

A 10 year review of the number of bovine dairy holdings and the dairy bovine population on the Maltese Islands

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Abstract. The process of identification and registration of bovines and bovine holdings on the Maltese Islands has been computerised since 2002, with the introduction of the National Livestock Database of Malta. This is a computerised and centralised system which has made collection, management and analysis of data possible. The aims of this paper were to study in detail ten year trends in the number of bovine dairy holdings together with the bovine population on these holdings and to compare these trends with those reported in other European countries. Six trends related to the number of bovine dairy holdings and their bovine population were analysed in the study. The general trends showed that there was a significant decrease in the number of dairy holdings, in the bovine population and in the number of female bovines greater than 2 years of age during the study period. The average herd size and the average number of females greater than 2 years of age on the dairy holdings showed no statistically significant changes. On the other hand, a significant increase in the ratio of female to male bovines was registered on these holdings.

Keywords National Livestock Database – number of bovine dairy holdings – bovine population – Maltese Islands

1 Introduction

The data collection with regards to the number of dairy holdings and the number of bovines takes place regularly in every European country. This is necessary

amongst other things to allow for the monitoring of various parameters such as production, animal welfare and food safety.

Jongeneel et al. (2011) report that the number of dairy holdings in the European Union has been gradually declining from the year 2000. Furthermore, Nowicki et al. (2009) reported that this trend was expected to continue.

The objectives of this paper were to study in detail the ten year trends in the number of dairy bovine holdings together with the population of bovines on these holdings and to compare these trends with those reported in other European countries. Three methods were used in the study to collect three datasets which were then analysed statistically.

The period of study was from the 1st January 2003, a year before Malta's accession to the European Union (EU) on the 1st of May 2004 (Government of Malta, 2003), to the 31st December 2012.

The study involved retrieval of data from the National Livestock Database (NLD) which is a computerised, centralised system set up in 2002, with the aim to facilitate the recording, management and analysis of livestock data.

The NLD is managed by the Veterinary and Phytosanitary Regulation Department (VPRD) within the Ministry for Sustainable Development, the Environment and Climate Change. This database was recognised as being fully operational by the European Union as stated by Commission Decision 2004/588/EC of the 3rd June 2004 (European Commission, 2004). Furthermore, by means of Commission Decision 2005/415/EC (European Commission, 2005), Malta was authorised to make use

of the NLD and replace surveys of bovine livestock as required by Directive 93/24/EC (European Commission, 1993).

All bovine herds are obliged by Maltese law to be registered with the VPRD. Two important laws in this regard are Subsidiary Legislation 437.78 published as Legal Notice 292 of 2005 (Government of Malta, 2005b) and Subsidiary Legislation 437.84 published as Legal Notice 311 of 2005 (Government of Malta, 2005a).

The obligation of identification and registration of each bovine together with the collection of all the data in one national computerised system has made it possible to collect and analyse data regarding all registered bovines on holdings present on the islands of Malta and Gozo at any point in time.

2 Materials and Methods

2.1 Study design

A retrospective longitudinal study was conducted on the entire population of dairy herds present on the islands of Malta and Gozo registered in the NLD. No bovines were registered on the island of Comino during the study period. Six trends related to the number of dairy holdings and the dairy bovine population were analysed.

Bovine holdings on the Maltese Islands fall into two categories. These are the dairy holdings and the non-dairy holdings. The dairy holdings are licensed to produce and sell their milk to a dairy processing plant and their main objective is the production of fresh milk.

The non-dairy holdings are those bovine holdings which are not licensed to produce and sell milk and their main activity is the fattening of bovines for slaughter. These latter holdings are relatively small, family run and mostly managed on a part-time basis. The mean number of active non-dairy holdings per year throughout the 10 year period under study as calculated by Method 2 described below was 206.40 (SD = 21.82) in Malta and 13.70 (SD = 4.06) in Gozo. The holdings in Malta had a mean bovine population of 8.50 (SD = 0.91) and those in Gozo had a mean of 4.67 bovines (SD = 0.70). The non-dairy holdings in Malta contained 14.57% (SD = 2.50) of the total bovine population of Malta, whereas the holdings in Gozo contained only 1.09% (SD = 0.17) of the total bovine population of Gozo.

Due to the dynamic nature of the livestock population on holdings, different results can be obtained depending on what is considered as being an active holding. As a result, three methods were used in this study:

Method 1 (M1): Using this method, an active bovine holding was taken as being a holding on which at least one bovine was registered at the reference date of the 1st December of each year of the study.

Method 2 (M2): This method considers an active holding as one on which at least an average of one bovine is registered on the holding throughout the year. This method takes into account the average population on the holding per year, starting from the 1st January to the 31st December of each year. The calculation of the average population is in principle the average of the number of animals present for each day in the period. For computational efficiency, the database locates all the animals that were present at any time during the period. It then calculates the number of days that each animal was present during the period (animal-days). The total number of animal-days is then divided by the number of days in the year to obtain the average population per year on any particular holding.

Method 3 (M3): Using this method, a holding was considered as being active when at least one female bovine older than 2 years of age ($F > 2y$) was present on the holding on the 1st December of each year of the study. In this case it is assumed that dairy holdings having $F > 2y$ are still involved in milk production since nearly all of these bovines would be milk producing cows. This consideration was made since a number of dairy holdings winding down their activities would still have a number of bovines on the holding, such as young heifers and male calves or bulls, but in actual fact they would not be actively involved in milk production. This is especially so since during the period 2007 to 2012 an eradication programme for enzootic bovine leucosis (EBL) was underway (Government of Malta, 2009). The fact that at least one $F > 2y$ is present on a holding licensed as being a dairy holding assumes that it contains dairy cows and therefore is still involved in milk production.

The 1st December of each year was chosen as the reference date in order to follow the guidelines of the National Statistics Office (NSO) of Malta which uses the 1st December as its reference date when compiling the yearly cattle census as per Commission Regulation (EC) 1165/2008 (European Commission, 2008a) and Commission Regulation (EC) 1166/2008 (European Commission, 2008b).

2.2 Statistical Analyses

The data collected from the NLD was transferred to Excel files where data verification and validation was carried out. In all cases data from 2003 to 2012 were used in the statistical analyses. However during the verification process, the data fields concerning the number of $F > 2y$ of age for the year 2003, were not considered to be sufficiently accurate. This is due to the fact that when inputting data for animals born prior to 2003 in the database, the date of birth had to be transposed from pre-existing paper records which at times had in-

complete or inaccurate data. As a result, data for 2003 were omitted when analysing trends regarding $F > 2y$ of age.

The data used in the statistical analyses was then transferred to SPSS version 21, a statistical package that permitted descriptive statistics, correlation analysis and analysis of variance to be carried out.

3 Results and Discussion

3.1 The trend in the number of dairy holdings on the Maltese Islands

The trend in the total number of dairy holdings per year on the Maltese Islands during the period 2003 to 2012, calculated by the three methods described, is shown by the line diagram in Figure 1.

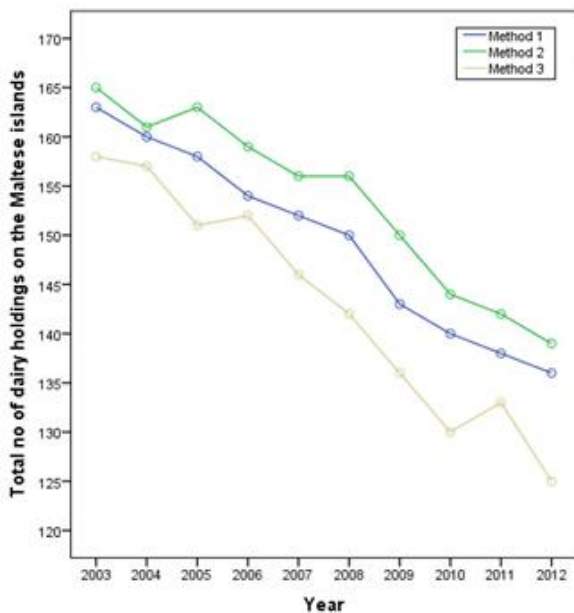


Figure 1: Line diagram showing the total number of dairy holdings on the Maltese Islands per year from 2003 to 2012 calculated by the three methods described.

All three methods show a decrease in the total number of dairy holdings on the Maltese Islands from maximum peaks in 2003 of 163, 165 and 158 holdings to minimum numbers in 2012 of 136, 139 and 125 holdings for methods 1, 2 and 3 respectively. This gives a decrease in the number of dairy holdings during the study period of 16.56% when using M1, 15.76% when using M2 and 20.89% when using M3. This decrease, although less pronounced, is similar to trends registered in EU-27 member states. These include all member states excluding Croatia which joined the European Union on the 1st of July 2013. The total number of holdings with dairy cows in the EU-27 member states fell by 32% from 2007 to 2010. The decrease amounts to 47% if values for 2003

and 2010 are compared (Marquer, 2013).

The biggest difference in the number of holdings is obtained when using M3. This method is more appropriate for calculating the actual number of active dairy holdings producing milk from their herds since it is only dairy holdings having at least one $F > 2y$ of age which are taken into consideration. M1 gives a mean number of dairy holdings of 149.40 (SD = 9.65) which is higher than 143.00 (SD = 11.63) obtained when using M3. This is due to the fact that the former would include some holdings which were closing down their activity during the 10 year period and had no $F > 2y$ of age present on the holding but still had some male or younger female bovines. When using M2, the mean number of holdings was 153.50 (SD = 9.23). The mean is even higher in this method since the yearly average would take a longer time to fall below the cut-off point of at least one bovine present on the holding.

Very strong negative correlations ranging from $r = -0.913$ to $r = -0.992$ ($n = 10$) are present between the total number of dairy holdings and the year, when analysed separately on both islands and as a total number of holdings in Malta plus Gozo. This applies to the three methods used and in all cases the correlations have a significance of $p < 0.0005$. This implies that there has been a statistically significant decrease in the number of dairy holdings from 2003 to 2012 in both Malta and Gozo.

The mean number of dairy holdings in Malta during the study period was significantly higher than in Gozo. This varied from 105.70 (SD = 7.03) calculated when using M1, 109.00 (SD = 6.46) calculated using M2 and 100.10 (SD = 8.40) as calculated using M3. The mean number of holdings in Gozo calculated by M1 was 43.70 (SD = 2.71). When calculated using M2 and M3 the values were 44.50 (SD = 2.92) and 42.90 (SD = 3.25) respectively.

The yearly percentage of dairy holdings present in Malta compared to Gozo calculated using the three methods was 70.74% (SD = 0.40) for M1, 71.02% (SD = 0.51) for M2 and 69.99% (SD = 0.25) for M3. This percentage does not show great variations during the 10 year period under study denoting that the percentage distribution of dairy holdings in Malta and Gozo was relatively stable from 2003 to 2012.

3.2 The trend in the total number of bovines on dairy holdings

The trend in the total number of bovines on dairy holdings on the Maltese Islands is shown in Figure 2

The data analysed is from year 2004 to 2012 since data concerning the number of $F > 2y$ of age for year 2003 were not deemed to be sufficiently reliable and were removed from the analysis. A small decrease in the total number

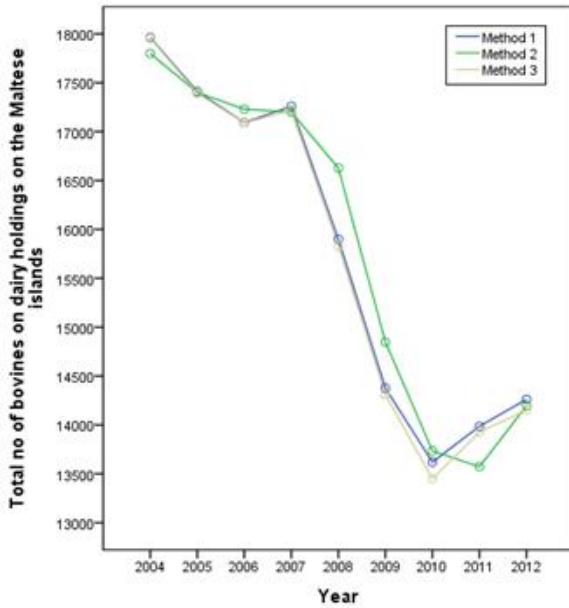


Figure 2: Line diagram showing the total number of bovines on dairy holdings on the Maltese Islands from 2004 to 2012 calculated by the three methods described.

of bovines on dairy holdings on the Maltese Islands was registered from 2004 to 2007 using the three methods. The decrease was of 3.92% when calculated using M1, 3.37% using M2 and 4.12% using M3. A sharp decrease in the bovine population then follows till 2010 and this is again demonstrated by all three methods. The decrease from 2007 to 2010 is of 21.08% for M1, 20.15% for M2 and 21.88% for M3. An increase of 4.71% and 5.23% is then present from 2010 to 2012 as calculated using M1 and M3 respectively, whereas M2 shows a further slight decrease of 1.19% till 2011 with an increase of 4.60% from 2011 to 2012.

The overall decrease in the total number of bovines on dairy holdings on the Maltese Islands from 2004 to 2012 is of 20.61%, 20.25%, and 21.18% as calculated using methods 1, 2 and 3 respectively.

The mean number of bovines on all dairy holdings on the Maltese Islands from 2004 to 2012, as calculated when using M1 was 15,763.00 (SD = 1,714.12). M2 gave a value of 15,845.56 (SD = 1,729.97) and M3 15,702.33 (SD = 1,758.47).

Very strong negative correlations of $r = -0.930$, -0.930 and -0.929 ($n = 9$) are present between the total number of bovines on dairy holdings and the year calculated using methods 1, 2 and 3 respectively. These correlations are highly significant at a value of $p < 0.0005$ denoting that there has been a significant decrease in the total number of bovines on dairy holdings on the Maltese Islands during the study period.

Statistically significant strong negative correlations

($p < 0.05$) ranging from -0.764 to -0.944 are also present when the bovine populations on dairy holdings on both islands are analysed separately showing that the decrease in the total number of bovines is present on both islands.

The bovine population on the dairy holdings in Malta is significantly larger than in Gozo. The mean number of bovines on all dairy holdings in Malta from 2004 to 2012, as calculated using M1 was 10,153.00 (SD = 1,265.76). M2 gave a value of 10,219.44 (SD = 1,298.12) and M3 10,107.00 (SD = 1,297.41). The values for Gozo were 5,610.00 (SD = 503.70) for M1, 5,626.11 (SD = 501.62) for M2 and 5,595.33 (SD = 513.77) for M3.

When the percentages of the number of bovines on dairy holdings in Malta relative to Gozo are analysed, the values show that 64.32% (SD = 1.44), 64.40% (SD = 1.64) and 64.27% (SD = 1.45) of bovines, as calculated using methods 1, 2 and 3 respectively, are present on dairy holdings in Malta relative to Gozo. Only M2 shows a significant correlation with $r = -0.692$, $n = 9$, $p < 0.05$ between the percentage bovine population and the year under review. The fact that a significant correlation, which is not very strong, was obtained in only one of the methods implies that the percentage distribution of bovines on dairy holdings in Malta relative to Gozo was relatively stable during the study period.

3.3 The trend in the number of female bovines over 2 years of age on dairy holdings

The trend in the number of $F > 2y$ of age on dairy holdings on the Maltese Islands was analysed since this data reflects the potential milk production on this type of holding. Method 3 was used in the analysis of this parameter. The trend for the period 2004 to 2012 is shown by the line diagram in Figure 3.

The number of $F > 2y$ of age on dairy holdings in Malta shows a decrease from 5,725 bovines in 2004 to 4,419 in 2012. This represents a decrease of 22.81%. The mean number of $F > 2y$ of age in Malta for the same period was 4,897.00 (SD = 461.63).

In Gozo, the number of $F > 2y$ of age increases slightly from 2,493 in 2004 to 2,811 in 2007. A slight decrease then follows to reach 2,331 in 2012. From 2004 to 2012 the number of $F > 2y$ of age on dairy holdings in Gozo decreased by only 6.50%. The mean number of $F > 2y$ of age in Gozo was 2,570.33 (SD = 175.80).

If the total number of $F > 2y$ of age on both islands is taken into consideration, a decrease of 17.86% from 8,218 in 2004 to 6,750 in 2012 can be seen. The mean number of $F > 2y$ of age on the Maltese Islands was 7,467.33 (SD = 563.73).

This trend is very similar to the trend in the number of dairy cows on holdings in the European Union.

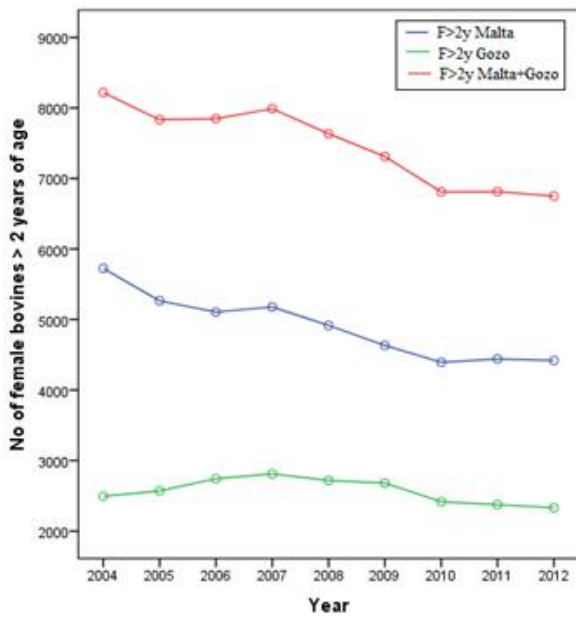


Figure 3: Line diagram showing the number of female bovines greater than 2 years of age on dairy holdings in Malta, Gozo and Malta + Gozo from 2004 to 2012.

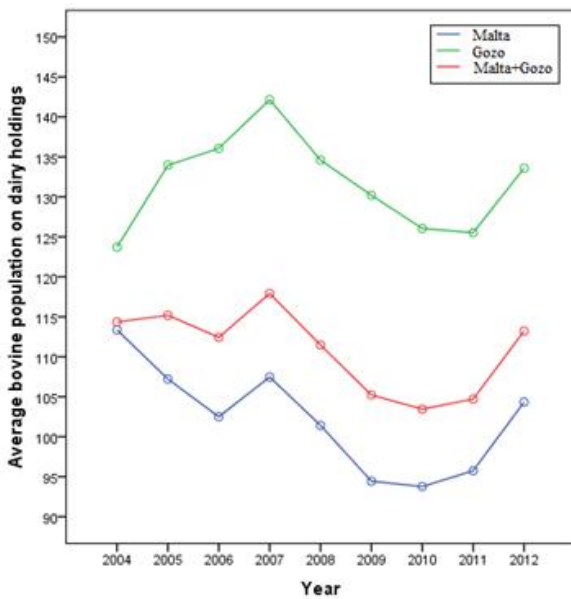


Figure 4: Line diagram showing the average bovine population (average herd size) on dairy holdings in Malta, Gozo and Malta + Gozo from 2004 to 2012.

(Marquer, 2013) reports a decrease of 20 % in the number of dairy cows on the specialist dairying holdings in the EU-27 countries from 2007 to 2010. Specialist holdings are defined as deriving at least two thirds of their output from the dairy activity (Marquer, 2013).

A statistically significant, strong negative correlation is present between the number of F>2y of age in

Malta and the period under study ($r = -0.956$, $n = 9$, $p < 0.0005$) showing that the number of F>2y of age in Malta decreased significantly during the study period. However, no significant correlation is present between the number of F>2y of age and the period under study in Gozo. This implies that their number in Gozo has remained relatively unchanged during the study period. When the trend for both islands is analysed together we obtained a statistically significant, strong negative correlation with $r = -0.946$, $n = 9$ and $p < 0.0005$.

The number of dairy cows in the EU stood at 22.9 million in 2011. Whilst Germany had the highest proportion of dairy cows, at 18.3 % within the EU-27 countries (Marquer, 2013), the Maltese Islands with a dairy cow population of 6,813 in 2011, had the smallest proportion at 0.03 %.

3.4 The trend in the average bovine population (average herd size) on dairy holdings

This trend was included in the study to determine if the average herd size on dairy holdings on both islands was increasing to make up for the decreasing number of holdings. The trend is shown by the line diagram in Figure 4. In this instance data obtained by Method 3 was used in the analysis.

The average herd size on dairy holdings on the Maltese Islands was relatively stable from 2004 to 2006. This was mainly due to a decrease in the average herd size on dairy holdings in Malta from 113.37 in 2004 to 102.50 in 2006 and an increase in Gozo from 123.70 in 2004 to 136.07 in 2006. In 2007 an increase was registered in both Malta (107.47) and Gozo (142.14). In Malta the average population reached its minimum of 93.77 in 2010 whilst in Gozo a minimum of 125.53 was reached in 2011. An increase was then registered in both islands in 2012 with values reaching 104.33 in Malta and 133.58 in Gozo. The decrease on both islands from 2007 to 2010 was mainly due to the ongoing EBL eradication programme.

No statistically significant correlation is present between the average bovine population and the year in Malta and Gozo ($r = -0.589$, $n = 9$, $p = 0.095$) or in Gozo alone ($r = -0.137$, $n = 9$, $p = 0.726$). A statistically significant, weak negative correlation is present between the average bovine population on dairy holdings in Malta and the period under study ($r = -0.692$, $n = 9$, $p = 0.039$). This implies that the average herd size on dairy holdings on both islands, although showing some fluctuations during the study period, remained relatively constant.

A statistically significant difference is present between the average herd size on dairy holdings in Malta and Gozo as determined by one-way ANOVA ($F(2,24) =$

58.42, $p < 0.0005$). A Tukey post-hoc test shows that the average herd size on dairy holdings as calculated using M3 in Malta is statistically significantly lower (102.25 ± 6.67 , $p < 0.0005$) than the average herd size on dairy holdings in Gozo (131.76 ± 5.93) for the period 2004 to 2012.

3.5 The trend in the average number of F>2y of age on dairy holdings

Apart from analysing the average herd size on dairy holdings, the trend in the average number of F>2y of age on these holdings on the Maltese Islands was also studied. This was considered important since any changes in this data group are very likely to affect the milk producing potential of the dairy holdings. The trend in the average number of F>2y of age on dairy holdings is shown in Figure 5.

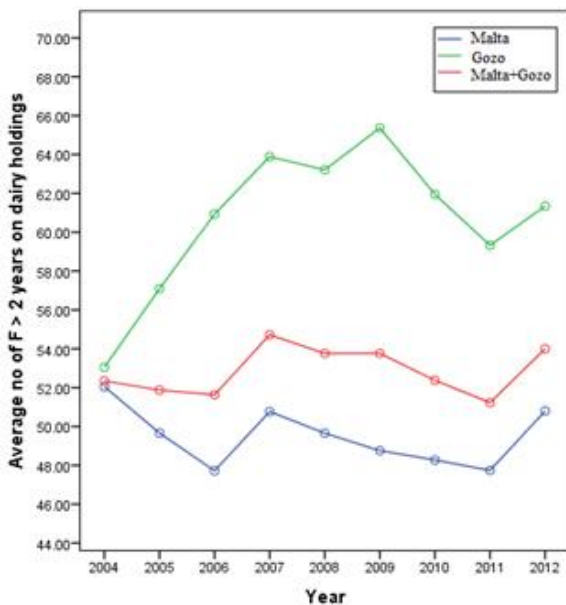


Figure 5: Line diagram showing the average number of female bovines greater than two years of age on dairy holdings in Malta, Gozo and Malta + Gozo from 2004 to 2012.

The trend on dairy holdings in Malta is quite different to that in Gozo. The trend in Malta is relatively stable throughout the period 2004 to 2012 with a mean of 49.49 (SD = 1.51). In Gozo, the average number of F>2y increases from a minimum value of 53.04 in 2004 to a maximum of 65.37 in 2009. The average then decreases till 2011 to increase to 61.34 in 2012. The trend for the two islands together follows closely the trend shown for Malta.

For the period under study, no statistically significant correlation was present between the average number of F>2y on dairy holdings and the year in Malta ($r = -0.354$, $n = 9$, $p = 0.350$), Gozo ($r = 0.525$, $n = 9$,

$p = 0.146$), or on both islands taken together ($r = 0.194$, $n = 9$, $p = 0.617$). This implies that the average number of F>2y of age on both islands was relatively constant during the study period. This is in contrast to the trend in the EU-27 countries where the average number of dairy cows per holding has been reported to have increased (Marquer, 2013).

A statistically significant difference is present between the average number of F>2y on dairy holdings in Malta and Gozo from 2004 to 2012 as determined by one-way ANOVA ($F(2,24) = 49.48$, $p < 0.0005$). A Dunnett T3 post-hoc test shows that the average number of F>2y on dairy holdings in Malta is statistically significantly lower (49.49 ± 1.51 , $p < 0.0005$) than the average on dairy holdings in Gozo (60.68 ± 3.77). The average number of F>2y on dairy holdings in Malta and Gozo (52.86 ± 1.23) lies in between these two values. If we assume that female bovines over two years of age on Maltese dairy holdings are in fact dairy cows, than this average is higher than the average of around 28 dairy cows on EU-27 specialist dairying holdings where a maximum of 141 dairy cows per holding was reported in Denmark and a minimum of 3 cows per holding was reported in Romania (Marquer, 2013).

3.6 The trend in the ratio of female to male bovines on dairy holdings

The mean number of female bovines on the Maltese Islands during the period 2004 to 2012 calculated using M3 was 12,567.89 (SD = 1,039.70) whereas the mean number of male bovines was 3,134.44 (SD = 730.22).

The ratio of female to male bovines on dairy holdings in both Malta and Gozo was relatively stable from 2004 to 2007. In Malta an increase in the ratio followed from 3.71 in 2007 to 5.75 in 2011. The ratio decreased slightly to 5.19 in 2012. In Gozo a marked increase was present from 2.93 in 2007 to 4.29 in 2009 and then the ratio remained relatively stable at 3.99 in 2012 (Figure 6).

The increase in both cases is due to a proportionally larger decrease in the number of males on the holdings. This was possibly due to the slaughtering trends during the EBL eradication campaign.

Statistically significant, strong positive correlations are present between the ratio of female to male bovines and the year in Malta ($r = 0.879$, $n = 9$, $p < 0.05$), Gozo ($r = 0.856$, $n = 9$, $p < 0.05$), and Malta and Gozo ($r = 0.884$, $n = 9$, $p < 0.05$).

A statistically significant difference is present between the female to male bovine ratios on dairy holdings in Malta and Gozo calculated using M3 over the period 2004 to 2012 as determined by one-way ANOVA ($F(2,24) = 5.01$, $p < 0.05$). A Tukey post-hoc test shows that the female to male bovine ratio on holdings in Malta is statistically significantly higher (4.55 ± 0.78 ,

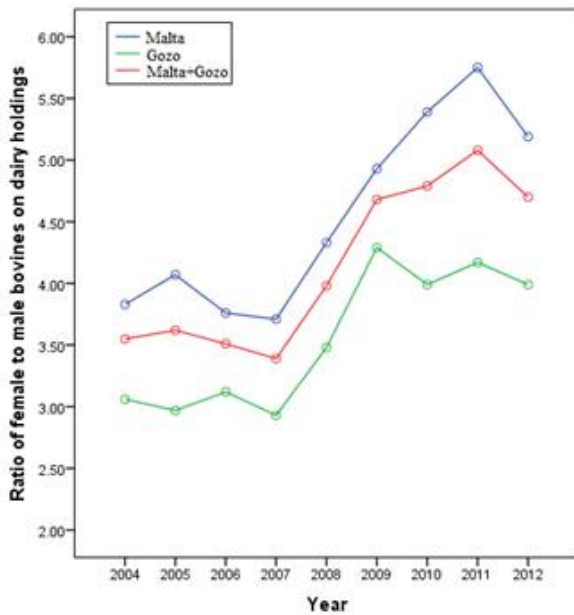


Figure 6: Line diagram showing the change in ratio between the number of female to male bovines on dairy holdings in Malta, Gozo and Malta + Gozo from 2004 to 2012.

$p < 0.05$) than the ratio on dairy holdings in Gozo (3.56 ± 0.56). This difference might be due to the fact that the number of non-dairy bovine holdings in Gozo and their average herd size are considerably lower than those in Malta. As a result dairy holdings in Gozo tend to keep more male bovines up to slaughtering age rather than selling them to non-dairy holdings at an early age as happens in Malta.

4 Conclusions

This study has described and analysed six trends with regard to dairy holdings and their bovine population on the Maltese Islands from 2003, a year before Malta's accession to the European Union to 2012. The general trends on the Maltese Islands show that there was a significant decrease in the number of dairy holdings, in the total bovine population and in the number of $F > 2y$ of age during the study period. The number of dairy holdings and the total bovine population decreased by approximately 17.74% and 20.68% respectively, depending on the method used for their calculation. The total number of $F > 2y$ on dairy holdings on the islands decreased by 17.86% from 2004 to 2012. On the other hand, the average herd size and the average number of $F > 2y$ on the dairy holdings on the Maltese Islands showed no statistically significant changes. A significant increase in the ratio of female to male bovines from 3.55 to 4.70 was registered on these holdings. The fact that the average herd size and the average number of $F > 2y$ of age on the holdings showed no significant changes im-

plies that the bovine population on the holdings during the study period was relatively stable.

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