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鄂尔多斯植物资源

PLANT RESOURCES OF ORDOS

主编 丁崇明

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内蒙古大学出版社

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上



内蒙古大学出版社
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序 一

在深入贯彻落实中央林业工作会议和全区林业工作会议精神的关键时期,在加快全区林业改革发展,构筑祖国北方重要生态屏障的新形势下,经过鄂尔多斯市全体林业编辑人员的辛勤劳动、艰苦努力,《鄂尔多斯植物资源》出版了,这是一项大工程,是一件大好事。

鄂尔多斯被黄河三面环绕,地处最具活力的呼包鄂“金三角”,是一个神奇而美丽的地方。鄂尔多斯物华天宝,资源富集,植物资源更是丰富,在自治区具有广泛的典型性和代表性,深入研究、利用这些植物资源,对于推进鄂尔多斯经济社会的可持续发展,促进人与自然的和谐发展具有重要的意义。多年来,鄂尔多斯植物资源吸引了国内外众多科学家的目光,并为之开展了长期的探索,为认识和开发鄂尔多斯植物资源奠定了非常好的基础。近年来,鄂尔多斯林业工作者在前人研究成果的基础上,深入实地开展了调查核实、探索发现和分析研究,组织专家进行了严密的论证和系统的归类划分,使鄂尔多斯植物资源更具全面性、系统性和适用性,这对于鄂尔多斯植物资源的利用、产业的发展、农村经济结构调整和农牧民增收将起到重大而深远的影响。

鄂尔多斯的生态建设就像本地的经济社会发展一样,突飞猛进,日新月异,近年来,认真实施国家林业重点工程,投巨资启动了“两个双百万亩”生态建设工程、“五区”绿化和碳汇造林项目,鄂尔多斯林分质量明显提高,人居环境显著改善,为内蒙古自治区的生态建设树立了标杆,作出了贡献。在加快推进鄂尔多斯林业现代化建设的进程中,《鄂尔多斯植物资源》不仅为鄂尔多斯农、牧、林、水等行业的发展提供了重要资料,有益于鄂尔多斯生态建设决策,有益于林业事业发展,而且在自治区其他地区也有借鉴价值。《鄂尔多斯植物资源》是一项庞大的系统工程,它的出版,是全体编辑人员多年

心血的结晶,我对全体编辑人员表示崇高的敬意,衷心希望《鄂尔多斯植物资源》在鄂尔多斯经济社会及林业事业发展中发挥重要作用。成书之际,赘言以贺之。



2011年6月

PROLOGUE I

Plant Resources of Ordos was published, which is a huge project and good deed. All the forestry editors spend amount of time and vigorous endeavour to accomplish the book. The book was finished in deep implementation of the forestry centre conference and the regional key forestry work conference, accelerating the development of forestry reformation in the region and built of important ecological barrier in north China under the new situation.

Ordos is surrounded by Yellow River on three sides, located in the most vigorous Golden Triangle (Huhhot, Baotou and Ordos), and is a miraculous and beautiful place. Ordos is rich in resources, especially plant resources with a wide range of typical and representative plants in the whole autonomous region. In-depth study and the use of these plant resources will promote sustainable development of economy and society. Meanwhile, these studies of plant resources also have great significance to promote the harmonious development between human race and nature. *Plant Resources of Ordos* attracted the attention of many scientists domestic and aboard over the years. A long-term exploration work has been carried out, which built a foundation for the understanding and development of plant resources. In recent years, on the basis of previous research, the forestry workers carried out deep investigation, verification and exploration and analysis. Experts were organised to carry out a rigorous proof and systematic classification. Therefore, Ordos' plant resources have become more comprehensive, systematic and applicable, which will play a significant and far-reaching impact for the use of plant resources, industrial development, rural e-

conomic structure adjustment and income increases of farmers.

Same to the local economic and social development, Ordos eco-building got rapid development and progress. In recent years, national forestry projects were implemented carefully. Our city invested heavily in starting the “two double-million acres” ecological construction projects, “five areas” forestrition and afforestation projects of carbon sequestration. According to these implementation project, the quality of Ordos forestry and the living environment have significantly improved, which made a contribution for ecological contribution in Inner Mongolia. In accelerating the process of forestry modernization, *Plant Resources of Ordos* is not only providing important information for agriculture, animal husbandry, water and other industry but also supplying useful reference value in the autonomous region, which is useful for ecological construction decision and forestry development. *Plant Resources of Ordos* is huge system engineering, and the publication owes to the editorial staff great efforts in many years. I will express great respect for all editorial staff. I sincerely hope *Plant Resources of Ordos* could play an important role for Ordos economic, social and forestry development. At this moment, the book is finished. Therefore, I write this preface to express my congratulation.

Xilin Gao

June 2011

序 二

在“十二五”开局之年、撤盟设市 10 周年之际,由市林业局组织编纂的《鄂尔多斯植物资源》正式出版了。这是一件很有意义的事。

植物资源是极为珍贵的自然资源、生态资源。加强植物资源保护与开发,既是维护生态安全的重大战略举措,也是事关经济社会可持续发展的重大工程。鄂尔多斯地域辽阔,植物资源丰富,特别是旱生、超旱生灌木植物资源丰富、独特,构成了特殊的植物区系,被誉为“灌木王国”。长期以来,全市广大林业工作者在推进生态环境保护与建设的同时,对全市植物资源进行了深入细致的调查研究,形成了大量的调查资料和研究论文。这些研究成果对推进植物资源保护与开发、生态文明建设、实现可持续发展具有重要的意义和作用。

当前,我市正在全力推进生态文明建设、建设国家生态园林城市。在这一伟大实践中,既需要大量的植物苗木作保障,更需要有翔实的植物资料作支撑。此次广大林业科技工作者集多年调查研究之积累,认真汲取他人研究成果,汇集形成了《鄂尔多斯植物资源》一书,这是全市植物资源普查研究取得的又一重大成果,是对过去植物资源调查研究成果的再丰富、再拓展、再延伸。该书以翔实的内容,大量的数据,图文并茂的形式,对全市植物资源的基本情况,包括每种植物资源的生物学特性、生境分布、应用价值,进行了详细介绍,是我市第一部集科学性、知识性、资料性和实用性于一体的植物资源百科全书。该书的出版,不仅为广大读者提供了珍贵的基础资料,而且为各级党委、政府决策提供了科学依据。希望全市上下认真学习利用,使之在促进保护植物资源可持续开发利用、推动生态文明建设、创建国家生态园林城市中发挥重要作用。

在本书编纂过程中,编委会及有关专家学者以实事求是的精神,严谨科学的态度,求真务实的作风,深入实际,调查研究,收集资料,付出了艰辛的努力。在此,一并对他们表示衷心的感谢!



2011年6月

PROLOGUE II

The compiled of *Plant Resources of Ordos* was official published by the Urban Forest organization in the “five” first year and the establishment 10th anniversary of Ordos. This is a very important thing.

Plant resources are extremely valuable natural and ecological resources. The protection and development for plant resources are not only the major strategic initiatives of maintenance ecological safety but also the major projects for sustainable economic and social development. Ordos has a vast territory and rich plant resources, especially unique xeric, super-xerophytic shrub, which constitute a special flora and is known as the “bush kingdom”. For a long time, the majority forestry workers promoted environmental protection and construction in the city, meanwhile, the city plant resources were investigated intensively. Therefore, a large number of survey data was formed and a series of research papers were published. These research results had very important significance and role to promote the protection and development of plant resources, ecological civilization construction and achievement sustainable development.

In the present, our city is pushing the ecological civilization construction and building national ecological garden city. We not only require large amounts of plant seedlings as protection but also need detailed plant information as supporting. The majority forestry researchers accumulate many years investigation and research results, meanwhile, learn others research results carefully, formed the book of *Plant Resources of Ordos*, which is another major achievement for survey of plant resources in the city, and is also the rich, expand and extend of plant resource for the past research results. The book with detail contents, a large number of data and in the form of illustration, which detail introduce the

basic situation of plant resources, including the biological of characteristics of every resources, habitat distribution and value of application. The book is also a set of scientific, intellectual and practical information in one of the Encyclopedia of plant resources. Publication of the book not only provides valuable basis data for general readers but also provides scientific basis for all levels government decision-making. We hope that the general public citizen serious study and use the book from upper to lower, which will play an important role to promote sustainable development and utilization of plant resources protection, promote ecological civilization construction and create national ecological garden city.

In the process of compiling the book, editorial board, the relevant experts and scholars made arduous efforts with a pragmatic manner, rigorous scientific attitude and pragmatic style by the actual depth, research and data collection. In here, we say my heartfelt thank for their help.

Su Lian
June 2011

前言

植物资源是自然资源的一部分,通常是指一切植物的总和。广义地说,地球上或生物圈内的所有植物都是植物资源。但许多学者认为,植物资源应该是经过人类活动或生产实践,筛选出来的某些植物种类,可为人类提供各种原料,并在国民经济中占有一定地位,具有生产价值的再生资源,即一切有用植物的总和。

鄂尔多斯地势复杂多样,既有平坦起伏的高原,又有沟壑梁峁的丘陵;既有沟谷平原,又有沙地沙漠;既有低湿滩地,又有干旱高山。气候的基本特征是温带四季分明的强大陆性、弱季风性干旱、半干旱气候,年均降水量从东至西由 400mm 递减到 160mm。特殊的地形地貌和气候,构成了高原东部典型草原、中部荒漠化草原、西部草原化荒漠有规律分布的植物区系。就同属种植物从东到西也呈现出群落分布规律。

鄂尔多斯是中旱生植物资源较为丰富的地区之一,仅高等植物就有 1 000 多种,其中旱生超旱生灌木 200 种之多,号称“灌木王国”。特殊的地理环境,构成特殊的植物区系,这里有:6 000~7000 万年残遗种四合木,古地中海植物区系的残遗植物鄂尔多斯半日花,蒙古高原特有的单种属植物革苞菊,古老的孑遗种绵刺,亚洲中部干旱地区植物区系重要种蒙古扁桃,古老的第三纪残遗渐危种沙冬青,荒漠区超旱生渐危种梭梭、沙拐枣、霸王、红砂,亚洲中部荒漠区稀有残遗种裸果木,毛乌素沙地优势种北沙柳、特殊头木作业种旱柳,库布齐沙漠天然分布超旱生植物柠条锦鸡儿,鄂尔多斯生长最好、分布最广的植物种中间锦鸡儿、沙棘、鄂尔多斯蒿,丘陵梁地生长的油松、侧柏、杜松、黄刺梅,毛乌素沙地天然分布的沙地柏,盐碱滩地生长着

怪柳、白刺、枸杞,人工栽植的樟子松,飞播植物种杨柴、花棒、籽蒿,等等,它们组成了鄂尔多斯特殊的植物资源和生态景观。

由于鄂尔多斯独特的地理位置和丰富的植物资源,一直以来,鄂尔多斯留下了众多中外科学家的足迹。受俄国地理学会委派,俄国探险家 Prze-walski 领导的第一个探险队于 1871 年 7 月末在库布齐沙漠及其边缘的黄河沿岸进行了一个多月的植物标本采集,采集到 1 个新属 14 个新种;法国耶稣教会牧师 E.Licent(中文名:桑志华),于 1917~1923 年先后在鄂尔多斯的库布齐沙漠和萨拉乌素(乌审旗南部小石砭一带)进行过植物调查;1957 年中国科学院邀请苏联著名治沙专家、生物学博士彼得洛夫在鄂尔多斯进行了两年多的考察研究,考察成果发表在《沙漠地区综合调查研究报告》(第一号,1958;第二号,1959)。彼得洛夫回国后在第二号资料的基础上出版了《中国北部的沙漠(鄂尔多斯和阿拉善东部)》、《鄂尔多斯(自然地理)》两部书。

夏纬英于 1933 年从陕北延安、榆林北上进入鄂尔多斯,由达布察克(今乌审旗旗府)、伊和乌素、特默林、察干敖包,最后到黄河沿岸的艾力套海,共采集标本 240 余种;1950 年,我国著名的植物学家林镕、张肇騫、李继侗、吴征镒、侯学煜、蔡希陶等考察者在伊克昭盟采集了大量的植物标本,为鄂尔多斯的植物学研究提供了丰富的资料;1954~1955 年,地理学专家严钦尚、郑威等在鄂托克旗南部的城川、乌审旗的大石砭和小石砭等地进行了调查,确定了鄂尔多斯优良固沙植物种:沙地柏、柠条、沙柳、乌柳、沙蒿、沙蓬、沙竹、牛心朴子等;1955 年 7 月,北京农业大学贾慎修教授等对鄂尔多斯鄂托克旗、杭锦旗进行了重点调查,其调查结果载入《内蒙古伊克昭盟草原调查报告》(内部资料);1959~1963 年,内蒙古大学李博、曾泗弟、赖守国等对鄂尔多斯境内的毛乌素沙地、库布其沙漠进行考察,采得新种毛果兴安虫实;1998 年内蒙古大学刘书润为西鄂尔多斯自然保护区编写《西鄂尔多斯自然保护区植物名录》(铅印本,内部资料);伊克昭盟林业局宋瑜生、李志忠经过两年多的实地调查和采集标本,于 1984 年编写了《伊克昭盟木本植物调查研究》(内部资料,打印本),共收入野生植物 51 科,138 属,233 种。

为了进一步开发利用鄂尔多斯植物资源,在前人调查研究和论文专著的基础上,我们又开展了多年的实地调查和系统研究,通过深入实地、查阅资料图片,走访、请教相关专家,整理和采集了植物标本 8 000 余份,拍摄照片 15 000 余张,搜集了大量的第一手资料,在这些资料调查、分析和总结的基础上编著了《鄂尔多斯植物资源》一书,旨在识别、研究、保护和持续开发利

用鄂尔多斯植物资源,充分发挥其在生态建设、植物资源产业发展、农村经济结构调整、农牧民增收和生物多样性保护等方面的作用。《鄂尔多斯植物资源》全书分六章,为概论、食用植物资源、药用植物资源、工业用植物资源、环境植物资源、种质资源。共收录植物种 111 科,491 属,1 195 种,配有彩图 904 种,图文并茂,形象直观。“蒙名”取消了汉译名标注方式,直接采用蒙文标注,使其发音更准确,体现了蒙古民族的特色。

《鄂尔多斯植物资源》在编写过程中,受到了各级领导的高度重视和大力支持,内蒙古农业大学马玉明教授、蓝登明教授、高永教授,内蒙古林科院姚洪林研究员在百忙之中抽出时间为本书创意指导、内容把关、标本鉴定和图片收集,我们一并对所有为成书过程作出贡献的领导、专家和各界同仁表示衷心的感谢。

由于编者水平有限,书中难免有遗漏和不足之处,恳请读者不吝赐教。

编著者

2011 年 6 月

PREFACE

Plant resources, commonly meaning all the plant species in the region, is a part of natural resources. Generally speaking, all plants on the Earth or in the biosphere are regarded as plant resources. However, a number of scholars considered that plant resources refer to the plants which are selected by the human beings in their production activities, i.e. the plants which can provide us with a variety of raw materials, play a certain role in the national economy, and are renewable resources of production value. Therefore, plant resources are the sum of all useful plants.

Ordos plateau has complex and varied topography. The landscapes include flat and undulating plateaus, gullies and mountain ridges, hills and sandy lands (even desert), low plains and wetlands. The basic feature of the climate is tem-

perate continental with four distinct seasons of the strong and weak monsoon of arid, semi-arid climate. Annual mean precipitation decreases from the east (400mm) to the west (160mm). Unique topography and climate lead to the successive distribution of the flora, i.e. typical steppe in the east, arid grasslands in the central and desert steppe in the west. The plant in the same genus has also shown a similar distribution pattern in the community level from the east to the west.

Ordos is rich in the resources of mesophytes and xerophytes. More than 1 000 higher plants have been found in the region, including 200 shrubs of xerophytes and super xerophytes. Therefore, Ordos is known as the "Realm of shrubs". The special geographical location determines the special flora of Ordos. Many special plant species are found in Ordos. *Tetraena mongolica* Maxim. is a relic species from 6,000~7,000 million years ago. *Helianthemum Ordosicum* Y. Z. Zhao, R. Cao et Z. Y. Zhu is an ancient relic plant of Mediterranean flora. *Tugarinovia mongolica* Iljin is an unique species of Mongolian Plateau. *Potaninia mongolica* Maxim. is an ancient relic species. *Prunus mongolica* (Maxim.) Ricker is an important species of arid flora in the central Asia. *Ammopiptanthus mongolicus* (Maxim.) Cheng f. is an endangered relict species. *Haloxylon ammodendron* (C.A.Mey.) Bunge, *Calligonum mongolicum* Turcz., *Zygophyllum xanthoxylon* (Bunge) Maxim., *Reaumuria soongorica* (Pall.) Maxim. are all special endangered species of super-xerophyte in the desert areas. *Cymnocarpus przewalskii* Maxim. is a rare relic species of Central Asia desert. *Salix psammophila* C. Wang et Ch. Y. Yang is a dominant species in Maowusu desert. *Salix matsudana* Koidz. is a species of special polling. *Caragana korshinskii* Kom. is an ultra-dry plant, which is naturally distributed in the Kubuqi desert. *Caragana intermedia* Kuang et H. C. Fu, *Hippophae rhamnoides* Linn. subsp. *chinensis* Rousi, *Artemisia ordosica* Krasch. have the best growth and the most wide distribution in Ordos. *Pinus tabulaeformis* Carr., *Platycladus orientalis* (Linn.) Franco, *Juniperus rigida* Sieb. et Zucc., *Rosa xanthina* Lindl. have a good growth in hilly ridge. *Sabina vulgaris* Ant. is naturally distributed in Maowushu desert. *Tamarix chinensis* Lour., *Nitraria tangutorum* Bobr., *Lycium chinensis* Miller grow in salt marshes. *Pinus sylvestris* Linn. var. *mongolica* Litv. are planted. *Hedysarum laeve* Maxim., *Hedysarum scoparium* Fisch. et Mey., *Artemisia sphaerocephala* Krasch. are aerial seeding species. All these formed a special plant resources and the ecological landscape in the Ordos.

Due to its unique geographical location and abundant plant resources, Ordos has attracted a large number of scientists in China and abroad. Appointed by the Russian Geographical Society, the Russian explorer, Przewalski leading an expedition team spent more than one month to collect the plants in the Kubuqi desert and along the Yellow River in late June 1871. A new genus and 14 new species were found in the expedition. E. Licent (Chinese name: Sang Zhihua), a Jesus church pastor come from French, conducted a plant survey in Kubuqi desert and Salawu (along Xiaoshifan of the southern of Wushen Banner) from 1917 to 1923. The Chinese Academy invited Dr. Peter Love, a famous de-

sertification control expert and biologist of the former Soviet Union, to conduct a biological investigation and study for plant resources in Ordos in 1957. He published *Report on Investigation of Desert* (number 1, 1958; number 2, 1959) by two years' investigation and study. After returning to the Soviet Union, Peter Love published his masterpieces of the *Desert of Northern China (East of Ordos and Alashan)*, and *The Ordos (Geography)* based on his *Report on Investigation of Desert* (number 2, 1959).

Xia Weiyong, starting from Yanan, Yulin to northern of Ordos, passed away Dabuchake (now the government of Wushen banner), Yihewusu, Temolin, Chaganaobao, and finally to the Ailitaohai along the Yellow River, collected more than 240 specimens in 1933. The famous botanist Lin Rong, Zhang Zhaoqian, Li Jitong, Wu Zhengyi, Hou Xueyi and Cai Xitao collected a large number of plant specimens in Yikezhao League, which provided a wealth of information for botanical research in Ordos in 1950. The geography experts, Yan Qinshang and Zheng Wei, found a number of excellent desertification control plant species, *Sabina vulgaris* Ant., *Caragana intermedia* Kuang et H.C.Fu, *Salix psammophila* C.Wang et Ch.Y.Yang, *Salix cheilophila* Schneid., *Artemisia ordosica* Krasch., *Agriophyllum squarrosum* (Linn.) Mop., *Psammochloa villosa* (Trin.) Bor., *Cynanchum komarovii* Al.Iljinski. *Cynanchum* by the expedition from Chenchun in the south of Etuoke Banner, to Dashifan and Xiaoshifan of Wushen Banner during 1954 and 1955. Jia Shenxiu, a professor of Beijing Agricultural University, carried out a major survey in Etuoke Banner and Hangjin Banner in July 1955. The survey results formed the *Report of Yikezhao League in Inner Mongolia* (unpublished). From 1959 to 1963. Li Bo, Zeng Sidi, Lai Shouguo of Inner Mongolia University investigated MaoWusu and Kubeqi deserts, and identified the new species of real *Larix trichocarpa*. Liu Shurun of Inner Mongolia University published *Plant List of Nature Reserve Region in West Ordos* (unpublished) in 1998. Based on two years of surveys and collection, Song Yusheng, Li Zhizhong of Yikezhao Forestry Bureau of Ordos, published the *Investigation and Study of Woody Plants in Yikezhao League* in 1984, including wild plants 51 families, 138 genus, 233 species.

In order to further explore and utilize *Plant Resources of Ordos*, on the base of previous research and published papers, we have carried out comprehensive investigations and research for many years. A large quantity of first-hand information was obtained by collecting pictures, visiting the relevant experts, and identifying collected specimens of the plants. Over 8,000 specimen and more than 15,000 pictures were assessed for the compiling of the *Plant Resources of Ordos*. The book has important value for identification, study, protection, sustainable development and utilization of the plant resources in Ordos. Meanwhile, the book plays important roles in various aspects such as ecological improvement, industrial development of plant resources, restructuring of rural economic, increasing farmers and herdsmen income, and biodiversity conservation, etc. The book *Plant Resources of Ordos* including six chapters: The general introduction, Food plant resources, Medicinal plant resources, Industrial plant

resources, Environmental plant resources and Germplasm resource. Totally, 111 families, 491 genus and 1,195 species of vascular plants were included, and 904 species accompanied by color pictures. Most plants were accompanied by colour photo-pictures. Local Mongolian names of the plants were directly translated with Mongolian pronunciations instead of via the common Chinese spellings.

In the process of compiling the book *Plant Resources of Ordos*, we got great help and support from many experts, including professor Lan Dengming, Ma Yuming, Gao Yong of Inner Mongolian Agriculture University, Yao Honglin of Inner Mongolia Forestry Institute. They guided the originality, the writings, plant identification, and colour photo-picture collections for the book. We heartfelt thank to the leaders, experts and all my colleagues for their contributions and supports for the publication of this book.

Due to the limited knowledge of editors, the book may still has some deficiencies. If readers have any question for this book, please do not hesitate to get in touch with the editors.

Thanks.

Editors
June 2011

凡 例

1.《鄂尔多斯植物资源》列举了5大类27小类资源植物,计111科491属,1195种植物,其中904种配有彩图。全书共分6章,主体正文列述了各植物的分类、学名、别名、蒙名、形态特征、生境与产地,用途方面按食用、药用、工业用、环境和种质分类重点叙述其利用部位、营养价值、有效成分、理化性质及开发利用等内容。

2.收载的植物以野生植物为主,间有少数栽培植物和国外种类。

3.植物种按科、属归类,先后顺序按恩格勒植物分类系统编排。为方便读者查阅,中文种名索引按笔画顺序编排,拉丁学名索引则按英文字母顺序编排。

4.如遇到一种植物有多种用途时,视该植物的主要用途,于重点植物资源类别中叙述,其他用途则记载于开发利用中。

5.植物种产地分述到鄂尔多斯市行政区划的各旗区、乡镇,以至山川、河流等。地名排列按由东向西、由北向南顺序编排。

6.饲用植物的营养成分,是其含量占干物质的百分比。

7.参考文献众多,本书仅列主要部分。

NOTES ON USAGES

1. The book *Plant Resources of Ordos* lists 5 categories and 27 sub-categories of local plants, including 111 families, 491 genera and 1,195 species with 904 species accompanied by color pictures. The book is divided into 6 chapters. The main text contains the taxonomy, scientific name, local name, Mongolian name, morphological characters, habitats and origin of the plants. Utilization value is described based on the plant's uses for food, medicinal, industrial, environmental and germplasm purposes with emphases on the utilization parts, nutritional value, effective ingredients, physical and biochemical properties, and utilization ways.

2. In the book, mainly wild plants are described, with only a few of cultivated plants and introduced foreign species.

3. Plant species are arranged according to the family and genus orders based on the Engler's System. For convenience, Chinese name are arranged by stroke numbers and Latin name are arranged alphabetically in their English corresponding letter.

4. If there are more than one usage for a plant, the main usage is regarded as the plant's resource property. The other usages are described as its developmental potentials.

5. The origin of the plant is listed to the Banner, District, Township, and even the mountain and river names. The listing arrangements are from east to west and from north to south in the Ordos Municipality.

6. The nutritional ingredient of forage plant is the content percentage of total dry matter.

7. Only principal Reference are listed at the end of the book.