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Green Biodiesel Production Potential from Oil Seeds in Iran

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ABSTRACT- Due to the concern on the accessibility of recoverable fossil fuel resources and the environmental problems caused by the use those fossil fuels considerable attention has been given to biodiesel production as an alternative to petro-diesel. In Iran, biodiesel can be as an optimal alternative fuel for diesel fuel. The biodiesel production potential from oil seeds such as cottonseed, soybean, rapeseed, corn, sesame, olive, sunflower, safflower, almond, walnut and hazelnut in Iran was investigated. Oil seeds are not commonly used for energy application in Iran. This is because of noticeable resources of oil and natural gas in Iran and also most of the edible oil (almost 90%) is being imported for human consumption. The urpose of this study is to cover several outlooks on the size of the biodiesel oil seeds resource in Iran. In the present study, data was collected from Iran's Ministry of Agriculture in 2014. Around Iran, 826708.6 ha of land from 13 states are anticipated to be suitable land for cultivating of oil seeds. There are about 2.72 million tons of oil seed crops in Iran that can potentially produce 408692.088 million litters of biodiesel every year. Cottonseed, soybean, rapeseed, almond and olive are the most favourable biodiesel production source. In Iran, water is a main problem for growing plants, therefore drought-resistant oil seed crops will be produced such as cotton, rapeseed, soybean and safflower etc. Based on the results, drought-resistant oil seed crops can be grown in Iran and these oils can be used in biodiesel production industry.

Key-words- Bioenergy, Biodiesel, Iran, Oil seed

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INTRODUCTION

Energy divided into two main groups non-renewable and renewable energy. Non-renewable energy is that cannot be readily replaced by natural means on a level equal to its consumption, whereas the renewable energy can be renewed via solar, wind energy, sunlight, geothermal heat, and bioenergy [1]. Renewable energy compare to non-renewable energy is more environmentally friendly, so it becomes a principal part of worldwide energy approach to decrease greenhouse gas emission which is created by fossil fuels [2].

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Today the primary resources of global energy supply are oil, natural gas and coal which provide 32%, 23.7% and 30% of the total energy utilization, relatively. In 2012, consideration to renewable energy sources has increased approximately 19% of energy utilization globally [3]. Iran has the second-largest natural gas and fourth-largest oil reserves in the world. Primary energy demand in Iran is projected to grow an average rate of 2.6%, annually from 2003 to 2030. This assumes that an advanced removal of energy contribution, now equal to about 10% of gross domestic product [4]. For fuels consumption the best scenario is decreasing dependency on fuel fossils and planning to produce and consume biofuels, thus Iran government needs to arrange its biofuel development plan and strong supporting strategies. The use of renewable energy, in particular biofuel will give Iran a better chance to have share of energy from non-fossil energy sources. Based on agricultural materials biofuels has a remarkable ability to improve energy production in Iran [5-8].

Biodiesel is one of the form of renewable energy which can be easily produced from vegetable oils and animal fats. It can be used alone, or blended with petro-diesel in any proportions. Biodiesel blends can also be used as heating oil [9,10]. In the world for distinguishing the amount of biodiesel in any fuel mix using a system known as the "B" factor [7,11]. Content of oxygen is the main differences between diesel and biodiesel. In addition, chemical properties of biodiesels are greatly different [12,13]. The first vegetable oils which used as liquid fuels were peanut oil in 1900 by Rudolf. Neat vegetable oils between 1930s to 1940s were used in diesel engines under an urgent situation [14]. The viscosity of vegetable oil for using as a direct replacement fuel oil in the most diesel engines is considerably high. Moreover, there are many methods to decrease the viscosity of vegetable oil. Four technologies including transesterification, micro-emulsification, dilution, and micro-emulsification have involved to solve the problems faced with the high fuel viscosity [13,15]. Transesterification is the most utilized process for biodiesel production and oil viscosity reduction [16] that will be briefly described in this review. The first record of transesterification of the vegetable oil was managed by Patrick Duffy in 1853 [17].

All over the world, there are about more than 350 oil crops that can be used to produce biodiesel [18,19]. Currently, the prominent feedstocks in the USA, Europe and Southeast Asia are soybean, rapeseed, and palm oil, relatively [20,21]. In Iran the major oil seeds are cottonseed, soybean, rapeseed, corn and almond with high area of plantation and production [5]. This paper present that various states in Iran has a considerable potential for the production of biodiesel due to high consumption of oil seeds.

Biodiesel

The main component of animal fats and vegetable oil are triacylglycerol or triglycerides. Typically, the triglycerides of vegetable oils and animal fats contain different fatty acids [22]. As different fatty acids have different physical and chemical properties, the fatty acid profile is probably the most important parameter influencing the properties of vegetable oil and animal fat [23]. The mixture of petro diesel and biodiesel oils called BX is a commercial fuel comprised of (100-X/B100) % in diesel oil volume and X% in biodiesel volume. It is important to note that blending with petro diesel is not biodiesel [23,24]. Biodiesel in comparison to the petroleum fuels has more advantages: free from aromatic and sulfur compounds, dissolved contents of oxygen (10–12% by weight), high Cetane number (in the US at $\geq$47 while for diesel at $\geq$40), and lower emission of hydrocarbons, carbon monoxide, and carbon dioxide, In addition environmentally beneficial such as: it is not toxic, biodegradable and from renewable sources, less polluting than diesel [10,22,25,26].

There are many technologies such as dilution, transesterification, micro-emulsification, and micro-emulsification for the production of biodiesel, but the most common method to produce biodiesel is used transesterification technology, which takes place between a vegetable oil and an alcohol (methanol or ethanol) in the existence a catalyst (homogeneous or heterogeneous) or without the application of catalyst as in supercritical fluid method (SCM) [27]. For increasing the rate of the transesterification reaction homogeneous catalysts such as basic (sodium hydroxide, potassium hydroxide and sodium methylate), and acidic catalysts (sulfuric acid) are essential [15,16]. Although, the type of homogenous utilized depends on the free fatty acids (FFA) component of the raw oil [28]. Heterogeneous catalysts, for instance carbonates or metal oxides [29], sulphonated amorphous carbon [30], heteropolyacid solid [31] and biocatalysts (particularly lipases) are usually used as well. Biodiesel production cycle from renewable bio-oils *via* catalytic transesterification and esterification shown in Fig. 1 [22,32].

Potential of biodiesel production from oil seeds in Iran

A rapid expansion in biodiesel production capacity is being noticed not only in the US or EU countries, but also in developing country like Argentina, Indonesia, Malaysia, and Brazil [33]. Fig. 2 shows the world's biggest biodiesel producers in the world. The major oils for the production of biodiesel are coconut (copra), corn (maize), palm oil, cottonseed, canola (a variety of rapeseed), olive, peanut, safflower, sesame, soybean, sunflower [34] and non-edible oils (algae, jatropha or ratanjyote) in the world [23,35]. At present, these feedstocks are frequently transformed to biodiesel. Soybean is the major feedstock for biodiesel production in the US and Argentina and largely produced in these countries [36]. In Brazil, approximately 77% of the total feedstock utilized for biodiesel is provided by soybeans [37]. In the EU, biodiesel is the prominent transport biofuel and 65.9% of oleo-chemical material (15.3 million tons (Mt), in 2012) involved to produce biodiesel is supported by rapeseed oil [38]. Non-edible sources, for example jatropha and microalgae can productively be used to produce biodiesel, but jatropha is rain-dependent and needs a high amount of water for optimal growth, which is not compatible with the arid semi-arid climate of Iran [39].

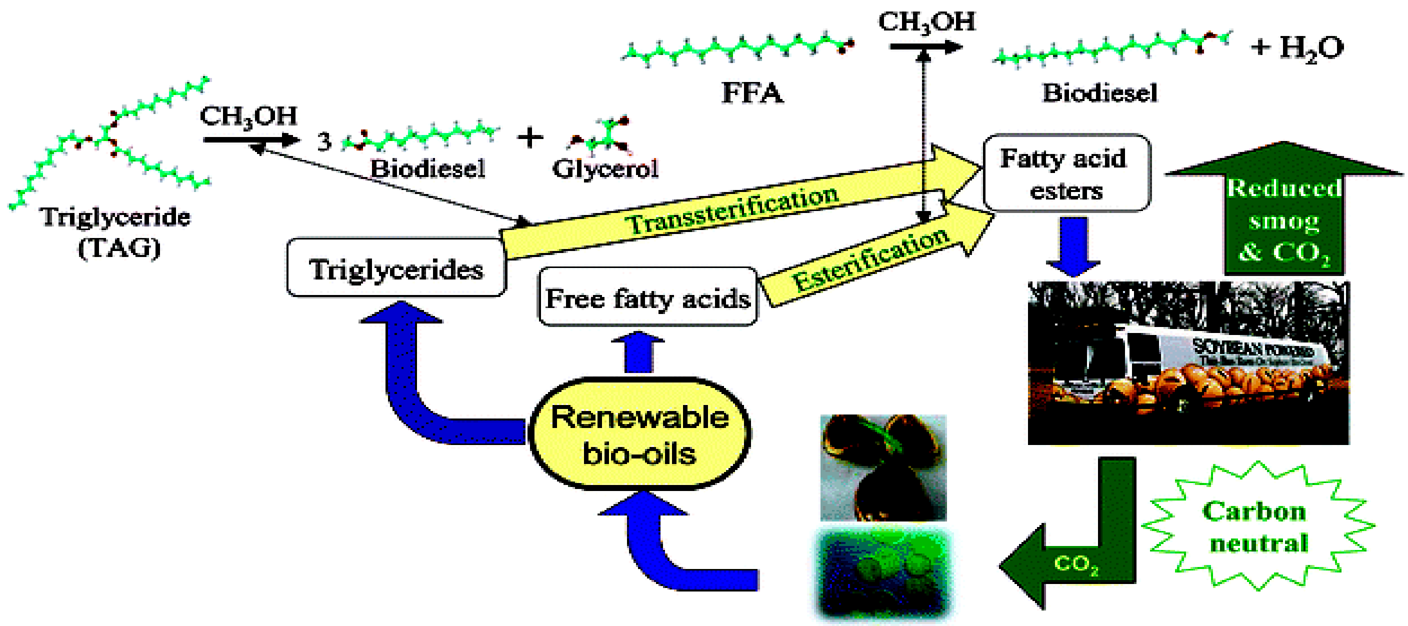


Fig. 1: Biodiesel production cycle from renewable bio-oils *via* catalytic trans-esterification and esterification [32]

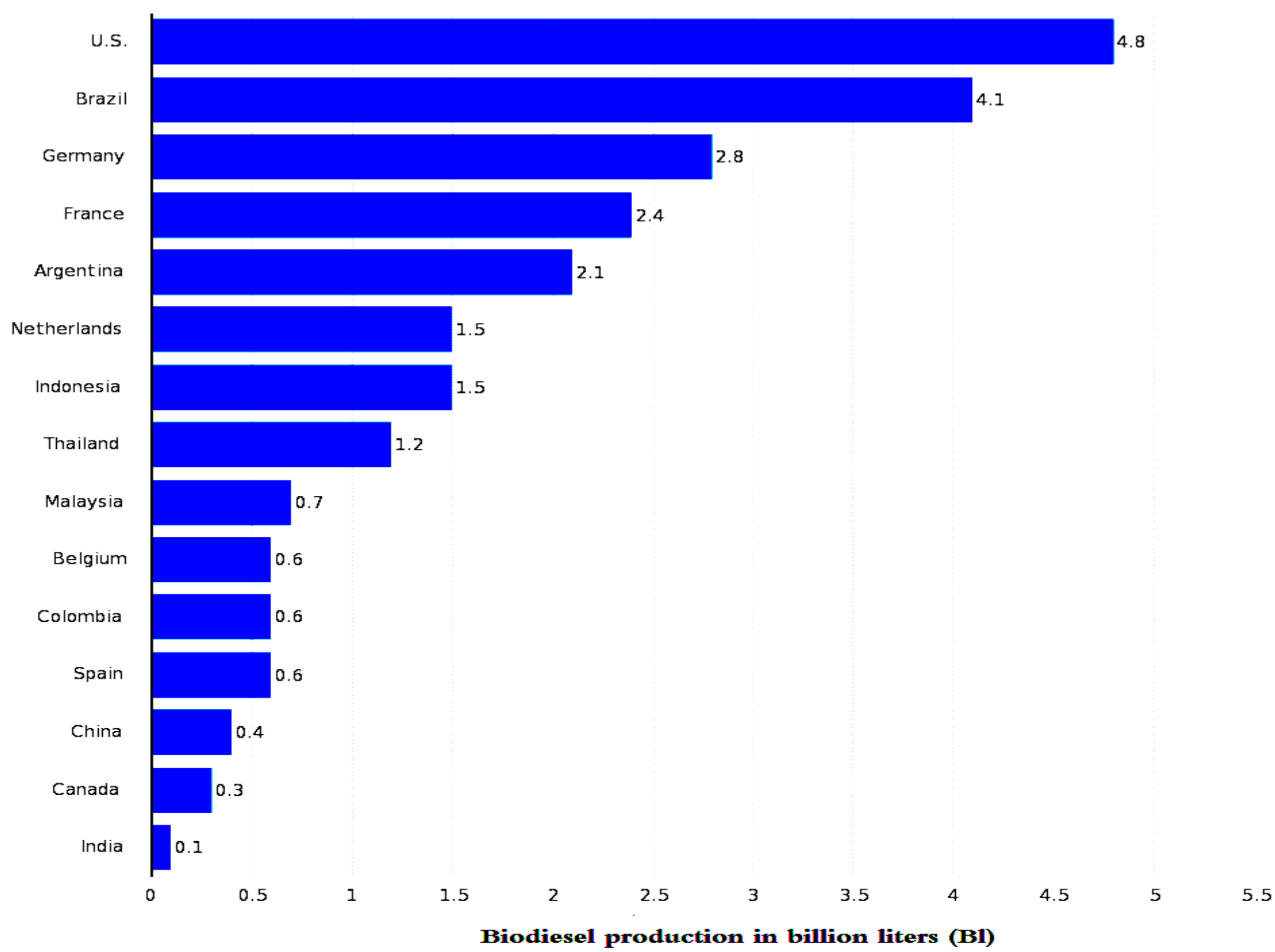


Fig. 2: The world's biggest biodiesel producers in 2015, by country, in billion liters [40]

Safieddin Ardebili et al. [5] has reported that approximately 1 million ha of land from 20 states were produced oil seeds in Iran, additionally about 3.67 Mt of oil seeds crops can produce 721 million liter (Ml) of biodiesel every year. Moreover, it has investigated by Karimi Alavijeh and Yaghmaei [6] that only 35% of total oilseeds can produce 350 Ml of biodiesel in Iran. The primary oilseeds are cotton, rapeseed and soybean and include 1.8%, 1.6%, and 14% of the total industrial products in Iran. In Asia, Iran ranks tenth with a share of about 0.4% of total cottonseed production and ninth with 0.7% of total soybean production. Thirteen countries in Asia cultivate rapeseed and Iran ranks third place with about 1.5% of total production. The high carbohydrate component (~60%) of rapeseed straw makes it a sustainable and potential biomass for biodiesel production [40]. Sesame seeds, olives, corn, sunflowers, safflowers, almonds, walnuts, and hazelnuts are other important oil-rich crops cultivate, these crops are cultivated in most of the states in Iran. The major oilseeds production is Khorasan, Fars, Golestan, Ardabil, and Khuzestan provinces [41].

In this study, 2014 data were used to estimating biodiesel production of Iran. Almost 826708.6 ha of land from 13 states were produced oil seeds (Fig. 3). These states largely divided in the north, north-east, east, and the center of Iran, which the percentage of rainfall in most of these countries is less than 250 millimeter (mm) every year. Fig. 4 illustrates the potential of three major oilseeds (cottonseed, rapeseed, and soybean) in Iran from 2004 to 2014. As seen in figure 4 production of cottonseed and soybean were decreased during these period, only in 2007 rapeseed had a considerable growth in production. It is because of low rainfall during this period. Fig. 5–8 demonstrate cottonseed, soybean, rapeseed, and corn the major cultivation area and production for these oil seeds in different provinces, respectively. It is obvious from Fig. 9 that corn, cotton; soybean, rapeseed and almond have more potential for biodiesel production. Table 1 depicts that total cultivation area and oilseed production in Iran were 826708.6 ha and 2,723,388 ton, relatively, and total potential biodiesel production can be 408692.088 ton/year. The data were collected from Iran's Ministry of Agriculture and analyzed [41].

Fig. 3: The recognized provinces for cultivation of oil seeds in Iran [41]

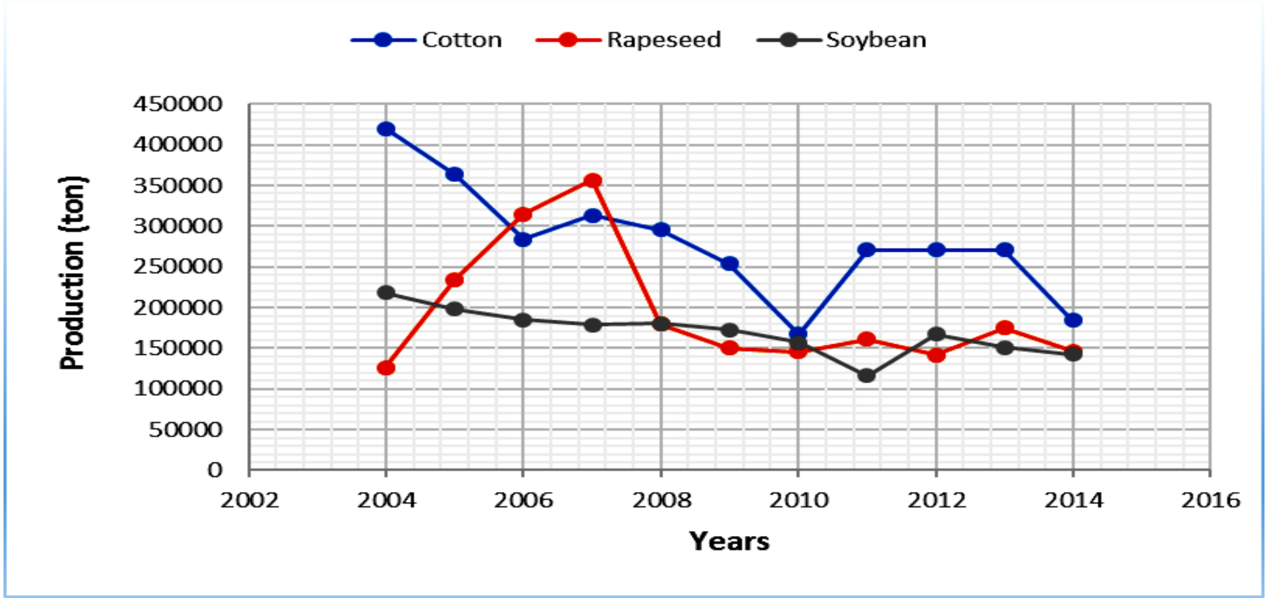
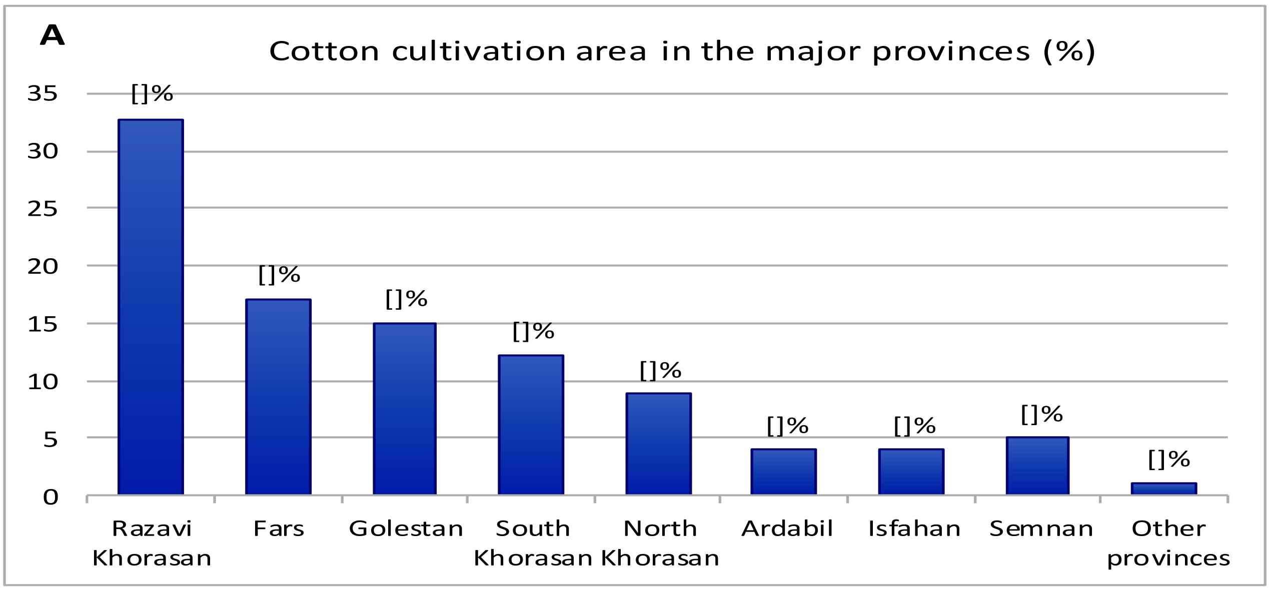


Fig. 4: Production of major oilseed crops in Iran, from 2004 to 2014 [41]



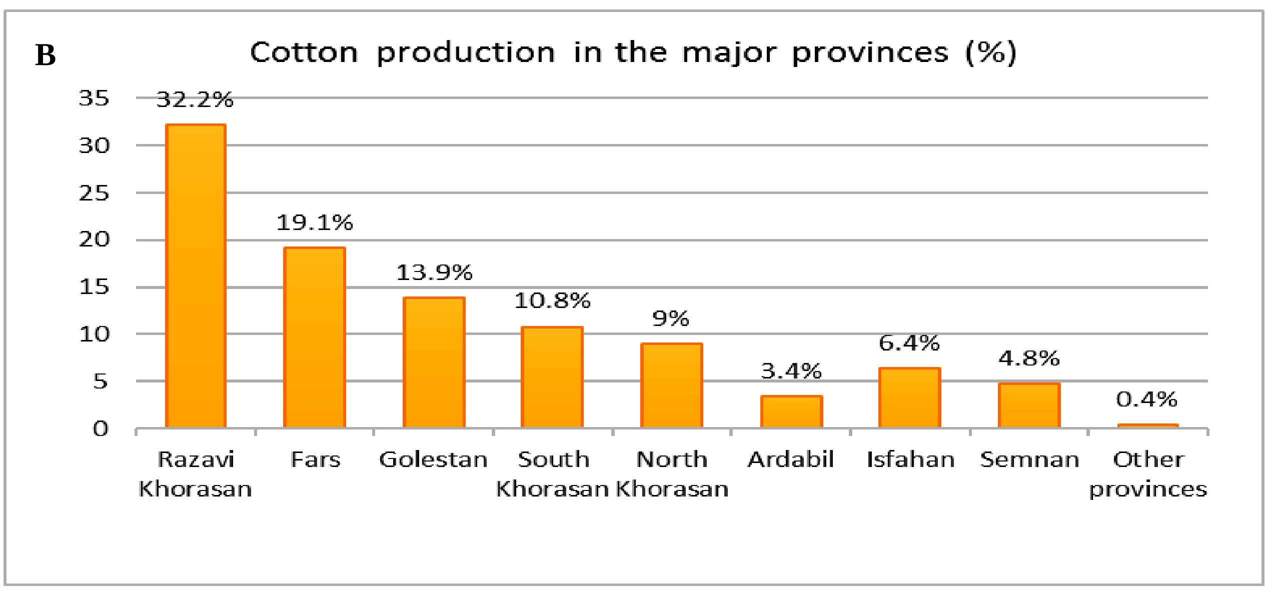


Fig. 5: Cotton (A) cultivation area and (B) production in Iran, major provinces [41]

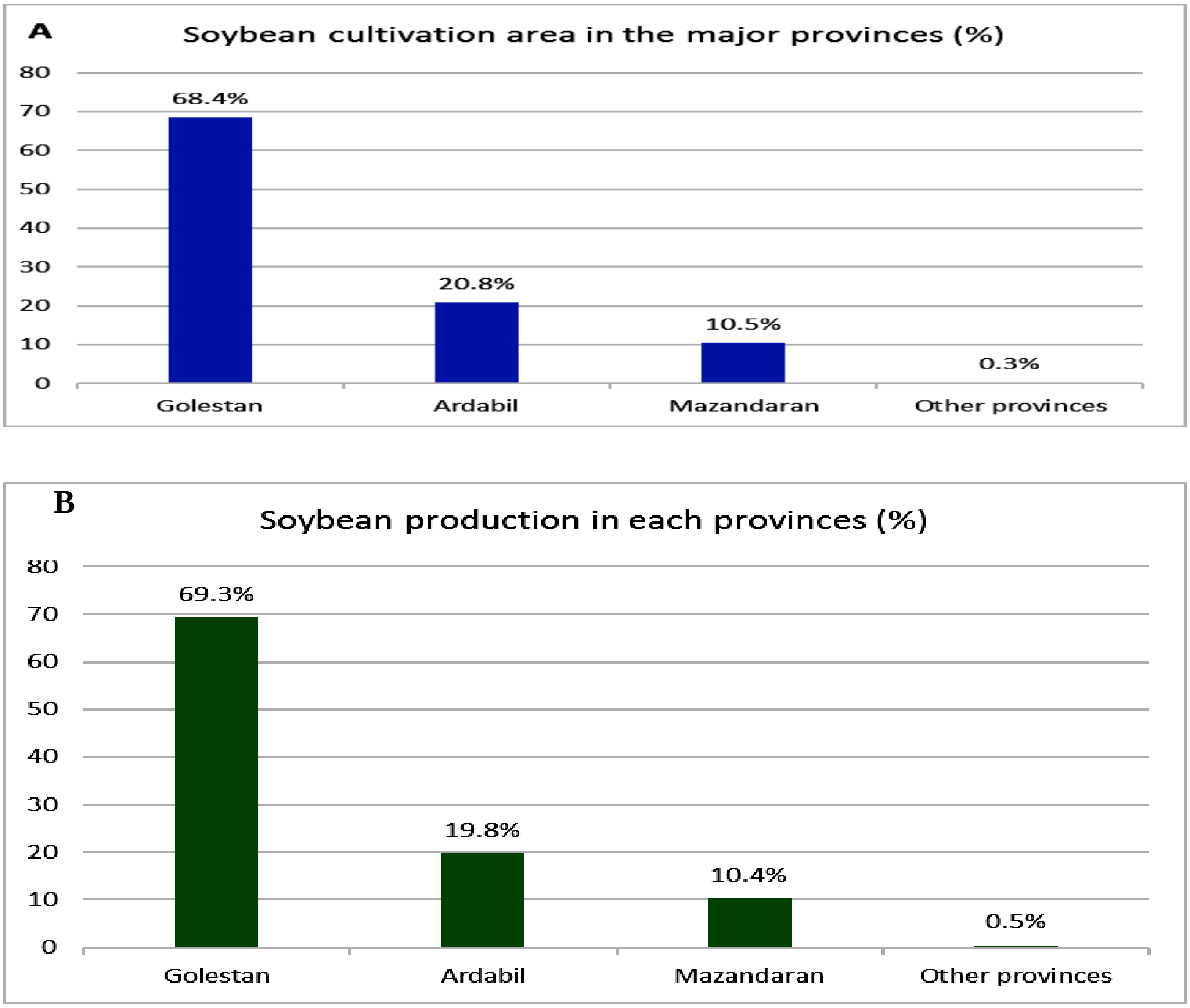
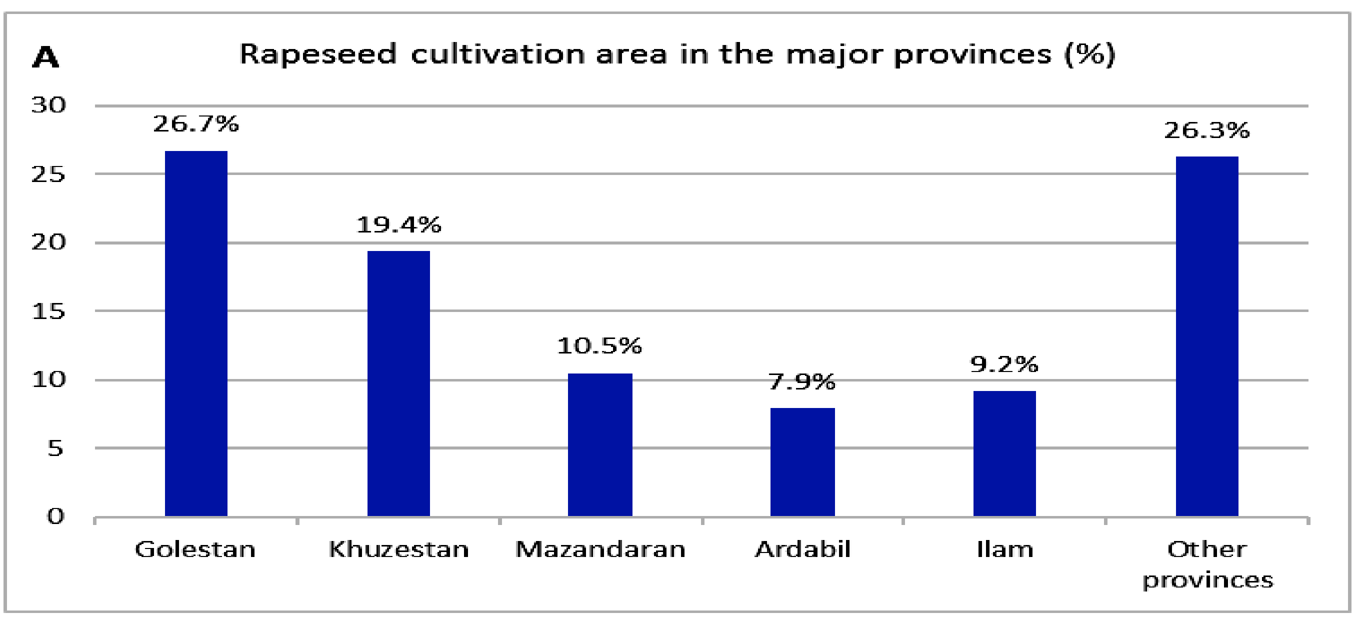


Fig. 6: Soybean (A) cultivation area and (B) production in Iran, major provinces [41]



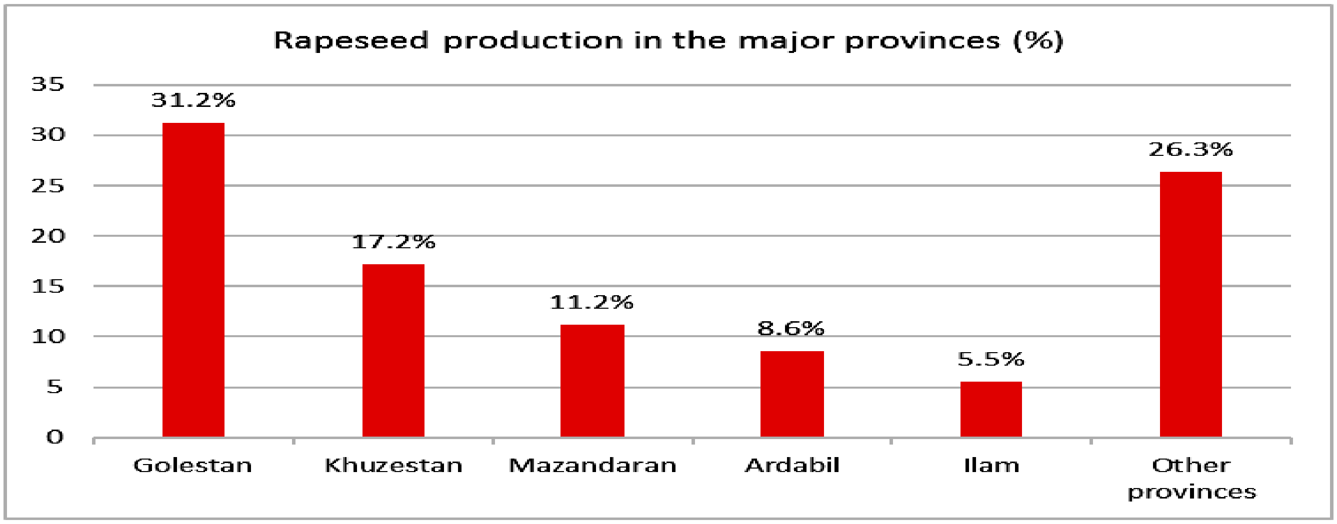
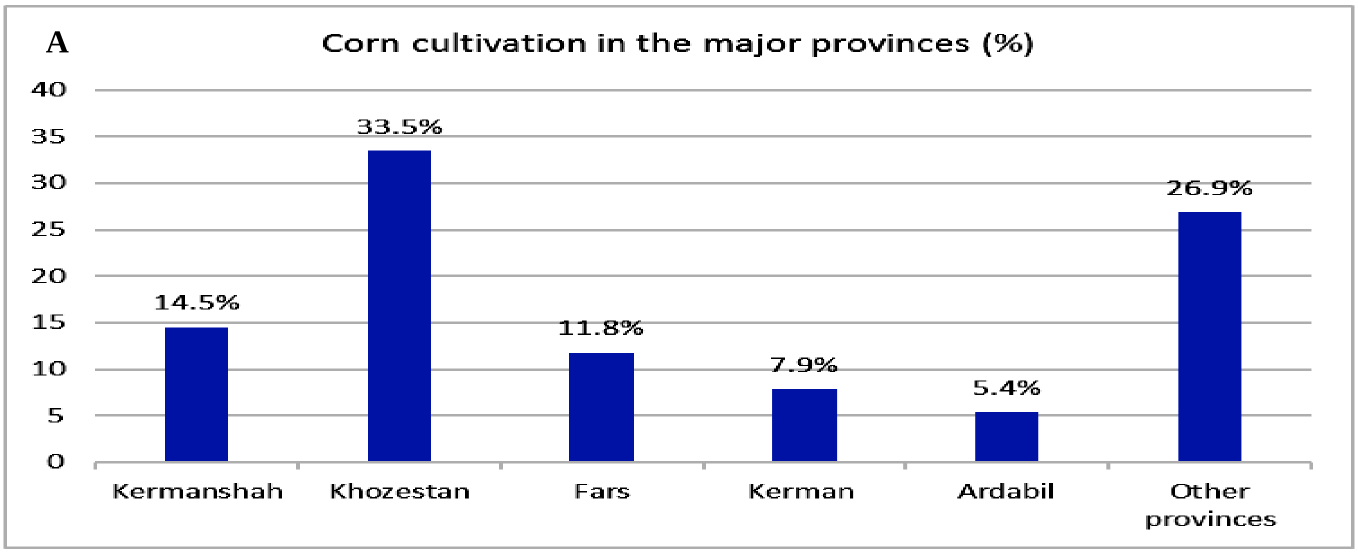


Fig. 7: Rapeseed (A) cultivation area and (B) production in Iran, major provinces [41]



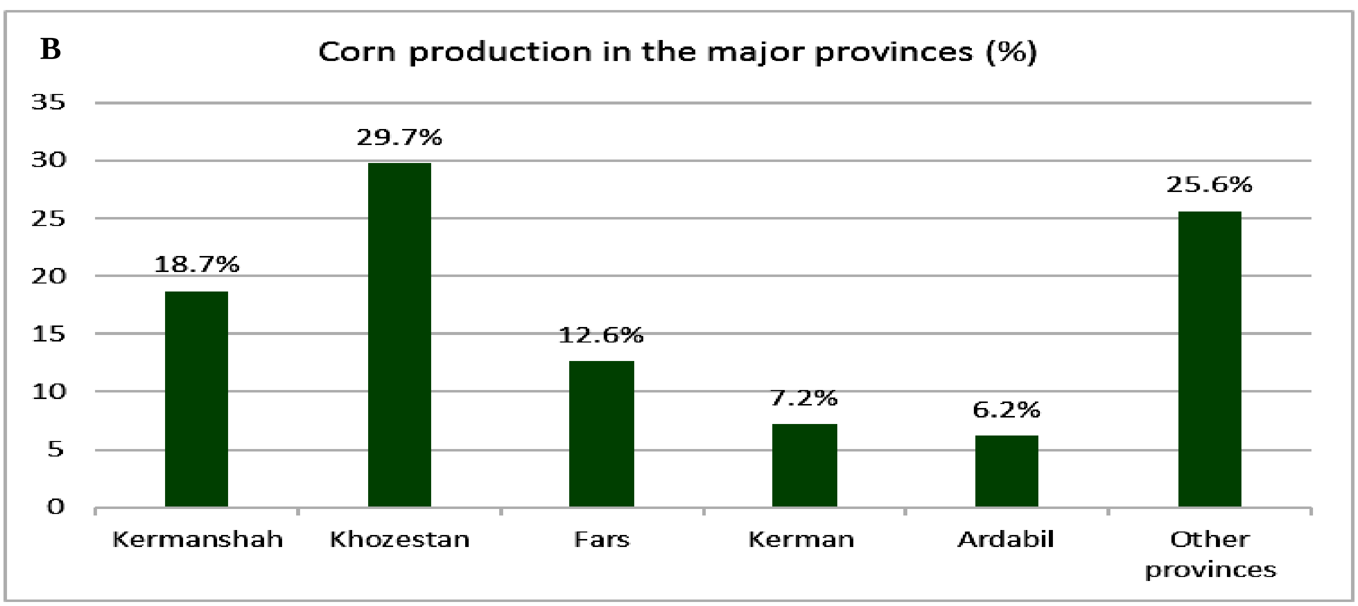


Fig. 8: Corn (A) cultivation area and (B) production in Iran, major provinces [41]

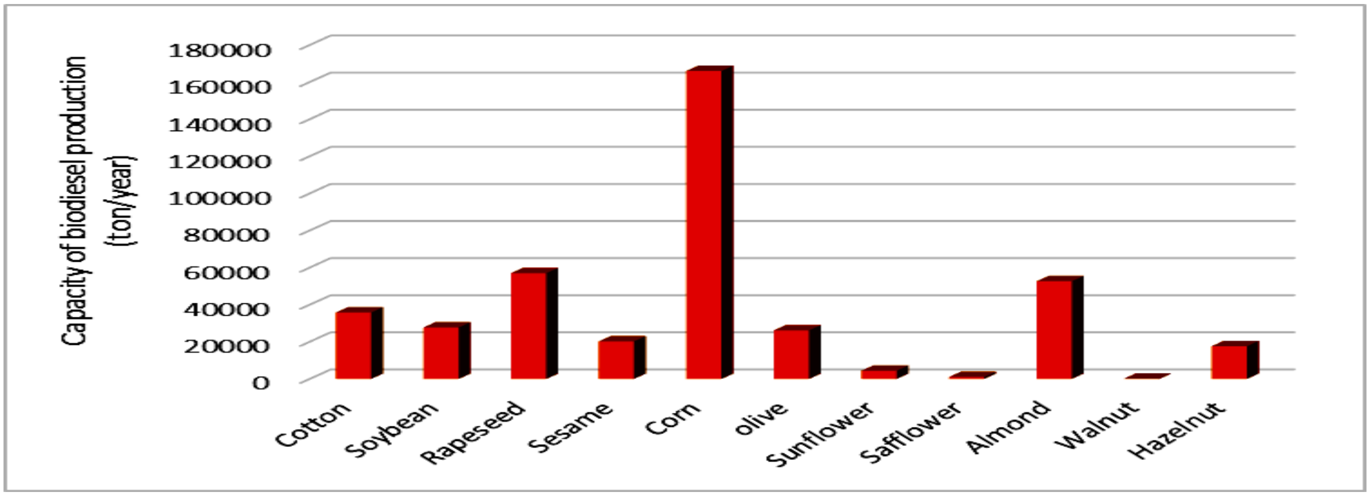


Fig. 9: Major oilseeds for production of biodiesel in Iran in 2014 [41]

Table 1: Biodiesel production potential from major edible oil seeds in Iran in 2014 [41]

No.	Oil seeds	Total area (ha)	Production (ton)	Oil content (%)	Yield (biodiesel ton/year)
1	Cotton	84800	184000	20	35799.825
2	Soybean	78700	142500	20	27703.389
3	Rapeseed	81780	146000	40	56963.446
4	Sesame	42948	40443	50	20221.5
5	Corn	234000	1660000	10	166003.54
6	olive	180545.5	130657.76	20	26132.127
7	Sunflower	8246	8776	50	4387.79
8	Safflower	2257	3214	32	1028.31
9	Almond	80543.6	95732	55	52652.502
10	Walnut	17453.7	280000	60	167.999
11	Hazelnut	15434.8	32065.7	55	17631.66
Total		826708.6	2723388.46	–	408692.088

CONCLUSIONS

Biodiesel, which is produced from oilseeds is an excellent substitute for diesel. In Iran biodiesel will form a small but very important part of energy supply. In detail, there is a noticeable potential for using oilseeds as a green diesel in Iran. Cottonseed, rapeseed, and soybean are the most desirable biodiesel production sources in Iran. Low rainfall in recent years is one of the main problems for growing of plants in Iran, so that drought-resistant oil seed crops will be produced such as cottonseed, rapeseed, soybean and safflower etc. There is no doubt, that in the future, oil and natural gas supplies will be depleted, and then Iran's government should decrease its dependency on importing oil and natural gas. There are suggesting to outline further researches on other economic issues related to biofuels in particular biodiesel. For performing this goal Iran's government must strongly support these types of projects by financial aids, free tax, and encouraging farmers to cultivate oilseeds in dry areas.

AUTHORS CONTRIBUTION

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