**Does Grazing Winter Cereal Rye in Iowa, USA, Make It Profitable?**

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****Table A1. Descriptive statistics of observed corn yields by treatment and location-year****

| Treatment~ | Location | Year | Cereal Rye | Corn for grain |
| --- | --- | --- | --- | --- |
| Seeding | Termination Date | #Obs. | Mean | StdDev | Min | Max |
| Method | Rate^ | Date | mt ha-1 |
| 1NCheck | Northwest | 2018/19 | None | None | None | None | 6 | 14.12 | 0.55 | 13.31 | 14.74 |
| 1NBL14 | Northwest | 2018/19 | Broadcast | 1.65 | 9/27/2018 | 4/24/2019 | 6 | 13.92 | 0.87 | 12.43 | 14.81 |
| 1NBM14 | Northwest | 2018/19 | Broadcast | 2.47 | 9/27/2018 | 4/24/2019 | 6 | 14.14 | 0.58 | 13.60 | 15.00 |
| 1NBH14 | Northwest | 2018/19 | Broadcast | 3.28 | 9/27/2018 | 4/24/2019 | 6 | 13.75 | 0.83 | 12.51 | 14.95 |
| 1NDL14 | Northwest | 2018/19 | Drilled | 0.82 | 9/27/2018 | 4/24/2019 | 6 | 14.34 | 0.83 | 12.77 | 15.07 |
| 1NDM14 | Northwest | 2018/19 | Drilled | 1.65 | 9/27/2018 | 4/24/2019 | 6 | 14.03 | 0.61 | 13.24 | 14.73 |
| 1NDH14 | Northwest | 2018/19 | Drilled | 2.47 | 9/27/2018 | 4/24/2019 | 6 | 14.20 | 0.40 | 13.62 | 14.65 |
| 1CCheck | Central | 2018/19 | None | None | None | None | 6 | 11.52 | 1.39 | 9.12 | 13.06 |
| 1CBL3 | Central | 2018/19 | Broadcast | 1.65 | 9/17/2018 | 5/3/2019 | 6 | 10.07 | 1.30 | 8.87 | 12.23 |
| 1CBM3 | Central | 2018/19 | Broadcast | 2.47 | 9/17/2018 | 5/3/2019 | 6 | 9.87 | 1.61 | 7.26 | 11.40 |
| 1CBH3 | Central | 2018/19 | Broadcast | 3.28 | 9/17/2018 | 5/3/2019 | 6 | 9.95 | 1.60 | 6.83 | 11.29 |
| 1CBL14 | Central | 2018/19 | Broadcast | 1.65 | 9/17/2018 | 4/26/2019 | 6 | 10.83 | 1.14 | 9.55 | 12.36 |
| 1CBM14 | Central | 2018/19 | Broadcast | 2.47 | 9/17/2018 | 4/26/2019 | 6 | 11.33 | 1.77 | 8.69 | 13.48 |
| 1CBH14 | Central | 2018/19 | Broadcast | 3.28 | 9/17/2018 | 4/26/2019 | 6 | 10.93 | 0.96 | 10.24 | 12.78 |
| 1CDL3 | Central | 2018/19 | Drilled | 0.82 | 10/29/2018 | 5/3/2019 | 6 | 12.41 | 0.55 | 11.40 | 12.93 |
| 1CDM3 | Central | 2018/19 | Drilled | 1.65 | 10/29/2018 | 5/3/2019 | 6 | 11.34 | 0.60 | 10.45 | 12.26 |
| 1CDH3 | Central | 2018/19 | Drilled | 2.47 | 10/29/2018 | 5/3/2019 | 6 | 11.98 | 0.72 | 11.31 | 13.02 |
| 1CDL14 | Central | 2018/19 | Drilled | 0.82 | 10/29/2018 | 4/26/2019 | 6 | 12.08 | 0.76 | 10.84 | 13.00 |
| 1CDM14 | Central | 2018/19 | Drilled | 1.65 | 10/29/2018 | 4/26/2019 | 6 | 12.04 | 1.11 | 9.85 | 12.82 |
| 1CDH14 | Central | 2018/19 | Drilled | 2.47 | 10/29/2018 | 4/26/2019 | 6 | 12.52 | 1.71 | 10.72 | 15.10 |
| 1SCheck | Southeast | 2018/19 | None | None | None | None | 6 | 13.43 | 0.40 | 12.78 | 13.84 |
| 1SBL14 | Southeast | 2018/19 | Broadcast | 1.65 | 9/13/2018 | 4/25/2019 | 6 | 13.38 | 0.61 | 12.66 | 14.00 |
| 1SBM14 | Southeast | 2018/19 | Broadcast | 2.47 | 9/13/2018 | 4/25/2019 | 6 | 12.70 | 1.00 | 11.03 | 13.86 |
| 1SBH14 | Southeast | 2018/19 | Broadcast | 3.28 | 9/13/2018 | 4/25/2019 | 6 | 12.78 | 0.63 | 12.14 | 13.78 |
| 1SDL14 | Southeast | 2018/19 | Drilled | 0.82 | 10/26/2018 | 4/25/2019 | 6 | 13.38 | 0.75 | 12.52 | 14.32 |
| 1SDM14 | Southeast | 2018/19 | Drilled | 1.65 | 10/26/2018 | 4/25/2019 | 6 | 13.46 | 0.81 | 12.44 | 14.92 |
| 1SDH14 | Southeast | 2018/19 | Drilled | 2.47 | 10/26/2018 | 4/25/2019 | 6 | 13.49 | 0.68 | 12.22 | 14.02 |
| 2NCheck | Northwest | 2019/20 | None | None | None | None | 6 | 14.24 | 1.18 | 12.85 | 15.62 |
| 2NBL14 | Northwest | 2019/20 | Broadcast | 1.65 | 9/16/2019 | 4/30/2020 | 6 | N/A | N/A | N/A | N/A |
| 2NBM14 | Northwest | 2019/20 | Broadcast | 2.47 | 9/16/2019 | 4/30/2020 | 6 | N/A | N/A | N/A | N/A |
| 2NBH14 | Northwest | 2019/20 | Broadcast | 3.28 | 9/16/2019 | 4/30/2020 | 6 | N/A | N/A | N/A | N/A |
| 2NDL14 | Northwest | 2019/20 | Drilled | 0.82 | 10/18/2019 | 4/30/2020 | 6 | 14.00 | 0.64 | 12.98 | 14.64 |
| 2NDM14 | Northwest | 2019/20 | Drilled | 1.65 | 10/18/2019 | 4/30/2020 | 6 | 14.56 | 0.45 | 13.94 | 15.20 |
| 2NDH14 | Northwest | 2019/20 | Drilled | 2.47 | 10/18/2019 | 4/30/2020 | 6 | 14.58 | 0.76 | 14.11 | 16.10 |
| 2CCheck | Central | 2019/20 | None | None | None | None | 6 | 9.61 | 1.73 | 6.35 | 11.36 |
| 2CBL3 | Central | 2019/20 | Broadcast | 1.65 | 9/5/2019 | 5/2/2020 | 6 | 9.92 | 1.04 | 8.74 | 11.04 |
| 2CBM3 | Central | 2019/20 | Broadcast | 2.47 | 9/5/2019 | 5/2/2020 | 6 | 8.99 | 0.85 | 8.01 | 10.26 |
| 2CBH3 | Central | 2019/20 | Broadcast | 3.28 | 9/5/2019 | 5/2/2020 | 6 | 9.14 | 2.59 | 4.26 | 11.33 |
| 2CBL14 | Central | 2019/20 | Broadcast | 1.65 | 9/5/2019 | 4/21/2020 | 6 | 8.20 | 3.30 | 3.66 | 12.03 |
| 2CBM14 | Central | 2019/20 | Broadcast | 2.47 | 9/5/2019 | 4/21/2020 | 6 | 8.89 | 2.20 | 4.84 | 11.49 |
| 2CBH14 | Central | 2019/20 | Broadcast | 3.28 | 9/5/2019 | 4/21/2020 | 6 | 9.32 | 0.79 | 8.28 | 10.36 |
| 2CDL3 | Central | 2019/20 | Drilled | 0.82 | 10/16/2019 | 5/2/2020 | 6 | 9.38 | 2.43 | 4.76 | 11.86 |
| 2CDM3 | Central | 2019/20 | Drilled | 1.65 | 10/16/2019 | 5/2/2020 | 6 | 10.90 | 1.78 | 8.62 | 12.89 |
| 2CDH3 | Central | 2019/20 | Drilled | 2.47 | 10/16/2019 | 5/2/2020 | 6 | 7.84 | 1.51 | 5.89 | 9.62 |
| 2CDL14 | Central | 2019/20 | Drilled | 0.82 | 10/16/2019 | 4/21/2020 | 6 | 10.30 | 1.82 | 7.18 | 12.48 |
| 2CDM14 | Central | 2019/20 | Drilled | 1.65 | 10/16/2019 | 4/21/2020 | 6 | 8.87 | 2.46 | 5.03 | 12.50 |
| 2CDH14 | Central | 2019/20 | Drilled | 2.47 | 10/16/2019 | 4/21/2020 | 6 | 11.69 | 1.73 | 9.34 | 13.43 |
| 2SCheck | Southeast | 2019/20 | None | None | None | None | 6 | 13.79 | 0.40 | 13.20 | 14.44 |
| 2SBL14 | Southeast | 2019/20 | Broadcast | 1.65 | 9/10/2019 | 4/21/2020 | 6 | 13.45 | 1.07 | 11.78 | 14.55 |
| 2SBM14 | Southeast | 2019/20 | Broadcast | 2.47 | 9/10/2019 | 4/21/2020 | 6 | 12.42 | 1.22 | 10.91 | 14.53 |
| 2SBH14 | Southeast | 2019/20 | Broadcast | 3.28 | 9/10/2019 | 4/21/2020 | 6 | 10.94 | 0.78 | 10.36 | 12.44 |
| 2SDL14 | Southeast | 2019/20 | Drilled | 0.82 | 10/17/2019 | 4/21/2020 | 6 | 13.76 | 1.21 | 11.79 | 15.35 |
| 2SDM14 | Southeast | 2019/20 | Drilled | 1.65 | 10/17/2019 | 4/21/2020 | 6 | 12.66 | 1.48 | 11.19 | 15.07 |
| 2SDH14 | Southeast | 2019/20 | Drilled | 2.47 | 10/17/2019 | 4/21/2020 | 6 | 12.39 | 1.09 | 10.30 | 13.45 |

~ 1= 2018/19, 2 = 2019/20; N = northwest farm, C = central farm, S= southeast farm; B= early-broadcast; D = late-drill; H = high seeding rate; M = medium seeding rate; L = low seeding rate; 3 = terminated 3 days before planting (*DBP*); 14 = terminated 14 *DBP*; Check = no cover crop.

^ Seeding rate in million PLS ha-1.

****Table A2. Descriptive statistics of cereal rye biomass,****$ B^{S}$, ****by treatment and location-year****

| Treatment~ | Collection Date | #Obs. | $$B^{S}$$ | Collection Date | #Obs. | $$B^{S}$$ |
| --- | --- | --- | --- | --- | --- | --- |
| Mean | StdDev | Min | Max | Mean | StdDev | Min | Max |
| Dry matter, kg ha-1  | Dry matter, kg ha-1 |
| 1NBL14 | 11/15/2018 | 6 | 47.72 | 18.50 | 26.91 | 77.50 | 4/24/2019 | 6 | 144.06 | 37.56 | 109.25 | 196.98 |
| 1NBM14 | 11/15/2018 | 6 | 70.06 | 10.43 | 56.51 | 82.88 | 4/24/2019 | 6 | 156.08 | 59.26 | 83.42 | 240.04 |
| 1NBH14 | 11/15/2018 | 6 | 114.01 | 58.57 | 59.20 | 193.75 | 4/24/2019 | 6 | 192.32 | 60.19 | 76.42 | 239.50 |
| 1NDL14 | N/A | N/A | N/A | N/A | N/A | N/A | 4/24/2019 | 6 | 42.61 | 28.19 | 24.76 | 99.03 |
| 1NDM14 | N/A | N/A | N/A | N/A | N/A | N/A | 4/24/2019 | 6 | 63.33 | 22.37 | 43.59 | 103.33 |
| 1NDH14 | N/A | N/A | N/A | N/A | N/A | N/A | 4/24/2019 | 6 | 77.41 | 9.96 | 65.66 | 95.26 |
| 1CBL3 | 11/16/2018 | 6 | 45.84 | 29.47 | 20.45 | 98.49 | 5/3/2019 | 6 | 1649.93 | 1193.71 | 613.01 | 3801.82 |
| 1CBM3 | 11/16/2018 | 6 | 56.42 | 26.23 | 25.83 | 90.42 | 5/3/2019 | 6 | 1239.91 | 552.01 | 667.36 | 2052.68 |
| 1CBH3 | 11/16/2018 | 6 | 66.38 | 39.75 | 0.00 | 109.25 | 5/3/2019 | 6 | 1382.09 | 1152.85 | 0.00 | 3434.77 |
| 1CBL14 | 11/16/2018 | 6 | 49.51 | 17.38 | 27.99 | 73.19 | 4/26/2019 | 6 | 1026.52 | 333.07 | 727.10 | 1461.20 |
| 1CBM14 | 11/16/2018 | 6 | 52.56 | 44.13 | 0.00 | 99.03 | 4/26/2019 | 6 | 612.29 | 491.12 | 0.00 | 1092.54 |
| 1CBH14 | 11/16/2018 | 6 | 93.29 | 29.21 | 67.27 | 143.70 | 4/26/2019 | 6 | 1067.33 | 247.65 | 858.42 | 1430.52 |
| 1CDL3 | N/A | N/A | N/A | N/A | N/A | N/A | 5/3/2019 | 6 | 115.53 | 64.20 | 58.13 | 232.50 |
| 1CDM3 | N/A | N/A | N/A | N/A | N/A | N/A | 5/3/2019 | 6 | 147.29 | 55.16 | 94.18 | 218.51 |
| 1CDH3 | N/A | N/A | N/A | N/A | N/A | N/A | 5/3/2019 | 6 | 199.94 | 94.54 | 76.96 | 350.90 |
| 1CDL14 | N/A | N/A | N/A | N/A | N/A | N/A | 4/26/2019 | 6 | 75.17 | 25.82 | 45.21 | 103.33 |
| 1CDM14 | N/A | N/A | N/A | N/A | N/A | N/A | 4/26/2019 | 6 | 102.53 | 36.08 | 61.35 | 153.92 |
| 1CDH14 | N/A | N/A | N/A | N/A | N/A | N/A | 4/26/2019 | 6 | 205.23 | 204.16 | 62.43 | 607.62 |
| 1SBL14 | 11/14/2018 | 6 | 102.89 | 59.93 | 40.90 | 191.06 | 4/25/2019 | 6 | 634.80 | 1048.49 | 70.50 | 2763.64 |
| 1SBM14 | 11/14/2018 | 6 | 192.41 | 134.29 | 46.82 | 444.01 | 4/25/2019 | 6 | 896.63 | 632.33 | 158.23 | 2012.31 |
| 1SBH14 | 11/14/2018 | 6 | 191.78 | 93.18 | 67.27 | 304.62 | 4/25/2019 | 6 | 944.18 | 684.58 | 364.36 | 1955.27 |
| 1SDL14 | N/A | N/A | N/A | N/A | N/A | N/A | 4/25/2019 | 6 | 94.63 | 64.42 | 21.53 | 192.67 |
| 1SDM14 | N/A | N/A | N/A | N/A | N/A | N/A | 4/25/2019 | 6 | 137.87 | 41.19 | 88.26 | 205.05 |
| 1SDH14 | N/A | N/A | N/A | N/A | N/A | N/A | 4/25/2019 | 6 | 242.19 | 97.26 | 89.88 | 344.45 |
| 2NBL14 | N/A | N/A | N/A | N/A | N/A | N/A | 4/30/2020 | N/A | N/A | N/A | N/A | N/A |
| 2NBM14 | N/A | N/A | N/A | N/A | N/A | N/A | 4/30/2020 | N/A | N/A | N/A | N/A | N/A |
| 2NBH14 | N/A | N/A | N/A | N/A | N/A | N/A | 4/30/2020 | N/A | N/A | N/A | N/A | N/A |
| 2NDL14 | N/A | N/A | N/A | N/A | N/A | N/A | 4/30/2020 | 4 | 110.33 | 57.38 | 69.96 | 193.75 |
| 2NDM14 | N/A | N/A | N/A | N/A | N/A | N/A | 4/30/2020 | 4 | 130.51 | 56.51 | 64.58 | 199.13 |
| 2NDH14 | N/A | N/A | N/A | N/A | N/A | N/A | 4/30/2020 | 4 | 130.51 | 67.27 | 80.73 | 226.04 |
| 2CBL3 | 11/2/2019 | 6 | 182.84 | 62.96 | 99.77 | 252.72 | 5/2/2020 | 4 | 4320.37 | 1274.73 | 2766.33 | 5656.44 |
| 2CBM3 | 11/2/2019 | 6 | 171.86 | 136.63 | 27.59 | 430.12 | 5/2/2020 | 4 | 3268.19 | 764.60 | 2545.67 | 4009.56 |
| 2CBH3 | 11/2/2019 | 6 | 149.17 | 57.41 | 83.75 | 235.73 | 5/2/2020 | 4 | 4273.28 | 1339.74 | 2804.00 | 6054.70 |
| 2CBL14 | 11/2/2019 | 6 | 174.34 | 58.61 | 78.15 | 249.95 | 4/21/2020 | 4 | 1677.82 | 732.56 | 1140.97 | 2755.57 |
| 2CBM14 | 11/2/2019 | 6 | 146.86 | 97.72 | 50.56 | 320.01 | 4/21/2020 | 4 | 1832.56 | 656.66 | 1114.07 | 2459.55 |
| 2CBH14 | 11/2/2019 | 6 | 210.04 | 133.94 | 103.65 | 467.96 | 4/21/2020 | 4 | 1376.44 | 811.64 | 828.82 | 2583.34 |
| 2CDL3 | N/A | N/A | N/A | N/A | N/A | N/A | 5/2/2020 | 4 | 513.98 | 95.32 | 398.26 | 597.40 |
| 2CDM3 | N/A | N/A | N/A | N/A | N/A | N/A | 5/2/2020 | 4 | 505.90 | 109.33 | 387.50 | 618.92 |
| 2CDH3 | N/A | N/A | N/A | N/A | N/A | N/A | 5/2/2020 | 4 | 714.46 | 151.80 | 570.49 | 893.41 |
| 2CDL14 | N/A | N/A | N/A | N/A | N/A | N/A | 4/21/2020 | 4 | 130.51 | 34.15 | 96.88 | 177.61 |
| 2CDM14 | N/A | N/A | N/A | N/A | N/A | N/A | 4/21/2020 | 4 | 176.26 | 58.52 | 91.50 | 226.04 |
| 2CDH14 | N/A | N/A | N/A | N/A | N/A | N/A | 4/21/2020 | 4 | 267.75 | 76.66 | 199.13 | 365.97 |
| 2SBL14 | 11/8/2019 | 6 | 7.60 | 5.97 | 3.56 | 19.22 | 4/21/2020 | 4 | 398.26 | 210.70 | 231.42 | 705.04 |
| 2SBM14 | 11/8/2019 | 6 | 54.81 | 27.12 | 26.22 | 106.03 | 4/21/2020 | 4 | 1151.74 | 1053.81 | 543.58 | 2728.66 |
| 2SBH14 | 11/8/2019 | 6 | 52.99 | 18.11 | 24.00 | 79.42 | 4/21/2020 | 4 | 1500.22 | 421.41 | 1065.63 | 1964.41 |
| 2SDL14 | N/A | N/A | N/A | N/A | N/A | N/A | 4/21/2020 | 4 | 543.58 | 290.06 | 123.79 | 742.71 |
| 2SDM14 | N/A | N/A | N/A | N/A | N/A | N/A | 4/21/2020 | 4 | 1197.49 | 516.08 | 516.67 | 1759.90 |
| 2SDH14 | N/A | N/A | N/A | N/A | N/A | N/A | 4/21/2020 | 4 | 1224.39 | 367.93 | 753.47 | 1646.88 |

Notes:

Unlisted plots (1NCheck, 1CCheck, 1SCheck, 2NCheck, 2CCheck, and 2SCheck) were not planted to cereal rye.

~ 1= 2018/19, 2 = 2019/20; N = northwest farm, C = central farm, S= southeast farm; B= early-broadcast; D = late-drill; H = high seeding rate; M = medium seeding rate; L = low seeding rate; 3 = terminated 3 days before planting (*DBP*); 14 = terminated 14 *DBP*; Check = no cover crop.

****Table A3. Observed yield differences, and net returns to cereal rye preceding no-till corn****

| Treatment | Planting Costs (*S*),$ ha-1 | Mean Yield in Treated Plots ($Y$),mt ha-1 | Mean Yield in Check Plots ($Y\_{c}$),mt ha-1 | Yield Difference ($∆Y$=$Y$-$ Y\_{c}$),mt ha-1 | Difference in Harvesting Costs ($∆H$).$ ha-1 | Difference in Crop Revenue ($∆R$),$ ha-1 | Net Returns($NRI^{No}$),$ ha-1 |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1NBL14 | $47.57 | 13.924 | 14.117 | -0.193 | -$1.57 | $46.00 | -$38.29 |
| 1NBM14 | $68.29 | 14.136 | 14.117 | 0.019 | $0.15 | $68.44 | $3.72 |
| 1NBH14 | $89.00 | 13.750 | 14.117 | -0.367 | -$2.99 | $86.02 | -$72.88 |
| 1NDL14 | $46.69 | 14.336 | 14.117 | 0.219 | $1.78 | $48.47 | $43.54 |
| 1NDM14 | $68.03 | 14.032 | 14.117 | -0.085 | -$0.69 | $67.34 | -$16.81 |
| 1NDH14 | $88.75 | 14.202 | 14.117 | 0.085 | $0.69 | $89.44 | $16.91 |
| 1CBL3 | $47.57 | 10.074 | 11.520 | -1.447 | -$11.79 | $35.78 | -$287.65 |
| 1CBM3 | $68.29 | 9.866 | 11.520 | -1.654 | -$13.48 | $54.80 | -$328.92 |
| 1CBH3 | $89.00 | 9.953 | 11.520 | -1.567 | -$12.77 | $76.23 | -$311.60 |
| 1CBL14 | $47.57 | 10.828 | 11.520 | -0.693 | -$5.64 | $41.92 | -$137.69 |
| 1CBM14 | $68.29 | 11.325 | 11.520 | -0.195 | -$1.59 | $66.69 | -$38.82 |
| 1CBH14 | $89.00 | 10.925 | 11.520 | -0.595 | -$4.85 | $84.15 | -$118.32 |
| 1CDL3 | $46.69 | 12.407 | 11.520 | 0.886 | $7.22 | $53.91 | $176.24 |
| 1CDM3 | $68.03 | 11.345 | 11.520 | -0.176 | -$1.43 | $66.60 | -$34.95 |
| 1CDH3 | $88.75 | 11.976 | 11.520 | 0.455 | $3.71 | $92.46 | $90.49 |
| 1CDL14 | $46.69 | 12.078 | 11.520 | 0.557 | $4.54 | $51.23 | $110.83 |
| 1CDM14 | $68.03 | 12.043 | 11.520 | 0.522 | $4.26 | $72.29 | $103.82 |
| 1CDH14 | $88.75 | 12.521 | 11.520 | 1.001 | $8.15 | $96.91 | $198.93 |
| 1SBL14 | $47.57 | 13.384 | 13.430 | -0.046 | -$0.37 | $47.19 | -$9.13 |
| 1SBM14 | $68.29 | 12.702 | 13.430 | -0.727 | -$5.93 | $62.36 | -$144.57 |
| 1SBH14 | $89.00 | 12.782 | 13.430 | -0.648 | -$5.28 | $83.73 | -$128.75 |
| 1SDL14 | $46.69 | 13.378 | 13.430 | -0.051 | -$0.42 | $46.27 | -$10.20 |
| 1SDM14 | $68.03 | 13.462 | 13.430 | 0.033 | $0.27 | $68.30 | $6.49 |
| 1SDH14 | $88.75 | 13.485 | 13.430 | 0.056 | $0.45 | $89.20 | $11.04 |
| 2NDL14 | $46.69 | 13.998 | 14.238 | -0.239 | -$1.95 | $44.74 | -$47.60 |
| 2NDM14 | $68.03 | 14.557 | 14.238 | 0.320 | $2.60 | $70.64 | $63.54 |
| 2NDH14 | $88.75 | 14.576 | 14.238 | 0.338 | $2.76 | $91.51 | $67.22 |
| 2CBL3 | $47.57 | 9.923 | 9.606 | 0.317 | $2.59 | $50.15 | $63.11 |
| 2CBM3 | $68.29 | 8.993 | 9.606 | -0.613 | -$5.00 | $63.29 | -$121.91 |
| 2CBH3 | $89.00 | 9.138 | 9.606 | -0.468 | -$3.81 | $85.19 | -$92.94 |
| 2CBL14 | $47.57 | 8.203 | 9.606 | -1.403 | -$11.43 | $36.13 | -$278.96 |
| 2CBM14 | $68.29 | 8.886 | 9.606 | -0.719 | -$5.86 | $62.42 | -$142.99 |
| 2CBH14 | $89.00 | 9.324 | 9.606 | -0.282 | -$2.30 | $86.71 | -$56.05 |
| 2CDL3 | $46.69 | 9.384 | 9.606 | -0.221 | -$1.80 | $44.89 | -$43.98 |
| 2CDM3 | $68.03 | 10.896 | 9.606 | 1.290 | $10.52 | $78.55 | $256.54 |
| 2CDH3 | $88.75 | 7.840 | 9.606 | -1.765 | -$14.39 | $74.37 | -$350.96 |
| 2CDL14 | $46.69 | 10.302 | 9.606 | 0.696 | $5.68 | $52.36 | $138.45 |
| 2CDM14 | $68.03 | 8.875 | 9.606 | -0.731 | -$5.96 | $62.08 | -$145.33 |
| 2CDH14 | $88.75 | 11.695 | 9.606 | 2.089 | $17.02 | $105.77 | $415.29 |
| 2SBL14 | $47.57 | 13.447 | 13.795 | -0.347 | -$2.83 | $44.74 | -$69.01 |
| 2SBM14 | $68.29 | 12.417 | 13.795 | -1.377 | -$11.23 | $57.06 | -$273.86 |
| 2SBH14 | $89.00 | 10.942 | 13.795 | -2.852 | -$23.25 | $65.76 | -$567.10 |
| 2SDL14 | $46.69 | 13.760 | 13.795 | -0.035 | -$0.28 | $46.41 | -$6.87 |
| 2SDM14 | $68.03 | 12.664 | 13.795 | -1.131 | -$9.21 | $58.82 | -$224.77 |
| 2SDH14 | $88.75 | 12.391 | 13.795 | -1.403 | -$11.44 | $77.32 | -$278.97 |

Notes:

Unlisted plots (1NCheck, 1CCheck, 1SCheck, 2NCheck, 2CCheck, and 2SCheck) were not planted to cereal rye.

~ 1= 2018/19, 2 = 2019/20; N = northwest farm, C = central farm, S= southeast farm; B= early-broadcast; D = late-drill; H = high seeding rate; M = medium seeding rate; L = low seeding rate; 3 = terminated 3 days before planting (*DBP*); 14 = terminated 14 *DBP*; Check = no cover crop.

****Table A4. Information used to calculate number of grazing days in full-grazing scenario****

| Treatment\* | End of Dormancy | Collection Date | Spring Growth Days | Daily Growth Rate (%) | Grazing Days$$G\_{}^{Full}$$ | Estimated 1st Day of Grazing |
| --- | --- | --- | --- | --- | --- | --- |
| 1NBL14 | 4/3/2019 | 4/24/2019 | 21 | 5.40 |  | 7.23 |  | 4/17/2019 |
| 1NBM14 | 4/3/2019 | 4/24/2019 | 21 | 3.89 |  | 8.08 |  | 4/16/2019 |
| 1NBH14 | 4/3/2019 | 4/24/2019 | 21 | 2.52 |  | 10.18 |  | 4/14/2019 |
| 1NDL14 | 4/3/2019 | 4/24/2019 | 21 | 5.40 | ^ | 2.44 | ~ | 4/22/2019 |
| 1NDM14 | 4/3/2019 | 4/24/2019 | 21 | 3.89 | ^ | 3.58 | ~ | 4/21/2019 |
| 1NDH14 | 4/3/2019 | 4/24/2019 | 21 | 2.52 | ^ | 4.41 | ~ | 4/20/2019 |
| 1CBL3 | 4/3/2019 | 5/3/2019 | 30 | 12.69 |  | 21.76 |  | 4/12/2019 |
| 1CBM3 | 4/3/2019 | 5/3/2019 | 30 | 10.85 |  | 21.33 |  | 4/12/2019 |
| 1CBH3 | 4/3/2019 | 5/3/2019 | 30 | 10.65 |  | 22.51 |  | 4/11/2019 |
| 1CBL14 | 4/3/2019 | 4/26/2019 | 23 | 14.09 |  | 17.16 |  | 4/9/2019 |
| 1CBM14 | 4/3/2019 | 4/26/2019 | 23 | 11.27 |  | 15.26 |  | 4/11/2019 |
| 1CBH14 | 4/3/2019 | 4/26/2019 | 23 | 11.18 |  | 19.74 |  | 4/7/2019 |
| 1CDL3 | 4/3/2019 | N/A | N/A | 12.69 | ^ | 5.25 | ~ | 4/28/2019 |
| 1CDM3 | 4/3/2019 | N/A | N/A | 10.85 | ^ | 6.49 | ~ | 4/27/2019 |
| 1CDH3 | 4/3/2019 | N/A | N/A | 10.65 | ^ | 8.09 | ~ | 4/25/2019 |
| 1CDL14 | 4/3/2019 | N/A | N/A | 14.09 | ^ | 3.71 | ~ | 4/23/2019 |
| 1CDM14 | 4/3/2019 | N/A | N/A | 11.27 | ^ | 4.90 | ~ | 4/22/2019 |
| 1CDH14 | 4/3/2019 | N/A | N/A | 11.18 | ^ | 8.12 | ~ | 4/18/2019 |
| 1SBL14 | 4/3/2019 | 4/25/2019 | 22 | 8.62 |  | 17.51 |  | 4/8/2019 |
| 1SBM14 | 4/3/2019 | 4/25/2019 | 22 | 7.25 |  | 22.00 |  | 4/4/2019 |
| 1SBH14 | 4/3/2019 | 4/25/2019 | 22 | 7.51 |  | 22.00 |  | 4/4/2019 |
| 1SDL14 | 4/3/2019 | N/A | N/A | 8.62 | ^ | 4.78 | ~ | 4/21/2019 |
| 1SDM14 | 4/3/2019 | N/A | N/A | 7.25 | ^ | 6.67 | ~ | 4/19/2019 |
| 1SDH14 | 4/3/2019 | N/A | N/A | 7.51 | ^ | 10.13 | ~ | 4/15/2019 |
| 2NBL14 | 3/4/2020 | N/A | N/A | N/A |  | N/A |  | N/A |
| 2NBM14 | 3/4/2020 | N/A | N/A | N/A |  | N/A |  | N/A |
| 2NBH14 | 3/4/2020 | N/A | N/A | N/A |  | N/A |  | N/A |
| 2NDL14 | 3/4/2020 | N/A | N/A | N/A |  | N/A |  | N/A |
| 2NDM14 | 3/4/2020 | N/A | N/A | N/A |  | N/A |  | N/A |
| 2NDH14 | 3/4/2020 | N/A | N/A | N/A |  | N/A |  | N/A |
| 2CBL3 | 3/4/2020 | 5/2/2020 | 59 | 5.51 |  | 50.69 |  | 3/13/2020 |
| 2CBM3 | 3/4/2020 | 5/2/2020 | 59 | 5.12 |  | 47.94 |  | 3/16/2020 |
| 2CBH3 | 3/4/2020 | 5/2/2020 | 59 | 5.85 |  | 48.62 |  | 3/15/2020 |
| 2CBL14 | 3/4/2020 | 4/21/2020 | 48 | 4.83 |  | 37.34 |  | 3/15/2020 |
| 2CBM14 | 3/4/2020 | 4/21/2020 | 48 | 5.40 |  | 36.69 |  | 3/16/2020 |
| 2CBH14 | 3/4/2020 | 4/21/2020 | 48 | 3.99 |  | 37.08 |  | 3/15/2020 |
| 2CDL3 | 3/4/2020 | N/A | N/A | 5.51 | ^ | 18.41 | ~ | 4/14/2020 |
| 2CDM3 | 3/4/2020 | N/A | N/A | 5.12 | ^ | 18.67 | ~ | 4/14/2020 |
| 2CDH3 | 3/4/2020 | N/A | N/A | 5.85 | ^ | 21.96 | ~ | 4/11/2020 |
| 2CDL14 | 3/4/2020 | N/A | N/A | 4.83 | ^ | 6.75 | ~ | 4/15/2020 |
| 2CDM14 | 3/4/2020 | N/A | N/A | 5.40 | ^ | 8.53 | ~ | 4/13/2020 |
| 2CDH14 | 3/4/2020 | N/A | N/A | 3.99 | ^ | 12.57 | ~ | 4/9/2020 |
| 2SBL14 | 3/4/2020 | 4/21/2020 | 48 | 8.60 |  | 13.47 |  | 4/8/2020 |
| 2SBM14 | 3/4/2020 | 4/21/2020 | 48 | 6.55 |  | 26.83 |  | 3/26/2020 |
| 2SBH14 | 3/4/2020 | 4/21/2020 | 48 | 7.21 |  | 28.81 |  | 3/24/2020 |
| 2SDL14 | 3/4/2020 | N/A | N/A | 8.60 | ^ | 16.12 | ~ | 4/5/2020 |
| 2SDM14 | 3/4/2020 | N/A | N/A | 6.55 | ^ | 27.34 | ~ | 3/25/2020 |
| 2SDH14 | 3/4/2020 | N/A | N/A | 7.21 | ^ | 26.32 | ~ | 3/26/2020 |

Notes:

^ Imputed from similar treatment with broadcasted seed.

~ Calculated using imputed rate of growth.

\* 1= 2018/19, 2 = 2019/20; N = northwest farm, C = central farm, S= southeast farm; B= early-broadcast; D = late-drill; H = high seeding rate; M = medium seeding rate; L = low seeding rate; 3 = terminated 3 days before planting (*DBP*); 14 = terminated 14 *DBP*; Check = no cover crop.

****Table A5. Descriptive statistics of net cost savings in the cow-calf enterprise from grazing in full-grazing scenario, *NCS*****

| Treatment\* | All Observations | Negative Net Cost Savings | Positive Net Cost Savings |
| --- | --- | --- | --- |
| N^ | Mean | StDev | Min | Max | % of N | Mean *NCS* | Mean *G* | % of N | Mean | Mean *G* |
| All | 42 | $39.15 | $6.57 | -$12.21 | $146.69 | 16.7% | -$6.57 | 4.2 | 83.3% | $48.29 | 20.8 |
| *Planting Date-Method*  |
| B | 21 | $63.22 | $43.17 | $3.57 | $146.69 | 0.0% | n/a | n/a | 100.0% | $63.22 | 25.3 |
| D | 21 | $15.08 | $25.27 | -$12.21 | $69.79 | 33.3% | -$6.57 | 4.2 | 66.7% | $25.90 | 14.0 |
| *Seeding Rate* |
| L | 14 | $32.12 | $45.18 | -$12.21 | $146.69 | 28.6% | -$6.92 | 4.0 | 71.4% | $47.74 | 20.6 |
| M | 14 | $39.58 | $43.56 | -$8.46 | $137.64 | 14.3% | -$6.28 | 4.2 | 85.7% | $47.22 | 20.5 |
| H | 14 | $45.75 | $41.03 | -$5.72 | $139.88 | 7.1% | -$5.72 | 4.4 | 92.9% | $49.71 | 21.2 |
| *Termination Date* |
| 14 | 30 | $30.88 | $35.22 | -$12.21 | $102.73 | 20.0% | -$7.17 | 4.0 | 80.0% | $40.40 | 18.4 |
| 3 | 12 | $59.82 | $53.29 | -$2.96 | $146.69 | 8.3% | -$2.96 | 5.3 | 91.7% | $65.52 | 26.0 |
| *Planting Date-Method × Seeding Rate* |
| B *×* L | 7 | $57.46 | $49.86 | $3.57 | $146.69 | 0.0% | n/a | n/a | 100.0% | $57.46 | 23.6 |
| B *×* M | 7 | $63.56 | $43.95 | $6.36 | $137.64 | 0.0% | n/a | n/a | 100.0% | $63.56 | 25.4 |
| B *×* H | 7 | $68.65 | $41.51 | $13.28 | $139.88 | 0.0% | n/a | n/a | 100.0% | $68.65 | 27.0 |
| D *×* L | 7 | $6.79 | $20.95 | -$12.21 | $40.38 | 57.1% | -$6.92 | 4.0 | 42.9% | $25.07 | 13.8 |
| D *×* M | 7 | $15.60 | $28.94 | -$8.46 | $69.79 | 28.6% | -$6.28 | 4.2 | 71.4% | $24.35 | 13.5 |
| D *×* H | 7 | $22.85 | $26.48 | -$5.72 | $66.44 | 14.3% | -$5.72 | 4.4 | 85.7% | $27.61 | 14.5 |
| *Planting Date-Method × Termination Date* |
| B *×* 14 | 15 | $49.88 | $33.62 | $3.57 | $102.73 | 0.0% | n/a | n/a | 100.0% | $49.88 | 21.3 |
| D *×* 14 | 15 | $11.89 | $25.81 | -$12.21 | $69.79 | 40.0% | -$7.17 | 4.0 | 60.0% | $24.60 | 13.6 |
| B *×* 3 | 6 | $96.59 | $49.20 | $50.00 | $146.69 | 0.0% | n/a | n/a | 100.0% | $96.59 | 35.5 |
| D *×* 3 | 6 | $23.05 | $24.12 | -$2.96 | $52.08 | 16.7% | -$2.96 | 5.3 | 83.3% | $28.25 | 14.7 |
| *Seeding Rate × Termination Date* |
| L *×* 14 | 10 | $21.42 | $34.31 | -$12.21 | $102.73 | 30.0% | -$8.25 | 3.6 | 70.0% | $34.13 | 16.5 |
| M *×* 14 | 10 | $32.41 | $37.93 | -$8.46 | $100.59 | 20.0% | -$6.28 | 4.2 | 80.0% | $42.08 | 18.9 |
| H *×* 14 | 10 | $38.82 | $34.78 | -$5.72 | $101.87 | 10.0% | -$5.72 | 4.4 | 90.0% | $43.77 | 19.4 |
| L *×* 3 | 4 | $58.89 | $63.07 | -$2.96 | $146.69 | 25.0% | -$2.96 | 5.3 | 75.0% | $79.50 | 30.3 |
| M *×* 3 | 4 | $57.50 | $57.50 | $1.13 | $137.64 | 0.0% | n/a | n/a | 100.0% | $57.50 | 23.6 |
| H *×* 3 | 4 | $63.06 | $55.73 | $6.40 | $139.88 | 0.0% | n/a | n/a | 100.0% | $63.06 | 25.3 |

Notes:

\* 1= 2018/19, 2 = 2019/20; N = northwest farm, C = central farm, S= southeast farm; B= early-broadcast; D = late-drill; H = high seeding rate; M = medium seeding rate; L = low seeding rate; 3 = target termination date 3 days before planting; 14 = target termination date 14 days before planting; Check = no cover crop.

^ Treatments 2NDL14, 2NDM14, 2NDH14 were excluded from the analysis due to the unavailability of biomass data from their broadcast-equivalent treatments 2NBL14, 2NBM14, and 2NBH14.

****Table A6. Spring biomass, grazing days, and, projected yield differences, and net returns in partial-grazing scenario****

| Treatment^ | Spring Biomass$(1-B^{'})$,kg ha-1 | Grazing Days$$G\_{mra}^{Partial}$$ | Projected Yield Difference$∆\hat{Y}\_{mra}$,mt ha-1 | Projected Yield Difference- Observed Yield Difference$∆\hat{Y}\_{mra}-∆Y\_{mra}$,mt ha-1 | Net Returns$NRI\_{mra}^{Partial}$,$ ha-1 |
| --- | --- | --- | --- | --- | --- |
| 1NBL14 | 14.41 | 6.62 | -0.48 | -0.28 | -136.87 |
| 1NBM14 | 15.61 | 7.37 | -0.24 | -0.25 | -109.22 |
| 1NBH14 | 19.23 | 9.27 | -0.53 | -0.17 | -180.36 |
| 1NDL14 | 4.26 | 2.21 | 0.13 | -0.09 | -34.74 |
| 1NDM14 | 6.33 | 3.25 | -0.43 | -0.35 | -159.57 |
| 1NDH14 | 7.74 | 3.99 | -0.30 | -0.39 | -153.10 |
| 1CBL3 | 164.99 | 20.94 | -0.38 | 1.06 | -71.86 |
| 1CBM3 | 123.99 | 20.43 | -0.65 | 1.01 | -144.86 |
| 1CBH3 | 138.21 | 21.58 | -0.54 | 1.03 | -140.25 |
| 1CBL14 | 102.65 | 16.45 | 0.25 | 0.95 | 34.93 |
| 1CBM14 | 61.23 | 14.48 | 0.46 | 0.66 | 47.89 |
| 1CBH14 | 106.73 | 18.87 | 0.37 | 0.96 | 22.66 |
| 1CDL3 | 11.55 | 4.85 | 0.60 | -0.29 | 63.72 |
| 1CDM3 | 14.73 | 6 | -0.40 | -0.23 | -144.98 |
| 1CDH3 | 19.99 | 7.52 | 0.33 | -0.12 | -20.57 |
| 1CDL14 | 7.52 | 3.41 | 0.25 | -0.31 | -8.91 |
| 1CDM14 | 10.25 | 4.51 | 0.22 | -0.30 | -31.87 |
| 1CDH14 | 20.52 | 7.56 | 0.89 | -0.11 | 85.47 |
| 1SBL14 | 63.48 | 16.55 | 0.76 | 0.80 | 130.98 |
| 1SBM14 | 89.66 | 21.42 | 0.31 | 1.04 | 41.76 |
| 1SBH14 | 94.42 | 21.65 | 0.42 | 1.07 | 41.93 |
| 1SDL14 | 9.46 | 4.38 | -0.42 | -0.36 | -131.78 |
| 1SDM14 | 13.79 | 6.12 | -0.25 | -0.28 | -116.12 |
| 1SDH14 | 24.22 | 9.39 | 0.00 | -0.05 | -77.39 |
| 2CBL3 | 432.04 | 48.86 | 1.23 | 0.92 | 328.65 |
| 2CBM3 | 326.82 | 46.03 | 0.31 | 0.92 | 122.18 |
| 2CBH3 | 427.33 | 46.89 | 0.45 | 0.92 | 131.12 |
| 2CBL14 | 167.78 | 35.51 | -0.51 | 0.89 | -48.74 |
| 2CBM14 | 183.26 | 34.99 | 0.18 | 0.90 | 61.04 |
| 2CBH14 | 137.64 | 35.05 | 0.58 | 0.86 | 116.46 |
| 2CDL3 | 51.40 | 17.2 | 0.20 | 0.42 | 27.49 |
| 2CDM3 | 50.59 | 17.42 | 1.70 | 0.41 | 292.48 |
| 2CDH3 | 71.45 | 20.66 | -1.12 | 0.64 | -254.99 |
| 2CDL14 | 13.05 | 6.16 | 0.48 | -0.22 | 45.12 |
| 2CDM14 | 17.63 | 7.83 | -0.87 | -0.14 | -228.44 |
| 2CDH14 | 26.78 | 11.56 | 2.09 | 0.00 | 327.09 |
| 2SBL14 | 39.83 | 12.62 | -0.12 | 0.23 | -49.09 |
| 2SBM14 | 115.17 | 25.49 | -0.20 | 1.18 | -42.25 |
| 2SBH14 | 150.02 | 27.51 | -1.60 | 1.25 | -323.18 |
| 2SDL14 | 54.36 | 15.19 | 0.63 | 0.67 | 103.79 |
| 2SDM14 | 119.75 | 25.98 | 0.06 | 1.19 | 9.26 |
| 2SDH14 | 122.44 | 25.06 | -0.20 | 1.20 | -65.08 |

Notes:

^ 1= 2018/19, 2 = 2019/20; N = northwest farm, C = central farm, S= southeast farm; B= early-broadcast; D = late-drill; H = high seeding rate; M = medium seeding rate; L = low seeding rate; 3 = target termination date 3 days before planting; 14 = target termination date 14 days before planting; Check = no cover crop; treatments 2NDL14, 2NDM14, 2NDH14 were excluded from the analysis due to the unavailability of biomass data from their broadcast-equivalent treatments 2NBL14, 2NBM14, and 2NBH14.