United Nations Asian and Pacific Centre for Agricultural Engineering and Machinery

(UNAPCAEM)

United Nations ESCAP

ESCAP 1947-2007

THE ROLE OF AGRICULTURAL ENGINEERING IN ECONOMIC DEVELOPMENT

Overview Report

CHANG Ping (Prof.)
Senior Expert
APCAEM
(for Dr. Bill Stout)

Contents

1. The Evolution of the Profession of Agricultural Engineering (AE)
2. AE and Economic Development
3. Government Policies
4. Conclusion

1. The Evolution of the Profession of AE

- Focus in the Early Stage
- Types of Activity in Mid 20th Century
- A Shift to Biological Engineering (BE) and Environmental Concern
- Three Challenges at Present

Focus in the Early Stage

- **Founded in 1907, the profession of AE focused on the development of:**
  - -- Rural roads and bridges;
  - -- Machinery (both animal and engine power);
  - -- Irrigation and drainage;
  - -- Surveying;
  - -- Layout, design and construction of farmstead buildings as well as heating and ventilation;
  - -- Rural electrification (developed later along with the development of rural water supplies and waste disposal).

Types of Activity in the Mid 20th Century

- **By the middle of the 20th century, AE evolved into four types of activity:**
  - -- Power and machinery
  - -- Irrigation and drainage
  - -- Farm structures and environment
  - -- Processing and electrification

A Shift to BE and Environment Concern

- **Background**
  -- The advancement of Science and Technology (S&T), especially the emerging biotechnology
  -- Environment concern, climate change- global warming
- **A Shift from Mechanical Engineering to BE and Environment Concern**
  -- Most AE programs in U.S. Univ. focused on:
    - biological engineering
    - efficient use of irrigation water
    - renewable energy, and
    - environmental issues *(Cont'd)*

A Shift to BE and Environment Concern

-- Department name change to include biological, biosystems, environmental, …
-- AG mechanization no longer exists in Univ. curricula and research programmes
-- ASAE changed to ASABE, celebrating its 100-year anniversary. *(Cont'd)*

- **More emphasis on environment including**
  -- Control of odors from livestock production;
  -- Precision application of chemical;
  -- Precision agriculture and associated sensors, GPS systems, and other electronics; and
  -- information technology

(Osborn and Stout: The Current Situation, 2002)

Agricultural Engineer

- The words “agricultural engineering” as used around the world have vastly different meanings.
- The term “agricultural engineer” means a person trained in **engineering** who applies engineering knowledge to agriculture and food as defined broadly to include biological processes and environmental aspects. *(defined by Stout)*

Three Challenges at Present

- **AE & BE at the focus of three great challenges facing humanity:**

-- ensuring an adequate and safe food supply for an expanding world population;

-- protecting or remediating the world's natural resources，including water, soil, air and energy;

-- developing engineering systems that monitor, replace, or intervene in the mechanisms of living organisms. AE and BE has a unique focus on biological systems, including the environment.

Where to Go for AE: Situation in Developing Countries

- Agricultural mechanization in the developing world

- Agricultural mechanization in Asia

Agricultural Mechanization in the Developing World

- Agricultural transformation will involve radical changes in both power and energy with greater use of machine power and higher levels of machine use.
- Agriculture in the developing world is still labor-intensive. Human labor accounts for 2/3 of the power input in agriculture, draft animals ¼, and machine power less than 1/10.

Situation in Asia

- **Lack of appropriate machineries that cater to and suit the requirements of small-scale farms.**
- **Basic farm mechanization requirements**:

  -- suitability to small farms;
  -- simple design and technology;
  -- versatility for using in different farm operations;
  -- affordability in terms of cost to farmers; and
  -- provision of support services from the government and the private sectors/ manufacturers. *(Soni)*

Recommendations on Tech. and Systems Development in Asia

- Compact, light, low-powered, and multi-purpose machines
- Locally-available materials must be incorporated in fabricating machines to reduce the manufacturing costs.
- Manufacturing and designing parts must be precise.
- Small-size tractors, mini-power tillers, and small farm equipment must meet the needs of small farmers.
- Operator's safety and comfort
- Energy-efficient machines should be developed. *(Soni)*

Compact, light, low-powered and multi-purpose machines are still urgently needed in Asia: Belwa Agricultural Mechanization Committee of **Bangladesh** posing with their new two-wheel tractor and reduced till-drill. *(Biggs, Justice, Gurung, Tripathi and Sah, 2003)*

R&D Institutions for AE

- Indonesian Center for Agricultural Engineering Research and Development, Indonesia
- Farm Machinery Institute, National Agricultural Research Center, Pakistan
- Agricultural Mechanization Development Program, University of the Philippines Los Banos
- Chinese Academy of Agricultural Engineering
- National Institute of Agricultural Engineering of ROK
- Farm Mechanization Research Centre of Sri Lanka
- Agricultural Engineering Research Institute of Thailand

Where to Go for AE?

- AE has experienced a long process along with the advancements of S&T. Their impact on AE should not be ignored.
- AG engineers are facing new challenges from the changing climate and environment concern, the limited natural resources and the changing demands of human civilization.
- The R&D for AE should be restructured to keep in line with the progress of S & T and be ready to provide solutions for the new needs of the world people. *(Cont'd)*

Where to Go of AE?

- We have seen the “traditional” needs of rural farmers in the Asian developing countries from the paper presentations. The R&D for AE should especially provide solutions to these needs.
- AE and BE are complementary each other in this regard.

New Major Disciplines

- Major disciplines in China *(Wang Maohua)*
- Major disciplines in India *(Nawab Ali)*
- Future emphasis in Pakistan:

  -- Precision Agriculture

  -- Post-harvest Engineering

  -- Energy Systems Engineering

  -- Environmental Engineering Restructuring

  (Anon)
- Major disciplines in Bangladesh, Indonesia, the Philippines, ROK, Sri Lanka and Thailand are also suggested.

2. Agricultural Engineering and Economic Development

- **Situation Analysis:**
  - -- Social Awareness of Engineering
  - -- Balance of Agricultural and Industrial Development
  - -- Human Cultures
  - -- Marketing
- **Holistic Engineering: Be Part of the Social Team**
- **Opportunities for AG engineers to contribute to economic development**

Social Awareness of Engineering

- **Engineering development programs can be justified only if they offer a better promise for the future.**

  A key to world development is an expanded role of engineers in the development process, but we must be more socially aware.

  We must consider carefully the social and economic impact of engineering decisions that influence the way people live. *(Henry et al, 2000)*

Agricultural Development and Industrialization

- **The problems of poverty cannot be solved exclusively within agriculture because this sector alone cannot provide enough employment and income.**

  The linkages between agriculture and the economy as a whole must be carefully considered.

  Agricultural development and industrialization are complementary and mutually reinforcing. *(FAO, 1981)*

Balance of Agricultural and Industrial Development

- Successful development normally requires a rise in agricultural productivity to accompany (or precede) industrial development.

  Until developing countries succeed in achieving and sustaining a reliable food surplus, they have not fulfilled the fundamental precondition for economic development.

  The challenge is to balance agricultural and industrial development.

Human Cultures

- Agriculture is not simply a technical matter. Farming is the core around which socially complex human cultures have evolved. People are slow to accept change in practice or technology, especially if there is a perceived risk. *(FAO, 1981)*

  (e.g. Conservation Agriculture)

Human Factors in Farm Management

Many writers have discussed the ingredients of success:

- Norman Borlaug, Nobel Laureate, advocates the introduction of simple but proven technology to small-scale farmers.
- Others have suggested a judicious blending of imported and local technology. To be successful, technology must be cheap, simple, and practical.
- While economics is the driving force in farm management, one should not overlook human factors that may not fit easily into the economic equation. *(Stout)*

Marketing

- The picture would not be complete without mentioning marketing of agricultural produce.

  Domestic markets predominate, but there are many niche markets where high value commodities such as flowers, fruits and vegetables, forest products, animal products, and plantation crops will be important.

  Globalization and loosening of trade barriers offer new opportunities. Value added processing of commodities involves food engineering and can reduce losses and enhance profits. *(Stout)*

A Case: Mechanization and Management System

- **Mechanization must be backed up by an efficient management system**, from training of drivers and mechanics, to the supply of fuel, oil, and spare parts and provision of speedy repairs.

  Where farms are too small, systems of sharing services will be needed. In ecologically sensitive zones, the use of machinery must be combined with careful soil and water management to prevent erosion and to optimize water use.

  More attention will be needed to design of machinery for conditions in developing countries and especially the needs of smaller farmers. *(Stout)*

Another Case: Investment and Adequate Returns

- Water resources are in tight supply and must be used more efficiently – both in irrigated and rain fed areas.

  The cost of irrigation systems is high, from a few hundred dollars per hectare for controlled flooding to several thousand dollars per hectare for a full sprinkler system.

  Such investment must be justified by adequate returns. *(FAO)*

Holistic Engineering: Be Part of the Social Team

- AE is a vital discipline supporting world agriculture. Adequate food supplies and a balanced diet for everyone will require a very significant contribution from agricultural engineers around the world.
- AE is not simply a technical matter but holistic engineering. Too often agricultural engineers are not part of the “team”. *(Stout, 1997,1998)*

Holistic Engineering: Be Part of the Social Team

Why the public doesn't appreciate us more:

- Not have communicated our achievements effectively
- Not think beyond our individual micro studies. The technical aspect is only part of the picture, sometimes the easy part. Engineering should help people, so social and economic discussions cannot be ignored. *(Stout)*

Holistic Engineering: Suggestions

- **Look at the big picture—think globally and multidisciplinary**
- **Become more involved with policy issues** and let administrators know about the benefits of your work to society and ensure that engineering is on the priorities list.

3. Government Policy

- The Situation
- Government Policies in Some Member Countries
- The Barriers for Agricultural Mechanization in Asia

Situation

- Increased crop production must come largely from higher yields and cropping intensities because of limited arable land.
- These require optimizing the use of existing farmland through increased inputs and improved management – from water and fertilizer to better seeds and plant protection, from mechanization to greater energy use – all supported by an institutional framework of government services and social relations.

(Cont'd)

Situation

- As the transformation of an economy advances, agriculture's share in national income falls and its importance for national economic growth diminishes.

  -- The nonagricultural sector becomes the primary engine of growth and is no longer as dependent on resource flows from agriculture or on agriculture's demand linkages.

  -- Agriculture's share of total employment falls more slowly than its share of national income.

  -- The inevitable result: agricultural labor productivity and farm incomes per capita lag behind the nonagricultural sector.

  -- Few countries have been able to manage this transition successfully. *(Cont'd)*

Situation

- Technical and engineering issues are only part of the problem. Governments must do everything possible to guarantee price stability and profitable operations for every link in the food chain.

  -- Greater investment along with credit at reasonable interest rates

  -- Land tenure policies to be reviewed

  -- Employment policies

  -- Comprehensive risk control through insurance schemes needed

  These issues are beyond the scope of engineering but must be part of the overall mix if agricultural development is to proceed.

Government Policy: ROK

- Government support significantly contributed to the advancement of farm mechanization in Korea:

  -- Institution of policies on financing for farm machinery and projects

  -- Subsidies by supplying farmers with machines at half the price.

  -- Machines and equipment have been developed for specific farm operations from land preparation to planting, to harvesting, to postharvest and transport. *(Soni, 2007)*

Government Policy: Indonesia

- An appropriate strategy has been established for promoting AE development as
  - **Selective strategy:** the technology level and type of mechanization that might be implemented should be suited to the local or regional conditions. The local conditions to be considered are physical, socio-economic-culture, farming system and farm infrastructure aspects. *(Cont'd)*

Government Policy: Indonesia

- **Progressive strategy**: the level of technology should start low and gradually be improved to a higher level. These changes of technology level support agricultural development from traditional into modern agriculture.
- **Participative strategy:** the implementation of AE development has to be done by involving the active participation of agribusiness, society, including consumers/farmers, related industry, producers and financial institutions. *(Hendriadi and Allihamsyah, 2007)*

Government Policy: China

- A series of policies have been taken by the Chinese government to strengthen support for agriculture, rural areas and farmers, including the pursuit of a rural policy of "**giving more, taking less and loosening control**", to increase direct subsides to grain producers, subsidies for growing superior grain cultivars, and subsidies for farmers to buy agricultural machinery and tools, and to rescind all agricultural taxes around the country since 2006. *(M. H. Wang, 2007)*

Government Policy: Pakistan

- There were 15 farm machinery manufacturers in Pakistan in 1959. Their number increased to 500 in 1984 particularly during the period from 1978 to 1984 because of **liberal government policies** such as a rebate in import duty for raw materials and exemption of income tax.
  (Anon: Pakistan Support for Agricultural Machinery Manufacturers, April 2007)

Barriers for AG Mechanization in Asia

- **The barriers that impede the growth and sustainability of farm mechanization industry and programs in Asia can be classified into:**
  - -- Technological constraints
  - -- Socio-cultural and behavioral barriers
  - -- Financial and economic problems
  - -- Environmental issues *(Cont'd)*

Barriers for AG Mechanization

- Indonesia, Thailand, Vietnam and the Philippines have been receiving similar support from the government for its special projects and program on farm mechanization. However, the level of mechanization is medium to low due:
  -- lack of resources, infrastructure, and institutional arrangements;
  -- prevalence of manual labor/operations; and
  -- lack of policies to support general economic welfare of the different stakeholders in the agricultural machinery industry. *(Soni)*

4. Conclusion

Commonalities Among the Asian countries

- All countries have predominately small, fragmented holdings
- Lack of capital and access to credit, high interest rates
- Limited experience, skills, educational level
- Movement of workers from the rural to urban areas causing farm seasonal labor shortages
- High proportion of poor farmers with annual incomes of 1-2 $US per day *(Stout)*

Conclusion

1. AE has experienced an evolution from traditional AG Mechanization to Agricultural and Biological Engineering under the impact of the advancement of S&T.

   The R&D for AE need to be restructured to cater to the fast development of S&T and contribute to providing solutions for the new needs of the world people, in consideration of limited natural resources, e.g. land, water, energy, and environment concern;

Conclusion

2. More attention will be needed to design of machinery for conditions in the Asian developing countries and especially the needs of small landholders;
3. AE and economic development are complementary each other. However, the profession of AE needs to be strengthened;

Conclusion

4. Identification of the priority of new disciplines of R&D for AE, especially in the following areas:
   -- AG Mechanization
   -- Food security and safety
   -- Cash crops and food processing for value addition
   -- Renewable energy
   -- Environmental sound AG technology (green technology)
   -- Precision agriculture

Conclusion

5. Government policy always plays a vital role in the R&D for AE.

   AG engineers should become a part of the social "team" and influence policy makers through effectively articulating the vital nature of our work in terms of social, economic and environmental benefits, and collecting and documenting examples of success stories of agricultural engineers.

Thank You!