**Supplementary table S1**

Table S1. The estimate, standard error (SE) and p-value of the coefficients of the previous method (yellow marking), smoothing methods 3, 5, 3 combined with 5 as one and as two variables, farm size adjusted as number of pigs per day given CHR (model A, green marking)), and PMD (model B, blue marking), of linear regression models for aminoglycosides, lincosamides, broad-spectrum penicillins/betalactam, macrolides, sulfonamides, and tetracyclines usage and resistance. In addition, the information measures; adjusted R-squared (Adj.R²), Akaike information criterion (AIC) and Bayesian information criterion (BIC) for each model.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | |  |  |  |  |  |  |  |  |  |  |
|  | | Estimate | | | | SE | p-value |  | Adj.R² | AIC | BIC |
| Aminoglycosides (Ami.) | |  | | | |  |  |  |  |  |  |
| **Model** (previous) | |  |  |  |  |  |  |  | 0.04 | 68.64 | 69.55 |
| *(intercept)* | | 18.08 | (12.40 | - | 23.76) | 2.47 | 0.000 |  |  |  |  |
| *Ami.* | | 0.11 | (-0.11 | - | 0.33) | 0.09 | 0.272 |  |  |  |  |
|  | |  |  |  |  |  |  |  |  |  |  |
| **Model A** (method 3) | |  |  |  |  |  |  |  | 0.21 | 66.67 | 67.58 |
| *(intercept)* | | 17.19 | (11.93 | - | 22.45) | 2.28 | 0.000 |  |  |  |  |
| *Ami.* | | 0.17 | (-0.04 | - | 0.38) | 0.09 | 0.101 |  |  |  |  |
| **Model A** (method 5) | |  |  |  |  |  |  |  | 0.25 | 66.13 | 67.04 |
| *(intercept)* | | 17.02 | (11.89 | - | 22.15) | 2.23 | 0.000 |  |  |  |  |
| *Ami.* | | 0.17 | (-0.03 | - | 0.37) | 0.09 | 0.079 |  |  |  |  |
| **Model A** (methods 3 and 5) | |  |  |  |  |  |  |  | 0.28 | 65.75 | 66.66 |
| *(intercept)* | | 16.82 | (11.73 | - | 21.92) | 2.21 | 0.000 |  |  |  |  |
| *Ami.* | | 0.19 | (-0.02 | - | 0.39) | 0.09 | 0.070 |  |  |  |  |
| **Model A** (methods 3 and 5) | |  |  |  |  |  |  |  | 0.57 | 61.29 | 62.51 |
| *(intercept)* | | 12.82 | (7.29 | - | 18.34) | 2.34 | 0.003 |  |  |  |  |
| *Ami. parenteral* | | 0.90 | (0.21 | - | 1.59) | 0.29 | 0.018 | \* |  |  |  |
| *Ami. peroral* | | -0.10 | (-0.41 | - | 0.21) | 0.13 | 0.483 |  |  |  |  |
|  | |  |  |  |  |  |  |  |  |  |  |
| **Model B** (method 3) | |  |  |  |  |  |  |  | 0.10 | 67.98 | 68.88 |
| *(intercept)* | | 17.90 | (12.51 | - | 23.28) | 2.33 | 0.000 |  |  |  |  |
| *Ami.* | | 0.16 | (-0.10 | - | 0.43) | 0.12 | 0.192 |  |  |  |  |
| **Model B** (method 5) | |  |  |  |  |  |  |  | 0.12 | 67.76 | 68.67 |
| *(intercept)* | | 17.77 | (12.40 | - | 23.14) | 2.32 | 0.000 |  |  |  |  |
| *Ami.* | | 0.17 | (-0.09 | - | 0.43) | 0.11 | 0.172 |  |  |  |  |
| **Model B** (methods 3 and 5) | |  |  |  |  |  |  |  | 0.14 | 67.61 | 68.72 |
| *(intercept)* | | 17.66 | (12.28 | - | 23.04) | 2.33 | 0.000 |  |  |  |  |
| *Ami.* | | 0.18 | (-0.09 | - | 0.44) | 0.11 | 0.159 |  |  |  |  |
| **Model B** (methods 3 and 5) | |  |  |  |  |  |  |  | 0.62 | 59.99 | 61.20 |
| *(intercept)* | | 11.16 | (5.31 | - | 17.01) | 2.47 | 0.003 |  |  |  |  |
| *Ami. parenteral* | | 1.83 | (0.66 | - | 3.01) | 0.50 | 0.009 | \* |  |  |  |
| *Ami. peroral* | | -0.16 | (-0.46 | - | 0.14) | 0.13 | 0.239 |  |  |  |  |
|  | |  |  |  |  |  |  |  |  |  |  |
|  | | Estimate | | | | SE | p-value |  | Adj R² | AIC | BIC |
| Lincosamides (Lin.) | |  |  |  |  |  |  |  |  |  |  |
| **Model** (previous) | |  |  |  |  |  |  |  | 0.20 | 89.22 | 90.12 |
| *(intercept)* | | 53.51 | (36.73 | - | 70.29) | 7.28 | 0.000 |  |  |  |  |
| *Lin.* | | 0.68 | (-0.19 | - | 1.54) | 0.38 | 0.109 |  |  |  |  |
|  | |  |  |  |  |  |  |  |  |  |  |
| **Model A** (method 3) | |  |  |  |  |  |  |  | 0.49 | 84.72 | 85.63 |
| *(intercept)* | | 52.11 | (39.57 | - | 64.66) | 5.44 | 0.000 |  |  |  |  |
| *Lin.* | | 0.62 | (0.16 | - | 1.07) | 0.20 | 0.015 | \* |  |  |  |
| **Model A** (method 5) | |  |  |  |  |  |  |  | 0.51 | 84.40 | 85.31 |
| *(intercept)* | | 52.59 | (40.49 | - | 64.68) | 5.24 | 0.000 |  |  |  |  |
| *Lin.* | | 0.64 | (0.18 | - | 1.10) | 0.20 | 0.013 | \* |  |  |  |
| **Model A** (methods 3 and 5) | |  |  |  |  |  |  |  | 0.51 | 84.31 | 85.22 |
| *(intercept)* | | 52.54 | (40.50 | - | 64.59) | 5.22 | 0.000 |  |  |  |  |
| *Lin.* | | 0.64 | (0.18 | - | 1.10) | 0.20 | 0.012 | \* |  |  |  |
| **Model A** (methods 3 and 5) | |  |  |  |  |  |  |  | 0.63 | 82.24 | 83.45 |
| *(intercept)* | | 58.24 | (45.29 | - | 71.18) | 5.48 | 0.000 |  |  |  |  |
| *Lin. parenteral* | | -0.20 | (-1.33 | - | 0.94) | 0.48 | 0.689 |  |  |  |  |
| *Lin. peroral* | | 2.23 | (0.18 | - | 4.28) | 0.86 | 0.037 | \* |  |  |  |
|  | |  |  |  |  |  |  |  |  |  |  |
| **Model B** (method 3) | |  |  |  |  |  |  |  | 0.58 | 82.66 | 83.57 |
| *(intercept)* | | 52.19 | (41.18 | - | 63.21) | 4.78 | 0.000 |  |  |  |  |
| *Lin.* | | 0.81 | (0.30 | - | 1.31) | 0.22 | 0.006 | \* |  |  |  |
| **Model B** (method 5) | |  |  |  |  |  |  |  | 0.56 | 83.26 | 84.17 |
| *(intercept)* | | 52.98 | (41.85 | - | 64.12) | 4.82 | 0.000 |  |  |  |  |
| *Lin.* | | 0.78 | (0.27 | - | 1.30) | 0.22 | 0.008 | \* |  |  |  |
| **Model B** (methods 3 and 5) | |  |  |  |  |  |  |  | 0.57 | 83.09 | 84.00 |
| *(intercept)* | | 52.85 | (41.79 | - | 63.92) | 4.53 | 0.000 |  |  |  |  |
| *Lin.* | | 0.79 | (0.28 | - | 1.30) | 0.11 | 0.007 | \* |  |  |  |
| **Model B** (methods 3 and 5) | |  |  |  |  |  |  |  | 0.63 | 82.24 | 83.45 |
| *(intercept)* | | 57.49 | (44.73 | - | 70.25) | 5.40 | 0.000 |  |  |  |  |
| *Lin. parenteral* | | -0.17 | (-1.74 | - | 1.40) | 0.66 | 0.807 |  |  |  |  |
| *Lin. peroral* | | 2.79 | (-0.36 | - | 5.94) | 1.33 | 0.075 | \* |  |  |  |
|  | |  |  |  |  |  |  |  |  |  |  |
|  | | Estimate | | | | SE | p-value |  | Adj R² | AIC | BIC |
|  | Penicillins (Pen.) (broad) - Betalactam resistance | | | | | | | | | | |
| **Model** (previous) | |  |  |  |  |  |  |  | 0.45 | 90.26 | 91.17 |
| *(intercept)* | | 52.55 | (36.01 | - | 69.09) | 7.17 | 0.000 |  |  |  |  |
| *Pen. (broad)* | | 0.71 | (0.15 | - | 1.27) | 0.24 | 0.020 | \* |  |  |  |
|  | |  |  |  |  |  |  |  |  |  |  |
| **Model A** (method 3) | |  |  |  |  |  |  |  | 0.36 | 91.87 | 92.78 |
| *(intercept)* | | 53.74 | (35.87 | - | 71.60) | 7.75 | 0.000 |  |  |  |  |
| *Pen. (broad)* | | 0.54 | (0.03 | - | 1.04) | 0.22 | 0.040 | \* |  |  |  |
| **Model A** (method 5) | |  |  |  |  |  |  |  | 0.49 | 89.65 | 90.56 |
| *(intercept)* | | 49.48 | (32.15 | - | 66.82) | 7.52 | 0.000 |  |  |  |  |
| *Pen. (broad)* | | 0.76 | (0.19 | - | 1.33) | 0.25 | 0.015 | \* |  |  |  |
| **Model A** (methods 3 and 5) | |  |  |  |  |  |  |  | 0.31 | 92.54 | 93.45 |
| *(intercept)* | | 53.41 | (34.40 | - | 72.42) | 8.24 | 0.000 |  |  |  |  |
| *Pen. (broad)* | | 0.56 | (-0.01 | - | 1.12) | 0.25 | 0.054 |  |  |  |  |
| **Model A** (methods 3 and 5) | |  |  |  |  |  |  |  | 0.35 | 92.74 | 93.95 |
| *(intercept)* | | 58.31 | (36.88 | - | 79.81) | 9.08 | 0.000 |  |  |  |  |
| *Pen.(broad) parenteral* | | -0.31 | (-2.14 | - | 1.52) | 0.77 | 0.700 |  |  |  |  |
| *Pen.(broad) peroral* | | 0.86 | (0.02 | - | 1.70) | 0.35 | 0.045 | \* |  |  |  |
|  | |  |  |  |  |  |  |  |  |  |  |
| **Model B** (method 3) | |  |  |  |  |  |  |  | 0.50 | 89.38 | 90.28 |
| *(intercept)* | | 53.89 | (38.81 | - | 68.97) | 6.54 | 0.000 |  |  |  |  |
| *Pen. (broad)* | | 0.70 | (0.19 | - | 1.21) | 0.22 | 0.013 | \* |  |  |  |
| **Model B** (method 5) | |  |  |  |  |  |  |  | 0.62 | 86.64 | 87.55 |
| *(intercept)* | | 50.52 | (36.59 | - | 64.46) | 6.04 | 0.000 |  |  |  |  |
| *Pen. (broad)* | | 0.89 | (0.37 | - | 1.42) | 0.23 | 0.004 | \* |  |  |  |
| **Model B** (methods 3 and 5) | |  |  |  |  |  |  |  | 0.49 | 89.66 | 90.57 |
| *(intercept)* | | 53.41 | (37.86 | - | 68.96) | 6.74 | 0.000 |  |  |  |  |
| *Pen. (broad)* | | 0.73 | (0.18 | - | 1.27) | 0.24 | 0.015 | \* |  |  |  |
| **Model B** (methods 3 and 5) | |  |  |  |  |  |  |  | 0.54 | 89.16 | 90.37 |
| *(intercept)* | | 58.12 | (41.14 | - | 75.10) | 7.18 | 0.000 |  |  |  |  |
| *Pen.(broad) parenteral* | | -0.53 | (-2.72 | - | 1.65) | 0.92 | 0.581 |  |  |  |  |
| *Pen.(broad) peroral* | | 0.94 | (0.30 | - | 1.58) | 0.27 | 0.010 | \* |  |  |  |
|  | |  |  |  |  |  |  |  |  |  |  |
|  | | Estimate | | | | SE | p-value |  | Adj R² | AIC | BIC |
|  | Macrolides (Mac.) | | | | | | | | | | |
| **Model** (previous) | |  |  |  |  |  |  |  | 0.66 | 108.03 | 108.93 |
| *(intercept)* | | 58.34 | (-5.52 | - | 122.20) | 27.69 | 0.068 |  |  |  |  |
| *Mac.* | | 1.82 | (0.85 | - | 2.78) | 0.42 | 0.002 | \* |  |  |  |
|  | |  |  |  |  |  |  |  |  |  |  |
| **Model A** (method 3) | |  |  |  |  |  |  |  | 0.23 | 116.30 | 117.20 |
| *(intercept)* | | 101.54 | (14.46 | - | 188.63) | 37.76 | 0.028 |  |  |  |  |
| *Mac.* | | 0.94 | (-0.18 | - | 2.06) | 0.49 | 0.090 |  |  |  |  |
| **Model A** (method 5) | |  |  |  |  |  |  |  | 0.19 | 116.89 | 117.79 |
| *(intercept)* | | 110.40 | (25.87 | - | 194.93) | 36.67 | 0.017 |  |  |  |  |
| *Mac.* | | 0.76 | (-0.21 | - | 1.76) | 0.43 | 0.118 |  |  |  |  |
| **Model A** (methods 3 and 5) | |  |  |  |  |  |  |  | 0.15 | 117.38 | 118.29 |
| *(intercept)* | | 105.03 | (18.77 | - | 191.29) | 45.53 | 0.023 |  |  |  |  |
| *Mac.* | | 0.86 | (-0.35 | - | 1.92) | 0.49 | 0.100 |  |  |  |  |
| **Model A** (methods 3 and 5) | |  |  |  |  |  |  |  | 0.28 | 116.30 | 117.51 |
| *(intercept)* | | 121.76 | (32.19 | - | 211.57) | 37.93 | 0.015 |  |  |  |  |
| *Mac. parenteral* | | -0.08 | (-2.06 | - | 1.89) | 0.83 | 0.923 |  |  |  |  |
| *Mac. peroral* | | 1.04 | (-0.05 | - | 2.13) | 0.46 | 0.059 |  |  |  |  |
|  | |  |  |  |  |  |  |  |  |  |  |
| **Model B** (method 3) | |  |  |  |  |  |  |  | 0.33 | 114.97 | 115.87 |
| *(intercept)* | | 99.51 | (22.51 | - | 176.51) | 33.39 | 0.018 |  |  |  |  |
| *Mac.* | | 1.24 | (0,01 | - | 2.47) | 0.53 | 0.048 | \* |  |  |  |
| **Model B** (method 5) | |  |  |  |  |  |  |  | 0.31 | 115.25 | 116.16 |
| *(intercept)* | | 101.96 | (24.79 | - | 179.14) | 33.47 | 0.016 |  |  |  |  |
| *Mac.* | | 1.17 | (-0.03 | - | 2.38) | 0.52 | 0.055 |  |  |  |  |
| **Model B** (methods 3 and 5) | |  |  |  |  |  |  |  | 0.34 | 114.86 | 115.77 |
| *(intercept)* | | 98.74 | (21.90 | - | 175.60) | 33.33 | 0.018 |  |  |  |  |
| *Mac.* | | 1.23 | (0.03 | - | 2.44) | 0.52 | 0.046 | \* |  |  |  |
| **Model B** (methods 3 and 5) | |  |  |  |  |  |  |  | 0.27 | 116.40 | 117.62 |
| *(intercept)* | | 112.76 | (12.03 | - | 213.48) | 42.60 | 0.033 |  |  |  |  |
| *Mac. parenteral* | | 0.28 | (-3.85 | - | 4.41) | 1.75 | 0.875 |  |  |  |  |
| *Mac. peroral* | | 1.22 | (-0.07 | - | 2.51) | 0.55 | 0.060 |  |  |  |  |
|  | |  |  |  |  |  |  |  |  |  |  |
|  | | Estimate | | | | SE | p-value |  | Adj R² | AIC | BIC |
|  | Sulfonamides (Sul.) | | | | | | | | | | |
| **Model** (previous) | |  |  |  |  |  |  |  | 0.74 | 7.14 | 8.04 |
| *(intercept)* | | -0.16 | (-0.50 | - | 0.19) | 0.15 | 0.327 |  |  |  |  |
| *Sul.* | | 0.02 | (0.01 | - | 0.03) | 0.00 | 0.001 | \* |  |  |  |
|  | |  |  |  |  |  |  |  |  |  |  |
| **Model A** (method 3) | |  |  |  |  |  |  |  | 0.70 | 8.23 | 9.14 |
| *(intercept)* | | -0.08 | (-0.42 | - | 0.26) | 0.15 | 0.593 |  |  |  |  |
| *Sul.* | | 0.02 | (0.01 | - | 0.03) | 0.00 | 0.001 | \* |  |  |  |
| **Model A** (method 5) | |  |  |  |  |  |  |  | 0.65 | 9.99 | 10.90 |
| *(intercept)* | | -0.11 | (-0.50 | - | 0.29) | 0.17 | 0.552 |  |  |  |  |
| *Sul.* | | 0.02 | (0.00 | - | 0.03) | 0.00 | 0.003 | \* |  |  |  |
|  | |  |  |  |  |  |  |  |  |  |  |
| **Model B** (method 3) | |  |  |  |  |  |  |  | 0.49 | 13.84 | 14.75 |
| *(intercept)* | | 0.00 | (-0.45 | - | 0.45) | 0.19 | 0.997 |  |  |  |  |
| *Sul.* | | 0.04 | (0.01 | - | 0.03) | 0.01 | 0.015 | \* |  |  |  |
| **Model B** (method 5) | |  |  |  |  |  |  |  | 0.50 | 13.63 | 14.54 |
| *(intercept)* | | -0.04 | (-0.51 | - | 0.42) | 0.20 | 0.833 |  |  |  |  |
| *Sul.* | | 0.04 | (0.00 | - | 0.06) | 0.01 | 0.014 | \* |  |  |  |
|  | |  |  |  |  |  |  |  |  |  |  |
|  | | Estimate | | | | SE | p-value |  | Adj R² | AIC | BIC |
|  | Tetracyclines (Tet.) | | | | | | | | | | |
| **Model** (previous) | |  |  |  |  |  |  |  | 0.35 | 108.83 | 109.74 |
| *(intercept)* | | 346.13 | (294.36 | - | 397.89) | 22.45 | 0.000 |  |  |  |  |
| *Tet.* | | 0.92 | (0.04 | - | 1.79) | 0.38 | 0.042 | \* |  |  |  |
|  | |  |  |  |  |  |  |  |  |  |  |
| **Model A** (method 3) | |  |  |  |  |  |  |  | 0.69 | 101.39 | 102.30 |
| *(intercept)* | | 332.60 | (296.63 | - | 368.56) | 15.60 | 0.000 |  |  |  |  |
| *Tet.* | | 0.91 | (0.45 | - | 1.36) | 0.20 | 0.001 | \* |  |  |  |
| **Model A** (method 5) | |  |  |  |  |  |  |  | 0.72 | 100.36 | 101.27 |
| *(intercept)* | | 331.55 | (297.38 | - | 365.73) | 14.82 | 0.000 |  |  |  |  |
| *Tet.* | | 1.03 | (0.55 | - | 1.52) | 0.21 | 0.001 | \* |  |  |  |
| **Model A** (methods 3 and 5) | |  |  |  |  |  |  |  | 0.66 | 102.48 | 103.38 |
| *(intercept)* | | 334.75 | (297.17 | - | 372.33) | 16.30 | 0.000 |  |  |  |  |
| *Tet.* | | 0.88 | (0.41 | - | 1.36) | 0.21 | 0.003 | \* |  |  |  |
| **Model A** (methods 3 and 5) | |  |  |  |  |  |  |  | 0.66 | 103.05 | 104.27 |
| *(intercept)* | | 329.04 | (288.51 | - | 369.57) | 17.14 | 0.000 |  |  |  |  |
| *Tet. parenteral* | | 1.41 | (0.12 | - | 2.70) | 0.55 | 0.037 | \* |  |  |  |
| *Tet. peroral* | | 0.77 | (0.21 | - | 1.33) | 0.24 | 0.014 | \* |  |  |  |
|  | |  |  |  |  |  |  |  |  |  |  |
| **Model B** (method 3) | |  |  |  |  |  |  |  | 0.71 | 100.64 | 101.55 |
| *(intercept)* | | 339.01 | (306.89 | - | 371.13) | 13.93 | 0.000 |  |  |  |  |
| *Tet.* | | 0.87 | (0.45 | - | 1.28) | 0.18 | 0.001 | \* |  |  |  |
| **Model B** (method 5) | |  |  |  |  |  |  |  | 0.74 | 99.38 | 100.29 |
| *(intercept)* | | 337.36 | (306.98 | - | 367.73) | 13.17 | 0.000 |  |  |  |  |
| *Tet.* | | 1.00 | (0.56 | - | 1.44) | 0.19 | 0.000 | \* |  |  |  |
| **Model B** (methods 3 and 5) | |  |  |  |  |  |  |  | 0.65 | 102.75 | 103.65 |
| *(intercept)* | | 340.65 | (307.23 | - | 274.06) | 14.49 | 0.000 |  |  |  |  |
| *Tet.* | | 0.93 | (0.42 | - | 1.28) | 0.19 | 0.002 | \* |  |  |  |
| **Model B** (methods 3 and 5) | |  |  |  |  |  |  |  | 0.82 | 96.69 | 97.90 |
| *(intercept)* | | 326.85 | (298.12 | - | 355.57) | 12.15 | 0.000 |  |  |  |  |
| *Tet. parenteral* | | 2.12 | (0.94 | - | 3.31) | 0.50 | 0.004 | \* |  |  |  |
| *Tet. peroral* | | 0.71 | (0.35 | - | 1.07) | 0.15 | 0.002 | \* |  |  |  |