Appendix

**Can we produce more beef without increasing its environmental impact? Argentina as a case study**

Carlos Gonzalez Fischerand David Bilenca

Table I: Description of cow-calf systems for the study area in Argentina. \*’Other’ includes grain, silage and hay. Adapted from: MAyDS, 2017. Segundo Informe Bienal de Actualización de la Republica Argentina a la Convencion Marco de las Naciones Unidas sobre el Cambio Climatico.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Region | System | Weaning rate | Weaning age (months) | Replacement rate | Age at first service (months) | Diet (% of dry matter intake) | | | | |
| Natural vegetation | Pastures | Summer grazing crops | Winter grazing crops | Other\* |
| 1 | South-eastern Pampa | high productivity | 81% | 6 | 22% | 15 | 55% | 10% | 15% | 20% | - |
| 2 | South-eastern Pampa | medium productivity | 80% | 7 | 17% | 27 | 75% | 5% | 10% | 10% | - |
| 3 | South-eastern Pampa | low productivity | 73% | 8 | 14% | 27 | 100% | - | - | - | - |
| 4 | South-western Pampa | high productivity | 84% | 6 | 22% | 15 | 15% | 45% | 40% | - | - |
| 5 | South-western Pampa | medium productivity | 80% | 7 | 17% | 22 | 65% | 30% | 5% | - | - |
| 6 | South-western Pampa | low productivity | 63% | 8 | 14% | 27 | 80% | 20% | - | - | - |
| 7 | Western Pampa | high productivity | 83% | 6 | 22% | 15 | 70% | 20% | - | - | 10% |
| 8 | Western Pampa | medium productivity | 66% | 7 | 17% | 22 | 85% | 10% | - | - | 5% |
| 9 | Western Pampa | low productivity | 49% | 8 | 14% | 27 | 90% | 10% | - | - | - |
| 10 | Northern Pampa | high productivity | 76% | 6 | 22% | 15 | 90% | 2% | 5% | - | 3% |
| 11 | Northern Pampa | medium productivity | 63% | 7 | 17% | 22 | 95% | 1% | 2% | - | 2% |
| 12 | Northern Pampa | low productivity | 39% | 8 | 14% | 27 | 100% | - | - | - | - |
| 13 | North-eastern Argentina | high productivity | 80% | 6 | 22% | 24 | 80% | 15% | - | 5% | - |
| 14 | North-eastern Argentina | medium productivity | 72% | 7 | 17% | 24 | 95% | 4% | - | 1% | - |
| 15 | North-eastern Argentina | low productivity | 34% | 8 | 14% | 36 | 100% | - | - | - | - |
| 16 | North-western Argentina | high productivity | 83% | 6 | 22% | 27 | 40% | 60% | - | - | - |
| 17 | North-western Argentina | medium productivity | 76% | 7 | 17% | 27 | 80% | 20% | - | - | - |
| 18 | North-western Argentina | low productivity | 34% | 8 | 14% | 36 | 100% | - | - | - | - |
| 19 | Semiarid region | high productivity | 83% | 6 | 22% | 20 | 55% | 45% | - | - | - |
| 20 | Semiarid region | medium productivity | 68% | 7 | 17% | 24 | 90% | 10% | - | - | - |
| 21 | Semiarid region | low productivity | 58% | 8 | 14% | 27 | 100% | - | - | - | - |

Table II: Description of finishing systems for the study area in Argentina. \*’Other’ includes grain, silage and hay. Adapted from: MAyDS, 2017. Segundo Informe Bienal De Actualización de la Republica Argentina a la Convencion Marco de las Naciones Unidas sobre el Cambio Climatico.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Region | System | Type of system | Initial live weight (kg) | Final live weight (kg) | Length of finishing stage (days) | Diet (% of dry matter intake) | | | | |
|  | Natural vegetation | Pastures | Summer grazing crops | Winter grazing crops | Other\* |
| 1 | North-eastern Argentina | SE2 - corr + past liviano | mixed | 160 | 390 | 420 | - | 50% | - | - | 50% |
| 2 | North-eastern Argentina | SE3 - past + corr liviano | mixed | 180 | 430 | 480 | - | 60% | - | - | 40% |
| 3 | North-eastern Argentina | SE1 - Pastoril Liviano | grazing | 160 | 350 | 300 | - | 50% | 35% | - | 15% |
| 4 | North-eastern Argentina | SE4 - pastoril liviano | grazing | 180 | 440 | 720 | 45% | 40% | - | - | 15% |
| 5 | North-eastern Argentina | SE5 - past pesado corto | grazing | 180 | 480 | 720 | 60% | - | 25% | - | 15% |
| 6 | North-eastern Argentina | SE6 - past pesado largo | grazing | 180 | 520 | 1080 | 100% | - | - | - | - |
| 7 | North-eastern Argentina | SE7 - Pastoril Corto | grazing | 160 | 320 | 270 | - | 35% | 55% | - | 10% |
| 8 | North-eastern Argentina | SE8 - Pastoril Largo | grazing | 160 | 350 | 360 | 60% | 25% | - | - | 15% |
| 9 | North-western Argentina | SE1 - corral corto | confined | 170 | 320 | 180 | - | - | - | - | 100% |
| 10 | North-western Argentina | SE2 - past.+corral | mixed | 180 | 350 | 360 | - | 70% | - | - | 30% |
| 11 | North-western Argentina | SE3 - Past.+corral | mixed | 160 | 320 | 330 | - | 45% | - | - | 55% |
| 12 | Northern Pampa | SE1 - Silo + Corral | confined | 160 | 350 | 210 | - | - | - | - | 100% |
| 13 | Northern Pampa | SE2 - Past + Corral | mixed | 160 | 400 | 270 | - | 20% | - | 30% | 50% |
| 14 | Northern Pampa | SE3 - Past + Corral | mixed | 170 | 400 | 480 | 70% | - | - | - | 30% |
| 15 | Northern Pampa | SE6 - Isla + Corral | mixed | 170 | 480 | 720 | 70% | - | - | - | 30% |
| 16 | Northern Pampa | SE4 - Pastoril | grazing | 170 | 420 | 330 | - | 65% | - | 25% | 10% |
| 17 | Northern Pampa | SE5 - Pastoril | grazing | 150 | 460 | 690 | - | 65% | - | 20% | 15% |
| 18 | Northern Pampa | SE7 - Silo + Corral | confined | 160 | 340 | 270 | - | - | - | - | 100% |
| 19 | Northern Pampa | SE8 - Pastoril | grazing | 150 | 350 | 330 | - | 20% | - | 25% | 55% |
| 20 | Western Pampa | SE1 - Solo Corral | confined | 190 | 320 | 150 | - | - | - | - | 100% |
| 21 | Western Pampa | SE2 - Recría Pastoril + Corral | mixed | 160 | 340 | 270 | - | - | - | 35% | 65% |
| 22 | Western Pampa | SE3 - Corral Recría + Pastura | mixed | 150 | 350 | 330 | - | 35% | - | - | 65% |
| 23 | Western Pampa | SE 4 - Pastoril + Corral | mixed | 150 | 390 | 360 | 40% | 20% | - | - | 40% |
| 24 | Western Pampa | SE 6 - Pastoril + Corral Pesados | mixed | 150 | 450 | 480 | - | 60% | - | - | 40% |
| 25 | Western Pampa | SE 5 - Pastoril - Cabeza Pesados | grazing | 160 | 420 | 420 | - | 80% | - | 12% | 8% |
| 26 | Western Pampa | SE 7 - Corral | confined | 150 | 320 | 180 | - | - | - | - | 100% |
| 27 | Western Pampa | SE 8 - Pastoril + Corral | mixed | 150 | 320 | 270 | - | 20% | - | 40% | 40% |
| 28 | Western Pampa | SE 9 - Pastoril | grazing | 150 | 300 | 300 | - | 75% | - | 10% | 15% |
| 29 | South-eastern Pampa | SE1 - Corral | confined | 170 | 350 | 210 | - | - | - | - | 100% |
| 30 | South-eastern Pampa | SE2 - Pastoril + Corral Liviano | mixed | 170 | 320 | 210 | - | - | - | 50% | 50% |
| 31 | South-eastern Pampa | SE4 - Corral Recría + Pastoril | mixed | 170 | 420 | 360 | - | 18% | 18% | 35% | 30% |
| 32 | South-eastern Pampa | SE5 - Pastoril + Corral Pesado | mixed | 160 | 390 | 390 | - | - | 50% | 30% | 20% |
| 33 | South-eastern Pampa | SE3 - Pastoril Liviano | grazing | 180 | 320 | 270 | - | - | 40% | 40% | 20% |
| 34 | South-eastern Pampa | SE6 - Pastoril Liviano | grazing | 170 | 340 | 360 | - | 100% | - | - | - |
| 35 | South-eastern Pampa | SE7 - Pastoril + Corral | mixed | 160 | 310 | 180 | - | - | - | 50% | 50% |
| 36 | South-eastern Pampa | SE9 - Pastoril + Corral Colas | mixed | 170 | 320 | 360 | - | 18% | 18% | 35% | 30% |
| 37 | South-eastern Pampa | SE8 - Pastoril | grazing | 160 | 340 | 330 | - | 23% | 23% | 45% | 10% |
| 38 | South-western Pampa | SE1 - Corral Recría + Pastoril | mixed | 190 | 420 | 360 | - | 60% | - | - | 40% |
| 39 | South-western Pampa | SE2 - Pastoril + Corral | mixed | 190 | 420 | 420 | - | 45% | - | 30% | 25% |
| 40 | South-western Pampa | SE4 - Pastoril + Corral Largo | mixed | 150 | 420 | 600 | 70% | - | - | - | 30% |
| 41 | South-western Pampa | SE3 - Pastoril Pesado | grazing | 180 | 450 | 510 | - | 60% | - | 30% | 10% |
| 42 | South-western Pampa | SE5 - Pastoril Corto | grazing | 160 | 340 | 270 | - | 40% | - | 60% | - |
| 43 | South-western Pampa | SE6 - Pastoril Largo | grazing | 160 | 380 | 480 | - | 100% | - | - | - |
| 44 | Semiarid region | SE1 - past.+corral liviano | mixed | 140 | 380 | 390 | - | 45% | - | 25% | 30% |
| 45 | Semiarid region | SE2 - past.+corral pesado | mixed | 140 | 430 | 450 | - | - | - | 15% | 85% |
| 46 | Semiarid region | SE3 - past. pesado | grazing | 170 | 450 | 540 | - | 50% | - | 40% | 10% |
| 47 | Semiarid region | SE4 - past.+corral liviano | mixed | 140 | 320 | 300 | - | 45% | - | 25% | 30% |

Table III: Manure management systems for finishing systems for the study area in Argentina. Adapted from: MAyDS, 2017. Segundo Informe Bienal De Actualización de la Republica Argentina a la Convencion Marco de las Naciones Unidas sobre el Cambio Climatico.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Region | System | Type of system | Manure Management System | | |
|  | Pasture/ Range/ Paddock | Daily spread | Dry lot |
| 1 | Northeastern Argentina | SE2 - corr + past liviano | mixed | 50% | 50% | - |
| 2 | Northeastern Argentina | SE3 - past + corr liviano | mixed | 60% | 40% | - |
| 3 | Northeastern Argentina | SE1 - Pastoril Liviano | grazing | 85% | 15% | - |
| 4 | Northeastern Argentina | SE4 - pastoril liviano | grazing | 85% | 15% | - |
| 5 | Northeastern Argentina | SE5 - past pesado corto | grazing | 85% | 15% | - |
| 6 | Northeastern Argentina | SE6 - past pesado largo | grazing | 100% | - | - |
| 7 | Northeastern Argentina | SE7 - Pastoril Corto | grazing | 90% | 10% | - |
| 8 | Northeastern Argentina | SE8 - Pastoril Largo | grazing | 85% | 15% | - |
| 9 | Northwestern Argentina | SE1 - corral corto | confined | - | - | 100% |
| 10 | Northwestern Argentina | SE2 - past.+corral | mixed | 70% | 30% | - |
| 11 | Northwestern Argentina | SE3 - Past.+corral | mixed | 45% | 55% | - |
| 12 | Northern Pampa | SE1 - Silo + Corral | confined | 0% | 100% | - |
| 13 | Northern Pampa | SE2 - Past + Corral | mixed | 50% | 50% | - |
| 14 | Northern Pampa | SE3 - Past + Corral | mixed | 70% | 30% | - |
| 15 | Northern Pampa | SE6 - Isla + Corral | mixed | 70% | 30% | - |
| 16 | Northern Pampa | SE4 - Pastoril | grazing | 90% | 10% | - |
| 17 | Northern Pampa | SE5 - Pastoril | grazing | 85% | 15% | - |
| 18 | Northern Pampa | SE7 - Silo + Corral | confined | - | - | 100% |
| 19 | Northern Pampa | SE8 - Pastoril | grazing | 45% | 55% | - |
| 20 | Western Pampa | SE1 - Solo Corral | confined | - | - | 100% |
| 21 | Western Pampa | SE2 - Recría Pastoril + Corral | mixed | 35% | 65% | - |
| 22 | Western Pampa | SE3 - Corral Recría + Pastura | mixed | 35% | 65% | - |
| 23 | Western Pampa | SE 4 - Pastoril + Corral | mixed | 60% | 40% | - |
| 24 | Western Pampa | SE 6 - Pastoril + Corral Pesados | mixed | 60% | 40% | - |
| 25 | Western Pampa | SE 5 - Pastoril - Cabeza Pesados | grazing | 92% | 8% | - |
| 26 | Western Pampa | SE 7 - Corral | confined | - | - | 100% |
| 27 | Western Pampa | SE 8 - Pastoril + Corral | mixed | 60% | 40% | - |
| 28 | Western Pampa | SE 9 - Pastoril | grazing | 85% | 15% | - |
| 29 | Southeastern Pampa | SE1 - Corral | confined | - | - | 100% |
| 30 | Southeastern Pampa | SE2 - Pastoril + Corral Liviano | mixed | 50% | 50% | - |
| 31 | Southeastern Pampa | SE4 - Corral Recría + Pastoril | mixed | 70% | 30% | - |
| 32 | Southeastern Pampa | SE5 - Pastoril + Corral Pesado | mixed | 80% | 20% | - |
| 33 | Southeastern Pampa | SE3 - Pastoril Liviano | grazing | 80% | 20% | - |
| 34 | Southeastern Pampa | SE6 - Pastoril Liviano | grazing | 100% | - | - |
| 35 | Southeastern Pampa | SE7 - Pastoril + Corral | mixed | 50% | 50% | - |
| 36 | Southeastern Pampa | SE9 - Pastoril + Corral Colas | mixed | 70% | 30% | - |
| 37 | Southeastern Pampa | SE8 - Pastoril | grazing | 90% | 10% | - |
| 38 | Southwestern Pampa | SE1 - Corral Recría + Pastoril | mixed | 60% | 40% | - |
| 39 | Southwestern Pampa | SE2 - Pastoril + Corral | mixed | 75% | 25% | - |
| 40 | Southwestern Pampa | SE4 - Pastoril + Corral Largo | mixed | 70% | 30% | - |
| 41 | Southwestern Pampa | SE3 - Pastoril Pesado | grazing | 90% | 10% | - |
| 42 | Southwestern Pampa | SE5 - Pastoril Corto | grazing | 100% | - | - |
| 43 | Southwestern Pampa | SE6 - Pastoril Largo | grazing | 100% | - | - |
| 44 | Semiarid | SE1 - past.+corral liviano | mixed | 70% | 30% | - |
| 45 | Semiarid | SE2 - past.+corral pesado | mixed | 15% | 85% | - |
| 46 | Semiarid | SE3 - past. pesado | grazing | 90% | 10% | - |
| 47 | Semiarid | SE4 - past.+corral liviano | mixed | 70% | 30% | - |

Figure I: Model of the beef production cycle (cow-calf stage) used for the herd model in this study.

Figure II: Calculation of beef production in each production system for cow calf (a) and finishing (b) stages.

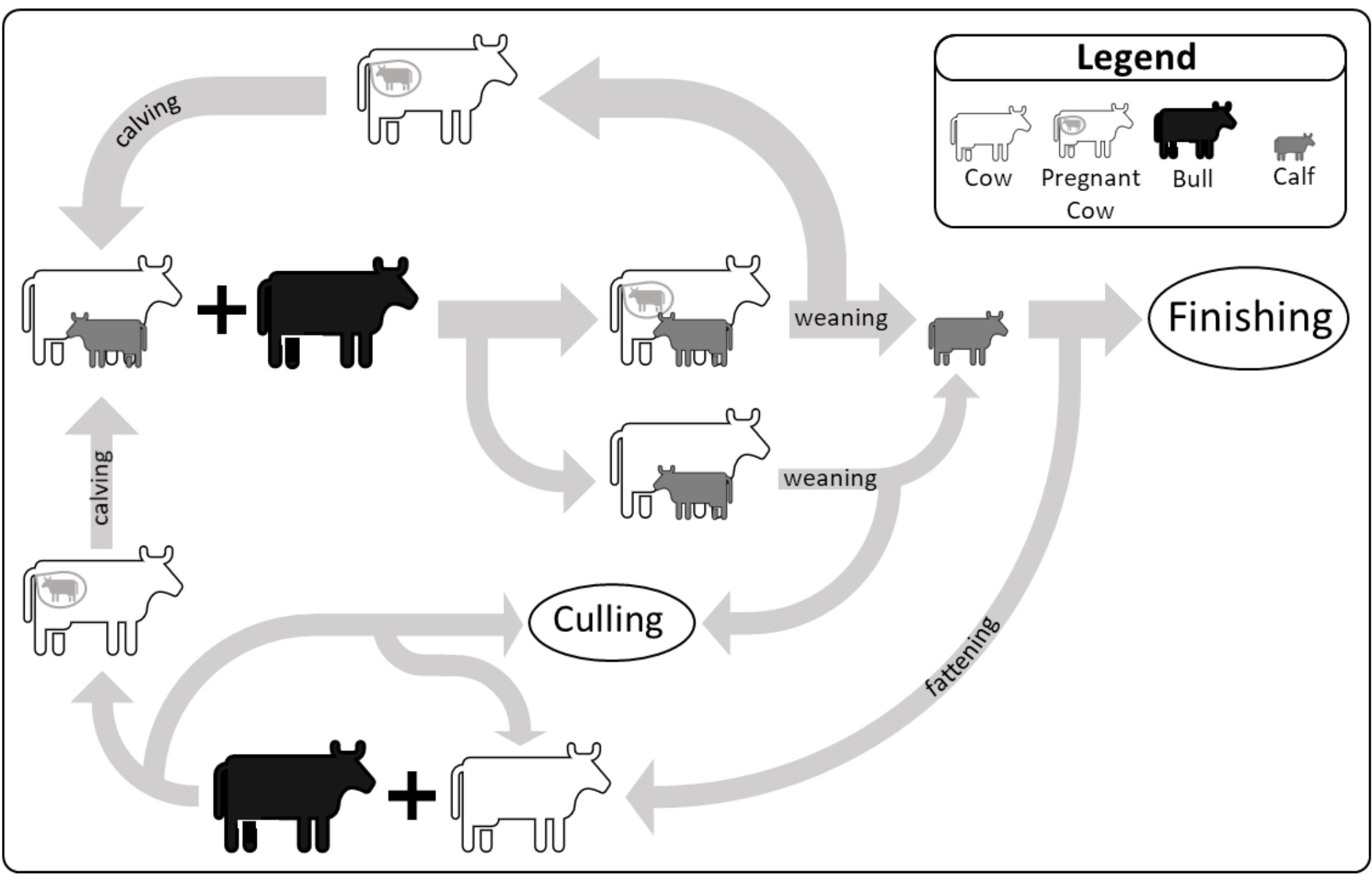


Figure III: Flowchart showing the calculations for the four impact dimensions (GHG emissions, Soil Erosion, Impact on Biodiversity and Pesticide Ecotoxicity) for beef production systems in Argentina.

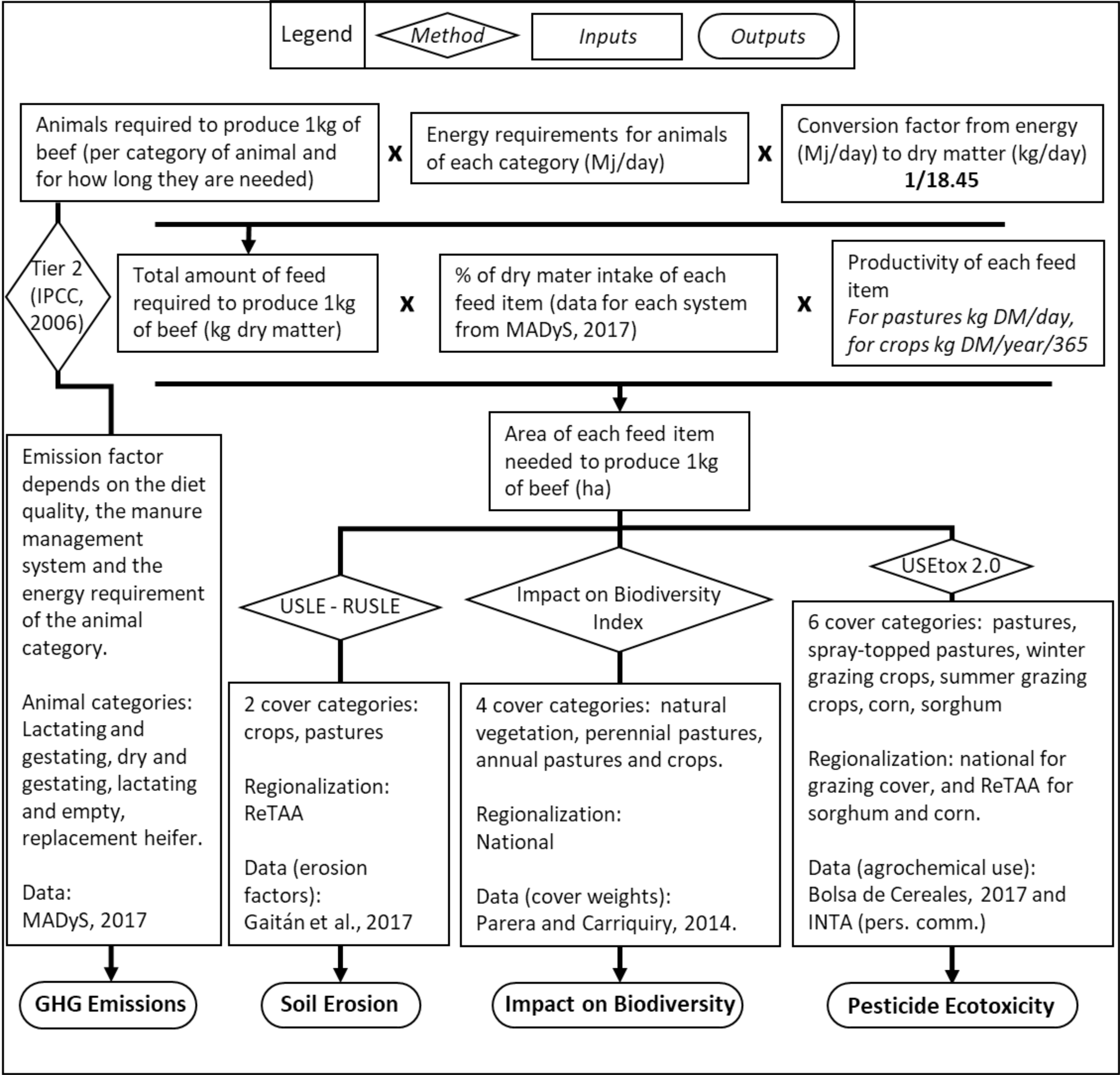
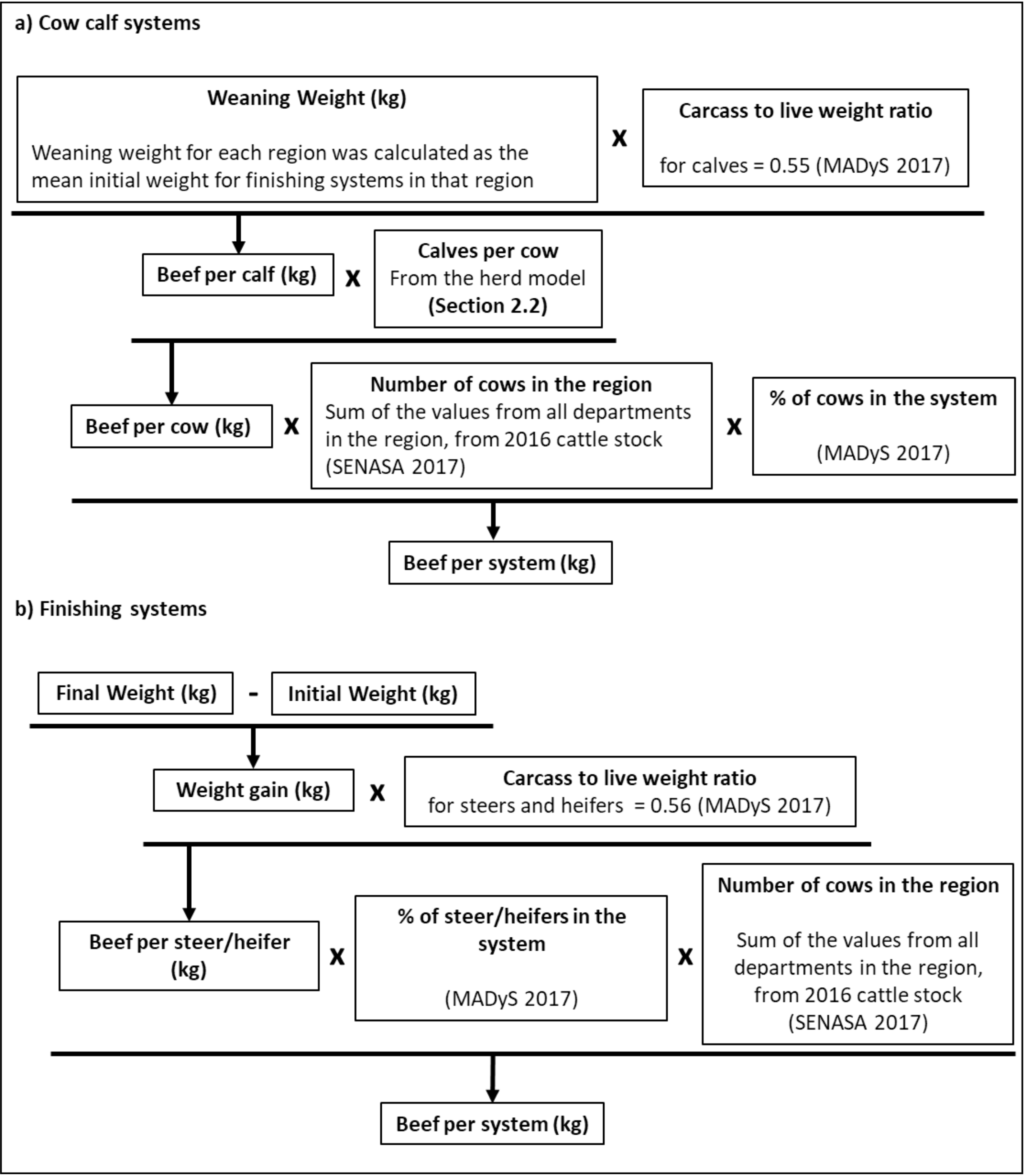


Figure IV: Regionalization of the 2017 edition of the Applied Agricultural Technology Survey (ReTAA, after its Spanish initials). Source: Bolsa de Cereales, 2017. Relevamiento de Tecnologia Agricola Aplicada: campaña 2016/2017. Buenos Aires.

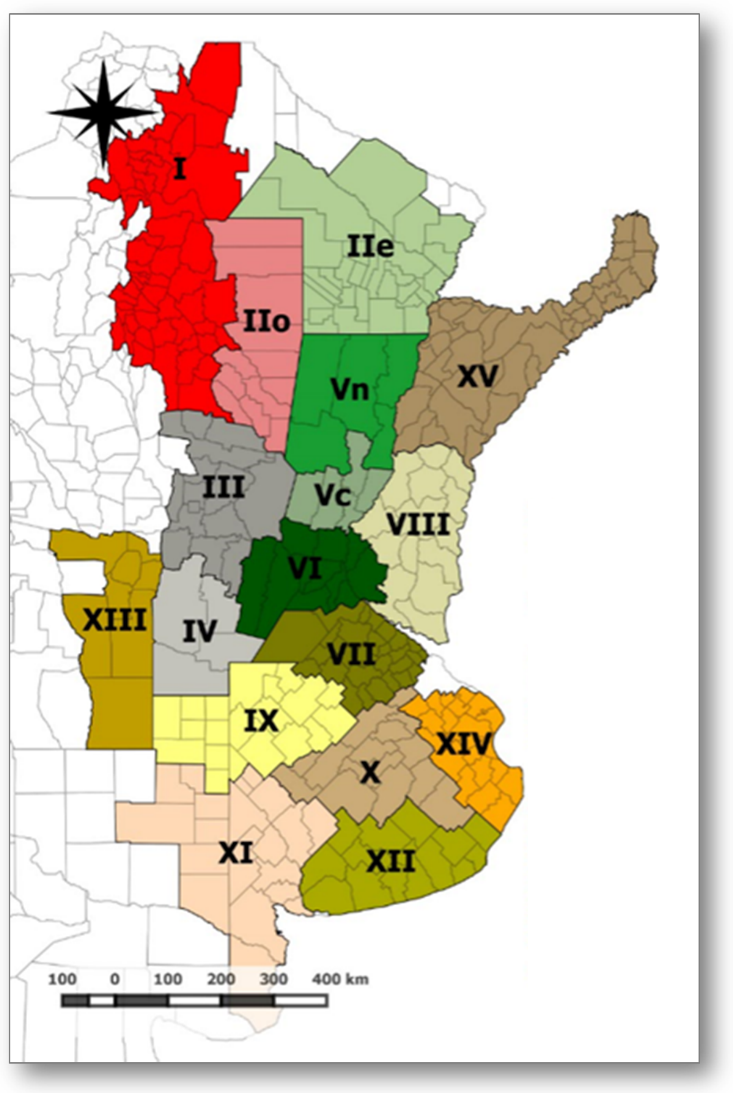


Table IV: Feed items used for this study, showing the yield values, and the categories each feed item was considered for different estimations. Adapted from: MAyDS, 2017. Segundo Informe Bienal De Actualización de la Republica Argentina a la Convencion Marco de las Naciones Unidas sobre el Cambio Climatico.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Feed item | Feed production (kg DM.ha-1.year-1) | Impact on biodiversity | | Soil erosion | Pesticide ecotoxicity |
| Natural grasslands - SEP | 5228 | | natural grasslands | pasture | natural vegetation |
| Lowland pastures - SEP | 8763 | | perennial pasture | pasture | pasture |
| Winter grazing crops - SEP | 4800 | | annual pasture | crop | winter grazing crops |
| Grazing sorghum - SEP | 7700 | | annual pasture | crop | summer grazing crops |
| Natural grasslands - SWP | 3865 | | natural grasslands | pasture | natural vegetation |
| Agropyron - SWP | 4100 | | perennial pasture | pasture | pasture |
| Alfalfa - SWP | 7700 | | perennial pasture | pasture | pasture |
| Grazing sorghum - SWP | 7500 | | annual pasture | crop | summer grazing crops |
| Natural grassland - WP | 4500 | | natural grasslands | pasture | natural vegetation |
| Agropyron (good quality) - WP | 5500 | | perennial pasture | pasture | pasture |
| Agropyron (degraded) - WP | 3000 | | perennial pasture | pasture | pasture |
| Natural grassland - NP | 4079 | | natural grasslands | pasture | natural vegetation |
| Pastures - NP | 8521 | | annual pasture | pasture | pasture |
| Oats or Rye grass - NP | 3945 | | annual pasture | crop | winter grazing crops |
| Grazing Sorghum -NP | 3940 | | annual pasture | crop | summer grazing crops |
| Natural vegetation - NEA | 3830 | | natural grasslands | pasture | natural vegetation |
| Setaria - NEA | 6280 | | perennial pasture | pasture | pasture |
| Winter grazing crops - NEA | 6400 | | annual pasture | crop | winter grazing crops |
| Natural vegetation - NWA | 1262 | | natural grasslands | pasture | natural vegetation |
| Gatton panic - NWA | 8500 | | perennial pasture | pasture | pasture |
| Buffel grass - NWA | 3627 | | perennial pasture | pasture | pasture |
| Natural grassland - SA | 2546 | | perennial pasture | pasture | natural vegetation |
| Weeping grass - SA | 7330 | | perennial pasture | pasture | pasture |
| Alfalfa - SA | 6500 | | perennial pasture | pasture | pasture |
| Festuca - SEP | 9963 | | perennial pasture | pasture | pasture |
| Spray-topped Rye grass - SEP | 4353 | | annual pasture | pasture | spray-topped pastures |
| Grazing sorghum - SEP | 7700 | | annual pasture | crop | summer grazing crops |
| Alfalfa - SWP | 7700 | | perennial pasture | pasture | pasture |
| Winter grazing crop - SWP | 3400 | | annual pasture | crop | winter grazing crops |
| Pastures - WP | 6630 | | perennial pasture | pasture | pasture |
| Winter grazing crops - WP | 6313 | | annual pasture | crop | winter grazing crops |
| Pastures - NP | 8521 | | perennial pasture | pasture | pasture |
| Winter grazing crops - NP | 3945 | | annual pasture | crop | winter grazing crops |
| Natural grassland - NP | 4079 | | natural grasslands | pasture | natural vegetation |
| Oats - NEA | 3460 | | annual pasture | crop | winter grazing crops |
| Alfalfa -NEA | 6500 | | perennial pasture | pasture | pasture |
| Gatton panic - NWA | 8500 | | perennial pasture | pasture | pasture |
| Alfalfa - SA | 6500 | | perennial pasture | pasture | pasture |
| Winter grazing crops - SA | 4058 | | annual pasture | crop | winter grazing crops |
| Grain | 7677 | | crop | crop | corn |
| Corn silage | 19817 | | crop | crop | corn |
| Sorghum silage | 20506 | | crop | crop | sorghum |
| Hay (good quality) | 6941 | | annual pasture | pasture | pasture |
| Hay (low quality) | 6941 | | annual pasture | pasture | pasture |

Table V: factors used for the USLE-RUSLE equation for each ReTAA region. Adapted from: Gaitán, J., Navarro, M.F., Tenti Vuegen, L., Pizarro, M.J., Carfagno, P., Rigo, S., 2017. Estimación de la pérdida de suelo por erosión hídrica en la República Argentina. Ediciones INTA.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| AATS region | Mean annual precipitation | R factor | K factor | LS factor | C factor | C factor | Crop erosion | Pasture erosion |
|  | (mm) | (MJ.mm.ha-1.h-1.year-1) | (tn.MJ-1.mm-1) |  | (crops) | (pastures) | (tn.ha-1.year-1) | (tn.ha-1.year-1) |
| I | 702 | 370 | 0.20 | 0.25 | 0.102 | 0.0502 | 1.9 | 0.93 |
| II-e | 977 | 538 | 0.36 | 0.25 | 0.102 | 0.0502 | 5.0 | 2.46 |
| II-o | 716 | 379 | 0.28 | 0.25 | 0.102 | 0.0502 | 2.7 | 1.35 |
| III | 797 | 427 | 0.29 | 0.25 | 0.102 | 0.0502 | 3.2 | 1.55 |
| III-e | 834 | 450 | 0.29 | 0.25 | 0.102 | 0.0502 | 3.3 | 1.63 |
| III-w | 760 | 405 | 0.29 | 0.25 | 0.102 | 0.0502 | 3.0 | 1.47 |
| IV | 785 | 420 | 0.32 | 0.25 | 0.102 | 0.0502 | 3.4 | 1.66 |
| IX | 849 | 459 | 0.32 | 0.25 | 0.102 | 0.0502 | 3.7 | 1.82 |
| V-c | 982 | 541 | 0.33 | 0.25 | 0.102 | 0.0502 | 4.5 | 2.21 |
| V-n | 988 | 545 | 0.32 | 0.25 | 0.102 | 0.0502 | 4.4 | 2.19 |
| VI | 936 | 512 | 0.36 | 0.25 | 0.102 | 0.0502 | 4.7 | 2.31 |
| VII | 988 | 545 | 0.36 | 0.25 | 0.102 | 0.0502 | 5.0 | 2.48 |
| VIII | 1105 | 618 | 0.27 | 0.25 | 0.102 | 0.0502 | 4.2 | 2.08 |
| X | 951 | 522 | 0.36 | 0.25 | 0.102 | 0.0502 | 4.8 | 2.34 |
| XI | 577 | 297 | 0.29 | 0.25 | 0.102 | 0.0502 | 2.2 | 1.10 |
| XII | 826 | 445 | 0.39 | 0.25 | 0.102 | 0.0502 | 4.4 | 2.18 |
| XIII | 499 | 252 | 0.20 | 0.25 | 0.102 | 0.0502 | 1.3 | 0.63 |
| XIV | 960 | 527 | 0.29 | 0.25 | 0.102 | 0.0502 | 3.9 | 1.94 |
| XV | 1442 | 834 | 0.23 | 0.25 | 0.102 | 0.0502 | 5.0 | 2.44 |

Table VI: Pesticide use in pastures and rangelands. Source: J. Otondo (INTA), personal communication

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | Unit | Pasture | Spray-topped pastures | Winter grazing crops | Summer grazing crops |
| Frequency |  | years-1 | 4 | 4 | 1 | 1 |
| Product |  |  |  |  |  |  |
| Flumetsulan | Herbicide | l/ha | 0.225 |  | 0.5 | 0.5 |
| Glyphosate | Herbicide | l/ha | 1 | 0.75 | 4 | 4 |
| 2,4-D | Herbicide | l/ha | 0.225 | 0.125 | 0.5 | 0.5 |
| atrazine | Herbicide | kg/ha |  |  |  | 2 |

Table VII: Pesticide use for corn in each ReTAA region. Adapted from: Bolsa de Cereales, 2017. Relevamiento de Tecnologia Agricola Aplicada: campaña 2016/2017. Buenos Aires.

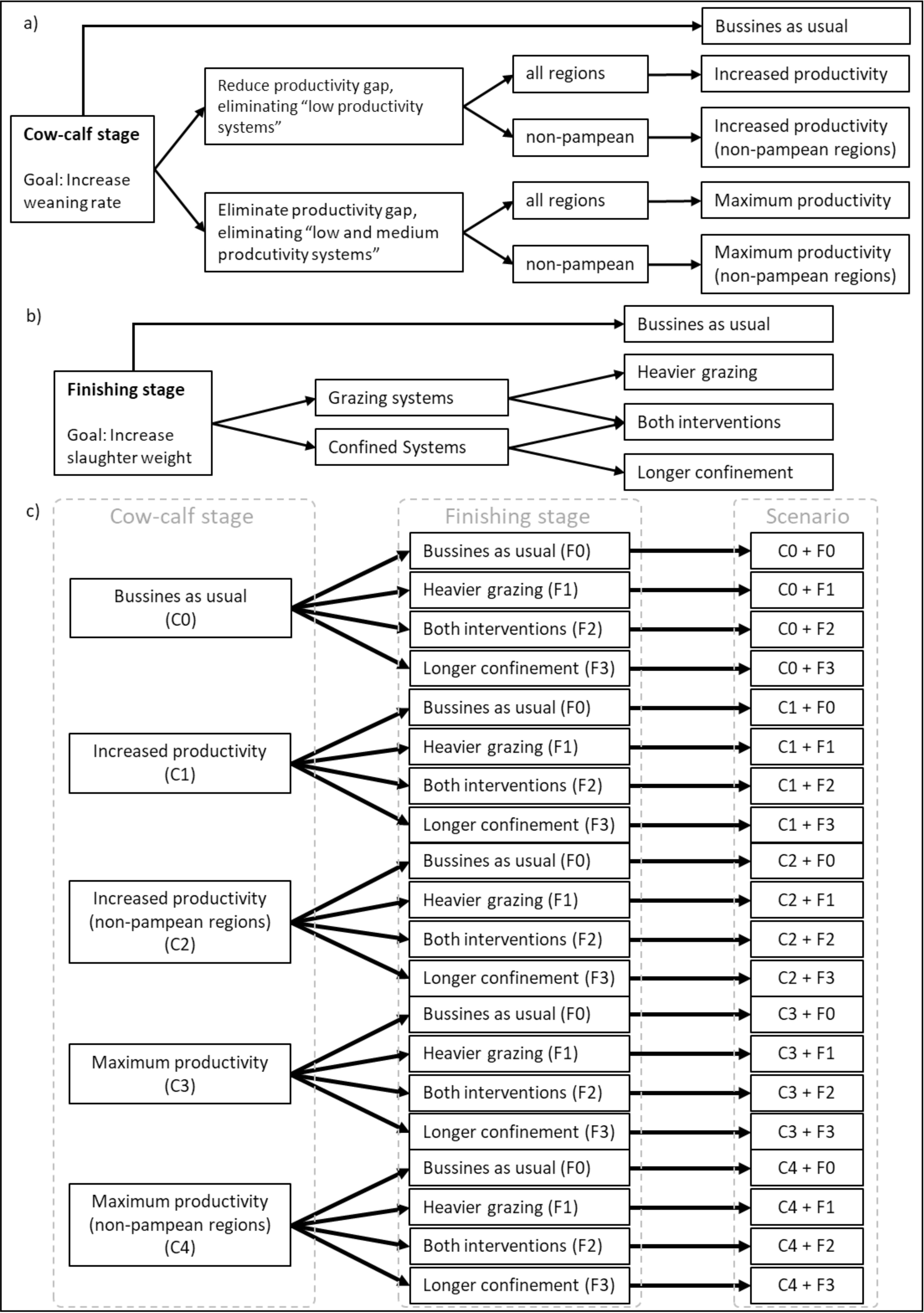
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | AATS Region | | | | | | | | | | | | | | | | |
| Product | Function | Unit | I | IIe | IIo | III | IV | Vc | Vn | VI | VII | VIII | IX | X | XI | XII | XIII | XIV | XV |
| Glyphosate | herbicide | l/ha | 19.4 | 7.6 | 17.2 | 15.3 | 16.8 | 17.5 | 18.0 | 15.5 | 18.8 | 14.2 | 15.6 | 9.3 | 19.1 | 13.4 | 14.4 | 11.3 | 11.9 |
| 2-4D | herbicide | l/ha | 2.8 | 1.6 | 3.3 | 2.7 | 1.9 | 22.2 | 2.6 | 2.8 | 1.9 | 1.8 | 2.3 | 2.1 | 2.2 | 1.8 | 2.2 | 2.1 | 0.8 |
| Dicamba | herbicide | l/ha | 0.4 | 0.2 | 0.5 | 0.7 | 0.5 | 0.4 | 0.4 | 0.5 | 0.4 | 0.4 | 0.6 | 0.5 | 0.5 | 0.6 | 0.4 | 0.2 | 0.0 |
| Atrazine | herbicide | l/ha | 6.2 | 4.7 | 10.7 | 10.2 | 8.9 | 7.5 | 14.3 | 12.1 | 7.5 | 5.8 | 11.1 | 8.1 | 8.9 | 9.1 | 8.7 | 8.0 | 7.9 |
| Acetochlor | herbicide | l/ha | 2.8 | 2.9 | 6.2 | 6.5 | 4.6 | 4.6 | 4.5 | 6.8 | 5.2 | 4.2 | 4.9 | 5.2 | 5.0 | 4.2 | 1.4 | 5.8 | 2.8 |
| Glufosinate - Ammonium | herbicide | l/ha | 3.8 | 0.0 | 1.4 | 2.6 | 0.0 | 5.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Metolachlor | herbicide | l/ha | 3.3 | 1.2 | 5.5 | 5.9 | 4.3 | 3.9 | 4.2 | 4.3 | 4.0 | 3.3 | 4.6 | 3.9 | 5.4 | 3.4 | 3.1 | 2.8 | 0.0 |
| Isoxaflutole | herbicide | l/ha | 0.7 | 1.1 | 0.7 | 0.8 | 0.4 | 0.4 | 0.4 | 0.7 | 0.3 | 0.6 | 0.0 | 0.0 | 0.0 | 0.2 | 0.5 | 0.0 | 0.3 |
| Nicosulfuron | herbicide | g/ha | 0.0 | 0.0 | 0.0 | 66.9 | 0.0 | 87.5 | 0.0 | 46.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Picloram | herbicide | l/ha | 0.0 | 0.0 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.3 | 0.3 | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 0.3 | 0.2 | 0.0 |
| Flumioxazin | herbicide | g/ha | 0.1 | 0.1 | 0.2 | 0.3 | 0.2 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| Imazapir + Imazetapir (CL) | herbicide | g/ha | 0.0 | 169.7 | 0.0 | 111.9 | 0.0 | 199.5 | 0.0 | 308.9 | 129.1 | 226.9 | 0.0 | 174.7 | 190.9 | 0.0 | 0.0 | 147.6 | 0.0 |
| S-metolaclhor | herbicide | l/ha | 0.0 | 0.0 | 0.0 | 0.0 | 2.1 | 0.0 | 0.0 | 1.6 | 2.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Cis-permethrin | insecticide | l/ha | 0.0 | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.03 | 0.0 |
| Lambda-cyhalotrhin | insecticide | l/ha | 0.2 | 0.2 | 0.3 | 0.2 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.04 | 0.1 | 0.0 | 0.0 | 0.01 | 0.0 |
| Chloropyrifos | insecticide | l/ha | 1.7 | 0.5 | 0.8 | 2.0 | 0.7 | 0.5 | 0.0 | 0.6 | 0.2 | 0.7 | 0.7 | 0.1 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 |

Table VIII: Pesticide use for sorghum in each ReTAA region. Adapted from: Bolsa de Cereales, 2017. Relevamiento de Tecnologia Agricola Aplicada: campaña 2016/2017. Buenos Aires.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | AATS Region | | | | | | | | | | | | | | | | |
| Product | Function | Unit | I | IIe | IIo | III | IV | Vc | Vn | VI | VII | VIII | IX | X | XI | XII | XIII | XIV | XV | |
| 2-4D | herbicide | l/ha | 0.0 | 0.0 | 0.0 | 0.7 | 0.0 | 1.0 | 1.7 | 0.0 | 3.6 | 0.0 | 0.5 | 0.7 | 0.0 | 0.0 | 0.0 | 0.7 | 0.0 | |
| Dicamba | herbicide | l/ha | 5.9 | 4.1 | 2.0 | 2.9 | 3.5 | 3.9 | 2.7 | 3.9 | 6.8 | 4.3 | 5.2 | 3.9 | 2.0 | 0.0 | 3.1 | 2.5 | 5.9 | |
| Atrazine | herbicide | l/ha | 1.1 | 1.1 | 0.7 | 1.0 | 1.1 | 0.9 | 0.9 | 1.2 | 1.1 | 1.0 | 0.7 | 1.0 | 0.5 | 0.0 | 1.6 | 0.8 | 0.0 | |
| Acetochlor | herbicide | l/ha | 0.0 | 0.0 | 0.2 | 0.3 | 0.1 | 0.3 | 0.3 | 0.2 | 0.3 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Glufosinate - Ammonium | herbicide | l/ha | 6.4 | 5.7 | 0.0 | 4.3 | 2.8 | 4.9 | 3.8 | 5.0 | 7.0 | 4.8 | 4.4 | 6.1 | 0.0 | 0.0 | 5.5 | 2.9 | 5.0 | |
| Metolachlor | herbicide | l/ha | 3.9 | 4.4 | 0.0 | 3.3 | 3.2 | 3.2 | 3.5 | 3.0 | 3.7 | 3.9 | 0.0 | 4.4 | 0.0 | 0.0 | 0.0 | 2.4 | 0.0 | |
| Nicosulfuron | herbicide | g/ha | 1.3 | 2.1 | 0.0 | 1.8 | 1.7 | 1.5 | 1.6 | 1.4 | 1.1 | 1.7 | 1.9 | 2.0 | 0.0 | 0.0 | 1.7 | 0.9 | 2.3 | |
| Imazapir + Imazetapir (CL) | herbicide | g/ha | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.1 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Chloropyrifos | insecticide | l/ha | 0.1 | 0.04 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.003 | 0.0 | 0.0 | 0.0 | 0.0 | |

Figure V: Flowchart showing the scenario building process for a) sub-scenario for the cow-calf stage, b) sub-scenarios for the finishing stage and c) scenarios for beef production systems in Argentina

Table IX: Average weaning rate in Argentina under different scenarios for the cow-calf stage



|  |  |  |
| --- | --- | --- |
| Scenario | | Weaning rate |
| C0 | Business as usual | 70% |
| C1 | Increased productivity (all regions) | 76% |
| C2 | Increased productivity (non-pampean regions) | 73% |
| C3 | Maximum productivity (all regions) | 81% |
| C4 | Maximum productivity (non-pampean regions) | 81% |

Table X: Average final weight and length of finishing stage in Argentina under different scenarios for the finishing stage.

|  |  |  |  |
| --- | --- | --- | --- |
| Scenario | | Final live weight (kg) | Length of finishing stage (days) |
| F0 | Business as usual | 383 | 425 |
| F1 | Heavier grazing | 391 | 455 |
| F2 | Both Interventions | 398 | 458 |
| F3 | Longer confinement | 390 | 429 |

Table XI: Changes in beef production and in the intensity of impacts relative to the Business as Usual scenario. Dotted line highlights the best performing scenario (*i.e.*, the one that managed to increase beef production while increasing the smallest number of absolute impacts).

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Beef production | Soil erosion | GHG emissions | Pesticide ecotoxicity | Impact on Biodiversity |
| Scenarios | C0+F0 | BAU + BAU | 0% | 0% | 0% | 0% | 0% |
| C0+F1 | BAU + Heavier grazing | 1% | -2% | 1% | -4% | -9% |
| C0+F2 | BAU + Both Interventions | 3% | -3% | -1% | 5% | -8% |
| C0+F3 | BAU + Longer confinement | 2% | -1% | -1% | 9% | 1% |
| C1+F0 | Increased productivity + BAU | 21% | -13% | -15% | 8% | 4% |
| C1+F1 | Increased productivity + Heavier grazing | 22% | -14% | -14% | 4% | -5% |
| C1+F2 | Increased productivity + Both Interventions | 25% | -15% | -15% | 13% | -3% |
| C1+F3 | Increased productivity + Longer confinement | 23% | -13% | -16% | 17% | 5% |
| C2+F0 | Increased productivity (NP) + BAU | 13% | -9% | -9% | 4% | -2% |
| C2+F1 | Increased productivity (NP) + Heavier grazing | 15% | -11% | -8% | 0% | -12% |
| C2+F2 | Increased productivity (NP) + Both Interventions | 17% | -12% | -10% | 8% | -10% |
| C2+F3 | Increased productivity (NP) + Longer confinement | 15% | -10% | -11% | 12% | -1% |
| C3+F0 | Maximum productivity + BAU | 31% | -20% | -24% | 7% | 13% |
| C3+F1 | Maximum productivity + Heavier grazing | 33% | -21% | -22% | 4% | 4% |
| C3+F2 | Maximum productivity + Both Interventions | 36% | -22% | -24% | 13% | 5% |
| C3+F3 | Maximum productivity + Longer confinement | 34% | -21% | -25% | 17% | 14% |
| C4+F0 | Maximum productivity (NP) + BAU | 25% | -17% | -16% | 12% | 1% |
| C4+F1 | Maximum productivity (NP) + Heavier grazing | 27% | -19% | -15% | 8% | -8% |
| C4+F2 | Maximum productivity (NP) + Both Interventions | 30% | -19% | -16% | 18% | -6% |
| C4+F3 | Maximum productivity (NP) + Longer confinement | 28% | -18% | -17% | 22% | 3% |