Epidemiological Investigation of the Prevalence of *Leptospira Spp.* In Pigs in Israel

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ABSTRACT

Twenty one pig farms, comprising about 14,400 sows and 90,000 fattening pigs, were examined relative to *Leptospira* serological positivity in fattening pigs. Twelve farms (57.14%) were positive with average of 41.67% positive samples. *L. canicola* was the predominant serovar (100%), with a few cross-reactions for other serovars. There was as strong correlation between average number of positive samples and number of sows in farm ($R^2 = 0.9615$). Number of positive samples was significantly higher in farms not vaccinating sows ($P = 0.0059$); practicing natural insemination ($P = 0.0280$); keeping fattening pigs on a full floor ($P = 0.0019$); presence of dogs ($P = 0.0002$); farms with high proximity to each other and shared infrastructures like perimetral walls, sewage, roads, workers ($P = 0.0005$). In such a situation, swine breeders should vaccinate their breeders population, their dogs and implement management measures. Leptospirosis is a notifiable disease in Israel.

Keywords: *Leptospira spp.*; Pigs; Israel; Swine Vaccination; Dog Vaccination; Treatment.

INTRODUCTION

There are 24 pig farms in Israel: one in the South (Negev) region and the others located in the North of Israel (Galilee) region, numbering some 15,000 breeders and averaging 180,000-190,000 slaughtered pigs per year (1). Out of 24 pig farms, one is a "mini-pig" farm, dedicated to supply of laboratory pigs and the others are intended for meat production. Fifteen farms are located in a unique densely populated compound in Iblin, using common infrastructures such as access roads, sewage and in some cases workers.

Leptospira spp. in swine breeding represents a cause of reproductive losses, which may vary from abortions at every stage of pregnancy to stillbirth, infertility (2) and so-called SMEDI syndrome (Stillbirth; Mummified; Embryo Death; Infertility). At least 13 pathogenic species of *Leptospira* are known, with some 260+ sero-variants. Of these pathogenic species, at least two, *L. interrogans* and *L. borgspetersenii* are considered relevant in swine breeding, with 6 sero-variants in *L. interrogans* and 2 sero-variants in *L. borgspetersenii* (Table 1) (2, 3).

The prevelance of different serovars of *Leptospira* varies in different geographical areas: for example, while *L. pomona* is widely prevalent in North America (2), *L. australis/Bratislava* is apparently the dominant serovar in European western countries (4), As further described, *L. canicola* appears to be the most prevalent *Leptospira* in Israeli swine farms, while it is considered of no significance for swine farms in European countries (2, 4).

Leptospira is generally transmitted between animals, but also from animals to humans, from contaminated water supplies, urine, soil or swine farms floor dirt, through dermal lesions, direct contact to mucosae and conjunctivae (eyes, mouth, nose) and even through aerosols directly to the respiratory tract (3, 4). Urine and kidneys may represent a hazard to workers at slaughter of infected pigs. Since 2014, *Leptospira* has not been listed in the OIE list. However, it is

considered an occupational hazard for professionals in constant contact with their reservoir (2, 4) and it is classed in Risk Group 2 for human infection (5, 6). Humans represent an incidental host (7). In this perspective, in Israel, 46 cases of human leptospirosis were diagnosed between 1986-1999 (8), including cases in swine farms workers. Another 7 cases, of cattle origin, along the Jordan river in 2006 (9), and 36 more cases, probably of wild boar and cattle origin and in 2018 through contamination of recreational areas and pools (7, 10). In fact, *Leptospira* infection is facilitated by its relatively low infective dose and its survival in a humid environment and neutral pH (4). Infection of humans through *Leptospira* contaminated pools, creeks, ponds and lakes have been reported in North America since the '40s (3). In Europe, in the last decade, the leptospirosis incidence in humans was between 0.1 to 0.2/100,000 inhabitants (11), but no reference has been given to a possible swine (wild or reared animal) origin.

Leptospira is also prevalent in Israeli swine farms, but to the best knowledge of the authors, without outbreaks or major episodes of clinical incidence. In fact, clinical disease or outbreaks have not been reported among swine farms in the last decade, despite serological evidence (1).

In this article we do not propose discussing *Leptospira* induced disease in pigs. Rather we present results of a serological survey, relative to *Leptospira spp.* in pig farms, its prevalence within examined farms with reference to breeders vaccination, type of insemination (natural; artificial), farms structural characteristics (flooring system), close proximity of farms within the Iblin area and the role of possible carriers.

MATERIAL AND METHODS

Twenty one pig farms, out of 24, were included in this survey: one in the South-Negev region and 20 in the Northern-Galilee region. Three small farms, one with one sow and some 10 pigs in Kfar Yassif, and two with 35-50 sows and about 300-450 pigs in Iblin, were not included in the survey due to of unavailability of owners within the time-frame of the survey. The total sow population of the examined farms was 14,441 (Standard Deviation ±908) (SD); average of 687 breeders; minimum 35; maximum 3,640 breeders. The total fattening pigs considered, at all ages, was assumed as 10,000 pigs in the South-Negev farm and 80,000 pigs in the North-Galilee region. This assumption was based on yearly average slaughter data from both South-Negev and North Galilee slaughterhouses with an estimated slaughter age around 6 months. Out of these 21 farms: in 11 farms, sows were not vaccinated; in 10 farms sows were regularly vaccinated. Vaccination was generally performed in gilts before their first insemination (priming and booster vaccination) and then a booster after each farrowing in sows, in the second week

Table 1: Relevant *Leptospira spp.* in reared swine; swine hosting role; excretion routes and length; natural hosts which may infect swine (from 3; modified).

		Serogroup	Swine hosting role	Excretion in swine	Excretion length	Natural hosts
Species	***L. interrogans***					
	serovar					
	pomona	Pomona	manteinance host	urine	3-4 weeks	skunk (?)
	australis	Bratislava	manteinance host	venereal		livestock & wildlife
		Muenchen	manteinance host	""		
	icterohaemorragiae	Copenhageni	incidental	urine	≤ 35 days	brown rat
		Icterohaemorragiae	incidental	urine	≤ 35 days	brown rat
	grippotyphosa	Grippotyphosa	incidental less common			wildlife
	tarassovi	Tarassovi	incidental			wildlife
	canicola	Canicola	incidental acquired	urine	up to 90 days	dogs
Species	***L. borgspetersenii***					
	serovar					
	hardjo	Sejroe	incidental			cattle
	sejroe	Sejroe	less common			

Maintenance host: species in which infection is endemic and is usually transferred from animal to animal by direct contact (from 2, 3, modified)

of lactation (4, 12). A vaccination plan against *Leptospira* in pigs is aimed to protect breeders against abortions and SMEDI syndrome (2, 4). Induced antibody-titer is of short time duration (2, 4) and does not last to give sufficiently protective titers until next farrowing, some 130-140 days later. Therefore, because of vaccination performed *after* each farrowing, vaccine-induced antibody titer in breeders' colostrum remains negligible or negative. In such a situation, consumption of colostrum will not induce antibody titers in piglets (12), or for a short time only (2). Fattening pigs are generally not vaccinated against *Leptospira*, and indeed, they were not vaccinated in this study.

In this survey, 10 fattening unvaccinated pigs from each farm were included (2) with a total of 210 animals. Assuming the swine populations as indicated above, and assuming that the Iblin area is a unique epidemiological entity due to the close proximity of farms and shared infrastructures, this sample ensures 99% confidence limits in detecting at least one single positive animal, with a 2.5% minimum prevalence (13). Pigs were sampled at slaughterhouse, immediately after slaughter by severing the brachiocephalic complex, as usual in pig slaughter, and collecting the blood using (open) vacutainers without anti-coagulant, without need of needles. Because of withdrawal times, sampling pigs at the slaughterhouse ensured a certain time interval from any antibiotic treatment which could mask infection. Blood samples were submitted at "Kimron" Veterinary Institute in Beit Dagan, Israel, and tested with an "in-house" Micro Agglutination Test (MAT) technique (6) against 8 serovars of *Leptospira spp.*, namely *canicola, pomona, tarassovi, hardjo, grippotyphosa, bratislava, ballum, icterohaemorrhagiae.* Reference antigens were supplied by OIE Reference Laboratory "KIT Royal Tropical Institute", Meibergdreef 39 1105 AZ Amsterdam, The Netherlands; www.kit.nl. MAT is considered the "gold standard" test for the detection of the disease, confirmation of clinical cases, prevalence of infection and disease surveillance (6). MAT threshold titers were considered at ≤ 1:100 as suspicious/doubtful and at > 1:100 as positive. Absence of vaccination in fattening pigs, age at blood-sampling and negligible/negative colostrum titers (12) were considered indicative of infection in pigs positive to MAT > 1:100.

The relative small number of samples, allowed data comparison using Fisher's exact test, to calculate an exact probability value between farms' results in relation to considered characteristics (https://www.scistat.com/statisticaltests/fisher.php); correlations (R^2) were calculated by mean Xcel data package; Windows 10).

Table 2: Overall results: positive and doubtful farms and samples; absolute numbers and percentages.

	Samples	Farms
Total tests	210	21
Positive	50	12
Doubtful	13	2
Positive samples, total	23.80%	57.14%
Positive samples in positive farms	41.67%	

RESULTS

Fifty samples (23.80%) were positive to the MAT test. Positive samples were found in 12 farms (57.14%), in which average number of positive samples was 4.17 (minimum 1; 10%; maximum 9; 90%). Overall results are presented in Table 2 below.

Leptospira serovar *canicola* was the prevalent serovar: it was represented in all the 50 positive samples; few samples revealed also positivity to another 4 serovars: *grippothyphosa* (4 positivity's); *bratislava* (2 positivity's); *ballum and icteroemorrhagiae* (1 positivity).

Positivity's to *Leptospira* showed a high correlation to the number of sows in the farms ($R^2 = 0.9615$)(Figure 1)

Relative to vaccination of breeders/sows against *Leptospira,* positivity was higher in fattening pigs from farms with non-vaccinated sows (NV), compared to farms with vaccinated sows (V): 7 out of 11 NV farms (63.6%) with a mean of 5.15 positive samples (SD 2.61); versus 5 V farms out of 10 (50%) with a mean of 2.80 positive samples (SD 2.17). There was a significant relationship (P = 0.0059) between vaccinated sows and less serological positivity in fattening pigs.

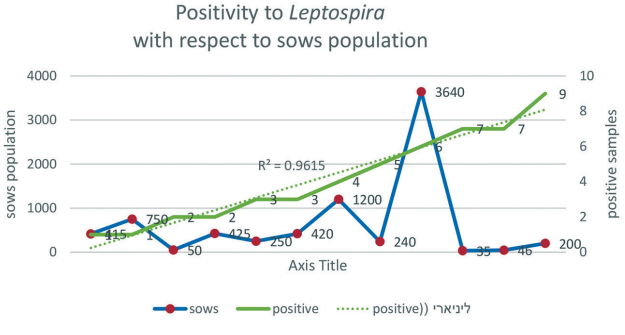

Figure 1: Positive samples in positive farms with respect to sow population

Relative to type of insemination: Fifteen farms used artificial insemination (AI): Five farms used natural insemination (NI) and one farm used both types of insemination. Seven AI farms, out of 15 (46.6%), 4 NI farms out of 5 (80%) resulted positive to *Leptospira* with a mean of 4.00 positive samples (SD 3.02) in AI farms and 4.00 positive samples in NI farms (SD 2.00). In the case of a farm using both natural and artificial insemination 2 pigs presented with positive samples. There was a significant difference (P = 0.028) between farms practicing AI or NI.

Relative to farms structural characteristics, namely floor construction: slatted (S) of full (F) floor, 10 farms kept fattening pigs on slatted floor; 11 farms on full floor. 5 slatted farms out of 10 (50%), 7 full-floor farms of out 11 (63.63%) resulted positive to *Leptospira*. Full-floor farms presented a mean of 5.14 positive samples (SD 2.73), while slatted-floor farms a mean of 2.80 positive samples (SD 1.92). There was a significant difference (P = 0.0019) between farms keeping fattening pigs on slatted or full floor (Figure 2). Note that the full-floor tends to lead to slurry and puddle accumulations.

In relation to the movements of fattening pigs from one farm to another: Eight farms, were moving pigs (M), while 13 were keeping fattening pigs at their original farm (NM). Out of the farms moving pigs, 5 farms out of 8 (62.50%), and from the farms not moving pigs, 7 farms out of 13 (53.84%) resulted positive to *Leptospira* antibodes. Farms moving pigs presented an average of 4.00 positive samples (SD 3.39), while farms not moving pigs averaged 4.29 positive samples (SD 2.21). There was no significant difference (P = 0.742) between farms moving or not moving their fattening pigs from site to site.

In relation to the proximity of farms in Iblin area, 15 farms were considered as in the same proximity (P) to each other, being located in the same compound sharing infrastructures like separation walls, access road, sewage, and in some cases also workers. 10 P farms out of 15 (66.67%) and 2 non-proximity (NP) out of 6 (33.33%) resulted positive to *Leptospira.* P farms presented an average of 4.50 positive samples (SD 2.12), while NP farms an average of 2.50 positive samples (SD 2.68). There was a significant difference (P = 0.0005) between the farms in close proximity and contact at Iblin compound, and other farms (Figure 3). Infection of *Leptospira* through shared sewage systems has been shown previously (4). It should be emphasized that among NP farms, two were completely isolated from North (Galilee) region: the mini-pigs farm, located in Yokneam, and the South (Negev) farm; both of them resulted serologically negative to *Leptospira.*

As above mentioned, *Leptospira* serovar *canicola* was the prevalent serovar: it was represented in all the 50 positive samples. *Leptospira canicola* has the dog as natural host or reservoir (2, 3, 4). In consideration of the almost exclusive positivity of sera to *canicola* serovar, we have considered the presence of dogs in the studied farms. Dogs, most of them stray dogs, were present, in 19 farms (D) out of the 21 examined (Figure 3) with 1 to 3 dogs each farm. In two farms, dogs were kept on lash during the day, then freed in the evening. Dogs were often freely present among animals and between different farms within the compound. In two farms, there were no dogs (ND) among the pigs at any times. Twelve farms with the presence of dogs out of 19 (63.15%) were positive to *Leptospira;* none of the farms without dogs were positive for *Leptospira* antibodies. Farms without dogs included the mini-pig farm and the farm in the South (Negev). Farms with the presence of dogs showed an average of 4.17 positive samples (SD 2.62). There was a significant difference (P = 0.0002) for the serological finding between farms having dogs and those without dogs. Results are summarized in Table 3 below.

Figure 2: Fattening pigs on full-floor: young breeders on slatted-floor. Full floor leads to slurry accumulation

Figure 3: Iblin compound is indicated by the red ellipse; many farms of the compound share perimetral walls; yellow shapes indicate other farms in Iblin area

Figure 4: a dog among sows in a Iblin compound farm

DISCUSSION

As above summarized, *L. canicola* resulted the predominant serovar in this survey; the few positivity's to other serovars may be considered as cross-reactions, which are common in the Leptospira MAT (3). *L. canicola* is considered of low epidemiological significance in intensive swine farming in EU/Western countries (4). Although wild animals may represent a source, it is commonly accepted that dogs represent the natural maintenance host (2, 3, 4) and previous epidemiological surveys have identified in dogs the source of infection for pigs (4). After infection and a period of leptospiremia, *Leptospira* localize in the pig kidneys' proximal tubules, multiply and then are excreted intermittently in the urine (3) for up to 90 days (4). Urine remain infectious 6 days or more when not diluted (4). On the full floor, *Leptospira* can remain in urine puddles and slurry enough time to represent a further source of infection to other pigs.

Vaccines in pigs mainly protect against reproductive disease (3), SMEDI syndrome (2, 4) and against urine shedding (3, 13, 14, 15). According to previous experience, passive/colostral immunity, induced by polyvalent *Leptospira* vaccines in sows, is scarce, unable to confer long-lasting colostrum passive protection against leptospirosis in piglets (12), or of short duration (2), because sows are vaccinated *after* farrowing. Vaccination will protect next pregnancy which will start 3-4 weeks after vaccination; but vaccine-induced titer will not or rarely persist enough in sows in order to induce an appreciable colostrum titer at the next farrowing, 4-5 months later; some authors attribute few weeks of protection in piglets from vaccinated sows (2). It should be empathized as pig vaccination reduced urine excretion to 1.5% of urine samples from vaccinated pigs towards 39.4% samples from non-vaccinated pigs; there was also a lower number of pigs shedding *Leptospira* in the urines: 31.5% vs 95% (14). Therefore, relative to differences between farms with vaccinated or unvaccinated sows, it should be assumed that vaccination reduces *Leptospira* shedding in sows, thereby reducing piglets exposure and infection.

Control of leptospirosis is dependent on the combined use of three strategies: vaccination at strategic times, antibiotic therapy and management (2, 4). Vaccination will not eliminate infection, however it will markedly reduce the prevalence of infection in a herd (2, 4).

Vaccination

In the described situation, vaccination must take into account both pig breeders (gilts, sows, boars) and dogs.

Multivalent vaccines are available in the market for both categories of animals; they should contain the *canicola* serovar, due to the serovar-restricted nature of immunity induced by a vaccine (16).

Pigs: *Leptospira* vaccines used in pigs, are inactivated and generally included with Porcine Parvovirus (PPV) and *Erysipelothrix rhusiopathiae* (Erysipelas) antigens. In the described situation, all pig breeders in North (Galilee) farms should be vaccinated. In pig breeders, vaccination plan

Table 3: Serological positivity's to *Leptospira spp.* according to the characteristics of the farms.

Parameter		No. farms	No. samples	+ve farms	+ve samples (mean)	difference
Vaccination	Yes	10	100	5	2.80	P = 0.0059
	No	11	110	7	5.15	
Insemination	AI	15	150	7	4.00	P = 0.0280
	NI	5	50	4	4.00	
	AI/NI	1	10	1	2.00	not tested
Floor	S	10	100	5	2.80	P = 0.0019
	F	11	110	7	5.14	
Moving fattening pigs	M	8	80	5	4.00	NS
	NM	13	130	7	4.29	
Proximity (compound)	P	15	150	10	4.50	P = 0.0005
	NP	6	60	2	2.50	
Dogs	D	19	190	12	4.17	P = 0.0002
	ND	2	20	0	0	

AI = Artificial Insemination; NI = Natural Insemination
S = Slatted floor; F = Full floor
M = Moving fattening pigs; NM = fattening pigs Not Moved
P = Proximity between farms at Iblin area; NP = farms not in the proximity to the compound
D = Presence of Dogs on the farms; ND = No Dogs on the farm

consists of two doses (priming; booster) in gilts and unvaccinated stock, generally 3 to 4 weeks apart; before the first insemination in gilts and before next insemination in sows. This is followed by a booster after every farrowing and generally in the second week of lactation. Boars are vaccinated first time (priming and booster) as in gilts; then a booster every six months. Immunity is aimed at preventing abortions and SMEDI syndrome, from a clinical point of view, by neutralizing *Leptospira* in the blood and preventing infection of the reproductive system and fetuses. Immunity will last between 3 to 6 months, and therefore the need to vaccinate twice a year as described, and before next insemination and pregnancy.

Furthermore, vaccination may not protect against renal colonization however it reduces urinary excretion of *Leptospira* (13, 14, 15). When infected from sows' urine, some piglets will suffer from acute/petechial, fatal disease and others will show weakness (2); *Leptospira* shedding will have its greater intensity in the first 3-4 weeks of infection (2). At this stage, the piglets will be already weaned, mixed within them; so that infection will spread in the growing/fattening areas.

Dogs: All the dogs in swine farms should be vaccinated. *Leptospira* vaccines used in dogs are also inactivated, multivalent and, in the described situation, should include the *canicola* serovar (16). Prevention of urinary shedding of *Leptospira* remains a key objective of the vaccination in dogs (17). In puppies, or in unvaccinated adult dogs, vaccination consists of two doses (priming and booster) 3 to 4 weeks apart; a booster vaccination is needed once a year (17). Vaccines protect against disease and renal shedding under experimental conditions, but transmission of serovar *icterohaemorrhagiae* from immunized dogs to humans has been reported (3). Only two farms, of 450 and 750 sows each, vaccinated their dogs; these two farms had only 1 serological positive sample, in one of the farms.

Antibiotic therapy or prophylaxis

It should be emphasized that antibiotics treatments alone will not completely eliminate pig-hosted *Leptospira* infections from individual carrier animals (3). Antibiotic treatment should be considered as only one of the three necessary coexistent strategies, together with vaccination and management.

There are different antibiotic protocols for *Leptospira* control in pigs. Some of them are probably more indicated in the course of *Leptospira* abortion or SMEDI outbreaks: (Streptomycin 25 mg/kg, i.m., once a day, 3 to 7 days; Tylosin 40mg/kg to 50mg/kg, per os, by feed, 5 days; etc.) (2, 4); one treatment cycle only in course of the outbreak. In the described situation, diffused positivity without clinical outbreak, an efficacious and proven antibiotic control protocol would be based on Tetracycline (Oxytetracycline; Clortetracycline) per os, in feed, at no less than 1,200 – 1,400 ppm, for 7 days in all the breeders at same time; treatment should be repeated, every 45 to 90 days, according to veterinary indications and to serological situation and/or SMEDI signs. Tetracyclines strongly reduce or even eliminates *Leptospira* shedding in treated swine (18). Such a treatment could also be implemented in fattening pigs, generally only once, when reports of kidney lesions from slaughterhouse are confirmed as caused by *Leptospira* infection. Twelve weeks of age is, generally, the age at risk of disease in fattening pigs (2, 4). In such a situation, withdrawal times should be accurately calculated before sending treated pigs to slaughterhouse.

In dogs, doxycycline therapy is recommended against *Leptospira* for its ability to eliminate the organism from all tissues, including the renal tubules. Elimination of organisms from the renal tubules terminates leptospiruria and prevents transmission of the organism. Doxycycline is used at 10 mg/

kg/24 hours, per os, once a day, for 10 days. Treating stray dogs *per os* and for a so long period, may be extremely difficult if not impossible at all. A pilot study suggested that cefovecin at the registered dose of 8 mg/kg/ sub-cutaneous injection; 2 doses at 14 days interval, would be effective (19), and much easier to use.

Management

Further than vaccination and antibiotic treatment, other predisposing factors in fattening units should be carefully investigated: presence of carriers; floor type; floor irregularities with puddles formation; slurry removal; cleanness; cleaning frequency, etc. The main management factor in the control of leptospirosis is the prevention of direct or indirect contact with carriers by other animals, including domestic (2, 3, 4, 16). Strict biosecurity should be implemented, and carriers (dogs in this case and also rodents) control programs should be implemented in the production complex (2, 4). A further contribution to reduction in piglet exposure may be represented by use of slatted-floor in farrowing crates, as was shown in this study (Figure 4). In the described situation, only 6 farms used full-floor farrowing crates; 4 farms, out of these 6, were positive to *Leptospira*, with average 5.5 positive samples; of these 4 farms, one vaccinated against *Leptospira*, and was positive for only one sample. Fifteen farms used slatted-floor farrowing crates: 8 farms, out of these 15, were positive to *Leptospira* with, average, 1.7 positive samples. Farrowing crates should be thoroughly cleaned and disinfected after every weaning of piglets; full-floor farrowing crates should be maintained in a way to avoid urine puddles and slurry in general; cleaned almost every day and/ or, at least, buffered and kept dry through abundant sawdust. *Leptospira*, in fact, cannot survive in a dry environment.

Leptospira also cannot survive in an acid environment: in such a perspective, the addition in feed of urine acidifiers (Benzoic acid, 0,5% - 1%) (20, 21), or a mixtures of acid salts (1% to 2%) (21) for prolonged periods in breeders (30-40 days), or even their entire fattening period in growing pigs (21), are considered effective. These feed inclusions can acidify pig urine from pH 7.50 - 7.48 down to pH 5.69 – 5.02 in growing and finishing pigs, respectively (21). Anyway, a study (21) also underlined how average pH of the top layer of the slurry may remain higher than pH of urine: pH 7.28 – 7.04, therefore ineffective against *Leptospira*. These data again underline the critical importance of routine cleaning and slurry removal when pigs are kept on full floor (Figure 2).

CONCLUSIONS

Leptospirosis is a notifiable disease in Israel (22); it may seriously affect swine production (2, 4, 23, 24); and it is considered a professional hazard (2, 4) and indeed infections between swine workers and pigs have been recorded in the past (8). Despite pig farming in Israel is limited, this work demonstrated prevalence of *Leptospira* in swine farms;

Figure 5: farrowing crates on slatted or full floor

12 out of 21 examined (57%) were positive with 23.8% of positive samples in general and 41.6% positivity within positive farms, with almost exclusive involvement of *canicola* serovar. Proximity of swine farms to each other with shared infrastructures, presence of dogs, rearing pigs on full floor, use of natural insemination, resulted in higher positivity to *Leptospira*. We can also state that all the positivity samples were relative to North (Galilee) farms.

Following the conclusion of this survey, farmers were recommended to vaccinate on a voluntary basis (1): this is erroneous; as it is not enough. In such a situation, especially due to the proximity of many farms, vaccination should be implemented in all the farms. In addition to vaccination, farmers should be made aware of infrastructures and management role in spread of *Leptospira*; infection, containment and reduction through wise use of antibiotics and alternative tools (e.g. acidifiers in feed).

No particular relevance has been given to the predominant role of the serovar *canicola*, and to numerous dogs in the area, inside the farms and even within the animals: this is also erroneous. In such a situation dogs should be vaccinated on a routine basis or if unwanted they should be relocated far away from pig farms.

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