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Agricultural Engineering Education in Turkey: the Struggle of Separating Engineering from Science*

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While the education in agricultural engineering has been evolving worldwide to include more biological emphasis, there are still problems for this part of the profession to be identified and recognized correctly by the general public in Turkey. Agricultural engineering education and profession in Turkey has long been controversial since it has been confused with agricultural science education. We present the current interpretation of 'agricultural engineering' in Turkey and highlight how engineering education has been mixed up with science education in agriculture. We take a historical approach and propose possible remedies within the world's general engineering education trends.

Keywords: agricultural engineering; biosystems engineering; curriculum history

INTRODUCTION

THERE HAVE BEEN major advances in science and technology during the last couple of decades in the 20th century. Irresistible globalization and innovations in biological subjects have been major influences in agricultural engineering education and in the profession.

As in the rest of the world, there have been departments in agricultural faculties in Turkish universities in two different streams:

- science-oriented departments such as soil science, animal science, plant protection (entomology and plant pathology), horticulture, agronomy, etc.
- engineering departments such as agricultural machinery and energy, agricultural structures and irrigation, etc.

However, the problem begins with the diploma granted with graduation. It gives a unique title to all of the graduates: 'agricultural engineer'. This means that, for instance, a 'weed control scientist' is an 'engineer'; similar to graduates of other science-oriented departments too.

As a result, agricultural engineers graduating from engineering-oriented departments have problems to define themselves as an engineer in the public domain. People consider all 'agricultural engineers' as if they should be experts in all agricultural related issues. A farmer may, for instance, refer an animals' disease to a soil scientist defining him/herself as an 'agricultural engineer'. A mini survey among freshmen students enrolled in the 'Agricultural Engineering Program' of the Agricultural Faculty of Yuzuncu Yil University was conducted as a preliminary study for this paper. Fifty students in two groups joined in this survey and results indicated that the 'agricultural engineering profession' is considered to be mostly related to animal science and plant production (52%). Only 4% indicated a direct relationship with engineering such as the correct use of machinery and equipment, machinery design, industrial and technological issues in agriculture etc.

Another question on 'what is engineering?' was answered correctly by a great majority of the students (88%). These answers covered legitimate definitions such as problem solving, creativity, design, expertizing in a specific engineering area, etc. In the end, 63% of the students indicated that their own definition of agricultural engineering does not fit with the definition of what engineering is. Only 33% said that agricultural engineering is a branch of engineering. The final result indicates that the picture is blurred in students' minds.

Instead of clearly and correctly redefining the agriculture-related jobs, there were recently major revisions in agricultural education in Turkish universities. Since 2003, only one unique agricultural program is offered in agricultural faculties for the first three years. Students then choose their interest areas (sub-programs) for the fourth year to become a soil scientist, animal scientist, agricul-

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tural economist, machinery designer, etc. More interestingly, the program name is 'agricultural engineering' and all students will be granted the title 'agricultural engineer' upon graduation. These changes are totally independent from the challenge in redefining the agricultural and biological engineering education and profession. However, these trends may also provide an opportunity to precisely redefine the boundaries between engineering departments and science departments in Turkey with a new definition of the profession.

In this study, the educational program in agricultural engineering in Turkey and the current changes and problems facing the discipline are presented and possible remedies discussed within the global trends in engineering education.

MEANING OF THE TERM 'AGRICULTURAL ENGINEERING' IN TURKEY

Current use of the term 'agricultural engineering' in Turkey is different to what it means in Europe, North America and probably the rest of the world. Therefore, it would be useful to define some related terms in order to eliminate dual meanings and possible misconceptions.

Definition of terms:

- AE_{INT} = Engineering applications in agriculture recognised worldwide.
- AE_{TR} = All agriculture-related subjects including agricultural science and engineering, valid only in Turkey.

The term 'agricultural engineering' is defined in wordIQ.com [1], one of the most comprehensive searchable references on the Web, as '*the discipline of engineering in agricultural, food, and biological systems*'. It goes without saying that '*the essence of engineering is problem solving*' or '*design is the essence of engineering*' and in fact '*engineering transforms scientific knowledge into reality*' [2].

Areas related to agricultural engineering are listed as follows:

> biosystems engineering, ergonomics, safety and health; emerging areas; information and electrical technologies which includes remote sensing; food and process engineering; forest engineering; power and machinery, which includes machine design; soil and water engineering, which includes irrigation and drainage; structures and environment, which includes designing livestock buildings as well as structures such as grain elevators and greenhouses.

We call the above definition of 'agricultural engineering' as $\mathbf{AE_{INT}}$. In Turkey, however, there is an important discrepancy in definition and use of this term. In fact, 'agricultural engineering' ('ziraat/tarim mühendisligi' in Turkish) is used synonymously with 'agricultural science'. 'Agricultural science' is defined in wordIQ.com [1] as '*a broad multidisciplinary field that encompasses the parts of exact, natural, economic, and social sciences that are used in the practice and understanding of agriculture*'. Therefore, 'agricultural engineering' in Turkey covers all aspects of agricultural sciences like agronomy, horticulture, animal science, entomology, agricultural economics, etc beside the true engineering subjects such as machinery design, structures and environment, precision farming, etc. The $\mathbf{AE_{TR}}$ symbol will be used, in this article, to represent what is meant by 'agricultural engineering' in Turkey.

Consequently, graduates who refer to themselves as an 'agricultural engineer' in Turkey can be a professional educated in animal science, entomology, horticulture, agronomy, food science, or even agricultural economy. They could be someone who graduated from an engineering-related department such as agricultural machinery, structures and irrigation, etc. However, doubt about a graduate's expertise area (i.e. the department of the agricultural college which he/she graduated from), makes it necessary to consult that department about the degree.

Turkish agricultural education had been influenced by the French system from the mid-19th century to 1923. In France, however, the word 'ingénieur' comes from the root 'génie' which has a dual meaning: 1) genius and 2) engineering. 'Agricultural engineering', for instance, is 'génie rural' and 'ingénieur agronome' does not mean 'agricultural engineer' ($\mathbf{AE_{INT}}$). On the other hand, the root of the word 'engineer' is 'engine' in the Old English which was borrowed from Latin 'ingenerate' meaning 'to create'. Theodore von Karman, one of the great aeronautical scientists of the twentieth century, described the difference between science and engineering with his famous words: '*The scientist explores what is, the engineer creates what has not been*' [30]. Although this definition is now commonly recognized world-wide, it is a matter of fact that definitions of the engineering profession and the word 'engineer' itself are still an issue in France [3] which in turn influences Turkish agricultural education.

Under the pressure of global and European trends as well as confusion in using the term 'agricultural engineering', there have been studies trying to clarify the status and problems of agricultural engineering education in Turkey and to suggest new solutions [4–10]. However, much further effort is needed to come up with a final resolution.

Interestingly, graduates from the departments of 'food science and technology' of agricultural faculties in Turkey do not define themselves as 'agricultural engineers' after a restructuring of these departments in 1995. What happened was that food science and technology departments in agricultural colleges changed their names to 'food engineering' and revised their curriculum accordingly. In addition, the title of graduates from these departments changed to 'food engineer' instead of 'agricultural engineer', which had been used by Turkish food scientists for many decades before

1995. Furthermore, most of these departments officially moved from colleges of agriculture to colleges of engineering within their universities. After that, there has not been any university program offering a classical food science curriculum. In other words, there has not been a food science department in Turkey anymore, a crucial situation for the food industry. So employers in the food industry now hire 'food engineers' for responsibilities which best suit 'food scientists'. On the other hand, one good thing is that significantly more students applied to register in these new departments, probably because 'food engineer' as a title sounds more attractive to them than 'agricultural engineer'.

A REVIEW OF THE HISTORY OF AGRICULTURAL SCIENCE AND ENGINEERING EDUCATION IN TURKEY

There has never been an attempt to delineate the borders between engineering and science aspects of agricultural education and its profession in Turkey. As a result, AE_{INT} education in Turkey cannot easily be explained without touching on general agricultural education.

Turkish agricultural undergraduate education including AE_{INT} can be divided into five periods:

1. The first attempt (1848-1850) and Halkali Agricultural School (1891–1928)
2. Ankara Higher Agricultural Institute, AHAI (1933–1947)
3. Ankara University Agricultural Faculty, AUAF (1948–1952; 1953–1955)
4. National agricultural education in Turkish universities including AUAF (1955–1999)
5. Reconstruction of national agricultural education (1999–2003; 2003–current)

The history of agricultural education is summarized in Table 1.

Stage 1. The first attempt (1848–1850) and Halkali Agricultural School (1891–1928)

First attempts to renew and improve education systems in terms of contemporary understanding of university systems in Turkey probably begin with the Tanzimat Dönemi (Reform Period),

Table 1. Overall picture of changes in agricultural undergraduate education in Turkey

Stage	Years	School	Duration	Programs	Title granted
1a	1848–1850	Ayamama Agricultural School[1]	?	No option (General agriculture)	?
1b	1891–1928	Halkali Agricultural School	4 years	No option[2] (General agric.)	Higher Agric. Engineer
2	1933–1947	AHAI Faculty of Agriculture[3]	4 years	No option[2] (General agric.)	Higher Agric. Engineer
3a	1948–1953	Ankara University Agricultural Faculty	4 years	No option[2] (General agric.)	Higher Agric. Engineer
3b–4a	1953–1967	Agricultural Faculties[4] in Turkish Universities	4 years	Departments (7 progs) + 1 general prog.	Higher Agricultural Engineer
4b	1967–1977	Agricultural Faculties in Turkish Universities	5 years (3.5+1.5)	Departments (11 progs)	Higher Agricultural Engineer
4c	1977–1999	Agricultural Faculties in Turkish Universities	4 years	Departments (12 progs)	Agricultural Engineer[5, 6]
5a	1999–2003	Agricultural Faculties in Turkish Universities	4 years (3+1)	3 Programs+ 10 sub-programs	Agricultural Engineer
5b	2003–current	Agricultural Faculties in Turkish Universities	4 years (3+1)	1 Program+ 10 sub-programs	Agricultural Engineer

[1] French Grignon Type (Ecole Nationale Supériore Agronomique of Grignon, 1826).
[2] Specialization after graduation.
[3] German style. All professors of the Institute were German until World War II.
[4] Mostly U.S. style until 1967, except diploma granted.
[5] Graduate education style (MS+PhD) has not changed after this period.
[6] Beginning 1995, "Food Science and Technology" Departments changed and revised their names and curriculum to be "Food Engineering" program and granting "Food Engineer" title to their graduates. Later, most of these departments moved to Engineering Faculties within their universities. "Landscape Architecture" departments also ended offering "Agricultural Engineer" title and started giving "Landscape Architect" title and diploma to their graduates from 1990. Therefore, these two departments excluded from the table after this stage.

1839–1876. In October 1846, establishment of the first university (Darülfünun, House of sciences) started and was completed in nine years. However, public interest in this university decreased gradually and it was closed within less than two decades. Several other attempts were made before the modern Turkish Republic, but they were below modern Western standards [11].

As in other areas, it was recognised that the challenging problems related to agriculture could be solved by advanced education and research [11, 12]. In 1848, agricultural education was first started with 46 students, using the Grignon Higher Agricultural School (Ecole Nationale Supérieure Agronomique of Grignon) in France as a model. However, this first attempt in agricultural education, which took place at Ayamama Farms in Istanbul, was not very successful and it was closed after two [11] or three [12] years. In the second attempt, Halkali Higher Agricultural School (Halkali Ziraat Mektebi Alisi) was opened in Yesilkoy, Istanbul, in 1891. A 4-year undergraduate education in general agriculture was offered in this school for 37 years, then closed in 1928 in order to render it relevant to changing technologies.

In the same way, there had been two other agricultural schools: Agricultural Operation Schools (Ziraat Ameliyat Mektepleri) of Selanik (1887) and Bursa (1891) [12]. A unique title of 'ziraat yüksek mühendisi' (higher agricultural engineer) (AE_{TR}) was granted to all graduates of these schools [11, 13], although a unique curriculum was offered in general agriculture which lacked engineering (AE_{INT}) aspects. Education programs offered in these schools are defined briefly by Sarikaya [12] as classes which were taught in the mornings with field and lab applications carried out in the afternoons. Learning the applications of agriculture was very important. However, research possibilities were practically nonexistent.

Atatürk and his Prime Minister Ismet Inönü recognised that the country's agriculture could only be advanced by applying modern education and research methods. Therefore, many graduates of Halkali Agricultural School were sent to Western countries especially Germany, to be further educated in modern research techniques, beginning in the year 1923 [11]. Akman [13] mentions some of these students by name and their brief vitae who then became university professors in Turkey.

Stage 2. Ankara Higher Agricultural Institute AHAI (1933–1947)

In order to improve Turkish agriculture, a group of German scientists (named 'Oldenburg Committee') were invited to Turkey for a detailed investigation of the prevailing status and possible remedies. This committee suggested that establishing a modern agricultural education would be necessary.

After a five-year preparation period, an institute was opened in Ankara in 1933 [15] with the name Ankara Higher Agricultural Institute, AHAI (Ankara Yüksek Ziraat Enstitüsü) by government legislation.

The establishment and foundation of the AHAI was very important for Turkish higher education in general because it was the first time that Western style higher education and research was introduced [11]. Although it was called an 'Institute' instead of 'University', its president was called 'rector' and its faculties were supervised by 'deans'. University laws were legislated after the AHAI Law. In addition, AHAI was the first autonomous academic institution in Turkey which was taken as a model for other universities in 1946 [15].

AHAI consisted of five faculties (Fig. 1). The Faculties of Natural Sciences, Agriculture, Agricultural Crafts, Veterinary Science and Forestry (joined to AHAI in 1934). Among them, only Faculties of Agriculture, Veterinary and Forestry offered undergraduate education. The Faculty of Natural Sciences conducted research and served the three faculties with basic science courses. The Faculty of Agricultural Crafts also conducted research and served the Faculty of Agriculture to teach agricultural technology courses related to agricultural products and processing technologies, fermentation technologies, agricultural machinery, power, and energy [13].

Education in AHAI Faculty of Agriculture

Undergraduate education in this faculty was 8 semesters (four years). Students were trained in government-owned farms during the first two semesters (10 months). Basic science courses i.e. physics, chemistry, botany, etc. as well as other courses like economy, anatomy, meteorology, etc. were taught during the third and fourth semesters (second year). Courses related to all aspects of agriculture were taught in the 2 years [11]. Although there existed various branches of agriculture (called Institutes, Fig. 1), all students were to follow one unique curriculum, i.e. there were no specializations and all graduates were granted the title 'Higher Agricultural Engineer'. This type of education continued until 1947 (Table 1).

Turkey needed modern technology applied to agriculture to move from traditional human muscle and animal power to agriculture with powered machinery and this could be realized through agricultural engineers (AE_{INT}). Ataturk declared in 1925 [29]:

> Since I am a farmer's son too, I know that farming cannot be possible without machines. Doing things with muscle force is difficult, (so) get together, then you can buy machines together. You can farm on hundred acres of field, seed ten times more, and get a hundred times more crops. Also you should find and use seeds suitable to specific soil types. Our country is not yet an agriculture country but it will be. This can only be made possible with using machines in agriculture.

These words indicate that Ataturk realized the link between industrial technology and agricultural

development and wanted to get the benefit of it for the sake of everyone's prosperity in Turkey. He legislated crucial laws related to agricultural education in 1927 and 1933. But unfortunately, engineering aspects of agricultural education did not get enough attention in practice, although the term 'engineering' had been used.

Perhaps Ataturk and his Prime Minister Inonu wanted to achieve this goal when they decided to reform Turkish agricultural education by inviting German scientists to Turkey. In fact, Inonu said in in 1933 that '*We recognize this Institute (AHAI) as a university to educate engineers in agriculture and veterinary science (in plant and animal production)*' [13].

Stage 3. Ankara University Agricultural Faculty, AUAF (1948–1952; 1953–1955)

Ankara University, in the capital of modern Turkey, was founded in 1946. A proposal to change the AHAI's status to university was prepared and discussed in the Grand National Assembly of Turkey (The Turkish Parliament) in 1948 but it was rejected after long and intense discussions [13]. Following the unsuccessful effort to change the name of AHAI to 'Inonu Agricultural University', AHAI's three faculties (Faculty of Agriculture, Faculty of Agricultural Crafts, and Faculty of Veterinary Sciences) joined Ankara University. In the same year, the Faculty of Natural Sciences merged with the Faculty of Science of Ankara University and the Faculty of Forestry into Istanbul University, which had been established at the same time as AHAI. Two agricultural faculties of AHAI then merged together to form one faculty named Ankara University Agricultural Faculty, AUAF. However, the same educational programme in AHAI continued until the year 1952.

The year 1953 was a very important milestone for agricultural engineering (AE_{INT}) education in Turkey. Because a departmental system was launched in that year with four departments: 1) Agricultural Machinery, 2) Animal Nutrition and Breeding, 3) Field Crops (Agronomy), and 4) Horticulture. The number of departments reached 6 by 1955. During this period, separate 4-year undergraduate education programs in various departments were offered in AUAF and this system continued until 1967 by which the number of departments was 9 (7 of them offered undergraduate education) [11]. Although only one of these 9 departments was directly related to engineering in agriculture (Machinery), all graduates of the AUAF were granted the title 'higher agricultural engineer'.

Stage 4. National agricultural education in Turkish universities including AUAF (1955–1999)

Until 1955, AUAF was the only institution which offered higher agricultural education in Turkey. Then, another agricultural faculty was opened in Ege University, Izmir. Ataturk and Cukurova Universities followed Ege by opening agricultural faculties in 1957 and 1970, respectively [11]. The number of agricultural faculties in Turkey had reached to 5 in 1976, 12 in 1984, and

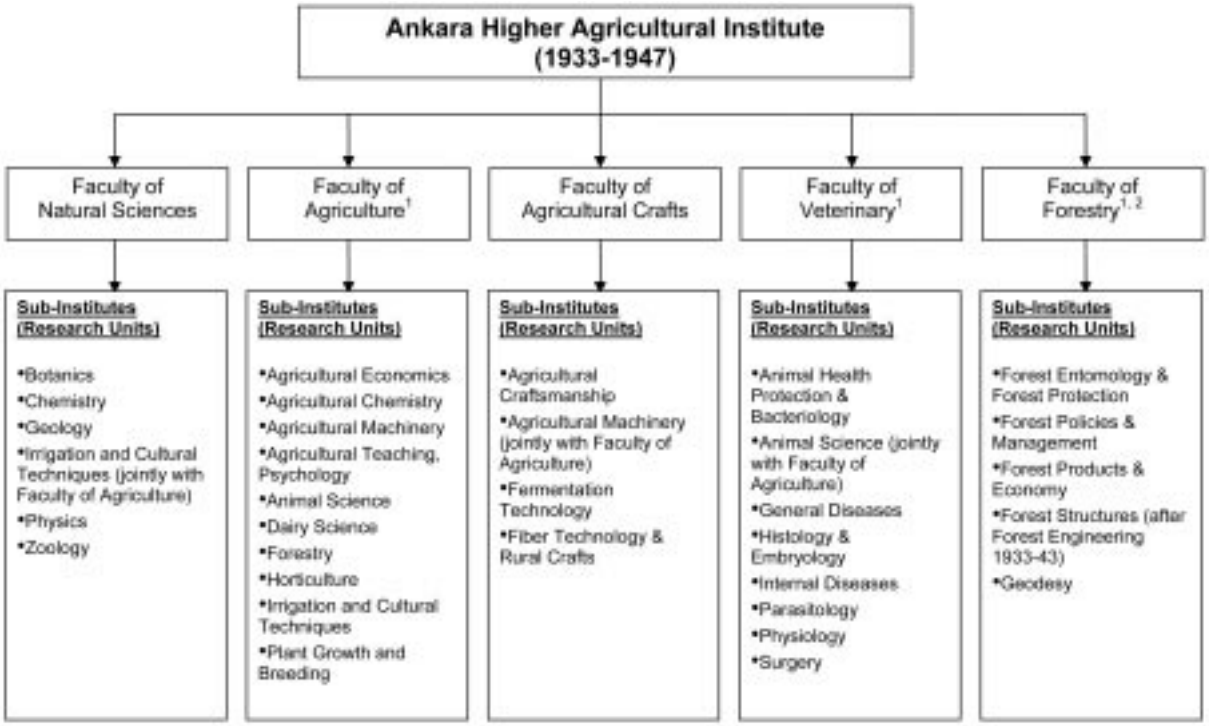

Fig. 1. Organizational scheme of AHAI, illustrated using information gathered from the literature [11, 13, 27].

22 in 1992 [5]. Note that the number of universities in Turkey was 75 in 2002 (54 state owned and 21 private). None of the private universities have any kind of 'agricultural' education, neither at undergraduate nor graduate level.

From 1956, an agricultural machines option has been offered within the Mechanical Engineering Program of Istanbul Technical University. Then several other mechanical engineering departments of other universities offered similar options but this plan was not successful because only a few students chose it as a final-year option [16].

In 1967, a departmental education system was initiated and a '3.5 + 1.5 system' started, so that education time was increased to 5 years. During the first 3.5 years all students took the same basic science courses as well as courses related to general agricultural sciences. Specialization was left to the last 1.5 years involving 3 semesters for agricultural science and engineering options. Another engineering department ('Kültürteknik', inspired from 'kulturtechnik' in German, which covers agricultural structures and irrigation subjects) was opened in 1970. The number of departments later reached to 12 with Departments of Landscape, Architecture and Aquaculture being opened by 1980. The names of 'Kültürteknik' departments were changed to 'Agricultural Structures and Irrigation' in 1991.

Table 2. A typical curriculum model for departments of agricultural machinery (until 1999)

First year	Second year	Third year	Fourth year
Botany I	Math III	Engineering Math	Agric. Machines II
Physics I & II	Statics	Thermodynamics	Ergonomy (Work Efficiency)
Chemistry I & II	Statistics	Fluid Mechanics	Amelioration Machinery
Math I & II	Technical Drawing II	Mechanisms	Agric. Mechanization Management & Planning
Meteorology I	Engineering Materials	Machine Elements	Natural Energy Resources
Technical Drawing I	Animal Science	Dynamics	Agric. Machinery Projects and Production Principles
Economy I	Field Crops	Dynamics of Machines	Product Processing Technology and Machines
Turkish Language	Horticultural Crops	Strength of Materials	Transporting and Elevating Techniques
Foreign Language	Cultural Techniques	Combustion Engines	Agric. Tractors
Ataturk's Principles and Reforms	Agric. Economy	Technical Properties of Biological Materials	Agric. Electrification
	Soil Science	Computer Programming	Systems Analysis in Agric. Mech.
		Agric. Machines I	Plant Protection Machines
			Farmyard Machinery
			Irrigation Machines
			Project Studies
			Agric. Extension and Communications

Table 3. A typical curriculum model for departments of agricultural structures and irrigation (until 1999)

First year	Second year	Third year	Fourth year
Botany I	Computer Programming	Hydrology	Agricultural Structures I & II
Physics I & II	Statics	Hydraulics I & II	Soil & Water Structures
Chemistry I & II	Agric. Economy	Ground Mechanics	Farm Size Management
Math I & II	Technical Drawing I & II	Structure Materials	Agriculture and Environment
Meteorology I & II	Field Crops	Soil, Plant, Water Relations	Geodesic Measurements II
Statistics	Soil Physics	Research and Experimental Methods	Soil Resources Planning
Economy I	Rural Residence Techniques	Amelioration Machinery	Irrigation Machinery
Introd. to Cultural Techiques	Agricultural Mechanization	Irrigation water quality and salinity	Making Projects and Evaluations
Graphical Analysis	Geodesic Measurements I	Drainage and Land Reclamation	Irrigation Systems Planning
Soil Science	Plant Protection	Reinforced Concrete	Irrigation Systems Operation Meth.
Introduction to Computers	Engineering Math	Soil & Water Management Eng.	Greenhouse Structures
Turkish Language	Animal Science	Applied Hydrology	Agric. Extension and Communications
Foreign Language	Horticultural Crops	Irrigation	
Ataturk's Principles and Reforms			

For a short time until 1980, there was one department [28], Ataturk University in Erzurum, that included both machinery and 'kulturtechnik' subjects. Agricultural faculty in that university, which had taken Nebraska State University as a model.

Of course, 1.5 years was not enough to gain a strong engineering background in agriculture. Also, whatever the option students chose for the last three semesters of their education, they were all granted the 'higher agricultural engineer' title (AE_{TR}).

After 10 years of the 5-year system with the 'higher agricultural engineer' title, a 4-year undergraduate college system with separate departmental education was introduced in 1977 and continued until 1999. 1977 was the first time that the 'agricultural engineer' title (AE_{TR}) was offered [11]. An average of 2 to 3 years of Master's and 4 to 6 years of Ph.D. were possible, too. This system was very similar to today's USA universities, except the same title was again given to all graduates regardless of their departments. Another important exception in terms of engineering education was that branches of standard agricultural engineering (AE_{INT}) had been offered in two different departments (agricultural mechanization and agricultural structures and irrigation). Typical curriculum models for these two departments are presented in Tables 2 and 3.

After the late 1980s, the agricultural engineering title and profession lost its popularity in Turkey. This resulted in a lower intake by students after high schools and a lower quality of education.

Table 4. A typical curriculum model for departments of food science and technology of agricultural faculties in Turkey (until 1995)

First year	Second year	Third year	Fourth year
Botany I	Technical Drawing I	Food Processing Engineering I & II	Food Processing Engineering III
Economy I	Animal Science	Principles of Human Nutrition	Alcohol and Distilled Beverages
Physics I & II	Analytical Chemistry	Food Chemistry and Biochemistry	Cereal Proc. Tech.
Chemistry I & II	Microbiology	Thermodynamics	Fruit and Vegetable Proc. Techn.
Math I & II	Statistics	Machine Elements	Dairy Science
Meteorology I	Field Crops	Food Microbiology	Technique of Food Preservation in Cold
Turkish Language	Horticultural Crops	Analytical Food Quality & Control	Biotechnology
Foreign Language	Agricultural Mechanization		Food Processing Hygiene and Sanitation
Ataturk's Principles and Reforms	Agric. Economy		Meat and Fish Proc. Tech.
	Statics & Strength of Materials		Special Foods Tech.
			Milk Proc. Tech.
			Essential Oil and Vegetable Oil Tech.
			Agric. Media
			Project Development and Assessment

Table 5. A typical revised curriculum model for departments of food engineering in agricultural faculties in Turkey (after 1995)

First year	Second year	Third year	Fourth year
General Biology	Engineering Math	Business Administration	Project Techniques
General Economy	Statistics and Experimental Methods	Food Biotechnology	Cereal Proc. Tech.
Inorganic Chemistry	Animal Science	Sanitation in Food Processing	Prin. of Meat Science
Organic Chemistry	Eng. Thermodynamics	Food Microbiology	Special Foods Tech.
Analytical Chemistry	Heat and Mass Transfer	Unit Operations in Food Eng.	Milk Proc. Tech.
Physics I & II	Energy and Material Balances	Food Analyses	Product Development
Math I & II	Technical Drawing	Process Design in Food Eng.	Advances in Food Technology
Introduction to Food Engineering	Lab Techniques	Principles of Nutrition	Fruit and Vegetable Proc. Techn.
General Microbiology	Refrigeration Tech.	Fermentation Tech.	Vegetable Oil Tech.
Intro.to Computer	Reaction Kinetics	Process Apps.	Meat Products Proc. Tech.
Turkish Language	Engineering Materials	Food Regulations and Quality Control	Food Marketing
Foreign Language	Fluid Mechanics	Food Additives	Graduation Project
Ataturk's Principles and Reforms	Food Chemistry and Biochemistry	*Electives*:	Two Electives from Other Programs
	Crop Production	Food Packaging	
		Food Storage	

That is why discussions about the restructuring of agricultural education in Turkey were common over the last two decades. As a result of some of these discussions, departments of food science and technology and landscape architecture gave up using the 'agricultural engineering' title and proposed to offer their students 'food engineer' and 'landscape architect' titles, respectively, in the mid-90s.

Tables 4 and 5 shows how food science and technology departments were restructured as 'food engineering' after 1995. These models indicate that numbers of engineering courses significantly increased while technology courses remained about the same after 1995. In order not to exceed credit hour limitations, credit hours of all courses were diminished resulting in a lower depth of understanding of subject materials. It should be taken into consideration that teaching 'everything about foods' is a very difficult task in a 4-year undergraduate program. On the other hand, this should not be more difficult than teaching 'everything about agriculture' in a 4-year undergraduate program, which is the most common current system in Turkey.

Stage 5. Reconstruction of national agricultural education (1999–2003, 2003–current)

At the end of 20th century, when numbers of scientific branches were increasing and new disciplines were appearing worldwide, a new agricultural education system was started, reducing the number of undergraduate programs to three (length of education remained the same, 4 years). They were:

1. Plant Production (specialization in horticulture, field crops, soil science and plant protection in the last year).
2. Animal Production (specialization in animal

Table 6. A typical curriculum model for Agricultural Technology Programs (1999–2003)

Agricultural Technology Program		
First year	**Second year**	**Third year**
Botany I	Engineering Math.	Hydrology
Physics I & II	Geology	Hydraulics
Chemistry I & II	Technical Drawing	Statics
Math I & II	Statistics	Soil Physics
General Economy	Agricultural Machinery	Plant Nutrition
Information Technologies	Engineering Materials	Agricultural Structures
Meteorology	Ecology	Amelioration Machines
Computer Programming	Geodesic Measurement Tech.	Fluid Mechanics
History of Agriculture	Plant Protection	Farm Size Management
Turkish Language	Soil Science	Irrigation
Foreign Language	Agric. Economy	Agric. Tractors
Ataturk's Principles and Reforms	Plant Production	Agric. Drainage
	Animal Production	Soil Etude and Mapping
		Agric. Electrification
		Project Studies
Fourth Year (Agricultural Machinery Sub-Program)		
Mechanical Technology	Machinery for Seeding, Weed Management, and Fertilization	
Machine Elements and Construction	Plant Protection Machines	
Thermodynamics and Heat Transfer	Machinery for Harvesting and Threshing	
Combustion Engines	Machinery Operations and Maintenance	
Soil Cultivation Machinery	Machinery for Animal Production	
Measurements and Control Techniques	Product Process Technology	
Agric. Mechanization Planning	Energy Use in Agriculture	
Greenhouse Mechanization	Graduation Thesis	
Air-conditioning Techniques	Electives	
Materials for Machinery		
Fourth Year (Agricultural Structures and Irrigation Sub-Program)		
General Structures	Drinking Water Management	
Water Structures	Rural Residence Planning	
Ground Mechanics	Greenhouse Construction	
Projecting Irrigation Systems	Ponds and Soil Barriers	
Strength of Materials	Improving Soil Resources	
Structural Materials	Graduation Thesis	
Irrigation Water Quality and Land Reclamation	Electives	

science, aquaculture and agricultural economics in the last year).
3. Agricultural Technology (specialization in agricultural machinery, structures and irrigation in the last year).

(Agricultural Economics options were offered in Plant Production and/or Agricultural Technology Programs in some universities.) All of these programs offered the same title 'agricultural engineer' to their graduates. A sample curriculum model for Agricultural Technology Programs is presented in Table 6. In fact, Agricultural Technology Programs (1999–2003) were very similar to those already existing in most Western countries as 'Agricultural Engineering' (AE_{INT}). However, since this term has already been used by others, the name 'Agric. Technology' was used instead of 'Agric. Engineering'.

Another restructuring in 2003 was enforced. This very new system reduced the number of programs to just one, bringing a $3+1$ system which is similar to that in 1967–1977. In this curriculum, all students enrolled in agricultural faculties (except food engineering and landscape architecture) take the same group of courses in the first three years and area specializations in the 4th year. The new program's name is 'Agricultural Engineering'. Sample curriculum models for engineering options are presented in Table 7. The first three years of education are common to all options such as horticulture, animal science, field crops, agric. economy, etc. A commonly mentioned reason for this latest curriculum system is given as 'to educate agricultural engineers who have some knowledge about every aspect of agriculture'. What happened was that the program name and the title given were consistent. Instead of just changing the titles given in the diplomas, the whole curriculum system of the agricultural faculties has been altered one more time.

The new system from 2003 has confused engineering education as well as science education in agriculture much more than the previous system. For instance, a student choosing an engineering option such as machinery or structures has to take many unrelated courses such as biochemistry, microbiology, genetics, dairy science, etc., lacking a strong engineering background. Similarly, a student choosing a science option such as plant pathology or entomology has to take unneeded courses like engineering mechanics, technical drawing, fluid mechanics, etc. In addition, whatever the option the student chooses he or she will be granted the same title 'agricultural engineer' (AE_{TR}) in the diploma.

DISCUSSION

Confusion in using the 'agricultural engineering' title in Turkey is summarized in Table 8. In fact, the title 'agricultural (higher) engineer' (AE_{TR}) has been protected by law since 1960. According to that law, it is enough to graduate from one of the agricultural faculties in Turkey or worldwide to be granted and use this title regardless of the department. Also, this term has already settled in the minds of the general public as 'one who graduated from an agricultural faculty and works in an area related to any field of agriculture'. Therefore, changing this public perception at this stage is extremely difficult if not totally impossible. If engineers are trying to highlight the differences between engineering and science in agriculture in Turkey, a new definition is needed. Since the law legislated in 1960 makes it impossible to use the term 'agricultural engineer' only for engineering in agriculture, several other options have been suggested and/or discussed such as 'agricultural machinery engineering' [5], 'agricultural structures and irrigation engineering' [17], 'agricultural mechanization engineering' [16], etc. Food engineering has already been successfully defined but at the cost of losing a very important science area. What is happening is a situation similar to that in the USA: *Once (people/students) hear 'agriculture' their attention turns off and they never hear 'engineer'* [18]. Apparently, people in Turkey have more reasons than in the USA for doing that.

Because AE_{TR} in Turkey has been used differently from AE_{INT}, trying to change its meaning is probably unnecessary as the current status of AE_{INT} and its future role have now been discussed and redefined globally (especially in Europe and Northern America) to include more diverse multidisciplinary engineering areas in biological systems [19–25]. Therefore, it should now be easier than ever to redefine engineering areas in agricultural and biological systems in Turkey. Since AE_{TR} has already been firmly comprehended by the general public to include agricultural sciences and usually considered to be outside of 'engineering', engineering in agriculture can well be included in Biosystems Engineering which can enable engineering faculties to offer a very strong engineering curriculum accredited by world-leading engineering accreditation institutions. This would also definitely contribute a lot towards harmonizing the European engineering education system.

There are good reasons to be optimistic about the future. Luckily, the term 'engineering' itself in Turkey is not in question as in France. '*Definition of engineering (in France) has been an issue for two centuries . . . Almost half of the people working as engineers in corporations are not graduate engineers.*' Apparently, the 'engineering profession' has a double meaning in French [3]. The problem is less complicated than in France; the term 'agricultural engineering' cannot be used for engineering applications in agriculture but the new, clear and simple name, the already well-defined term in Turkey 'Biosystems Engineering' fits this role very well.

In the late 80s and 90s, there were several attempts to separately define and establish an

Table 7. A typical curriculum model for Agricultural Engineering Programs (AE_{TR}): students enrolled in agricultural faculties are to choose options among 10 agricultural science and engineering branches for the last year of their undergraduate education (2003–current)

Agricultural Engineering Program (AE_{TR})		
First year	**Second year**	**Third year**
Botany	Fluid Mechanics	Food Science and Tech.
Physics	Hort.Crops Production I&II	Aquacultural Production
Chemistry	Animal Production I&II	Agric. Economy
Math I & II	Statistics	Agricultural Structures
General Economy	Material Science	Agricultural Extension
Meteorology	Microbiology	Seedling and Tech.
Biochemistry	Field Crops Production I&II	Seeds and Animal Nutrition
Ecology	Plant Nutrition and Fertilization	Plant Protection
Engineering Mechanics	Genetics	Irrigation
Geodesic Measurement Tech. I	Landscape Architecture	Dairy Science
Technical Drawing	History of Agriculture	Agricultural Machinery
Soil Science		Agricultural Valuation
Turkish Language		Tech. Electives
Foreign Language		
Ataturk's Principles and Reforms		
Fourth Year (Agricultural Machinery Sub-Program)		
Machine and Mechanism Theory	Combustion Engines	
Soil Cultivation Machinery	Thermodynamics and Heat Transfer	
Graduation Thesis	Plant Protection Machines	
Machinery for Harvesting and Threshing	Machinery for Seeding, Planting, and Fertilization	
Agric. Tractors	Amelioration Machines	
Tech. Electives	Business Administration in Machinery Industry	
Technical Properties of Biological Materials	Design of Agricultural Machines	
Energy and Agric. Electrification	Transportation and Elevation Tech.	
Ergonomics	Food Process Tech. & Machinery	
Machine Elements		
Hydraulic Machinery		
Machine Tools		
Fourth Year (Agricultural Structures and Irrigation Sub-Program)		
Hydraulics	Farm Size Management	
Hydrology	Drainage Systems Design	
Strength of Materials	Photogrammetry	
Agric. Meteorology	Rural Residence Techniques	
Ground Mechanics	Rural Drinking Water Sources	
Graduation Thesis	Computer Applications	
Tech. Electives	Remote Sensing for Cultural Techniques	
Reinforced Concrete	Geodesic Measurement Tech. II	
Analysis of Biological & Physical Systems	Greenhouse Planning	
Rural Infrastructures	Water Resources Planning	
Projects in Cultural Techniques	Water Collection Basin Manag.	
Systems Engineering	Agro-Civil Engineering	
Irrigation Water Quality and Salinity	Design in Agric. Structures	
Structure Statics	Soil and Water Structures	
Fourth Year[1] (Plant Protection Sub-Program)[2]		
Plant Bacteriology	Industrial Crop Diseases	
Plant Mycology	Industrial Crop Insects	
Plant Virology	Fruit and Vineyard Diseases	
Insect Ecology	Fruit and Vineyard Insects	
Insect Morphology	Plant Protection in Organic Farming	
Insect Tacsonomy	Vegetable Diseases	
Pest Control Methods and Pesticides	Vegetable Insects	
Graduation Thesis	Ornamental Plant Diseases	
Weeds and Their Control	Ornamental Plant Insects	
Tech. Electives	Grain, Bean, and Feed Crop Diseases	
Stored Crop Diseases	Grain, Bean, and Feed Crop Insects	
Stored Crop Insects		

[1] Given as an example among 8 science options, namely Agric. Economy, Animal Science, Aquacultural Science, Dairy Science, Field Crops (Agronomy), Horticulture, Plant Protection, and Soil Science.

[2] Entomology, Plant Pathology, and Weed Science are all included in this option i.e. there are no other sub-programs for undergraduate or graduate education in these agricultural science branches.

Table 8. Titles awarded for graduates of agricultural faculties in Turkey under recent educational system and curriculum changes

1977-1999		1999-2003		2003-Current	
Departments	**Diploma**	**Prog/Sub-Progs**	**Diploma**	**Prog/Sub-Progs**	**Diploma**
		Plant Production		**Agricultural Engineering (AE_{TR})**	
Agric. Economy	Agric.Eng.	- Field Crops	Agric.Eng.	- Agric.Economy	Agric.Eng.
Agric. Machinery	Agric.Eng.	- Horticulture	Agric.Eng.	- Agric. Machinery	Agric.Eng.
Agric.Struct.&Irrig.	Agric.Eng.	- Plant Protection	Agric.Eng.	- Agric.Struct.&Irrig.	Agric.Eng.
Animal Science	Agric.Eng.	- Soil Science	Agric.Eng.	- Aquaculture	Agric.Eng.
Aquaculture	Agric.Eng.	**Animal Production**		- Field Crops	Agric.Eng.
Dairy Science	Agric.Eng.	- Agric.Economy	Agric.Eng.	- Horticulture	Agric.Eng.
Field Crops	Agric.Eng.	- Aquaculture	Agric.Eng.	- Plant Protection	Agric.Eng.
Horticulture	Agric.Eng.	- Zootechnique	Agric.Eng.	- Soil Science	Agric.Eng.
Plant Protection	Agric.Eng.	**Agric.Technology**		- Zootechnique	Agric.Eng.
Soil Science	Agric.Eng.	- Agric. Machinery	Agric.Eng.	**Food Engineering**	
Landsc.Architecture*	Agric.Eng.	- Agric.Struct.&Irrig.	Agric.Eng.	- Food Engineering	Food Eng.
Food Sci.&Techn**	Agric.Eng.	**Food Engineering**		**Landsc.Architecture**	
		- Food Engineering	Food Eng.	- Landsc.Arch.	L.Arch.
** Until 1990*		**Landsc.Architecture**			
*** Until 1995*		- Landsc.Architecture	L.Arch.		

engineering department and title apart from the 'agricultural engineer' (AE_{TR}) title used by all graduates from agricultural faculties. Proposed titles were usually 'agro-mechanical engineer' or 'agricultural mechanization engineer' but these attempts were not successful. Firstly, none of the agricultural departments had used a title different from 'higher/agricultural engineer' (AE_{TR}) until that time and use of another engineering title offered by machinery departments was considered by other departments to be unusual and even offensive. Secondly, it did not include other engineering areas in agriculture such as structures and environment, soil and water engineering, food engineering, etc. So the proposals were too weak to resist objections. And thirdly, the above-mentioned new engineering programs were proposed outside the engineering colleges. Also, engineers such as mechanical were not yet ready to recognize these new engineering branches born from agricultural or biological areas. There may be other reasons such as global trends to move away from classical agricultural engineering areas [26]. On the other hand, similar discussions have taken place for structures and irrigation. Yildiz [17] pointed out that the term 'agricultural engineering' covers both science and engineering aspects of agriculture in Turkey but using a well-defined term like 'biosystems engineering' could be used by professionals educated in both agricultural machinery and structures & irrigation.

CONCLUSIONS

The aim of this paper is not to criticize the realities that exist in Turkey. The origins of some problems are based on certain historical facts. Currently, engineering education in all areas besides agriculture has been under discussion as the technology advances very quickly. Turkey has been a developing country that is trying to become a part of industrialized, westernized, modern society. Reconstruction of engineering education in agriculture has severe problems and challenges. In order to contribute to the solution, this article is trying to highlight the boundaries between science and engineering education in agriculture.

Conforming with the Bologna Declaration of the European Union an offer of a higher education system consisting of two stages: undergraduate and graduate levels would be suitable. Agriculture is rather diverse so that specialization should start from the undergraduate level. In order to sustain the competitive ability and conform to global trends, a very strong engineering background from the very first year of undergraduate level is needed. Otherwise, international recognition of future Turkish Biosystems Engineers in a competitive environment can never be possible. This can only be achieved with an engineering program offered in engineering schools where there is an agricultural school in the same university campus.

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