Agenda I

Agricultural Engineering Education in Indonesia

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Abstract

Historically, the name and scopes of Agricultural Engineering have changed considerably affected by many factors including global trend of Agricultural Engineering. There were times when this education program became unpopular but then again regained in the aftermath of economic crises. The afterward national policy has given big opportunity to resources based developments. Even though agriculture has shown its capability in maintaining local community to support their lives during the time of crises, the global markets have become the real threats. The challenge of Indonesian Agricultural Engineers now is how to produce agricultural commodities in any kind of forms but cheaper than the international price. Agricultural Engineering Education has to find a proper role of contribution to solve these problems. And, the education system of Agricultural Engineering itself has to be upgraded to some extend to anticipate changes of the global trends.

Preface

Dates back to 1967, there was a national symposium held in Ciawi-Bogor, which one of the main concerns was to define and to state the roles of Agricultural Mechanization. Agricultural Mechanization was defined a field of science that studies how to explore and utilize natural resource and energy for the development of human creativeness in developing agriculture for the prosperity of human kind. By that definition, the roles of the Agricultural mechanization were stated as follows 1) to increase the efficiency of human labor; 2) to alleviate the status and living standard of farmers; 3) to guarantee the increase in quality and quantity of agricultural production convincingly; 4) to be able to develop farming type from subsistence to commercial; 5) to accelerate the transition of economical nature from traditional to industrial agriculture. Scopes of Agricultural Mechanization were then classified into six fields: 1) Agricultural Machinery which studies the problems in utilization of power and equipments in agriculture; 2) Soil and Water Engineering which studies the problems in relation to the water use in agriculture and soil conservation; 3) Agricultural Building which studies the problems in utilization of agricultural buildings and infrastructures; 4) Agricultural Electrification which studies the problems of utilization of electrical energy in agriculture; 5) Agricultural Product Processing Machinery which studies the problems in the utilization of machineries in conditioning and processing of agricultural products to be stored or directly to be consumed; 6) Food Processing Machinery which studies the problems in the utilization of machinery and pre-conditioned requirements for food processing[1].

Since then, department of agricultural mechanization was initially developed in two main national universities such as Bogor Agricultural University in Bogor, and Gadjah Mada University in Yogyakarta. As state-university, both were obliged to conduct three activities

[1]Dasawarsa Alumni 1980, Departemen Mekanisasi Pertanian, 1980.

known as 'Tri-Darma', i.e., for education, research, and outreach programs. The activities of Agricultural Mechanization were: 1) to conduct education program based on agricultural mechanization sciences, technical skill of agricultural mechanization, entrepreneur skill to manage agribusiness and agricultural structures; 2) to conduct research stressed on adaptive research to support education and agricultural development; and 3) to convey and disseminate the research results to concerned societies. In some periods after, the Agricultural Mechanization took a lead in intensifying agriculture production, which results in the opening of new agricultural field while at the same time preparing land for the new community transmigrated from Java to Sumatra, Kalimantan and Sulawesi. One of the achievements was that Indonesia attained rice self-sufficiency in the early 80s.

External Environment

Later development of Agricultural Mechanization Education took different forms as Indonesia facing soaring of population, food and energy crises, as well as environmental degradation. The mechanization activity was widely being claimed as damaging to soil and environment. The other was the economic reason since, until recently, Indonesia has never been succeeded in developing agricultural machinery. This country has been highly relied on imported machinery which mostly believed unsuitable for Indonesian soils and infrastructures. Nowadays, opening new agricultural land or constructing dam for agriculture is like to try to stand a wet thread. The condition more or less influenced the development of the Agricultural Mechanization Education. Several attempts were then conducted to improve the image or to make a new image of Agricultural Mechanization, which came lately as Agricultural Engineering (AE). This term was of course not new to Indonesian ears, since lots of lecturers were graduated from western universities. The term agricultural engineering is translated into Indonesian word as *Teknik Pertanian,* i.e., *Pertanian* stands for Agriculture and *Teknik* is supposed for Engineering. But it might be confusing with the word technique in English, which has different meaning. However, *Teknik* as the translation of engineering is widely adapted by other discipline such as *Teknik Sipil* (Civil Engineering), *Teknik Kimia* (Chemical Engineering), *Teknik Fisika* (Physical Engineering), and so on.

In the 90s, there were three state universities (the other is Brawijaya University in Malang) and two private universities that have Department of AE. Five other universities use the agricultural engineering discipline as study programs. Only two universities (Bogor Agricultural University and Gadjah Mada University) have graduate programs on AE. In the three state universities, the Department of AE is the sub-ordinate of Faculty of Agricultural Technology. In the other five universities, the Undergraduate Study Program of AE belongs to the Department of Agricultural Technology, under the Faculty of Agriculture. The slow development of AE might be attributed to the following conditions. In Indonesia, a study program is grouped according the national consortium for sciences. Up to this time, it is not clear whether AE as study program is grouped into Engineering or Agricultural Sciences even though the curricula has met with the minimum requirement of Engineering Consortium, and all of the lecturers are called engineers and involve in engineering society. This condition might result in the situation that AE is less recognizable by common society and accordingly decrease student enrollment both in term of quantity and quality. As a result, the Department of AE in two private universities (Mercu Buana University and Indonesia Institute of Technology) was closed due to less number of students. The other condition that also might cause the decrease in student enrollment was the global trend of Information Technology (IT). Almost all IT or Computer Department has experienced enormous applicants.

Coming to the end of the 90s, while the country experienced high level of economic crises which caused widespread lay-off and unemployment especially in industrial and business sectors, the agricultural sector was merely undisturbed and played big roles in stabilizing rural economic. Increase in the US Dollar exchange rate raised the competitiveness of plantation products in the international markets. Instantaneously, prosperity came to the lucky farmers. This phenomenon attracted many others to find fortune in agribusiness. In the policy level, it has been clear that future national development will be based on the exploration of renewable resources with an intensive and smart approach in utilizing environmentally friendly technology.

Government supports are real in encouraging agricultural education in ways of allocating competitive grants for the development of study program. Among others are some programs intended to strengthen the RAISE (Relevance, Academic Atmosphere, Internal Management, Sustainability and Efficiency and Productivity) such as QUE (Quality Undergraduate Education), DUE-Like (Development for Undergraduate Education), and Plan-B. In practical or real sector, improving infrastructure and applying intensive and appropriate technology in agriculture has resulted in higher productivity. For example, after rice production considerably declined in the time of crises in 1998 and rice import continued until 2001, last year (2003) production of rough rice hit an all time high of 52.1 million tons, and it is forecasted this year production would increase to 53.7 million tons or equal to 33 tons of milled rice. Those figures exceed national consumption of 31 tons, attributed to the improved irrigation system, integrated pest management and technology application especially the use of fertilizer. However, the remaining problem is that the price in the international market is still lower, which would give a potential threat when the import bans were removed. The real challenge now and for the future is how to produce agricultural products or by-products cheaper than the international price while maintaining proper benefits to the farmers. At the moment, the national price of rice is between Rp. 2,500-3,000 whilst the international price is in between Rp. 2,000 - 3, 000 per kilogram[2].

Trends of Development

There has been no new definition of Agricultural Engineering in Indonesian but it is already accepted as a field of science that studies how to explore and utilize biological resource and energy in sustainable ways for the prosperity of Indonesian people and human kind as a whole. This trend, which is also attributed to global trend, benefits the development of AE. This trend took shapes in the form of updated program and curricula. Intelligent approach has become supporting parts of all fields of study. As a signaling result, the number of student enrolled is increasing in term of quantity and quality almost in all universities offering AE Study Program, not only in undergraduate but also in graduate level. To develop curricula is not a matter of introducing national consortium for those universities becoming autonomous such as Bogor Agricultural University and Gadjah Mada University. The development of Curricula should consider the global trend and be based on objective tracer studies on how graduates could fill the requirement of the job markets in country as well as in foreign countries. Competency and competitiveness are of the main concerns to make a clear identity of the graduates while at the same time capable of acting as a social entity that has moral and social responsibly. Fields of AE study become broader by the emerging of agricultural engineering

[2] Jakarta Post, August 10 and 11, 2004.

and technology, such as in the fields of Aqua-cultural Engineering, Seri-cultural Engineering, Renewable Energy, Intercropping in Agro-forestry, Bio-environmental Control, etc.

For example, the AE Education in Bogor Agricultural University is preparing to develop a new system, which is called Major and Minor Program. The Department has AE Program, which is a Major Program. It is also possible to have one or more Minor Program offered to other Departments within the University. The AE students have some options to take Minor Program from other departments. This concept opens the opportunity for the students to have additional knowledge and chance to get together with their compatriots from other departments. The benefits for AE Education are among others enabling to develop collaboration program such as Aqua-cultural Engineering with the Department of Aquaculture, Seri-cultural engineering with the Departments in the Faculty of Forestry, Landscape Engineering, Biological Engineering, Environmental Engineering, etc.

National Curriculum

In general, the national curricula classify five categories of lectures such as for: 1) Developing personality (9 credit units out of 144~147 cu[3]); 2) Mastering basic sciences and skill (58 cu); 3) Specializing creativity (55-56 cu); 4) Developing creative behavior (17 cu); and 5) Developing communal interaction (7 cu).

The first category, developing personality is applied for the national education, which occupies about 6% of the total credit unit of 144. Lectures grouped in this category are Religion Education, State Ideology and Civics, Introduction to Sociology, and Physical Education and Arts. The government of Indonesia acknowledges the existence of five religions such as Islam, Christian, Catholic, Hindu, and Buddha.

The second category, mastering basic sciences and skill (40%) is given differently according to the consortium, in which for agricultural consortium, it consists of lectures given in preparatory levels in the first and second semester, and basic lectures for agricultural engineering education. The lectures in the preparatory levels (18%) are Introduction to Agriculture, Biology, Physics, Chemistry, Mathematics, Calculus, Climatology, and Economics. The basic lectures for AE Education (22%) are Statics and Dynamics, Fluid Mechanics, Engineering Mathematics, Engineering Statistics, Engineering Drawing, Thermodynamics and Heat Transfer, Engineering Materials, Workshop, Agricultural Materials, Surveying, and Soil Properties.

The third category, specializing creativity (38%) consists of Agronomy, Computer Application, Instrumentation, Strength of Materials, System Analysis, Engineering Economics, Energy and Electrification in Agriculture, Engineering Plan, and 2 to 4 lectures elected by students for more specialization in AE Fields. Elective lectures are generally provided by each laboratory/division existed in the department. In most cases, student who participates in these courses are then having an advisor from the faculty members of the related laboratory/division.

The fourth category, developing creative behavior (12%) consists of Introduction to Agricultural Technology, Management, Entrepreneurship, Field Practices, and

[3] The minimum total credit unit for undergraduate education is 144 cu. Mostly; engineering education is more than that number.

Research/Special Problem. It is an obligation for the student of AE to spend about 2 months to take a close look at the real activities or real world either in community, private estates, or industrial sectors. The students choose and determine by themselves what sectors they are interested in. Many companies are also offering places to be filled by the student in this respect. The student may be part of their production activities and guided directly by a supervisor from the company. Some of the students may find some topics that are suitable for their research/special problem topics. In this case, they can extend their stay in the company to carry out his/her final assignment.

The fifth category, developing communal interaction (5%), consists of Indonesian Language, English, Scientific Presentation and Seminar. In this respect, they are given guidance on how to prepare good manuscripts and to present report whether orally or in poster, and to behave properly in scientific gatherings. Nowadays, participation of undergraduate students in the annual seminar of the Indonesian Society of Agricultural Engineering is highly encouraged. Yet, it becomes mandatory for the graduate students to present their original articles in the seminar.

Each lecture given should have a syllabus. The syllabus is in the form of Guideline of Teaching Program, which consists of Name of Lecture, Code of Lecture, Credit Units, Brief Description, Main Instructional Objectives, and Materials for Lecture and Laboratory Work, if any. It is also necessary to list some lectures used as prerequisites. Materials for Lecture/Lab-work are organized into Specific Instructional Objectives, Main Topics, Sub-topics, Time Allocation and References. This teaching guideline should be clear enough for the student to understand, and also for the instructors assigned for the lecture. It is also necessary to explain to the student how many evaluations and tasks are given, and percentages of those will be applied. Mostly, the student will be given two evaluation tests (middle and final), lab-work evaluation and other assignments such as home works, etc. One example of a syllabus/Guideline of Environmental Measurement can be seen in the attachment.

Curriculum Development

The Ministry of National Education has inaugurated an independent agency of educational accreditation (BAN) in the late of 90s. Until this time, BAN is the only body available to do accreditation for all program studies in the country. Any program studies can apply to be accredited by mean of submitting relevant documents such as port-folio, self-evaluation, and subjected to site visit. For undergraduate programs, BAN makes 3 (three) categories or ranks such as A for excellent, B for Common and C for Poor. For graduate programs, there are only 2 ranks, A and B. Present lists of accredited AE study programs can be seen in the attachment.

The Ministry of National Education of the Government of Indonesia has introduced competitive projects for the development of curriculum in various study programs. One of the project namely DUE-Like has been awarded to the Department of AE Study Program of Bogor Agricultural University from 2002 until 2006. This program has main objectives to increase relevance, efficiency, productivity, and academic atmosphere. Followings are some results of the project.

1. Increase Relevance

In connection to this program, the Department chooses to increase English proficiency, technical capability, and managerial and entrepreneurship skills of the students.

English proficiency. The purpose is to improve their capability in deciphering lecture materials and assignments given in English. Each year, some selected lectures, lab-works, and assignments are given in English. Students who get less grade in a pre-test (TOEFL less then 480) are given special tutorial or should go to an additional English Course. There is also English Club for those who interested to join. At this moment, there are 8 lectures available in English version and at the end of the project there would be 20 lectures. About 35% of the students managed to pass the assignments.

Technical Capability. The purposes are to enrich laboratory works with the installment of new facilities, and to intensify the use of computer networks. Activities are to upgrade laboratory manual, to procure new instruments, equipments and computers, and assign senior students as laboratory assistants. At this moment, 42 manuals have been upgraded and by the end of the project there would be 60 manuals. About 86% of the students got more then 70 mark. The target is 90% that the student would pass in 2006.

Entrepreneurship and Managerial Skills. The purpose is to equip graduates with entrepreneurship and managerial skills for better adaptation to the real world environment. In this context, a lecture of entrepreneurship is given, giving alternatives to initiate a new business entity for the final assignment, and to cooperate with the university's auxiliary ventures to place students for temporary employment for their final assignments. Until this time, there are 40 students who make proposals to create business entities of which 5 were approved by the Directorate General of Higher Education and the University to be financed and implemented. About 10% of the graduates in 2004 opened new business. There are two groups of students to create business entity, and five students are now temporarily employed in small and medium industries for their final assignments.

2. Increase Efficiency and Productivity.

The purposes are to increase interest of best school graduates to enroll in AE Study Program, and to increase quality of learning system so the graduated students are not only mastered in theoretical aspects but also have enough skill and capability to enter into job markets. The activities are:

1) To make broad promotions in any possible means such as booklet distribution, homepage updating, road-show, talk-show in radio and television, open-house, student participation in various scientific competitions, etc. It is targeted that by the end of the project, the ratio between enrolled and applicant is 1/12. At present time, the ratio is 1/7.
2) To give competitive grants to create innovative learning methods. Four grants have been awarded each year. Most of them use interactive multimedia and develop Self-Access Center (SAC).
3) To give competitive grants for doing researches which involve students and contribute to the accomplishment of their final assignments. Four grants have been awarded each year.

4) To send lecturers to do comparison study to other well-known universities in the country.
5) To invite prominent experts to give fresh information on teaching system and methodology.
6) To give appreciation to the best lecturers voted or surveyed by the students at the end of each semester.

3. Increase Academic Atmosphere.

The objective is to increase interaction between lectures and students in order to improve academic atmosphere and subsequently to increase motivation to study and complete their final assignments in due time. The activities are:

1) To hold *studium generale*. The target is to hold one *studium generale* in one semester with the speaker invited from other institutions or industries.

2) To conduct field trips to industries and research centers. This is an optional program but at least a student has experience to conduct field trip to industry or other related fields.

3) To involve more students in researches carried out by the lecturers. About 23% of the students involve in research carried out by their academic advisors. By the end of the project, it will attain to at least 25%. The results show that students who participate are faster in accomplishing their final assignments (6 months) as compared to those who finance their assignments by themselves (9 months).

4) To involve more students in scientific meetings and competitions. Students are more active in participating in scientific competitions, which now the numbers are exceeding the target of 15% by the end of the projects. Two groups succeeded to win gold and silver medals in a recent national competition. Some of them (10%) participate as presenters in the annual seminar of ISAE.

4. Other Programs

Inclusive to these programs is to develop cooperation with alumni, governmental institution and private sectors. Finding an effective networking is sought. It is of interest to secure places for field trips, field research, and to feel or to be in a working environment. The activities are:

1) To identify and communicate with potential partners and then to undertake signing of Memorandum of Understanding. Now, about 81 partners have been recorded, which is exceeded the target of 80. Among them, six have been established in term of MoU. The target is 10 MoUs by the end of the project.

2) To intensify communication with the partners through any means such as visiting, formal discussion, exchange of information, etc.

3) To update data of alumni and put the alumni as spearheads in developing networking or cooperation with private sectors.

5. Performance Indicators

There are five main performance indicators to see the success of the project, such as presented in the Table 1 below. Almost 80% of the candidates are invited based on their performance in high school. The rest is going through the national entrance examination. There are seven main subjects to be considered: Mathematics, Physics, Chemistry, Biology, English, Indonesian, and English. As shown in the Table 1, the baseline data for averaged mark of the candidate is 25% above 48. In 2001 it decreased to 22% then again increased to 36% in 2002, which exceeded the target of 30% in 2005. Final marks of graduates increased considerably from 21% in 2001 to 33% in 2003. Length of Study within less than 5 months, increase significantly and have passed the target in 2002 as well as in 2003. Waiting periods within less than 6 months also increased significantly and have passed the target in 2001. TOEFL-*Like,* even decreased in 2001 but then increased gradually to 32% in 2003.

Table 1. Performance Indicator of DUE-Like Curriculum Development Project

No	Items	Baseline 2001	Achievemen t 2002	Achievement 2003	Target 2005
1	Cumulative Marks of Incoming Students (>48.0)[4]	25%	22%	36%	30%
2	Final Marks of Graduates (>3.0)[5]	21%	33%	33%	40%
3	Length of Study (<5 months)	17%	43%	45%	35%
4	Job Waiting Periods (<6 months)[6]	50%	78%	71%	60%
5	TOEFL-*Like* (>500)	20%	6%	32%	40%

It is concluded that the progress of the project has resulted in significant developments and it is predicted that it would continue to achieve the targets. However, future development after the end of projects or the sustainability is still unknown when the grants and incentives are removed.

References

1. Dasa warsa alumni 1980. Departemen Mekanisasi Pertanian.Fatemeta-IPB. 1980.
2. Summary of DUE-Like Activities in 2004.
3. Self-Evaluation of the Department of Agricultural Engineering of Bogor Agrcultural University

[4] Averaged from 7 main subjects (max. 70)
[5] Maximum is 4.0
[6] Averaged from 99 graduates, by sampling.

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List of AE Program Study Accredited By National Accreditation Agency (2004)

No	University	Year	Grade	Rank
1	Bogor Agricultural University, West-Java	2000	Undergraduate	A
2	Pajajaran University, West-Java	1998	Undergraduate	A
3	Andalas University, West-Sumatera	1998	Undergraduate	B
4	Jember National University, East-Java	1998	Undergraduate	B
5	STIPER Agriultural Institute, Central-Java	1998	Undergraduate	B
6	Brawijaya University, East-Java	2001	Undergraduate	B
7	Lampung University, Lampung	2000	Undergraduate	C
8	Udayana Univesity, Bali	2000	Undergraduate	C
9	Sam Ratulangi University, North-Sulawesi	1998	Undergraduate	C
10	Hasanuddin University, Makassar	1998	Undergraduate	C
11	Muhammadiyah University, Mataram	2000	Undergraduate	C
12	Gadjah Mada University, Yogyakarta	2003	Undergraduate	A
13	North-Sumatera Univesity, North-Sumatera	2003	Undergraduate	B
14	Sriwijaya University, South-Sumatera	2004	Undergraduate	B
15	Indonesia Institute of Technology, West-Java	2004	Undergraduate	B
16	Gadjah Mada University, Yogyakarta	2004	Graduate	B
17	Bogor Agricultural University, West-Java	2000	Graduate	A

Guideline of Teaching Program

Title of Lecture : Environmental Measurement
Code of Lecture : TEP 362
Credit Unit : 3(2-3)[7]
Prerequisite : Physics, Mathematics, Calculus, Statistics and Thermodynamics

Brief Description
Methods in measuring environmental entities and their applications in agriculture. Scopes of learning are: measuring movement, velocity, acceleration, strain and stress, flow, temperature, light and sound; accuracy and precision of measurement; and data statistical analysis; and analog and digital instruments; and data acquisition system.

Main Instructional Objective:
To understand how to and be able to utilize standard instruments to measure and to record environmental entities, and to analysis the results of measurement properly.

Materials for Lecture

No	Specific Instructional Objectives	Main Topics	Sub-topics	Allocation Time (minutes)	References
1	To understand rules of lecture and the importance of environmental measurement in agriculture.	Introduction	▪Rules of lecture ▪Environmental entities ▪Measurement in agriculture	100	
2	To understand basics of measurement and enable to understand and to present scientific data.	Basics of Measurement	▪Accuracy and precision. ▪Error analysis ▪Statistical design ▪Replication ▪Selection of instrument ▪Data collection ▪Data analysis ▪Data checking ▪Generalization	100	1 (Ch. 1) 2 (Ch. 1)
3	To understand and enable to use varieties of sensors and transducers for environmental measurement.	Sensors and Transducers	▪Movement ▪Velocity ▪Acceleration ▪Strain ▪Flow ▪Temperature ▪Light ▪Sound ▪Hall-Effect	200	2 (Ch. 2) 1 (Ch. 2- 9) 3 (Ch. 5- 8)
4	To understand and enable to analyze circuitry of signal conditioning	Signal Conditioning	▪Circuit bridge o Direct current o Alternating Current ▪Op-Amplifier:	200	2 (Ch. 3) 1 (Ch. 10)

[7] TEP is the abbreviation for the Department of AE; 3(2-3) means 3 cu consists of 2 lecture time (2 x 50 minutes) and 3 practice time (3 x 50 minutes).

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No	Specific Instructional Objectives	Main Topics	Sub-topics	Allocation Time (minutes)	References
			o Analysis o Inverting o Non-inverting o Differential o Integrator		3 (Ch. 4)
5	To understand and enable to analyze circuitry of analog filtration.	Analog Filtration	▪Order of Filtration ▪Class of Filtration ▪Filtration of Op-Amplifier: o 1st order o 2nd order o 3rd order o 4th order	200	2 (Ch. 4)
6	To understand and enable to analyze circuitry of signal conversion.	Signal Conversion	▪Electromechanical ADC ▪Frequency ADC ▪Voltage ADC ▪Digital to Analog	100	2 (Ch. 5) 1 (Ch. 13)
7	To understand and enable to analyze circuitry of digital processing.	Digital Techniques	▪Logic counting systems ▪Logic gates. ▪Flip-flop ▪BCD ▪Seven Segments Display	400	1 (Ch. 6) 2 (Ch. 13)
8	Enable to design and apply proper techniques to measure environmental entities.	Applications	▪Measurement Designs: ▪Temperature, ▪Light ▪Etc.	200	1 (Ch 15)

References:

1. Henry, A.Z., G.C. Zoerb and G.S. Birth. 1991. Instrumentation and Measurement for Environmental Sciences. Third Edition. American Society of Agricultural Engineers.
2. Turner, J.D. 1988. Instrumentation for Engineers. Macmillan Education Ltd.
3. Usher, M.J., and D.A. Keating. 1996. Sensors and Transducers: Characteristics, Applications, Instrumentation and Interfacing. Second Edition. Macmillan Press Ltd.

Evaluation:

1. Final Value = 0.25 (Middle Test + Final Test + Practice + Assignments)
2. Grade: $A \geq 85$; $70 \leq B < 85$; $55 \leq C < 70$; $40 \leq D < 55$; $E \leq 40$

Instructors:

1. Prof.Dr.Ir. Budi I. Setiawan, M.Agr
2. Dr.Ir. I Dewa M. Subrata, M.Agr.