



吴建平 主编

草食畜生产体系

可持续发展研究与实践



Practices to Achieve
Sustainability for
Ruminant Production Systems



甘肃科学技术出版社

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Preface

Sustainable development of Ruminants production is the core of the ruminant industries. The content of sustainability has been enriched through decade long discussion and practice. At the same times, the technologies in pursuing sustainability has been updated and made available for wide range application. Sustainability of the ruminants industries contains all the elements of the livestock production systems, including feeds resource and its production, livestock breeding, feedlot management, quality products and animal welfare, it also contains the concepts of pasture utilization and efficiency of production systems in grazing animal husbandry. China's livestock production systems can be categorized into three major systems. The first is a grazing livestock production system which is a specialized pasture based or grazing livestock production with nomadic practice and extensive management. The second is the mixed production systems, which is a most common livestock production seen in cropping area or transition region from grassland to cropping area. This system is characterized for subsistence production rather than business operation with small scale operation and inefficiency. And the third is the specialized and intensive livestock production systems such as dairy and large scale feedlot of beef and sheep. The system is known with high efficiency and capital intensive and nutrients concentration. As evolving of livestock production systems, in addition to diversified market demanding ruminant products in China, the sustainability of livestock production systems does not only determine the quality of the livestock sectors but also indicates the public views over the civilized operation of the livestock industry.

Sustainable development of the livestock industries is the common understanding and an only choice adopted by all countries of the world. The concept of the sustainability of ruminant production systems has been enriched over the decade discussion, which touches many aspects, such as government policy, environment, natural resource, economy and social sectors. The technologies in pro-

moting sustainability of ruminant production were also developed or updated in the last decade, for instance, environment friendly practice of ruminant production technologies, recycling animal husbandry, food safety and quality control technologies. Sustainable ruminant production technologies also focus on the issue of the climate change, which benefits the reduction of green - house gas emission.

Ruminant production systems has been evolving toward more business operation in China, the structure of ruminant production systems and main production regions has been shifted from the pasture regions to the cropping regions, moderate scale operation such as dairy and feedlot of beef and sheep gradually replaced back - yard operation of small household. The total output of ruminant products coming from cropping regions was over 70% . Using straw and other forms of agriculture aftermath for ruminant production is appearing as recycling ruminant husbandry or recycling agriculture in China. The straw utilization in ruminant production has been promoted by availability of straw treatment technologies. Efficiency production, quality and safety products as well as environmental friendly practice composes core of the sustainability of ruminant production systems. So far, the pasture tenure policy, fenced pasture for rotational grazing has been implemented in the most of the pasture area in China. Feed balance management is imposed by government polices together with subsidies in promoting farmers to reduce the livestock numbers on the pasture. As the results, the quality of pasture including grassland production has been improved constantly and the trends of the pasture degradation has been reversed or stopped although the true sustainability of the pasture management still needs hard endeavor including policy support and technique innovation. The higher market value of the livestock products from grazing systems has been widely accepted by the public because of advantages of public views towards natural products from grazing systems. Improved market value of livestock products from the pasture will directly benefit herders to increase their incomes, at the same time it will be also an incentive to the herders for taking good care of the nature pasture. Tibetan high plateau pasture and Qilian mountain pasture is such important ecological zone where China's major rivers are generated and it is a fragile and very significant ecosystems in China, there-

fore, water sheds management and biodiversity conservation needs to be integrated into the content of sustainability of management in these regions.

Intensive ruminant production has the high risk of environment consequences, as the waste management and N and P overflowing are the major threaten to the environment from intensive ruminant production. In addition, natural products of ruminant has an advantage of quality and views by the consumers in China, which need to be further promoted and maintained using precision nutrition technology, animal welfare and non – antibiotic and non – drug health control of livestock program.

Germ plasma of livestock is the base of sustainable production systems, sustainable production systems determined by the sustainable breeding systems. China has enriched resource of livestock germ plasma including beef, sheep and goats. The indigenous breed often has the unique traits in fitness and production. The sustainable breeding system emphasizes fitness and efficiency. Crossbreeding technique is often used breeding practice for all meat animals to promote heterosis for growth. However, too much focusing on heterosis and ignoring environment causes inefficiency of production systems and loses of genetic biodiversity as the consequence of mismatch – up between the genotype and the environment. The feeds availability and quality, climate type are critic referring environment ceiling. The environment as the ceiling constrains the expression of the genotype. Therefore, crossbreeding system needs to focus on the best match – up between the genotype and environment where the genotype lives in. Molecular biology enables genotype testing, heterosis prediction and trait regulating the option to enhance sustainability of breeding system. Therefore, breeding system can be precisely set for certain production systems to promote germs plasma preservation and maximizing genotype expression and high efficiency of production.

Since 2001, the series projects focusing on sustainability of ruminant production systems have been carried out cooperatively among the team of Gansu Agricultural University and Gansu Academy of Agriculture Sciences of China and teams from US, Canada and Australia. The researches including animal genetics and breeding, animal nutrition, quality fattening, straw treatment and utilization

for ruminant, production systems and optimization, products quality control and so on. Over last 15 years, the teams made a series achievements on a theory of environment ceiling over genotype expression and the best match – up between environment and livestock genotype, on the model of precision feed balance evaluation using bench mark of metabolic energy and grassland management. In addition, the teams also studied techniques of progressive and precision quality fattening for Chinese feedlot beef and the techniques of straw treatment and utilization. The content of the book is the results from over decade long cooperative research activities. Hopefully, the book will enrich the content of sustainability of livestock production systems in China. At the same times, it will serve a reference for those who may be interested in the same topic.

By Authors

前 言

草食畜牧业可持续发展是草食畜产业的核心。关于草食畜产业可持续性的基本内容和技术实践已有许多积累,同时,国内外在这个领域的技术研究和实践也有了长足的进步。草食畜产业可持续性涉及草食畜生产体系的所有要素,包括:饲草料生产、家畜品种、健康养殖、品质育肥、动物福利、产品品质、生产效率、草地可持续利用和草地生态系统健康等方面。我国草食畜生产体系基本可分为三类:第一类是专门化的放牧草食畜生产体系,它的特征是专门化、传统型、粗放管理,是以放牧或游牧为主要生产方式的草食畜生产。第二类是混合型草食畜生产体系,它是我国草食畜产业的主体,主要是指农区或农牧交错带小农户为单位,小规模、非专业的生产方式,自给自足是这种生产体系的重要特点。第三类是集约化、专门化的草食畜牧业生产体系,是近年来蓬勃发展的新型草食畜产业类型,它的特征是专门化、集约化、商品化、高效率、高风险,高投入,主要以肉牛、肉羊集中育肥以及奶牛生产为主。随着我国草食畜产业生产方式、生产主体以及消费多元化的不断演变,草食畜产业可持续发展关系到产业本身的品质和生产技术水平,也关系到社会发展和社会文明。

可持续发展是世界草食畜产业发展的方向,近几年,草食畜产业可持续性的内涵在不断发展和丰富,其内容包括了生态、资源、经济、政策、社会、文化等各个方面。与此同时,关于草食畜产业可持续性的研究进展迅速,新技术不断涌现,生产管理方式也在发生重大的变化,涉及到环境保护、生态友好、循环高效、优质安全生产等各项技术环节,每项管理方案,也涉及到了气候变化和温室气体排放等领域。

近年来,我国草食畜牧业的产业结构、主要产区和生产方式都发生了根本变化,农区已经成为草食畜产业发展的重点。以奶牛、肉牛和肉羊育肥为代表的集约化、专门化生产蓬勃发展,农区草食畜产业已经成为我国草食畜牧业的主体,其产值和畜产品产量已经超过总产值的70%。以农作物秸秆为主要饲草料资源的农区循环农业生产体系正在形成。秸秆的饲用化技术水平不断提升,秸秆饲料化利用率稳步提高。草食畜产业的高效、优质、安

全、生态成为可持续发展的重要内涵,特别是畜产品安全生产技术和生态友好越来越受到公众的关注和政府的重视。草原地区的放牧型草食畜牧业已经从数量型向质量型,生态型和产品的纯天然方向发展。草畜平衡,生态保护成为草原畜牧业可持续发展的重要指标。目前,我国牧区已经基本实现草地承包到户和围栏轮牧,以草定畜,草畜平衡已成为共识,相应的许多措施和技术已用于草地管理的实践当中。草地生态健康水平、生产能力不断提高,生态环境得到有效保护,草地生态恶化的趋势得到了遏制。但要真正实现草原畜牧业的可持续发展还需要做不懈的努力。这不仅需要政策的支持,更需要理论和技术创新。要提高家畜个体生产水平,凸显放牧家畜肉奶产品的天然优质特性,不断提高畜产品的附加值,增加牧民收入。要提高草地生产水平,维护草地生物多样性,把水资源管理纳入到草地可持续利用的内涵和具体指标中去,切实维护青藏高原、祁连山等生态屏障地区草地生态系统的健康。

农区草食畜牧业可持续发展的重要内容是生产体系内资源的高效循环利用,从根本上解决集约化生产带来的点源污染和面源污染的问题,既要强调高效,更要强调生态。纯天然优质是草食畜产品的特性和优势,畜产品安全、优质是可持续发展的重要的指标。目前,草食畜品质化生产技术发展迅速,包括精准高效营养技术,健康养殖、品质育肥技术,无抗无药、纯天然动物健康保健等技术。

家畜种质资源是草食畜产业可持续发展的基础,草食畜产业的可持续发展取决于可持续的繁育体系。我国有丰富的地方家畜种质资源,这些种质资源无论在生产性能、产品特性、环境适应性方面都有着独特的品质和优势。现代家畜可持续繁育体系更强调个体适应性,生产的高效和优质。目前,除奶牛生产外,杂交繁育是所有肉类家畜生产的基本繁育技术。长期以来,过分强调杂种优势,忽略家畜基因型与环境型的高效匹配,致使家畜种质资源丢失,品种同质化,适应性降低,生产体系整体效率不高。环境型对家畜基因型表达的屋顶效应理论表明,特定生产体系,特别是生产体系内饲草料资源条件和环境条件的差异,决定了家畜生产的种类和特定杂交组合。杂种优势的表达水平取决于家畜所处的环境,环境对杂种优势的表达具有屋顶效应。忽略环境的屋顶效应将会显著降低草食畜生产体系的整体效率。随着分子生物学的发展,家畜遗传育种技术日新月异,发展迅速。分子

信息辅助育种、基因型分析,杂种优势预测,性状调控等现代育种技术得到广泛应用。家畜基因型的表达水平是衡量繁育体系效率的指标,也是草食畜生产体系可持续性的基础。

从2001年至今,甘肃农业大学和甘肃省农科院课题组与美国、澳大利亚、加拿大等国专家开展了一系列关于草食畜牧业可持续性方面的研究。研究内容包括反刍家畜遗传育种、家畜营养,品质育肥,秸秆饲料化,草食畜生产体系优化、畜产品品质等领域。提出了环境对家畜基因型表达具有屋顶效应,基因型和环境型匹配的理论,提出了草原地区以代谢能为指标的草畜平衡精准评价与草地管理模型;建立了绵(山)羊精准管理和淘汰选育,肉牛全过程、阶段式品质育肥,秸秆饲料化利用等一系列技术。这本书的内容都是课题组近十多年合作研究的成果,其中一些成果和概念丰富了草食畜产业可持续性的内涵。希望这本书对从事相关研究、教学的同事,对学习动物科学的学生有所启发和借鉴。

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Original paper in English

Sustainable Grasslands: Resolving Management Options for Livelihood and Environmental Benefits

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Abstract: To help solve the major issues of improving livelihoods and environmental services, grassland research needs to be evaluated within the context of relevant farm systems. Treatments need to show that they not only have significant effects but that they have effects that are meaningful in the context of the relevant farm system. Researches often defines an optimum criterion for management that is a single point, but that is difficult to achieve in practice, especially when there are several components in a grassland system that need to be optimised. It is argued that an appropriate criterion for optimising management is a range of values wherein management should aim to maintain the grassland. Typically grasslands comprise many species and appropriate frameworks are needed to determine suitable management practices so that the desirable species dominate. Examples of quantifiable frameworks are presented. A theory of animal production from grassland is then used that shows how optimising stocking rates and then considering the implications can lead to defining managing criteria that create a win-win circumstance for sustaining livestock, household livelihoods and environmental services. Traditionally farmers have thought in terms of the animal carrying capacity on areas of grassland as their main management criteria; which is only a measure of demand. A central component in many relationships is the grassland herbage mass and it is argued that this should be the primary criterion for managing grasslands; herbage mass is a net measure of supply and demand and better links to a wide range of measures of environmental services.

Key words: Research strategies, optimal management, plants, livestock, stocking rates, herbage mass

Introduction

Grassland ecosystems^①, including natural systems and those resulting from man clearing shrub and woodlands, collectively occupy vast areas of the landscape. About 10% of the world's population depend directly on livestock and grasslands for their livelihoods. Often these are poor communities and ways need to be found to improve household incomes with the resources available. In developed countries the objective is more to optimise financial returns. Because they are such a large part of the landscape, the management of grasslands does have big effects on the environment and the services provided. Mismanaged grasslands can be badly eroded by wind and water, organic carbon stores run down releasing green house gases and productivity decline severely affects many of the world's poor.

During the past century much grassland research focused on managing them to sustain livestock production. Today it is acknowledged that grassland management needs to sustain production, livelihoods and the desired environmental services grasslands provide. Decisions are now more complicated and require a greater understanding of how system components interact. Ideally these decisions need to anticipate the impact of management practices and aim to avoid any degradation. It is acknowledged though that farmers are more likely to first make decisions that directly impact on livestock production and then adjust those decisions, based upon how various social and environmental factors may be affected.

Grassland research has often been about designing treatments to understand how the agro-ecosystem functions and, or how best to manage some aspect of the grassland. Results are then analysed and published in terms of the boundaries of the experiments done. Significant treatment effects may not though, be significant

① Grassland systems are broadly defined as those areas utilised by grazing herbivores, which includes shrubs and forbs. We include sown pastures and forages within the definition of grasslands. Grassland is used to refer to all forage resources.