**Graph-based impact analysis as a framework for incorporating practitioner knowledge in dairy herd health management**

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Supplementary material

Supplementary Table S1 Outgoing and incoming impacts (quartiles and median) at different path length (1-6 links) for the 13 system variables.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Path length (number of links) | | | | | | | | | | | | | | | | | |
|  |  |  | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | |
|  |  | Variable | Q1 | Med | Q3 | Q1 | Med | Q3 | Q1 | Med | Q3 | Q1 | Med | Q3 | Q1 | Med | Q3 | Q1 | Med | Q3 |
| Outgoing | 1 | Milk performance | 5 | 7 | 10 | 22 | 38 | 71 | 90 | 184 | 464 | 300 | 916 | 2 696 | 873 | 3 567 | 13 758 | 1 916 | 11 608 | 61 906 |
|  | 2 | Production diseases | 12 | 15 | 18 | 46 | 75 | 107 | 166 | 357 | 642 | 506 | 1 451 | 3 418 | 1 298 | 5 329 | 16 356 | 2 742 | 15 722 | 65 326 |
|  | 3 | Financial resources | 3 | 5 | 9 | 15 | 29 | 56 | 59 | 165 | 358 | 213 | 733 | 2 013 | 584 | 2 913 | 9 001 | 1 231 | 9 334 | 37 595 |
|  | 4 | Labour capacity | 6 | 10 | 14 | 33 | 60 | 96 | 138 | 298 | 557 | 452 | 1 359 | 3 200 | 1 205 | 5 061 | 15 396 | 2 645 | 16 460 | 63 340 |
|  | 5 | Feeding | 7 | 10 | 13 | 29 | 54 | 83 | 114 | 279 | 538 | 412 | 1 293 | 3 159 | 1 101 | 5 240 | 16 218 | 2 526 | 17 014 | 72 625 |
|  | 6 | Housing conditions | 5 | 9 | 13 | 27 | 57 | 90 | 109 | 297 | 570 | 397 | 1 388 | 3 259 | 1 227 | 5 188 | 17 224 | 2 882 | 17 262 | 77 301 |
|  | 7 | Reproduction management | 4 | 7 | 10 | 18 | 40 | 70 | 79 | 209 | 439 | 283 | 946 | 2 606 | 888 | 4 049 | 13 687 | 1 886 | 14 007 | 61 444 |
|  | 8 | Dry cow management | 4 | 8 | 13 | 24 | 46 | 93 | 106 | 225 | 583 | 403 | 1 068 | 3 224 | 1 172 | 4 379 | 15 965 | 2 902 | 14 668 | 70 478 |
|  | 9 | Calf and heifer management | 5 | 8 | 12 | 26 | 48 | 82 | 107 | 254 | 529 | 382 | 1 205 | 2 959 | 1 081 | 4 859 | 15 063 | 2 747 | 15 923 | 66 587 |
|  | 10 | Herd health monitoring | 6 | 10 | 14 | 34 | 62 | 104 | 157 | 337 | 661 | 503 | 1 494 | 3 659 | 1 545 | 5 937 | 17 931 | 3 403 | 19 253 | 82 632 |
|  | 11 | Hygiene | 5 | 8 | 13 | 26 | 52 | 91 | 115 | 268 | 576 | 406 | 1 186 | 3 264 | 1 208 | 4 666 | 15 928 | 2 680 | 15 068 | 68 116 |
|  | 12 | Treatment | 5 | 8 | 12 | 30 | 50 | 83 | 124 | 267 | 528 | 433 | 1 274 | 3 233 | 1 203 | 5 254 | 16 169 | 2 812 | 17 338 | 67 591 |
|  | 13 | Knowledge and skills | 10 | 13 | 18 | 52 | 76 | 113 | 202 | 397 | 688 | 661 | 1 773 | 3 926 | 1 784 | 6 748 | 19 596 | 3 904 | 22 095 | 78 078 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Incoming | 1 | Milk performance | 11 | 15 | 19 | 50 | 75 | 116 | 197 | 385 | 665 | 725 | 1 787 | 3 823 | 2 098 | 6 862 | 19 551 | 4 608 | 22 483 | 81 289 |
|  | 2 | Production diseases | 10 | 14 | 18 | 40 | 65 | 104 | 144 | 306 | 609 | 454 | 1 305 | 3 485 | 1 126 | 4 781 | 16 905 | 2 286 | 14 206 | 64 303 |
|  | 3 | Financial resources | 12 | 15 | 19 | 56 | 85 | 120 | 245 | 449 | 768 | 836 | 2 073 | 4 474 | 2 464 | 8 140 | 21 798 | 5 210 | 27 498 | 91 023 |
|  | 4 | Labour capacity | 8 | 12 | 16 | 38 | 66 | 102 | 149 | 341 | 628 | 472 | 1 414 | 3 471 | 1 224 | 5 092 | 15 387 | 2 493 | 15 796 | 62 689 |
|  | 5 | Feeding | 5 | 7 | 10 | 24 | 45 | 74 | 98 | 247 | 471 | 361 | 1 126 | 2 678 | 1 143 | 4 851 | 14 327 | 2 708 | 17 190 | 67 573 |
|  | 6 | Housing conditions | 3 | 5 | 9 | 17 | 40 | 66 | 72 | 210 | 425 | 270 | 965 | 2 512 | 828 | 3 684 | 13 662 | 1 941 | 13 309 | 57 625 |
|  | 7 | Reproduction management | 4 | 7 | 12 | 25 | 49 | 84 | 105 | 264 | 550 | 374 | 1 192 | 3 143 | 1 154 | 4 949 | 17 123 | 2 874 | 16 120 | 72 898 |
|  | 8 | Dry cow management | 3 | 7 | 10 | 18 | 40 | 73 | 66 | 211 | 474 | 243 | 1 052 | 2 646 | 820 | 4 367 | 12 879 | 2 091 | 14 550 | 56 351 |
|  | 9 | Calf and heifer management | 3 | 6 | 11 | 16 | 38 | 68 | 71 | 214 | 452 | 269 | 1 026 | 2 560 | 742 | 4 123 | 12 836 | 1 889 | 13 725 | 55 914 |
|  | 10 | Herd health monitoring | 5 | 7 | 11 | 25 | 43 | 82 | 100 | 226 | 513 | 325 | 1 027 | 2 822 | 940 | 3 894 | 13 684 | 2 173 | 12 579 | 57 173 |
|  | 11 | Hygiene | 4 | 7 | 11 | 24 | 43 | 81 | 98 | 217 | 521 | 351 | 978 | 3 115 | 1 076 | 3 745 | 15 171 | 2 436 | 13 025 | 64 097 |
|  | 12 | Treatment | 4 | 7 | 11 | 23 | 43 | 75 | 99 | 216 | 480 | 369 | 1 104 | 2 586 | 1 054 | 4 330 | 13 053 | 2 333 | 13 881 | 60 998 |
|  | 13 | Knowledge and skills | 5 | 9 | 13 | 29 | 51 | 89 | 103 | 258 | 553 | 345 | 1 107 | 2 978 | 858 | 4 139 | 13 609 | 1 822 | 12 859 | 55 813 |

Q – quartiles, Med - median

Supplementary Table S2 Outgoing and incoming impacts and according ranks at different path length (1-6 links) of the 13 system variables in two farms A and B.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Farm A | | | | | | | | | | | | Farm B | | | | | | | | | | | |
|  |  |  | Impacts | | | | | | Ranks | | | | | | Impacts | | | | | | Ranks | | | | | |
|  |  | Variable | 1\* | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 |
| Outgoing | 1 | Milk performance | 2 | 1 | 4 | 8 | 7 | 2 | 6 | 10 | 10 | 9 | 8 | 8 | 9 | 50 | 310 | 1 788 | 9 146 | 40 293 | 9 | 12 | 12 | 13 | 13 | 13 |
|  | 2 | Production diseases | 12 | 17 | 19 | 21 | 17 | 12 | 1 | 1 | 3 | 4 | 6 | 6 | 17 | 109 | 671 | 3 648 | 17 109 | 67 758 | 2 | 3 | 4 | 5 | 7 | 7 |
|  | 3 | Financial resources | 1 | 3 | 9 | 8 | 5 | 1 | 8 | 9 | 8 | 10 | 10 | 10 | 9 | 56 | 363 | 2 076 | 10 400 | 44 308 | 9 | 11 | 11 | 11 | 11 | 11 |
|  | 4 | Labour capacity | 3 | 3 | 9 | 11 | 11 | 9 | 4 | 8 | 9 | 7 | 7 | 7 | 14 | 96 | 598 | 3 202 | 14 714 | 57 111 | 5 | 6 | 6 | 9 | 10 | 10 |
|  | 5 | Feeding | 5 | 16 | 21 | 28 | 29 | 17 | 3 | 2 | 2 | 2 | 2 | 4 | 8 | 46 | 299 | 1 793 | 9 434 | 42 654 | 12 | 13 | 13 | 12 | 12 | 12 |
|  | 6 | Housing conditions | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 11 | 11 | 11 | 11 | 11 | 9 | 76 | 528 | 3 087 | 15 454 | 65 285 | 9 | 9 | 10 | 10 | 9 | 9 |
|  | 7 | Reproduction management | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 11 | 11 | 11 | 11 | 11 | 10 | 75 | 535 | 3 383 | 18 815 | 90 184 | 8 | 10 | 9 | 6 | 4 | 2 |
|  | 8 | Dry cow management | 1 | 4 | 14 | 18 | 27 | 27 | 8 | 7 | 6 | 6 | 4 | 2 | 15 | 107 | 710 | 4 166 | 21 112 | 90 562 | 4 | 4 | 2 | 2 | 1 | 1 |
|  | 9 | Calf and heifer management | 2 | 12 | 17 | 21 | 27 | 21 | 6 | 3 | 4 | 3 | 3 | 3 | 18 | 112 | 689 | 3 815 | 18 336 | 74 735 | 1 | 2 | 3 | 4 | 5 | 6 |
|  | 10 | Herd health monitoring | 3 | 11 | 13 | 9 | 6 | 1 | 4 | 4 | 7 | 8 | 9 | 9 | 17 | 123 | 774 | 4 348 | 21 061 | 86 372 | 2 | 1 | 1 | 1 | 2 | 3 |
|  | 11 | Hygiene | 1 | 9 | 16 | 19 | 21 | 17 | 8 | 6 | 5 | 5 | 5 | 5 | 8 | 80 | 562 | 3 383 | 17 496 | 76 362 | 12 | 8 | 8 | 7 | 6 | 5 |
|  | 12 | Treatment | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 92 | 583 | 3 302 | 16 207 | 67 260 | 7 | 7 | 7 | 8 | 8 | 8 |
|  | 13 | Knowledge and skills | 6 | 11 | 32 | 52 | 56 | 59 | 2 | 5 | 1 | 1 | 1 | 1 | 13 | 97 | 660 | 3 876 | 19 512 | 82 929 | 6 | 5 | 5 | 3 | 3 | 4 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Incoming | 1 | Milk performance | 7 | 16 | 23 | 32 | 30 | 19 | 1 | 2 | 2 | 2 | 3 | 4 | 11 | 88 | 626 | 3 903 | 21 039 | 96 360 | 7 | 7 | 6 | 3 | 2 | 2 |
|  | 2 | Production diseases | 5 | 6 | 6 | 6 | 6 | 1 | 3 | 7 | 8 | 8 | 7 | 11 | 16 | 107 | 660 | 3 614 | 17 052 | 68 170 | 2 | 3 | 4 | 6 | 6 | 6 |
|  | 3 | Financial resources | 6 | 18 | 32 | 33 | 32 | 16 | 2 | 1 | 1 | 1 | 2 | 6 | 16 | 116 | 782 | 4 709 | 24 559 | 108 400 | 2 | 2 | 2 | 1 | 1 | 1 |
|  | 4 | Labour capacity | 3 | 7 | 17 | 22 | 28 | 25 | 4 | 5 | 5 | 5 | 4 | 3 | 28 | 147 | 807 | 4 139 | 18 707 | 72 444 | 1 | 1 | 1 | 2 | 3 | 5 |
|  | 5 | Feeding | 3 | 5 | 7 | 8 | 5 | 6 | 4 | 8 | 7 | 7 | 9 | 8 | 8 | 52 | 389 | 2 533 | 14 218 | 68 006 | 10 | 12 | 12 | 12 | 10 | 7 |
|  | 6 | Housing conditions | 2 | 7 | 13 | 22 | 27 | 33 | 8 | 5 | 6 | 6 | 5 | 2 | 14 | 105 | 667 | 3 742 | 18 339 | 76 452 | 5 | 4 | 3 | 4 | 4 | 3 |
|  | 7 | Reproduction management | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 13 | 13 | 13 | 13 | 13 | 2 | 16 | 130 | 856 | 4 785 | 22 660 | 13 | 13 | 13 | 13 | 13 | 13 |
|  | 8 | Dry cow management | 1 | 1 | 4 | 2 | 2 | 4 | 9 | 11 | 10 | 12 | 11 | 9 | 7 | 64 | 432 | 2 543 | 12 798 | 54 186 | 12 | 11 | 11 | 11 | 12 | 12 |
|  | 9 | Calf and heifer management | 1 | 1 | 3 | 3 | 2 | 3 | 9 | 11 | 11 | 10 | 11 | 10 | 10 | 89 | 586 | 3 321 | 16 142 | 66 177 | 8 | 6 | 7 | 7 | 7 | 8 |
|  | 10 | Herd health monitoring | 3 | 10 | 22 | 32 | 25 | 18 | 4 | 3 | 3 | 3 | 6 | 5 | 13 | 79 | 520 | 2 876 | 13 611 | 54 375 | 6 | 9 | 8 | 10 | 11 | 11 |
|  | 11 | Hygiene | 1 | 3 | 6 | 5 | 6 | 6 | 9 | 10 | 8 | 9 | 8 | 7 | 8 | 75 | 516 | 3 029 | 15 316 | 65 667 | 10 | 10 | 10 | 8 | 8 | 9 |
|  | 12 | Treatment | 3 | 8 | 20 | 29 | 38 | 34 | 4 | 4 | 4 | 4 | 1 | 1 | 15 | 101 | 648 | 3 656 | 17 866 | 73 981 | 4 | 5 | 5 | 5 | 5 | 4 |
|  | 13 | Knowledge and skills | 1 | 4 | 3 | 2 | 5 | 1 | 9 | 9 | 11 | 11 | 10 | 11 | 10 | 80 | 520 | 2 946 | 14 366 | 58 935 | 8 | 8 | 9 | 9 | 9 | 10 |

\* path length (number of links)