中国秸秆资源评价与利用

Straw Resources Evaluation and Utilization in China

毕于运　王道龙　高春雨　王亚静　等著

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高效利用秸秆资源　全面建设社会主义新农村（代序）

秸秆“用则利，弃则害”。当今社会，秸秆资源的开发利用，既涉及到农业生产系统中的物质高效转化和能量高效循环，成为循环农业的重要实现途径，也涉及到整个农业生态系统中的土壤肥力、水土保持、环境安全以及可再生资源高效利用等可持续发展问题，又涉及到农民生活系统中的家居温暖和环境清洁，逐步成为农业和农村社会经济可持续发展的必然要求。

我国是世界秸秆大国。合理利用秸秆资源是我国传统农业的精华之一。在现代农业生产条件下，高效开发和集约利用秸秆资源，对实现“家居温暖清洁化，农业生产无害化，庭院经济高效化，生态环境良性化”，全面建设社会主义新农村具有重大的现实意义和深远意义，被人们称为改善农村卫生条件的清洁工程，建设资源节约型社会的能源工程，减轻大气污染的环境工程，优化畜牧业结构的节粮工程，提高耕地综合生产能力的沃土工程，实现农业可持续发展的生态工程，增加农民收入的富民工程。

一、高效利用秸秆资源是改善农村卫生条件的清洁工程

高效利用秸秆资源有利于农业废弃物的无害化处理，解决农村的“脏、乱、差”问题，提高农民生活质量，是改变农民传统的生产生活方式和改善农村卫生条件的清洁工程。

秸秆散装、散运和在庭院内外、房前屋后随意堆放是我国延续了数千年的秸秆收集储藏方式。这种传统的秸秆收集储藏方式，不仅导致秸秆资源的大量浪费，而且成为鼠、蚊、蝇等病虫害的孳生场所和重要的火灾隐患。

秸秆资源的高效利用，可消灭疫病传染源，切断疫病传播途径，把环境卫生安全问题解决在家居、庭院和街区之内，有效地改善农村公共卫生脏、乱、差的现状，是目前改善农村公共卫生最经济、最有效、最便捷的方式。它不仅促进了农民传统生活方式的改变，提高了农民的生活质量，而且减轻了农村妇女的劳动强度，使广大农民走向清洁、卫生、健康的生活之路。

二、高效利用秸秆资源是建设资源节约型社会的能源工程

秸秆资源高效利用集能源节约、化肥节约、饲料节约等于一体，成为建设资源

节约型社会的典范。秸秆资源的新型能源化开发利用，是落实国家可再生能源替代战略，建设资源节约型社会，实现农村社会经济可持续发展的能源工程。

首先，秸秆资源的新型能源化开发利用对缓解我国能源危机具有重要的历史使命。我国人口众多，资源相对不足，能源短缺已成为现实社会经济可持续发展的瓶颈，并与耕地、水资源一起成为我国农业可持续发展的三大制约因素。2004 年，我国农村能源①消费量为 86 983万 t 标准煤，占全国能源消费总量的 37%，但人均能源消费量仅为城镇人均的 1/4，人均商品能源②消费量仅及城镇人均的 15%，存在很大的增长空间。假如我国农村人均商品能源消费量达到现实城镇人均消费水平的 1/2，仅此就将使全国商品能源消费量在现实基础上净增 60%。因此，未来我国农村发展如果主要依靠商品能源，不仅会严重加剧全国能源的供给压力，而且会形成城乡争夺能源的局面。

提高能源效率和发展可再生能源已成为全球能源可持续发展的两个车轮。从战略上来说，世界最终将转入可再生能源的永续利用。因此，世界各国都把推动可再生能源发展当作 21 世纪能源发展的基本选择。据统计，2001 年全世界消费的可再生能源为 19.3 亿 t 标准煤，约相当于全球一次能源消费总量的 13.5%。其中，传统可再生能源③消费约占 80%，新型可再生能源④利用约占 20%。欧盟规定，可再生能源在一次能源中的比重要由 1997 年的 6% 提高到 2010 年的 12%，2020 年的 20%，2050 年将达到 50%。美国提出，到 2025 年除水电外，可再生能源生产将为 2000 年的两倍，其中，生物质发电 4 500 万 kW，风电 1 000 万 kW，光伏发电 300 万 kW，光热发电2 000万 kW。2005 年 9 月，国家发展改革委员会副主任张国宝在国务院新闻发布会上明确指出：我国“可再生能源在一次能源消费中的比重，由目前的 7% 提高到 2020 年的 15%，可替代化石能源 4 亿 t 标准煤，减排二氧化碳 10 亿 t、二氧化硫 700 万 t 以上”。

秸秆是当今世界上仅次于煤炭、石油和天然气的第四大能源。由于秸秆属于可再生资源，既可替代煤炭发电，又可用于生产沼气、燃气、颗粒燃料、木炭、生物酒精和生物柴油等，因此我们可以将其称为永不枯竭的能源或永不枯竭的“煤田”、“油田”、“气田”。我国秸秆资源丰富，具有极大的新型能源化开发潜力。如果我国现有秸秆的 1/3 用于新能源开发，按 30% 的热效率计，相当于16 100万 t 标准煤直接燃用，不仅可全部替代现有秸秆的直接燃烧，而且可为社会提供约相当于8 000万 t 标准煤的商品能源。

其次，秸秆资源的新型能源化开发利用是全面小康社会建设的现实需要。秸秆

① 农村能源包括农村生活用能源和农村生产用能源，主要由煤炭、火电、成品油、天然气、液化气、煤气等化石能源与水电、秸秆、薪柴、沼气等可再生能源构成。

② 商品能源主要包括煤炭、成品油、天然气、液化气、煤气、电力（火电和水电）等。除水电外，其他商品能源几乎全部为化石能，薪柴、沼气等生物质能的商品量可忽略不计。

③ 传统可再生能源主要包括大水电和用传统技术开发利用的秸秆、薪柴等生物质能源。

④ 新型可再生能源主要是指用现代技术开发利用的生物质能、太阳能、风能、小水电、地热能、海洋能和固体废弃物等。

燃用消耗过多是我国现实秸秆利用中面临的最为突出的问题。目前，我国农村秸秆燃用量约为2.4亿t（折合标准煤1.03亿t），约占全国农村生活用能总量的1/4，占全国秸秆可利用总量的1/3。大量秸秆低效燃用不仅造成严重的资源浪费，而且污染环境（包括大气环境和家居环境），成为农村落后生活方式的典型表现。

2020年全面实现小康是我国现代化建设的阶段奋斗目标。届时，与之相适应的是我国农村必须初步实现能源消费的新型能源化，即形成以新型可再生能源和商品能源为主的农村能源消费结构，传统的生物质能消费要大大减少，除经济较贫困的山区和边远地区外，大多地区的大多数农户不应再直接燃烧秸秆和薪柴。即使是经济较贫困的山区和边远地区，也要杜绝对林木和草地的过度樵采。

秸秆资源的新型能源化开发利用既可显著提高秸秆资源的燃用转化效率，又可替代煤炭、天然气、液化石油气等化石能源，对于增加农村优质能源供应，不断改善农村生活能源消费结构，缓解农村能源供应紧张状况具有重要的现实意义，将为我国农村新型能源化的早日实现做出积极的贡献。

秸秆新型能源化开发利用主要包括“四化一电”：“四化”是指秸秆气化、秸秆固化、秸秆炭化和秸秆液化；“一电”是指秸秆发电。秸秆沼气是秸秆气化的重要内容，可称其为秸秆生物气化。

三、高效利用秸秆资源是减轻大气污染的环境工程

秸秆资源高效利用有利于秸秆“焚烧”问题的解决，有效地减少秸秆和煤炭的直接燃用消耗，是减轻大气污染的环境工程。

我国农业连年丰收，农作物秸秆越来越多，而秸秆综合利用相对滞后，秸秆出现了相对剩余。每逢农村夏、秋“双抢”季节，由于大量秸秆得不到及时和妥善的处置，最终被付之一炬，全国相当部分地区出现了村村点火、处处冒烟的现象。一些地区特别是经济和农业比较发达的大中城市郊区，田间地头随意焚烧秸秆的现象十分普遍，不仅浪费了宝贵的生物质资源，而且烟雾弥漫，污染环境，而由此造成的交通事故和飞机航班延误以及引发的火灾和其他事故，每年都造成不同程度的社会经济损失，给人民生活和经济建设带来不良影响，成为必须认真对待、下决心解决的紧迫问题。

除秸秆燃用外，目前我国农村每年燃用煤炭5亿t以上，约占常年全国原煤总产量的1/5。广大农村地区秸秆和煤炭的大量低效燃用，已成为我国大气污染的重要根源。

秸秆资源的高效利用，不仅可促使农民更加珍惜和合理利用有限的秸秆资源，结合灭茬机械、免耕播种技术的推广，逐步解决秸秆的焚烧问题，而且可通过秸秆资源的新型能源化开发利用，有效地替代秸秆和煤炭的直接燃用消耗，降低农村能源消耗中CO_2和SO_2的排放量，减轻大气污染。

四、高效利用秸秆资源是优化畜牧业结构的节粮工程

据统计，目前我国人均粮食综合消费量为发达国家的55%～60%，人均肉类和奶类消费量分别为发达国家平均数的70%和7%。随着人口增加和人民生活水平的提高，我国将长期面对饲料粮短缺的问题。为了我国的粮食和生态安全，必须广辟饲料（草）来源，大力发展以草食畜为主的节粮型畜牧业。但从饲草来源看，一方面我国主要牧区天然草地超载过牧较为严重，草地生态建设需求迫切，部分地区的当务之急是禁牧、休牧、限牧，在现有条件下进一步增加我国天然草地载畜量的空间不大；另一方面，我国耕地资源稀缺，人工饲草地的开辟只能在部分地区有限制地进行。因此，秸秆养畜在我国草食畜牧业大发展中肩负着无可推卸的历史重任。

2005年，我国秸秆总产量约为8.42亿t，可收集利用量6.86亿t，饲用量1.77亿t，按照饲料单位折算，相当于5 300万t玉米的净能量，约为我国现实玉米总产量的40%。已利用秸秆养殖量近4亿只羊单位，占全国草食畜养殖总量的30%以上。如果我国能有一半的秸秆用于养畜，在现实养殖水平下可养畜8亿只羊单位，相当于我国现实草食畜养殖总量的2/3，可节约饲料粮约1亿t。

五、高效利用秸秆资源是提高耕地综合生产能力的沃土工程

秸秆还田有利于提高土壤有机质和土壤养分，改善土壤结构和土壤墒情，是培肥土壤、提高耕地综合生产能力的沃土工程。

精耕细作是我国传统农业的精华。秸秆和粪肥还田、用地与养地相结合又是我国精耕细作的精髓。早在春秋战国时期，我国就开始注重施肥，《吕氏春秋》提出了“地可使肥，又可使棘”的肥力辩证观。东汉时期，中国思想家王充正式提出了“粪壤论”（《论衡·率性篇》），并被历代农学家继承和发扬，成为我国古代有关土壤肥料的基本理论。南宋陈旉《农书》提出了“凡田土……若能以粪肥之，则益精熟肥美，其力常新壮”的观点，这就是我国农学史上著名的“地力常新论”，元代王祯的《农书·粪壤篇》、清代杨屾的《知本提纲·农则耕稼》等众多农学著作进一步丰富和发展了该理论。明、清人在上述理论的基础上，基于“收多收少在于肥”的认识，提出了“粪肥倍收法”，该理论已含有“投入—产出”理论的基本思想。

目前，我国每年生产秸秆达8亿t以上，这些秸秆中含氮460万t以上，含磷约125万t，含钾1 100万t以上，相当于2005年全国化肥施用量的82%，并且还含有大量的有机质和微量元素。在现有农业生产条件下，如果每公顷耕地还田秸秆3.0～4.5 t，平均可增产粮食15%以上；连续三年秸秆还田，可使土壤理化性状有明显改善。我国耕地中有一半是旱地，干旱缺水始终困扰着农业的发展，实行秸秆还田或秸秆覆盖是提高旱作农业生产水平的重要举措。

六、高效利用秸秆资源是实现农业可持续发展的生态工程

秸秆资源高效利用既可减轻草原超载过牧压力，又可有效地减少林木消耗，对保护植被，巩固生态环境建设成果具有重要作用，是实现农业和农村经济可持续发展的生态工程。

“三料”（燃料、饲料、肥料）俱缺是我国西部地区较为普遍的现象，并成为该地区农业资源过度利用和生态退化的重要根源。目前，我国农村薪柴消费量常年维持在2.6亿t左右，占全国森林资源年消费总量的45%～50%。在我国农村薪柴消费总量中，薪炭林生产、森林抚育间伐以及木材加工的剩余物等，每年可为农村提供薪柴1.5亿t，非合理利用的薪柴达1.1亿t左右，占全国农村薪柴消费总量的40%～45%。与此同时，除西北绿洲农业区外，我国西部广大地区农业生产水平低，秸秆单产水平和人均占有量都不高，加之大量秸秆用于燃料，导致可饲用秸秆资源的严重不足。

秸秆资源的高效利用有利于优化秸秆利用结构，减少秸秆燃用消耗，增加可饲用秸秆数量，为舍饲养殖业的发展奠定基础。计算表明：每节约1 t秸秆，可满足2～3只羊全年的饲草需求，分别相当于青藏高原区3 hm^2草地、西北干旱区2.4 hm^2草地和黄土高原区1.33 hm^2草地的牧草可采食量。

秸秆新型能源化开发利用可有效地减少薪柴的燃用消耗，保护我国有限的森林资源。在农户日常炊事中，每吨秸秆的气化气可替代2 t以上的薪柴。另外，利用秸秆替代木材造纸和加工板材，也可有效地减少木材消耗。据测算，如果我国将10%的秸秆投入造纸业，可节约原木1亿～1.2亿m^3，相当于中国目前计划森林采伐量的2倍。

七、高效利用秸秆资源是增加农民收入的富民工程

秸秆资源高效利用是植物生产和动物转化的有效纽带，它上承种植业，下启养殖业，对农业生产系统的物质高效转化和能量高效循环有着最直接的作用，使农业种养一体化水平迈向新高度，显著节约资源，成为循环农业的重要实现途径。

秸秆资源高效利用对农民的增收作用可通过以下几个途径来实现：一是种植增收。秸秆还田可培肥土壤，改善农产品质量，增强农产品竞争力；增加农产品产量，提高种植业投入产出率。二是养畜增收。通过对河南周口地区的调查表明，秸秆利用率较高的养殖户与一般农户相比，人均收入高出300～500元。三是秸秆加工增收。秸秆造纸、秸秆板材加工、秸秆炭化、秸秆袋装微贮饲料和秸秆颗粒饲料加工、秸秆发电、秸秆气化等秸秆的综合加工和秸秆的新型商品能源开发，可使秸秆利用逐步迈向产业化，形成一个门类众多的产业化体系。调查表明，秸秆造纸和秸秆炭化可使秸秆增值数倍到数十倍。

总之，秸秆资源的高效利用具有良好的经济、生态、社会复合效益。为此，要

在国家的统一领导与部署下，调动广大农民和各级政府、社会团体、科技界的积极性，推进部门协作与区域联合行动，通过高新技术示范、工程带动、政策配套与机制创新，以秸秆饲料化、工业化、新型能源化、肥料化为基础，以科技为支撑，充分发挥秸秆的多功能性，优化秸秆利用结构，提高秸秆资源的利用率和利用效率，基本消除秸秆的废弃和焚烧，构建我国秸秆高效转化的循环农业体系，形成以秸秆资源为支撑的农业新产业群，在区域农村经济发展、农民致富和生态环境建设中发挥更大的作用，为全面建设社会主义新农村做出贡献。

作　者

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Highly Efficient Utilization of Straw Resources for Building New Socialist Countryside in An All-Around Way (As A Preface)

Straw will be beneficial if used and deleterious if discarded. Nowadays, the exploitation and utilization of straw resources involves efficient material transformation and energy circulation in the agricultural production system which has become an important way for realizing circulatory economy, and it also relates to the sustainable development problems of soil fertility, soil and water conservation, environment security and highly-effective utilization of renewable resources in the agro-ecosystem, and also involves warmth habitation and clean environment in the peasants' living system, it has turned an inevitable demand for the sustainable development of agriculture and rural society and economy.

China is a large straw production country in the world. Rational utilization of straw resources is the essence of traditional agriculture of our country. Under the conditions of modern agricultural production, it has great practical significance to develop the straw resource efficiently and intensively for peasant environmental sanitation, no pollution of agricultural production, sustainable utilization of resource and cycle of ecosystem, and it gradually becomes an inevitable requirement for the sustainable development of agriculture and rural economy, therefore it is called the cleaning project to improve the living conditions of rural area, the energy project to build a resource saving society, the environmental project to reduce pollution, the grain project to save grain via optimizing animal husbandry structure, the soil project to raise the comprehensive productivity of agriculture via fertilizing the fields, the ecological project to achieve sustainable development of agriculture, the rich project to increase farmers income.

1 Highly efficient utilization of straw resources is a cleaning project to improve the rural sanitary conditions

Highly efficient utilization of straw resources is the cleaning project which can transform the traditional prod uction and life style and improve the rural sanitary conditions, it also will be helpful to the harmless disposal of agricultural wastes, and can change the poor rural

environmental, and improve peasants' life quality.

Transportation in bulk and random stacking around peasants' houses are the long-last traditional straw collection storage modes which have continued for few Millenniums in our country, and they not only cause the massive waste of straw resources but also supplies the breeding places for mice, mosquito and flies and has the hidden hazard of fire.

Highly efficient utilization of straw resources is the most economical, effective and convenient way to improve rural public health by eradicating of the disease source of infection and interrupting disease transmission routes and solving the environmental problems within the household, courtyards and street blocks. It can not only facilitate transforming peasants' traditional lifestyle and improve their life quality, but also alleviate rural women's labor intensity and help peasants to lead a clean, sanitary and healthy life.

2 Highly efficient utilization of straw resources is an energy project to build a resource saving society

Highly efficient utilization of straw resources that integrates energy saving, chemical fertilizer saving and forage saving has become the model of building a resource saving society. Straw resources new energy regeneration is the energy project to implement the country's renewable energy substitution strategy, the project to build a resource saving society and the project to realize the sustainable development of the rural economy.

Firstly, the development and utilization of the straw resources for new energy is an important historical mission which can buffer our country's energy crisis and even to solve the crisis ultimately. We have a large population and relative insufficient resources, and the energy shortage not only has become the greatest bottle-neck that affects the sustainable development of economy and society, but also has turned three main factors restraining sustainable development of Chinese agriculture along with cultivated land and water resources. In 2004 the rural energy consumption of China① is 869.83 million tons of standard coal which accounts for 37% of the total energy consumption in China. But the per capita energy consumption in rural areas only is 25% of the urban and the per capita commercial energy consumption in rural areas is only 15% of the urban②, so there still has much growth room. If the per capita commercial energy consumption in rural area occupies 50% of the urban area, the total commercial energy consumption of China will increase by 60% based on the re-

① Rural energy concludes the energy for rural living and agricultural production, and it is consisted of fossil energy such as coal, thermal power, refined oil, natural gas, liquefied petroleum gas, gas etc. and renewable energy such as water and electricity, straw, firewood and biogas etc.

② Commercial energy mainly concludes coal, refined oil, natural gas, liquefied petroleum gas, gas, electric power (thermal power and hydropower) etc.. Except hydropower, the rest commercial power is almost the fossil energy, and the commercial part of the biomass energy such as firewood and biogas etc. can be neglected.

ality amount. Thereby, if rural areas development in the future mainly depends on commercial energy, the energy supply will have greater pressure, further more, it will make the rural and urban compete for the energy.

Improving the energy utilization efficiency and developing renewable energy resources have become the two wheels of the global sustainable energy development. From a strategic point of view, the whole world will switch to the sustainable utilization of the renewable energy finally. Thus, every country in the world makes promoting renewable energy development as the basic choices of the energy development in the 21st century. According to statistics, the renewable energy consumption allover the world is 1.93 billion tons of standard coal in 2001 which accounts for 13.5% of the total primary energy consumption of the global, and the traditional renewable energy① consumption accounts for about 80% and the rest 20% is for new renewable energy②. European Union stipulates that the proportion of renewable energy in the primary energy consumption must improve from 6% of the year of 1997 to 12% of 2010, 20% of 2020 and 50% of 2050. USA says that the production of renewable energy of the year of 2025 will be twice about that of 2000 except hydropower and in which concludes 45 000 000 kilowatts of biomass energy power generation, 10 000 000 kilowatts of wind power, 3 000 000 kilowatts of photovoltaic power generation, 2 000 000 kilowatts of photothermal power generation. In September 2005, Guobao Zhang who is a deputy director of National Development and Reform Commission clearly pointed out at a press conference hosted by China's State Council: "Raise the proportion of renewable energy in primary energy consumption up to 15% of 2020 from 7% at present, which can substitute for 0.4 billion tons standard coal, reduce letting off 1 billion tons carbon dioxide and more than 7 million tons sulfer dioxide."

Straw is the fourth biggest energy which is just inferior to coal, petroleum and natural gas. Straw belongs to renewable energy, and it can substitute coal for generating electricity, and can also be using for making biogas, burned gas, particle fuelcharcoal, biologic ethanol and biologic diesel oil, thus we can call it the energy or "coal field", "oil field", "gas field" which will never dry up. China has abundant straw resources, which has a huge potential of new energy exploiture. If one third straw resources in our Country are using for new energy exploiture, supposing thermal efficiency is 30%, is equal to burn 161 000 000 tons standard coal directly. It can not only completely substitute the directly burning of existing straw, but can also supply commercial energy for the social which is equal to 80 000 000 tons standard coal.

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① Traditional renewable energy mainly includes big hydropower and biomass energy such as straw, firewood which are exploited by traditional technology.

② New renewable energy mainly includes biomass energy, solar energy, wind energy, small hydropower, geothermal energy, ocean energy and solids waste which are exploited by modern technology.

Secondly, the development and utilization of the straw resources for new energy is the realistic demand for building the Well-of Society all-around. Burning too much straw is the most remarkable problem that exists in the utilization of straw in our Country. Nowadays, Rural China consume 0. 24 billion tons straw (equal to 0. 103 billion standard coal), which accounts for one fourth of the total life energy consumption in Rural China and accounts for one third of total quantity straw available. Too much straw burning inefficiently results in serious waste and also pollutes environment (include atmospheric environment and home environment) which has became typical for backward life style in Rural China.

To achieve Well-off Society all-around in 2020 is the goal of our modernization construction. At that moment, Rural China must reach new energy regeneration of energy consumption that means Rural China must form energy consumption structure based on the principle of new renewable energy and commercial energy, there will be less consumption of traditional biomass energy, most farmers in most areas should not burning straw and Fuel wood directly expect for poorer mountain areas and distant areas. Even the poorer mountain areas and distant areas should put an end to excessive deforestation and overgrazing.

The development and utilization of the straw resources for new energy is not only improving straw resources' transformation efficiency for burning, but can also substitute for fossil energy such as coal, natural gas, liquefied petroleum gas, it has realistic meaning for increasing supply of high quality energy in Rural China, for improving energy consumption structure of rural living and for easing energy supply tensity in rural areas, it will make positive contribution to the reach of new energy regeneration in Rural China.

The development and utilization of the straw resources for new energy mainly contains "four modernizations and one electricity": "four modernizations" means straw gasification、straw solidification, straw carbonization and straw liquefaction. "one electricity" means straw power generation. Straw biogas is a very important part of straw gasification which can be called straw biological gasification.

3 Highly efficient utilization of straw resources is an environmental project to reduce atmosphere pollution

Highly efficient utilization of straw resources is the environmental project to reduce pollution, which is helpful to solve the problem of straw "burning" and efficiently reduce the quantity of straw and coal burning directly.

Because of good harvest in China for years, there are more and more straws, but the comprehensive utilization of straw is relatively lagging, straw becomes relative surplus. Every year in summer and autumn when paddy matures, quite place in China choose to burn straws at last because of a large number of straws can't be dealed timely and properly. Espe-

cially in the rural of some big and medium cities which are relatively developed in economy and agriculture, it's normal to see straw burning everywhere in the fields with a lot of smog, this phenomena is not only a waste of precious biological energy but also pollute environment, causing traffic accident, delay of flight, fire and some other accidents which result in different degree of economic loss every year and bring about negative impacts on people's life and social construction.

Besides burning straw, rural areas in China consume more than 0.5 billion tons coal every year at present which accounts for more than one third of the total coal production in China. Straw and coal burning inefficiently in most rural areas has become an import root of atmosphere pollution in China.

Highly efficient utilization of straw resources can not only promote farmers to treasure and properly utilize limited straw resources, resolving the problem of straw burning gradually with the expand of stubble cleaning machines and no-till sowing technology, but can also efficiently substitute straw and coal burning directly, reduce the quantity of CO_2 and SO_2 in rural energy consumption and mitigate atmosphere pollution through the development and utilization of the straw resources for new energy.

4 Highly efficient utilization of straw resources is a grain project to save grain via optimizing animal husbandry structure

According to statistics, China consumes about 55% to 60% as much grain per person as developed countries, the consumption of meat and milk per person are of 65% and 5% respectively in the average of developed countries. With increasing of population and improving of people's life, China will confront the shortage of feed grain for a long time. For the food and ecological security in China, we must expand the source of forage (grass) and strive to develop animal husbandry via saving grain which is based on the principle of herbivore. But in terms of the source of forage, on one hand, overgrazing of natural grassland in China's main grazing district is severe, and the demands for grassland ecological construction are urgent, and forbidding breed, stopping breed and restricting breed are the first imperative in some place. There's not much likelihood that the carrying capacity of natural grassland will further increased based on the condition we are in; On the other hand, opening up of cultivated pasture can be proceeded restrictively in some place because of shortage of China's arable land. Therefore, straw raising the livestock has an inevitable historic duty in the great development of China's animal husbandry based on the principle of herbivore.

In 2005, China's total straw production is about 0.842 billion tons, and the collectible and available straw is 0.698 billion tons, and feeding quantity is 0.177 billion tons, according to food unit, it's equal to the net energy of more than 53 million tons corn which accounts

for about 40% of corn's real total quantity in China. Exploited quantity of straw for feeding is about 0.4 billion sheep units that accounts for more than 30% of the whole country's herbivore feeding. We can feed 0.8 billion sheep units animals under conditions if half of the straw in China are used for feeding animals, which are equal to two thirds of our country's total herbivore feeding and can save about 0.1 billion tons feed grain.

5 Highly efficient utilization of straw resources is a soil project to raise the comprehensive productivity of agriculture via fertilizing the fields

Returning straw to soil is the soil project to raise the comprehensive productivity of agriculture via fertilizing the fields which is beneficial for improving organic matter, nutrients, structure and moisture content of soil.

Intensive cultivation is the essence of our traditional agriculture. Returning straw and manure to soil, combination of utilizing land and maintaining land are the essence of intensive cultivation. Early in the stage of spring, autumn and warring states, China began to pay attention to application of fertilizer, "LU's Spring and Autumn Annals" proposed the soil fertility dialectical outlook that land could be fertilized or be handled thorns. In the stage of Eastern Han Dynasty, Chinese ideologist Chong Wang formally proposed his theory of manure and soil ("Measuring. Following what is natural"), it was inherited and developed by agronomists in all ages and became basic theory of soil fertilizer in ancient China. "Fu Chen · on Agriculture" in Southern Song period proposed that fields will be much more fertile and the productivity of the fields will keep higher if fertilized by using manure, this is the famous theory in history of agronomy that soil productivity will always keep new, many other agronomy works, such as Wang Zhen's "On Agriculture · Manure and Soil" in Yuan dynasty and Shen Yang's "Outlines of knowing the basis. Ploughing and sowing when farming" in Qing dynasty, further improved and developed the theory. On the basis of theory mentioned above, people in Ming and Qing dynasty proposed the method of manure multiple rewards basing on the notion that manure determines harvest; this theory has already included the basic thought of Input-output theory.

Nowadays, China produces more than 0.8 billion tons straw every year, these straws contain more than 4.6 millions tons nitrogen, about 11 million tons kalium, a large number of organic matter and microelement which account for 82% of the total application of fertilizer in 2005. Under conditions of present agricultural production, if returning 3.0 ~ 4.5 tons straw per hectare of arable land, it can increase at least 15% foodstuff on average; Soil physical properties will be improved obviously if returning straw into field for three years. Half of China's arable land is dry land, water shortage restricts agricultural development all the time, so returning straw into field is an important measure to improve agricultural production level of dry farming.

6 Highly efficient utilization of straw resources is an ecological project to achieve sustainable development of agriculture

Highly efficient utilization of straw resources is the ecological project to achieve sustainable development of agriculture which can ease the press of overgrazing and decrease trees consumption, it also helpful to protect vegetation, and play an important role in consolidating the outcome of biological environment construction.

Shortage of fuel, fodder and fertilizer are prevalent in western China, and has become an important root of excessive utilization of agricultural resources and degeneration of entironment. Nowadays, consumption of firewood in rural China maintain at about 0.26 billion tons annually, which accounts for about 45% ~ 50% of forest resources' annual consumption in China. In the consumption of firewood in rural China, production of firewood forest, forest thinning and wood machining residues can supply 0.15 billion tons firewood every year for rural areas, in which about 0.11 billion tons firewood are utilized unreasonably that accounts for about 45% ~50% of the total consumption of firewood in rural China. Meanwhile, expect for oasis agriculture in northwest regions, the level of agricultural productivity in most areas of western China is low, the level of straw yield and per capital occupancy volume is also low, together with a large number of straw utilized as fuel, resulting in severe shortage of feeding straw resources available. At present, straw for feeding respectively accounts for 21%, 22% and 23% of straw available in Tibet plateau area, in southwest and in loess plateau region.

Highly efficient utilization of straw resources is helpful to optimization of straw-use structure and decrease consumption of straw burning, it can also add the quantity of available feeding straw, and can lay the foundation for the development of breeding industry indoors. The calculation shows that: saving 1 ton straw can meet the needs of herbage for 2 ~ 3 sheep, which is respectively equal to 45, 36 and 20 mu grassland's available herbage intake in Tibet plateau area、in northwest arid region and in loess plateau region.

The development and utilization of the straw resources for new energy can reduce the consumption of burning firewood and protect China's infinite forest resources. In farmers' daily kitchen work, gas of straw gasification from every 1 ton straw can substitute for more than 2 tons firewood. Furthermore, using straw for paper and board processing can efficiently reduce wood consumption. According to calculation, if we put 10% of straw into papermaking industry, it can save logs about 0.1to 0.12 billion cubic meter which is two times as current planned forest felling quantity in China.

7 Highly efficient utilization of straw resources is a rich peasant project to increase farmers' income

Highly efficient utilization of straw resources provides the effective links between plant