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Editors: Min Zhang Peiqin Zhou Chunli Li
Caiju Zhang Yufei Hua

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Proceedings of the International Agricultural Engineering Conference (IAEC2002)

Editors: Min Zhang Peiqin Zhou Chunli Li
Caiju Zhang Yufei Hua

Southern Yangtze University

Wuxi, China

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FOREWARD

Since the first International Agricultural Engineering bi-annual conference(IAEC) was held in Thailand, each IAEC in this serial conference attracted many experts, scholars and entrepreneurs from more than 20 countries and regions. It made great success and brought enormous reverberate. The 7^{th} IAEC is held at Southern Yangtze University(SYTU), Wuxi, China from 28-30 November 2002. The conference was sponsored by the Asian Association for Agricultural Engineering(AAAE) and co-sponsored by American Society of Agricultural Engineers (ASAE),Association of Overseas Chinese Agricultural, Biological, and Food Engineers(AOC), Chinese Society of Agricultural Engineering (CSAE),Chinese Society of Agricultural Machinery (CSAM),Chinese Society of Cereals & Oils (CSCO),Chinese Society of Food Science and Technology (CSFST),Indian Society of Agricultural Engineering (ISAE), International Commission of Agricultural Engineering (CIGR), Iowa State Water Resources Research Institute, USA, Japanese Society of Agricultural Machinery (JSAM), and Japanese Society of Terramechanics (JST).

The proceedings include abstracts of five keynote lectures and four technical reports and ninety five full research papers. The contributions were submitted by the scientists from eighteen countries. The papers are divided into four sections as Soil & Water, Post-harvest Technologies and Food Engineering, Power & Machinery and Terramechanics, and Environmental Engineering & Others.

I would like to express my sincere thanks to our all members of International Scientific Committee and Organizing Committee of IAEC 2002 for their keen interest and support. We cannot forget the support from Shanghai Jingtop Group Company at the first stage of the preparation of IAEC2002. Thanks are due to Professor V.M.Salokhe, AAAE president, for his coordinating the organizer and AAAE. Special thanks are to Mr. Odahara, Dr. Renfu Lu, Prof. M. Hoki, and Prof. N.Ito for their efforts to promote the delegates from both institutions and industries.

I would like to gratefully acknowledge the assistance of Ms. Peiqin Zhou, Ms. Chunli Li, Ms. Caiju Zhang and Dr. Yufei Hua for editing the proceedings efficiently. Finally, I would like to thank all members of Secretariate, especially Ms. Zhenqing Xu, Ms. Wenli Huang, Mr.Xiaoming Yang, Ms Xiaolu Gu, Mr. Jianfeng Zhang, and Mr. Quanlin Li for their handling the logistics of this conference efficiently.

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November 28-30,2002

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THE EVOLVING PROFESSION OF AGRICULTURAL ENGINEERING

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ABSTRACT

The profession of agricultural engineering is now nearly 100 years old.It began with the need to reduce arduous and stoop farm labor.The early emphasis was on agricultural mechanization. Mechanization improved the quality and productivity of farm operations.Freeing the workforce from agriculture was a major factor towards industrialization of many western countries.The manufacturing sector has benefited significantly from agricultural mechanization. Mechanization has had enabling effect on the farmer and has helped transform subsistence faming to a major industry.

Agricultural engineers were later involved in irrigation, drainage, and soil conservation as well as building farm roads.The impact of irrigation in arid and semi-arid regions has been huge; doubling, sometime tripling, yields thereby adding to the profitability of farmers. Soil conservation has had a significant impact on reducing erosion and improving water quality.

Farm building design and rural electrification by agricultural engineers made it possible to process and store crops thereby adding value and further increasing the profitability of farmers. Agricultural engineers did not confine themselves to the farm. They have contributed to food processing, handling, storage, packaging, and transport of agricultural and food products.Today agricultural engineers are involved in the entire food system from farm to fork (or chopsticks).

The profession continues to evolve in response to the changing need of society. During the 20th century the emphasis was on quantity. The consumer is now demanding quality, safe, and healthful food products. Farm size is increasing while the number of farms is declining. There is a greater emphasis on environmental protection and conservation of natural resources. There is a need to develop consumer products and energy based on bio-based renewable resources. Agriculture will no longer be a just source of food, it will become a major driver of bio-based economy. The profession will continue to evolve and meet the challenges of the 21st century.

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THE SITUATION AND TREND OF THE STORING TECHNOLOGY IN CHINA

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ABSTRACT

In the year of 2000, the fruit output of China reached 62 million ton, which account for 14% of the international output in that year. Meanwhile the vegetable output of China reached 0.38 billion ton. According to those figures above, China has been considered as the biggest producer of fruit and vegetable in the world.

Before 1980, people always use vault, common warehouse and ventilated warehouse to keep fruit and vegetable fresh. Those kinds of methods cannot store fruit and vegetable for a long time and the fruit and vegetable quality is not satisfying. After 1980, some refrigerators (from 1980) and refrigerators with CA technology (from 1990) are built and developed in many producing areas. Although the problems of quality are resolved, the high operating costs of those methods prevent the popularization in large scale.

Obviously, China needs some effective storing methods with low cost to be developed. As the times require, the technology of "Keeping Fruit and Vegetable Fresh with Natural Cold Resource" which is developed by China Agricultural University emerges. As well known, water will give out or absorb latent heat when phase change occurs. In winter, people bring water into contact with the cold air outside to make ice; a great deal of latent heat will be released to prevent cold damage occurs. As summer comes, the thawing ice will keep a necessary low temperature and a high humidity. This technology has been utilized successfully in Hebei, Gansu and Sinkiang province. The research on keeping fruit and vegetable with high-voltage electric field has acquired some good results. With the treatment of 50~200 kV/m high-voltage electric field, the respiratory activity of fruit reduced and the synthesis of ethylene is controlled. Meanwhile the activity of Polygalacturonase and carboxymethylcellulase go down. The hardness of fruit can be kept preferable.

We believe those technologies showed above possess great potential.

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CHINA – U.S. COOPERATION IN SUSTAINABLE-AGRICULTURE RESEARCH: CAN AOC HELP?

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ABSTRACT

Sustainable agriculture is a common issue for China and the U.S. American agricultural engineers have played a world-leading role in technological development and research on sustainable agriculture. Collaborative research on sustainable agriculture would benefit both China and U.S. However, international collaboration receives a low priority in the U.S. mainly due to concerns about intensified competition caused by the fast pace of globalization. Overseas Chinese agricultural engineers and their association AOC can play a "bridge" role to promote U.S. – China collaborative research. AOC has made many efforts towards this goal.
Keywords: China-U.S. collaboration, sustainable agriculture, globalization, overseas Chinese, AOC, agricultural engineering, research, development, education

SUSTAINABLE AGRICULTURE IS A COMMON ISSUE FOR CHINA AND THE U.S.

Sustainable development is "a process of change in which the direction of investment, the orientation of technology, the allocation of resources, and the development and functioning of institutions meet present needs and aspirations without endangering the capacity of natural systems to absorb the effects of human activities, and without compromising the ability of future generations to meet their own needs and aspirations" (Scott, 2002).

Development of sustainable agriculture systems has become a high priority for both China and the U.S. With a projected 1.5 – 1.6 billion population in the middle of the 21st century and less than 0.1 hectare arable land per capita in China, resource shortage and environment degradation have placed a great pressure on agricultural engineers to develop technologies that are consistent with the needs of sustainable development.

During the past century, U.S. agricultural engineers have played a leading role in the world development of modern technologies for agricultural production. Agricultural mechanization, as a fundamental revolution in agricultural production systems, was first completed in the U.S. Within the past two decades, the rapid development of information technologies has led to yet another revolution in U.S. agriculture, aiming at a higher production efficiency with a lower cost and reduced adverse effects to natural resources and the environment. With more complete understanding of the ecological and environmental consequences of agricultural activities and awareness of the shortage in soil, water, and energy resources, attentions of U.S. agricultural engineers have been gradually directed towards technologies that support the sustainability of agriculture. Agricultural engineering in China, on the other hand, has gone through a major development during the past three decades. Although mechanization still remains an unfinished task, information revolution has taken place without an obvious deferment, and has started guiding the progression of mechanization to make it a more efficient process. Awareness of issues related to agriculture sustainability also has been raised among scientists, engineers, and government agencies at both the state and local levels.

The major issues on sustainable agriculture that need to be addressed by agricultural scientists in both China and the U.S. in the 21st century are common. According to a science roadmap that was developed by a task force, which consisted of 24 member universities across the U.S. under the leadership of the National Association of State Universities and Land-Grand Colleges (NASULGC), U.S. agriculture faces the following challenges in the 21st century (Yang, 2002a):

- Developing competitive crop products and uses

- Developing new products and new uses for animals
- Lessening the risks of climate change
- Providing information and knowledge for environmental stewardship
- Improving economic return to agricultural producers
- Strengthening communities and families
- Ensuring improved safety and health agriculture

It is obvious that some of these issues are a step ahead of the most urgent tasks that Chinese scientists are facing. The time lag, however, is only within one or two generations. According to Wang (2002), the urgent tasks that Chinese agricultural engineers are facing include:

- mechanization combined with information technologies and mechatronics,
- industrialized agriculture,
- soil and water resource management and protection,
- value-added processing and extension of the agricultural-production chain,
- rural electrification and automation, and
- integrated management based on the principle of precision agriculture.

Although technologies developed by Chinese agricultural engineers should have their unique features to address the specific needs of Chinese agriculture, there is certainly no need for reinventing the wheel. Chinese agricultural engineers can take short cuts by referencing, borrowing, and modifying existing knowledge and technologies from their U.S. counterparts through effective academic exchange and cooperative research. Meantime, inventions of Chinese agricultural engineers can also benefit U.S. agriculture. Theoretically, this type of exchange and collaboration should result in a "win-win" situation. However, in realty, exchange and collaboration between Chinese and U.S. agricultural engineers have not been very effective. The obstacles that have prevented a rapid development of such cooperation contain technical, economic, cultural, and even political factors.

INTERNATIONAL COLLABORATION RECEIVES A LOW PRIORITY IN THE U.S.

According to published data, U.S. international cooperation and foreign aid have been in a constant decline during the past decades. While agricultural aid from all industrialized nations plummeted almost 50 percent over the period of 1986-96, the U.S. has been leading the decline. Fifty years ago, the U.S. provided almost two-thirds of all the foreign assistance in the world. According to the Organization for Economic Cooperation and Development (OECD), the U.S. now ranks last among the 21 industrialized nations in percentage of GNP per capita devoted to humanitarian assistance abroad. In actual donations, the U.S. ranks behind nations with much smaller populations than the U.S., such as Japan, Germany and France. There has been a 40% erosion in U.S. aid (in real dollars) over the last decade, and 28 missions of the U.S. Agency for International Development (USAID) have been closed since 1993. Letson (2002) commented on this decline from an agricultural marketing standpoint and pointed out: "Other nations, our competitors, are becoming more generous and more strategic with their aid programs as we shrink from our rightful role as the world leader."

Letson (2002) also referenced a University of Maryland poll on the perception of American people on foreign aid. He stated: "...a majority of Americans believe the United States spends 15 percent or more of the federal budget on foreign aid. The same respondents believe the proper amount should be about 6 percent. Congressional support for foreign aid has ebbed in recent years. Too many Americans misunderstand the win-win aspect of international economic development and are cynical because past aid in certain cases propped up dictators. In general, we Americans say we support the idea of development and humanitarian assistance, and we tend to be generous when disaster strikes. However, citizen support for aid is more a latent value than an urgent, activist concern, and Capitol Hill has consequently treated it as a low priority."

The U.S. Department of Agriculture (USDA) 2003 Budget Summary shows that, while the entire budget for USDA in the research and development section has increased from $1,438 million in 1994 to $1,975 million in 2003, an increase of 37.3%, the budget for the Foreign Agriculture Service (FAS) was maintained at a low level of $1 million, which amounts to 0.07% in 1994 and 0.05% in 2003. Within the Education section of the 2003 budget, which has a total amount of $507 million, only a fraction of $26 million, listed under "Integrated Activities", was proposed for International Science and Education Grants (USDA website, 2002).

The Cooperative State Research, Education, and Extension Service (CSREES) of USDA sponsors a small number of international projects. Funding level for these projects, however, has been "very modest", "usually between $5,000 and $20,000" (USDA CSREES website, 2002).

With an extremely limited budget, the FAS provides researchers and educators with a referral list of "selected international grants, exchanges, fellowships, and collaborate research opportunities in agriculture" form public as well as private sources (USDA FAS website, 2002). From this list, it is obvious that funding opportunities for international cooperation are very limited. Most of the programs offer a very small number of projects with a very low funding level (usually below $10,000).

The U.S. Agency for International Development (USAID) is an independent federal government agency that receives overall foreign policy guidance from the Secretary of State. The goals of USAID include "furthering America's foreign policy interests in expanding democracy and free markets while improving the lives of the citizens of the developing world". It has a total budget of less than 0.5 percent of the federal budget. For a long period, USAID had no presence in China. Seven years ago, USAID started its first program in China. However, the first agriculture-related "farmer-to-farmer" program ($2 million), cosponsored by USDA, is only in the planning stages (USAID website, 2002).

COMPETITION AND COLLABORATION ARE NOT MUTUALLY EXCLUSIVE

The main reason for the decline in foreign collaboration is fear of competition. This competition, in the eyes of many Americans, has become fierce as globalization is rapidly proceeding. While China is trying to fully understand the impact of joining WTO on all aspects of the Chinese economy, especially on agriculture, U.S. farmers also are feeling the great impact of globalization. "The single most daunting, exciting, and pervasive factor affecting the viability of U.S. farming and ranching today", said, Ann Veneman (2002), the USDA Secretary in her "white paper", is" globalization".

The concept of globalization can be easily connected to the concept of competition. Farmers in all countries, developed, developing, or in transition, must respond to worldwide competition governed by international trade agreements. U.S. farmers believe that developing countries, such as China, are a threat to the balance of commodity trade because of their low input costs, especially labor costs. Farmers in developing countries, on the other hand, see U.S. producers as their biggest competitors because of their tremendous advantage in access to technological innovation and affluence. Apparently, the U.S. policy on international cooperation has responded to a strong concern of the public about competition.

Yet competition is only one of many outcomes of globalization. A globalized economy will bring about much more than merely competition to the world. First, sustainability of agriculture is a global issue. Conserving the capacity of natural systems to absorb the effects of human activities and allowing future generations to maintain the ability to meet their own needs and aspirations, while meeting our own needs and aspirations, is not a task for one single nation along. No country can maintain their agricultural sustainability without global collaboration. Degradation in natural resources, including soil, water, and energy, has to be dealt with by a global effort. To preserve the Earth for many generations to come, an extensive, cooperative effort in natural resource conservation has to be taken simultaneously by all nations.

Owing to the revolution in communication technologies and new, stringent regulatory standards and requirements on environment and food safety, worldwide public scrutiny on the quality and safety of food train has been greatly strengthened. As a result, "traceability" has become a rising issue. "Traceability" is "the ability to track the history, deployment, or location of an entity (a plant, animal, or food-stuff) by means of recorded identifiers" (Pierce and Cavalieri, 2002). With an increasing concern on chemical pesticides/fertilizers, use of genetic resource, biological control, transgenic food/fiber plants, and waste management/recycling, traceability has to be placed in the global context. Development of technologies for enhancing traceability should therefore be a cooperative, global effort.

Competition does not always mean rivalry. Competition and collaboration are not mutually exclusive. Competition can serve as a motivation for readjustment and changes, whereas readjustment and changes can be made more effectively under collaboration. History has repeatedly shown that economy has always progressed under severe competition. A global competition will be accompanied by readjustment, changes, and development in the global arena. This competition will bring in more success than failure. Avoiding international collaboration due to fear of competition is therefore not a sensible policy.

COLLABORATION SHOULD BE MUTUALLY BENEFICIAL

A misconception about U.S. – China collaboration in research is that this collaboration is unidirectional, with China always being the sole beneficiary. This misconception has led to concerns and has further prevented the development of U.S. – China collaboration. It is true that the U.S. has been and still is at the leading position for the development of agricultural engineering technologies in general. However, fast adoption and further development of adopted technologies by Chinese agricultural engineers have resulted in new technologies that would greatly benefit American researchers and farmers. In many aspects of agricultural engineering, especially in areas like dryland agriculture, water and soil conservation and management, biological engineering, energy-saving technology, biomass utilization, mechanization for special crops, and small-scale greenhouse technology, Chinese agricultural engineers are actually leading the world. However, due to technical, cultural, and language barriers, many of these technologies have never been introduced to the world. This situation can only be corrected through bi-directional, international collaboration.

Another concern about U.S. - China collaboration is on protection of intellectual properties. When collaboration is seen as unidirectional, the laws and ethics for intellectual properties are often ignored. Mutually beneficial collaborations need to be guarded by commonly accepted rules of ethics and professionalism.

CAN AOC HELP?

The Association of Overseas Chinese Agricultural, Biological, and Food Engineers (AOCABFE, or AOC) was established in 2001. The mission of AOC is "to promote information exchange and networking among agricultural, biological, and food engineers of Chinese origin worldwide; to facilitate collaboration in research; to foster educational exchange; to enable technology transfer; and to encourage professional development." (AOC website, 2002). Obviously, collaboration is a central mission of AOC.

A majority of AOC members are Chinese scholars and students who came to the U.S. and Canada to study agricultural engineering after 1980. Since early 1990s, these scholars have entered many major educational and research institutions on agricultural engineering in North America to teach and conduct research. Many also entered industry to take positions on research, development, design, and management. At the present time, near one half of the agricultural engineering departments in North America's universities have hired Chinese faculty. The research areas of these Chinese scholars covered the entire spectrum of agricultural engineering (Zhang, 2002). Because of their extraordinary achievements, these Chinese scholars have gained tremendous reputations among their peers. Most of them also have become the core force for research and teaching in their respective institutions. Their achievements are demonstrated by the following facts:

- With no exception, Chinese faculty members working in the universities of North America have been successful in pursuing their tenure and promotion.
- Two mainland Chinese scholars have become the heads of agricultural engineering departments in North America.
- During the past seven years, Chinese scholars have been the first authors of more than 15% of the papers published on Transactions of the ASAE.

- They have won at least 25% of the ASAE paper awards during the past six years.
- Eleven Chinese scholars have become the Division and Associate Editors of Transactions of the ASAE.
- More than 30 Chinese scholars have become chairs of various technical committees within ASAE.
- Most of them have become the leading researchers of interdisciplinary projects and lead their respective institutions in research funding.
- They have won many national and regional awards.
- They have obtained many patents.

These Chinese scholars have good knowledge on both Chinese and U.S. agricultures. They also have good understanding on the needs, usefulness, and transferability of various technologies in both counties. In addition, they have the knowledge and skills to help overcome the cultural and language barriers. More importantly, they have the willingness to serve as the bridge between U.S. and Chinese agricultural engineers to assist, promote, and foster academic exchange and collaboration. In many institutions where Chinese scholars work, collaborations with China have been greatly enhanced. This is reflected by an increasing number of mutual visits, collaborative research projects, student exchange, and, in some cases, formal agreements on collaboration.

In June, 2002, AOC co-organized with the Chinese Society of Agricultural Engineering and Chinese High Academy President Of Agricultural Engineering, a Forum on Agricultural and Biosystem Engineering Development Strategy in Yangling, Shaanxi ("Yangling Meeting"). AOC sent a delegation of 12 members to the meeting. This was the first such event in the history of agricultural-engineering profession and is considered a milestone in the development of agricultural engineering in China. The invited speeches given by the AOC delegates covered a wide range of topics:

1. Development Strategies for Agricultural Engineering In China

- Challenges and opportunities of agricultural, biological, and food engineering, Dr. K.C. Ting, The Ohio State University
- Roadmaps of US agricultural research in the 21st century, Dr. Xiusheng Yang, University of Connecticut
- Strategy for agricultural science and technology and west development in 21^{st} century, Dr. Xiusheng Yang, University of Connecticut

2. Agricultural Engineering Education

- Undergraduate education in agricultural engineering, Dr. Rongsheng Ruan, University of Minnesota
- Undergraduate/graduate education in agricultural engineering - China model vs. U.S. model, Dr. Naiqian Zhang, Kansas State University

3. Agricultural Mechanization and Information Technology

- From agricultural mechanization to agricultural infotech, Dr. Lei Tian, University of Illinois
- Next step for precision agriculture, Dr. Lei Tian, University of Illinois
- Information technology revolution and its impact on agricultural universities, Dr. Jiannong Xin, University of Florida
- Applications of embedded systems and controller area network in agriculture, Dr. Ning Wang, Kansas State University

4. Value-added Processing and Food/Bio Engineering

- New development and future trends of value-added research in grain-based materials, Dr. Xiuzhi Sun, Kansas State University
- Food safety engineering: interdisciplinary practice and systematic approach, Dr. Yanbin Li, University of Arkansas
- Biosensors: concepts, technologies and applications, Dr. Yanbin Li, University of Arkansas

- Applications of non-thermal plasma and ozone in food and environmental engineering, Dr. Rongsheng Ruan, University of Minnesota
- New thermal and non-thermal food processing technology research and development, Dr. Juming Tang, Washington State University
- Techniques and collaborations in fruit/food quality sorting, x-ray detection of hazardous materials in foods, and other related high-speed machine vision on-line inspections, Dr. Yang Tao, University of Maryland
- Near-infrared technology in agricultural and food products, Dr. Donghai Wang, Kansas State University

5. Natural Resource Conservation

- Advancement of science and engineering in waste treatment and utilization, Dr. Ruihong Zhang, University of California, Davis

6. Protected Agriculture

- Research and development in controlled environment bioproduction systems, Dr. K.C. Ting, The Ohio State University

Through participation, presentation, and interaction, the AOC delegation not only introduced new information and knowledge to the meeting, they also brought inspiration and excitement to Chinese agricultural engineers. During a brainstorm session at the forum, AOC delegates, working with their Chinese colleagues, identified the following areas as the most critical areas for future development of agricultural engineering in China (Yang, 2002b):

- Value-added processing for agricultural products (plant and animal)
- Biological materials
- Bio-energy conversion
- Agricultural waste treatment
- Marketing system for animal and biological products
- Point and non-point source pollution
- Forward-looking management incorporating climate changes
- Ecological engineering to retard desertization
- Water-saving irrigation
- Water resource management
- Importation and digestion of foreign equipment for agriculture industrialization
- Low-cost, high-efficiency agricultural machinery
- Rice and corn production mechanization
- Protective tillage
- Protected agriculture and horticulture
- Food quality and safety
- Automation and information technology
- Integrated planning and development for small urban areas
- Establishment of standards and government legislation
- Establishment of platforms for technical consulting and extension

Obviously, AOC can play important roles in accomplishing these tasks by contributing their technical expertise. However, a more important role for AOC in this historical development is to help Chinese agricultural engineers strategically establish an infrastructure for developing and sustaining a modern agriculture. Similar infrastructures have long been established in many developed countries and have been proven effective. This role is more important because what really separates Chinese agriculture from the world is the infrastructure of the agriculture system, not individual technologies.

Reform of agricultural engineering education also is a critical issue in China. Being educated in both China and the U.S., the AOC scholars are at a good position to provide useful suggestions. At the brainstorm session of the Yangling Meeting, AOC delegates identified the following strategic issues for future development of agricultural engineering education in China (Yang, 2002b):

- Establishing a commission led by agricultural engineers, at the central government level, for