

**Table 1**

Soil particle size distribution, bulk density, air capacity and moisture retention capacity.

| Depth (m)              | Sand | Silt | Clay | Gravel in    | Bulk               | Air                   | Available          | Wilting            |
|------------------------|------|------|------|--------------|--------------------|-----------------------|--------------------|--------------------|
|                        |      |      |      | whole sample | density            | capacity <sup>a</sup> | water <sup>b</sup> | point <sup>c</sup> |
| % of fine earth        |      |      |      | %            | g cm <sup>-3</sup> | vol%                  |                    |                    |
| Kvithamar <sup>d</sup> |      |      |      |              |                    |                       |                    |                    |
| 0-0.21                 | 3    | 70   | 27   | 3            | 1.13               | 6                     | 36                 | 15                 |
| 0.21-0.36              | 2    | 64   | 34   | 2            | 1.81               | 3                     | 13                 | 17                 |
| 0.36-0.65              | 0    | 63   | 37   | 2            | 1.71               | 5                     | 10                 | 24                 |
| Værnes <sup>e</sup>    |      |      |      |              |                    |                       |                    |                    |
| 0-0.30                 | 51   | 43   | 6    | 0            | 1.53               | 8                     | 27                 | 6                  |
| 0.30-0.50              | 73   | 25   | 2    | 0            | 1.62               | 9                     | 26                 | 3                  |
| 0.50-0.62              | 92   | 7    | 1    | 0            | 1.54               | 33                    | 4                  | 1                  |
| Apelsvoll <sup>f</sup> |      |      |      |              |                    |                       |                    |                    |
| 0-0.25                 | 55   | 31   | 14   | 11           | 1.47               | 12                    | 21                 | 10                 |
| 0.25-0.50              | 55   | 32   | 13   | 12           | 1.52               | 14                    | 18                 | 9                  |
| 0.50-0.60              | 51   | 32   | 17   | 11           | 1.5                | 16                    | 16                 | 10                 |
| Ås <sup>g</sup>        |      |      |      |              |                    |                       |                    |                    |
| 0-0.30                 | 22   | 43   | 35   | 8            | 1.36               | 9                     | 20                 | 19                 |
| 0.30-0.39              | 14   | 46   | 40   | 4            | 1.62               | 5                     | 9                  | 27                 |
| 0.39-0.70              | 15   | 46   | 39   | 4            | 1.58               | 5                     | 10                 | 26                 |

<sup>a</sup> at 10 kPa, <sup>b</sup> 10-1500 kPa, <sup>c</sup> >1500 kPa, <sup>d</sup> from profile no. 6 in Sveistrup et al. (1994), <sup>e</sup> from profile 20177 in Solbakken (1987), <sup>f</sup> six profiles from Riley (unpublished), <sup>g</sup> Østre Voll in Sveistrup et al. (1994).

**Table 2**

Means ( $\pm$ SD) of total C and N (% of fine earth) at various sampling depths (cm) at the four sites. Samples taken from all treatments were pooled blockwise before analysis (n = 4).

| Depth | Total-C     |             |             |             | Total-N     |                   |             |             |
|-------|-------------|-------------|-------------|-------------|-------------|-------------------|-------------|-------------|
|       | Kvithamar   | Værnes      | Apelsvoll   | Ås          | Kvithamar   | Værnes            | Apelsvoll   | Ås          |
| 0-20  | 4.90 (1.57) | 1.39 (0.07) | 2.14 (0.17) | 2.08 (0.08) | 0.40 (0.11) | 0.11(0.01)        | 0.21(0.03)  | 0.20 (0.01) |
| 20-30 | 4.40 (1.37) | 1.26 (0.05) | 1.76 (0.25) | 1.61 (0.26) | 0.36 (0.10) | 0.09 (0.01)       | 0.17 (0.03) | 0.15 (0.02) |
| 30-60 | 1.08 (0.47) | 0.38 (0.04) | 0.79 (0.14) | 0.46 (0.08) | 0.09 (0.04) | 0.01 <sup>a</sup> | 0.07 (0.02) | 0.05 (0.01) |

<sup>a</sup> n = 1

**Table 3**

Overview of treatments in the 3-year crop rotation. 2008 was a preparatory year with establishing of green manure (G) in spring barley. In 2009 the green manure herbage was removed (0M) or mulched (1M or 3M). Unfertilized oats (C) was control. In the following spring, green manure was ploughed under and barley was sown and fertilized with digestate (D) at 11 g N m<sup>-1</sup>, inorganic fertilizer (I) at 8 g N m<sup>-1</sup> fertilization or unfertilized.

| Term   | 2008                    | 2009                                      | 2010                |
|--------|-------------------------|---|---------------------|
| G-3M   | Barley with G undersown | G 3 cuts mulched                          | Barley              |
| G-1M   | Barley with G undersown | G 2 cuts removed, 3 <sup>rd</sup> mulched | Barley              |
| G-0M   | Barley with G undersown | G 3 cuts removed                          | Barley              |
| G-0M-D | Barley with G undersown | G 3 cuts removed                          | Barley + digestate  |
| C-D    | Barley                  | Oats                                      | Barley + digestate  |
| C-I    | Barley                  | Oats                                      | Barley + fertilizer |

**Table 4**

Overview of crops and operations at the four sites during the experiment.

|                               | Treatment dates |        |           |               |
|-------------------------------|-----------------|--------|-----------|---------------|
|                               | Kvithamar       | Værnes | Apelsvoll | Ås            |
| <b>Preparatory year 2008</b>  |                 |        |           |               |
| Ploughing                     | 28 Oct 07       | 15 Apr | 30 Oct 07 | 19 May        |
| Soil sampling                 | 28 Apr          | 29 Apr | 21 May    | 20 May        |
| Barley sowing                 | 28 Apr          | 29 Apr | 21 May    | 20 May        |
| Green manure sowing           | 29 Apr          | 29 Apr | 21 May    | 22 May        |
| Barley harvest                | 12 Aug          | 16 Aug | 18 Sep    | 1 Sep         |
| Green manure sampling         | 22 Sep          | 23 Sep | 6 Oct     | 7 Oct         |
| Soil sampling                 | 22 Oct          | 23 Oct | 23 Oct    | 4 Nov         |
| <b>Green manure 2009</b>      |                 |        |           |               |
| Soil sampling                 | 28 Apr          | 29 Apr | 6 May     | 4 May         |
| Oats sowing                   | 29 Apr          | 29 Apr | 6 May     | 5 May         |
| Green manure first cut        | 1 Jun           | 5 Jun  | 17 Jun    | 3 Jun         |
| Soil sampling                 | 1 Jun           | 5 Jun  | 17 Jun    | 8 Jun         |
| Soil sampling                 | 11 Jun          | 15 Jun | 26 Jun    | 15 Jun        |
| Soil sampling                 | 20 Jun          | 25 Jun | 7 Jul     | 24 Jun        |
| Irrigation <sup>a</sup>       | -               | -      | 2 Jun     | 26 Jun, 2 Jul |
| Green manure second cut       | 17 Jul          | 22 Jul | 6 Aug     | 17 Jul        |
| Oats harvesting               | 27 Aug          | 25 Jul | 21 Aug    | 23 Aug        |
| Green manure third cut        | 15 Sep          | 15 Sep | 24 Sep    | 15 Sep        |
| Green manure sampling         | 21 Oct          | 21 Oct | 19 Oct    | 24 Oct        |
| Soil sampling                 | 21 Oct          | 21 Oct | 13 Oct    | 30 Oct        |
| <b>Barley cropping 2010</b>   |                 |        |           |               |
| Soil sampling                 | 23 Apr          | 22 Apr | 5 May     | 22 Apr        |
| Ploughing                     | 7 May           | 26 Apr | 6 May     | 23 Apr        |
| Digestate application         | 11 May          | 6 May  | 24 May    | 12 May        |
| Fertilizer application        | 14 May          | 8 May  | 20 May    | 12 May        |
| Harrowing                     | 14 May          | 7 May  | -         | 12 May        |
| Barley sowing                 | 14 May          | 12 May | 24 May    | 14 May        |
| Weed harrowing                | 21 May          | 19 May | 31 May    | -             |
| Soil sampling                 | 31 May          | 27 May | 7 Jun     | 31 May        |
| Barley sampling               | 20 Jun          | 15 Jun | 26 Jun    | 11 Jun        |
| Barley sampling               | 5 Jul           | 1 Jul  | 5 Jul     | 28 Jun        |
| Irrigation <sup>b</sup>       | -               | -      | -         | 29 Jun, 9 Jul |
| Barley harvesting             | 26 Aug          | 19 Aug | 2 Sep     | 31 Aug        |
| Harrowing                     | -               | 10 Sep | 6 Sep     | 7 Sep         |
| Soil sampling                 | 27 Aug          | 20 Aug | 3 Sep     | 1 Sep         |
| Soil sampling                 | 29 Oct          | 2 Nov  | 15 Oct    | 26 Oct        |
| <b>Carry over effect 2011</b> |                 |        |           |               |
| Soil sampling                 | 16 May          | 18 May | 19 May    | 20 May        |

<sup>a</sup> Apelsvoll: 30-35 mm; Ås: 25 mm each time, <sup>b</sup> Ås: 20-25 mm and 25-30 mm

**Table 5**

Green manure 2009: Biomass (g DM m<sup>-2</sup>), N content (g m<sup>-2</sup>) and clover proportion in three consecutive cuts ( $\pm$  S.E), where the herbage was either mulched (G-3M) or removed (G-0M). \*:  $P \leq 0.05$  for the test G-3M  $\neq$  G-0M for each site x cut combination.

|                  | 1 <sup>st</sup> cut |             | 2 <sup>nd</sup> cut |             | 3 <sup>rd</sup> cut |  |
|------------------|---------------------|-------------|---------------------|-------------|---------------------|--|
|                  | G-3M/G-0M           | G-3M        | G-0M                | G-3M        | G-0M                |  |
| <b>Kvithamar</b> |                     |             |                     |             |                     |  |
| Biomass          | 296 (9)             | 461 (27)    | 495 (7) *           | 286 (13)    | 290 (8)             |  |
| Nitrogen         | 7.1 (0.3)           | 10.3 (1.0)  | 10.8 (0.3)          | 8.4 (0.3)   | 7.8 (0.3)           |  |
| Clover fraction  | 0.55 (0.10)         | 0.54 (0.10) | 0.65 (0.05)         | 0.43 (0.04) | 0.53 (0.04)         |  |
| <b>Værnes</b>    |                     |             |                     |             |                     |  |
| Biomass          | 321(14)             | 439 (23)    | 429 (8)             | 173 (8)     | 178 (3)             |  |
| Nitrogen         | 8.3 (0.5)           | 9.3 (0.5)   | 8.8 (0.6)           | 5.0 (0.1)   | 5.6 (0.3)           |  |
| Clover fraction  | 0.71 (0.03)         | 0.84 (0.05) | 0.83 (0.02)         | 0.69 (0.06) | 0.64 (0.03)         |  |
| <b>Apelsvoll</b> |                     |             |                     |             |                     |  |
| Biomass          | 355 (11)            | 316 (24)    | 383 (12) *          | 52 (6)      | 99 (4) *            |  |
| Nitrogen         | 8.5 (0.5)           | 8.5 (0.6)   | 9.1 (0.5)           | 1.8 (0.3)   | 3.1 (0.3) *         |  |
| Clover fraction  | 0.83 (0.03)         | 0.87 (0.02) | 0.95 (0.01) *       | 0.63 (0.04) | 0.70 (0.05)         |  |
| <b>Ås</b>        |                     |             |                     |             |                     |  |
| Biomass          | 366 (8)             | 174 (9)     | 182 (6)             | 326 (20)    | 327 (12)            |  |
| Nitrogen         | 6.9 (0.3)           | 4.8 (0.3)   | 5.1 (0.3)           | 7.6 (0.6)   | 7.9 (0.1)           |  |
| Clover fraction  | 0.34 (0.05)         | 0.67 (0.03) | 0.74 (0.04)         | 0.79 (0.01) | 0.85 (0.02)         |  |

**Table 6**

Biomass (g DM m<sup>-2</sup>) and nitrogen (g m<sup>-2</sup>) in barley plants in 2010 at 250-330 day degrees, DD, (with base temperature 0°C) and at growth stage 47 (flag leaf sheath opened) according to the BBCH scale. Abbreviations for the treatments are explained in Table 3. Within a site, treatment means ( $\pm$  S.E) which do not share any letter in common are significantly different ( $P < 0.05$ ) by Tukey HSD method. The highest value is shown as a.

|                        | 250-330 DD    |               |                |               |               |
|------------------------|---------------|---------------|----------------|---------------|---------------|
|                        | G-3M          | G-0M          | G-3M-D         | C-D           | C-I           |
| <b>Kvithamar</b>       |               |               |                |               |               |
| Biomass                | 43(7) bc      | 31(4) c       | 65(7) ab       | 70(7) a       | 58(4) ab      |
| Total N                | 1.17(0.20) bc | 0.72(0.15) c  | 1.49(0.23) abc | 1.85(0.22) ab | 2.11(0.14) a  |
| <b>Værnes</b>          |               |               |                |               |               |
| Biomass                | 42(9) bc      | 20(1) c       | 79(8) a        | 88(10) a      | 70(9) ab      |
| Total N                | 1.80(0.35) bc | 0.92(0.07) c  | 2.81(0.38) ab  | 3.38(0.49) a  | 3.18(0.47) ab |
| <b>Apelsvoll</b>       |               |               |                |               |               |
| Biomass                | 60(5) b       | 54(6) b       | 53(5) b        | 40(8) b       | 110(16) a     |
| Total N                | 1.92(0.13) ab | 1.64(0.14) bc | 1.79(0.15) bc  | 1.16(0.20) bc | 3.19(0.54) a  |
| <b>Ås</b>              |               |               |                |               |               |
| Biomass                | 70(3) bc      | 64(3) c       | 83(3) bc       | 109(2) ab     | 139(2) a      |
| Total N                | 2.05(0.15) b  | 1.78(0.15) b  | 2.16(0.13) b   | 2.68(0.02) b  | 3.88(0.18) a  |
| <b>Growth stage 47</b> |               |               |                |               |               |
| <b>Kvithamar</b>       |               |               |                |               |               |
| Biomass                | 129(22) bc    | 87(7) c       | 159(16) bc     | 186(25) ab    | 245(18) a     |
| Total N                | 1.71(0.29) b  | 1.11(0.15) b  | 1.84(0.23) b   | 2.20(0.28) b  | 3.97(0.32) a  |
| <b>Værnes</b>          |               |               |                |               |               |
| Biomass                | 168(10) b     | 62(6) c       | 263(12) a      | 270(11) a     | 259(20) a     |
| Total N                | 3.68(0.16) b  | 1.69(0.14) c  | 4.29(0.22) ab  | 4.28(0.26) ab | 5.20(0.58) a  |
| <b>Apelsvoll</b>       |               |               |                |               |               |
| Biomass                | 149(13) b     | 125(11) b     | 126(9) b       | 118(28) b     | 218(16) a     |
| Total N                | 3.45(0.28) ab | 2.59(0.22) b  | 3.36(0.20) ab  | 2.38(0.36) b  | 4.02(0.15) a  |
| <b>Ås</b>              |               |               |                |               |               |
| Biomass                | 111(15) bc    | 103(26) c     | 136(13) bc     | 177(8) ab     | 226(14) a     |
| Total N                | 3.04(0.45) ab | 2.48(0.31) b  | 3.20(0.40) ab  | 3.89(0.38) ab | 5.66(1.22) a  |

**Table 7**

Barley grain and straw DM and N yield ( $\text{g m}^{-2}$ ), and grain N concentration (%), at the different sites in 2010. Abbreviations for the treatments are explained in Table 3. Within a site, treatment means ( $\pm$  S.E) which do not share any letter in common are significantly different ( $P < 0.05$ ) by Tukey HSD method. The highest value is shown as a.

|                     | G-3M          | G-1M           | G-0M          | G-0M-D        | C-D           | C-I            |
|---------------------|---------------|----------------|---------------|---------------|---------------|----------------|
| <b>Kvithamar</b>    |               |                |               |               |               |                |
| Grain DM            | 140 (15) bc   | 122 (11) bc    | 89 (9) c      | 155 (20) b    | 156 (14) b    | 264 (8) a      |
| Grain N conc.       | 1.52 (0.05) a | 1.50 (0.02) ab | 1.84 (0.03) a | 1.29 (0.04) c | 1.23 (0.04) c | 1.35 (0.01) bc |
| Grain N yield       | 2.1 (0.2) b   | 1.8 (0.1) b    | 1.3 (0.3) b   | 2.0 (0.2) b   | 1.9 (0.2) b   | 3.6 (0.1) a    |
| Grain+straw DM      | 360 (31) b    | 337 (26) b     | 276 (22) b    | 385 (32) b    | 386 (29) b    | 568 (11) a     |
| Grain+straw N yield | 3.3 (0.1) b   | 2.8 (0.2) b    | 2.3 (0.1) b   | 3.3 (0.5) b   | 3.3 (0.3) b   | 5.7 (0.4) a    |
| <b>Værnes</b>       |               |                |               |               |               |                |
| Grain DM            | 327 (16) ab   | 260 (28) bc    | 217 (16) c    | 362 (11) a    | 310 (10) ab   | 392 (29) a     |
| Grain N conc.       | 1.83 (0.02) a | 1.76 (0.03) a  | 1.84 (0.03) a | 1.64 (0.02) b | 1.48 (0.01) c | 1.63 (0.03) b  |
| Grain N yield       | 6.0 (0.3) ab  | 4.6 (0.3) bc   | 4.0 (0.2) c   | 5.9 (0.4) ab  | 4.6 (0.1) bc  | 6.4 (0.5) a    |
| Grain+straw DM      | 613 (24) bc   | 481 (31) cd    | 474 (51) d    | 689 (22) ab   | 666 (20) b    | 803 (36) a     |
| Grain+straw N yield | 7.6 (0.4) ab  | 5.6 (0.4) c    | 5.5 (0.6) c   | 7.2 (0.3) abc | 6.0 (0.2) bc  | 8.4 (0.5) a    |
| <b>Apelsvoll</b>    |               |                |               |               |               |                |
| Grain DM            | 322 (11) ab   | 260 (15) bc    | 249 (10) c    | 347 (15) a    | 253 (21) bc   | 372 (14) a     |
| Grain N conc.       | 1.74 (0.05)   | 1.75 (0.13)    | 1.61 (0.02)   | 1.75 (0.02)   | 1.70 (0.01)   | 1.68 (0.14)    |
| Grain N yield       | 5.6 (0.2) a   | 4.5 (0.1) b    | 4.0 (0.2) b   | 6.1 (0.1) a   | 4.3 (0.4) b   | 6.2 (0.3) a    |
| Grain+straw DM      | 482 (22) b    | 376 (20) c     | 377 (22) c    | 523 (25) b    | 397 (27) c    | 573 (24) a     |
| Grain+straw N yield | 6.6 (0.1) a   | 5.2 (0.1) b    | 4.7 (0.2) b   | 7.3 (0.3) a   | 5.3 (0.5) b   | 7.3 (0.3) a    |
| <b>Ås</b>           |               |                |               |               |               |                |
| Grain DM            | 254 (18) b    | 252 (25) b     | 241 (13) b    | 313 (24) ab   | 279 (12) ab   | 356 (18) a     |
| Grain N conc.       | 1.95 (0.05)   | 1.92 (0.07)    | 1.83 (0.05)   | 1.72 (0.05)   | 1.71 (0.04)   | 1.89 (0.08)    |
| Grain N yield       | 4.9 (0.4) ab  | 4.8 (0.3) b    | 4.4 (0.5) b   | 5.4 (0.4) ab  | 4.8 (0.3) b   | 6.7 (0.6) a    |
| Grain+straw DM      | 427 (38) d    | 424 (35) d     | 397 (18) d    | 499 (41) c    | 508 (24) b    | 637 (40) a     |
| Grain+straw N yield | 6.5 (0.6) b   | 6.6 (0.4) b    | 6.2 (0.8) b   | 7.8 (1.2) ab  | 7.7 (1.0) ab  | 9.7 (0.7) a    |
| <b>All sites</b>    |               |                |               |               |               |                |
| Grain DM            | 260 (21) bc   | 223 (18) cd    | 199 (18) d    | 291 (23) ab   | 249 (17) bcd  | 346 (15) a     |
| Grain N yield       | 4.7 (0.4) bc  | 3.9 (0.3) cd   | 3.4 (0.3) d   | 4.8 (0.5) b   | 3.9 (0.3) cd  | 5.7 (0.4) a    |
| Grain+straw DM      | 402 (24) bc   | 336 (17) c     | 312 (21) d    | 453 (29) b    | 421 (25) bc   | 573 (21) a     |
| Grain+straw N yield | 6.2 (0.4) b   | 5.3 (0.3) bc   | 4.7 (0.4) c   | 6.3 (0.6) b   | 5.6 (0.5) bc  | 7.8 (0.4) a    |

**Table 8**

Apparent recovery (%) by spring barley (grain or above-ground biomass) of N applied as mulched herbage (G-3M or G-1M) or digestate (G-0M-D). See equation 1 for calculations. For digestate, the results are calculated in total N, as well as for NH<sub>4</sub>-N. Abbreviations for the treatments are explained in Table 3. Within sites, treatment means for total N which do not share any letter in common are significantly different ( $P < 0.05$ ) by Tukey HSD method. The highest value is shown as a.

|                      | G-3M <sub>Total N</sub> | G-1M <sub>Total N</sub> | G-0M-D <sub>Total N</sub> | G-0M-D <sub>NH4-N</sub> |
|----------------------|-------------------------|-------------------------|---------------------------|-------------------------|
| Kvithamar            |                         |                         |                           |                         |
| Grain                | 3                       | 7                       | 6                         | 12                      |
| Above-ground biomass | 6                       | 11                      | 10                        | 18                      |
| Værnes               |                         |                         |                           |                         |
| Grain                | 9                       | 10                      | 18                        | 34                      |
| Above-ground biomass | 9 ab                    | 1 b                     | 16 a                      | 29                      |
| Apelsvoll            |                         |                         |                           |                         |
| Grain                | 8                       | 16                      | 19                        | 36                      |
| Above-ground biomass | 10                      | 16                      | 24                        | 44                      |
| Ås                   |                         |                         |                           |                         |
| Grain                | 3                       | 5                       | 9                         | 17                      |
| Above-ground biomass | 2                       | 5                       | 15                        | 29                      |
| All sites            |                         |                         |                           |                         |
| Grain                | 6 b                     | 10 ab                   | 13 a                      | 25                      |
| Above-ground biomass | 7 b                     | 8 ab                    | 16 a                      | 30                      |



**Table 9**

Stability (%) to simulated rainfall of two aggregate fractions (2-6 mm and 6-10 m), given as means of each site and of three treatments with green manure and/or digestate application. Abbreviations for the treatments are explained in Table 3.

|           | 2-6 mm | 6-10 mm |
|-----------|--------|---------|
| Site      |        |         |
| Ås        | 61.0   | 77.6    |
| Kvithamar | 59.0   | 69.4    |
| Apelsvoll | 78.1   | 85.6    |
| Værnes    | 40.1   | 52.7    |
| LSD, 5%   | 18.3   | 13.0    |
| Treatment |        |         |
| G-3M      | 55.9   | 70.3    |
| G-0M-D    | 64.8   | 74.6    |
| C-D       | 57.9   | 69.0    |
| LSD, 5%   | 5.5    | 4.9     |
| Mean      | 59.5   | 71.3    |

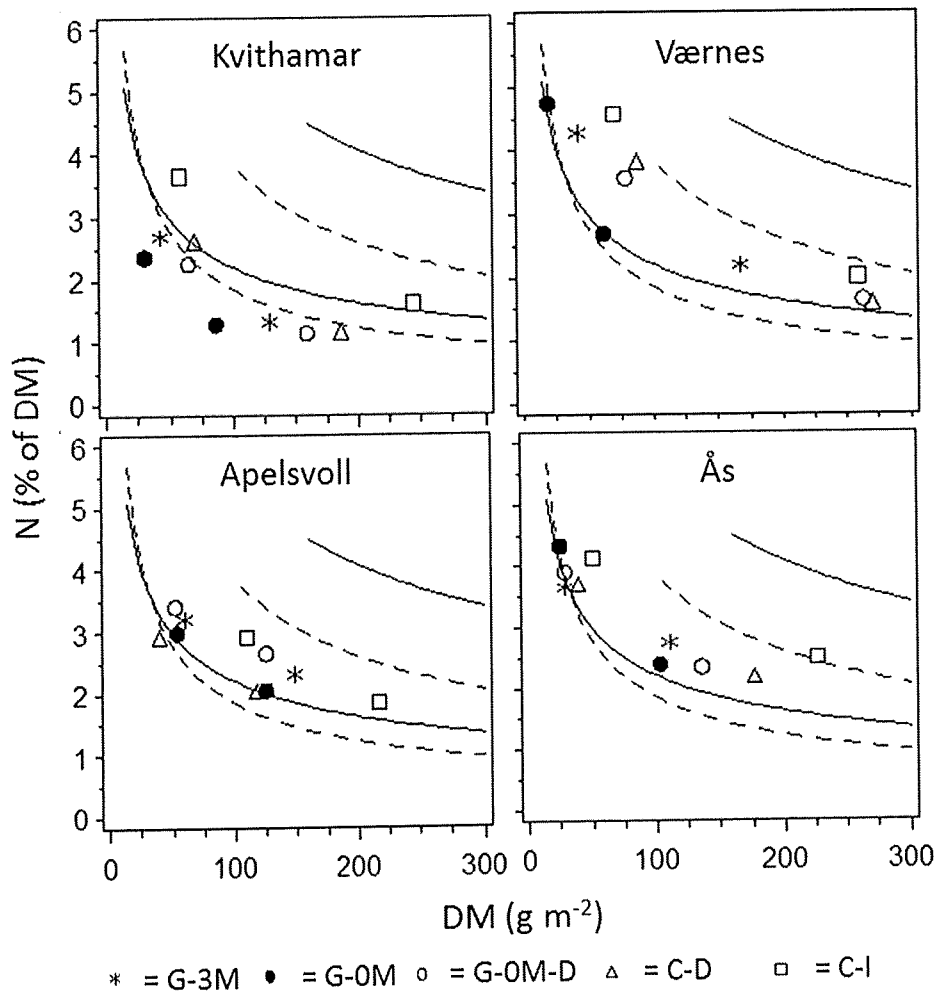
**Table 10**

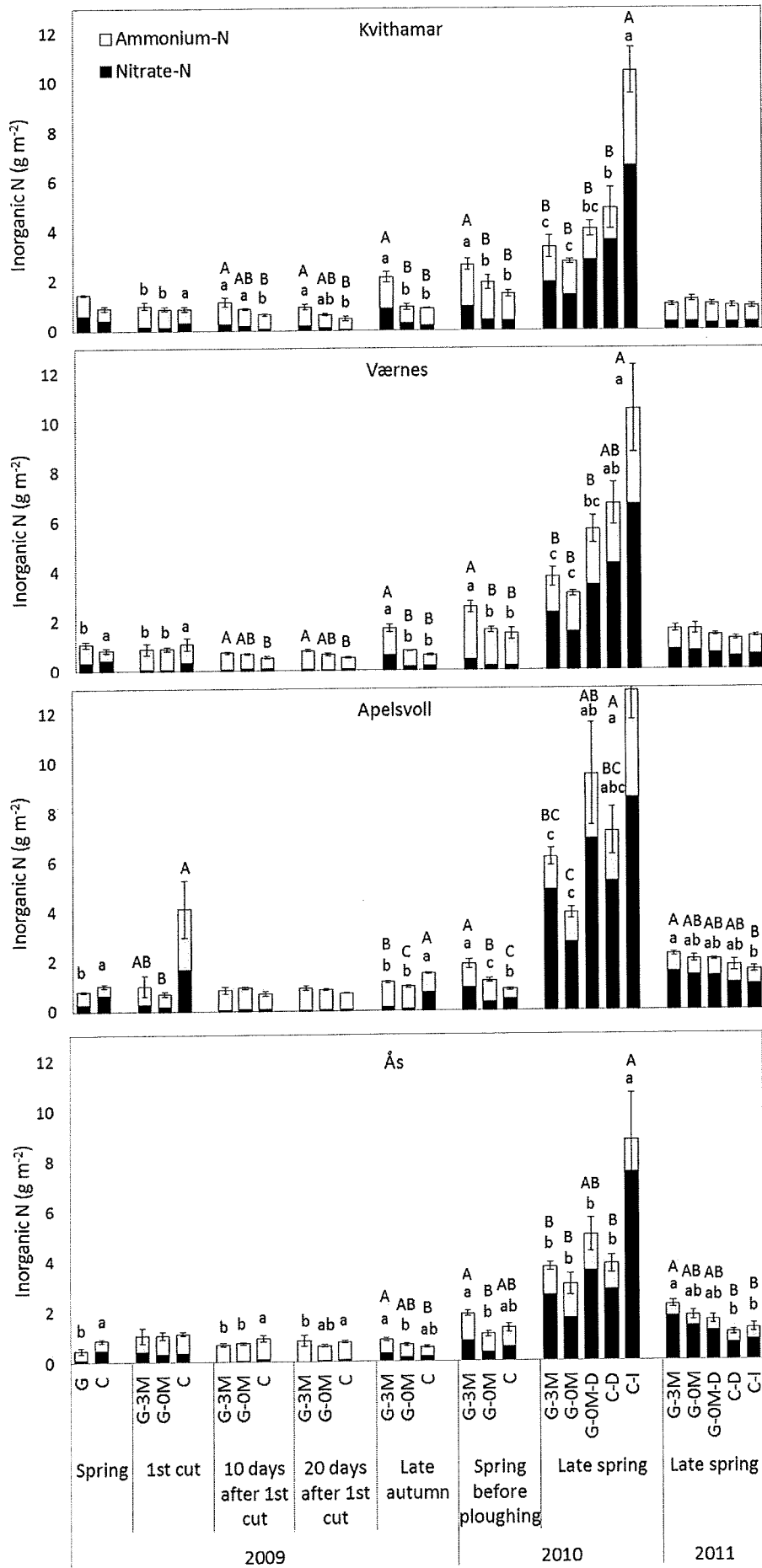
Biomass ( $\text{g m}^{-2}$ ) and number ( $\text{m}^{-2}$ ) of earthworms (0-20 cm depth) at Kvithamar (silty clay loam) and Værnes (sandy loam) in autumn 2009 and 2010 ( $n=8$ ). Means ( $\pm$ S.E.) within each site, earthworm component and year, which do not share any letter in common, are significantly different ( $P < 0.05$ ) by Tukey comparison method.

The highest value is shown as a.

|           | G-3M      | G-0M       | G-0M-D    | C-D       |
|-----------|-----------|------------|-----------|-----------|
| 2009      |           |            |           |           |
| Kvithamar |           |            |           |           |
| Number    | 206 (48)a | 84 (26)b   | 94 (27)ab | 72 (15)b  |
| Biomass   | 137 (48)a | 26 (12)b   | 35 (13)b  | 36 (8)b   |
| Værnes    |           |            |           |           |
| Number    | 266 (43)a | 184 (21)ab | 131 (22)b | 181 (23)b |
| Biomass   | 178 (33)a | 72 (12)b   | 64 (18)b  | 78 (12)b  |
| 2010      |           |            |           |           |
| Kvithamar |           |            |           |           |
| Number    | 172 (33)a | 78 (7)b    | 78 (25)b  | 66 (15)b  |
| Biomass   | 66 (12)a  | 34 (4)ab   | 42 (17)ab | 20 (4)b   |
| Værnes    |           |            |           |           |
| Number    | 197 (45)a | 172(21)a   | 216 (53)a | 138 (25)a |
| Biomass   | 92 (23)a  | 95 (14)a   | 125 (30)a | 74 (16)a  |

**Fig. 1.** N concentration (% of DM) versus standing biomass (g DM m<sup>-2</sup>) at 250-330 day degrees and at growth stage 47. Weighted averages of four replicates. Upper lines are the critical N dilution curve according to Justes et al. 1994 (continuous line) or Ziadi et al. 2010 (dashed line). Lower lines are the minimum N concentration curves by the same authors. Abbreviations for the treatments are explained in Table 3. The statistical differences between the treatments are given in Table 6.





1 **Fig. 2.** Inorganic N in soil (0-20 cm depth) in spring 2009, at first cut and until 20 days after, in late autumn after  
2 the green manure treatments, in spring 2010 before ploughing and 7-10 days after the germination of the barley  
3 crop, and in May 2011. Abbreviations for the treatments are explained in Table 3. Bars ( $\pm$  S.E) within each  
4 sampling which do not have any letter in common are significantly different ( $P < 0.05$ ) by Tukey HSD method.  
5 Upper case letters show inorganic N and lower case letters show nitrate-N.