

An Overview of the World Agricultural Machinery Manufacturing Sector

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Abstract: The problem that manufacturers of agricultural machinery are trying to overcome today is that they can develop the most appropriate technologies and products for the world's arable agricultural areas in different structures. While Europe and North America respectively account for 4% and 10% of the world's arable land, this rate is 35% for Asia, 24% for Africa, 18% for Latin America and 9% for Australia. Nowadays, rise and diversification of demand for agricultural machinery and equipment depend on such parameters as production patterns, product prices, alternative credit resources, and credit costs. Agricultural needs that are different from each other can only be met by machine-equipment designed and manufactured according to these needs. In this study, analyses of world agriculture sector have been evaluated in terms of agricultural production, income, sectoral structure, rural population, and level of trade and export. By evaluating world agricultural machinery manufacturing industry, technological tendencies, in the sector have been put forward. The most important result of the study is the growth of size in the farms in the developed countries like the USA, Canada, the EU, Australia and in some Latin American countries like Argentina, Brazil, Mexico, and the utilization of high technology is the most important advancement in the sector. In these countries, a great number of sales of the agricultural machinery and equipments are mainly for replacing the old technology equipments. On the other hand, the increase of the average farm size affects the sales of the machines per farm negatively. However, this situation does not negatively affect turnover as more expensive machines will be sold. Farmers demand the use of innovative machines for private use and production, multi-tasking possession and include features that can be used in niche production areas. Minimal energy consuming machines summarize safety, efficiency, comfort and versatility expectations.

Key words: Agricultural machinery, agricultural mechanization, agricultural machinery sector

INTRODUCTION

Tractor and agricultural machinery manufacturing area includes both Agricultural Sector and Industrial Sector, which are very important components of overall economics. For that reason it is under the influence of advantages and disadvantages of each sector, not only during the normal circumstances but especially in crisis periods. The power and sustainability of this intersection industry branch on long term depends on the precise estimation capability of production/demand balance, transformation ability under the pressure of changing conditions and concepts (Ulusoy, İleri, Yazgı, 2013).

"Agricultural Sector" may get into a bind occasionally due to national or international challenging conditions and changes. Global threats, coming to the forefront in the agenda that may be correlated with Nature, Agriculture, Mankind, may be brought together under the titles of (Ulusoy, 2011)

- Greenhouse gases and global warming
- Variation of precipitation
- Competition for scarce fresh water
- Desertification and degradation of soil
- Clear-cut deforestation
- Endangered biodiversity
- Energy demand
- Pollution of the environment
- Unbalanced population growth and
- Economic crises

The current world population of 7.6 billion is expected to reach 8.6 billion in 2030, 9.8 billion in 2050 (Anonymous, 2017a). The population of the World has been increasing as much as that of Turkey each year. Will Agriculture be able to feed the world? "The question is always on the agenda more than ever. It can be seen as "the task of achieving the

impossible," in spite of the pressures on agriculture and the ability to meet the expectations of the population. The world has to increase agricultural production.

Necessities for Sustainable Agricultural Production (Evcim, 2011).

- Globally competitive: Producing high yields of quality crops with lowest costs.
- Antipollutionist: Operating with fewer interventions to the nature and lowest emissions.
- Adaptable to the conditions of climate change: Meeting uncertainties with higher capacities and improved timeliness.
- Energy efficient: Working for positive energy audit.

Sustainable agricultural production is required minimalist and productive approach. The unique answer is modern production technologies based on efficient mechanisation. Because, mechanisation is such a tool that improve other inputs' efficiency besides itself (Evcim, 2011).

In this study, by evaluating world agriculture, new developments on agricultural machinery manufacturing sector with a "mechanization" focused view towards agricultural production in the directions of these evaluations, have been set forth.

MATERIALS AND METHODS

To evaluate on world agricultural sector, data regarding agriculture, Food and Agriculture Organization of the United Nations (FAO), European Commission Agricultural and Rural Development Statistical and Economic Indicators, United Nations Conference on Trade and Development statistics are analysed and compiled in detail.

To evaluate on world agricultural machinery manufacturing sector, Trade Statistics for International Business Development, German Machinery and Facility – Germany Engineering Federation Agricultural Machinery Market Perspectives are utilized.

RESULTS AND DISCUSSION

Agricultural Production

Individual expectations from the agricultural sector vary according to the relationship between consumer needs and demands. People's vital needs and their demands do not always coincide. In the developing countries and authoritarian regimes, while the agriculture sector is being programmed to meet the vital needs, current consumer demands, which may have different dimensions in developed countries and liberal economies, are at the forefront. The change of needs and demands over time; population growth, income growth, new information, social

sensitivity, prestige indicator, and it can even be linked to fashion adaptation (Ulusoy, Yazgi, 2012). However as the main requirement of human being is nutrition, agricultural sector is the leading area, not losing its importance and increasing it more and more (Özoğul, 2012).

In the period between 1980-1989, the annual rate of increase in world agricultural production was 2,54% while it decreased to 2,21% in the period between 2010-2014 (Table 1).

Table 1. Agricultural manufacturing rate of increase (%)

	1980-1989	1990-1999	2000-2009	2010-2014
World	2,54	2,22	2,58	2,21
Developed countries	0,80	0,90	1,80	1,44
Developing countries	3,6	3,52	1,55	1,90
Least developed countries	2,05	2,99	4,33	2,23

Calculated using (Anonymous, 2017b) data

When an evaluation is made in terms of country groups, it is found that in developed countries, agricultural production rate of increase, which was 0,8% annually on average in the period between 1980-1989, increased to 1,44% in the period between 2010-2014. Agricultural production, which decreased from 3,60% to 1,90% in developing countries, increased from 2,05% to 2,23% in underdeveloped countries (Table 1). In general, agricultural product volume of developed countries expanded. Depending on globalization process, world agriculture is shaped according to agreements of developed countries (Özoğul, 2012).

Income per capita as world average is 10171,2 USD as of 2015. The difference between Developing and Developed Countries in terms of income per capita is 8 times (Table 2).

Table 2. Per capita income (USD)

	1990	2000	2010	2015	Variation (%) 1990-2015
World	4322,6	5435,2	9473,0	10171,2	135,3
Developed Countries	19926,7	26396,5	40743,4	40603,5	103,8
Developing Countries	979,8	1490,2	3871,4	5055,5	416,0

Calculated using (Anonymous, 2016a)

The share of agriculture, industry, manufacturing sector, a sub sector of industry sector, in GDP (Gross Domestic Product) per capita are decreasing both in world countries and in developed countries (Table 3).

This data set forth that in the pattern of economic activities there is an important shift towards services worldwide.

Table 3. Sectoral structure

	Years	World	Developed Countries	Developing Countries
Agriculture	1990	5,4	2,8	14,2
	1995	4,3	2,2	11,9
	2000	3,5	1,6	9,9
	2005	3,9	1,6	10,5
	2010	4,1	1,4	9,2
	2014	4,5	1,4	8,9
Industry (Total)	1990	32,8	31,9	35,6
	1995	30,6	29,3	35,2
	2000	28,9	26,6	36,6
	2005	28,3	24,9	37,8
	2010	29,3	24	39
	2014	29,5	23,5	38
Manufacturing (Share of industry)	1990	21,7	21,4	21,7
	1995	20,4	19,8	22,5
	2000	17,2	17,6	15,5
	2005	17,8	15,9	23,5
	2010	16,7	14,5	21,1
	2014	16,5	14,1	20,2
Services	1990	61,9	65,4	50,3
	1995	65,1	68,5	52,9
	2000	67,7	71,8	53,5
	2005	67,8	73,5	51,7
	2010	66,6	74,7	51,8
	2014	66	75	53,1

Source: (Anonymous, 2007a), (Anonymous, 2011), (Anonymous, 2016a)

An interesting important point in the table is that while the sectoral ordering in manufacturing is as services, industry and agriculture, the share of agriculture in manufacturing has decreased to levels, which can be considered as marginal in developed and developing countries. This change definitely arises from higher rate of manufacturing increase, experienced in other sectors, rather than the fact that production in agriculture has decreased.

As engaged population in agriculture decline, the enterprises grow, agricultural income per enterprise and per capita increase and on one hand all of these entail mechanization and on the other hand they form required resources for mechanization investment. Consequently, declining agricultural population, labour power and employment are precursors of developing mechanization (Evcim, 2003).

While population continuously increases, agricultural population decreases in developed countries and increases in developing countries and least developed countries worldwide. When an analysis is carried out with regard to agricultural population, it is found that the percentage of agricultural population in total population tends to decrease regularly. In 1990 57,2%, in 2000 53,4%, in 2010 48,3%, in 2015 45,8% of world population operated in agricultural sector respectively (Table 4).

Although the percentage of agricultural population in the total population is similar within developed, developing and least developed countries, there is a big gap among these country groups. Thus, in 2015, the share of agricultural population in total population in developed countries was only 19,3%, this ratio was 51,3% in developing countries and 67,6% in least developed countries.

The fact, that agricultural population is still very high in Developing and Least developed Countries, causes that labour productivity, consequently income are low. In Developed Countries, a contrary situation is experienced, average income of those, operating in agricultural sector, are above country's average income level (Özoğul, 2012).

Although trade of agricultural products has increased through the global trade increase and participation of new countries to global markets, world's total export as of the end of 2012 has been EUR 12,4 trillion. EUR 995 billion of this export, in other words its 8%, is agricultural products export (Table 5).

Table 4. The ratio of agricultural population in total population (%)

		1990	2000	2010	2015
Population	World	5309668	6126622	6929725	7349472
	Developed Countries	906738	973238	1026978	1046497
	Developing Countries	4088122	4854025	5603433	5998782
	Least Developed Countries	510058	664386	847255	954158
Agricultural Population	World	3035786	3271569	3344911	3367497
	Developed Countries	236659	235524	213611	201974
	Developing Countries	2673632	2926977	3037061	3077375
	Least Developed Countries	401891	501234	596585	644791
The Ratio of Agricultural Population in Total Population (%)	World	57,2	53,4	48,3	45,8
	Developed Countries	26,1	24,2	20,8	19,3
	Developing Countries	65,4	60,3	54,2	51,3
	Least Developed Countries	78,8	75,4	70,4	67,6

Source: Calculated using (Anonymous, 2016a) data

Table 5. Agriculture in world trade (Billion EUR)

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
World Total Exports (*)	4981,7	5188,6	5991,7	6778,1	9856	10597,6	8708,9	11146,9	12622,9	12436,9
Agricultural products	314,3	312,3	337,3	363,4	647,3	735,9	687,7	818,1	952,9	995,3
Other	4667,4	4876,3	5654,4	6414,7	9208,7	9861,7	8021,2	10328,8	11670	11441,5
Share of agriculture	6,3	6	5,6	5,4	6,6	6,9	7,9	7,3	7,5	8

Source: (Anonymous, 2007b), (Anonymous, 2013)

In 2014, important exporters in sector are USA, Netherland, Germany, Brazil, China and shares of these countries in world agricultural sector are 10,3%, 6,3%, 5,7%, 5% and 4,8%, respectively. The share of these five countries in the total exports of agricultural products is 32%. The share of 10 largest exporters of agricultural products reaches 50%, while the share of 20 countries reaches 70%. Turkey ranks 26th among the agricultural exporters with a share of 1% (Table 6).

Table 6. Shares of countries in global agricultural export (2014)

	Country	Agricultural Export	
		Billion \$	(%)
1	U.S.	182	10,3
2	Netherlands	112	6,3
3	Germany	101	5,7
4	Brazil	88	5
5	China	85	4,8
6	France	81	4,6
7	Canada	68	3,9
8	Spain	55	3,1
9	Belgium	50	2,9
10	India	47	2,7
26	Turkey	18	1
	Top 10	870	49,3
	Top 20	1231	69,7
	World	1765	100

Source: (Anonymous, 2016b)

One of the most important reasons why the developed countries in the world agricultural products exports take leading places is that the agricultural mechanization in these countries is carried out in the most advanced level and high-quality processed products are produced. Apart from that, the fact that countries, having limited agricultural field, like Belgium and Netherlands, make high amount of re-export, based on their organizational talents, get these countries to higher places in the ranking (Özoğul, 2012).

World Agricultural Machinery Manufacturing Industry

The world agricultural machinery sector, like in the automotive sector, advances in a high integration and globalization level (Anonymous, 2009). This integration provides aforementioned companies important advantages with regard to price competition and meeting large-scale demands (Özoğul, 2012).

It is observed in Figure 1 that the world's largest farm machinery manufacturers in 2015, based on revenue. Deere Corporation generated some 28.9 billion U.S. dollars in revenue, and was ranked first.

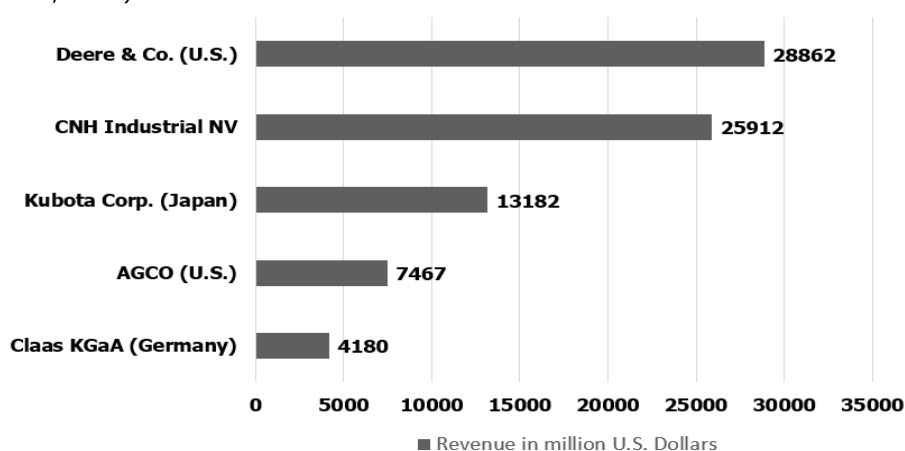


Figure 1. The World's largest farm machinery manufacturers

Source: (Anonymous, 2017c)

Many large companies like John Deere, Case New Holland (CNH Global) and AGCO Corporation are multinational companies, owning joint manufacturing investments and distributions channels, expanded to many countries. Other companies, not having overseas manufacturing, have agencies and distribution channels. Companies like Japanese Kubota Tractor or Swedish De Laval have established facilities and distribution networks in USA and other places worldwide. Parts and components are forwarded worldwide and used in the manufacturing of original equipment (Anonymous, 2012).

Outline classification of agricultural machinery is based on three basic agricultural enterprise sizes, valid worldwide. Large-scale and capital-intensive farming is practiced in USA, Canada and Australia and to some extent, in Mexico, Argentina, Brazil and South Africa. Although Russia, Ukraine and other former Soviet Republics carry out large-scale farming, intensity of agricultural capital and mechanization level in these countries is not as much as aforementioned countries. Medium-scale but advanced farming is practiced in Europe, Latin America and in some parts of Asia. Small-scale farming is practiced in Asia and Africa (Anonymous, 2012).

Agricultural machinery, manufactured in USA and Canada, essentially serves large-scale farming. Mostly, medium-sized machines are manufactured in Europe both by European companies and companies, affiliated to US companies. Via licence agreements or joint ventures, held with USA and European companies, medium-scale agricultural machinery production has increased considerably in Mexico, Brazil and Argentina. Japan is a leader in small-scale equipment market. On the other hand, South Korea, India, Taiwan and China increase their share in small-scale machinery manufacturing (Anonymous, 2012).

Worldwide Agricultural Machinery Exports

When the distribution of trade according to countries is taken into account, it is found that developed countries take leading places in machinery trade as in agricultural products. This situation indicates that in agricultural machinery sector, intra-industry trade is widespread. Main reason for this is that developed countries are able to meet demand in

the sector within themselves as a result of their production of machinery with cutting-edge technology (Özoğul, 2012).

In 2015, China has been the biggest agricultural machinery exporter worldwide. USA, Germany, Japan and Netherlands follow this country (Table 7).

The most important exception among exporter countries is China. Thanks to its cheap labour power, China has begun to come to the forefront in agricultural machinery sector like every field. Thus, it is in a more advantageous position, especially with regard to cost-effective but low-quality machinery production (Özoğul, 2012).

Table 7. World agricultural machinery export by country (Value: Million US \$)

	Country	2013	2014	2015
1	People's Republic of China	2209	2342	2282
2	United States of America	1578	1620	1504
3	Germany	1451	1498	1331
4	Japan	715	690	625
5	Netherlands	672	673	568
6	South Korea	560	573	527
7	France	581	581	506
8	Hong Kong	535	524	499
9	England	548	511	466
10	Italy	518	530	459
11	Canada	457	474	407
12	Belgium	469	473	400
13	Mexican	380	397	381
14	Singapore	410	410	347
15	Russian Federation	527	498	334
16	Swiss	358	311	292
17	Taiwan	305	313	280
18	Spain	311	319	278
19	India	337	318	264
20	Saudi Arabia	378	347	213
31	Turkey	152	158	144
	Grand total	82254	81215	69893

Source: (Anonymous, 2016c)

Worldwide Agricultural Machinery Imports

In the import of world agricultural machinery, developed countries are again among the top countries. The reason of this situation is intra-industry trade, common in the sector.

USA is the country with the highest amount of agricultural machinery import with its 8,5 % in 2015. Germany, France and Canada follow USA (Table 8).

The main factors affecting the market for agricultural machinery according to the VDMA evaluations are as follows according to "VDMA Market Perspectives 2012":

- Agricultural income/purchasing power
- Investment needs
- Overall economic environment
- Interest charges and liquidity
- Taxes and agricultural policy
- Used machinery market
- Shift in alternative investments

Table 8. World agricultural machinery import by country (Value: Million Dollars)

Country	2013	2014	2015
1 United States of America	4181	4324	4067
2 Germany	3169	3118	2584
3 France	3342	3071	2556
4 Canada	2971	2660	2236
5 England	1499	1855	1638
6 Russian Federation	2288	1900	1079
7 Australia	966	1013	1013
8 Belgium	1150	1183	1013
9 People's Republic of China	826	820	885
10 Poland	957	981	852
11 Mexican	694	737	771
12 Netherlands	897	902	722
13 Italy	672	721	645
14 Austria	767	743	638
15 Swedish	660	723	633
16 Spain	570	586	542
17 Czech Republic	563	585	532
18 Denmark	662	640	527
19 Ukraine	761	475	448
20 Japan	338	381	397
30 Turkey	444	322	283
Grand total	40760	40109	34654

Source: (Anonymous, 2016c)

The investment climate plays a central role. Only when farmers are optimistic that they have a solid financial basis, and the outlook is that this will

continue over the coming years, will they invest in machinery. Although the necessity of purchasing machinery is reduced in the core markets, at the same time there is sufficient purchasing power in agriculture to permit continued participation at the forefront of state-of-the-art technology. In the Emerging Markets, the expansive trend towards higher production volumes of agricultural commodities will in medium term continue to play a positive role on demand for agricultural machinery (Anonymous, 2012).

Technological Trends

The major driving powers of technological trends are market, manufacturers and legislation; there are different routes to achieve the main objectives such as sustainability, increased yield, reduced work required and safety (Figure 2).

- **Electronization:** Many of today's innovations in the agricultural machinery sector are based on the ISOBUS standard — a definition of the interface between tractor and implement (Anonymous, 2012).

In combination with a global positioning system (GPS), ISOBUS contributes additional advantages, such as "precision farming" (Anonymous, 2012).

European agricultural machinery manufacturers have disclosed that 70% of all fertilizing and spraying machines they release into the market today are equipped with precision farming technologies and smart or ISO-BUS enabled equipment (Armağan, 2016).

Future scenarios are conceivable in which ISOBUS connects not only operational but also inter-operational preceding and subsequent work procedures with one another (Anonymous, 2012).

- **Further development of machinery:** Today the further development of machinery in addition to the electronization is focusing increasingly on the optimisation and precision of machine components (Anonymous, 2012).

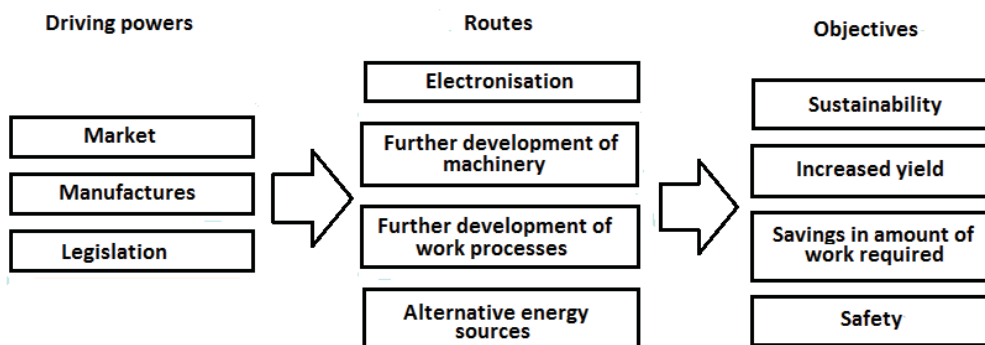


Figure 2. Technology trends-driving powers and objectives

Source: (Anonymous, 2012)

Precision agriculture technology applications:

- ✓Global positioning system (GPS)
- ✓Variable rate technology (VRT)
- ✓Geographic information systems (GIS)
- ✓Remote sensing technology
- ✓Efficiency mapping system
- ✓Automatic steering and controlled field traffic technologies
- ✓Electromagnetic compatibility (EMC) ...

The latest technological developments in sensitive agriculture are carried out by sensing and imaging platforms and agricultural use of especially unmanned aerial vehicles (UAV), close sensing with satellite technology, applications with smart sensors (smart), computer software for tablets or handheld computers, field-type portable computers, wireless data transfer and communication systems, vehicle to vehicle data transmission, autonomous equipment & platforms, robots, intelligent machinery, tractors fitted with ISO-Bus systems and compatible equipment (Türker et al., 2015).

Technologies that are predicted to have the most profound effect on agriculture within the next 10 years: GPS, Biotechnology, Web Based Farming Applications, Precise Climate Satellites, Smart Phones.

- Further development of work processes: In order to design work processes more efficiently and to save resources, entire processes are increasingly being restructured. For instance, increasingly frequently a transition is being made to combine sowing and fertilising into a single operation, in order to save energy and labour (Anonymous, 2012).

- Use of alternative sources of energy: The use of alternative sources of energy is playing an increasingly important role for tractors and agricultural machinery. The electricity in particular seems to be a trend for the future. In many cases the electrification of agricultural equipment would not only be a step toward sustainability, but would also result in more exact and easier control of the machinery (Anonymous, 2012).

CONCLUSIONS

Future of world agricultural markets is extremely dependent on economical developments in Brazil, China and India, also constituting three countries among world's agricultural giants.

Growth in global agricultural market slides to developing countries. As production capacity and infrastructure investment have led production, especially with regard to unprocessed agricultural products, to move to developing countries from

developed countries, it is expected that this tendency accelerate in the next years. Reforms in agricultural policy in developing countries shall lead to change in the nature of support, given to agricultural production, gradually and shall affect amount, quality and place of production (Özoğul, 2012).

Agricultural production can be carried out in some regions very conveniently, while in some regions it is carried out under very difficult conditions and constraints (Ulusoy, Yazgi, 2012).

Manufacturers of agricultural machinery who want to open up to world markets come to dead end "for whom, what technology?" As each market has its own needs and demands, there is a need for funding sources to be able to make purchasing decisions. Generally speaking, it is not possible to overcome this bottleneck without the cooperation of the firms without the contribution of the international support organizations, the incentives of the states in the special sense (Ulusoy, Yazgi, 2012).

Automation, new technologies and products must comply with farmer's requirements, make systems simple to operate and integrate functionality. High-tech must be used on behalf of costumers and preserve investment in the face of changing Technologies (Ulusoy, İleri, Yazgi, 2013).

The growth of size in the farms in the developed countries like the USA, Canada, the EU, Australia and in some Latin American countries like Argentina, Brazil, Mexico, and the utilization of high technology is the most important advancement in the sector. In these countries, a great number of sales of the agricultural machinery and equipments are mainly for replacing the old technology equipments (Anonymous, 2009).

The number of machines sold decreases in line with the growth of farm land and the increase of capacity and size of the machines used in cultivation. However, this situation does not negatively affect turnover as more expensive machines will be sold.

Farmers demand the use of innovative machines for private use and production, multi-tasking possession and include features that can be used in niche production areas (Anonymous, 2008).

Minimal energy consuming machines summarize safety, efficiency, comfort and versatility expectations (Anonymous, 2008).

The future of tractor and agricultural machinery sector shall develop or regress in parallel with the future of agricultural sector. The main target for development must be increase the financial power of farmers (Ulusoy and Gülsoylu, 2001).

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