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Intention of agricultural professionals toward biofuels in Iran: Implications for energy security, society, and policy

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ABSTRACT

This research applies the Health Beliefs Model (HBM) as a framework for understanding the intentions of agricultural professionals with respect to biofuels. We argue that it is essential to understand these intensions as agricultural professionals play critical role as educators, gatekeepers, and stakeholders in the agricultural domain. A face-to-face survey was undertaken in South Western Iran using a multi-stage, stratified random sample of agriculture professionals (n=288). The reliability and validity of the instruments were examined and approved. Structural equation modeling showed that general beliefs regarding fuels and biofuels, perceived benefits, perceived severity, self-efficacy, and cue to action are significant predictors of professionals' willingness to support biofuels. These variables can predict nearly 43% variance in professionals' willingness. The findings yield public policy implications for biofuel use and development support among professionals and provide preliminary support for the HBM as an effective framework for examining intention toward biofuels among agriculture professionals in Iran.

1. Introduction

Scientific evidence confirms that heavy use of fossil fuels such as oil, coal and natural gas leads to emissions of greenhouse gases, destruction of natural resources, concerns about energy security and the threat of conflict [1,11,15,17,30,32,34,42,47,50,58,62]. On the other hand, renewable energy sources, in general, and biofuels, in particular can satisfy energy demand with low carbon energy, which would address concerns of climate and energy security as well as other above mentioned risks. Biofuels sources, such as sugarcane, oleaginous plants, forest biomass, and other sources of organic matter, have emerged as promising agricultural products that can either be sequestered or blended with conventional fuels.

The word "biofuels" refers to any energy source from renewable organic matter, including wood and other forest products, plants, human and animal waste, and agricultural crops [11]. Some examples of biofuels are biodiesel, ethanol, methanol, methane, and charcoal [17].

Biofuels basically are divided into three main categories: forestry biomass, agricultural biomass and waste biomass [22]. However, there is still a debate among scholars regarding the advantages and disadvantages of biofuels. According to researchers, biofuels have a range of different environmental, economic, social, and even political benefits, but of primary importance is their contribution to economic growth and development, particularly in rural areas. Researchers suggest that biofuel production is an important path toward poverty reduction, food security, and meeting rural development goals [1,30,46,61]. Biofuel production can also support local agriculture [30]. Kleinschmit [31] has argued that biofuels may also offer the promise of new investment, job opportunities, economic growth, and revitalization of rural areas. For example, Kleinschmit [31] revealed that a small, local biofuel refinery was providing: i) a one-time boost of about $142 million to the local economy; ii) creation of about 40 full-time jobs; and iii) an increase in annual direct spending in the community of around $56 million. Moreover, putting such a facility under local ownership ensured that it would be based to some extent on local resources and needs and that much of the money generated would remain in the local economy. Arndt et al. [5] also found that biofuel investments increased economic growth by half a percentage point each year over a decade and could lift 5% of the population above the national poverty line. Biofuel production as a means to promote development in developing countries was justified [6]. Many (particularly low-income) countries see biofuels as a potential boost for development. Moreover, Goldemberg [29] has argued that generally,

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biofuels cause less pollution, both in terms of local air pollution (such as particulates, sulfur, and lead) and greenhouse gas emissions (carbon dioxide and methane), which lead to global warming. Biofuels directly reduce negative externalities related to vehicle miles traveled [29]. In other words, biofuels are "climate-neutral" [42]. Furthermore, they can serve as a direct and immediate replacement for the liquid fuels used in transport and can easily be integrated into the logistical systems that are operating today [17]. They have the added benefit of enhancing soil and water quality [15]. Finally, they can increase energy independence locally and internationally.

Although there is a growing body of literature on the advantages of biofuels, it must also be acknowledged here that biofuels have attracted much criticism. Critics have argued that biofuel production and end use may have harmful repercussions for the environment, sustainability, and society in general. Opponents believe that using major feed stocks such as corn, wheat, barley, sugarcane, rapeseed, soybean, and sunflowers for biofuel production causes a significant increase in the price of feedstock and thus of food. Ajanovic [1] has argued that the use of farmland to grow grains, which could be consumed by humans but are used instead for biofuel production, is already having repercussions in some parts of the world and that even if all available crops, forests, and grasses were used for biofuels, independence from fossil fuels could not be achieved. Furthermore, the supply potential of biofuels is highly dependent on land availability and demand, given that the amount of land in the world available for agriculture is finite [17,18]. Using huge amounts of land for the cultivation of biofuel feedstock may not reduce greenhouse gas emissions once the effects of land clearance and fertilizer use are taken into account [36].

Researchers also argue that biofuel production has different kinds of environmental impacts, for instance, on soil, water, diversity, wildlife habitat, and the landscape [1,31,33]. Donner and Kucharik [16] revealed that meeting the 2022 US ethanol targets will increase nitrogen loading by 10–34% from farmland into the Gulf of Mexico. In Malaysia, development of palm oil plantations is occurring at the expense of natural habitats [13]. It thus seems that what is good for the climate may not be good for other ecosystems [33]. Some researchers go even further, suggesting that certain biofuel production pathways may cause more greenhouse gas emissions [32]. For example, Groom et al. [30] have argued that last but not least cost continues to be fundamental barrier to the widespread adoption of traditional biomass for fuel, despite its attractiveness from a sustainability perspective [29].

In the light of the benefits mentioned, many countries have set goals to replace some fossil fuels by biofuels, and the production of biofuels is rising [1,15,38,46,47]. For example, in the European Union 10% of the energy used for transportation should come from biofuels by the year 2020. Indonesia recently announced plans to invest US$1.1 billion to develop 8–11 additional palm oil-based biodiesel planted by 2010 [4]. The governments of Australia, China, Japan, Korea, Philippines, Singapore, and Thailand are also actively pursuing energy policies aimed at increasing the production or use of biodiesel [32]. In the year 2007 Brazil and USA had the highest share of biofuels in total transport, 20% and 3%, respectively [1].

The production of biofuel to a great extent depends on farmers providing the feedstock supply. Policymakers should thus explore opportunities to engage farmers in the production of biofuels. To develop strategies and guidelines to encourage more farmers to grow energy crops, there must be assistance for all farmers at every level in the form of outreach and technical support to ensure access to the information and training needed to inform investment [31,62]. However, lack of knowledge is a major barrier. Paulrud and Laitila [38] found that farmers do not have the sufficient level of knowledge to grow energy crops successfully. They confirmed that farmers' attitudes are more important than the promise of economic benefits in terms of decisions regarding future energy crop production. Qu et al. [41] argued that lack of knowledge regarding energy crop production is one of the biggest constraints to the development of biofuels. This lack of knowledge about bioenergy is a common phenomenon among the public and particularly among farmers worldwide ([11], Gossling et al., 2007).

A stream of literature shows that education plays a significant role in the adoption of innovation [11,19,21,22,35,41]. Providing educational programs and disseminating knowledge about renewable energy for different stakeholder can enhance adoption. The more knowledge people have about a subject, the more likely they are act in accordance with it (Roberts, 1996). For example, Mayfield et al. [35] revealed that the lack of knowledge and information about biofuels has left farmers with only a vague understanding of the forest biomass industry. They suggest that, to resolve this issue, effective educational programs about biofuels need to be prepared to meet different stakeholders' needs. Furthermore, it is clear that education is one of the keystones of sustainable development; for example, not only can it change people's opinions and habits regarding the environment, but it can also influence decision makers, which is vital for the successful introduction of new technologies (Agenda 21, cited in [41]).

Halder et al. [21] have argued that the delivery of quality education and training is a prerequisite for those involved in activities linked to biofuel production. Agricultural professionals are increasingly important stakeholders in supporting and guiding farmers with respect to growing energy crops [41], and they have a pivotal role in knowledge dissemination about innovations in this area via agricultural extension activities (Wheeler 2008; [7]). Stakeholders, such as land-owners, need advice from professionals when they make practical decisions in many areas of management [23]. Information for farmers, which is given by agricultural professionals, combines practical experiences with scientific knowledge [40]. The importance of professionals as educators must thus be increasingly highlighted. Furthermore, a fundamental requirement for successful policy implementation is public understanding and social acceptance. In other words, if there is high social acceptance of biofuel energy, its implementation will be easier [11,21,41]. To achieve this, public attitudes toward bioenergy must be studied, with the focus on different targets groups such as consumers, non-governmental organizations, central and local governments, producers, and academic experts. Agricultural professionals are important stakeholders in the social acceptance process ([58]c). They can act as gatekeepers, impacting decisions to adopt biofuel crops and influencing the diffusion of innovations (Tornatzky and Fleisher 1990). In the diffusion-related literature, gatekeepers are known as "innovators, inter-mediators, helpers, adapters, opinion leaders, brokers, or facilitators" (Metoyer-Duran 1993) who can frequently influence others' attitudes or behavior (Rogers and Kincaid 1981). As gatekeepers in the domain of bioenergy, they have the potential to engage farmers in the production of biofuels. Thus, agricultural professionals' intentions regarding biofuel production need to be well understood. As such, the goal of this study is to investigating agricultural professional 'intention toward the use of biofuels. Due Iran has good potential for utilization of biofuels. Agriculture and forestry waste and livestock waste are the main sources of biofuels in Iran [49]. It is important to note that Iran is an energy superpower, which has the fourth largest oil reserves and the second largest natural gas reserves in the world [25]. However, Iran also faces high level of domestic consumption of natural gas. Furthermore, per capita energy consumption in Iran is fifteen times higher than in Japan and ten times higher than in the European Union. Energy intensity of Iran is three times higher than global average and two and a half times higher than the Middle-East average. The country is also the second largest gasoline consumer in the world following the United States [26]. Moreover, International Energy Agency (IEA) has anticipated that natural gas and crude oil will be run out in the next 60.3 and 41.8 years respectively. Therefore, RES have potentials to become the most important energy source in Iran in the future [25]. As such, the government of Iran is recognizing the potentials of RES and announced the plan to deploy 2 GW of RES capacity between the years 2010 – 2015 [58].