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Seroprevalence and risk factors for reproductive diseases in dairy cattle in Mexico

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The purpose of the study was to estimate seroprevalence of four reproductive diseases: brucellosis, bovine virus diarrhea (BVD), neosporosis and bovine respiratory rhinotracheitis (IBR) in dairy cattle in Mexico. In a stratified multi-stage design, 4,487 serum samples were collected in 182 herds from different states of Mexico. Epidemiologic and spatial information was also collected to evaluate risk factors and elaborate maps of risk. Overall seroprevalence rates were: Brucellosis 14.7% (with the Rose Bengal test) and 5.1% (with the radial immunodifusion test), BVD 78.8%, neosporosis 36.8% and IBR 73%. The highest prevalence for neosporosis (46%) and brucellosis (21.8%) was observed in the intensive system. In the familiar and double-purpose systems, the prevalence was 34 and 15.8%, respectively. No big differences were observed for IBR and BVD in the three systems, 69 to 75% for IBR and 63.9 to 87.8% for BVD. The states with the highest prevalence for brucellosis were Hidalgo (77%), Aguascalientes (36%), Guanajuato (30%), and La Laguna (Coahuila and Durango) (17%). Prevalence was low in Veracruz (1%), Chiapas (2%), and Sinaloa (3%); for BVD ranged from 55% (in the state of Sinaloa) to 98% (in the state of Aguascalientes). Prevalence for neosporosis was high in Hidalgo (55%), Guanajuato (53.7%), and Querétaro (47.9%). Risk factors associated to prevalence of brucellosis were: herd size, introduction of animals from different herds, common sheds, production system, and source of replacements. For BVD, herd size, common sheds, intensive production, and large calving intervals were significant factors. Abortion rate, use of fresh colostrum, services per conception, and intensive production were the factors associated with neosporosis. Factors significantly associated to IBR were: use of bull for breeding, and positive serology to parainfluenza virus 3. Areas of risk and probability of disease were related with areas of high density of dairy cattle.

Key words: Dairy cattle, reproductive diseases, seroprevalence, epidemiology, Mexico.

INTRODUCTION

Reproductive infectious diseases are a permanent threat to dairy herds all over the world (Juyal et al., 2011). Diseases like neosporosis, brucellosis, infectious bovine rhinotrachieitis (IBR), and bovine viral diarrhea (BVD) alter reproductive performance, reduce productivity, limit access to livestock markets, and, in the case of brucellosis represent a risk to public health (Houe et al., 2006; Anderson, 2007). In addition, they reach other than the reproductive organs causing different clinical manifestations.

Brucellosis, caused by *Brucella abortus* is one of the most important reproductive diseases of cattle. In some cases, co-existence with small ruminants promotes infection with *B. melitensis* (Lopez-Merino, 1989). Since livestock is important and represents an important source of currency for the country (Dirección de Tuberculosis Bovina y Brucelosis, 2000; Rio, 1977), a national campaign for the eradication of animal brucellosis has been implemented in Mexico since 1995. However, brucellosis is still a big problem in cattle, dairy and beef goats, sheep and pigs (Pacheco and Luna-Martínez, 1999), causing losses for about USD 200 million a year (Luna-Martínez, 1999a; Luna-Martínez, 1999b). In humans, an average of 2000 cases a year have been reported for the last 7 years (Pacheco and Luna-Martínez, 1999).

Bovine viral diarrhea (BVD) is found worldwide in cattle causing considerable economic losses due to the impact on health and reproduction (Davies and Carmichael, 1973). Early embryonic death, mummification, congenital defects and abortion are some of the consequences of infection during pregnancy. Fetuses infected during the first 120 days of gestation can develop immunotolerance and become lifelong virus carriers (Fray et al., 2000). In regions with high prevalence over 1 to 2% of the newborn calves are persistently infected (Houe et al., 2006). Reduction in milk production is perhaps the most important feature in lactating cows (Howard, 1990).

Two genotypes of BVDV (BVDV-1 and BVDV-2) have been identified by serology and molecular biology (Cantú and Alvarado, 1998); however, subtypes of the two genotypes have also been described (Río, 1977; Vilcek et al., 2001). BVDV-2 is prevalent in North America (Fulton et al., 2005), in Europe (Jackova et al., 2008; Letellier et al., 1999; Luzzago et al., 2001; Tajima et al., 2001); and in Asia (Nagai et al., 1998). It has been associated with severe clinical disease in adults and with hemorrhagic syndrome in youngsters (Carman et al., 1998). In the past two years, a severe form of BVDV-2 has been reported in Germany and in the Netherlands (Arias et al., 2003; Hurtado et al., 2003; Schirrmeier, 2014).

Neospora caninum in cattle is recognized as a major cause of abortions and economic losses to farmers worldwide (Dubey, 1999a). Cows aborting in previous pregnancies abort repeatedly or give birth to sick calves or calves with subclinical infection. The life cycle of *N. caninum* is well known, dog is recognized as the final host (McAllister, 1988). Canine-derived oocysts have been found contaminating the environment (Wouda et al., 1999) and are infective for calves (De Marez et al., 1999). Sources of postnatal infection for cows are unknown but vertical transmission is the predominant mode of natural infection. *N. caninum* has been reported World-wide (Dubey, 1999a, b); however, no much information is available for Mexico (Morales et al., 2001a, b). Herd-level prevalence has been estimated in between 10 and 100% (García-Vázquez et al., 2002).

Infectious bovine rhinotracheitis (IBR) is a disease of the upper respiratory tract that causes substantial economic loses to the cattle industry worldwide (Hage et al., 1998). Infection may occur by first exposure to the virus; reactivation of the virus in latency, or by vaccination with live virus during pregnancy (Muylkens et al., 2007; Ormsbee, 1963; Smith, 1997). It causes embryonic death, mummified animals, infertility, stillbirths, or birth of weak calves that die after a few days (Arthur et al., 1991; Blood and Radostis, 1992; Correa, 1986). IBR virus can be transmitted by respiratory, ocular, and reproductive secretions; however, introduction of infected animals to the herd is the most important source of infection (Moles et al., 2002). Cattle of all ages and breeds are susceptible, but the disease typically occurs in animals older than six months (Wentink et al., 1993). Therefore, the purpose of this study was to estimate the seroprevalence and associated risk factors of four reproductive diseases: brucellosis, bovine viral diarrhea, neosporosis and bovine respiratory rhinotracheitis in dairy cattle in Mexico.

MATERIALS AND METHODS

Sampling strategy

Data was obtained from a large cross-sectional study in 182 farms conducted between January, 2010 and December, 2012. Farms from different states of Mexico and from three systems of production were included. Systems were intensive [States of

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Aguascalientes, Chihuahua, Guanajuato, Hidalgo, Coahuila and Durango (La Laguna), and Queretaro)]; family-type (Jalisco), and double-purpose (Chiapas, Sinaloa and Veracruz). The Intensive system comprises Holstein-Friesian cows kept in closed premises with no access to grazing; herds may hold from 150 to 10,000 head of cattle, with an average of 300. Family-type farms are run mostly by family members, Holstein breeds and cows used have access to grazing for short periods of time during the day; herd size is about 50 cows. Double-purpose mainly utilizes *Bos Taurus indicus* and crosses of this with some *Bos Taurus taurus*, which are primarily used for calving and, as a secondary purpose, milk production.

Samples were collected in a stratified multistage sampling design. Since the population of dairy cattle is located in specific regions, each of these regions was considered as a stratum in the first stage. In the second stage, states were selected within each stratum, and counties within each state. Counties were not randomly selected since not all counties in a state have dairy cattle; they were selected from a counties milk-producing list. Finally, due to the lack of a good sampling frame, convenience sampling was used to select herds and animals within herds. Sampling personnel were advised to select herds from different areas of each county to make a representative sample. To reduce variance of sampling, a sampling fraction by stratum (region) was determined dividing the total number of samples by the total dairy cattle population for the states included (3,500/2,000 000 = 0.0018). Subsequently, to determine the number of animals sampled per stratum, the sample fraction was multiplied by the size of the population in each stratum. With a 10% hypothetical prevalence for brucellosis, 1% error and a 95% confidence level, the estimated sample size was 3,500 animals; however, for practical reasons, -due to proportional sampling, in some herds the required number of animals to sample was less than 5, a non-worthy number. The final number of samples collected was 4,487.

Samples

Ten milliliters of blood were collected from each animal from the middle coccygeal vein with a 20-gauge, 1-inch needle in a 10 ml serum-separator Vaccutainer tube (Becton Dickinson and Company, Becton Dickinson Vacutainer Systems, Fralklin lakes, NJ 07417 to 1885. USA). The study was conducted in accordance with the Animal Welfare Legislation of Mexico. Collection of blood samples was performed by a qualified veterinarian following official procedures from the Norma Oficial Mexicana (NOM-041-ZOO-1995) of the National Campaign against Brucellosis in Animals (46). Animals were handled aiming to minimize stress and suffering. Samples were stored at -20°C until analysis.

Serological tests

Presence of antibodies against brucellosis was determined by the Rose Bengal test and then, some were positively confirmed by the radial immunodiffusion test (RIT). For IBR, the plate sero-neutralization in MDK cells with the IBR758 virus was used. Antibodies against BVD were identified by an Enzyme-Linked ImmunoSorbent Assay using CIVTEST bovis BVD/BDab 80 Hipra, Girona Spain. Antibodies against *Neospora caninum* were determined by an indirect immunofluorescence assay. This method uses two antibodies; the unlabeled first (primary) antibody specifically binds to the target molecule, and the secondary antibody, caring the fluorophore, recognizes and binds to the primary antibody. This provides signal amplification by increasing the number of fluorophore molecules per antigen. The protocol of this study was approved by the Bioethics Committee of the Faculty of Natural Sciences in the Autonomous University of Queretaro.

Epidemiological information

In order to collect epidemiological information, a questionnaire was supplied to all herd owners to identify farm management practices and herd performance. Questionnaire included open items (any answer possible) and closed items (possible answers provided in the questionnaire) related to general characteristics of farms, such as size, breed and production, as well as target questions referring to potential risk factors for disease prevalence.

Statistical analysis

The statistical analysis was carried out in three steps. First, a univariate descriptive analysis was performed throughout frequencies and descriptive statistics, followed by a bivariate analysis to identify variables potentially associated with disease prevalence. Finally, all variables with a p value $\leq$ 0.20 were considered for a multivariate logistic regression analysis to obtain adjusted odds ratios. Analysis was performed with Epiinfo tm7.1.0.6 (Centers for Disease Control and Prevention, Atlanta, Georgia, EE. UU) and SPSS (SPSS Inc. 233 South Wacker Drive, 11th Floor, Chicago, IL 60606-6412 EE.UU).

Spatial information

All farms were spatially located using spatial location devices (GPS). This information was used to estimate risk areas of the disease throughout geostatistical modeling by ordinary kriging. Kriging was used based on the farm prevalence of the disease. These analyses were performed with ArcView from ArcGis 10 (ESRI, Inc Redlands, CA, USA).

Ecological niche modeling

In order to determine relationship between environmental variables from BIOCLIM (http://www.worldclim.org) (Museum of Vertebrate Zoology, University of California, Berkeley, EE.UU) and presence of disease, an ecological niche analysis with Maxent (Princeton University, Center for Biodiversity and Conservation, American Museum of Natural History) was performed. Maps showing predicted relative suitability for the presence of cases were elaborated. Twenty-five percent of the herds were randomly selected to test model accuracy. Environmental data used in the Maxent analyses were: temperature and precipitation, and the 19 environmental variables from BIOCLIM with 2.5 min of resolution converted to a common projection. These variables are coded as follows:

BIO1 = Annual mean temperature
BIO2 = Mean diurnal range (mean of monthly (max temp - min temp))
BIO3 = Isothermality (BIO2/BIO7) (* 100)
BIO4 = Temperature seasonality (standard deviation *100)
BIO5 = Max temperature of warmest month
BIO6 = Min temperature of coldest month
BIO7 = Temperature annual range (BIO5-BIO6)
BIO8 = Mean temperature of wettest quarter
BIO9 = Mean temperature of driest quarter
BIO10 = Mean temperature of warmest quarter
BIO11 = Mean temperature of coldest quarter

Table 1. Average seroprevalence for reproductive diseases by production system in dairy cattle in Mexico.

System of production	Brucellosis	VBD	Neosporosis	IBR	Number of Farms
	Prevalence (%)				
Intensive	21.8	87.8	46	75	74
Double- purpose	2.4	63.9	24	74	82
Familiar	15.8	81.2	34	69	26
Average	14.7	78.8	37	73	

Table 2. Average seroprevalence of reproductive diseases by state in dairy cattle in Mexico.

Parameter	Brucellosis	VBD	Neosporosis	IBR	Number of farms
Aguascalientes	36	98	38.7	73	9
Chiapas	2	56	27.9	83	21
Chihuahua	6	95	44.7	81	16
Guanajuato	30	90	53.7	74	5
Hidalgo	77	96	55.0	71	14
Jalisco	16	81	33.9	67	26
Laguna	17	96	39.1	71	13
Queretaro	10	64	47.9	73	17
Sinaloa	3	55	30.6	57	12
Veracruz	1	69	18.6	74	49
Average	22.2	69	36.8	75	182

BIO12 = Annual precipitation
BIO13 = Precipitation of wettest month
BIO14 = Precipitation of driest month
BIO15 = Precipitation seasonality (coefficient of variation)
BIO16 = Precipitation of wettest quarter
BIO17 = Precipitation of driest quarter
BIO18 = Precipitation of warmest quarter
BIO19 = Precipitation of coldest quarter

RESULTS

Seroprevalence

Prevalence for the different reproductive diseases by production system and state are presented in Tables 1 and 2, and Figure 1. The overall seroprevalence for the four reproductive diseases was: brucellosis with the Rose Bengal test 14.7%; brucellosis with the RIT test 5.1%; BVD, 78.8%; neosporosis, 36.8%; and IBR, 73%. By system of production, the highest prevalence for brucellosis (21.8%) and (46%) neosporosis was observed in the intensive system. The lowest prevalence for these two diseases observed in the double-purpose system was 2.4 and 24%, respectively; in the familiar system, prevalence was 15.8 and 34%. No big differences were observed for IBR and BVD in the three systems, ranging from 69 to 75% for IBR and from 63.9 to 87.8% for BVD.

The states with the highest prevalence for brucellosis were Hidalgo (77%), Aguascalientes (36%), Guanajuato (30%), and La Laguna (Coahuila and Durango) (17%). Those with the lowest prevalence were Veracruz (1%), Chiapas (2%) and Sinaloa (3%). With the RIT tests, the states with the highest prevalence were: Hidalgo (25.3%), Aguascalientes (13.5%) and La Laguna (9.5%). The seroprevalence for BVD ranged from 55% in the state of Sinaloa to 98% in the state of Aguascalientes. The states with the highest prevalence for neosporosis were: Hidalgo (Tizayuca) (55%), Guanajuato (53.7%) and Querétaro (47.9%), whereas the state with the lowest prevalence was Veracruz, with 18.6%. The prevalence for IBR was high in all the states included in the study, ranging from 57% in the state of Sinaloa to 83% in the state of Chiapas.

Risk factors

A multivariate regression analysis to identify factors associated to disease prevalence was performed. Adjusted odd ratios of factors with statistic significance for each disease are in Table 3. Five factors were associated with prevalence of brucellosis: herd size, herds with 200 to 300, and those with more than 300 had more chances of having brucellosis than those with less

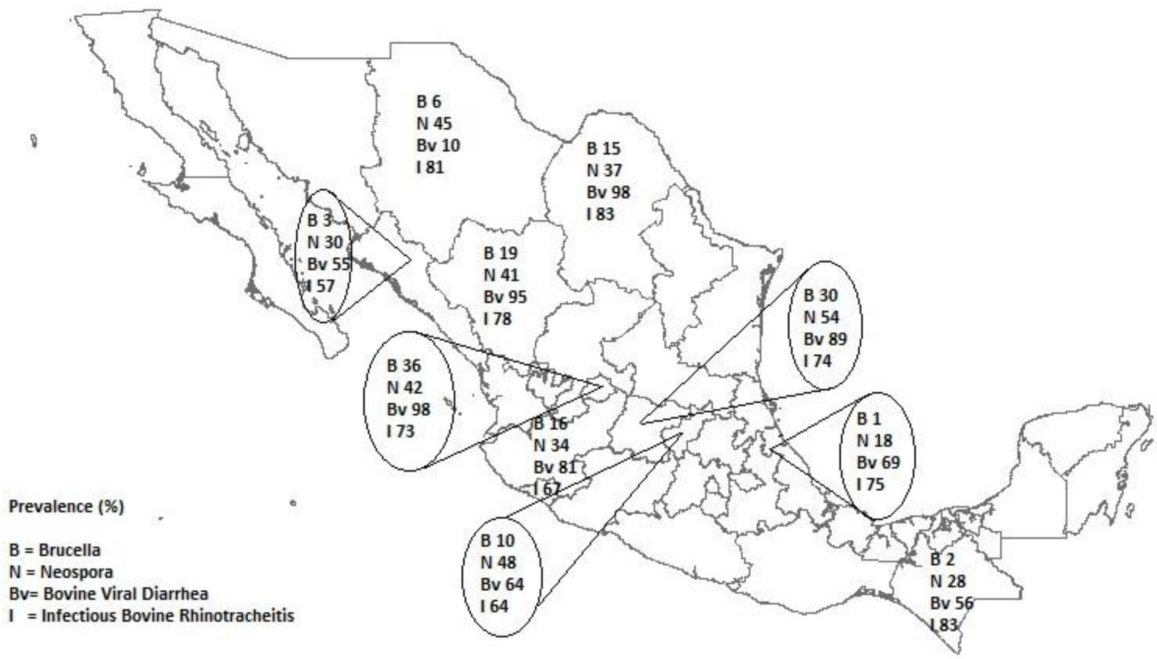

Figure 1. Seroprevalence of reproductive diseases in dairy cattle in Mexico for states included in the study.

than 200 animals. The OR´s were 4.4 (95%CI 1.2 to 7.6), and OR = 5.2 (95%CI 2.4 to 11.2), respectively. Herds introducing more than 30 animals a year had 4.1 (95%CI 2.3 to 7.6) more chances of having brucellosis, compared to herds introducing less than 30 animals. Herds with common sheds, intensive system of production, and origin of replacements (same vs. different herd) were all associated with having brucellosis.

For BVD, herd size (≥ 200 animals), common sheds, production in intensive systems (family-type vs. double purpose), and calving intervals (≥ 395 days) were factors associated to prevalence. Herds with 200 to 300 animals had an OR = 59.3 (95%CI 20.2 to 174), and herds with more than 300 animals had an OR = 7.5 (95%CI 3.6 to 15.8), compared to herds with less than 200 animals.

More than five abortions (OR = 1.12, 95%CI 0.87 to 1.4), the use of fresh colostrum (OR = 1.9, 95%CI 1.5 to 2.6), more than six services per conception (OR = 3.9, 95%CI 2.1 to 7.0), and production in intensive systems (OR = 2.3, 95%CI 2.3 to 3.9) were associated with presence of neosporosis. In the case of IBR, only two factors were significantly associated: type of breeding (insemination vs. bull use) OR = 1.6 (95%CI 1.2 to 2.2), and positive serology to parainfluenza virus 3 (PI3) OR = 2.5 (95%CI 2.1 to 3.1). The respiratory complex bovine infections occurred in conjunction with infections by other viruses associated with respiratory disease, namely, PI-3V and bovine respiratory syncytial virus (BRSV). These other viruses may occur singly or in combination with each other.

Risk maps

Figure 2 shows maps of the continuous surface risk generated by ordinary kriging for brucellosis, BVD, neosporosis and IBR. Colors indicate free, low and high prevalence areas. As expected, high prevalence areas for brucellosis and neosporosis correspond to areas with a high density of dairy cattle in central and central north of Mexico. In the case of BVD and IBR, maps clearly show high risk of these two diseases in practically all the study area. Even when colors indicate differences in risk, most of them indicate high risk prevalence. In the case of BVD, a high risk area is observed in La Laguna, a geographic region including the states of Coahuila and Durango.

Probability distribution maps

Figure 3 shows maps with the probability distribution of disease provided by Maxent. Color indicates probability, red color means higher probability of occurrence while blue indicates low probability. Black dots indicate prevalence. Conditions for presence of neosporosis is almost all over the study area, especially in central Mexico and the coast of the Gulf of Mexico. Conditions for brucellosis seem to be associated with presence of

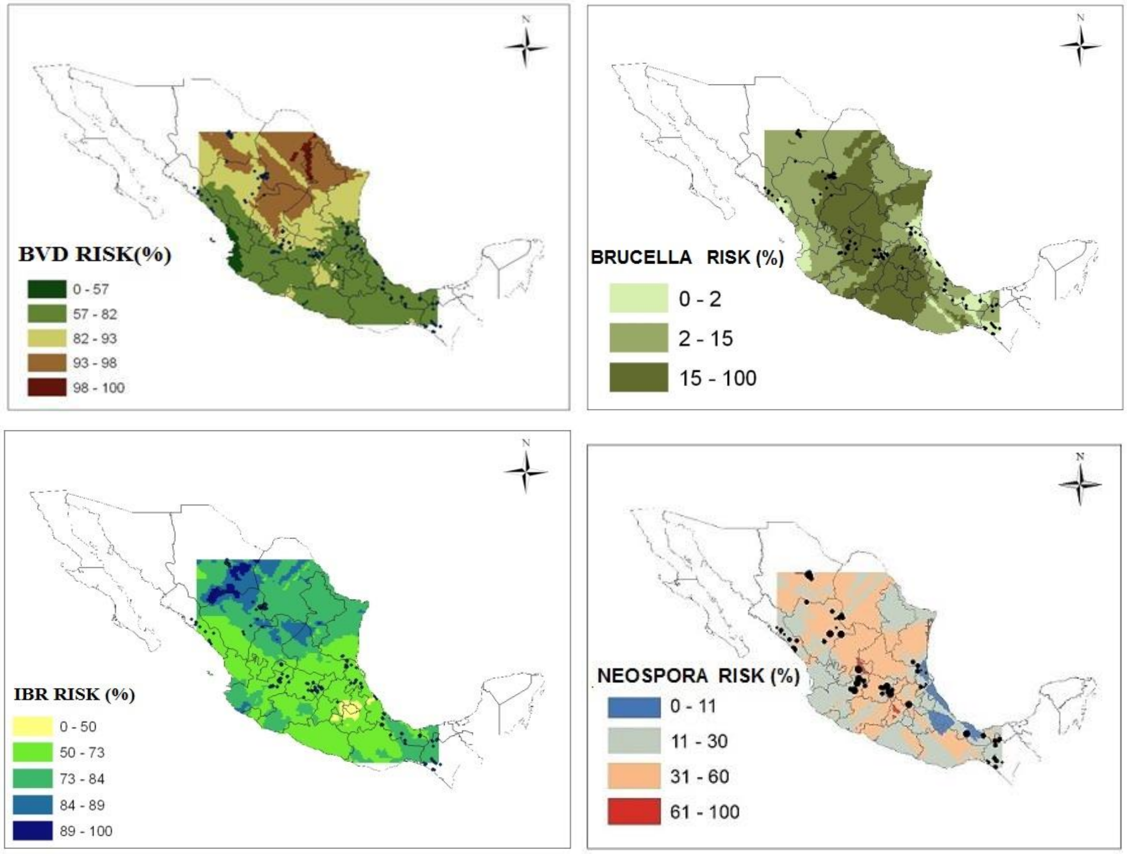

Figure 2. Maps of risk for reproductive diseases in dairy cattle by ordinary kriging for the study area. Intensity of color represents disease risk in terms of prevalence.

dairy cattle in central and central north of Mexico. IBR and BVD are both more probable of occurring in central Mexico and in the coast of the Gulf of Mexico. It seems that disease presence is more a consequence of the presence of cattle than climatic conditions.

DISCUSSION

The overall prevalence of brucellosis with the Rose Bengal test was 14.7%, and witn RIT test 5.1%. It is possible that results from the Rose Bengal test are influenced by vaccination. Most herds in Mexico use either the *B. abortus* RB51 or the strain19 vaccine, both are allowed. In the intensive and family type systems, calves are vaccinated at 5 months of age, with a boost of 6 months later and a second boost 12 months later. Therefore, the 5.1% from the RIT test is more accurate since this method discriminates the vaccinated from the infected.

Previous studies reported prevalence rates of Brucellosis of 10.3% in La Laguna (states of Coahuila and Durango) (Salgado et al., 1991), and from 42.8 to 75% in Guerrero (Xolalpa et al., 1991). In the present study, the highest prevalence was observed in Tizayuca, Hidalgo (77%). Tizayuca is a dairy complex with about 25,000 cows in an intensive system where contact between animals from different herds is common and entrance of animals from different sources is frequent. Prevalence of brucellosis in double-purpose system was 2.4%. This kind of system occurs in the tropical areas of Mexico, where the average temperature is 24 ± 6°C and the number of cattle per hectare is low (≈2.4) compared to the intensive (≈9) and family-type systems (≈3.0). Therefore, conditions for the pathogen are adverse and have less probable transmission than in the intensive system.

Risk factors associated with prevalence of brucellosis were: herd size, introduction of animals to the herd, use of common sheds, intensive production system and replacements coming from different herds. Some of these factors may be modified to reduce the chances of disease transmission, such as introduction of replacements from different herds. As can be modified, other research previously reported no disposal of abortions, presence of dogs in production premises,

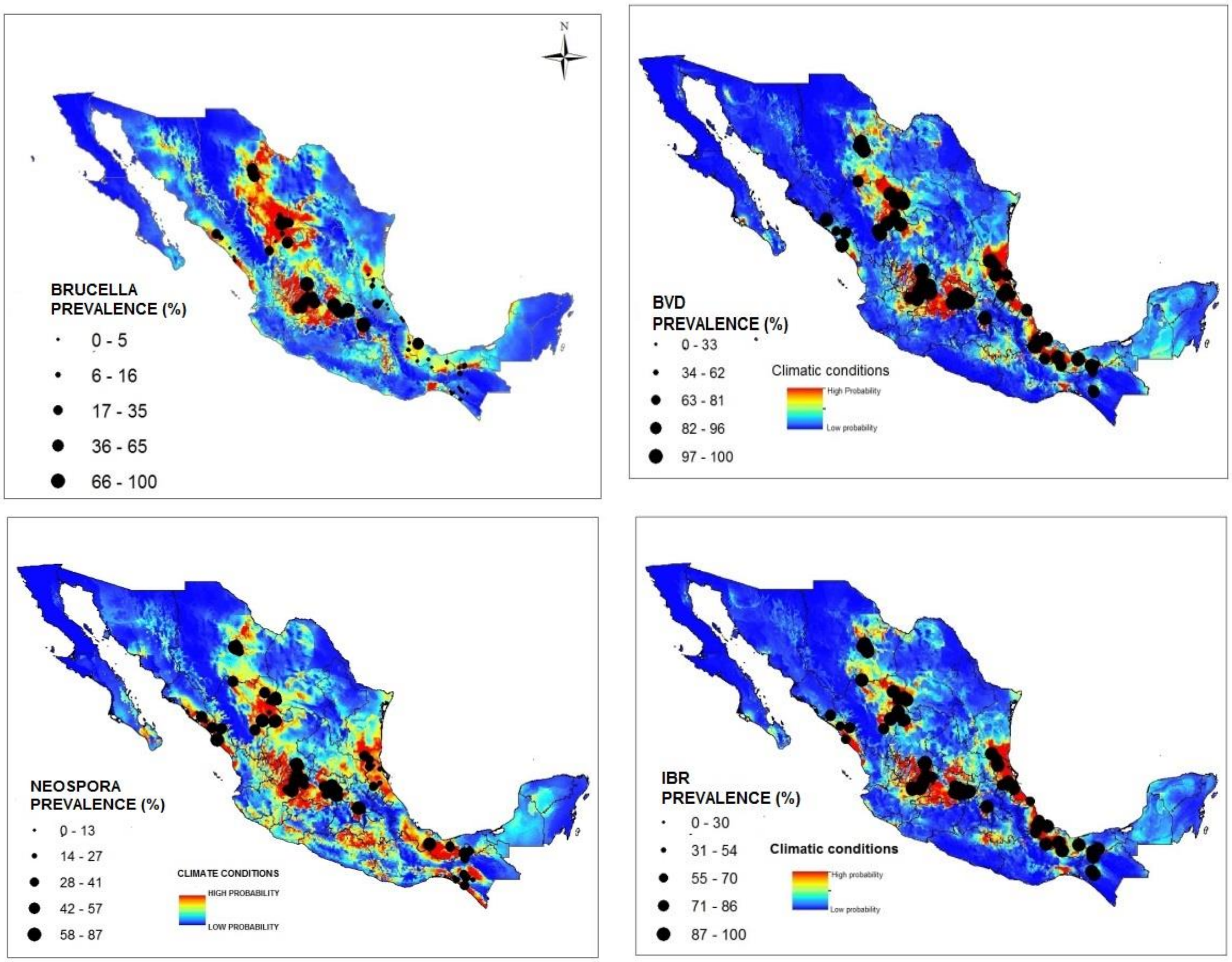

Figure 3. Maps showing regions with prediction of occurrence for brucellosis, BVD, neosporosis and IBR in Mexico. Color indicates predicted probability, red color indicates higher probability and blue color lower probability. Black dots indicate actual disease prevalence.

milking sick and healthy animals at the same time, and no eliminating of reactors (Rosales et al., 2012).

The 79% prevalence rate for BVD found in this study is similar to those reported previously: between 89.2 and 97% for the states of Aguascalientes, Jalisco, Guanajuato and Zacatecas (Solís-Calderón et al., 2003), 60% for Veracruz (Salas et al., 2009), and 67.2 for Tabasco (Rosete et al., 2014), but is much higher than the 21.1% reported in the state of Hidalgo (Sanchez-Castilleja et al., 2012), and the 14% reported for beef cattle in the south of Mexico (Solís-Calderón, 2005). Risk factors such as herd size and introduction of replacements from different herds have been associated with seroprevalence (Solis-Calderón et al., 2005). Type of milking, reproductive disorders and season (winter) has been previously associated with higher prevalence of BVD (Cantu and Alvarado, 1998; Sánchez-Castilleja et al., 2012).

Prevalence of neosporosis in this study was 36.8%, close to that previously reported for dairy cattle in Coahuila, Tamaulipas and Nuevo Leon, 42 to 72% ((Garcia-Vazquez et al., 2002; Garcia-Vazquez et al., 2005; Morales et al., 2001b), but higher than that reported in beef cattle in the south (8.5 to 15%) (Garcia-Vazquez et al., 2009). In the northeast the prevalence was 16% (Meléndez et al., 2005) lower than that reported in central Mexico 59% (Garcia-Vazquez et al., 2002). Relationship between seroprevalence and abortions in the herd has been documented. Herds with 13 to 30% of abortions had seroprevalence of 72%, while herds with12% of abortions or less had seroprevalence of 36% (Morales et al., 2001b).

Table 3. Risk factors associated to presence of reproductive diseases in dairy cattle in Mexico.

Disease	Risk factor	Categories	P	OR	95%CI lower	Upper
Brucellosis	Herd size	< 100				
		201 to 300	0.026	4.4	1.2	16.3
		≥ 300	0.000	5.1	2.4	11.2
	Introduction of animals	< 30				
		31 to 60	0.000	4.1	2.3	7.6
	Type of shed	Individual				
		Mixed	0.000	4.1	2.5	6.9
	Production system	Double Purpose				
		Intensive	0.001	2.4	1.4	4.2
	Origin of Replacements	Same Ranch				
		Diferent ranch	0.000	6.0	3.2	11.2
BVD	Total of animals	< 100				
		201-300	0.000	59.2	20.2	174.0
		≥ 300	0.000	7.5	3.6	15.8
	Type of shed	Individual				
		Mixed	0.000	2.4	1.5	3.8
	Calving intervals	< 395				
		More than 395	0.000	3.5	2.1	5.7
	Production system	Double purpose				
		Intensive	0	21.8	10.8	44.1
		Family-run	0	5.5	3.3	9.0
Neosporosis	Abortion	< 3				
		3 to 5	0.000	0.6	0.5	0.8
		≥ 5	0.37	1.1	0.8	1.4
	Colostrum type	Treated				
		Fresh	0.009	1.9	1.5	2.6
	Services per conception	< 3				
		≥ 6	0.000	3.9	2.1	7.0
	Production system	Double purpose				
		Intensive	0.009	2.9	2.3	3.9
IBR	Type of breeding	Artificial				
		Direct breeding	0.001	1.6	1.2	2.2
	Parainfluenza 3 virus	Negative				
		Positive	0	2.5	2.1	3.1

Previous studies about seroprevalence of IBR in Mexico have reported dissimilar results to the 75% found in this study: 90% in dairy cattle in Queretaro (Escamilla et al., 2007), 3.4% in Michoacan (Segura-Correa et al., 2010) and 69.5 in central Mexico (Morales et al., 2002). In beef cattle, the seroprevalence was also variable, 5% in Yucatán in Holstein-Cebu cross breeds (Calderon et al., 1997), 13.6% (Cordova-Izquierdo et al., 2009) to 54.4% (Solis-Calderon et al., 2003) also in Yucatán, and 44.2% in the state of Veracruz, in the Gulf of Mexico (Gutierrez, 2009).

Figure 2 shows areas of risk for the four diseases. The areas of high risk are wide and the risk is high. Risk for brucellosis and neosporosis is specially high in central and central north of Mexico, where the dairy cattle population is dense and the system of milk production intense, suggesting relationship between these two factors.

Figure 3 shows the results of Maxent. Red color indicates favorable conditions for the presence of disease. Conditions for brucellosis are more evident in central and central north, confirming that intensive systems of milk production favor the presence of the disease. Conditions for neosporosis are all over the study area, confirming that this disease affects cattle in all production systems. In the case of BVD and IBR, favorable conditions are present in the center of the country and in the coast of the Gulf of Mexico. The high prevalence in the central region is not surprising, where prevalence rates may be influenced by vaccination. In the coast of the Gulf of Mexico, however, the vaccine is not used but the prevalence is high, suggesting that the seroprevalence is due to real infections.

Conclusion

Brucellosis, BVD, neosporosis and IBR are four reproductive diseases that are widely distributed in dairy cattle in Mexico. The seroprevalence of these diseases is high and is especially associated with intensive systems of production. Common farming practices such as the introduction of replacements from different farms significantly contribute to increase disease prevalence in the herd. Eventhough vaccination may have a role in the high prevalence of these diseases observed in some parts of Mexico, the high prevalence in some areas where vaccination is not common, suggest that the real prevalence is high.

Conflict of Interests

The authors have not declared any conflict of interests.

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