing resources. They also have established forage banks and apply controlled rangeland burning to maintain healthy rangeland conditions.

- **Water management:** Availability of water is an indirect means to regulate the spatial organization of grazing. During dry seasons, the Boran and the Somali allow their herds to use permanent sources of water and adjacent pastures at temporarily high stock densities, whereas during rainy seasons the herds disperse on regenerating pastures in the periphery. These groups have developed formal organizations for managing traditional deep wells and coordinating water with rangeland management.
- **Herding:** Guarding and conducting animals to favorable grazing areas and water is a demanding and honorable task. It includes night herding during the dry season for higher forage intake and less heat stress, as well as tuning watering frequencies according to distances to available feed resources.
- **Herd management:** Livestock keepers are well informed about livestock nutritional needs. They divide their animals into separate herds according to sex, age and performance, and thereby disperse grazing pressure over large areas. The Fulani in Senegal or Dinka in Sudan maintain a milk herd (lactating cows, calves, and weak animals) near settlements, and they split off dry sub-

herds with better walking capacity (young animals and males) to graze areas further away where grazing pressure is less. In the long term they adapt herd composition to rangeland conditions, with cattle and sheep as typical grazers and goats and camels as browsers. This allows them to make use of the different feeding behaviors of the animal species. The Boran traditionally focus on cattle to exploit rangelands of high grazing value but have responded to the woody species encroachment by increasing the proportion of browsers in their herds. They have also started keeping camels.

- **Animal breeding:** Breeding preferences and strategies are geared towards drought tolerance and high reproduction rates and include selecting for robust and productive female lines. A profound knowledge on the progeny of female animals and selection strategies has resulted in animal types that are well adapted to harsh environmental conditions. Many livestock keepers purposely maintain a diversity of animal types within a herd. For example, the Samburu in Kenya combine camels with special traits in walking ability and endurance together with camels that outperform in reproduction and milk production.
- **Ethnoveterinary practices:** Livestock keepers have developed profound ethnoveterinary knowledge on parasites, diseases, and poor body condition, with a broad diversity of local methods of diagnosis and treatment using locally available resources. Disease resistance is an important criterion for breeding and selection. For example, the Kenyan Boran has developed a trypanotolerant type of cattle.

6.3 ORGANIZATIONAL & INSTITUTIONAL RANGELAND IK

All this technical knowledge is ultimately linked with organizational and institutional IK, which determines how the knowledge is used. Communal resource-tenure regimes are purposely designed for extended user groups to sustain flexibility in decision-making and resource portioning over the large areas. They allow coordination of daily herd movements, sharing access to grazing resources with neighboring groups in normal years, and negotiations over use of key resources during times of scarcity.

Strong systems of social and cultural control enforce the temporary agreements between multiple users, such as reciprocal assistance, livestock loans and gifts, “orally fenced demarcations” for certain grazing areas, or priority rights to use water and forage banks. They also ensure application of general codes of conduct, e.g., avoidance of areas already in use and those vacated recently, maintaining appropriate distance from others, and establishing peace among all members that belong to the same user group.

Informal and formal networks provide clear roles for every member of a user group. Genealogy-based social systems allocate control and obligations to clan members, and the tasks and responsibilities are further differentiated by age-sets. Young men are often appointed for herding, watering, and defending rangeland resources (updating information and implementation), whereas the older men gain status as arbitrators and decision-makers (advising and coordination). The clan-based institutions merge with territorial institutions to address challenges at the local level, e.g., village councils, neighborhood councils, temporary grazing management committees, focal water management committees, or ad hoc drought rehabilitation committees.

Maintaining social and economic linkages with neighboring groups is another form of reducing the various forms of risk, e.g., temporary user rights for rangelands and water, exchanging animals against agricultural products, assistance in herd rebuilding after a drought or adopting new technologies. Maintaining such linkages is part of drought preparedness and conflict resolution.

6.4 RANGELAND INDIGENOUS KNOWLEDGE AND RESEARCH AND DEVELOPMENT

Despite the growing recognition of the value of rangeland indigenous knowledge (IK), it has not yet been widely integrated into research, development and extension services. If it is, livestock keepers will be able to make better-informed decisions and adopt technologies that enhance the productivity of their rangelands. This section describes how rangeland IK can be integrated with conventional rangeland research in order to facilitate learning processes within the local context and maximize the use of the available natural resources and institutional networks.

6.5 CHALLENGES FOR THE RELEVANCE OF RANGELAND IK

In the past, livestock keepers used to have a proven IK and a wide range of techniques to deal with the erratic nature of rangelands. Today, however, the application and generation of new rangeland indigenous knowledge is becoming increasingly difficult. Many IK-based management strategies are no longer adequate or strong enough to cope with new challenges of increasingly scarce rangeland resources, higher frequency of droughts and poverty. Droughts have a bigger impact than before, delaying recovery and resulting in below-minimum reproductive herd sizes. This causes unsustainable land use practices and aggravates rangeland degradation,

leading to irreversible cycles of vulnerability and impoverishment. Severe external threats also contribute to the difficulty of maintaining the relevance of rangeland IK. These can be physical (environmental degradation, climate change) or sociopolitical (human population growth and unfavorable policies that promote cropland expansion into high-quality rangelands, indiscriminate water policies, sedentarization and land nationalization, as well as market crashes, user conflicts and political interruptions).

Livestock keepers have different options to adapt to these new challenges:

- **Intensification of the livestock system**, including new market opportunities that can drive livestock keepers to increase the productivity of their natural resource base. This option is probably valid for only a few people who have access to the necessary information and capacity, and it requires new skills.
- **Diversification into alternative sources of livelihoods**, whereby livestock keepers combine their livestock activities with non-livestock activities such as cultivation, employment or trade. This option is valid for a larger number of people and incurs some synergies, but also redirects resources (land, labor, capital) away from livestock keeping.
- **Outward migration** is essentially for the rural poor who cannot stay in livestock production or the younger generations who are attracted to urban areas and modern ways of living.

Livestock keepers are thus challenged to incorporate new elements in rangeland management, or to replace the rangeland IK that is gradually being lost.

6.6 INTEGRATING RANGELAND IK AND CONVENTIONAL RANGELAND RESEARCH

Understanding the rationales behind conventional rangeland research and rangeland IK reveals complementary strengths. In conventional rangeland research, information can be extracted, transferred, stored, tested, and modified without reference to context. It focuses on specialized production traits and is mostly found in capital-intensive rangeland systems such as commercial cattle, sheep and goat ranches found in Eastern and Southern Africa. The objective is to maximize the productivity of individual animals, based on calculated carrying capacities of the land and controlled stocking densities (equilibrium model). In comparison, IK-based systems have the objectives to enhance spatial distribution of livestock and achieve maximum herd sizes by adapting to the natural boom-and-bust cycles in stocking densities following drought mortality and recovery (non-equilibrium model).

Integrating these two forms of knowledge into “intermediate” technologies can improve existing rangeland management systems. IK can bring new scientific insights, for example, enhancing rangeland productivity by optimizing herd composition, flexible grazing committees for administering multiple rangeland users, or drought rehabilitation mechanisms through binding livestock loans. On the other hand, conventional science would be able to test the validity and transferability of IK. It could answer such questions as how far mobile land use is still applicable, whether existing land use classification is still functional, and how can existing grazing committees ensure sustainable rangeland utilization. The IK-based practices and technologies appear as a good basis for the “intermediate” technologies and can redirect external interventions in order to support livestock keepers’ own strategies in securing their livelihoods. Taking IK into account is likely to result in faster, wider and more sustainable impacts of decision-making and planning processes. An example of this is the

successful merging of these two knowledge systems by the Afar in Ethiopia and Eritrea. They incorporated clan-based grazing associations into administrative units, and the formal government facilitated this.

6.7 PRECONDITIONS TO KEEP IK ALIVE

For IK to help address the challenges of developing more efficient and sustainable natural resource use, the following steps need to be endorsed:

- **Identification and documentation of rangeland IK:** Special efforts are required to make technical and organizational IK explicit and to characterize its context, as it is often tacit and embedded in social and cultural values. A major restriction of IK is that it can only be generated through continuous application and active engagement. Once lost, it is almost impossible to retrieve, and its disappearance signals a loss of a community's capacity to manage ecological and socioeconomic challenges.
- **Evaluation and validation of rangeland IK:** To use IK as a foundation for development, it is necessary to check its relevance and limitations in a changing environment and analyze the conditions that encourage the generation of new IK. Livestock keepers' perception on the current applicability of their IK, factors that inhibit using IK and opportunities for revitalizing IK are important aspects.
- **Generation of new IK and herder learning circles:** Innovative approaches that foster IK integrate new technologies within a given context, or they transfer IK-based technologies into a different context. These approaches require livestock keepers to systematically experiment and learn anew, monitor and evaluate

progress under different conditions, and modify their strategies accordingly. Herder-to-herder learning circles can foster exchange of experience among livestock keepers, stimulate new questions for further experiments, and improve their communication.

- **Integration of IK into multistakeholder learning processes:** Innovative institutional forms that enhance IK are being designed. These bring livestock keepers as presenters of IK together with researchers, development agents, and policymakers as well as input suppliers and market agents. These actors exchange information, define priority interventions, and develop local structures for continuous experimentation and communication. Learning takes place in iterative processes involving the different stakeholders and knowledge systems, geared by self-evaluation and discussions about emerging challenges and potentials, redefining their objectives and further developing their local innovations.

6.8 ROLE OF RESEARCH AND DEVELOPMENT IN STRENGTHENING RANGELAND IK

Functional IK-based practices and technologies must be merged with effective external support. Local differences in livestock keepers' IK-based rangeland management need to be acknowledged and shared through local communication processes. Future interventions must account for changes in the respective natural, cultural, social and economic context, as well as the history and impact of previous interventions. Research and development are supposed to facilitate these processes, enhance livestock keepers' capacity to communicate their needs, integrate them into decision-making structures and link them with higher levels of governance in order to create a more favorable environment for local innovation processes.

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7 LIVESTOCK DIVERSITY AND INDIGENOUS BREEDS

Wolfgang Bayer *

Rangelands are mostly marginal lands, i.e., too dry, too cold, too high or with soil too shallow for crop production, and they are ecologically very diverse. Livestock using these resources also needs to be diverse. The diversity of livestock that rangeland users keep depends, however, not only on ecological conditions, but also on many other factors, such as what they need for their livelihood, what products they can sell or trade, and their cultural preferences.

7.1 DIVERSITY OF SPECIES IN THE RANGELANDS

Livestock diversity includes diversity in terms of species as well as diversity in terms of the types or breeds within a species. Worldwide, the most common livestock species on rangeland are cattle, sheep, and goats. Similarly, equines – horses, donkeys and mules – are kept under a wide range of ecological conditions. Species of more regional importance are the camelids – the one-humped dromedary in Africa and Asia and two-humped Bactrian camel in cooler parts of Asia – which are well adapted to dry and very dry rangelands; the llamas and alpacas in South America, which are

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well adapted to highlands; the yaks (closely related to cattle) in Asia, which are probably the species best adapted to very high altitudes; and the reindeer in the arctic region. Livestock-keepers' preference for particular animal species and the mix of species they keep also varies according to vegetation structure. For example, sheep and cattle prefer grass, whereas goats and camels tend to thrive when browsing leaves and fruit from trees and shrubs.

Commercial ranchers may keep only one species for one purpose (e.g., beef cattle), whereas traditional pastoralists often keep a mix of species to fulfil a variety of functions. They keep larger animals, such as cattle or camels, for milk, transport, sale and prestige, whereas they prefer sheep and goats for home consumption of meat and for sale, because of the relatively fast reproduction rate of these smaller species. Sheep and goats are also kept for fiber (wool, hair) production. Equines, camels and yaks are generally used for riding and as beasts of burden, although there are regional variations. For example, camels are not ridden in parts of East Africa, but cattle are ridden in other parts of Africa. In Mongolia, horses are kept for milk production and, in the Himalayas, sheep and goats may be used as beasts of burden, as are llamas in the Andes. Where agropastoralism is practiced, cattle, yaks, camels, horses, mules or donkeys are often important as draught animals.

The production objectives of the livestock-keepers influence herd structure. Whereas herds kept primarily for reproduction have a large proportion of reproductive females and a small percentage of adult, entire males, herds that are kept primarily to produce wool or hair include a higher proportion of male castrates. Also, in cases where animals are important for riding, transport or draught, males (entire or castrated) make up a larger part of the herds. Herds of animals kept mainly for fattening can include a larger percentage of males, because males grow more quickly than females. Male

animals being fattened may be castrated (which slows down the growth rate but leads to more tender meat) or left entire.

Cultural preferences can also play a role. For high religious holidays, certain types of animals are preferred. For example, Muslims prefer entire male sheep above one year of age for particular festivities.

7.2 DIVERSITY OF BREEDS IN THE RANGELANDS

Because husbandry systems in the rangelands are extensive, the animals need to be adapted to the harsh conditions prevailing there, such as heat or cold, low-quality forage and/or seasonal forage scarcity, and they also need to be tolerant of or resistant to disease and endo- and ectoparasites. A higher degree of resistance to stress is generally correlated with smaller body size and – compared to animals bred to be kept under intensive conditions in a controlled environment – lower production in terms of meat or milk.

Whether indigenous livestock types should be referred to as “breeds” is open to dispute. “Breed” is a Western concept that was developed in the 18th century to improve livestock production. Important tools in breed development are herd-books, well-defined breeding objectives, elite animals and a strict selection process. The selection pressure depends on the rate of reproduction of the species and the way the breeding is done (natural service or artificial insemination). Animals are selected that grow very quickly, mature early or produce more milk – indeed, several times more milk than the wild ancestors produced. However, to be able to achieve these high-performance levels, the animals need a controlled environment, i.e., disease control and high-quality feed. Such breeds are not well suited for extensive rangelands.

Some fundamental differences between the concept of “animal breeds” and the concept of “plant varieties” need to be kept in mind. A plant variety is genetically (almost) uniform. An animal breed is a population of individuals with common characteristics, especially with respect to phenotypes that breed true to type but with some degree of genetic diversity. Plant breeding is separate from production whereas, in the case of the animal species kept on rangelands, breeding and production are intertwined. Plants can be multiplied quickly, by seed or if necessary, by cell culture, whereas animals on the range can have a generation interval of three to four years or more, a gestation period of one year, intervals between births of two years or more, and a litter size of only one. This makes animal breeding a much slower process than plant breeding.

On commercial stud farms, offspring that come close to the breeding ideals are kept as breeding animals and the remaining are used for production (meat, wool, pelts etc.) Herd-books can be closed or open. If the herd-books are closed, only selection within the registered population is allowed. Open herd-books allow new entries, and other breeds may be used for crossbreeding to introduce new vigor into the breed.

Genetic diversity is important to avoid inbreeding and, therefore, different lines have to be maintained. As a rule of thumb, a breed will be viable if a minimum of six lines, e.g., of bulls, are maintained. Populations with fewer lines may become endangered.

Over the past decades, emphasis on high production led to crossbreeding of indigenous types of animals with or even their replacement by larger types of animals that grow faster or give more wool or milk but require better-quality feed and more veterinary care. In the absence of a reliable supply of good-quality feed and good veterinary care, the production actually achieved by such “improved” breeds is sometimes worse than that

of indigenous animals and more risky and thus may endanger the livelihood security of the livestock-keepers. Moreover, the more intensive use of external inputs needed for animal production with “improved” breeds can increase the amount of fossil energy needed per unit of production.

The development of indigenous genotypes of animals by their keepers took many generations and, if such genotypes are lost, they cannot be recreated easily. Therefore, the conservation of indigenous breeds is high on the agenda of the Food and Agricultural Organization of the United Nations (FAO) and many governments, particularly in view of the potential future use of the genes. One difficulty in conserving breeds is that there is no universal definition of “breed”. An animal breed is commonly defined as a population of animals of one species that have distinct characteristics and differ from other populations of the same species, but there is no agreement as to how much they have to differ from other populations to be regarded as a separate breed. In reality, livestock breeders determine what is called a breed. In some cases, it is mainly the color that distinguishes one breed from another (e.g., red and black Angus cattle), whereas other breeds, such as Nguni cattle in South Africa, may include animals with 100 or more different color patterns and also different horn shapes.

The level of documentation of farm animal genetic diversity varies greatly between countries, and many important indigenous breeds are still not well documented, if at all. Data on genetic diversity within a breed is very rare. Population size is not sufficient as an indicator for diversity, because breeding methods can have a substantial impact on genetic structure within a breed. In the case of natural service, a bull may have 30-50 offspring per year (or more than 200 over its total active breeding life) whereas, if artificial insemination is used, top bulls can have several thousand offspring. In cases where there is little flow of genes between animals kept by different pastoral groups, inbreeding of the stock can be a problem. For practical

reasons, animals need not be regarded as inbred, if mother and father do not have common grandparents.

Breeds are not only productive assets and a “treasure chest” for the future; they are also cultural “monuments”. Breed conservation can be of great cultural importance for people living in a particular area. However, breed conservation cannot be static, as breeds evolve. This becomes clear when common breeds are examined more closely. Even if the name has remained the same, the breed itself has undergone changes, e.g., in body size, wool growth or milk yield. Moreover, the animals constantly have to fine-tune their adaptation in the face of changing disease agents. What is important is not that breeds look exactly like animals with the same breed-name that were kept 200 or 300 years ago, but that particular characteristics important for survival are maintained, such as tolerance of or resistance to external and internal parasites, and adaptability to heat, cold or high altitudes, low water availability etc., and animal behaviour, including dealing with predators, e.g., there are indigenous cattle breeds that can protect their calves against leopards, cheetahs or wolves.

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8 LIVESTOCK MOBILITY AND TRANSHUMANCE

*María Fernández-Giménez **

Livestock movement is an important aspect of grazing management at a variety of spatial and temporal scales. Here, we address livestock mobility at extensive spatial scales and time scales of seasons to years. Most mobile pastoralists clearly understand and can describe why herd movements are important to the well-being of their animals and families. However, only recently have many rangeland managers and development professionals begun to recognize the importance of livestock movements to sustainable pastoral development and rangeland management in semi-arid and arid regions. In the 20th century, a variety of factors worked to restrict livestock mobility in many pastoral systems around the world. In some cases, mobility was intentionally curtailed or eliminated, while in others the decline in mobility was an indirect consequence of political or economic change. In this section, we briefly discuss: (1) why livestock movements are important; (2) some typical types of movement; (3) sedentarization and the causes, costs, and benefits of declining mobility; and (4) the future of mobile pastoralism.

Why move? Pastoralists move their herds to access the resources required for their animals to gain weight and reproduce, including forage, water, minerals, and shelter. Resources are often patchily distributed in arid and semi-arid rangelands, and many pastoralists graze multiple species of

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livestock, so herders move to obtain the necessary quality and quantity of resources for a variety of different animals across seasons, habitats, and terrain. Pastoralists may move to avoid seasonal or periodic environmental stresses that can sicken or kill livestock, such as insects, disease, drought, severe cold, or deep snow. Herders also move for social and economic reasons, including marketing livestock and animal products and trading for needed goods, maintaining social ties with distant relatives or friends, avoiding political or inter-ethnic conflict, accessing health and educational services, and seeking non-livestock income earning opportunities.

8.1 TYPES OF LIVESTOCK MOBILITY

At the spatial scale of a landscape or bioregion and the temporal scale of a season to several years, we identify three primary types of pastoral movements: nomadism, transhumance (either vertical or horizontal), and seasonal aggregation and dispersal.

Nomadism refers to movements that display no clear spatial pattern repeated over time. Movement appears random, in response to stochastic variation in the timing and location of rainfall. Truly nomadic movement is observed in very extreme environments where rainfall is highly variable and unpredictable spatially and temporally, for example, among Bedouin herders on the Arabian Peninsula.

Transhumance refers to a pattern of repeated movements among distinct seasonal pastures. In a transhumance system herds follow the same general pattern of movement among seasonal pasture areas each year. Although pastoralists follow the same basic pattern of movement most years, the specific campsites and pastures used may vary year to year, depending on local conditions.

Vertical transhumance describes a pattern of seasonal movements that follows an elevational gradient from lowlands to highlands or vice versa. For example, in the intermountain region of the western United States, many sheep ranchers graze their sheep on lowland desert salt shrub communities in the winter, moving to mid-elevation sagebrush grasslands in the spring and fall, and spending the summer months in high elevation mountain meadows. Vertical transhumance is also common in the Pyrenees and Cantabrian ranges of Spain, the Swiss Alps, and mountainous regions of Central Asia.

Horizontal transhumance indicates a pattern of seasonal movement where herds move across a landscape/region in one direction during summer and return in the other direction for winter. For example, in Spain, large herds of sheep historically were trekked from north to south and back across the Iberian Peninsula each year. Transhumance systems are common in temperate, mountainous, and Mediterranean regions, where seasonal variation in temperature is significant, and also in West Africa.

Seasonal aggregation and dispersal patterns often occur where there are distinct wet and dry seasons, but less seasonal difference in temperature. In some systems (such as the Turkana of northern Kenya), households and livestock are most densely aggregated during the wet season, when abundant natural forage and water permit large number of animals to use a relatively small area. In such systems, livestock and households disperse during the dry season, when forage is less abundant and animals and people must spread out to locate and exploit the remaining forage. In other systems, herds are more densely aggregated during the dry season, when water is a limiting factor and foraging is constrained by the location of water points. In these systems, herds disperse during the wet season, when there is sufficient surface water to allow use of more distant pastures.

8.2 SEDENTARIZATION AND THE CAUSES, COSTS, AND BENEFITS OF DECLINING MOBILITY

Sedentarization is the process by which mobile pastoralists spontaneously or forcibly become settled people, living year-round in one location, usually in permanent dwellings. There is lively debate among scholars as to the point at which mobile pastoralists are no longer considered mobile and must be labelled sedentary. In our view, there is a broad continuum of mobility, and many pastoral systems include flexible and creative arrangements that allow all or a portion of the herd or household to remain mobile, while some animals and people stay in a permanent residence for some or all of the year.

Mobility has declined in many pastoral systems during the past 50 years. Some view this process as an inevitable consequence of modernization, whereby pastoralists voluntarily settle in order to access the services and amenities available only in towns. Some pastoralists have been forcibly settled because it is easier to govern and control a sedentary population, or because settlement was thought to be in their best interest. In many instances, the declining distance and frequency of pastoral movements are indirect consequences of other social, economic, or political changes, such as: conversion of grazing land to crop agriculture, migration or relocation of non-pastoral people into traditional pastoral territories, changes in land tenure that limit access to extensive grazing areas (e.g., land privatization), formation of new administrative or political units within which pastoralists are confined, creation of protected areas that exclude pastoralists from traditional grazing grounds, economic policies that increase pastoral poverty and decrease access to the labor and transportation needed to move, and increased political and inter-ethnic conflict that make mobility too dangerous.

Potential ecological costs of declining livestock mobility include overgrazing and degradation, especially near permanent settlements and water points. When loss of mobility is accompanied by changes in land tenure that lead to fenced pastures, wildlife mobility may be impeded. When declining mobility is associated with an increase in crop agriculture, permanent buildings, and roads, these changes fragment the landscape affecting landscape patterns and associated ecological processes. In Spain, abandonment of traditional stock driveways and grazing areas has led to a loss of biodiversity in these grazing-maintained systems. There may also be ecological benefits to declining mobility if some previously overused areas are allowed to rest and recover. On balance, however, most evidence suggests that where mobility has been curtailed and mobile pastoralists permanently settled, the ecological consequences are primarily negative.

Loss of mobility also entails potential social and economic costs. A major consequence of declining mobility is a loss of flexibility and adaptive capacity that affects pastoralists' ability to manage risks, especially those due to weather. Declining mobility may weaken social networks that both facilitate and are maintained by pastoral movements. When herders stop moving, they may lose access to other key resources, such as medicinal plants and sacred sites, that are important to herd or household well-being. Permanent settlement may lead to loss of cultural identity and associated values and norms, which can contribute to a variety of social problems. However, sedentarization also offers potential benefits to pastoralists, including access to markets, services, and amenities, and potential opportunities for increased participation in governance, economic, and social development.

8.3 THE FUTURE OF MOBILE PASTORALISM

Although some proclaim the end of mobile pastoralism, we believe that mobility remains a vital strategy for sustainable livestock-based livelihoods in arid and semi-arid rangelands. We also agree that pastoralists deserve the same opportunities for economic and social development as other people. Key challenges to maintaining pastoral mobility include the development and maintenance of institutions that facilitate movements, as well as the provision of services and opportunities for meaningful participation in governance and development. Critical institutions include resource tenure regimes that balance herders' needs for flexible access to grazing with needs for secure rights to key forage resources, institutions that coordinate and regulate the timing, destination, and duration of movements, and arrangements for reciprocal pasture use in times of emergency. Continued innovation and creativity will be required to assure mobile pastoralists have equitable access to the benefits of social and economic development.

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9 GRASSLAND/RANGELAND INTENSIFICATION VS EXTENSIFICATION DEBATE

*Shauna B. Burnsilver **

The Debate: The focus of intensive livestock production systems is to produce livestock products for commercial purposes, often on limited areas of land, and based on the investment of capital into inputs, such as water development, feed supplies, breeding stock and veterinary inputs. In contrast, extensive livestock-based livelihood systems are oriented towards providing either meat, milk or wool products for subsistence first and the market second, depend largely on human energy (in the form of labor) and local knowledge as the basis for livestock production, and rely on livestock mobility in order to access naturally occurring forage and water resources. The differences between these system types therefore include varying dependence on economic (e. g., inputs), demographic (e. g., labor), and spatial (e. g., mobility) components of livestock raising. The current debate over extensive production vs. intensive production rests on the perception of many rangeland managers and policymakers that extensive livestock systems are wasteful and inefficient, and lead inexorably to overuse of resources, whereas intensive livestock production strategies are economically more efficient and will provide greater productivity and economic growth over the long-term. There is significant policy pressure on pastoralists in extensive systems to intensify the way they raise livestock.

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However, two issues that are often ignored in this debate are: (1) the effects of underlying climatic and ecological variability on herding households, which demand continued mobility across extensive areas; (2) a lack of access to critical productive inputs that would ideally substitute for the need to be mobile. I briefly address the following issues in this section: (1) the global distribution of extensive and intensive livestock raising; (2) the characteristics of extensive livestock raising vs. intensive livestock raising; (3) how the intensification paradigm has been applied to extensive pastoralism; (4) the future of the debate over intensive and extensive pastoralism.

Current Global Distribution of Extensive vs. Intensive Livestock Raising: Open grazing lands that support a majority of the world's livestock-based economies cover 45% of the earth's surface (excluding Antarctica), or approximately 61.2 million km² (Reid et al. 2008). Extensive grazing lands, where human population densities are less than 20 people/km², represent 91% of this area, with the remainder categorized as intensive grazing areas. Approximately two thirds of grazing lands are in developing countries, where the effects of structural adjustment programs (SAPs) and market liberalization measures¹ in the 1990s have meant a decline in national-level resources (i.e., livestock market development and veterinary services) available in many pastoral regions. Although strong differences define extensive vs. intensive grazing systems, a gradient exists in practice, where herding economies may combine aspects of both extensive and intensive production. For example, in Australia and Argentina,

¹ SAPs are policies prescribed by the International Monetary Fund (IMF) and the World Bank as conditions for loans and repayment which often involve cutbacks in health, education, and other vital social services around the world. Market liberalization refers to the process by which developing nation governments are required to open their economies to compete with each other and with industrialized nations.

livestock are produced primarily for the market, water development, veterinary services and improved livestock breeds are used widely, but animals are still managed over extensive land areas.

Extensive Livestock Raising: Herding peoples usually keep multiple livestock species and subdivide these species into subgroups according to age and sex (e. g., young vs. old sheep and goats, and milking animals vs. non-milking females and males). The substantial labor required by these arrangements is satisfied through extended household kinship structures. Pastoral areas globally are defined by ecological variability and extreme seasonality in precipitation across either wet/dry or winter/summer seasons, which translate into temporal and spatial heterogeneity of the grazing and water resources available to livestock. Herders therefore track water and forage quality and quantity through patterns of mobility, based on use rights to communal resources. The critical point here is that in extensive systems, pastoralists bring animals to forage and water resources. There are examples of systems, however, where substantial mobility is combined with herders cutting hay in summer for use as supplemental forage at their winter settlements, as is common in most pastoral areas across temperate central and east Asia. The traditional emphasis in extensive systems has been on keeping enough animals to satisfy subsistence needs and sustain households through periods of drought or heavy winters, and not on producing animals for strategic sale in the marketplace. Even so, herders do have a long history of selling animals to satisfy household needs for expenses such as school fees, consumer goods, and food.

Livestock Intensification: Livestock intensification is defined as an increase in the units of livestock products produced (i.e., kg of meat or wool, liters of milk) based on a given level of inputs (i.e., feed, water, veterinary drugs, labor or land area). This implies an increase not only in output levels, but also in the efficiency of output (e.g., output per unit of input). This

process of intensification requires that producers have access to investment capital that allows them to purchase inputs so there is also an emphasis on providing credit opportunities to producers. Animals are stocked on rangeland parcels based on a calculated “carrying capacity,” or the maximum number of animals a given land area can support, based on available vegetation, vegetation type, and the purpose for which livestock are raised in a particular area. Intensive production is therefore often associated with formalized (and usually privatized) rights to land. When forage resources within the prescribed area available to a producer are exhausted, they are expected to either sell excess animals or supply additional feed in order to sell animals at strategic time periods and maximize market returns. This combination of production characteristics conforms to those that evolved over time in the context of rangeland management in the Midwestern United States, and this paradigm of livestock intensification has been applied in efforts to “modernize” extensive livestock production systems globally.

Application of the Intensification Paradigm to Extensive Pastoralism:

The logic of intensification has been used as the basic premise to modernize extensive pastoral systems since the 1950s. Economists and policy makers considered extensive pastoral subsistence strategies to be economically inefficient and irrational, given that they were based on the maintenance of large numbers of “unproductive” animals, and mobility over extensive areas of land that were only used seasonally. Prescriptions to intensify pastoral production included a combination of increasing livestock offtake rates, development of livestock markets, use of veterinary drugs, adoption of livestock breeds that produced more milk and meat than local breeds, provision of credit, and water development. A critical piece of the intensification (and modernization) paradigm was to move away from communal land use rights to a system of private property rights, based on the assumption that more exclusive property ownership would be a catalyst

for investment and greater economic productivity (see Ostrom, this volume). Pastoral areas where the intensification paradigm has been applied include Kenya Maasailand and many others. Expected results of livestock intensification were that economic returns to pastoralists would increase, destocking and privatization would mitigate against grassland degradation, and pastoralists would be transformed into sedentary livestock producers.

The Future of the Debate over Intensive and Extensive Pastoralism:

Many would agree that policy efforts to modernize pastoralism through sweeping programs to intensify production have had a checkered history of achievement. The sweeping transition from subsistence-oriented, mobile pastoralism to intensified, sedentary livestock production for the marketplace has not occurred in many areas, although research shows that pastoralists are experimenting with improved breeds, increasingly sell their animals as they become engaged with the cash economy, and are using veterinary drugs where and when the services are available. However, climatic variability remains a key feature of most extensive pastoral systems and mobility continues to be an important coping mechanism in the face of uncertainty – even across private or leased boundaries. In addition, herders' access to the productive inputs that were to be the catalysts for livestock intensification has declined under the impact of structural adjustment and economic liberalization programs on funding for rural services. For example, access to credit and market infrastructure for small-scale livestock producers is very low across much of the developing world.

This combination of circumstances suggests that herders in extensive systems may be caught in a 'bottleneck' between policy priorities pushing intensification, and ecological and economic conditions that encourage herders to maintain critical components of extensive pastoralism. Yet despite these significant challenges, ongoing policy debates regarding pastoral development and mobility often still take place within a top-down

development paradigm based on the goals of pastoral intensification and modernization.

There is a compelling need to look beyond the current confines of the intensification-extensification debate in thinking about what sustainable pastoralism would look like under the multiple polices, economic, and social contexts characterizing arid, resource-poor regions. This discussion should be informed by new theoretical work on common property systems, emerging community-based grazing arrangements, non-equilibrium dynamics in rangeland systems (Vetter 2005), and the role of social capital mechanisms and adaptive capacity in supporting pastoral resilience in the face of change (Adger 2006).

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10 COMMON POOL RESOURCES AND RANGELANDS

*Elinor Ostrom * and Esther Mwangi ***

One general way of thinking about the goods that we value is in terms of excludability and subtractability. Excludability refers to the ability to limit potential beneficiaries from using or benefiting from a good. This can be through physical means, such as fencing, or through non-physical means such as by imposing social restrictions. The mechanism of exclusion is often dependent on the characteristics of the good itself. Some goods that are mobile, such as water in a stream or wildlife in a national park cannot be fenced (or perhaps at very high cost), while others such as arable land can be fenced. Subtractability relates to the observation that one person's consumption of a resource unit makes it unavailable to the next person. For example, if one herder grazes his livestock on a pasture, the grass consumed by his livestock is unavailable to the next herder; or if one child picks a fruit from a tree, that fruit is unavailable to other children.

These two attributes, excludability and subtractability, are often used to provide a general and simple classification of goods, regardless of whether they are provided in nature or created by humans. This classification places goods into four categories: private goods, public goods, common pool goods,

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and club/toll goods. A private good is easy to exclude and its benefits are subtractable. The fuel used for operating a borehole pump can be considered a private good. In some areas, even though a bore-hole may be owned by communities, each herder provides his own fuel that is used to pump water for his livestock. Public goods on the other hand, are difficult to exclude; their use by one person does not reduce what is available to the next consumer. Drought forecasting, often provided by governmental and non-governmental agencies, is availed to all herders. Access and use of this information by one herder does not bar another herder's use.

Finally, common pool resources are those that exhibit both the characteristics of excludability and of subtractability. Like private goods, they are subtractable. Like public goods (and unlike private goods), they are difficult to exclude. Fisheries, wildlife, rangelands and forests are good examples of common pool resources in which the nature of the resource itself, whether its mobility, or just its sheer size, makes it difficult or impractical to exclude. Difficulties in exclusion can also arise from the existence of norms and conventions that prevent exclusion. In some cultures, for example, social norms require herders to share their pastures with others during drought times, or to allow children access to fruit trees during lean times. Most natural resources in the world, especially in the rangelands, can be classified as common pool resources. Their attributes, i.e., difficulties in exclusion and subtractability, present particular dilemmas for public policy. Because they are difficult to exclude, they are overwhelmed by multiple users, including unauthorized ones. Because they are subtractable, there is often competition for use and access. Common pool resources thus face problems of sustainable management and use, which have often been illustrated in an exaggerated fashion by the tragedy of the commons metaphor.

How can common pool dilemmas be overcome in order to sustain the critical goods and services provided by common pool goods, including ecosystem services and livelihoods, especially of the poor?

A large body of scholarly work indicates that assigning property rights to a common pool good can assist in mitigating susceptibility to overuse and the likelihood of under provision that is so widespread in the use of common pastures, fisheries, forests etc. Assigning property rights is expected to identify and clarify the 'owner' of the resource, thus solving the exclusion problem. By solving the exclusion problem, i.e., keeping out unauthorized users or non-owners, those with the authority to use have the incentive to invest in improving the resource because they anticipate to appropriate benefits of the resource into the future. This solves the provision problem. However, a wide range of property arrangements can be used to achieve this objective and the debate on which property structure is best suited to common pool goods rages on. While private, individual rights create owners with the ability to exclude, at least theoretically, it poses several challenges. As noted earlier, some common pool goods can be spatially expansive or so mobile, which would make the costs of exclusion prohibitive. Secondly, some common pool goods are of marginal productivity and characterized by spatial and temporal heterogeneity. The creation of individual, private property rights would potentially exclude some resource users from critical resources that can help reduce risk and hedge against lean times. Renegotiating access across a large number of owners on a fragmented commons involves huge negotiation costs. Finally, some common pool resources are valuable to the broader society (e.g., biodiversity, soil and water conservation, climate mitigation, etc.) over and above an individual, private owner.

Property rights can also be vested in the state as the sole owner. Despite several advantages such as economies of scale in the provision of

monitoring and enforcement, or the consideration of societal and intergenerational values, as well as distribution as some states do allow local users to harvest resources, there are several disadvantages. The history of nationalization of resources has been plagued by tales of resource degradation, especially where states have inadequate resources for monitoring and enforcement and/or where they have evicted customary users who had managed such resources. Ambiguities in roles and responsibilities by a plethora of state management agencies confound the problem.

Common property, i.e., collective management by a well-defined group of owners, provides another institutional option for the management of common pool resources. In recent years, scholars have demonstrated that where resources users have exclusion rights and are able to devise and enforce their own norms and rules for access, use, management, and maintenance, common pool resources have been managed sustainably. Specifically, successful common property regimes that have been able to overcome the commons dilemma over long time periods tend to demonstrate the following characteristics: well-defined resource users with clearly defined rights and well-defined resource boundaries; correspondence between the rules, technologies of use and management and the properties of the resource being managed; the capacity and procedures for changing rules when necessary; an ability to monitor appropriation and sanction rule breakers; accountability of all users; graduated sanctions; processes for resolving conflicts between appropriators and outsiders; and some degree of freedom to devise their own institutions without interference by external agents. Thus, by awarding rights to a collective of individuals, common property overcomes the exclusion problem. By devising and following rules, resource users circumvent the subtractability problem and are in fact able to constrain use, while improving the supply/availability of their resource. Additional

advantages of common property relate to permitting access to a broader range of users than under private, individual property. This is especially important in rangeland areas where the productivity of resources is uncertain over space and time, and resource users face considerable environmental risk.

A growing literature on property rights for rangelands advocates for flexible property regimes to facilitate livestock mobility and resource access over a heterogeneous landscape. Drawing from empirical examples in Asia and Africa, a subset of this scholarship suggests that the notion of boundaries invoked in the design principles in the previous paragraph is insufficiently representative of the observed ‘porosity’ of social and physical boundaries that is necessary in such a highly variable environment. Indeed, the term ‘fuzzy boundaries’ has been created to describe this phenomenon. This extension of the design principles is useful because it bears on the sensitivity of institutional choice to the attributes of resources. However, even where multiple resource users are involved, the nature of the rights they hold, or when they can exercise those rights and its timing, are often well recognized. While rights may be multiple and overlapping in time and space, they can at the same time be ordered and hierarchical with clear obligations held by each rights holder. The notion of fuzzy rights is not necessarily at odds with social and spatial exclusion that is at the basis of common property theory.

One final point worth emphasizing – common pool resources refer to a type of good, which is difficult to exclude and highly subtractable. It does not refer to a property arrangement. In fact, a common pool resource can be held and managed under a broad range of property arrangements. Common property regimes appear to offer certain advantages, especially where resources are of marginal productivity, are heterogeneously distributed and where broad access must be guaranteed to multiple users.

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11 COMMUNITY-OWNED GRAZING RIGHTS

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Arid and semi-arid rangelands, as well as many high-elevation and high or low-latitude rangelands, are common pool resources (see Ostrom and Mwangi, *Common Pool Resources*, this volume). This means that it is difficult to exclude potential grazers from these areas, and use by one individual reduces the amount of forage available for other herders. In the absence of any rules that limit who may graze and place restrictions on the amount, timing or spatial distribution of grazing, there is a risk of overuse and subsequent degradation of the forage resource. This absence of rules is referred to as an “open access” situation. Most rangelands are not open access, however. Instead, they are subject to some type of property regime, that is, a set of formal or informal rules that define the rights and obligations of specific individuals or groups with respect to access, use, and management of the resource in question. Private property gives an individual the exclusive right to use and manage a resource, and the right to sell or transfer their property to another person. In many countries cropland is private property, as is the land on which a permanent home is built. State property is owned and managed by the government on behalf of a nation’s citizens. National parks are one example of state property. Common property occurs where a group of resource users collectively holds the rights to use and manage a specific resource, including the right to exclude non-members from use. In this section we discuss the forms of and rationale for

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rangeland common property regimes, threats to the function of these systems, initiatives to create new community-based grazing management institutions, and considerations for policy makers, donors, and practitioners in crafting land tenure policy for extensive pastoral systems.

In reality, many rangelands are subject to multiple and often overlapping property rights associated with different pastoral resources (e.g., seasonal grazing areas, campsites, hay-cutting fields, water sources, fuelwood, medicinal plants, etc.), and held by different rights-holders (e.g., individuals, households, encampments, lineage members or residents of a larger territorial or administrative unit). For example, the summer pastures and natural water sources in an area may be open to all residents of a district, while adjacent winter pastures and mechanical wells are the customary property of herding camps composed of several households. Many rangelands are held under a property regime where at least some of the resources are collectively owned and managed. One of the best-known and often-cited examples of community-owned and managed grazing lands is the Swiss mountain community, Törbel (Netting 1981, Ostrom 1990). In Törbel, use of clearly defined mountain pasture commons was restricted to villagers and regulations limiting the number of cattle an individual could graze were easily monitored and strictly enforced. Written rules dating back over 500 years document the territorial boundaries of the commons and specify membership and management rules. A wide variety of successful community-managed grazing regimes existed historically in many indigenous pastoral systems and has been documented across pastoral regions of Africa and Asia.

Common property regimes make sense in many rangelands. The low productivity and patchy and unpredictable distribution of forage, and pastoralists' use of diverse vegetation types across seasons to support multi-species herds, call for access to large land areas, and often demand a

mobile system of livestock husbandry (see Fernández-Giménez, *Livestock Mobility and Sedentarization*, this volume). Under these circumstances, large land areas, collectively held and managed, make more sense than small parcels owned by individuals.

Many historically well-functioning community-managed rangelands have been converted into other types of property (private or state) or de facto open access, often to the detriment of the environment and the pastoralists who depend on it. Such reforms can involve widespread top-down introduction of individual household grazing rights, frequently combined with other top-down policy initiatives aimed at settling mobile pastoralists (see Fernández-Giménez, *Livestock Mobility and Sedentarization*, this volume) or promoting more intensive livestock production systems (see Burnsilver, *Intensification vs. Extensification Debate*, this volume). In other cases, privatization of key resources, especially wetland areas with potential for crop agriculture, have occurred piecemeal, resulting in incremental and progressive loss of access to important seasonal resources for pastoralists.

Nationalization of rangeland resources occurs when a state claims jurisdiction over large areas of seemingly vacant or mismanaged rangelands. If the government lacks the resources or capacity to manage such lands actively, these state-owned lands often become de facto open access when customary common property regimes are undermined or abolished by nationalization policy. When governments establish protected areas and eliminate grazing within them, functional common property regimes may be disrupted.

Even well-intended policies designed to formalize and secure community ownership of grazing rights have resulted in unintended consequences. Often the area over which a community holds rights is insufficient to buffer against a variable climate, or does not contain the necessary diversity of

resources to sustain an extensive production system (Lane 1998). In some cases, such as the group ranches of Kenya, formal community ownership led to the eventual loss of community stewardship, fragmentation into small, privately held plots, and disenfranchisement of some customary community rights-holders (see Mwangi and Ostrom, Group Ranches, this volume). Despite these cautionary histories, there is reason to believe that community-owned grazing rights can succeed. Indeed, they have persisted in some areas in adapted contemporary forms, even where other arrangements have been formally introduced (Banks et al., 2003; Ashenafi and Leader-Williams, 2005).

In the past decade, increased attention to, and investment in, community-based natural resource management (CBNRM) has led to a proliferation of community-based rangeland management initiatives. CBNRM refers to resource management institutions in which local resource users participate directly in, and ideally benefit economically and socially from, sustainable management of resources. In Mongolia, for example, over 2000 community-based herder groups and pasture user groups have been established since 1999 with donor or NGO assistance, most with twin goals of improving pasture management and herder livelihoods. Although most Mongolian groups do not hold formal property rights over pastures, many have defined territorial boundaries and membership, and worked towards developing flexible systems of self-governance to coordinate, monitor, and enforce sustainable grazing practices. The performance of these new institutions is as yet untested, and no data are available on their environmental outcomes.

As governments, donors, and development practitioners grow to appreciate the logic of pastoral mobility and common property in extensive livestock production systems that typify many rangelands, policy tools and new or hybrid institutions must be carefully crafted or allowed to evolve on a case-by-case basis to account for the historical, cultural, and ecological nuances

of each locality and community. Key considerations include the definition of “community”, which in practice may not be synonymous with a territorially defined social group bound by common values and norms. Conventional notions of community often obscure profound differences in resource access and use, voice, and power along gender, age, ethnic, religious, class, or caste lines. They also fail to account for the temporally dynamic composition of many pastoral social groupings, where membership may shift annually, seasonally, or more often. A second consideration is the spatially dynamic land use patterns of pastoralists. Mobile pastoralists move across large areas, and their customary resource rights may be defined less by a static polygon that can be drawn easily on a map, than by dynamically expanding and contracting spheres of influence around key resources. The complexity of customary pastoral property regimes where multiple resources are associated with distinct rights and users also deserves careful consideration.

In the face of these and other challenges some scholars and practitioners argue for an emphasis on allocating secure formal grazing rights or land title to pastoral groups, allowing them to develop and enforce their own management rules. Others caution against formalization of informal or customary property regimes and emphasize support for the development of strong institutions to regulate the timing and location of grazing (which results in a *de facto* property regime). Still others highlight the importance of conflict management institutions that can flexibly respond to disagreements over grazing rights and management. The spatially extensive, mobile nature of many pastoral systems suggests that multiple, nested institutional arrangements may be required to provide secure rights over key home range resources, while enabling flexible access to more distant resources in times of need. Though the focus here has been community-owned grazing, local and regional governments may also have important roles to play, and co-management (shared decision-making authority) may be a viable option in some cases.

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12 GROUP RANCHES

*Esther Mwangi * and Elinor Ostrom ***

Policy makers in Kenya and elsewhere have long grappled with the problem of crafting initiatives and incentives to enhance sustainable resource management and the livelihoods of the poor. Kenya's group ranches and their evolution exemplify this dilemma. A group ranch is land that has been demarcated and allocated to a group. The Kenyan group ranch was the forerunner of similar projects that were started in Burkina Faso, Rwanda, East Senegal, Niger, and Botswana.

Group ranches were created with the expectation that they would provide tenure security, creating incentives for the pastoralists to invest in range improvement and ultimately to reduce the tendency to over accumulate livestock. Economically, they aimed at marketizing subsistence pastoral herds. This was anticipated to help improve the welfare of herders. Ecologically, group ranches were intended to prevent range degradation by imposing constraints that would keep livestock holdings at predetermined levels in keeping with an identified rangeland 'carrying capacity.' Culturally, they were intended to ensure that the composition and organization of the groups did not deviate widely from traditional authority structures. The

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program entailed a shift in land tenure and organization from one under which the range was under communal ownership, to an abridged version of the original commons, variable in size and membership, but held under corporate title.

The Land Adjudication Act of June 1968, which provided for the recordation of rights and interests in customary lands, and their assignment to their customary users, facilitated the creation of group ranches. In the case of the Maasai of Kenya, such determinations were made by an adjudication committee that comprised officers from the Land Adjudication Department and elders from each section of the Maasai. After the group was recorded as having joint interests and thus ownership of the land, the group ranch was incorporated under the Land (Group Representatives) Act of June 1968. Under this Act, every member of the group ranch is deemed to share in the ownership of group land in equal, undivided shares. And each is entitled to reside in group land with family and dependents. The group representatives are expected to ensure that the rights of any person under recognized customary law are safeguarded. They are also authorized to hold property on behalf of, and to act on behalf of and for the collective benefit of all members of the group. They are required to fully and effectively consult group ranch members. The Act empowers the group to craft its own rules regarding the running of its own affairs such as procedures for the administration of its property, the registration of new members, and the disbursement of funds for group projects. Each group is required to hold a general meeting of its members every year. All group members are entitled to attend these meetings and to vote in them. No business should be transacted at a meeting of a group unless at least 60% of the members of the group are present at the meeting. A resolution supported by this quorum is treated as the group's decision.

From the group representatives, a committee is to be elected by open ballot each year at the group's annual general meeting. The committee comprises a Chair, Vice Chair, Secretary, Treasurer, and three other members of whom at least two are elected from the group representatives. The committee is required to assist and encourage members to manage the land or graze their stock in accordance with sound principles of land use, range management, animal husbandry, and commercial practice. This committee has the responsibility of achieving "the greatest practicable social and economic benefits" for the members. It can raise credit and is involved in development planning. Every member is required to accept and comply with decisions of the committee regarding membership and the rights and obligations of any person in matters relating to the use of the group land and other assets. However, any member aggrieved by a committee decision has the right to appeal to the group representatives, the registrar of group representatives, or to a subordinate court having jurisdiction in the area.

The last item in the Act provides for group ranch dissolution. This can only occur after a written application signed by a majority of the group representatives, after a resolution passed by a 60% majority of the group in a special general meeting convened for that purpose. Subsequently, the affairs of the group may be wound up in a manner approved by the registrar or failing that, in a manner directed by the High Court. The persons who were officers of the group immediately before the dissolution shall continue in office until after the completion of the proceedings.

To implement the group ranch program, the Kenyan government sought loans and grants from international agencies such as the World Bank, USAID, the Swedish Aid agency, Canadian Development Agency and the United Kingdom. The loans were granted under the auspices of the Kenya Livestock Development Program (KLDP). The Department of Land

Adjudication and Registrar of Group Representatives, both in the Ministry of Lands and Settlement, were involved in the initial establishment of group ranches. The Range Management division of the Ministry of Agriculture designed group ranch development plans. The Ministry of Water Development coordinated water development. The Agricultural Finance Corporation administered the loans provided by the donors.

Many scholars agree that although the Maasai did not accept or even understand some features of the group ranch such as grazing quotas, boundary maintenance, and the management committee, they accepted the idea of group ranches primarily because it afforded them protection against further land appropriation from government, against the incursion of non-Maasai, and from a land grab by the elite Maasai. Group ranch development also promised water development in the form of dams and boreholes, improved livestock husbandry through introduction of dipping facilities, and regular vaccination against prevalent animal diseases.

It is now widely accepted that group ranches failed to meet their intended objectives. A consequence of this failure has been increasing demands for their dissolution and subsequent division into individual, titled units for distribution among their registered members. This disintegration began as early as the mid-1970s but gained momentum ten to fifteen years later in other parts of Kajiado district. A variety of reasons have been given for the failure of group ranches. Some scholars note that group ranches were not ecologically viable. Ranches were not sufficiently extensive to allow pastoralists to exploit the heterogeneity of resources and group ranch boundaries were not respected, especially in times of drought. The key argument levied here is that if ranch boundaries are not strictly observed, their logic is undermined because the incentive to invest in pasture management is weakened as those who did not invest in the effort would also benefit. Others argue that group ranches were unable to gather

sufficient resources, especially the development of water and pastures, to counter ecological constraints.

In several cases, the major credit institution, the Agricultural Finance Corporation, was reluctant to advance new credits to group ranches because group ranch land was deemed as ineffective collateral as it was held collectively and difficult to foreclose the entire group ranch. Group ranches were thus locked out of their principal source of development funds. The organizational structure of the project, with many donor agencies and many implementing governmental agencies, was thought to have militated against long-term planning, and gradual change. Indeed, the project was too centralized, top-down, and did not stimulate local responsiveness.

Beyond these technical problems, studies indicate that group ranches were beset by internal governance problems that also contributed to their failure. These included the unauthorized allocation of group land to non-group members, the gradual addition of newly matured men into the register as population increased, and the inability of the group ranch committee to enforce stock quotas and grazing management. These challenges resulted in some members benefitting disproportionately from collective resources and also created a sense of tenure insecurity for other group ranch members. Subdivision was found preferable.

Over and above a flawed project design and coordination failures, what more can we learn from the group ranch initiative? First, those women, who are key resource managers were excluded from group ranch decision making and ultimately from land ownership when group ranches were subdivided. The same applied to young men, who are now dependent on their fathers for both land and livestock, the primary building blocks of a livestock production system. Second, accountability processes and their enforcement is critical for the success of any collective endeavor. Indeed,

the lack of accountability resulted in a skewed allocation of individual parcels after subdivision. Third, current research is starting to show that subdivision of group ranches further militates against the viability of pastoral production systems, which require mobility to access resources that are patchily distributed over the landscape. The range is less capable of supporting the livestock populations needed to ensure Maasai food security and sustain livelihoods. However, a research and action agenda that can help to moderate this unwelcome prognosis is urgently needed. Some individual parcel owners are re-unifying their parcels, others are engaging in leasing arrangements, and others are opting not to. The institutional basis of these arrangements and their implications for local economies, risk management, and ecology can shed light on appropriate remedies. The implications of women's exclusion require urgent attention, as do the different ways in which research can be linked to policy for appropriate action. Ultimately, there is great scope for comparative policy analysis across settings.

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13 PARTICIPATORY GRASSLAND RESEARCH AND DEVELOPMENT

Ann Waters-Bayer *

Participatory research and development (PRD) involves all relevant stakeholders in a systematic cycle of jointly examining a current situation, planning how it might be improved, trying out something that appears likely to work better, observing and analyzing the results, and reflecting critically together before entering into the next round of the cycle. This short article describes how concepts and methods of PRD emerged over the last decades and how they are applied in grassland/rangeland areas.

13.1 EMERGENCE OF PARTICIPATORY APPROACHES TO R&D

Research and development (R&D) in the rangelands should contribute to improving the existing systems of resource management and use and to improving the livelihoods of the resource-users. It must therefore deal not only with plants and animals, but also with people and their perceptions (e.g., of what “improvement” is), aims, problems, needs and institutions (socially accepted ways of doing things). In systems of extensive resource use, such as in the rangelands, social, economic, cultural and institutional aspects play important roles. The local people’s decisions about resource

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use depend on many factors, such as the functions and values of the livestock, rights of access to pasture and water, differing rights within households or groups to the animals and their products, local assessment of risks and constraints, and the visions of families and communities for their future. The complex interactions of livestock and range management with other components in the livelihood systems of the resource-users create huge challenges for R&D.

The classical approach to research has been to regard the people living in the rangelands as the “end-users” of research findings. Scientists identified the end-users’ problems and developed technologies meant to solve them. Extension services were supposed to disseminate the new technologies for adoption by the end-users. This “transfer-of-technology” approach met with limited success for two main reasons. Firstly, in many countries, extension staff are poorly trained, equipped, and paid and, in many rangeland areas, they are virtually non-existent. Moreover, their roles rarely include the testing needed to adapt a technology to local conditions. Secondly, most grassland and range researchers have sought how to increase animal yields in terms of weight gain and to define the inputs needed to overcome biophysical constraints to higher production. However, people in the rangelands keep animals for many other reasons than just to produce meat, and they use the natural resources for more than just keeping animals. Moreover, the conditions under which they operate (in relatively low-potential areas with high production risks and far from input and output markets) require an approach of optimizing the use of available resources and more or less accepting the biophysical parameters as given.

The socioeconomic, cultural, and institutional settings in which people manage rangelands differ greatly between and within countries. The recognition that research must be embedded in these different contexts gave rise to Livestock Systems R&D in the 1970s and 1980s.

This consisted basically of:

- Identifying different, more or less homogenous livestock systems or “recommendation domains”;
- Conducting baseline studies in the field and analyzing the major problems in each system;
- Suggesting “best-bet” technologies that might solve these problems;
- Testing the technologies under real conditions (“on-farm” or “in-herd”) in trials managed initially by the researchers and then by the herders, and modifying the technologies where necessary;
- Monitoring and evaluating the results and passing on the field-tested technologies to extension.

The trials were intended primarily to adapt technologies developed by biological scientists to existing livestock systems. Accompanying studies by social scientists were meant to help biotechnical scientists explain the livestock-keepers’ behavior, especially the social and cultural constraints to adoption.

The focus of Livestock Systems R&D was on livestock, but, even with this limited focus, it was found that the complexities of livestock systems on rangelands offered little scope for carrying out researcher-managed trials in pastoralists’ herds. Pastoralists depend on their animals for survival and must therefore have the final say in how they are used, also in the trials. Their decisions are based on more than just the biological aspects of the system and must respond to changing conditions. The scientists could

therefore not enforce control over the trials, which were in fact managed by the pastoralists. Some scientists who experienced this form of R&D recognized its merits in combining scientific and local knowledge in developing, testing, and adapting new technologies. They also started to realize that the livestock-keepers are themselves seeking and testing innovations other than those introduced from formal science.

Livestock Systems R&D proved to be time-consuming, costly and slow, and the detailed system studies were often out of date by the time they were finally published. In the mid-1980s, some development projects and non-governmental organizations developed methods of Rapid Rural Appraisal (RRA) to speed up data collection, but these methods were still largely extractive: the information was collected from local people and analyzed by “outsiders”. Methods of participatory rural appraisal (PRA) were then designed to strengthen local people’s capacities to analyze their situation themselves and to generate ideas about how to solve the problems they identified. RRA/PRA focused mainly on problem analysis. Participatory Learning and Action (PLA) methods went beyond this; they were designed to support local people in their own efforts to plan and implement change, monitor and assess the results, and continue a process of self-determined development (Pretty et al., 1995). All these approaches and methods form part of the wider concept of PRD.

13.2 APPLICATION OF PRD

In PRD, the land users play a major role in deciding on research questions and how to address them, manage the experiments themselves and interpret the results with scientists’ support. PRD may focus on a specific component of a rangeland system, such as developing ways to manage and use a new pasture species. In the case of improving the system of nature resource management (NRM), the innovations with the greatest

impact are likely to be of a socio-institutional nature, such as new ways of dealing with conflict, regulating access to water, or managing grazing control. All relevant stakeholders (groups that could gain or lose from the changes) need to be involved in experimentation with such innovations. This experimentation can be done only through Participatory Action Research (PAR) in repeated cycles in which stakeholders jointly analyze the situation, plan and carry out experiments with new institutional arrangements, monitor and analyze what is happening, and draw conclusions for further action. By experimenting with change in a real-life setting, both the scientists and the land users experience the various factors that interact within the rangeland system, such as resource tenure and inter- and intra-household decision-making, and other gender and sociocultural issues, and learn from these. PRD includes facilitation of the social process to make the desired changes. Thus, the distinction between research and development is erased.

In general, PRD in the rangelands involves the following activities (Waters-Bayer and Bayer, 2000):

Analyzing the situation. Scientists and local stakeholders examine how the rangelands are currently managed and used. The biological and livestock related components are regarded in the framework of the entire livelihood systems of the land users, which includes not only herders. PRA tools, such as mapping, transects, calendars and preference ranking are useful for this joint analysis of the situation by local people, scientists and development agents.

Setting priorities and seeking relevant innovations. Based on their joint analysis, the PRD partners identify priority problems and opportunities in NRM and agree on innovations to test in order to see if they will improve the situation. New ideas to try out may come from innovations developed

by local people or in other similar areas, or technologies developed by scientists.

Joint experimentation/action research. The land-users wanting to explore a new possibility agree on how to do it: defining the question(s) for which answers are being sought, the aspects to be observed, the means of recording, and the division of tasks. They take the lead in carrying out the experimentation, with support of the scientists and possibly also development agents. Those scientists who would like to measure aspects of the innovation that the local people are not interested in monitoring can negotiate agreement to measure this, possibly by compensating the local people in some way. Alternatively, they can conduct parallel experiments in the same area on land borrowed or leased from the local people.

Participatory monitoring and evaluation (PM&E) and sharing. The PM&E system is designed jointly by the PRD partners, giving precedence to the land-users' criteria. Higher animal production may not be their top priority; other factors, such as saving labor at critical times of the year, may be more important. During the course of the PRD, unexpected events may occur or new opportunities may arise that force or invite the partners to alter their original plans. PM&E includes monitoring these changes, which may reveal unforeseen possibilities of an innovation. The results are shared not only through publications and conferences but also through herder-to-herder exchange, stakeholder fora, and mass media.

Approaches and methods of people-centered and development-oriented research in the rangelands bridge the different worlds of experience of land-users and scientists and make research an integral part of the development process.

In addition to revealing the sociocultural factors that drive the NRM systems, PRD serves several purposes:

- It incorporates local knowledge and insights into the design and analysis of the research;
- It helps develop the land users' own knowledge systems;
- It supports local efforts to plan and implement change;
- It strengthens land users' confidence to seek relevant support from R&D services;
- It increases the likelihood that research results will be relevant for and applied by land users.

13.3 ROLE OF CONVENTIONAL GRASSLAND RESEARCH IN PRD

A participatory approach to R&D cannot do without conventional grassland/range-land research. During PRD, many questions arise that need to be studied under controlled conditions to validate results or to investigate elements needed in developing new technologies. Such research addressing specific issues coming from the field supports the PRD process. PRD also needs scientific research and advisory services that: (1) help link the local people with diverse sources of information and other inputs; (2) support research design and the interpretation of research results gained in the field. This will enhance local people's capacities to adjust their NRM and livelihood systems to changing conditions and to seize new opportunities.

13.4 EXAMPLES OF PRD IN THE RANGELANDS

1. Participatory action research in grassland management

Having experienced severe drought, pastoralists in northern Mali were open to new ideas as to how to manage the natural vegetation on which their herds depend. They entered into discussions with government livestock services and external consultants to identify possible improvements in resource management. They jointly observed current range conditions and analyzed how these had changed. Some older pastoralists recalled that, in the past, certain pastures were not grazed during the rains and were then available in the dry season. They also noted that *fonio* or hungry rice (*Panicum laetum*), which the pastoralists collected to eat in times of need, had become scarce.

They started experimenting on a small scale with protecting *fonio* areas from grazing. The trials then expanded to reserving areas for deferred grazing. In a meeting after the rains ended, the pastoralists assessed what vegetation was needed and available and decided whether and when to open up the protected areas. At subsequent twice-yearly meetings, they drew lessons from experience and adjusted the management regime, e.g., by changing the size of the reserved areas, the period of reservation or how fines were imposed on herders who did not comply. The pastoralists took the lead in this action research in NRM, with government staff and consultants providing support where needed.

Source: André Marty. pers. comm. 1994

2. Experimenting with grassland co-management in Mongolia

In Mongolia, nomadic livestock producers are the backbone of the economy, but many face serious problems of grassland degradation. Addressing these problems not only requires dealing with the biophysical and social dynamics of

NRM but also unlearning "Soviet-style rule" and responding to the economic and political opening-up that the Mongolian Government promotes since 1992.

A multidisciplinary team in the Ministry of Nature and the Environment addressed this challenge through participatory research in three major ecosystems of the country. Methods included PRA, social and gender analysis, and PM&E. Field research and discussions amongst government officials and herders revealed that most herder groups graze too many animals per hectare. The pastures are used as common-property resources but are State-owned. Collective reflection and action involving all stakeholders is therefore required for improved NRM.

The team tried out a series of experiments in collective action. These included: (1) formation of sub district-level herder groups, based on kinship or neighborhood relations as basic units of social organization in a given area (e.g., watershed, mountain); (2) formation of district-level co-management teams, involving the district governor, sub-district governors, and other community leaders. The team facilitated discussion among the stakeholders to define the roles and responsibilities of the herders and various government bodies and to reach consensus on "co-management agreements", including guidelines for herd movements, monitoring and dispute settlement, which were signed by all parties.

The team and herders also carried out other joint experiments, such as animal breeding to improve resilience and productivity; haymaking, pasture improvement and pasture-rotation practices; and exploring new economic opportunities such as adding value to raw materials (e.g., felt and wool).

The entire series of experiments, supported by continuous and multi-level capacity-building, provided an opportunity to define locally appropriate, new common rules and regulations and other site-appropriate innovations.

Source: Vernooy et al. (2005)

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14 LANDCARE

*Andrew Ash **

14.1 BACKGROUND

Landcare as a concept has its origins in Australia. In the 1980s, it was becoming increasingly apparent that many of the European style agricultural practices were not well suited to Australia's variable climate, fragile and nutrient poor soils and sensitive vegetation and fauna. At this time, many farmers were receiving some government funded support for farm-scale soil conservation but many of the sustainability issues were much broader than soil erosion i.e., salinity, weeds, land clearing, and loss of biodiversity. The term "Landcare" came into existence in the mid-1980s in the south-eastern mainland state of Victoria and rapidly grew to become a national program of effective environmental action by local communities. The Prime Minister of Australia declared the 1990s as the Decade of Landcare.

14.2 WHAT IS LANDCARE?

Landcare is a community-based approach to improve sustainability of agricultural production systems, address environmental issues, and protect natural resources. Landcare is based on the concept and practice of

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community members providing their time and energy to identify, plan and implement on-ground land management works. The movement is independent from government, but governments have supported Landcare through grants for projects.



A key feature of the Landcare approach is the partnership between governments, individuals, and the community. Sustainable natural resource management depends on a cooperative approach based on respective roles and responsibilities.

The role of the Australian Government is to provide national leadership and coordination in natural resource management. It fulfils this role by providing an institutional framework for the establishment of coordinated strategies addressing natural resource management issues at a national level; providing coordination and funding for research and development on issues of national significance; and increasing public awareness, education, and information exchange, including the identification of gaps in the knowledge base.

The State and Territory governments have the main operational role in implementing policies and programs for achieving sustainable natural resource use and providing a suitable institutional and legislative framework.

Landholders and regional communities have primary responsibility for identifying natural resource management problems and devising appropriate strategies for addressing them. Activities and investment decisions at a regional level are most effective when generated by the regional communities themselves.

14.3 THE ROLE OF SCIENCE

Scientists have played an important role in the Landcare movement through partnering with government, communities, and farmers to provide technical support to on-ground research and monitoring. Farmer groups often identify a problem, and in partnership with scientists develop a proposal to tackle the problem in a participatory, on-farm research project.

14.4 THE STATUS OF LANDCARE

There are over 4000 community-based groups associated with Landcare working on natural resource management issues. Over 40% of Australian farmers are involved in Landcare. Groups operate on both private and public land and in addition to agricultural lands; landcare groups are active in peri-urban and coastal landscapes.

The development of the Landcare movement in rural Australia has resulted in benefits which go well beyond the environmental arena. Landcare has achieved not only a significant change in attitude to the value and management of Australia's natural resources, but has also been very important in mobilizing and revitalizing rural communities.

Other countries have now adopted and adapted the Landcare concept. The common principle is community empowerment to identify, plan and systematically address environmental problems. Some overseas governments are using the Landcare approach to address not just

environmental problems, but also social and educational issues in rural communities.

Landcare – a case study: Woody Yaloak Catchment Group (WYCG)

South-west of Ballarat, Victoria the Woody Yaloak Catchment Group's 170 landholders share their knowledge, experience, and commitment to the adoption of on-farm Landcare solutions. The Group's objective is to blend productivity, environmental restoration, and community development.

Over the last ten years, WYCG has moved from a collection of landholders tackling rabbits, erosion, revegetation, and pasture improvement, to a sophisticated catchment-wide grouping completing holistic projects for the benefit of business and the environment.

Early in the 1990s, Landcare groups in the area amalgamated into WYCG. During its first five years it established 4000 hectares of perennial pasture, 135 hectares of trees, stabilized 40 hectares of erosion, and eliminated 200000 rabbits. The second five-year plan was more ambitious, taking a triple-bottom line approach and bringing landholders, schools, local governments, Ballarat University and the community together to achieve major landscape change.

Source: Youl et al. (2006)

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15 ECOSYSTEM FUNCTIONS OF GRAZING LANDS

Kris M. Havstad *

An ecosystem is a community of animals and plants interacting with one another and their physical environment. Rangeland ecosystems are the communities of organisms including humans, interacting with each other within environments characterized by herbaceous and/or shrubby vegetation common to arid and semi-arid regions around the world. These ecosystems occur within the grasslands of Asia, the deserts of North America, the savannas of Africa, the shrublands of Australia, the Pampas of South America, and in many other regions. Over one billion people live within these rangeland ecosystems.

Ecosystem services from these rangelands are processes by which these ecosystems produce the resources, or goods, that humans have come to expect. Typically, rangelands around the world have been utilized for the production of livestock, and the provisionary ecosystem services of food and fiber have been commonly harvested from these grazed lands. However, many other services are commonly provided by these systems. These services include supporting services (primary production, water cycling, and nutrient cycling), cultural services (recreation, educational values), regulating services (climate regulation, pollination), and other

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provisionary services (genetic resources). Though many of these services, such as food production, are commonly recognized and appreciated, many ecosystem services are often taken for granted or are unappreciated. Examples include seed dispersal, decomposition of waste, conservation of soil fertility, and pest regulation.

The capacity of rangelands to provide specific goods and services, or any particular combination of goods and services is a result of ecological features of a landscape. Five key interacting ecological principles of any specific rangeland landscape that create a set combination of goods and services are: (1) historical legacies; (2) environmental drivers; (3) transfer vectors (primarily wind and water); (4) redistribution of resources; and (5) the basic soil-geomorphic template. Figure 4 illustrates these interactions and their linkages to goods and services produced from rangelands.

Though many goods and services from rangeland ecosystems are critically important to the one billion people living on or adjacent to rangeland, many of these services lack specific economic values. Few services are linked to an economic market that would create specific values, or incentives for conservation of their provisions to the public. Often values for services have been based on the known values of common goods, such as the value of rangeland for providing forage for grazing livestock. These economic values are often quite low because of the relatively low production capacities of the world's rangelands. However, markets for less traditional regulating services such as carbon sequestration, or cultural services such as recreation, are emerging. It will be critical that appropriate policies are implemented that provide appropriate incentives and benefits that will support the conservation of any ecosystem services as their economic values are more readily apparent and utilized.

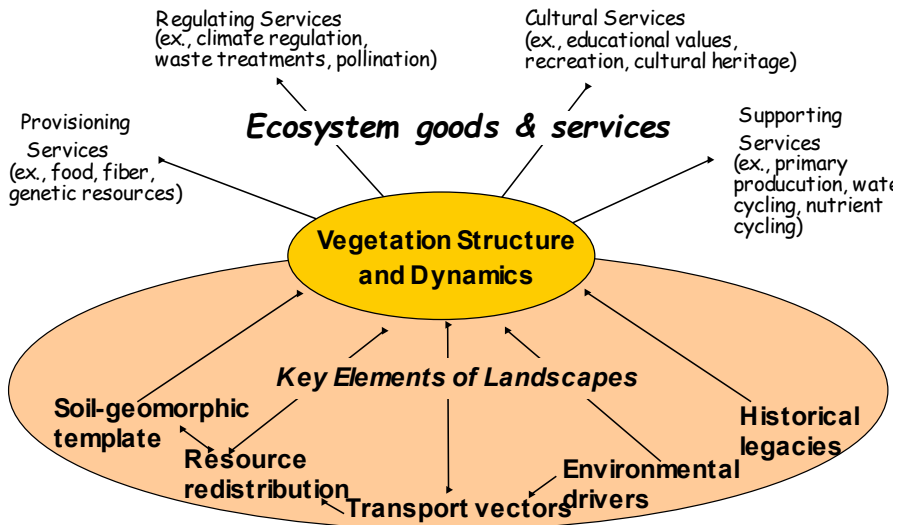


Figure 4: Five key elements of rangeland landscapes interact to determine vegetation structure and dynamics with resulting effects on ecosystem goods and services (Havstad et al., 2007; Peters et al., 2006)

(1) historical legacies of past climate, disturbances, and human activities; (2) environmental drivers; (3) transport vectors, such as the run-on and run-off of water during extreme rain events; (4) redistribution of resources, such as soil, nutrients, and seeds; (5) the soil-geomorphic template

Irrespective of the specific arrays of goods and services provided from rangelands, a key service to rangelands will be the use of ecologically based practices to ensure their sustained resilience, or the capacity to reorganize and provide their characteristic functions, structures and feedbacks following disturbances. Rangelands are coupled systems of nature and humans, and proper management of these landscapes is critical to their continued supply of services and goods that we request, recognized or not and appropriately valued or not.

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16 MULTIPLE USE NATURE RESERVES

*Lynn Huntsinger * and Paul Starrs ***

The term “nature reserve” implies an area set aside to protect or preserve nature. From the sacred groves of antiquity to today’s parks and preserves, the purposes and types of reserves that have been designated by individuals, communities, and governments vary greatly. Unfortunately, as the concept of setting aside nature for its own sake evolved in the nineteenth century, “nature reserves” were seen as a necessity to protect nature from human enterprise, and as a result, people using reserve lands to earn a living were often excluded. Too often, “nature reserves” have come to be associated with the removal of indigenous residents in natural areas at the behest of powerful conservation or governmental entities. Multi-use nature reserves are part of a recognition that people and their activities, within and adjacent to reserve lands, can play a crucial role in sustaining nature reserves and their ecosystems.

In the conservation field, the social equity issues that arise from the establishment of nature reserves have been much debated. Globally, there have been successful and unsuccessful attempts to incorporate local people into nature reserves, and/or to develop economic relationships with

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local people that allow them to benefit from reserve establishment. Multiple-use nature reserves ideally allow local people to remain in their homelands, continue sustainable traditional uses, and as a result, support the reserve more than if the land was expropriated.

In a multiple use nature reserve, conservation goals are combined with some economic uses of the land. Such a reserve may be used for any combination of production of saleable goods, protection of soil and water, conservation of biodiversity or other ecosystem services, and the provision of socio-cultural goods. This can have ecological benefits, as traditional economic uses of forests and rangelands can contribute to biodiversity and the ecological values of areas selected for reserves may in some ways reflect local management. For example, in some places grazing may increase the structural heterogeneity of grassland, shrubland, and woodland, or increase forbs and reduce invasions of shrubs. Limited hunting by local people may prevent animal over-population problems.

Multiple use reserves can also have social and cultural benefits. Local residents may have considerable knowledge of local resources and ecosystem processes, and their skills and abilities are increasingly seen by anthropologists, cultural ecologists, geographers, and enlightened preserve-planners as fully as important as the plant or animals communities held within preserve boundaries. Traditional land management practices, and the landscapes they produce, may also have cultural value. Traditional agriculture, gathering, and grazing may be part of the identity of a nation, region, or community, and contribute to maintaining cultural traditions.

On the other hand, compromise may be required to prevent damaging practices and to shift emphasis more toward conservation goals. The amount of cultivation, grazing, hunting, or timber harvest may have to be limited. People using reserves may have to tolerate more predation, less use of available technology, and reduced returns due to lower intensity

production than they might otherwise. In exchange, preserves may be able to offer local people more opportunities to earn income from tourism, compensation for crop or animal losses through depredation or “payment for environmental services” programs that benefit the local people.

Multi-use nature reserves can provide buffer zones and linkages between core preserves designed around the habitat needs of particular sensitive species. They can also serve as educational opportunities for communities outside the reserve, promoting environmentally sensitive practices and helping to develop markets for the specialty products that may result. This expands the effective impact of the preserve on biodiversity. But if in some part the economic benefits from multiple-use nature reserves do not flow to local people and/or communities but instead flow to the government or to outside businesses, then the possibility of benefiting from local support for reserves is lost. This is especially true in poorer areas where people may need to use reserve resources to survive. Excluded from the benefits of the reserve, they may be forced to make use of resources illegally, and this makes the entire reserve and its resources less sustainable. Yet if they do support the reserve, local inhabitants are often in the best position to enforce restrictions that ensure its continued existence.

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17 CONSERVATION THROUGH GRASSLAND USE

*Lynn Huntsinger **

Rangeland livestock production can be important for conservation of ecosystems for numerous reasons. The grazing process itself can be used to maintain ecosystems that have evolved or developed under grazing, managing invasives, encouraging native plants, and reducing fire hazard. For example, in some ecosystems the plant communities we seek to conserve depend on grazing to preserve their species diversity and structural characteristics. As another example, flammable build-ups of dry grass and shrub invasion can be controlled through grazing on some rangelands.

Rangeland livestock production systems, whether they are ranches in the United States or pastoralist households in Asia, are important for sustaining traditional lifeways – producing food and helping to keep rangelands as undeveloped semi-natural land. Well-managed rangelands provide an array of environmental services to society, including maintaining open space, wildlife habitat, watershed, and scenery. However, to use grazing as a tool to manage ecosystems and to use livestock producers to sustain landscapes, it is important that the livestock operations that produce the livestock remain economically viable.

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Two “tools” that have been used to help maintain livestock grazing and graziers in the United States are conservation easements and grassbanks. Both of these help livestock producers to stay in business and can be used to encourage good grazing practices. Conservation easements change the land tenure on a ranch to preclude changes in land use, while grassbanks provide a grazing area to be used during times when regular grazing areas are not available or have little forage. These tools are especially important when land is at risk of conversion, or on lands where forage supplies are highly variable from year to year due to unpredictable droughts or fire. In this review we will describe each tool.

The following information about conservation easements and grassbanks is adapted from White and Conley (2007) and from the website www.landtrustalliance.org.

17.1 CONSERVATION EASEMENTS

A rangeland conservation easement is a legal agreement between a landowner and a land trust (conservation organization that holds lands) or government agency that permanently limits uses of the land in order to protect its conservation values. It allows the landowner to continue to own and use their ranch land, and to sell it or pass it on to heirs. However, the conservation easement takes away their right, or option, to develop the land. This change becomes part of the title stipulations for the land. Though in the U.S. conservation easements are a method for preserving privately-owned lands, they might be adapted for land that is held under a long-term lease or contract, or perhaps even applied to lands held by a community.

Conservation easements are voluntary and established through a “willing seller-willing buyer” arrangement. A rancher may sell an easement on his or her land and use the money to help stay in business, invest for future use, pay off debt, or buy out other owners or heirs. A rancher may also

donate an easement to a conservation organization – in which case they may receive a tax break from the national government for the value of the donation. Removing the right to develop land may also lower its value and result in lower property taxes in some cases. For the conservation organization or agency, purchasing an easement is an opportunity to preserve land for conservation or cultural reasons for far less than it would cost to purchase and manage the land. In addition, the grazing activities and management practices that may help maintain desirable ecosystem conditions on the land continue.

Easements are individually negotiated and can have few or many stipulations for the landowner. For example, in one case the owner might give up the right to build additional structures, while retaining the right to grow crops. An easement on property containing rare wildlife habitat might prohibit any development, for example, while one on a farm might allow continued farming and the building of additional agricultural structures. An easement may apply to just a portion of the property and need not require public access. Future owners will also be bound by the easement terms. The conservation organization (land trust) or agency that purchased, or accepted, the easement is responsible for making sure the easement's terms are followed. If a conservation easement is more restrictive, the landowner is likely to set a higher price for the purchase of the easement.

By providing some funds, reducing taxes, setting conservation standards, and stabilizing ranch tenure for the long term, a conservation easement can help maintain ranching and improve management. Perhaps most importantly, it can be essential for passing land on to the next generation.

17.2 GRASSBANKS

In the disequilibrium environments of arid rangelands, unusual shortages of forage within years and between years can be expected but seldom

predicted. While conservative stocking can help to protect rangelands and pastoralists from much of the variability, at times there will be forage shortages despite a low stocking rate. Traditional mobility allowed the movement of stock over long distances to evade forage-short conditions. However, as rangeland tenure is fragmented and lands are fenced, new strategies are needed. In the United States, a group of ranchers in the arid southwest known as the Malpais Borderlands Group developed what they term the “grassbank” concept to cope with drought and support range improvement and conservation, and it has been applied with mixed success in various areas.

A grassbank is an area of land that is not grazed regularly but can be accessed when forage supplies are in crisis. When the Malpai Borderlands Group of Arizona and New Mexico invented the term, they were describing the use of a reserve area managed by a private conservation organization as an area for grazing during exceptional drought. By giving ranchers access to this “grassbank” when they needed it, the conservation group and the Malpai Borderlands Group earned the trust of nearby ranchers, the respect of government agencies, and eventually expanded their conservation influence to a larger area. It helped to preserve the local community. Other examples in the United States have used government land, with ranchers gaining access by agreeing to changed practices or improvement projects on their grazing leases or private land.

In general, a grassbank can be defined as a physical place as well as a voluntary collaborative process, where forage is exchanged for one or more tangible conservation benefits on neighboring or associated lands. Grassbanks are one of the innovative initiatives spawned by efforts to maintain working ranches and rangeland landscapes.

In 2007 a group of grassbank operators came to the following consensus on seven conditions for success which provide a useful framework for

evaluating new grassbank opportunities and for modifying existing programs:

1. Providing conservation should be the primary objective of a grassbank – it is a conservation investment;
2. It must provide a meaningful benefit to participating ranchers;
3. It has to be financially realistic;
4. It must have the cooperation of all parties involved;
5. A grassbank needs flexibility;
6. The relationship between the grassbank and participating ranchers must build long-term capacity;
7. Goals and standards for success must be clear.

Agencies and preserves that own rangelands might consider whether occasional grazing of their lands would be possible and would allow them to continue meeting their conservation goals. Using some of their lands as a grassbank could be a good way to begin the process of building a long-term, positive relationship with rangeland livestock producers.

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18 CARBON SEQUESTRATION AND SINK RESOURCES IN GRAZED LANDS

*Joel R. Brown **

The movement of carbon from the atmosphere and storage in the soil and vegetation (sequestration) is seen as an important contribution that agriculture and forestry can make to mitigate one of the drivers of global climate change. Fixing atmospheric carbon into more stable soil compounds via naturally occurring processes is relatively well understood by scientists and land managers. Rangeland vegetation fixes carbon via photosynthesis and moves the fixed carbon to the roots where it is ultimately decomposed. Some is released to the atmosphere during this process, but some becomes attached to soil particles and is aggregated into larger, more stable structures. Carbon in the soil is found in three forms, generally referred to by turnover time: short term carbon is that portion which turns over on an annual basis; medium term refers to that portion which is contained in relatively stable aggregates and turns over on a multi-year to decadal basis; long-term carbon typically refers to carbon that is retained for decades to centuries. In arid and semi-arid soils, inorganic calcium carbonate is often formed during soil development. It can persist for thousands of years. Rangeland management affects primarily the soil carbon component that turns over in the short-medium term, though it can slowly increase long-term carbon. All three forms of carbon can be rapidly

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diminished by cultivation and other intensive soil disturbances that remove plant cover.

The amount of carbon in any rangeland soil at any particular time is determined by net primary productivity (NPP), plant growth form (especially root distribution and turnover rates), current disturbance regime and the history of these factors. NPP determines how much carbon is put into the soil system on an annual basis and also reflects the capacity of the soil to hold carbon. Capacity of the soil to hold carbon is limited by the inherent fertility of the soil and long-term precipitation regime. The capacity of any given soil to hold carbon or increase carbon storage reflects these limitations. Although fertility can be enhanced and water can be added to rangelands, upon cessation of the addition, stored carbon will be lost. Plant growth form determines how much carbon is returned to the soil, at what depth, and how easily it is released to the atmosphere. Soil disturbance also has a major influence on soil carbon levels at any particular time. Exposing soil carbon compounds to the atmosphere oxidizes carbon. In most rangeland ecosystems, soil disturbance is seldom an important factor determining soil carbon levels because few rangeland management practices disturb the soil beyond 2 cm. However, vegetation disturbance can result in a shift in species composition, which can have dramatic effects on carbon storage. From a historical (multidecadal) standpoint, although rangeland soil carbon levels are always seeking equilibrium with soil fertility and precipitation regimes, flux rates can be very dynamic. Drought, in particular, can deplete soil carbon if NPP input in previous years is relatively high due to above normal precipitation. Conversely, rangeland soil carbon levels can be expected to increase even in average precipitation years following an extended drought, regardless of management.

In the more humid rangelands where NPP can exceed $4000 \text{ kg}/(\text{hm}^2 \cdot \text{a})$, sequestration rates may approach $500 \text{ kg}/(\text{hm}^2 \cdot \text{a})$ in wet years following extended drought. At the arid extreme, where NPP is often $<100 \text{ kg}/(\text{hm}^2 \cdot \text{a})$

a), carbon sequestration is typically less than $<10 \text{ kg}/(\text{hm}^2 \cdot \text{a})$, even when rainfall conditions are favorable and management is appropriate. Regardless of the ecosystem, annual fluxes can exceed 10% of the soil carbon pool.

Managing rangelands to optimize carbon sequestration is relatively well understood. Proven livestock grazing practices designed for sustainability are usually compatible with the desire to store carbon. Heavy grazing that ultimately reduces NPP either through changes to vegetation composition or soil degradation will reduce both the amount of carbon in the soil at any given time as well as reducing the potential for future storage. Moderate to light grazing generally has little, if any, effect on carbon fluxes, but research results have been highly variable depending on soil type, vegetation, and climatic regime.

Importantly, there are some paradoxes in the management of rangelands in general and soil carbon levels in particular that must be accounted for in any assessment of carbon dynamics on rangelands. Many rangelands are susceptible to undesirable increases in shrub cover as a result of inappropriate livestock hygiene practices and alteration of fire regimes. Herbaceous material in most rangelands turns over annually, while woody biomass continues to accumulate from year to year. In addition, woody plants often exploit a greater volume of the soil, increasing access to nutrients and water and altering NPP. While this increase in woody productivity and storage may increase system carbon storage, it often comes at the expense of herbaceous production, increasing the chances that long-term overgrazing will reduce productivity and economic performance.

Although rangelands represent a very large potential carbon sink if properly managed, the potential for unintended losses should not be overlooked. There is some evidence that arid rangelands may be sources of carbon to

the atmosphere, but substantial research is required to confirm their role in global carbon dynamics. Whenever land degradation results in soil loss, soil carbon can be lost to the atmosphere. In addition, arid rangelands which contain high levels of calcium carbonate could be a source of emissions via the exposure of CaCO_3 to the atmosphere. Also, there is a general consensus that carbon storage on rangelands would be affected by management practices to reduce shrub populations, but the direction of the fluxes is dependent upon the relationships in the driving factors of precipitation and soil properties.

Carbon storage in terrestrial sinks is attractive as a policy alternative in that: (1) results can be achieved quickly; (2) technologies for enhanced sequestration can be implemented without major economic impact and are generally associated with improved management of resources and more efficient production systems; (3) delivery infrastructure (extension, conservation programs) is in place and proven successful. However, the design and implementation of policies and programs to accelerate and realize the potential of terrestrial sequestration requires analyses that examine regional land use patterns, human activity systems, and economic development objectives.

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19 PLANT VARIETY RIGHTS: ISSUES SURROUNDING THE UPOV CONVENTION

T. A. Jones *

Plant variety rights (PVR) are maintained by national law and internationally by the International Union for the Protection of New Varieties of Plants (UPOV) Convention, an entity of the UN World Intellectual Property Organization (WIPO) located in Geneva, Switzerland. The stated mission of UPOV is “to provide and promote an effective system of plant variety protection with the aim of encouraging the development of new varieties of plants for the benefit of society. “Its initial code was released in 1961 with revisions in 1972, 1978, and most notably in 1991. The 1961 code and the 1972 and 1978 revisions provide two exemptions to PVP: (1) a farmers’ exemption to save and sell seed; (2) a breeders’ exemption to allow use for new variety development. To date approximately 65 countries are signatories, with notable exceptions including India, Thailand, Costa Rica, and the Solomon Islands.

To qualify for plant variety protection (PVP) under the 1978 revision, a variety must be distinct (in comparison to other varieties of the same species), uniform (consistent) and stable (across generations). It must also possess a generic name under which it will be marketed.

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Expansion of PVRs has been championed by business interests in the developed world. Seed companies contend they must have protection to recoup costs of plant variety development, particularly for expensive biotechnologies. But PVR remains controversial in developing countries. For example, India's law has been rejected by UPOV for non-conformance. Concerns about PVR and UPOV include perceived negative impacts such as genetic erosion of crops, disincentives for non-trivial plant breeding, downsizing of publicly funded plant breeding research and subsequent reductions in numbers of trained plant breeders, increased restrictions on germplasm exchange, monopolizing activities of multinational corporations, prohibition of farmers' rights to save and sell seed, inflated seed costs, institution of terminator technologies, and endangerment of food security. Developing countries express concerns over a double standard: genetic resources, much of which originate in developing countries, are considered to be public property, but varieties and biotechnology, which mostly originate in developed countries, are considered to be proprietary. The consensus is that PVRs are a contributing factor to the trend towards consolidation of the agricultural sector by agribusiness interests over the last generation.

Countries joining UPOV up to 1999 may opt for the 1978 revision, but members joining since 1999 are required to adopt the substantial 1991 revision. The 1991 revision requires the variety to be new (not previously offered for sale) and extends the protection period from 15 to 20 years. In addition, it removes the farmers' exemption, instead making it optional and dependent on laws of individual member nations, while stipulating a royalty payment. For example, the U.K. Plant Varieties Act 1997 permits "sensible" remuneration for farm-saved seed. The 1991 revision also protects a variety when used in 'dependent' and 'essentially derived' varieties and prohibits protection of such derived material. To explain, a dependent variety might be a hybrid created by a protected inbred, and an essentially derived variety might be a protected variety modified by the insertion of a single gene via biotechnology.

Members of the World Trade Organization (WTO) are required to protect plant varieties according to the Trade Related Aspects of the Intellectual Property Systems (TRIPS). Joining UPOV fulfils this requirement, but this, too, is controversial. There may be impetus for another revision of UPOV in the near future. European interests have opposed the farmers' exemption, and American interests have opposed the breeders' exemption. In addition, a longer protection period is possible in the next revision.

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20 GRASSLAND PRODUCT CERTIFICATION AND NICHE MARKETING

*Bernie Sontagg **

'Niche' marketing refers to identification or discovery of a unique or special market for a specific product or service. The product or service itself must, in some fashion, be unique or different from other like or similar products. What makes the product unique is a set of characteristics that sets it apart from other similar products. These characteristics generally need to be measurable and repeatable. The ultimate objective of 'niche' marketing is higher profits. For example, the market for Rolls Royce cars could be described as a 'niche' market. They are produced to exacting standards for materials, workmanship, and technology. Relatively few are produced and the market is small – relatively few wealthy customers want them and can afford them, but profit margins are high.

An agricultural example is from Canada – No. 1 Canadian Western Hard Red Spring Wheat. This is considered the best quality bread wheat grown in Canada and usually has the highest price. It has certain product characteristics – a minimum level of protein, a minimum weight per unit volume, specific color and kernel shape, low tolerance for foreign material, and other specifications.

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The standards that this product must meet before it can be produced, graded, and sold as No. 1 CWRS wheat are established by the Canadian Grain Commission, a national government agency responsible for grades and standards for Canadian grains. Lower grades of CWRS must satisfy somewhat lower standards and usually sell for a lower price. These standards constitute 'product certification'. It is an important Canadian export commodity though it is only a small proportion of total world wheat trade, thus it can be considered a 'niche' market commodity. This product is often used by foreign buyers to blend with other types or grades of wheat in the production of flour for bread.

'Niche' marketing in a grassland context would require the identification and certification of some unique products or services that some buyers or customers would be willing to buy at a premium price. The objective in 'niche' marketing is to define and manage or control the supply of a unique product or service in order to extract premium prices and profits from sales to buyers interested in that product or service. Grassland products aimed at 'niche' markets might include meat products with unique characteristics dependent on specific certified production methods. Perhaps cashmere produced from certain flocks in a specific location according to a specific protocol could enjoy a higher price and profit than that produced with conventional methods. 'Niche' marketing in a grassland context might include 'ecotourism' to unique natural areas where 'eco-tourists' are willing to pay premium prices for a unique experience.

21 RANGELAND ECOTOURISM

*Jonathan Davies **

Ecotourism is frequently touted as a solution to both conserving the environment and boosting rural incomes. It is thought to be of great potential in rangeland regions, and countries with a predominance of rangelands, such as China, Kenya, and Tanzania, have been among the world's most popular ecotourism destinations (Whelan 1991, Honey 1999). Ecotourism is one of the fastest growing sectors of the tourism market (Honey 1999, Hawkins and Lamoureux 2001) and it offers many opportunities (as well as potential threats) for both economic development and conservation of biodiversity.

Ecotourism has been described as “environmentally responsible travel and visitation to relatively undisturbed natural areas, in order to enjoy and appreciate nature (and any accompanying cultural features – both past and present) that promotes conservation, has low negative visitor impact, and provides for beneficially active socio-economic involvement of local populations” (Lascurain 1996). Ecotourism should: contribute to conservation of biodiversity; sustain the well-being of local people; include an interpretation/learning experience; involve responsible action on the part of tourists and the tourism industry; be delivered primarily to small groups by small scale businesses; require the lowest possible consumption of non-renewable resources; and be based on local participation, ownership and

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business opportunities, particularly for rural people (Wood 2002).

Ecotourism is a way of promoting community-based conservation, by allowing local resource users to derive additional benefits from their conservation skills and practices and their sustainable land use methods. Community-based conservation has proven to be a very effective way of managing the environment, so long as the local community benefits equitably from the revenues that conservation generates. There are, however, numerous challenges in ensuring that the dual economic and conservation objectives are both attained.

21.1 RANGELANDS BIODIVERSITY

The Earth's rangelands form a vast reservoir of biodiversity, although data is somewhat weak since definitions of rangelands are somewhat diverse. The drylands, where most rangelands are found and which are largely made up of rangelands, possess 17% of the global Centres of Plant Diversity, 47% of the Endemic Bird Areas, 23% of the Global Terrestrial Ecoregions, and 26% of the Protected Areas worldwide (White et al. 2002). They are home to a great diversity of domestic plants and livestock, with at least 30% of the world's cultivated plants originating in drylands, and they constitute a precious genetic stock for future crops.

Drylands are home to some of the most charismatic species, support high species endemism and comprise many unique ecosystems and biomes, including Mediterranean-type ecosystems, grasslands, savannahs, dry forest, coastal areas, and deserts (Zeidler and Mulongoy 2003, White et al. 2002, Bonkougou 2001, World Bank 2000). Many other ecosystems are also found within the drylands, such as riparian or forest ecosystems, and depend on the drylands for their own ecosystem integrity, whilst adding to the tourist potential of those dryland regions.

21.2 RANGELANDS TOURISM

A great deal of nature-based tourism occurs in the world's drylands, as for example in Eastern Africa where tourism contributes strongly to national GDPs, and where a significant part of that tourism is to view wildlife and so-called "charismatic species" that inhabit the rangelands. In addition to the richness in biodiversity, dryland areas are also home to natural, geological, and archaeological features and an array of cultures that have high tourist value.

Ecotourism in the rangelands is challenging because of the sheer scale of the landscape and the diversity of peoples that use it, the challenges these peoples face in securing and formalizing their land tenure, and the existence of political boundaries bisecting many rangelands. These challenges are frequently compounded by the fact that rangelands populations in many countries have low levels of education, weak access to financial services, and numerous other constraints that are symptomatic of their marginalization.

The expansive nature of rangelands environments means that protected areas are often vast, encompassing large areas of productive land that are often made off-limits to the former land users. Tourism in particular covets the rich resource pockets where wildlife congregates, which are of course key resources for pastoralists and other land users as well. Nevertheless, there are great opportunities for complementarity between systems.

21.3 CAPITALISING ON THE COSTS OF PROTECTED AREAS

Ecotourism has developed in some places as a solution to the problem of residing adjacent to a protected area, as in parts of Northern Kenya.

Samburu communities around Laikipia have been confronted with the costs not only of losing land to protected areas, but of coping with large numbers of wildlife moving across their remaining land to access the protected areas. Samburu communities were concerned that they received the costs of this high wildlife population but received few of the benefits. Their solution was to develop their own ecotourism projects to tap directly into tourist revenues, enabling them to simultaneously capitalize on the high-nature-value of their primary enterprise: pastoralism. The outcome has been increased empowerment and economic prosperity for the communities and improved conservation outcomes in the wider landscape.

Elsewhere, Namibia has promoted ecotourism in its drylands in order to spread the benefits of tourism to rural households. Natural Resource Management responsibilities have been devolved, and community conservancies have been established through a process of mobilizing and registering community members, identifying boundaries, developing constitutions, management plans and plans to distribute the benefits, and organizing systems for monitoring and sustainably harvesting resources. The change in policy from State-controlled parks to community conservancies has contributed to significant increases in wildlife populations and growth in wildlife tourism along with increased empowerment of the host communities.

21.4 REGAINING BENEFITS FROM LAND LOST TO CONSERVATION

Ecotourism can provide a vehicle through which communities can reclaim benefits from land that has at some point been gazetted to create exclusionary (Category I) protected areas. Kenya, where 80% of the protected areas are situated in the rangelands, again provides an interesting example. The Kenyan Wildlife Service (KWS) has gradually shifted its attitude to protected areas over recent years to guarantee greater

benefits to local communities, with management of some parks now integrated with the wider rangelands community so that the effective area for wildlife is greater than the central protected areas. This has devolved some of the authority over natural resources to local communities, simultaneously improving livelihoods and conservation outcomes (Lindsay 1987). This change in policy has raised local ownership of conservation efforts, leading to reduction in poaching and subsequent reduction in management costs, and a steady increase in wildlife numbers (Talbot and Olindo 1990).

21.5 LAND TENURE, POWER, AND CONTROL

Ecotourism offers both opportunities and threats to rural communities, as evidenced by experiences in Tanzania, where growing numbers of rural communities are going into business with private companies to develop ecotourism on communal land. There is tremendous variability in the extent to which rural communities benefit from these ventures, and in the equitable distribution of the benefits. Common features of the more successful examples are a strong sense of land ownership and responsibility for natural resources and strong local institutions to provide effective structures to develop community-based tourism.

Evidently, if ecotourism can generate socio-economic benefits, then there is scope for abuse of those benefits, and this can lead to conflict and can threaten community cohesion. Conflict and power struggles lead to the exclusion of some sectors of a community, and this can undermine many of the principles of ecotourism. For community-based ecotourism to benefit local communities most effectively it is important that local people maintain control over natural resources. Supportive policy is therefore required to ensure that communities are aware of local governance process and have access to legal redress where necessary. However, as communities benefit

from ecotourism revenues, they are more likely to develop the capacity to manage resources effectively.

21.6 ALTERNATIVES TO ECOTOURISM

The term 'ecotourism' has numerous definitions, but the sector is not yet very closely regulated, and variations on ecotourism include pro-poor tourism, "responsible travel," sustainable tourism, community-based tourism, and agro-tourism. Agro-tourism is favored in a number of industrialized countries, including Australia and members of the EU. In Switzerland, agro-tourism is promoted as a way of passing on information to people about the nature-value of a landscape, and although biodiversity conservation may not be the main aim of agro-tourism, ecological conditions are implied in the various related legislation. Agro-tourism in this case may well qualify as ecotourism, but categorization of approaches to 'responsible tourism' is obviously difficult, making regulation of the sector a challenge.

21.7 POLICIES IN SUPPORT OF ECOTOURISM

From some of the lessons drawn in Eastern Africa, it is possible to suggest some policy recommendations that can ensure equitable and sustainable ecotourism development:

- Equitable ecotourism development must be based on strong governance, within the local community and from local and national government;
- Outside business interests can seek to usurp control over ecotourism ventures so government has a role in protecting the interests of local communities;

- Government can boost the development of ecotourism by providing information and resources to rural communities, including information on resource rights;
- Government support is required to help communities affirm their rights to protect and manage natural resources (Nelson, F. 2004);
- Local people need to be made aware of the dangers of pursuing short-term economic opportunities at the expense of longer-term social and ecological sustainability.

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22 GRASSLAND-BASED COOPERATIVES

*Yan Zhaoli * and Yi Shaoliang ***

Grassland-based ecosystems represent the basic interface between people and the environment. Livestock husbandry has been, and will continue for the foreseeable future, to be the use of grassland ecosystems. These systems will provide fodder and forage for livestock, which further produce a significant portion of food, clothing and other materials for people, especially for nearly two thirds of the world's poor. However, it has been increasingly recognized that grassland ecosystems are far more than a component of livestock production and that they provide a wide range of non-grazing rangeland products and services (NGRPS) which might be of more importance than livestock alone. These include spaciousness and clean air, scenic amenity, diverse plant and animal life and its genetic resources, water, carbon sequestration, soil and climate stabilization, minerals, wild food, construction materials, and a material basis for different cultures and their consumption, recreational, educational, and socio-economic needs.

This also necessitates co-existence among multiple stakeholders to utilize and conserve resources and functions of grassland ecosystems, especially those managed as natural ecosystems (or rangelands). Grassland and

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rangeland stakeholders include people and organizations living inside these ecosystems and also others who are concerned about, or have impacts on grasslands/rangelands. Rangelands are also highly variable in terms of providing material products and other types of ecosystem services, and this necessitates their adaptive management to respond to ecosystem variability and maximize desired outputs. Grassland tenure is often contested, particularly in developing countries, where conflicts between customary and statutory systems may emerge, particularly under the pressures of increasing populations and a changing environment. This means that grassland-based ecosystems require effective collective action that recognizes ecosystem complexity and responds to multi-stakeholder needs.

Such a cooperative management system aims to promote efficient, equitable, and sustainable resource use. There are a number of key concepts emerging internationally which define this new management system. These include “adaptive management”, “joint management”, “grassland-based cooperatives”, “livestock-oriented cooperatives”, “collaborative management” or “co-management”, “community-based natural resource management” and so on, of which the last two are most widely accepted and practiced worldwide. “Co-management” is defined as “a situation in which two or more social actors negotiate, define, and guarantee amongst themselves a fair sharing of the management functions, entitlements and responsibilities for a given territory, area or set of natural resources” (Borrini-Feyerabend et al 2000). Key actors in co-management are usually government (inclusive of its representative bodies) and local communities, accompanied by researchers, non-governmental organizations, and entrepreneurs. Co-management situates government and communities as key actors without excluding other stakeholders, such as enterprises, as partners. This facilitates acceptance by legislative and other bodies. Co-management is an open-ended process for multiple stakeholders to negotiate, monitor, and revise respective actions through

“learning-by-doing”.

Cooperatives can be a form of co-management which involves not only participation of concerned parties, but also call on key actors to achieve consensus on a blueprint for the future and to agree on actions and mutual benefits, on information flow, and monitoring mechanisms. Individuals, communities or organizations will only invest human or financial resources in grassland/rangeland if they anticipate a fair system in which they can reap benefit from their contributions and efforts. Grassland-based cooperatives help allocate tasks fairly by involving concerned key parties throughout the process. Available resources and technologies are exchanged when needed. This helps to link different types and levels of organization for collective action and reduces transaction costs through facilitating information flow and risk sharing in a highly variable and changing environment. These cooperatives can also provide mechanisms for conflict resolution and decision sharing (Carlsson and Berkes 2005).

Grassland-based cooperatives differ across time, geographic locations, and socio-economic and political contexts. Traditional groupings for mobile livestock grazing are actually nascent cooperative organizations with developed regulations for when, where, and how to move their herds. More recent cooperatives have also been undertaken as governmental or non-governmental research and demonstration projects. State collectives experienced some success, but also failure, in east and Central Asia. In West Asia and North Africa, state-owned herder cooperatives prevailed until the late 20th century when they crumbled due to lack of genuine support from local communities and institutions. The failure of state-driven cooperatives has encouraged some herders to organize their own cooperatives to request land from government and to use traditional institutions and available resources from outside government. Such cooperatives, however, still face unsecured rights to exclude non-cooperative members from government grants.

The success of grassland-based cooperatives depends on the existence of legally protected rights for concerned parties and their collaborative and adaptive actions. Research and demonstration projects on collective, collaborative or adaptable management of grassland/rangeland have been reported from the western United States, Australian dry lands, and in the southern New Zealand highlands. The international community is also seeking to build capacity and advocate for legally entrusted cooperatives in grassland/rangeland management in developing countries. Such institutions include donors and development research institutions like the World Bank, International Fund for Agricultural Development, International Food Research Institute, the International Centre for Integrated Mountain Development, the Institute for Development Studies at Sussex University (UK), the International Development Research Centre (Canada), United States Agency for International Development and many others.

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23 LIVESTOCK INSURANCE AND CREDIT

Daniel Miller *

Financial services, including insurance and credit, are key aspects of livestock production systems. In the developing world, however, and especially in countries where nomadic pastoral systems dominate the livestock economy, livestock producers' ability to access financial services is often limited. Where services do exist, many pastoralists are still exposed to extensive market failures, high transaction costs and risks, and gaps in service. Incomplete markets and institutional gaps in financial services impose huge costs in forgone economic growth and welfare losses for pastoralists, threatening their competitiveness in producing livestock products and, in many cases, their survival.

The ability of nomadic pastoralists to invest for livestock long-term and to make informed management decisions for what are often risky enterprises and time-patterned income flows is dependent on the financial services provided by the country. In many countries, pastoralists do not have access to the financial services they need to compete and improve their livelihoods. Broader access to financial services would expand pastoralists' opportunities to enlarge herd sizes, adopt new technology, secure needed inputs, and more efficiently allocate resources available to them.

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Livestock production in arid and semi-arid environments is risk prone. In the developing world, pastoralists often confront droughts, snowstorms, armed conflicts, and livestock epidemics that can greatly affect their livestock assets. For example, in Mongolia during the period 1999 and 2002, a series of severe winters led to the loss of one-third of the national herd. Livestock losses seriously impacted national GDP and had a major effect on rural poverty. Risks such as these affect investments in the livestock sector and put assets (i.e., livestock) in danger of being lost. Insurance can assist livestock producers in taking on more risk in production and prevent natural 'shocks' such as drought or snowstorms from depleting their assets.

23.1 LIVESTOCK INSURANCE IN MONGOLIA

The Government of Mongolia, with financing from the World Bank and other donors, is piloting an innovative livestock insurance program as a way of mitigating pastoralists' risk in an environment where severe winter snowstorms and drought can decimate herds. Since 2005, Mongolia has piloted index-based livestock insurance to share risks among pastoralists, insurance companies, and the government. The project combines self-insurance, market-based insurance, and social insurance. Herders retain small livestock losses that do not affect the viability of their livestock enterprise, while larger losses are transferred to the private insurance industry (market insurance through a Base Insurance Product). The Disaster Response Product is a social program financed predominantly by the Government to cover catastrophic losses (i.e., over 30% mortality in a given geographical area).

Herders pay a market premium rate for the base insurance product, which pays out to individual herders whenever the livestock mortality rate in a particular *soum* (rural district) exceeds a specific threshold. As excess mortality reflects a combination of dry, windy summers and cold, high-snowfall winters, the insurance index is linked not to a weather event, but

to historical livestock mortality data. Insurance payments are thus not directly linked to individual herders' livestock losses; payments are instead based on local mortality. This avoids or reduces moral hazard and adverse selection issues, reduces costs, and creates an incentive on the part of the herders to adopt effective pastoral risk management techniques.

One of the keys to developing this insurance program was having good data to develop the livestock mortality index. Fortunately, Mongolia had a 33-year time series on adult animal mortality for all regions and for the four major species of livestock (cattle, horses, sheep, and goats). The mortality index provides the basis for determining the specific mortality rates that would trigger indemnity payments under the insurance scheme. Indemnity payments made under the Mongolia livestock insurance program are expected to be used for livestock production activities. These include the replacement of livestock lost and purchases of goods and services to increase risk preparedness and enhance livestock productivity.

The index-based livestock insurance program in Mongolia is considered as an 'enabling' operation, promoting livestock insurance as just one mechanism to enhance the livelihoods of pastoralists by reducing their vulnerability to catastrophic livestock mortality events. While not focused specifically on the needs of poor pastoralists, the program does provide an opportunity to reduce the social and economic impact of severe snowstorms on herder's livelihoods, thus contributing to poverty reduction in Mongolia.

As such, the project holds promise for initiating livestock insurance schemes for other pastoral areas throughout the world. Livestock insurance, however, is only one part of the solution to addressing pastoralist vulnerability to livestock mortality shocks and greater efforts are also required to promote broader risk management approaches, including early warning systems, improve grazing management and effective disaster response systems.

23.2 REVOLVING SHEEP BANK IN TIBET

In a remote, nomadic pastoral area of the Tibetan Autonomous Region of China, where credit facilities are non-existent, a pioneering “sheep bank” was organized as an informal provision of financial services to nomads that has proven highly successful. Since the disbandment of the pastoral communes in the early 1980s and the introduction of the household responsibility system, a serious problem in pastoral areas of Tibet has been the emergence of impoverished nomad households. These poor nomad households own only a few livestock (less than 30 head) and subsist mainly on welfare from the local township administration. The local government has been unable to acquire resources needed to assist these poor families to improve their economic status and rise above the poverty level.

As a result, a revolving sheep bank was established that lends fertile adult female sheep to poor families for a period of five years, allowing them to keep all the products (offspring, milk, wool, butter, cheese) from these ‘borrowed’ sheep and requiring them to repay the same number of fertile female sheep, half in the fourth year and the remaining half in the fifth year. This approach ensures that the aid is not a one-time grant to temporarily help families but rather allows recipient households to attain economic self-sufficiency. It is also a way to establish a self-perpetuating ‘sheep bank’ in a nomad area that would be able to continue to assist poor nomad households indefinitely.

With the financial assistance of an Australian non-governmental organization, BODHI, a five-year revolving sheep bank was initiated in 2000 in two nomad areas in the Tibetan Autonomous Region. Each year four poor nomad households were given a loan of 50 ewes, which were purchased from richer nomads in the same area. During the trial period, a total of 1000 sheep were provided to 20 households. An evaluation conducted in 2005 indicated that the trial program had worked extremely well. Nomad

households involved have increased their herd size, improved their standard of living, and have started to repay their loans on time. As a result, the nomad community now has a functioning revolving sheep bank as originally planned.

In contrast to a one-time grant or gift of money or animals, the program allows households to develop a stable, new resource base that can be maintained in the future. Both nomads and local officials are positive about the impact of the program and plan to expand it to other communities. The success of the project was dependent on the local nomad leaders insisting that the loan recipients manage the animals well so that they will be able to repay the loan at the end of the loan period. Not surprisingly, the local nomads understand that this is an effective way to improve their standard of living and are eager to get the opportunity to receive a sheep loan. Because of this, they all support the idea of mandatory repayment so that the animal capital can circulate indefinitely.

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