



## UNDERSTANDING DAIRY SMALLHOLDERS' INTENTION TO PARTICIPATE IN THE CONTROL AND ERADICATION OF BOVINE BRUCELLOSIS †

[ESTUDIO DE LAS INTENSIONES DE PRODUCTORES DE LECHE EN PEQUEÑA ESCALA PARA PARTICIPAR EN EL CONTROL Y ERRADICACIÓN DE BRUCELOSIS BOVINA]

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### SUMMARY

**Background:** Brucellosis (*Brucella abortus*) is a disease that affects cattle and has a significant economic impact on the livelihood of farmers in developing countries. **Objective:** The research aimed to understand the dairy smallholders' intention to participate in the national campaign to control and eradicate bovine brucellosis in Aculco, State of Mexico. **Methodology:** The study was conducted with 196 farmers who were already engaged in the campaign. The reasoned action approach (RAA) was used as a theoretical framework, and Spearman rank-order correlations were used to analyze the data. **Results:** The results showed that farmers firmly intended to participate in the campaign in the next 12 months. The intention was associated with farmers' years of experience as milk producers and perception of the importance and usefulness of the campaign in addition to farm characteristics. Farmers' intention was also related to positive beliefs (drivers), such as participation in the campaign, preventing the disease in the herd, enabling access to government support and subsidies, and avoiding spreading the disease to people. Other social referents such as veterinarians, farmers, and farmers' sons also played an important role in farmers' intentions. A couple of significant constraints were identified: the lack of financial resources, communication between farmers and personnel in charge of the campaign. **Implications:** The study provided insights to improve extension activities towards small-scale dairy farmers to participate in the national campaign of control and eradication of bovine brucellosis. **Conclusion:** the three components of the RAA (attitude, perceived norms, and perceived behavioral control) were strong predictors of farmers' intention to participate in the brucellosis eradication campaign. They enabled the factors influencing farmers' intentions to be explored more deeply.

**Key words:** Reasoned action approach; small-scale dairy farmers; intention; bovine brucellosis.

### RESUMEN

**Antecedentes:** La brucelosis (*Brucella abortus*) es una enfermedad que afecta al ganado y tiene un impacto económico significativo en los modos de vida de los productores de leche de países en desarrollo. **Objetivo:** La investigación tuvo como objetivo conocer la intención de los productores de leche en pequeña escala para participar en la campaña nacional para el control y erradicación de la brucelosis bovina en Aculco, Estado de

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México. **Metodología:** El estudio se realizó con 196 productores que participaban en la campaña. Se utilizó el enfoque de acción razonada (RAA, por sus siglas en inglés) como marco teórico. Para analizar los datos se utilizaron correlaciones de Spearman. **Resultados:** Los resultados mostraron que los productores tenían una firme intención de participar en la campaña en los próximos 12 meses. La intención estuvo asociada a los años de experiencia como productores de leche y a la percepción de la importancia y utilidad de la campaña, además de las características de la unidad de producción. La intención de los productores de leche también mostró relación con creencias positivas (conductores), como la participación en la campaña, la prevención de la enfermedad en el hato, permitir el acceso a apoyos y subsidios gubernamentales, así como evitar la propagación de la enfermedad a las personas. Otros referentes sociales como los veterinarios, productores de leche vecinos y los hijos de los productores, también jugaron un papel importante en las intenciones de los productores de leche participantes. Se identificaron un par de limitaciones importantes: la falta de recursos financieros, la comunicación entre los productores de leche y el personal a cargo de la campaña. **Implicaciones:** El estudio proporciona información que permite mejorar los servicios de extensión, hacia los productores de leche para participar en la campaña nacional de control y erradicación de brucelosis bovina. **Conclusión:** Los tres componentes del RAA (actitud, normas percibidas y control conductual percibido) fueron fuertes predictores de la intención de los productores para participar en la campaña de control y erradicación de la brucelosis y permitieron explorar con mayor profundidad los factores que influyen en las intenciones de los productores. **Palabras clave:** Enfoque de acción razonada; pequeños productores lecheros; intención; brucelosis bovina.

## INTRODUCTION

Brucellosis in cattle (*Brucella abortus*) is a contagious disease with a significant economic impact on the livelihood of farmers in developing countries (OIE, 2020). It is the most widespread zoonosis worldwide, representing a significant public health problem (Arif *et al.*, 2017). Every year, 500,000 new cases of human brucellosis are reported worldwide (Méndez-Lozano *et al.*, 2015). The first cases of brucellosis in Mexico were identified in 1923 (Hernández-Santiago, 2002). However, it was not until 1995 that the Mexican government established a national campaign to control and eradicate brucellosis in cattle (NOM-041-ZOO-1995). However, in the last four years, vaccinated dairy cattle decreased from 507,729 in 2017 to 361,294 in 2019 (SENASICA, 2020).

Mexico in 2006 was ranked twenty-first in the number of cases worldwide and second in the American continent. It was reported an incidence of 1.74 cases per 100,000 inhabitants, and in 2011 the incidence rose to 2.97 cases (Méndez-Lozano *et al.*, 2015). Despite government efforts to control the disease, the high incidence of bovine brucellosis, increased 15% the incidence of human brucellosis between 2000 and 2011 (Méndez-Lozano *et al.*, 2015). however, since 2012 the brucellosis incidence in Mexico was decreasing, until reaching 0.24 cases per 100,000 inhabitants in 2022 (Panorama epidemiológico de brucellosis, 2022); however, in 2023 the number of cases reported were 1381, which represents an incidence of 1.1 cases per 100,000 inhabitants (Secretaría de Salud, 2023). On the other hand, the State of Mexico is considered as an eradication zone of the

disease; however, no cases of brucellosis in bovine were reported in 2023 (SENASICA, 2023); whereas, eleven cases of brucellosis in humans (three men and eight women) were reported in the same year, this data represent an incidence of 0.06 per 100,000 inhabitants (Secretaría de Salud, 2023). The risk of the spread of brucellosis to humans is high in rural areas where access to cattle vaccination is scarce and fresh cheese made from raw milk is widely consumed (Oseguera-Montiel *et al.*, 2013).

In Mexico, small-scale dairy farms contribute 35% of the national milk supply and represent over 78% of dairy farms (Sainz-Sánchez *et al.*, 2017). Most of these farmers (90%) consider milk yield the primary source of family income, yet 80% do not contact extension services (Martínez-García *et al.*, 2012). Therefore, it can be assumed that many of these farmers lack knowledge of managing, preventing and controlling different diseases. Derks *et al.* (2013) recommended promoting programs focused on animal health and disease prevention. However, farmers regularly do not enroll in voluntary disease control programs (Ritter *et al.*, 2017). The latter is influenced by farmer characteristics such as age, education, experience, personality, routine, previous experiences and goals, financial resources, governmental policies, extension services, and knowledge (Frössling and Nöremark, 2016). However, it is widely accepted that farmers' decision-making can also be explained by individual farmer traits such as attitudes, beliefs, other peoples' opinions, intentions, and skills (Ritter *et al.*, 2017). Different theoretical frameworks have been applied to account for these cognitive and social-

psychological factors in the agricultural context. Three of the frameworks most used to investigate the effects of socio-psychological variables on farmers' decision-making and a better understanding of farmer behavior are the theory of reasoned action (TRA) (Ajzen and Fishbein, 1980), the theory of planned behavior (TPB) (Ajzen, 1991) and the reasoned action approach (RAA) (Fishbein and Ajzen, 2010).

Several studies have provided interesting and valuable findings on the cognitive and social-psychological factors influencing farmers' decisions on animal health and disease control based on the theory of reasoned action (TRA) (Garforth *et al.*, 2006), the theory of planned behavior (TPB) (Alarcon *et al.*, 2014; Bruijn *et al.*, 2013; Ellis-Iversen *et al.*, 2010), and the reasoned action approach (RAA) (Sok *et al.*, 2015). Alarcon *et al.* (2014) argued that farmers' beliefs, social referents, and control beliefs could be used as sources of information to identify factors influencing farmers' decisions regarding disease control. In Mexico, psychological models based on the TRA and TPB have been used to identify factors influencing the adoption of improved pasture management (Juárez-Morales *et al.*, 2017; Martínez-García *et al.*, 2013). The RAA is a novel research approach that could better understand the factors influencing small-scale dairy farmers' intention to participate in the national campaign to control and eradicate bovine brucellosis in central Mexico. The aims of the study were 1) to understand the small-scale dairy farmers' intention to participate in the national campaign to control and eradicate bovine brucellosis in central Mexico over the next 12 months; 2) to identify farmer and farm characteristics associated with the intention to participate; 3) to understand the beliefs, social referents, and behavioral control beliefs that underline farmers' decision to participate; and 4) to identify drivers, barriers and social referents influencing farmers' participation. The influential factors can formulate strategies to improve communication with farmers and promote their participation in the national campaign.

## MATERIALS AND METHODS

### Theoretical framework

The study's theoretical framework was based on a socio-psychological approach to understanding farmers' intention to participate in Mexico's national campaign to control and eradicate bovine brucellosis. The RAA approach was used (Fishbein and Ajzen, 2010) to improve and extend the TPB

(Ajzen, 1991). This approach argues that a person's intention to perform or not perform a behavior in question, or participation herein, is directly guided by the direct and indirect measures of the following three constructs: 1) the attitude toward the behavior (behavioral beliefs), 2) the perceived norm (normative beliefs) and 3) the perceived behavioral control (PBC) (control beliefs).

The perceived norm has two components: Descriptive normative beliefs are those held by social referents regarding what others should do or not do in a particular situation, and injunctive normative beliefs are those held by social referents regarding what others approve or disapprove of (Fishbein and Ajzen, 2010), and the perceived behavioral control (PBC) is defined as people's perception of their ability to perform a given behavior; however, it is difficult or impossible to determine how much control a person has over the performance of a given behavior; thus perceived behavioral control is typically used as a proxy for actual control (Sok *et al.*, 2020). It is assumed that farmers have not developed any skills or capacities since they are the receivers of the national campaign for controlling and eradicating bovine brucellosis since control activities, such as administering vaccinations, are conducted by veterinarians. Therefore, we used measures of PBC as proxy measures of actual control.

The behavioral, normative and control beliefs provide the basis for attitude, subjective norm, and perceived behavioral control (Sok *et al.*, 2020) and specific outcome attitudes, social referents, and control beliefs that have a strong correlation with intention can be considered as influential cognitive drivers or barriers that encourage or discourage the adoption of a particular behavior (Garforth *et al.*, 2006). On the other hand, the background factors are properties of the individual or the social group that may influence intention, such as age, education, and personality traits (Fishbein and Ajzen, 2010). The farmer characteristics, farm characteristics, and governmental support were considered background factors for this research.

### Study region

The research was carried out in the State of Mexico, Mexico (22,367 km<sup>2</sup>). It is the most densely populated region of the country, with more than 16 million (Martínez-García *et al.*, 2018). Specifically, the study was conducted in 16 communities in the municipality of Aculco, one of the central milk-producing regions in the State of Mexico. Milk production began in the 1950s.

During the 1980s, a working group emerged among small-scale dairy farmers, milk collectors, and producers of artisanal-type cheese (Crespo *et al.*, 2014). Currently, the area is renowned for milk and cheese production. Also, Aculco is currently considered in the control phase of bovine brucellosis. The above means that the national campaign has implemented diagnosis and control measures to control and eradicate bovine brucellosis (NOM-041-ZOO-1995) of the National Service for Health, Safety, and Agri-Food Quality (SENASICA, 2020).

### Farmer selection

Data from October 2018 to July 2019 from 196 small-scale dairy farmers who are already enrolled in the national campaign since the National Official Norm NOM-041-ZOO-1995 pointed out that all dairy farmers must participate in the campaign at the national level (NOM, 1995). The sample size represents 21% of the total farmers (900) in the study area (Sainz-Sánchez *et al.*, 2017). The snowball sampling method was used to identify participants (Vogt and Johnson, 2016). The farmers selected have a herd size of 3 to 35 animals, a characteristic of small-scale dairy farmers in central Mexico (Juárez-Morales *et al.*, 2017).

### Data collection and survey instrument

Data were collected using the RAA in two phases (Fishbein and Ajzen, 2010). In the first phase, 20 farmers from the original sample (n=196) were randomly selected to conduct a pilot study (semi-structural interviews) in order to elicit outcome beliefs regarding participation in the brucellosis campaign to identify social referents, i.e., people and organizations that potentially influence farmers' decision making; and to identify the control outcome beliefs that possibly influence farmers' PBC and participation in the campaign in the next 12 months.

The second phase comprised an interview survey with the original sample (n=196 farmers). The first part of the survey gathered information on farmer characteristics (age, education, and experience), farm characteristics (number of family members, number of work members, milk yield as a primary source of income, the total number of hectares, herd size, number of milking cows, milk yield per

cow per day, milk sold per day, and milk price per liter) (Martínez-García *et al.*, 2013), the total number of years of participation in the campaign, and the participation in another governmental program sponsored by the Program for Sustainable Livestock Production and Livestock and Apicultural Planning (Programa de Producción Pecuaria Sustentable y Ordenamiento Ganadero y Apícola [PROGAN]). The second part of the survey was designed with the information collected from the semi-structural interviews. Thus, the survey included nine outcome beliefs (Table 3), eight injunctive norms, four descriptive norms (Tables 4 and 5), and four control outcome beliefs (Table 6).

### Data analysis

Descriptive statistics were calculated for the data on farmers and farms. To identify variables (Table 2) correlated with farmers' intention to participate in the campaign, the Spearman Rank-Order correlations ( $P < 0.05$ ) were calculated (Field, 2013). The components of the RAA were measured and analyzed as follows: Farmers' intention to behave (IB) was measured by asking the following: *How strong is your intention to participate in the national campaign to control and eradicate bovine brucellosis in the next 12 months?* The responses were recorded on the bipolar five-point Likert scale ranging from very weak (-2) to very strong (+2) (Martínez-García *et al.*, 2013).

An extra measure of farmers' perception of participation in the campaign came from asking: *How useful would it be to participate in the national campaign to control and eradicate bovine brucellosis in the next 12 months?* The responses were recorded on a bipolar five-point Likert scale ranging from very useless (-2) to very useful (+2) (Lalani *et al.*, 2016).

The direct measures of attitude, subjective norm and perceived behavioral control were determined by recording the responses to the questions shown in Table 1. The responses were recorded on a bipolar five-point Likert scale (Lalani *et al.*, 2016; Martínez-García *et al.*, 2018). The indirect measures of attitude, subjective norm, and perceived behavioral control were measured and estimated with a bipolar five-point Likert scale (Rehman *et al.*, 2007), as shown in Fig. 1.

**Table 1. Questions and scales for the direct measures of the RAA.**

Direct measures		Question	Scale of measure
Direct attitude		How important would participating in the national campaign to control and eradicate bovine brucellosis be in the next 12 months?	Unimportant (-2) to very important (+2)
Direct norm	injunctive	How likely would people you know to influence your decision to participate in the national campaign to control and eradicate bovine brucellosis in the next 12 months?	Very unlikely (-2) to very likely (+2)
Direct norms	descriptive	How likely would it be that people you know, and who participate in the national campaign will influence your decision to participate in the campaign in the next 12 months?	Very unlikely (-2) to very likely (+2)
Direct behavioral control	perceived	How difficult would it be for you to participate in the national campaign to control and eradicate bovine brucellosis in the next 12 months?	Very difficult (-2) to very easy (+2)

The *indirect attitude* (A) was calculated as the sum of the products of the outcome beliefs ( $b_i$ ) and outcome evaluation ( $e_i$ ) attributed to each salient belief. Outcome beliefs are what a subject generally expects to happen due to a particular action taken (Rehman *et al.*, 2007). The overall indirect attitude ( $\sum_{i=1}^n b_i e_i$ ) was obtained by summing the products of all salient beliefs ( $b_i * e_i$ ). The result was then correlated with IB to obtain weight one (Aw1) (Fishbein and Ajzen, 2010).

The *indirect injunctive norms* (IN) and the *indirect descriptive norms* (DN) were calculated as the sum of the products of outcome normative beliefs ( $in_j$  and  $dn_j$ ) and motivation to comply ( $m_j$  and  $i_j$ ) attributed to each salient referent. Fishbein and Ajzen (2010) indicated that a salient referent is a person or group of persons in a subject's social environment or, according to his or her perception, that is influential in performing or not performing the behavior in question. The overall injunctive norm ( $\sum_{k=1}^n in_j m_j$ ) and overall descriptive norm ( $\sum_{i=1}^n dn_j i_j$ ) were calculated by summing the products of all salient normative beliefs ( $in_j * m_j$  and  $dn_j * i_j$ , respectively), which were then correlated with the IB to obtain weight two (INw2) and weight three (DNw3) (Fishbein and Ajzen, 2010).

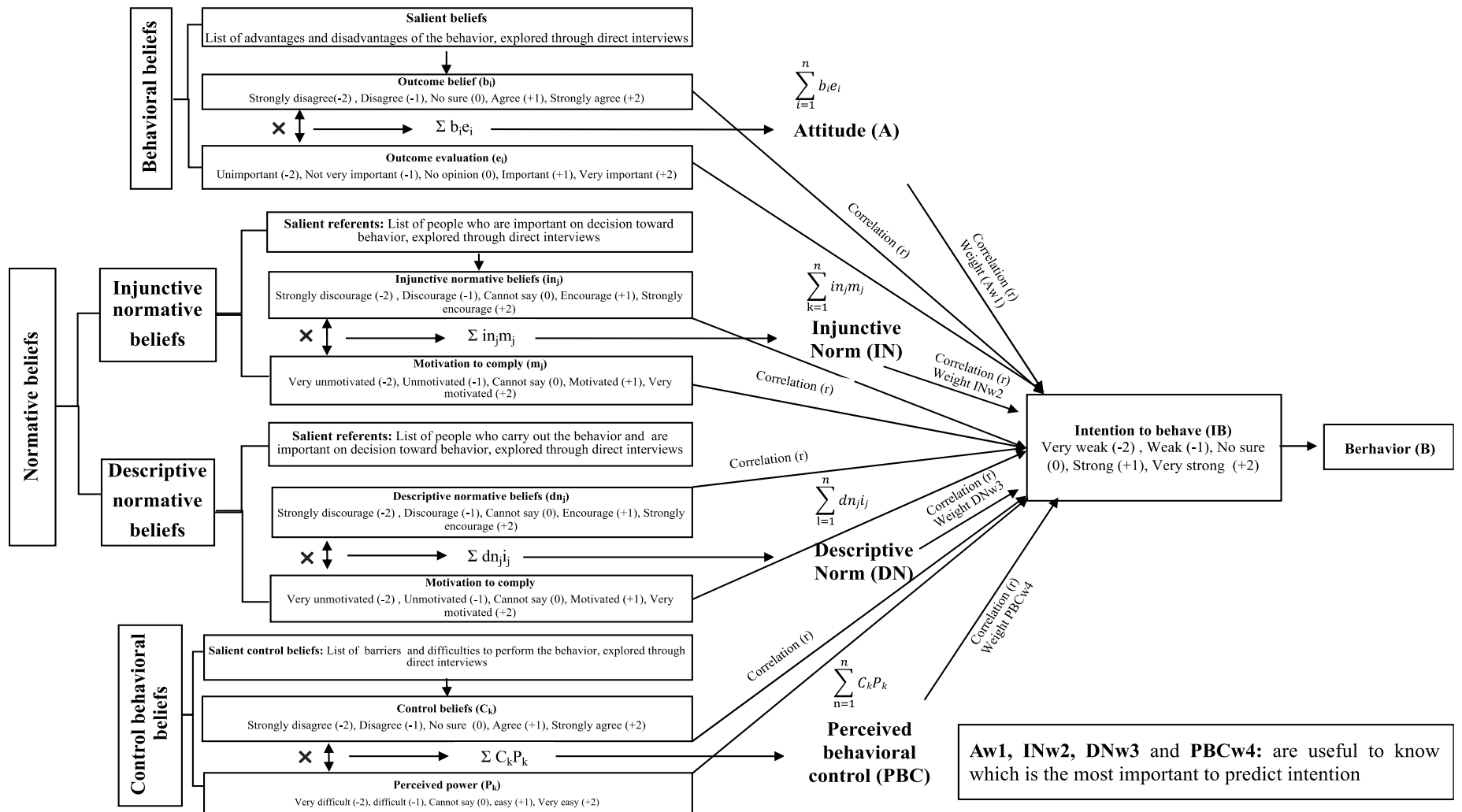
The *indirect measure of PBC* was calculated as the sum of the products of the control beliefs ( $c_k$ ) and the perceived power of the control beliefs ( $p_k$ ) attributed to each salient control belief. The above may be based on experience with the behavior but is usually also influenced by the experiences of acquaintances and friends and other factors that increase or reduce the perceived difficulty of performing the behavior in question (Ajzen 1991); in this case, farmers' participation in the campaign.

The overall PBC ( $\sum_{i=1}^n ckpk$ ) was obtained by summing the products of all salient beliefs ( $c_k * p_k$ ), which was correlated with IB to obtain weight four (PBCw4) (Lalani *et al.*, 2016).

The RAA constructs were analysed in disaggregated form. This approach provides the means for describing the decision process in greater depth and identifying the influence of each belief and social referent (Carr and Tait, 1991). In addition, given the non-parametric nature of the RAA data and the sample size ( $n=196$ ), Spearman Rank Order correlations were conducted to analyze the data (Borges *et al.*, 2014; Bruijnijis *et al.*, 2013; Van Hulst and Posthumus, 2016). Sok *et al.* (2020) pointed out that correlation analysis was conducted to assess the relative impact of the TPB constructs on intention when the sample size was below  $n=200$ . The mean and standard deviation were used to measure central tendency and dispersion to represent the direct and indirect measures of the RAA constructs (Lalani *et al.*, 2016; Van Hulst and Posthumus, 2016). To identify drivers and barriers, the components of the RAA were correlated with intention (Garforth *et al.*, 2006). The data were analyzed in SPSS version 22. The measure scales and the RAA analysis were summarized in Fig. 1; the following hypotheses were derived:

**H<sub>1</sub>:** Farmers' intention to participate in the national campaign to control and eradicate bovine brucellosis is significantly correlated ( $P < 0.05$ ) with farmer and farm characteristics.

**H<sub>2</sub>:** Farmers' intention to participate in the national campaign to control and eradicate bovine brucellosis is significantly correlated ( $P < 0.05$ ) with the overall indirect attitude.



**Fig. 1.** Analysis of the reasoned action approach (RAA) components. Source: Constructed using information from Fishbein and Ajzen (2010), Martínez-García *et al.* (2013), Lalani *et al.* (2016), and Van Hulst and Posthumus (2016).

**H3:** Farmers' intention to participate in the national campaign to control and eradicate bovine brucellosis is significantly correlated ( $P < 0.05$ ) with the overall injunctive norm.

**H4:** Farmers' intention to participate in the national campaign is significantly correlated ( $P < 0.05$ ) with the overall descriptive norm.

**H5:** Farmers' intention to participate in the national campaign to control and eradicate bovine brucellosis is significantly correlated ( $P < 0.05$ ) with the overall PBC.

## RESULTS

### General characteristics of the sample

The average age of farmers was 52 years. Most had primary-level education (52%), and one-third (32%) had secondary-level education. Few had high-school level education (5%) or university studies (2%), and 9% had no formal education. The average number of years of farming experience was 30. Farmers had been participating in the campaign for an average of 8.3 years. The average family size was four, with an average of two individuals contributing toward farm activities, mostly family members. The average farm size was 5 hectares, and the average herd size was ten animals, with seven animals in production. The mean milk yield was 13 liters per day per cow; most farmers (90%) milked by hand. The mean milk price was 0.26 USD (exchange rate at the study time: 1 USD = 21.88 Mexican pesos).

### Farmers' intention to participate in the campaign

Most farmers expressed a strong (70%) or very strong intention (14%) to participate in the campaign in the next 12 months. However, 16% had a weak intention.

### Variables correlated with farmers' intention

Of the three variables describing farmers' characteristics, only farmers' experience was significantly correlated ( $P < 0.001$ ) with intention (Table 2). Of the eight variables describing farm characteristics, four were significantly and positively correlated ( $P < 0.001$ ) with intention: total number of hectares, herd size, number of milking cows, and total milk yield per herd per day. The years of participation in the campaign and the governmental program of PROGRAN were also significantly correlated ( $P < 0.001$ ) with intention.

Thus, **H1** is partially accepted: Farmers' intention to participate in the campaign is significantly correlated ( $P < 0.05$ ) with some variables describing farmer and farm characteristics.

### Direct measures of the RAA

Regarding the *direct attitude* toward the campaign, 45% of the farmers reported that participation in the campaign in the next 12 months would be very important and 44% said that it would be important. The remaining 11% indicated that it would be of little importance. The overall mean of the direct attitude was positive (1.20) and significantly correlated ( $r = 0.564$ ,  $P$  (2-tailed)  $< 0.001$ ) with farmers' intention. On the other hand, 53% of the farmers indicated that participation in the campaign in the next 12 months would be useful, and 31% very useful. The remaining 16% reported that it would be of little use. The overall mean of the usefulness was positive (1.00) and significantly correlated ( $r = 0.735$ ,  $P$  (2-tailed)  $< 0.001$ ) with farmers' intention.

The *direct measure of the injunctive norm* indicated that farmers' participation in the campaign was influenced (mean 1.01) by the individuals they knew. More than half (69%) of farmers indicated they would likely be influenced, and 24% would be influenced. Meanwhile, 7% indicated they would be less likely to be influenced. Farmers' intentions were significantly correlated ( $r = 0.365$ ,  $P$  (2-tailed)  $< 0.001$ ) with the direct measure of the injunctive norm.

The *direct measure of the descriptive norm* indicated that farmers' participation in the campaign would be influenced (mean 1.2) by other referents that they know who participate in the campaign. More than half (59%) of farmers indicated that they would likely be influenced and 34% indicated that they would very likely be influenced. Only 7% said that it would be less likely. Thus, farmers' intention was significantly correlated ( $r = 0.286$ ,  $P$  (2-tailed)  $< 0.001$ ) with the direct measure of the descriptive norm.

The *direct measure of the PBC* indicated that participation in the campaign would be easy (mean 0.71) for farmers. Specifically, over half (74%) mentioned that it would be easy, and 9% would be very easy. However, 15% of farmers felt it would be difficult, and 2% would be very difficult. Thus, farmers' intention to participate was significantly correlated ( $r = 0.483$ ,  $P$  (2-tailed)  $< 0.001$ ) with the direct measure of the PBC.

**Table 2. Correlations between farmers' intention to participate and farmer and farm characteristics**

Variables	Correlation with intention, whole sample (n=196)
<b>Farmer characteristics</b>	
Farmer age	0.130 <sup>ns</sup>
Farmer education	0.030 <sup>ns</sup>
Farmer experience	<b>0.218<sup>a</sup></b>
<b>Farm characteristics</b>	
Family members	-0.109 <sup>ns</sup>
Farming work members	-0.056 <sup>ns</sup>
Milk yield the primary source of income	-0.110 <sup>ns</sup>
Total number of hectares	<b>0.225<sup>a</sup></b>
Herd size	<b>0.327<sup>a</sup></b>
Number of milking cows	<b>0.340<sup>a</sup></b>
Total milk yield per herd per day	<b>0.347<sup>a</sup></b>
Milk price per liter	0.078 <sup>ns</sup>
<b>Governmental supports</b>	
Years participating in the brucellosis campaign	<b>0.365<sup>a</sup></b>
Participation in PROGAN <sup>1</sup>	<b>0.319<sup>a</sup></b>

<sup>1</sup>In Mexico, the Program for Sustainable Livestock Production and Livestock and Apicultural Planning [PROGAN] aims to promote the production and adoption of agro-livestock technologies.

ns: Not significant. <sup>a</sup> Significant at the 0.01 level (2-tailed).

### Indirect measures of the RAA

The results for the *indirect attitude* are presented in Table 3. Five out of nine salient beliefs were viewed as positive, and four as negative. Farmers' intentions were significantly correlated ( $P < 0.01$ ) with the outcome belief ( $b_i$ ) and outcome evaluation ( $e_i$ ) of the five positive beliefs. In particular, their intention to participate was significantly correlated ( $P < 0.01$ ) with three positive beliefs describing the following outcomes ( $b_i * e_i$ ): prevents disease in the herd, allows access to governmental supports and subsidies, and avoids the spread of the disease to people. Moreover, farmers agreed ( $b_i$ ) and considered these three beliefs important ( $e_i$ ). On the other hand, there was a significant negative correlation ( $P < 0.05$ ) between the intention to participate and the outcome belief ( $b_i$ ) that participation would cause abortion in cattle. However, the intention to participate was not significantly correlated ( $P > 0.05$ ) with the rest of the negative beliefs. The overall attitude ( $\sum b_i * e_i$ ) derived from the nine outcome beliefs was significantly correlated ( $P < 0.01$ ) with farmers' intentions. Thus, hypothesis H2 is accepted: Farmers' intention to participate in the campaign is significantly correlated ( $P < 0.05$ ) with the overall attitude.

### Social referents influencing farmers' participation

The results for the *indirect injunctive norm* are described in Table 4. Farmers indicated that they

would be encouraged ( $in_j$ ) and motivated ( $m_j$ ) to participate in the campaign by personnel of the governmental organization (SAGARPA) and extension services; in this case,  $in_j$  and  $m_j$  were significantly correlated ( $P < 0.01$ ) with intention. Farmers were also encouraged ( $in_j$ ) and motivated ( $m_j$ ) by their brothers, wife and sons; however, there was no significant correlation ( $P > 0.05$ ) with intention. Notably, intention to participate was negatively associated with the municipal delegate: More than half of farmers (52%) indicated that they would not be encouraged ( $in_j$ ) or motivated ( $m_j$ ) if the delegate invited them to participate in the campaign. However, the intention was significantly correlated with  $ni_j$  and  $m_j$ , indicating that some farmers (48%) would be encouraged and motivated by the municipal delegate to participate in the campaign.

However, veterinarians and other farmers were the most important social referents who encouraged ( $in_j$ ) and motivated ( $m_j$ ) farmers to participate in the campaign. In this case,  $in_j$ ,  $m_j$ , and  $in_j * m_j$  were significantly correlated ( $P < 0.05$ ) with intention. Also, farmers' intention was significantly correlated ( $r = 0.159$ ,  $P$  (2-tailed)  $< 0.05$ ) with the overall injunctive norm ( $\sum in_j * m_j$ ). Thus, hypothesis H3 is accepted: Farmers' intention to participate in the campaign is significantly correlated ( $P < 0.05$ ) with the overall injunctive norm.



**Table 3. Means of the salient beliefs, overall attitude, and correlations between intention and the components of the attitude.**

Salient beliefs	Outcome beliefs (b <sub>i</sub> ) Mean (SD) <sup>1</sup> (range -2 to +2)	(b <sub>i</sub> ) Correlation with intention	Outcome evaluation (e <sub>i</sub> ) Mean (SD) <sup>1</sup> (range -2 to +2)	(e <sub>i</sub> ) Correlation with intention	Outcome attitude (b <sub>i</sub> *e <sub>i</sub> ) Mean (SD) <sup>1</sup> (range -4 to +4)	(b <sub>i</sub> *e <sub>i</sub> ) Correlation with intention (n=196)
<b>Positive beliefs</b>						
...prevents the disease in the herd.	1.22 (0.51)	<b>0.417<sup>b</sup></b>	1.23 (0.58)	<b>0.444<sup>b</sup></b>	1.75 (1.30)	<b>0.419<sup>b</sup></b>
...maintains the herd free of the disease.	0.60 (0.88)	<b>0.343<sup>b</sup></b>	0.10 (1.10)	<b>0.222<sup>b</sup></b>	0.46 (1.16)	0.016 <sup>ns</sup>
...enables the opening of the market for milk sales.	-0.82 (1.20)	<b>0.206<sup>b</sup></b>	-0.83 (1.26)	<b>0.180<sup>a</sup></b>	1.82 (1.74)	-0.127 <sup>ns</sup>
...enables access to governmental support and subsidies.	1.2 (0.87)	<b>0.283<sup>b</sup></b>	1.20 (0.90)	<b>0.267<sup>b</sup></b>	2.00 (1.53)	<b>0.302<sup>b</sup></b>
...prevents the spread of the disease to people.	0.86 (0.57)	<b>0.232<sup>b</sup></b>	0.89 (0.57)	<b>0.209<sup>b</sup></b>	1.00 (0.62)	<b>0.177<sup>a</sup></b>
<b>Negative beliefs</b>						
...causes abortions in cattle.	-0.51 (0.96)	<b>-0.180<sup>a</sup></b>	-0.33 (1.20)	-0.078 <sup>ns</sup>	0.87 (1.22)	0.018 <sup>ns</sup>
...causes an animal to leave the herd if it tests positive.	0.65 (0.90)	0.019	0.70 (0.84)	0.066 <sup>ns</sup>	0.87 (1.10)	0.067 <sup>ns</sup>
Technicians do not have the necessary knowledge.	-0.36 (0.94)	-0.074	0.34 (1.00)	0.017 <sup>ns</sup>	-0.31 (1.14)	-0.103 <sup>ns</sup>
Technicians do not track the cattle on the farm.	-0.13 (1.10)	-0.039	0.43 (0.95)	-0.057 <sup>ns</sup>	-0.31 (1.15)	-0.077 <sup>ns</sup>
<b>Overall attitude</b>					8.75 (4.48)	<b>0.193<sup>b</sup></b>
<b>(<math>\Sigma b_i * e_i</math>): range -36 to +36</b>						

<sup>1</sup>SD: standard deviation. ns: not significant. <sup>a</sup>significant at the 0.05 level (2-tailed), <sup>b</sup>significant at the 0.01 level (2-tailed).

**b<sub>i</sub>** = strongly disagree (-2), disagree (-1), not sure (0), agree (+1), strongly agree (+2).

**e<sub>i</sub>** = unimportant (-2), not very important (-1), no opinion (0), important (+1), very important (+2).

**Table 4. Means of the injunctive normative beliefs, overall injunctive norm, and correlation between intention and the components of the injunctive norm.**

Injunctive normative beliefs	Normative belief (in <sub>j</sub> ) Mean (SD) <sup>1</sup> (range -2 to +2)	(in <sub>j</sub> ) Correlation with intention	Motivation to comply (m <sub>j</sub> ) Mean (SD) <sup>1</sup> (range -2 to +2)	(m <sub>j</sub> ) Correlation with intention	Injunctive norm (in <sub>j</sub> *m <sub>j</sub> ) Mean (SD) <sup>1</sup> (range -4 to +4)	(in <sub>j</sub> *m <sub>j</sub> ) Correlation with intention (n=196)
Salient referents influencing farmers' participation in the campaign:						
personnel of the governmental organization (SAGARPA) <sup>2</sup>	0.70 (0.74)	<b>0.201<sup>b</sup></b>	0.71 (0.75)	<b>0.219<sup>b</sup></b>	1.06 (0.43)	0.063 <sup>ns</sup>
personnel of extension services	0.37 (0.99)	<b>0.143<sup>a</sup></b>	0.41 (0.94)	<b>0.198<sup>b</sup></b>	1.03 (0.67)	-0.025 <sup>ns</sup>
veterinarians	1.55 (0.64)	<b>0.154<sup>a</sup></b>	1.58 (0.60)	<b>0.172<sup>a</sup></b>	2.78 (1.50)	<b>0.178<sup>a</sup></b>
municipal delegate	-0.02 (1.15)	<b>0.164<sup>a</sup></b>	-0.36 (1.12)	<b>0.215<sup>b</sup></b>	1.19 (0.94)	-0.062 <sup>ns</sup>
other farmers	1.65 (0.53)	<b>0.142<sup>a</sup></b>	1.71 (0.91)	<b>0.168<sup>a</sup></b>	3.12 (2.03)	<b>0.176<sup>a</sup></b>
brother	1.00 (0.53)	0.131 <sup>ns</sup>	1.00 (0.55)	0.083 <sup>ns</sup>	1.28 (0.91)	0.036 <sup>ns</sup>
wife	1.00 (0.45)	0.046 <sup>ns</sup>	1.01 (0.46)	0.076 <sup>ns</sup>	1.21 (0.86)	0.034 <sup>ns</sup>
sons	0.98 (0.54)	0.095 <sup>ns</sup>	1.00 (0.54)	0.127 <sup>ns</sup>	1.26 (0.86)	0.052 <sup>ns</sup>
<b>Overall injunctive norm (Σin<sub>j</sub>*m<sub>j</sub>): range -32 to +32</b>					12.9 (3.97)	<b>0.159<sup>a</sup></b>

<sup>1</sup>SD: standard deviation, <sup>2</sup>SAGARPA: Secretariat of Agriculture, Livestock, Rural Development, Fisheries, and Food.

ns: not significant. <sup>a</sup> significant correlation at the 0.05 level (2-tailed). <sup>b</sup> <sup>c</sup> significant correlation at the 0.01 level (2-tailed).

in<sub>j</sub> = strongly discourage (-2), discourage (-1), cannot say (0), encourage (+1), strongly encourage (+2).

m<sub>j</sub> = very unmotivated (-2), unmotivated (-1), cannot say (0), motivated (+1), very motivated (+2).

### Social referents of the descriptive norm influencing farmers' participation

The results for the *indirect descriptive norm* are presented in Table 5. The municipal delegate received negative scores since farmers (47%) indicated that they would feel discouraged (dn<sub>j</sub>) and demotivated (i<sub>j</sub>) if invited to participate in the campaign by him. However, farmers' intentions were significantly correlated ( $P < 0.05$ ) with dn<sub>j</sub>, as 53% of the farmers would feel encouraged by the municipal delegate.

On the other hand, farmers felt encouraged (dn<sub>j</sub>) and motivated (i<sub>j</sub>) by their brothers and strongly encouraged (dn<sub>j</sub>) and very motivated (i<sub>j</sub>) by other farmers; however, the descriptive norms (dn<sub>j</sub>\*i<sub>j</sub>) were not correlated with intention. On the other hand, farmers' intentions were significantly correlated ( $P < 0.05$ ) with the dn<sub>j</sub> and i<sub>j</sub> of sons. Overall, the descriptive norm (dn<sub>j</sub>\*i<sub>j</sub>) did not show a significant correlation ( $P > 0.05$ ) with farmers' intention. Thus, hypothesis H4 is rejected: Farmers' intention to participate in the campaign is not significantly correlated ( $P < 0.05$ ) with the overall descriptive norm.

**Table 5. Means of the descriptive normative beliefs, overall descriptive norm, and correlation between intention and the components of descriptive norm.**

Descriptive normative beliefs	Normative belief (dn <sub>j</sub> )	(dn <sub>j</sub> ) Correlation with intention	Motivation to comply (i <sub>j</sub> )	(i <sub>j</sub> ) Correlation with intention	Descriptive norm (dn <sub>j</sub> *i <sub>j</sub> )	(dn <sub>j</sub> *i <sub>j</sub> ) Correlation with intention (n=196)
Salient referents that farmers know who participate in the campaign:	Mean (SD) <sup>1</sup> (range -2 to +2)		Mean (SD) <sup>1</sup> (range -2 to +2)		Mean (SD) <sup>1</sup> (range -4 to +4)	
municipal delegate	-0.13 (1.37)	<b>0.141<sup>a</sup></b>	-0.14 (1.37)	0.140 <sup>ns</sup>	1.87 (1.42)	-0.038 <sup>ns</sup>
other farmers	1.73 (0.59)	0.125 <sup>ns</sup>	1.73 (0.61)	0.130 <sup>ns</sup>	3.35 (1.25)	0.106 <sup>ns</sup>
brother	1.01 (0.50)	0.129 <sup>ns</sup>	1.01 (0.54)	0.098 <sup>ns</sup>	1.27 (0.96)	0.034 <sup>ns</sup>
sons	0.98 (0.50)	<b>0.184<sup>b</sup></b>	0.96 (0.56)	<b>0.183<sup>a</sup></b>	1.20 (0.88)	0.092 <sup>ns</sup>
<b>Overall descriptive norm (Σdn<sub>j</sub>*i<sub>j</sub>):</b>					7.69	0.090 <sup>ns</sup>
						<b>range -16 to +16</b>

<sup>1</sup>SD: standard deviation. ns: not significant. <sup>a</sup>significant correlation at the 0.05 level (2-tailed). <sup>b</sup> significant correlation at the 0.01 level (2-tailed).

dn<sub>j</sub> = strongly discouraged (-2), discouraged (-1), cannot say (0), encouraged (+1), strongly encouraged (+2).  
i<sub>j</sub> = very unmotivated (-2), unmotivated (-1), cannot say (0), motivated (+1), very motivated (+2).

### Control beliefs influencing farmers' participation in the campaign

The results for the *indirect measure of PBC* are presented in Table 6. Farmers agreed (c<sub>k</sub>) with the following two control beliefs: Participating in the campaign requires a payment for the service (2.28 USD per cow), and communication is lacking between farmers and the personnel in charge of the service. These two control beliefs (c<sub>k</sub>) were significantly and negatively correlated ( $P < 0.05$ ) with intention. The control belief (c<sub>k</sub>) that it is necessary to travel a long distance to request the service was also significantly and negatively correlated ( $P < 0.05$ ) with intention. On the other hand, farmers' perceived power (p<sub>k</sub>) of this belief was significantly and positively correlated ( $P < 0.05$ ) with intention. The overall PBC was significantly correlated ( $P < 0.05$ ) with intention. Thus, hypothesis H5 is accepted: Farmers' intention to participate in the campaign is significantly correlated ( $P < 0.05$ ) with the overall PBC.

## DISCUSSION

Most farmers (84%) had a strong intention to participate in the campaign to control and eradicate

bovine brucellosis in the next 12 months; this can be associated with the farmers' positive perceptions and beliefs surrounding participation in the campaign. On the other hand, the farmers with weak intentions (16%) may have had poor experiences with the campaign or hold negative beliefs (Table 3). Garforth *et al.* (2006) pointed out that positive and negative beliefs can be considered cognitive drivers and barriers, respectively, encouraging or discouraging adopting a particular behavior.

Previously, farmers' intention to change heat detection practices in dairy herds was influenced by age and education (Garforth *et al.*, 2006). In the present study, intention to participate was not significantly correlated ( $P > 0.05$ ) with farmers' age and education; this may be attributed to the fact that veterinarians are the ones who carry out the brucellosis tests. However, intention to participate was significantly correlated ( $P < 0.05$ ) with farmers' years of experience. Alarcon *et al.* (2014) found that farmers' years of experience similarly influenced animal health decisions.

**Table 6. Means of the control beliefs, overall perceived behavioral control, and correlation between intention and the components of perceived behavioral control.**

Control beliefs	Control belief ( $c_k$ ) Mean (SD) <sup>1</sup> (range -2 to +2)	( $c_k$ ) Correlation with intention	Perceived power ( $p_k$ ) Mean (SD) <sup>1</sup> (range -2 to +2)	( $p_k$ ) Correlation with intention	PBC ( $c_k^* p_k$ ) Mean (SD) <sup>1</sup> (range -4 to +4)	( $c_k^* p_k$ ) Correlation with intention (n=196)
...requires a payment for the service.	0.75 (1.05)	<b>-0.191<sup>b</sup></b>	-0.68 (1.01)	<b>0.272<sup>b</sup></b>	-1.49 (1.19)	0.112 <sup>ns</sup>
...requires compliance with the established requirements.	0.37 (1.11)	0.002 <sup>ns</sup>	-0.29 (1.10)	0.029 <sup>ns</sup>	-1.23 (0.94)	0.064 <sup>ns</sup>
...requires traveling a long distance to request the service.	0.90 (1.11)	<b>-0.158<sup>a</sup></b>	-0.84 (1.14)	0.103 <sup>ns</sup>	-1.84 (0.11)	0.125 <sup>ns</sup>
... lack of communication between farmers and the personnel in charge of the service.	-0.02 (1.05)	<b>-0.141<sup>a</sup></b>	0.07 (1.04)	<b>0.181<sup>a</sup></b>	-1.03 (0.60)	0.047 <sup>ns</sup>
<b>Overall PBC<sup>2</sup></b> <b>(<math>\Sigma c_k^* p_k</math>): range -16 to +16</b>					<b>-5.59</b>	<b>0.155<sup>a</sup></b>

<sup>1</sup>SD: standard deviation, ns: not significant. <sup>a</sup>significant correlation at the 0.05 level (2-tailed), <sup>b</sup>significant correlation at the 0.01 level (2-tailed). <sup>2</sup>PBC: perceived behavioral control

$c_k$  = strongly disagree (-2), disagree (-1), not sure (0), agree (+1), strongly agree (+2).

$p_k$  = very difficult (-2), difficult (-1), cannot say (0), easy (+1), very easy (+2).

Concerning farm characteristics, four variables were significantly correlated ( $P < 0.05$ ) with the intention to participate. Specifically, farms with more hectares, herd size, and the number of cows in production and those with higher milk production were more likely to participate. Previously, farm characteristics were found to play an essential role in farmers' decision-making regarding the use of cultivated pastures (Martínez-García *et al.*, 2013). In the present study, the intention to participate was also significantly and positively correlated ( $P < 0.05$ ) with the number of years participating in the brucellosis campaign and participation in the PROGRAM program. This suggests that the intention to participate was stronger in farmers who have continuously participated or previously received governmental support.

The perceived importance (*direct attitude*) and utility of participating in the campaign were significantly correlated ( $P < 0.05$ ) with farmers'

intention. Specifically, intention to participate was stronger among farmers who considered participation in the campaign important and valuable for their farms. Previously, farmers' perception of importance and utility was found to play an essential role in the use of cultivated pastures (Martínez-García *et al.*, 2013) and the implementation of agricultural conservation practices (Lalani *et al.*, 2016).

Social referents have been found to play an important role in farmers' decision-making, for example, in the control of diseases affecting pig production (Alarcon *et al.*, 2014) and the use of cultivated pastures for milk production (Martínez-García *et al.*, 2018). The *direct injunctive and direct descriptive norms* were significantly correlated ( $P < 0.05$ ) with the intention to participate, confirming that social pressure influences farmers' intentions to participate in the campaign. On the other hand, the *direct measure of the PBC* indicated that farmers' participation in the

campaign would be accessible in the next 12 months; the above may be associated with the fact that farmers are the receivers of the national campaign since veterinarians conduct control activities such as the administration of vaccinations.

The State of Mexico is considered as an eradication zone of brucellosis; however, no cases of the disease in bovine were reported in 2023 (SENASICA, 2023); whereas, eleven cases of brucellosis in humans were reported in the same year, this data represent an incidence of 0.06 per 100,000 inhabitants (*Secretaría de Salud*, 2023). Although, the brucellosis incidence was low, the *indirect attitude* measure suggested that three positive beliefs were significantly correlated ( $P < 0.05$ ) with farmers' intention, specifically that participation prevents disease in the herd, prevents the spread of the disease to people and enables access to governmental support and subsidies. These can be considered drivers of participation in the campaign. Meanwhile, the belief that participation would cause abortions in cattle was significantly and negatively correlated ( $P < 0.05$ ) with intention and can be considered a barrier; two or three weeks after vaccination, farmers have observed abortions in cows. Therefore, farmers who held this belief showed a weak intention to participate. Lalani *et al.* (2016) argued that more people would adopt the desired behavior if the barriers could be counteracted, and the drivers strengthened. Therefore, the extension services personnel should work to change farmers' negative perceptions and beliefs and, at the same time, promote positive beliefs.

In addition, the overall attitude ( $\sum b_i^* e_i$ ) was significantly correlated ( $P < 0.05$ ) with farmers' intention, indicating that farmers' attitudes toward participation in the campaign were influenced by their beliefs. Previously, farmers' beliefs were found to play an important role in their decision to participate in vaccination schemes (Sok *et al.*, 2015) and improve dairy cows' foot health (Bruijnjs *et al.*, 2013). Therefore, farmers' beliefs appear to be an important factor underlining farmers' decision to participate in the campaign.

The results of the *indirect injunctive norm* indicated that veterinarians and other farmers were the social referents that most influenced farmers' decision-making. Accordingly, these individuals could be considered channels of communication and motivation (Bruijnjs *et al.*, 2013) to promote participation in the campaign. Ritter *et al.* (2015)

also found that other farmers, veterinarians, and the personnel of the health authorities influenced farmers' decision-making to participate in herd health management. Similarly, Sok *et al.* (2015) indicated that veterinarians were perceived as a highly trusted and influential referent in herd health management. The latter suggests that promoting social interaction and communication between farmers and veterinarians, including farmers already participating in the campaign, could encourage additional farmers to participate in the campaign.

The governmental organization and extension services personnel were additional social referents influencing farmers' decisions to participate in the campaign. However, the family members of farmers, including the farmer's brother, wife, and sons, were not found to influence farmers' intention to participate. However, these results contrast slightly with those of the *indirect descriptive norm*, in which the sons of farmers were identified as social referents that play an important role in farmers' decisions. Bruijnjs *et al.* (2013) found that family members influenced farmers' decisions to treat foot problems in dairy cattle. Finally, the municipal delegate could be an important social referent, as confirmed by the indirect injunctive norm and indirect descriptive norm. However, the influence is stronger on farmers who have a friendship or contact with him.

Based on these results, extension services should consider the social referents identified in the present study to spread information and promote the participation of farmers in the campaign. Sok *et al.* (2015) suggested that the social referents that generate greater trust and motivation among farmers should be utilized as communication channels to generate a more significant impact.

The *indirect measure of the PBC* indicated that three out of the four control beliefs might be barriers to participation in the campaign; specifically, participation in traveling a long distance to request the service requires payment, and communication is lacking between farmers and the personnel in charge. Martínez-García *et al.* (2012) pointed out the lack of financial resources and communication between farmers and extension services were important constraints in adopting technologies. In particular, the perceived power ( $p_k$ ) of the beliefs that participation requires payment for the service and that communication is lacking between farmers and personnel in charge of the service was positively and significantly

correlated ( $P < 0.05$ ) with farmers' intention. This implies that farmers' intention to participate in the campaign would improve if they had the financial resources to pay for the service (22%) and good communication with the personnel in charge (54%). Bruijn *et al.* (2013) previously identified that knowledge, financial resources, time, labor, and communication were important factors that motivated farmers to take action to improve dairy cow foot health.

Similarly, the overall measure of PBC suggested that farmers perceived limited participation in the campaign. Therefore, the channels used to communicate information about the campaign need to be credible and trusted by farmers. In this context, the subsidization of costs may be complementary to communication interventions that emphasize the negative consequences of brucellosis infection and, at the same time, improve trust in the government-sponsored campaign (Sok *et al.*, 2015). On the other hand, the intention and its predictors should be measured at the same time on the same questionnaire, using similar items, scales and conditions that should maximize predictive power and minimize the bias of sample size (Sutton, 1998).

## CONCLUSIONS

The findings showed that the strength of small-scale dairy farmers' intention to participate in the national campaign for the control and eradication of bovine brucellosis was associated with farmers' years of experience as milk producers, farm characteristics such as farm size and years of participation in the campaign, and the perception of the importance and usefulness of participation in the campaign. Moreover, the indirect measure of farmers' attitudes revealed positive and negative beliefs that favor and constrain farmers' participation in the campaign. The direct and indirect measures of the injunctive and descriptive norms showed that social referents such as veterinarians, other farmers, and farmers' sons played an important role in farmers' decisions to participate in the campaign. Thus, these social referents could be used by extension services as channels for encouraging and motivating farmers to participate in the campaign. Although the direct measure of PBC initially indicated that farmers' participation in the campaign in the next 12 months would be easy, the indirect measure of PBC highlighted several significant constraints: the lack of financial resources and lack of communication between farmers and personnel in charge of the

campaign. Therefore, subsidies and communication improvement should be considered additional means for encouraging farmers' participation. Ultimately, the three components of the RAA (attitude, perceived norms, and perceived behavioral control) were found to be strong predictors of farmers' intention to participate.

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**Compliance with ethical standards.** The research present original data that are not submitted to other journal at the same time.

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## Author contribution statement (CRediT). J.A.

**Albiter-Albiter:** investigation, data analyses, writing - original draft. **C.M. Arriaga-Jordán:** writing review and editing. **P. Dorward:** methodology, supervision, data analyses. **A.A. Rayas-Amor:** writing – review and editing. **Carlos Galdino Martínez-García:** conceptualization, resources, data analyses, Writing – review and editing, investigation, supervision, funding acquisition.

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