Water footprinting of pasture based farms; Beef and Sheep

E. Murphy1,2\*, T. P. Curran2, N. M. Holden2, D. O’Brien1 and J. Upton,1

1 Animal and Grassland Research and Innovation Centre, Teagasc, Moorepark, Fermoy, Co.Cork, Ireland.

2 UCD School of Biosystems and Food Engineering, University College Dublin, Belfield, Dublin 4, Ireland.

\* Corresponding Author: John Upton, Animal and Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork, Ireland

Email: [john.upton@teagasc.ie](mailto:john.upton@teagasc.ie)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Farm Number** | **1** | | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
|  | | **2014** | | | | | | | | | |
| Livestock Unit | | 79 | 64 | 66 | 70 | 89 | 153 | 106 | 184 | 142 | 201 |
| Area, Ha | | 40 | 28 | 30 | 31 | 46 | 75 | 43 | 89 | 48 | 65 |
| Total kg CW output | | 16 180 | 11 525 | 8 448 | 19 045 | 16 318 | 26 852 | 21 812 | 65 368 | 18 091 | 34 987 |
| Grazed grass intake, kgDM | | 181 103 | 189 544 | 79 223 | 221 563 | 234 124 | 378 553 | 214 234 | 511 510 | 271 896 | 439 468 |
| Grass silage intake, kgDM | | 120 850 | 100 610 | 102 112 | 132 740 | 138 214 | 221 226 | 131 615 | 242 720 | 177 827 | 281 480 |
| Total forage intake, kg DM | | 301 953 | 290 154 | 181 335 | 354 303 | 372 339 | 599 778 | 345 850 | 754 229 | 449 723 | 720 948 |
| Concentrate intake, kg DM | | 32 222 | 5 690 | 15 854 | 45 110 | 12 605 | 39 864 | 81 033 | 123 000 | 33 646 | 113 444 |
| Grass Yield, kg DM/ Ha | | 7 614 | 10 363 | 5 965 | 11 356 | 8 142 | 7 997 | 8 043 | 8 472 | 9 287 | 11 092 |
| On-Farm water, Litres/year | | 947 000 | 566 883 | 1 186 788 | 744 000 | 790 600 | 2 093 000 | 3 728 966 | 2 149 388 | 367 331 | 652 247 |
|  | | **2015** | | | | | | | | | |
| Livestock Unit | | 77 | 66 | 71 | 70 | 84 | 155 | 112 | 194 | 156 | 197 |
| Area, Ha | | 38 | 28 | 31 | 31 | 46 | 75 | 43 | 89 | 53 | 65 |
| Total kg CW output | | 15 170 | 9 291 | 6 151 | 19 748 | 15 475 | 31 346 | 16 924 | 69 979 | 20 636 | 37 816 |
| Grazed grass intake, kgDM | | 197 517 | 160 788 | 49 470 | 243 048 | 259 800 | 349 519 | 169 607 | 565 095 | 291 467 | 441 703 |
| Grass silage intake, kgDM | | 118 192 | 97 008 | 94 466 | 122 021 | 119 142 | 228 061 | 114 331 | 248 920 | 122 877 | 282 436 |
| Total forage intake, kg DM | | 315 710 | 257 797 | 143 936 | 365 070 | 378 942 | 577 580 | 283 938 | 814 014 | 414 344 | 724 139 |
| Concentrate intake, kg DM | | 35 318 | 4 650 | 18 467 | 44 327 | 12 728 | 109 799 | 79 775 | 128 100 | 37 380 | 107 182 |
| Grass Yield, kg DM/ Ha | | 8 212 | 9 207 | 4 683 | 11 701 | 8 287 | 7 701 | 6 603 | 9 143 | 7 872 | 11 141 |
| On-Farm water, Litres/year | | 931 000 | 493 000 | 716 000 | 685 000 | 851 600 | 1 695 000 | 2 928 480 | 2 301 000 | 419 000 | 887 000 |

Table S1 Beef Production Parameters of 10 beef study farms for 2014 and 2015.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Farm Number | 1 | 2 | 3 | 4 | 5 | 6 |
| Parameter | 2014 | | | | | |
| Livestock Unit | 43 | 200 | 38 | 115 | 41 | 77 |
| Area, Ha | 22 | 108 | 24 | 58 | 18 | 33 |
| Total kg CW output | 6 134 | 24 904 | 5 414 | 25 289 | 5 860 | 17555 |
| Grazed grass intake, kgDM | 100 336 | 477 031 | 77 558 | 303 347 | 109 115 | 191521 |
| Grass silage intake, kgDM | 36 882 | 155 092 | 27 978 | 68 499 | 22 283 | 58941 |
| Total forage intake, kg DM | 137 217 | 632 123 | 105 536 | 371 845 | 131 398 | 250462 |
| Concentrate intake, kg DM | 6 294 | 5 853 | 4 446 | 6 461 | 7 323 | 7696 |
| Grass Yield, kg DM/ Ha | 21 096 | 29 600 | 18 734 | 8 000 | 23 058 | 40852 |
| On-Farm water, Litres/year | 169 085 | 1 021 000 | 234 600 | 862 278 | 377 392 | 492694 |
|  | 2015 | | | | | |
| Livestock Unit | 45 | 216 | 43 | 97 | 45 | 75 |
| Area, Ha | 22 | 105 | 23 | 48 | 19 | 29 |
| Total kg CW output | 8228 | 33686 | 6514 | 19914 | 6663 | 14 437 |
| Grazed grass intake, kgDM | 117494 | 545106 | 83036 | 246910 | 118502 | 207 266 |
| Grass silage intake, kgDM | 38978 | 172124 | 33792 | 109130 | 31287 | 44 651 |
| Total forage intake, kg DM | 156472 | 717230 | 116828 | 356040 | 149789 | 251 917 |
| Concentrate intake, kg DM | 7178 | 6831 | 5130 | 7455 | 8032 | 8 652 |
| Grass Yield, kg DM/ Ha | 17220 | 42280 | 28561 | 17332 | 15886 | 32 480 |
| On-Farm water, Litres/year | 180000 | 1063000 | 270096 | 780000 | 275604 | 413 982 |

Table S2 Production parameters for 6 sheep study farms for 2014 and 2015.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Farm Number** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
|  | **2014** | | | | | | | | | | |
| On-farm Blue WF | 59 | 49 | 140 | 39 | 48 | 78 | 171 | 33 | 20 | 19 |
| Concentrates GWF | 737 | 183 | 695 | 877 | 288 | 563 | 1 375 | 696 | 688 | 1 219 |
| Concentrates BWF | 95 | 23 | 89 | 112 | 37 | 72 | 176 | 89 | 88 | 156 |
| Grass WF | 6 157 | 10 875 | 5 770 | 8 721 | 7 976 | 7 688 | 5 484 | 4 174 | 9 745 | 9 458 |
| Total BWF | 153 | 73 | 230 | 151 | 85 | 150 | 347 | 122 | 109 | 175 |
| Total GWF | 6 894 | 11 058 | 6 464 | 9 598 | 8 264 | 8 251 | 6 859 | 4 871 | 10 434 | 10 677 |
| Total WF | 7 047 | 11 130 | 6 694 | 9 749 | 8 350 | 8 401 | 7 206 | 4 993 | 10 542 | 10 852 |
| Stress weighted on-farm BWF | 2.1 | 1.8 | 5.1 | 1.4 | 1.8 | 2.8 | 6.2 | 1.2 | 0.7 | 0.7 |
| Stress weighted concentrate BWF | 80 | 20 | 76 | 95 | 31 | 61 | 150 | 76 | 75 | 133 |
| Total stress weighted BWF | 82 | 22 | 81 | 97 | 33 | 64 | 156 | 77 | 76 | 133 |
|  | **2015** | | | | | | | | | | |
| On-farm Blue WF | 61 | 53 | 116 | 35 | 55 | 54 | 173 | 33 | 20 | 23 |
| Concentrates GWF | 862 | 185 | 1141 | 831 | 304 | 1 289 | 1843 | 730 | 665 | 1 139 |
| Concentrates BWF | 110 | 24 | 146 | 107 | 39 | 165 | 236 | 94 | 85 | 146 |
| Grass WF | 7 329 | 10 796 | 5 176 | 8 903 | 8 691 | 6 139 | 4 907 | 4 498 | 6 818 | 8 824 |
| Total BWF | 172 | 77 | 263 | 141 | 94 | 219 | 409 | 127 | 106 | 170 |
| Total GWF | 8 190 | 10 981 | 6 317 | 9 734 | 8 996 | 7 428 | 6 750 | 5 229 | 7 482 | 9 963 |
| Total WF | 8 362 | 11 058 | 6 580 | 9 875 | 9 090 | 7 648 | 7 159 | 5 355 | 7 588 | 10 133 |
| Stress weighted on-farm BWF | 2.2 | 1.9 | 4.3 | 1.3 | 2.0 | 2.0 | 6.3 | 1.2 | 0.7 | 0.9 |
| Stress weighted concentrate BWF | 94 | 20 | 124 | 90 | 33 | 140 | 201 | 79 | 72 | 124 |
| Total stress weighted BWF | 96 | 22 | 128 | 92 | 35 | 142 | 207 | 81 | 73 | 125 |

Table S3 Calculated blue water footprint (BWF), green water footprint (GWF) and stress weighted WF of 10 beef study farms for 2014 and 2015.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Farm Number | 1 | 2 | 3 | 4 | 5 | 6 |
| Parameter | 2014 | | | | | |
| On-farm Blue WF | 28 | 41 | 43 | 34 | 64 | 28 |
| Concentrates GWF | 1 384 | 478 | 1 393 | 127 | 1 584 | 937 |
| Concentrates BWF | 0.29 | 0.1 | 0.29 | 0.03 | 0.33 | 0.2 |
| Grass WF | 7 228 | 7 724 | 4 762 | 4 856 | 8 230 | 5 464 |
| Total BWF | 28 | 41 | 44 | 34 | 65 | 28 |
| Total GWF | 8 613 | 8 203 | 6 155 | 4 983 | 9 813 | 6 400 |
| Total Volumetric WF | 8 640 | 8 244 | 6 198 | 5 017 | 9 878 | 6 429 |
| Stress weighted on-farm BWF | 1 | 1.5 | 1.6 | 1.2 | 2.4 | 1 |
| Stress weighted concentrate BWF | 1 | 0.4 | 1 | 0.1 | 1.2 | 0.7 |
| Total stress weighted BWF | 2 | 1.9 | 2.6 | 1.3 | 3.5 | 1.7 |
|  | 2015 | | | | | |
| On-farm Blue WF | 22 | 32 | 41 | 39 | 41 | 29 |
| Concentrates GWF | 842 | 505 | 1765 | 350 | 960 | 905 |
| Concentrates BWF | 0.18 | 0.11 | 0.37 | 0.07 | 0.2 | 0.19 |
| Grass WF | 6 862 | 7 368 | 4905 | 6 663 | 8 932 | 7 394 |
| Total BWF | 22 | 32 | 42 | 39 | 42 | 29 |
| Total GWF | 7 705 | 7 873 | 6 670 | 7 013 | 9 891 | 8 300 |
| Total Volumetric WF | 7 727 | 7 904 | 6 712 | 7 052 | 9 933 | 8 329 |
| Stress weighted on-farm BWF | 0.8 | 1.2 | 1.5 | 1.4 | 1.5 | 1 |
| Stress weighted concentrate BWF | 0.6 | 0.4 | 1.3 | 0.3 | 0.7 | 0.7 |
| Total stress weighted BWF | 1.4 | 1.5 | 2.8 | 1.7 | 2.2 | 1.7 |

Table S4 Calculated blue water footprint (BWF), green water footprint (GWF) and stress weighted WF of 6 sheep study farms for 2014 and 2015.