Effectiveness of Conservation Crop Rotation   
for Water Pollutant Reduction   
from Agricultural Areas

Appendix

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| Table A1. Summary of research articles on legume N credits to a following corn crop. Those with a range of values vary based on yield or stand quality of the previous legume crop, estimation method, or study location. For the estimation method, Difference refers to the difference approach, Traditional refers to the traditional (or FRV) approach, Other indicates that a method other than Traditional or Difference was used, and Various denotes that more than one method was used. | | | | |
| Reference | Location | Crop | N Credit (kg N ha-1) | Estimation Method |
| Nafziger et al., 1984 | DeKalb, Illinois | Soybean | 73 | Difference |
|  | Alfalfa | 121 |  |
| Attia et al., 2015 | Brunswick, Nebraska | Soybean | 30 to 66 | Various |
| Carpenter-Boggs et al., 2000 | Brookings, South Dakota | Alfalfa | 189 | Other |
| Ding et al., 1998 | Elora, Ontario, Canada | Soybean | 80 | Traditional |
|  |  | Soybean | 41 to 59 | Difference |
| Omay et al., 1998 | Kansas | Soybean | 144 to 155 | Traditional |
| Beauchamp et al., 1996 | Elora, Ontario, Canada | Soybean | 4-99 | Traditional |
| Gentry et al., 2001 | Urbana, Illinois | Soybean | 40 | Other |
| Ma et al., 2003 | Ottawa, Ontario, Canada | Alfalfa | 133 | Difference |
| Yost et al., 2012 | Brewster, Minnesota | Alfalfa | 82 | Other |
| Yost et al., 2014 | Iowa and Minnesota | Alfalfa | 73 to 203 | Other |
| Oyer and Touchton, 1990 | Alabama | Soybean | 12 to 46 | Traditional |
| Bundy et al., 1993 | Wisconsin | Soybean | -22 to 210 | Various |
| Green and Blackmer, 1995 | Iowa | Soybean | 53 | Other |
| Varvel and Wilhelm, 2003 | Nebraska | Soybean | 65 | Traditional |
| Claassen and Kissel, 1984 | Powhattan, Kansas | Soybean | 22 | Traditional |
| Fox and Piekielik, 1988 | State College, Pennsylvania | Alfalfa | 136 | Traditional |
| Hesterman et al., 1986 | Minnesota | Alfalfa | 35 to 305 | Difference |
| Paré et al., 1993 | Québec, Canada | Soybean | 0 | Traditional |
| Beckie et al., 1997 | Saskatchewan, Canada | Field pea | 25 | Other |
| Harris and Hesterman, 1990 | Michigan | Alfalfa | 24 | Other |
| Rembon and MacKenzie, 1997 | Québec, Canada | Soybean | 11 to 150 | Various |
| Stecker et al., 1995 | Novelty, Missouri | Soybean | 0 to 159 | Various |
| Stute and Posner, 1995 | Arlington, Wisconsin | Alfalfa | 13 to 182 | Traditional |
| Vanotti and Bundy, 1995 | Lancaster, Wisconsin | Soybean | 75 | Traditional |
|  |  | Alfalfa | 36 to 153 |  |
| Franzleubbers et al., 1994 | Nebraska | Soybean | 0 to 177 | Various |
| N’Dayegamiye et al., 2015 | Québec, Canada | Alfalfa | 8 to 26 | Other |
|  |  | Soybean | 8 to 26 |  |
|  |  | Field pea | 8 to 26 |  |
| Bruulsema and Christie, 1987 | Elora, Ontario, Canada | Alfalfa | 90 to 125 | Traditional |

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| Table A2. Summary of U.S. land grant university publications on legume N credits to a following corn crop. Those with a range of values vary based on stand quality or yield of the previous legume crop, or estimation method. | | | | |
| Institution | State | Reference | Crop | N Credit  (kg N ha-1) |
| University of Georgia | Georgia | Kissel and Sonon, 2008 | Soybean | 22 to 45 |
|  |  | Peanut | 22 to 45 |
|  |  | Alfalfa | 90 to 112 |
| Kansas State University | Kansas | Leikam et al., 2007 | Soybean | 45 |
|  |  | Alfalfa | 0 to 134 |
| University of Nebraska - Lincoln | Nebraska | Shapiro et al., 2019 | Soybean | 39 to 50 |
|  |  | Alfalfa | 45 to 168 |
| Oregon State University | Oregon | Gardner et al., 2000 | Field Pea | 56 |
| Clemson University | South Carolina | Clemson University, 2007 | Soybean | 22 to 34 |
| Virginia Tech | Virginia | Alley et al., 2009 | Peanut | 50 |
|  |  | Alfalfa | 56 to 101 |
|  |  | Soybean | 22 |
| University of Vermont | Vermont | Jokela et al., 2004 | Soybean | 34 |
|  |  | Alfalfa | 90 to 134 |
|  |  | Field Pea | 34 |
| Iowa State University | Iowa | Sawyer, 2016 | Alfalfa | 0 to 34 |
| Pennsylvania State University | Pennsylvania | Beegle, 2015 | Alfalfa | 45 to 134 |
| South Dakota State University | South Dakota | Reitsma et al., 2008 | Alfalfa | 0 to 168 |
|  |  | Soybean | 45 |
|  |  | Pea | 45 |
| Utah State University | Utah | Topper et al., 2010 | Alfalfa | 28 to 112 |
| University of Wisconsin | Wisconsin | Laboski and Peters, 2012 | Alfalfa | 45 to 212 |
|  | Shelley, 2004 | Soybean | 45 |
|  | Bundy, 1998 | Soybean | 0 to 45 |
| North Dakota State University | North Dakota | Franzen, 2018 | Soybean | 45 |
|  |  | Field Pea | 45 |
|  |  | Chickpea | 45 |
|  |  | Alfalfa | 56 to 168 |
| Cornell University | New York | Ketterings et al., 2007 | Soybean | 22 to 34 |
| Michigan State University | Michigan | Warncke et al., 2009 | Soybean | 34 |
|  | Vitosh et al., 1995 | Alfalfa | 157 |
| The Ohio State University | Ohio | Vitosh et al., 1995 | Soybean | 34 |
|  |  | Alfalfa | 157 |
| Purdue University | Indiana | Vitosh et al., 1995 | Soybean | 34 |
|  |  | Alfalfa | 157 |
| University of Wyoming | Wyoming | Blaylock et al., 1996 | Any Bean | 34 |
| University of Minnesota | Minnesota | Yost et al., 2015 | Alfalfa | 56 to 168 |
| University of Maine | Maine | Ketterings et al., 2007 | Soybean | 0 |
| University of Massachusetts - Amherst | Massachusetts | Ketterings et al., 2007 | Soybean | 0 |
| University of New Hampshire | New Hampshire | Ketterings et al., 2007 | Soybean | 34 |
| Rutgers University | New Jersey | Ketterings et al., 2007 | Soybean | 17 |
| University of Maryland | Maryland | Ketterings et al., 2007 | Soybean | 16 to 45 |
|  |  | Haering and Evanylo, 2015 | Alfalfa | 112 to 168 |
| University of Illinois | Illinois | Fernandez et al., 2009 | Alfalfa | 0 to 112 |
|  | Shelley, 2004 | Soybean | 11 |
| Missouri State University | Missouri | Killpack and Buchholz, 1993 | Alfalfa | 134 to 157 |
|  | Scharf and Lory, 2018 | Alfalfa | 112 |
|  |  | Soybean | 33 |
| University of California - Davis | California | Pettygrove and Putnam, 2009 | Alfalfa | 45 to 90 |
| Colorado State University | Colorado | Davis and Westfall, 2014 | Alfalfa | 0 to 157 |
| University of Idaho | Idaho | Brown et al., 2010 | Alfalfa | 33 to 112 |
| University of Delaware | Delaware | Ketterings et al., 2007 | Alfalfa | 101 |
| Mississippi State University | Mississippi | Larson and Oldham, 2008 | Soybean | 0 |
|  |  | Alfalfa | 0 |
| Montana State University | Montana | Jones and Olson-Rutz, 2018 | Alfalfa | 45 |
| Oklahoma State University | Oklahoma | Arnall and Hiner, 2016 | Alfalfa | 90 |
|  |  | Soybean | 22 |
|  |  | Pea | 45 |
|  |  | Peanut | 22 |
| Washington State University | Washington | Hermanson et al., 2000 | Soybean | 45 |
|  |  | Pea | 22 |
|  |  | Alfalfa | 56 |

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| Table A3. Nitrate-nitrogen (NO3) concentrations and losses in subsurface drainage and runoff from various sources (NR = not reported; Conc. = concentration). Crops shown in bold indicate that values in those rows are reported for the individual crop in the given crop rotation sequence. | | | | | | | | | | |
| Reference | Crop | Year | Fertilization | Tillage | Runoff  (mm) | Runoff  NO3 Conc.  (mg L-1) | Runoff  NO3 Loss  (kg N ha-1) | Subsurface  Discharge  or Leachate  (mm) | Drainage  NO3 Conc.  (mg L-1) | Drainage  NO3 Loss  (kg N ha-1) |
| Zhu and Fox,  2003 | **Corn**-soybean | 1997 | 0 kg N ha-1 | Chisel plow | NR | NR | NR | 630 | 1.7 | 11 |
| 100 kg N ha-1 | Chisel plow | NR | NR | NR | 630 | 6.6 | 41 |
| 200 kg N ha-1 | Chisel plow | NR | NR | NR | 630 | 21.4 | 135 |
| 1999 | 0 kg N ha-1 | Chisel plow | NR | NR | NR | 392 | 2.0 | 8 |
| 100 kg N ha-1 | Chisel plow | NR | NR | NR | 392 | 5.1 | 20 |
| 200 kg N ha-1 | Chisel plow | NR | NR | NR | 392 | 25.7 | 101 |
| Corn-**soybean** | 1998 | 0 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 349 | 3.3 | 11 |
| 100 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 349 | 7.3 | 25 |
| 200 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 349 | 19.4 | 68 |
| 2000 | 0 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 317 | 9.1 | 29 |
| 100 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 317 | 11.4 | 36 |
| 200 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 317 | 35.8 | 113 |
| Kanwar et al.,  1997 | Continuous corn | 1990-1992 | 202 kg N ha-1 | Chisel plow | NR | NR | NR | 191 | 32 | 65 |
| Moldboard | NR | NR | NR | 122 | 38 | 47 |
| Ridge-till | NR | NR | NR | 203 | 25 | 55 |
| No-till | NR | NR | NR | 246 | 23 | 64 |
| Soybean-corn | 168 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 178 | 20 | 36 |
| Moldboard | NR | NR | NR | 130 | 20 | 28 |
| Ridge-till | NR | NR | NR | 145 | 17 | 24 |
| No-till | NR | NR | NR | 132 | 15 | 24 |
| Corn-soybean | 168 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 183 | 20 | 35 |
| Moldboard | NR | NR | NR | 152 | 21 | 33 |
| Ridge-till | NR | NR | NR | 168 | 16 | 26 |
| No-till | NR | NR | NR | 168 | 14 | 25 |
| Weed and  Kanwar, 1996 | Continuous corn | 1990-1992 | 202 kg N ha-1 | Chisel plow | NR | NR | NR | 194 | 31.0 | 63 |
| Moldboard | NR | NR | NR | 128 | 36.9 | 45 |
| Ridge-till | NR | NR | NR | 252 | 21.9 | 60 |
| No-till | NR | NR | NR | 207 | 21.7 | 51 |
| **Corn**-soybean | 168 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 134 | 20.1 | 31 |
| Moldboard | NR | NR | NR | 113 | 23.6 | 28 |
| Ridge-till | NR | NR | NR | 132 | 14.4 | 22 |
| No-till | NR | NR | NR | 129 | 15.5 | 22 |
| Corn-**soybean** | 168 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 226 | 16.2 | 37 |
| Moldboard | NR | NR | NR | 171 | 16.5 | 29 |
| Ridge-till | NR | NR | NR | 168 | 13.5 | 24 |
| No-till | NR | NR | NR | 183 | 12.1 | 22 |
| Bakhsh and  Kanwar, 2007 | Continuous corn | 1990-1992 | 202 kg N ha-1 | Chisel plow | NR | NR | NR | 195 | 32.6 | 64.9 |
| No-till | NR | NR | NR | 263 | 23.0 | 63.2 |
| Corn-soybean-corn | 168 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 178 | 19.7 | 35.2 |
| No-till | NR | NR | NR | 132 | 16.1 | 24.1 |
| Soybean-corn-  soybean | 168 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 181 | 19.6 | 35.0 |
| No-till | NR | NR | NR | 177 | 13.1 | 23.6 |
| Continuous corn | 1993-1998 | 202 kg N ha-1 | Chisel plow | NR | NR | NR | 144 | 10.9 | 16.9 |
| No-till | NR | NR | NR | NR | NR | NR |
| Corn-soybean-corn | 168 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 122 | 12.0 | 13.7 |
| No-till | NR | NR | NR | 246 | 11.0 | 25.7 |
| Soybean-corn-  soybean | 168 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 122 | 10.4 | 13.3 |
| No-till | NR | NR | NR | 252 | 8.3 | 20.0 |
| Baksh et al.,  2007 | Soybean-**corn** | 1999-2003 | Manure, fall,  172 kg N ha-1 | Chisel plow | NR | NR | NR | 79 | 21.6 | 16 |
| Soybean-**corn** | Manure, spring,  166 kg N ha-1 | No-till | NR | NR | NR | 120 | 13.2 | 15 |
| Soybean-**corn** | Preplant UAN,  170 kg N ha-1 | Chisel plow | NR | NR | NR | 70 | 15.9 | 10 |
| Corn-**soybean** | Manure, fall,  172 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 153 | 14.7 | 17 |
| Corn-**soybean** | Manure, spring,  166 kg N ha-1  to corn | No-till | NR | NR | NR | 164 | 9.7 | 14 |
| Corn-**soybean** | Preplant UAN,  170 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 94 | 16.4 | 11 |

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| Table A3 (continued). Nitrate-nitrogen (NO3) concentrations and losses in subsurface drainage and runoff from various sources (NR = not reported; Conc. = concentration). Crops shown in bold indicate that values in those rows are reported for the individual crop in the given crop rotation sequence. | | | | | | | | | | |
| Reference | Crop | Year | Fertilization | Tillage | Runoff  (mm) | Runoff  NO3 Conc.  (mg L-1) | Runoff  NO3 Loss  (kg N ha-1) | Subsurface  Discharge  or Leachate  (mm) | Drainage  NO3 Conc.  (mg L-1) | Drainage  NO3 Loss  (kg N ha-1) |
| Fox et al.,  2001 | Continuous corn | 1988-1999 | 0 kg N ha-1 | Chisel plow | NR | NR | NR | NR | 4 | NR |
| Continuous corn | Non-manure, 140  to 200 kg N ha-1 | Chisel plow | NR | NR | NR | NR | 17 | 91 |
| Continuous corn | 1988-1990 | Manure, 0 to  100 kg N ha-1 | Chisel plow | NR | NR | NR | NR | 19 | NR |
| Alfalfa-**corn** | 1994 | 0 kg N ha-1 | Chisel plow | NR | NR | NR | NR | 15 | NR |
| **Alfalfa**-corn | 1991-1993 | 0 kg N ha-1  to corn | Chisel plow | NR | NR | NR | NR | 4.3 | NR |
| Corn-**soybean** | 1998 | 0 to 100 kg N ha-1  to corn | Chisel plow | NR | NR | NR | NR | 10 | NR |
| Kanwar et al.,  2005 | Soybean-corn | 1993-1998 | 110 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 122 | 12.0 | 13.7 |
| Corn-soybean | 110 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 122 | 10.4 | 13.3 |
| Alfalfa-alfalfa-alfalfa-  corn-soybean-oat | 0 kg N ha-1 | Chisel plow | NR | NR | NR | 179 | 6.4 | 11.8 |
| Strip corn-soybean-  oat | 95 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 178 | 6.6 | 13.3 |
| King et al.,  2016 | **Corn**-soybean | 2005-2012 | 13 to 456 kg N ha-1  14 to 117 kg P ha-1 | Chisel plow | NR | NR | NR | 284 | NR | 28.2 |
| Chisel plow | NR | NR | NR | 252 | NR | 39.7 |
| Chisel plow | NR | NR | NR | 455 | NR | 59.9 |
| Corn-**soybean** | 0 kg N ha-1 | No-till | NR | NR | NR | 215 | NR | 21.4 |
| No-till | NR | NR | NR | 262 | NR | 37.0 |
| No-till | NR | NR | NR | 624 | NR | 53.7 |
| Owens and  Edwards, 1993 | **Corn**-soybean | 1984-1989 | Ammonium nitrate,  224 kg N ha-1  to corn | Chisel plow | 45.7 | 10.1 | 4.2 | NR | NR | NR |
| Paraplow | 45.7 | 25.9 | 11.6 | NR | NR | NR |
| No-till | 45.7 | 12.6 | 6.7 | NR | NR | NR |
| Corn-**soybean** | Ammonium nitrate,  224 kg N ha-1  to corn | Chisel plow | 81.2 | 1.7 | 1.3 | NR | NR | NR |
| Paraplow | 81.2 | 3.4 | 3.6 | NR | NR | NR |
| No-till | 81.2 | 1.2 | 1.0 | NR | NR | NR |
| Owens et al.,  2000 | **Corn**-soybean | 1984-1990 | Ammonium nitrate,  140 to 196 kg  N ha-1 to corn | Chisel plow | NR | NR | NR | 294 | 13.3 | 40.2 |
| 1990-1996 | Chisel plow | NR | NR | NR | 295 | 9.8 | 27.2 |
| Corn-**soybean** | 1984-1990 | Chisel plow | NR | NR | NR | 308 | 8.4 | 27.8 |
| 1990-1996 | Chisel plow | NR | NR | NR | 337 | 10.0 | 34.8 |
| Randall et al.,  1997 | Continuous corn | 1990-1993 | Urea, 35 to 180  kg N ha-1 | Moldboard | NR | NR | NR | 193 | 32.3 | 54.5 |
| **Corn**-soybean | Urea, 105 to 180  kg N ha-1 to corn | Moldboard | NR | NR | NR | 226 | 22.8 | 50.8 |
| Corn-**soybean** | Moldboard | NR | NR | NR | 225 | 25.8 | 53.0 |
| Alfalfa | 0 kg N ha-1 | Moldboard | NR | NR | NR | 104 | 3.1 | 2.7 |
| Shipitalo et al.,  2013 | **Corn**-soybean | 1990-2005 | 152 to 22 kg  N ha-1 | Chisel plow | 95 | NR | 9.0 | NR | NR | NR |
| No-till | 109 | NR | 5.8 | NR | NR | NR |
| Manure, 158 kg N  ha-1, 27 kg P ha-1 | Disked | 130 | NR | 6.6 | NR | NR | NR |
| Corn-**soybean** | 152 to 228 kg  N ha-1 | Chisel plow | 93 | NR | 2.0 | NR | NR | NR |
| No-till | 106 | NR | 1.6 | NR | NR | NR |
| Manure, 158 kg N  ha-1, 27 kg P ha-1 | Disked | 139 | NR | 3.8 | NR | NR | NR |
| Basso and  Ritchie, 2005 | Continuous alfalfa | 1994-1999 | Control, 0 kg  N ha-1 | Moldboard | NR | NR | NR | 164 | NR | 20.3 |
| Compost, 120 kg  N ha-1 | Moldboard | NR | NR | NR | 175 | NR | 24.0 |
| Manure, 120 kg  N ha-1 | Moldboard | NR | NR | NR | 297 | NR | 64.7 |
| Continuous corn | Control, 0 kg  N ha-1 | Moldboard | NR | NR | NR | 231 | NR | 31.3 |
| Compost, 120 kg  N ha-1 | Moldboard | NR | NR | NR | 215 | NR | 41.0 |
| Manure, 120 kg  N ha-1 | Moldboard | NR | NR | NR | 200 | NR | 48.8 |
| Urea, 120 kg N ha-1 | Moldboard | NR | NR | NR | 199 | NR | 38.0 |

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| Table A3 (continued). Nitrate-nitrogen (NO3) concentrations and losses in subsurface drainage and runoff from various sources (NR = not reported; Conc. = concentration). Crops shown in bold indicate that values in those rows are reported for the individual crop in the given crop rotation sequence. | | | | | | | | | | |
| Reference | Crop | Year | Fertilization | Tillage | Runoff  (mm) | Runoff  NO3 Conc.  (mg L-1) | Runoff  NO3 Loss  (kg N ha-1) | Subsurface  Discharge  or Leachate  (mm) | Drainage  NO3 Conc.  (mg L-1) | Drainage  NO3 Loss  (kg N ha-1) |
| Huggins et al.,  2001 | Continuous corn | 1994-1996 | Urea, 112 to 148  kg N ha-1  + 17-15-18 | Moldboard | NR | NR | NR | 168 | NR | 17 |
| **Corn**-soybean | Urea, 67 to 95 kg  N ha-1 to corn  + 17-15-18 | Moldboard | NR | NR | NR | 175 | NR | 16 |
| Corn-**soybean** | Moldboard | NR | NR | NR | 171 | NR | 13 |
| Alfalfa-**corn**-corn-  soybean | Urea, 0 to 60 kg  N ha-1 to corn  + 17-15-18 | Moldboard | NR | NR | NR | 103 | NR | 3 |
| Alfalfa-corn-**corn**-  soybean | Moldboard | NR | NR | NR | 175 | NR | 14 |
| Alfalfa-corn-corn-  **soybean** | Moldboard | NR | NR | NR | 133 | NR | 7 |
| Alfalfa/grass-**corn**-  corn-soybean | Urea, 132 to 160  kg N ha-1 to corn  + 17-15-18 | Moldboard | NR | NR | NR | 116 | NR | 1 |
| Alfalfa/grass-corn-  **corn**-soybean | Moldboard | NR | NR | NR | 212 | NR | 17 |
| Alfalfa/grass-corn-  corn-**soybean** | Moldboard | NR | NR | NR | 152 | NR | 11 |
| Klocke et al.,  1999 | Continuous corn | 1993-1998 | Ammonium nitrate | NR | NR | NR | NR | 218 | 24 | 52 |
| Corn-soybean | Ammonium nitrate | NR | NR | NR | NR | 218 | 42 | 91 |
| Lawlor et al.,  2008 | **Corn**-soybean | 1990-1993 | 0 kg N ha-1 | Chisel plow | NR | NR | NR | 256 | 9.9 | 48 |
| 56 kg N ha-1 | Chisel plow | NR | NR | NR | 256 | 11.1 | 54 |
| 112 kg N ha-1 | Chisel plow | NR | NR | NR | 256 | 13.1 | 74 |
| 168 kg N ha-1 | Chisel plow | NR | NR | NR | 256 | 12.0 | 59 |
| Corn-**soybean** | 0 kg N ha-1 to corn | Chisel plow | NR | NR | NR | 256 | 7.8 | 52 |
| 56 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 256 | 7.8 | 41 |
| 112 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 256 | 10.3 | 64 |
| 168 kg N ha-1  to corn | Chisel plow | NR | NR | NR | 256 | 11.7 | 57 |
| Randall and  Vetsch, 2005 | **Corn**-soybean | 1994-2000 | Fall, anhydrous  ammonia,  135 kg N ha-1 | NR | NR | NR | NR | 150 | 14 | 22 |
| Fall, anhydrous NH3  135 kg N ha-1,  + nitrapyrin | NR | NR | NR | NR | 153 | 12 | 20 |
| Spring, anhydrous  NH3 135 kg N ha-1 | NR | NR | NR | NR | 133 | 11 | 14 |
| Spring, anhydrous  NH3, 135 kg N ha-1,  + nitrapyrin | NR | NR | NR | NR | 122 | 11 | 14 |
| Corn-**soybean** | Fall, anhydrous  NH3, 135 kg N ha-1  to corn | NR | NR | NR | NR | 135 | 10 | 14 |
| Fall, anhydrous  NH3, 135 kg N ha-1,  + nitrapyrin to corn | NR | NR | NR | NR | 156 | 10 | 16 |
| Spring, anhydrous  NH3, 135 kg N ha-1  to corn | NR | NR | NR | NR | 130 | 11 | 14 |
| Spring, anhydrous  NH3, 135 kg N ha-1,  + nitrapyrin to corn | NR | NR | NR | NR | 141 | 11 | 16 |

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| Table A3 (continued). Nitrate-nitrogen (NO3) concentrations and losses in subsurface drainage and runoff from various sources (NR = not reported; Conc. = concentration). Crops shown in bold indicate that values in those rows are reported for the individual crop in the given crop rotation sequence. | | | | | | | | | | |
| Reference | Crop | Year | Fertilization | Tillage | Runoff  (mm) | Runoff  NO3 Conc.  (mg L-1) | Runoff  NO3 Loss  (kg N ha-1) | Subsurface  Discharge  or Leachate  (mm) | Drainage  NO3 Conc.  (mg L-1) | Drainage  NO3 Loss  (kg N ha-1) |
| Syswerda et al.,  2012 | **Corn**-soybean-wheat | 1995-2006 | Conventional,  153 to 163 kg  N ha-1 to corn | Moldboard/  chisel | NR | NR | NR | 334 | NR | 33.7 |
| No-till | NR | NR | NR | 388 | NR | 22.8 |
| Clover cover crop  + 28 to 31 kg  N ha-1 | Moldboard/  chisel | NR | NR | NR | 220 | NR | 13.8 |
| Clover cover crop,  0 kg N ha-1 | Moldboard/  chisel | NR | NR | NR | 403 | NR | 10.1 |
| Corn-**soybean**-  wheat | Conventional,  153 to 163 kg  N ha-1 to corn | Moldboard/  chisel | NR | NR | NR | 334 | NR | 5.9 |
| No-till | NR | NR | NR | 388 | NR | 3.9 |
| Clover cover crop  + 28 to 31 kg  N ha-1 | Moldboard/  chisel | NR | NR | NR | 220 | NR | 3.6 |
| Clover cover crop,  0 kg N ha-1 | Moldboard/  chisel | NR | NR | NR | 403 | NR | 3.4 |
| Corn-soybean-  **wheat** | Conventional,  56 to 90 kg N ha-1  to wheat | Moldboard/  chisel | NR | NR | NR | 334 | NR | 22.4 |
| No-till | NR | NR | NR | 388 | NR | 14.6 |
| Clover cover crop  + 28 to 54 kg  N ha-1 | Moldboard/  chisel | NR | NR | NR | 220 | NR | 6.8 |
| Clover cover crop,  0 kg N ha-1 | Moldboard/  chisel | NR | NR | NR | 403 | NR | 5.4 |
| Alfalfa | None | No-till | NR | NR | NR | 198 | NR | 12.8 |
| Tan et al.,  2002 | Continuous corn | 1998-2000 | 16.8 kg N ha-1,  67.2 kg P2O5 ha-1,  33.6 kg K2O ha-1 +  112 kg N ha-1 to corn | Moldboard/  disk | NR | NR | NR | 180 | 15.2 | 27.3 |
| None | Moldboard/  disk | NR | NR | NR | 85 | 3.3 | 2.8 |
| **Corn**-oat-alfalfa-  alfalfa | 16.8 kg N ha-1,  67.2 kg P2O5 ha-1 ,  33.6 kg K2O ha-1 +  112 kg N ha-1 to corn | Moldboard/  disk | NR | NR | NR | 184 | 18.0 | 33.3 |
| None | Moldboard  /disk | NR | NR | NR | 175 | 8.4 | 14.7 |
| Corn-**oat**-alfalfa-  alfalfa | 16.8 kg N ha-1,  67.2 kg P2O5 ha-1,  33.6 kg K2O ha-1 +  112 kg N ha-1 to corn | Moldboard  /disk | NR | NR | NR | 125 | 5.8 | 7.3 |
| None | Moldboard  /disk | NR | NR | NR | 181 | 2.5 | 4.6 |
| Corn-oat-**alfalfa**-  alfalfa | 16.8 kg N ha-1,  67.2 kg P2O5 ha-1,  33.6 kg K2O ha-1 + 112 kg N ha-1 to corn | None | NR | NR | NR | 122 | 6.3 | 7.7 |
| None | None | NR | NR | NR | 136 | 2.6 | 3.5 |
| Corn-oat-alfalfa-  **alfalfa** | 16.8 kg N ha-1,  67.2 kg P2O5 ha-1,  33.6 kg K2O ha-1 +  112 kg N ha-1 to corn | Moldboard  /disk | NR | NR | NR | 144 | 16.2 | 23.3 |
| None | Moldboard  /disk | NR | NR | NR | 185 | 9.1 | 16.8 |
| Drury et al.,  2001 | Continuous corn | 1991-1994 | Average 165 kg  N ha-1 | Chisel plow | 52 | 1.9 | 1.0 | 169 | 11.4 | 19.3 |
| Chisel plow | 96 | 1.8 | 1.8 | 126 | 7.0 | 8.7 |
| Soybean-corn | 1995-1999 | Average 75 kg  N ha-1 to corn | no-till | 111 | 2.5 | 3.0 | 199 | 7.3 | 14.4 |
| no-till | 154 | 2.3 | 3.6 | 124 | 4.0 | 4.9 |
| Udawatta et al.,  2006 | **Corn**-soybean | 1991-1997 | 59-0-0 or  160-50-100 N-P-K | no-till or field  cultivator | 309 | NR | 22.2 | NR | NR | NR |
| **Soybean**-corn | None or 0-40-20  N-P-K | 309 | NR | 2.7 | NR | NR | NR |

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| Table A3 (continued). Nitrate-nitrogen (NO3) concentrations and losses in subsurface drainage and runoff from various sources (NR = not reported; Conc. = concentration). Crops shown in bold indicate that values in those rows are reported for the individual crop in the given crop rotation sequence. | | | | | | | | | | |
| Reference | Crop | Year | Fertilization | Tillage | Runoff  (mm) | Runoff  NO3 Conc.  (mg L-1) | Runoff  NO3 Loss  (kg N ha-1) | Subsurface  Discharge  or Leachate  (mm) | Drainage  NO3 Conc.  (mg L-1) | Drainage  NO3 Loss  (kg N ha-1) |
| Toth and Fox,  1998 | Continuous corn | 1991 | EON rate 185 kg  N ha-1 | Chisel/disk | NR | NR | NR | 510 | 16.2 | 80.5 |
| 1992 | EON rate 200 kg  N ha-1 | Chisel/disk | NR | NR | NR | 249 | 13.7 | NR |
| 1993 | EON rate 177 kg  N ha-1 | Chisel/disk | NR | NR | NR | 224 | 13.9 | NR |
| 1994 | EON rate 199 kg  N ha-1 | Chisel/disk | NR | NR | NR | 300 | 17.4 | 54.5 |
| Alfalfa | 1991 | None | No-till | NR | NR | NR | 235 | 3.8 | 9.3 |
| 1992 | None | No-till | NR | NR | NR | 93 | 4.1 | NR |
| 1993 | None | No-till | NR | NR | NR | 148 | 4.6 | NR |
| Corn after alfalfa | 1994 | EON rate 0 kg  N ha-1 | Chisel/disk | NR | NR | NR | 356 | 14.9 | 27.2 |
| Qi et al., 2011 | Corn | 2006-2009 | 140 kg N ha-1 | Cultivator,  chisel plow | NR | NR | NR | 327 | 13.8 | 39.8 |
| Rye-corn | 140 kg N ha-1 | Cultivator,  tandem disk | NR | NR | NR | 327 | 12.8 | 41.1 |
| Soybean | None | Cultivator,  tandem disk | NR | NR | NR | 327 | 12.8 | 36.3 |
| Rye-soybean | None | Cultivator,  tandem disk | NR | NR | NR | 327 | 11.4 | 36.5 |
| Clover-corn | 140 kg N ha-1 | no-till | NR | NR | NR | 327 | 6.8 | 24.2 |
| Perennial forage | None | no-till | NR | NR | NR | 327 | 4.6 | 13.4 |
| Smith et al.,  2013 | **Corn**-corn-soybean-  corn | 2008 | 28% UAN 168  kg N ha-1 | Chisel plow | NR | NR | NR | NR | NR | NR |
| Corn-**corn**-soybean-  corn | 2009 | 28% UAN 202  kg N ha-1 | Chisel plow | NR | NR | NR | 138 | NR | 21.0 |
| Corn-corn-**soybean**-  corn | 2010 | None | Chisel plow | NR | NR | NR | 139 | NR | 9.8 |
| Corn-corn-soybean-  **corn** | 2011 | 28% UAN 180  kg N ha-1 | Chisel plow | NR | NR | NR | 59 | NR | 7.0 |
| Woodley et al., 2018 | Continuous corn | 2008 | 112 + 16.8 kg  N ha-1 | Moldboard plow,  disk, harrowing | 438 | 3.2 | 14.1 | 151 | 4.6 | 7.0 |
| 2009 | 112 + 16.8 kg  N ha-1 | Moldboard plow,  disk, harrowing | 39 | 6.8 | 2.6 | 36 | 10.4 | 3.7 |
| 2010 | 112 + 16.8 kg  N ha-1 | Moldboard plow,  disk, harrowing | 233 | 4.3 | 10.0 | 125 | 5.3 | 6.7 |
| 2011 | 112 + 16.8 kg  N ha-1 | Moldboard plow,  disk, harrowing | 556 | 1.4 | 8.1 | 78 | 1.7 | 1.3 |
| 2012 | 112 + 16.8 kg  N ha-1 | Moldboard plow,  disk, harrowing | 101 | 7.5 | 7.6 | 56 | 6.5 | 3.7 |
| **Corn**-oat-alfalfa-  alfalfa | 2008 | 112 + 16.8 kg  N ha-1 | Moldboard plow,  disk, harrowing | 79 | 3.2 | 2.5 | 420 | 8.3 | 34.9 |
| 2009 | 112 + 16.8 kg  N ha-1 | Moldboard plow,  disk, harrowing | 3 | 23.7 | 0.8 | 29 | 19.5 | 5.8 |
| 2010 | 112 + 16.8 kg  N ha-1 | Moldboard plow,  disk, harrowing | 43 | 7.2 | 3.1 | 322 | 14.3 | 45.9 |
| 2011 | 112 + 16.8 kg  N ha-1 | Moldboard plow,  disk, harrowing | 218 | 2.1 | 4.5 | 466 | 7.1 | 32.9 |
| 2012 | 112 + 16.8 kg  N ha-1 | Moldboard plow,  disk, harrowing | 1 | 7.2 | 0.1 | 106 | 20.2 | 21.8 |
| Corn-**oat**-alfalfa-  alfalfa | 2008 | 16.8 kg N ha-1 | Disk, harrowing | 153 | 1.3 | 1.9 | 447 | 4.2 | 18.6 |
| 2009 | 16.8 kg N ha-1 | Disk, harrowing | 4 | 3.3 | 0.1 | 40 | 6.8 | 2.7 |
| 2010 | 16.8 kg N ha-1 | Disk, harrowing | 33 | 1.5 | 0.5 | 330 | 1.0 | 3.3 |
| 2011 | 16.8 kg N ha-1 | Disk, harrowing | 207 | 0.9 | 1.8 | 414 | 2.2 | 9.0 |
| 2012 | 16.8 kg N ha-1 | Disk, harrowing | 32 | 3.9 | 1.2 | 77 | 5.0 | 3.9 |
| Corn-oat-**alfalfa**-  alfalfa | 2008 | 16.8 kg N ha-1 | No-till | 141 | 1.5 | 2.1 | 359 | 4.1 | 14.8 |
| 2009 | 16.8 kg N ha-1 | No-till | 2 | 2.1 | 0.0 | 17 | 6.1 | 1.0 |
| 2010 | 16.8 kg N ha-1 | No-till | 89 | 1.9 | 1.7 | 124 | 4.8 | 6.0 |
| 2011 | 16.8 kg N ha-1 | No-till | 263 | 0.6 | 1.5 | 559 | 0.9 | 5.2 |
| 2012 | 16.8 kg N ha-1 | No-till | 18 | 2.6 | 0.4 | 68 | 6.4 | 4.4 |

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| Table A3 (continued). Nitrate-nitrogen (NO3) concentrations and losses in subsurface drainage and runoff from various sources (NR = not reported; Conc. = concentration). Crops shown in bold indicate that values in those rows are reported for the individual crop in the given crop rotation sequence. | | | | | | | | | | |
| Reference | Crop | Year | Fertilization | Tillage | Runoff  (mm) | Runoff  NO3 Conc.  (mg L-1) | Runoff  NO3 Loss  (kg N ha-1) | Subsurface  Discharge  or Leachate  (mm) | Drainage  NO3 Conc.  (mg L-1) | Drainage  NO3 Loss  (kg N ha-1) |
| Woodley et al., 2018  (continued) | Corn-oat-alfalfa-  **alfalfa** | 2008 | 16.8 kg N ha-1 | Moldboard plow | 84 | 1.5 | 1.3 | 499 | 8.8 | 44.0 |
| 2009 | 16.8 kg N ha-1 | Moldboard plow | 10 | 2.8 | 0.3 | 18 | 17.9 | 3.3 |
| 2010 | 16.8 kg N ha-1 | Moldboard plow | 9 | 2.0 | 0.2 | 279 | 16.8 | 46.6 |
| 2011 | 16.8 kg N ha-1 | Moldboard plow | 215 | 1.2 | 2.6 | 495 | 2.1 | 10.4 |
| 2012 | 16.8 kg N ha-1 | Moldboard plow | 2 | 7.5 | 0.1 | 63 | 17.9 | 11.2 |
| Continuous corn | 2008 | None | Moldboard plow,  disk, harrowing | 280 | 1.4 | 4.0 | 63 | 0.9 | 0.6 |
| 2009 | None | Moldboard plow,  disk, harrowing | 99 | 2.8 | 2.8 | 16 | 1.6 | 0.3 |
| 2010 | None | Moldboard plow,  disk, harrowing | 377 | 2.1 | 7.8 | 25 | 0.5 | 0.1 |
| 2011 | None | Moldboard plow,  disk, harrowing | 900 | 1.1 | 10.3 | 31 | 0.2 | 0.1 |
| 2012 | None | Moldboard plow,  disk, harrowing | 166 | 2.8 | 4.6 | 10 | 0.7 | 0.1 |
| **Corn**-oat-alfalfa-  alfalfa | 2008 | None | Moldboard plow,  disk, harrowing | 57 | 2.4 | 1.3 | 296 | 9.0 | 26.7 |
| 2009 | None | Moldboard plow,  disk, harrowing | 13 | 10.4 | 1.3 | 64 | 10.7 | 6.9 |
| 2010 | None | Moldboard plow,  disk, harrowing | 27 | 6.2 | 1.7 | 328 | 10.3 | 33.7 |
| 2011 | None | Moldboard plow,  disk, harrowing | 215 | 3.3 | 7.1 | 356 | 2.3 | 8.0 |
| 2012 | None | Moldboard plow,  disk, harrowing | 5 | 5.2 | 0.3 | 147 | 9.3 | 14.0 |
| Corn-**oat**-alfalfa-  alfalfa | 2008 | None | Disk, harrowing | 218 | 1.5 | 3.4 | 351 | 3.2 | 11.1 |
| 2009 | None | Disk, harrowing | 28 | 2.7 | 0.7 | 62 | 6.4 | 4.0 |
| 2010 | None | Disk, harrowing | 89 | 1.2 | 1.1 | 247 | 1.6 | 3.8 |
| 2011 | None | Disk, harrowing | 486 | 1.6 | 7.5 | 211 | 1.1 | 2.3 |
| 2012 | None | Disk, harrowing | 41 | 2.4 | 1.0 | 132 | 5.0 | 6.7 |
| Corn-oat-**alfalfa**-  alfalfa | 2008 | None | No-till | 165 | 2.6 | 4.2 | 244 | 3.3 | 8.0 |
| 2009 | None | No-till | 18 | 2.3 | 0.4 | 55 | 2.9 | 1.6 |
| 2010 | None | No-till | 129 | 1.3 | 1.5 | 143 | 3.4 | 4.8 |
| 2011 | None | No-till | 339 | 0.4 | 1.5 | 241 | 0.4 | 1.0 |
| 2012 | None | No-till | 69 | 2.5 | 1.7 | 119 | 3.7 | 4.4 |
| Corn-oat-alfalfa  -**alfalfa** | 2008 | None | Moldboard plow | 81 | 2.3 | 1.9 | 391 | 5.6 | 21.8 |
| 2009 | None | Moldboard plow | 0 | 1.4 | 0.0 | 32 | 15.1 | 5.0 |
| 2010 | None | Moldboard plow | 42 | 3.5 | 1.5 | 266 | 5.5 | 14.6 |
| 2011 | None | Moldboard plow | 306 | 1.2 | 3.8 | 281 | 2.1 | 5.8 |
| 2012 | None | Moldboard plow | 31 | 13.2 | 4.2 | 95 | 11.9 | 16.1 |

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| Table A4. Total nitrogen (TN) concentrations and losses in subsurface drainage and runoff from various sources (NR = not reported; Conc. = concentration). Crops shown in bold indicate that values in those rows are reported for the individual crop in the given crop rotation sequence. | | | | | | | | | | |
| Reference | Crop | Year | Fertilization | Tillage | Runoff  (mm) | Runoff  TN Conc.  (mg L-1) | Runoff  TN Loss  (kg N ha-1) | Subsurface  Discharge  or Leachate  (mm) | Drainage  TN Conc.  (mg L-1) | Drainage  TN Loss  (kg N ha-1) |
| King et al.,  2016 | **Corn**-soybean | 2005-2012 | 13 to 456 kg N ha-1,  14 to 117 kg P ha-1 | Chisel plow | NR | NR | NR | 284 | NR | 32.4 |
| Chisel plow | NR | NR | NR | 252 | NR | 43.0 |
| Chisel plow | NR | NR | NR | 455 | NR | 66.1 |
| Corn-**soybean** | 0 kg N ha-1 | No-till | NR | NR | NR | 215 | NR | 25.8 |
| No-till | NR | NR | NR | 262 | NR | 42.9 |
| No-till | NR | NR | NR | 624 | NR | 62.4 |
| Richardson and  King, 1995 | Corn | 1985-1989 | 141 kg N ha-1,  31 kg P ha-1 | Chisel /disk | 133 | NR | 8.5 | NR | NR | NR |
| 142 kg N ha-1,  31 kg P ha-1 | No-till | 143 | NR | 3.0 | NR | NR | NR |
| Wheat | 143 kg N ha-1,  31 kg P ha-1 | Chisel /disk | 156 | NR | 14.7 | NR | NR | NR |
| 144 kg N ha-1,  31 kg P ha-1 | No-till | 158 | NR | 4.4 | NR | NR | NR |
| Sorghum | 145 kg N ha-1,  31 kg P ha-1 | Chisel /disk | 142 | NR | 5.8 | NR | NR | NR |
| 146 kg N ha-1,  31 kg P ha-1 | No-till | 156 | NR | 3.3 | NR | NR | NR |
| Udawatta et al.,  2006 | Corn | 1991-1997 | 59-0-0, 160-50-00  N-P-K | No-till or  field cultivator | 309 | NR | 30.7 | NR | NR | NR |
| Soybean | None,  0-40-20 N-P-K | 309 | NR | 5.7 | NR | NR | NR |

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| Table A5. Dissolved phosphorus (DP) concentrations and losses in subsurface drainage and runoff from various sources (NR = not reported; Conc. = concentration). Crops shown in bold indicate that values in those rows are reported for the individual crop in the given crop rotation sequence. | | | | | | | | | | |
| Reference | Crop | Year | Fertilization | Tillage | Runoff  (mm) | Runoff  DP Conc.  (mg L-1) | Runoff  DP Loss  (kg P ha-1) | Subsurface  Discharge  or Leachate  (mm) | Drainage  DP Conc.  (mg L-1) | Drainage  DP Loss  (kg P ha-1) |
| King et al.  2016 | **Corn**-soybean | 2005-2012 | 13 to 456 kg N ha-1,  14 to 117 kg P ha-1 | Chisel plow | NR | NR | NR | 284 | NR | 0.48 |
| Chisel plow | NR | NR | NR | 252 | NR | 0.25 |
| Chisel plow | NR | NR | NR | 455 | NR | 0.74 |
| Corn-**soybean** | 0 kg N ha-1 | No-till | NR | NR | NR | 215 | NR | 0.36 |
| No-till | NR | NR | NR | 262 | NR | 0.42 |
| No-till | NR | NR | NR | 624 | NR | 0.48 |
| Shipitalo et al.,  2013 | **Corn**-soybean | 1990-2005 | 152 to 228 kg  N ha-1 | Chisel plow | 95 | NR | 0.23 | NR | NR | NR |
| No-till | 109 | NR | 0.34 | NR | NR | NR |
| Manure, 158 kg N  ha-1, 27 kg P ha-1 | Disked | 130 | NR | 1.34 | NR | NR | NR |
| Corn-**soybean** | 152 to 228 kg  N ha-1 | Chisel plow | 93 | NR | 0.19 | NR | NR | NR |
| No-till | 106 | NR | 0.30 | NR | NR | NR |
| Manure, 158 kg N  ha-1, 27 kg P ha-1 | Disked | 139 | NR | 0.35 | NR | NR | NR |
| Richardson and  King, 1995 | Corn | 1985-1989 | 141 kg N ha-1,  31 kg P ha-1 | Chisel/disk | 133 | NR | 0.3 | NR | NR | NR |
| 142 kg N ha-1,  31 kg P ha-1 | No-till | 143 | NR | 0.5 | NR | NR | NR |
| Wheat | 143 kg N ha-1,  31 kg P ha-1 | Chisel/disk | 156 | NR | 1.5 | NR | NR | NR |
| 144 kg N ha-1,  31 kg P ha-1 | No-till | 158 | NR | 0.5 | NR | NR | NR |
| Sorghum | 145 kg N ha-1,  31 kg P ha-1 | Chisel/disk | 142 | NR | 0.6 | NR | NR | NR |
| 146 kg N ha-1,  31 kg P ha-1 | No-till | 156 | NR | 0.8 | NR | NR | NR |
| Pease et al.,  2018 | Continuous corn | 2012-2015 | Multiple sites | Multiple  sites | 69 | NR | 0.17 | 305 | NR | 0.57 |
| Corn-soybean | 69 | NR | 0.44 | 305 | NR | 0.35 |
| Corn-soybean-wheat | 69 | NR | 0.20 | 305 | NR | 0.22 |
| Corn-wheat | 69 | NR | NR | 305 | NR | 0.35 |
| Algoazany et al.,  2007 | Corn-soybean | 1994-2000 | Average 74 kg P ha-1 | Multiple  sites | 17.1 | 0.270 | 0.046 | 157 | 0.102 | 0.160 |
| Soybean-corn | Average 47 kg P ha-1 | 24.1 | 0.253 | 0.061 | 115 | 0.099 | 0.113 |
| Soybean-seed corn | Average 56 kg P ha-1 | 23.0 | 0.534 | 0.123 | 117 | 0.194 | 0.226 |
| Corn-soybean | Average 44 kg P ha-1 | 21.9 | 0.572 | 0.125 | 160 | 0.086 | 0.137 |
| Smith et al.,  2015 | Corn-soybean | 2005-2013 | NR | Multiple  sites | NR | 0.12 | 0.031 | NR | NR | 0.0317 |
| Corn-soybean-wheat-oat | NR | 0.04 | 0.0046 | NR | NR | 0.0245 |

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| Table A6. Total phosphorus (TP) concentrations and losses in subsurface drainage and runoff from various sources (NR = not reported; Conc. = concentration). Crops shown in bold indicate that values in those rows are reported for the individual crop in the given crop rotation sequence. | | | | | | | | | | |
| Reference | Crop | Year | Fertilization | Tillage | Runoff  (mm) | Runoff  TP Conc.  (mg L-1) | Runoff  TP Loss  (kg P ha-1) | Subsurface  Discharge  or Leachate  (mm) | Drainage  TP Conc.  (mg L-1) | Drainage  TP Loss  (kg P ha-1) |
| King et al.,  2016 | **Corn**-soybean | 2005-2012 | 13 to 456 kg N ha-1,  14 to 117 kg P ha-1 | Chisel plow | NR | NR | NR | 284 | NR | 0.57 |
| Chisel plow | NR | NR | NR | 252 | NR | 0.29 |
| Chisel plow | NR | NR | NR | 455 | NR | 0.81 |
| Corn-**soybean** | 0 kg N ha-1 | No-till | NR | NR | NR | 215 | NR | 0.47 |
| No-till | NR | NR | NR | 262 | NR | 0.53 |
| No-till | NR | NR | NR | 624 | NR | 0.69 |
| Shipitalo et al.,  2013 | **Corn**-soybean | 1990-2005 | 152 to 228 kg N ha-1 | Chisel plow | 95 | NR | 1.24 | NR | NR | NR |
| No-till | 109 | NR | 0.86 | NR | NR | NR |
| Manure, 158 kg N  ha-1, 27 kg P ha-1 | Disked | 130 | NR | 2.33 | NR | NR | NR |
| Corn-**soybean** | 152 to 228 kg N ha-1 | Chisel plow | 93 | NR | 0.44 | NR | NR | NR |
| No-till | 106 | NR | 0.73 | NR | NR | NR |
| Manure, 158 kg N  ha-1, 27 kg P ha-1 | Disked | 139 | NR | 1.35 | NR | NR | NR |
| Richardson and  King, 1995 | Corn | 1985-1989 | 141 kg N ha-1,  31 kg P ha-1 | Chisel/disk | 133 | NR | 1.7 | NR | NR | NR |
| 142 kg N ha-1,  31 kg P ha-1 | No-till | 143 | NR | 0.6 | NR | NR | NR |
| Wheat | 143 kg N ha-1,  31 kg P ha-1 | Chisel/disk | 156 | NR | 2.0 | NR | NR | NR |
| 144 kg N ha-1,  31 kg P ha-1 | No-till | 158 | NR | 0.5 | NR | NR | NR |
| Sorghum | 145 kg N ha-1,  31 kg P ha-1 | Chisel/disk | 142 | NR | 1.4 | NR | NR | NR |
| 146 kg N ha-1,  31 kg P ha-1 | No-till | 156 | NR | 0.9 | NR | NR | NR |
| Pease et al.,  2018 | Continuous corn | 2012-2015 | Multiple sites | Multiple  sites | 69 | NR | 0.56 | 305 | NR | 0.76 |
| Corn-soybean | 69 | NR | 0.49 | 305 | NR | 0.43 |
| Corn-soybean-wheat | 69 | NR | 0.48 | 305 | NR | 0.50 |
| Corn-wheat | 69 | NR | 0.00 | 305 | NR | 0.76 |
| Smith et al.,  2015 | Corn-soybean | 2005-2013 | NR | Multiple  sites | NR | 0.80 | 0.208 | NR | NR | 0.139 |
| Corn-soybean  wheat-oat | NR | 0.36 | 0.0413 | NR | NR | 0.134 |

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| Table A7. Sediment concentrations and losses in subsurface drainage and runoff from various sources (NR = not reported; Conc. = concentration). Crops shown in bold indicate that values in those rows are reported for the individual crop in the given crop rotation sequence. | | | | | | | | | | |
| Reference | Crop | Year | Fertilization | Tillage | Runoff  (mm) | Runoff  Sediment  Conc.  (mg L-1) | Runoff  Sediment  Loss  (kg ha-1) | Subsurface  Discharge  or Leachate  (mm) | Drainage  Sediment  Conc.  (mg L-1) | Drainage  Sediment  Loss  (kg ha-1) |
| Shipitalo et al.,  2013 | **Corn**-soybean | 1990-2005 | 152 to 228 kg N ha-1 | Chisel plow | 95 | NR | 1609 | NR | NR | NR |
| No-till | 109 | NR | 719 | NR | NR | NR |
| Manure, 158 kg N  ha-1, 27 kg P ha-1 | Disked | 130 | NR | 734 | NR | NR | NR |
| Corn-**soybean** | 152 to 228 kg N ha-1 | Chisel plow | 93 | NR | 537 | NR | NR | NR |
| No-till | 106 | NR | 894 | NR | NR | NR |
| Manure, 158 kg N  ha-1, 27 kg P ha-1 | Disked | 139 | NR | 2600 | NR | NR | NR |
| Edwards et al.,  1993 | Corn-soybean | 1984-1990 | NR | Chisel plow | 8 | NR | 407 | NR | NR | NR |
| NR | Chisel plow | 91 | NR | 604 | NR | NR | NR |
| NR | Paraplow | 33 | NR | 189 | NR | NR | NR |
| NR | Paraplow | 115 | NR | 1010 | NR | NR | NR |
| NR | No-till | 54 | NR | 352 | NR | NR | NR |
| NR | No-till | 80 | NR | 597 | NR | NR | NR |
| Richardson and  King, 1995 | Corn | 1985-1989 | 141 kg N ha-1,  31 kg P ha-1 | Chisel /disk | 133 | NR | 2868 | NR | NR | NR |
| 142 kg N ha-1,  31 kg P ha-1 | No-till | 143 | NR | 269 | NR | NR | NR |
| Wheat | 143 kg N ha-1,  31 kg P ha-1 | Chisel /disk | 156 | NR | 779 | NR | NR | NR |
| 144 kg N ha-1,  31 kg P ha-1 | No-till | 158 | NR | 50 | NR | NR | NR |
| Sorghum | 145 kg N ha-1,  31 kg P ha-1 | Chisel /disk | 142 | NR | 1752 | NR | NR | NR |
| 146 kg N ha-1,  31 kg P ha-1 | No-till | 156 | NR | 224 | NR | NR | NR |

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# Supplemental Material

The following tables and information show details of the cost analysis that was performed as part of this literature review for a hypothetical field in the state of Iowa. A table is given for each cropping system studied in the cost analysis containing a list of variables, their respective units, input values for these variables, data sources, and comments on the specific assumptions or information regarding the inputs that were used. Overall net revenues in the text are based on the “mean” columns in each table.

An example calculation for net revenue of the continuous corn cropping system (*RCC*) for the ten-year study period (gross revenue minus total costs) is shown below:

 (A1)

where

*GRC* = gross revenue from corn (market price times yield)

*SCC* = cost of seeding corn (seed cost times seeding rate)

*CPC* = cost of planting corn

*NCC* = cost of N fertilization for corn-after-corn (N fertilizer cost times application rate)

*FA* = cost of applying N fertilizer based on application method

*PC* = cost of pesticides for corn-after-corn

*L* = total cost of labor (excluding harvesting)

*CR* = cash rental cost of the land

*HC* = cost of harvesting corn

*T* = cost of soil preparation (tillage).

For other cropping systems, users can repeat the above method for each crop in the rotation according to the number of years that that crop appears in the rotation sequence instead of multiplying by 10. Users would also use the appropriate percentage changes for corn yield and pesticide cost (i.e., corn planted after legumes has a percentage yield increase from continuous corn yields, and pesticide costs have a percentage decrease in extended rotations, such as in CSAAA). To find the equal annualized net revenue (*RA*) of the cropping system, users simply divide the *R* value calculated using the above equation by 10.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Table S1. Continuous corn cropping system input variables and their units, minimum, mean, and maximum values where applicable, data sources, and important notes. If the data source for an input variable reported one value, only a mean value is presented. The total net revenue values are given at the bottom of the table for one growing season. Min = minimum reported value; Max = maximum reported value. | | | | | | |
| Variable | Units | Min | Mean | Max | Source | Notes |
| Market price of  corn grain | $ kg-1 | 0.13 | 0.13 | 0.14 | NASS Quick Stats 2016-2018 | Price received, survey data |
| Assumed corn yield | kg ha-1 | 12302 | 12574 | 12742 | NASS Quick Stats 2016-2018 | Survey data |
| Estimated revenue  from corn | $ ha-1 | 1598.28 | 1668.26 | 1755.68 | - | Grain price times yield |
| Cost of seed for corn | $ seed-1 | - | 0.003538 | - | NASS Quick Stats 2014 | Price paid, survey data,  $283 per 80,000 kernels |
| Corn seeding rate | seeds ha-1 | - | 86487 | - | Iowa State University 2007 | Converted from optimal rate of  35,000 seeds per acre |
| Estimated cost for  seeding corn | $ ha-1 | - | 305.95 | - | - | Cost of seed times seeding rate |
| Cost of planting corn | $ ha-1 | 35.21 | 50.41 | 74.13 | Iowa Farm Custom Rate Survey 2019 | Method: drilling small grain |
| Cost of N fertilizer | $ kg-1 | 0.51 | 0.61 | 0.71 | USDA Market News: Iowa Production  Cost Report, IFBF Agriculture Analytics  and Research 2017 | Anhydrous ammonia; min: $0.23 lb-1 N,  max: $0.32 lb-1 N, 2017 |
| N fertilizer application  rate to corn-after-corn | kg ha-1 | 198 | 215 | 234 | Corn N Rate Calculator;  http://cnrc.agron.iastate.edu | Inputs: Iowa, market price of corn grain,  cost of N fertilizer, anhydrous ammonia,  corn-after-corn |
| Estimated cost of N  fertilizer for corn | $ ha-1 | 100.60 | 130.47 | 165.26 | - | Cost of N fertilizer times application rate;  one application per season |
| Cost of applying  fertilizer | $ ha-1 | 19.77 | 30.89 | 44.48 | Iowa Farm Custom Rate Survey 2019 | Assumed to include costs of operating  machinery and fuel but not materials;  one application per season |
| Cost of pesticides for  corn-after-corn | $ ha-1 | - | 195.46 | - | Estimated Costs of Crop Production in  Iowa 2019; Illinois Crop Budget 2019 | Combined herbicides, fungicides, and  pesticides; assumed to include fuel and  machinery costs; total application over season |
| Labor costs | $ ha-1 | 88.96 | 127.51 | 222.39 | Iowa Farm Custom Rate Survey 2019 | Not including harvesting |
| Cash rental cost of land | $ ha-1 | 570.81 | 574.11 | 580.70 | NASS Quick Stats 2016-2018 | Price paid, survey data |
| Cost of harvesting corn | $ ha-1 | 96.37 | 133.68 | 222.39 | Iowa Farm Custom Rate Survey 2019 | Complete harvesting, includes fuel and  labor costs |
| Cost of soil preparation | $ ha-1 | 24.71 | 38.05 | 55.30 | Iowa Farm Custom Rate Survey 2019 | Method: disk tilling, tandem; once per season |
| Total net cost of  corn-after-corn (one  growing season) | $ ha-1 | -267.79 | 81.74 | 317.85 | - | - |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Table S2. Corn-soybean rotation input variables and their units, minimum, mean, and maximum values where applicable, data sources, and important notes. If the data source for an input variable reported one value, only a mean value is presented. The total net revenue values are given at the bottom for each crop in the rotation. Min = minimum reported value; Max = maximum reported value. | | | | | | |
| Definition | Units | Min | Mean | Max | Source | Notes |
| Cost of seed for corn | $ seed-1 | - | 0.003538 | - | NASS Quick Stats 2014 | Price paid, survey data, $283 per 80,000 kernels |
| Corn seeding rate | seeds ha-1 | - | 86487 | - | Iowa State University 2007 | Converted from optimal rate of 35,000 seeds  per acre |
| Estimated cost for  seeding corn | $ ha-1 | - | 305.95 | - | - | Cost of seed times seeding rate |
| Cost of planting corn | $ ha-1 | 35.21 | 50.41 | 74.13 | Iowa Farm Custom Rate Survey 2019 | Method: drilling small grain |
| Cost of applying N  fertilizer | $ ha-1 | 19.77 | 30.89 | 44.48 | Iowa Farm Custom Rate Survey 2019 | Assumed to include costs of operating  machinery and fuel but not materials; one  application per season |
| Labor costs | $ ha-1 | 88.96 | 127.51 | 222.39 | Iowa Farm Custom Rate Survey 2019 | Not including harvesting |
| Cash rental cost of land | $ ha-1 | 570.81 | 574.11 | 580.70 | NASS Quick Stats 2016-2018 | Price paid, survey data |
| Cost of harvesting corn | $ ha-1 | 96.37 | 133.68 | 222.39 | Iowa Farm Custom Rate Survey 2019 | Complete harvesting, includes fuel and  labor costs |
| Cost of soil preparation | $ ha-1 | 24.71 | 38.05 | 55.30 | Iowa Farm Custom Rate Survey 2019 | Method: disk tilling, tandem; once per season |
| Market price of soybean  grain | $ kg-1 | 0.33 | 0.35 | 0.37 | NASS Quick Stats 2016-2018 | Price received, survey data |
| Assumed soybean yield | kg ha-1 | 3515 | 3619.60 | 3766 | NASS Quick Stats 2016-2018 | Survey data |
| Estimated revenue  from soybean | $ ha-1 | 1170.69 | 1284.85 | 1384.78 | - | Grain price times yield |
| Cost of seed for soybean | $ seed-1 | - | 0.0004786 | - | Michigan State University 2017 | $67 for 140,000 seeds |
| Soybean seeding rate | seeds ha-1 | - | 345947 | - | Iowa State University 2013 | Converted from optimal rate of 140,000  seeds per acre |
| Estimated cost for  seeding soybean | $ ha-1 | - | 165.56 | - | - | Cost of seed times seeding rate |
| Cost of planting soybean | $ ha-1 | 37.07 | 47.20 | 62.64 | Iowa Farm Custom Rate Survey 2019 | Method: drilling small grain |
| Cost of pesticides for  soybean | $ ha-1 | - | 109.79 | - | Estimated Costs of Crop Production in  Iowa 2019; Illinois Crop Budget 2019 | Combined herbicides, fungicides, and  pesticides; assumed to include fuel and  machinery costs; total application over season |
| Cost of harvesting  soybean | $ ha-1 | 86.49 | 127.38 | 210.04 | Iowa Farm Custom Rate Survey 2019 | Complete harvesting, includes fuel and  labor costs |
| Market price of corn  grain | $ kg-1 | 0.13 | 0.13 | 0.14 | NASS Quick Stats 2016-2018 | Price received, survey data |
| Assumed corn yield | kg ha-1 | 12302 | 12574 | 12742 | NASS Quick Stats 2016-2018 | Survey data |
| Percent yield increase  from previous crop | % | - | 0.045 | - | Liebman et al., 2008 | Average yield increase of 4.5% for corn  following legumes |
| Estimated revenue from  corn-after-soybean | $ ha-1 | 1670.20 | 1743.34 | 1834.69 | - | Grain price times yield |
| Cost of pesticides for  corn-after-soybean | $ ha-1 | - | 166.28 | - | Estimated Costs of Crop Production in  Iowa 2019; Illinois Crop Budget 2019 | Combined herbicides, fungicides, and  pesticides; assumed to include fuel and  machinery costs; total application over season |
| Cost of N fertilizer | $ kg-1 | 0.51 | 0.61 | 0.71 | USDA Market News: Iowa Production  Cost Report, IFBF Agriculture  Analytics and Research 2017 | Anhydrous ammonia; min: $0.23 lb-1 N, max: $0.32 lb-1 N, 2017 |
| N fertilizer application  rate to corn-after-  soybean | kg ha-1 | 145 | 160 | 176 | Corn N Rate Calculator;  http://cnrc.agron.iastate.edu | Inputs: Iowa, market price of corn grain, cost  of N fertilizer, anhydrous ammonia,  corn-after-soybean |
| Estimated cost of N  fertilizer for corn-after-  soybean | $ ha-1 | 73.32 | 97.17 | 124.15 | - | Cost of N fertilizer times application rate;  one application per season |
| Total net cost of corn-  after-soybean (one  growing season) | $ ha-1 | -125.57 | 219.29 | 453.31 | - | - |
| Total net cost of soybean  (one growing season) | $ ha-1 | -235.74 | 95.25 | 301.39 | - | - |

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| Table S3. Corn-soybean-alfalfa-alfalfa-alfalfa rotation input variables and their units, minimum, mean, and maximum values where applicable, data sources, and important notes. If the data source for an input variable reported one value, only a mean value is presented. The total net revenue values are given at the bottom for each crop in the rotation. Min = minimum reported value; Max = maximum reported value. | | | | | | |
| Definition | Units | Min | Mean | Max | Source | Notes |
| Cost of seed for corn | $ seed-1 | - | 0.003538 | - | NASS Quick Stats 2014 | Price paid, survey data, $283 per 80,000 kernels |
| Corn seeding rate | seeds ha-1 | - | 86487 | - | Iowa State University 2007 | Converted from optimal rate of 35,000 seeds per acre |
| Estimated cost for  seeding corn | $ ha-1 | - | 305.95 | - | - | Cost of seed times seeding rate |
| Cost of planting corn | $ ha-1 | 35.21 | 50.41 | 74.13 | Iowa Farm Custom Rate Survey 2019 | Method: drilling small grain |
| Cost of applying N  fertilizer | $ ha-1 | 19.77 | 30.89 | 44.48 | Iowa Farm Custom Rate Survey 2019 | Assumed to include costs of operating  machinery and fuel but not materials; one  application per season |
| Labor costs | $ ha-1 | 88.96 | 127.51 | 222.39 | Iowa Farm Custom Rate Survey 2019 | Not including harvesting |
| Cash rental cost of land | $ ha-1 | 570.81 | 574.11 | 580.70 | NASS Quick Stats 2016-2018 | Price paid, survey data |
| Cost of harvesting corn | $ ha-1 | 96.37 | 133.68 | 222.39 | Iowa Farm Custom Rate Survey 2019 | Complete harvesting, includes fuel and  labor costs |
| Cost of soil preparation | $ ha-1 | 24.71 | 38.05 | 55.30 | Iowa Farm Custom Rate Survey 2019 | Method: disk tilling, tandem; once per season |
| Market price of corn  grain | $ kg-1 | 0.13 | 0.13 | 0.14 | NASS Quick Stats 2016-2018 | Price received, survey data |
| Assumed yield of corn | kg ha-1 | 12302 | 12574 | 12742 | NASS Quick Stats 2016-2018 | Survey data |
| Percent yield increase  from previous crop | % | - | 0.045 | - | Liebman et al., 2008 | Average yield increase of 4.5% for corn  following legumes |
| Estimated revenue from  corn-after-soybean | $ ha-1 | 1670.20 | 1743.34 | 1834.69 | - | Grain price times yield |
| Cost of pesticides for  corn-after-soybean | $ ha-1 | - | 166.28 | - | Estimated Costs of Crop Production in  Iowa 2019; Illinois Crop Budget 2019 | Combined herbicides, fungicides, and  pesticides; assumed to include fuel and  machinery costs; total application over season |
| Cost of N fertilizer | $ kg-1 | 0.51 | 0.61 | 0.71 | USDA Market News: Iowa Production  Cost Report, IFBF Agriculture  Analytics and Research 2017 | Anhydrous ammonia; min: $0.23 lb-1 N,  max: $0.32 lb-1 N, 2017 |
| N fertilizer application  rate to corn-after-  soybean | kg ha-1 | 8097 | 8976 | 9855 | Corn N Rate Calculator;  http://cnrc.agron.iastate.edu | Inputs: Iowa, market price of corn grain, cost  of N fertilizer, anhydrous ammonia,  corn-after-soybean |
| Estimated cost of N  fertilizer for corn-after-  soybean | $ ha-1 | 73.32 | 97.17 | 124.15 | - | Cost of N fertilizer times application rate;  one application per season |
| Market price of soybean  grain | $ kg-1 | 0.33 | 0.35 | 0.37 | NASS Quick Stats 2016-2018 | Price received, survey data |
| Assumed yield of  soybean | kg ha-1 | 3515 | 3620 | 3766 | NASS Quick Stats 2016-2018 | Survey data |
| Estimated revenue from  soybean | $ ha-1 | 1170.69 | 1284.85 | 1384.78 | - | Grain price times yield |
| Cost of seed for soybean | $ seed-1 | - | 0.0004786 | - | Michigan State University 2017 | $67 for 140,000 seeds |
| Soybean seeding rate | seeds ha-1 | - | 345947 | - | Iowa State University 2013 | Converted from optimal rate of 140,000  seeds per acre |
| Estimated cost for  seeding soybean | $ ha-1 | - | 165.56 | - | - | Cost of seed times seeding rate |
| Cost of planting soybean | $ ha-1 | 37.07 | 47.20 | 62.64 | Iowa Farm Custom Rate Survey 2019 | Method: drilling small grain |
| Cost of pesticides for  soybean | $ ha-1 | - | 109.79 | - | Estimated Costs of Crop Production in  Iowa 2019; Illinois Crop Budget 2019 | Combined herbicides, fungicides, and  pesticides; assumed to include fuel and  machinery costs; total application over season |
| Cost of harvesting  soybean | $ ha-1 | 86.49 | 127.38 | 210.04 | Iowa Farm Custom Rate Survey 2019 | Complete harvesting, includes fuel and  labor costs |
| Estimated revenue from  corn-after-alfalfa | $ ha-1 | 1670.20 | 1743.34 | 1834.69 | - | Grain price times yield |
| Cost of pesticides for  corn-after-alfalfa | $ ha-1 | - | 41.05 | - | Liebman et al., 2008 | Average decrease in pesticide application  cost of 79% for corn-after-alfalfa |
| N fertilizer application  rate for corn-after-alfalfa | kg ha-1 | 0 | 17 | 34 | Iowa State University 2015 | For first year of corn after one year of alfalfa,  good stand |
| Estimated cost for N  fertilizer for corn-after-  alfalfa | $ ha-1 | 0.00 | 10.19 | 23.72 | - | Cost of N fertilizer times application rate;  one application per season |
| Market price of alfalfa  hay | $ Mg-1 | 98.11 | 121.62 | 144.40 | NASS Quick Stats 2016-2018 | Price received, survey data |
| Assumed yield of alfalfa | Mg ha-1 | 7.24 | 7.66 | 8.32 | NASS Quick Stats 2016-2018 | Survey data |
| Estimated revenue from  alfalfa | $ ha-1 | 710.35 | 931.52 | 1200.96 | - | Grain price times yield |
| Cost of pesticides for  alfalfa | $ ha-1 | - | 44.97 | - | Estimated Costs of Crop Production  in Iowa 2019 | Combined herbicides, fungicides, and  pesticides; assumed to include fuel and  machinery costs; total application over season |
| Cost of seed for alfalfa | $ kg-1 | 7.19 | 8.76 | 10.34 | NASS Quick Stats 2014 | Legume, alfalfa, public and common seed or  proprietary seed, price paid, National: $326  to $469 per cwt |
| Alfalfa seeding rate | kg ha-1 | 13.45 | 15.13 | 16.81 | Iowa State University 2004 | - |
| Estimated cost for  seeding alfalfa | $ ha-1 | 96.67 | 132.60 | 173.84 | - | Cost of seed times seeding rate |
| Cost of planting alfalfa | $ ha-1 | 32.12 | 45.34 | 60.86 | Iowa Farm Custom Rate Survey 2019 | Method: drilling small grain |
| Cost of harvesting  alfalfa | $ ha-1 | 158.15 | 205.84 | 247.11 | Iowa Farm Custom Rate Survey 2019 | Mowing/conditioning: $14|$15.30|$20 per acre;  haying baling, small square: $0.50|$0.68|$0.80  per bale; 5 ton hay per acre at 100 lb per bale;  assume one cutting per year; includes fuel  costs for equipment and labor costs |
| Total net revenue of  corn-after-soybean  (one growing season) | $ ha-1 | -125.57 | 219.29 | 453.31 | - | - |
| Total net revenue of  soybean (one growing  season) | $ ha-1 | -235.74 | 95.25 | 301.39 | - | - |
| Total net revenue of  alfalfa (one year) | $ ha-1 | -674.82 | -236.91 | 184.56 | - | - |
| Total net revenue of corn  (one growing season of  corn after three years  of alfalfa) | $ ha-1 | 100.08 | 431.50 | 651.86 | - | - |

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| Table S4. Corn-soybean-wheat input variables and their units, minimum, mean, and maximum values where applicable, data sources, and important notes. If the data source for an input variable reported one value, only a mean value is presented. The total net revenue values are given at the bottom for each crop in the rotation. Min = minimum reported value; Max = maximum reported value. | | | | | | |
| Definition | Units | Min | Mean | Max | Source | Notes |
| Market price of corn  grain | $ kg-1 | 0.13 | 0.13 | 0.14 | NASS Quick Stats 2016-2018 | Price received, survey data |
| Assumed corn yield | kg ha-1 | 12302 | 12574 | 12742 | NASS Quick Stats 2016-2018 | Survey data |
| Percent yield increase  from previous crop | % | - | 0.045 | - | Liebman et al., 2008 | Average yield increase of 4.5% for corn  following legumes |
| Estimated revenue from  corn-after-soybean | $ ha-1 | 1670.20 | 1743.34 | 1834.69 | - | Grain price times yield |
| Cost of seed for corn | $ seed-1 | - | 0.003538 | - | NASS Quick Stats 2014 | Price paid, survey data, $283 per 80,000 kernels |
| Corn seeding rate | seeds ha-1 | - | 86487 | - | Iowa State University 2007 | Converted from optimal rate of 35,000 seeds  per acre |
| Estimated cost for  seeding corn | $ ha-1 | - | 305.95 | - | - | Cost of seed times seeding rate |
| Cost of planting corn | $ ha-1 | 35.21 | 50.41 | 74.13 | Iowa Farm Custom Rate Survey 2019 | Method: drilling small grain |
| Cost of N fertilizer | $ kg-1 | 0.51 | 0.61 | 0.71 | USDA Market News: Iowa Production  Cost Report, IFBF Agriculture  Analytics and Research 2017 | Anhydrous ammonia; min: $0.23 lb-1 N,  max: $0.32 lb-1 N, 2017 |
| N fertilizer application  rate to corn following  soybean | kg ha-1 | 145 | 160 | 176 | Corn N Rate Calculator; http://cnrc.agron.iastate.edu | Inputs: Iowa, market price of corn grain, cost  of N fertilizer, anhydrous ammonia, corn-  after-soybean |
| Estimated cost of N  fertilizer for corn-after-  soybean | $ ha-1 | 73.32 | 97.17 | 124.15 | - | Cost of N fertilizer times application rate;  one application per season |
| Cost of applying N  fertilizer | $ ha-1 | 19.77 | 30.89 | 44.48 | Iowa Farm Custom Rate Survey 2019 | Assumed to include costs of operating  machinery and fuel but not materials; one  application per season |
| Cost of pesticides for  corn-after-soybean | $ ha-1 | - | 166.28 | - | Estimated Costs of Crop Production in  Iowa 2019; Illinois Crop Budget 2019 | Combined herbicides, fungicides, and  pesticides; assumed to include fuel and  machinery costs; total application over season |
| Labor costs | $ ha-1 | 88.96 | 127.51 | 222.39 | Iowa Farm Custom Rate Survey 2019 | Not including harvesting |
| Cash rental cost of land | $ ha-1 | 570.81 | 574.11 | 580.70 | NASS Quick Stats 2016-2018 | Price paid, survey data |
| Cost of harvesting corn | $ ha-1 | 96.37 | 133.68 | 222.39 | Iowa Farm Custom Rate Survey 2019 | Complete harvesting, includes fuel and  labor costs |
| Cost of soil preparation | $ ha-1 | 24.71 | 38.05 | 55.30 | Iowa Farm Custom Rate Survey 2019 | Method: disk tilling, tandem; once per season |
| Estimated revenue from  corn-after-wheat | $ ha-1 | 1598.28 | 1668.26 | 1755.68 | - | Grain price times yield |
| N fertilizer application  rate to corn following  wheat | kg ha-1 | 198 | 215 | 234 | Corn N Rate Calculator;  http://cnrc.agron.iastate.edu | Inputs: Iowa, market price of corn grain, cost  of N fertilizer, anhydrous ammonia, corn-  after-corn |
| Estimated cost of N  fertilizer for corn-after-  wheat | $ ha-1 | 100.60 | 130.47 | 165.26 | - | Cost of N fertilizer times application rate;  one application per season |
| Cost of pesticides for  corn-after-wheat | $ ha-1 | - | 195.46 | - | Estimated Costs of Crop Production in  Iowa 2019; Illinois Crop Budget 2019 | Combined herbicides, fungicides, and  pesticides; assumed to include fuel and  machinery costs; total application over season |
| Market price of soybean  grain | $ kg-1 | 0.33 | 0.35 | 0.37 | NASS Quick Stats 2016-2018 | Price received, survey data |
| Assumed soybean yield | kg ha-1 | 3515 | 3620 | 3766 | NASS Quick Stats 2016-2018 | Survey data |
| Estimated revenue from  soybean | $ ha-1 | 1170.69 | 1284.85 | 1384.78 | - | Grain price times yield |
| Cost of seed for soybean | $ seed-1 | - | 0.0004786 | - | Michigan State University 2017 | $67 for 140,000 seeds |
| Soybean seeding rate | seeds ha-1 | - | 345947 | - | Iowa State University 2013 | Converted from optimal rate of 140,000 seeds  per acre |
| Estimated cost for  seeding soybean | $ ha-1 | - | 165.56 | - | - | Cost of seed times seeding rate |
| Cost of planting soybean | $ ha-1 | 37.07 | 47.20 | 62.64 | Iowa Farm Custom Rate Survey 2019 | Method: drilling small grain |
| Cost of pesticides for  soybean | $ ha-1 | - | 109.79 | - | Estimated Costs of Crop Production in  Iowa 2019; Illinois Crop Budget 2019 | Combined herbicides, fungicides, and  pesticides; assumed to include fuel and  machinery costs; total application over season |
| Cost of harvesting  soybean | $ ha-1 | 86.49 | 127.38 | 210.04 | Iowa Farm Custom Rate Survey 2019 | Complete harvesting, includes fuel and  labor costs |
| Market price of wheat | $ kg-1 | 0.14 | 0.16 | 0.19 | NASS Quick Stats 2016-2018 | Price received, survey data |
| Assumed wheat yield | kgs ha-1 | 3641 | 3954 | 4268 | NASS Quick Stats 2016-2018 | Survey data |
| Estimated revenue from  wheat | $s ha-1 | 518.82 | 636.72 | 798.15 | - | Grain price times yield |
| Cost of seed for wheat | $ kg-1 | - | 0.72 | - | NASS Quick Stats 2014 | Price paid, winter wheat |
| Wheat seeding rate | kg ha-1 | 105 | 112 | 119 | Illinois Agronomy Handbook, Chapter 4: Small Grains and Grain Sorghum, Nafziger, 2012 | 1.5 to 1.7 million seeds per acre; 1.5 million  seeds = 100 lbs |
| Estimated cost for  seeding wheat | $ ha-1 | 75.78 | 80.83 | 85.88 | - | Cost of seed times seeding rate |
| Wheat planting cost | $ ha-1 | 32.12 | 45.34 | 60.86 | Iowa Farm Custom Rate Survey 2019 | Method: drilling small grain |
| N fertilizer application  rate to wheat after  soybean | kg ha-1 | 45 | 106 | 168 | University of Minnesota 2019 | - |
| Estimated cost of N  fertilizer for wheat-  after-soybean | $ ha-1 | 22.73 | 64.56 | 118.61 | - | Cost of N fertilizer times application rate;  one application per season |
| Cost of pesticides for  wheat | $ ha-1 | - | 69.19 | - | Illinois Crop Budget 2019 | Combined herbicides, fungicides, and  pesticides; assumed to include fuel and  machinery costs; total application over season |
| Cost of harvesting wheat | $ ha-1 | 61.78 | 78.83 | 88.96 | 2019 Iowa Farm Custom Rate Survey | Small grain combining; includes fuel costs  for equipment and labor costs |
| Total net revenue of  corn-after-soybean  (one growing season) | $ ha-1 | -125.57 | 219.29 | 453.31 | - | - |
| Total net revenue of  soybean (one growing  season) | $ ha-1 | -235.74 | 95.25 | 301.39 | - | - |
| Total net revenue of  corn-after-wheat (one  growing season) | $ ha-1 | -267.79 | 81.74 | 317.85 | - | - |
| Total net revenue of  wheat (one growing  season) | $ ha-1 | -807.55 | -472.59 | -78.74 | - | - |

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| Table S5. Corn-oat-alfalfa-alfalfa-alfalfa input variables and their units, minimum, mean, and maximum values where applicable, data sources, and important notes. If the data source for an input variable reported one value, only a mean value is presented. The total net revenue values are given at the bottom for each crop in the rotation. Min = minimum reported value; Max = maximum reported value. | | | | | | |
| Definition | Units | Min | Mean | Max | Source | Notes |
| Market price of corn  grain | $ kg-1 | 0.13 | 0.13 | 0.14 | NASS Quick Stats 2016-2018 | Price received, survey data |
| Assumed corn yield | kg ha-1 | 12302 | 12574 | 12742 | NASS Quick Stats 2016-2018 | Survey data |
| Estimated revenue from  corn-after-soybean | $ ha-1 | 1670.20 | 1743.34 | 1834.69 | - | Grain price times yield |
| Cost of seed for corn | $ seed-1 | - | 0.003538 | - | NASS Quick Stats 2014 | Price paid, survey data, $283 per 80,000 kernels |
| Corn seeding rate | seeds ha-1 | - | 86487 | - | Iowa State University 2007 | Converted from optimal rate of 35,000 seeds  per acre |
| Estimated cost for  seeding corn | $ ha-1 | - | 305.95 | - | - | Cost of seed times seeding rate |
| Cost of planting corn | $ ha-1 | 35.21 | 50.41 | 74.13 | Iowa Farm Custom Rate Survey 2019 | Method: drilling small grain |
| Cost of N fertilizer | $ kg-1 | 0.51 | 0.61 | 0.71 | USDA Market News: Iowa Production  Cost Report, IFBF Agriculture  Analytics and Research 2017 | Anhydrous ammonia; min: $0.23 lb-1 N,  max: $0.32 lb-1 N, 2017 |
| N fertilizer application  rate to corn following  soybean | kg ha-1 | 145 | 160 | 176 | Corn N Rate Calculator;  http://cnrc.agron.iastate.edu | Inputs: Iowa, market price of corn grain, cost  of N fertilizer, anhydrous ammonia, corn-  after-soybean |
| Estimated cost of N  fertilizer for corn-after-  soybean | $ ha-1 | 73.32 | 97.17 | 124.15 | - | Cost of N fertilizer times application rate;  one application per season |
| Cost of applying N  fertilizer | $ ha-1 | 19.77 | 30.89 | 44.48 | Iowa Farm Custom Rate Survey 2019 | Assumed to include costs of operating  machinery and fuel but not materials; one  application per season |
| Cost of pesticides for  corn-after-soybean | $ ha-1 | - | 166.28 | - | Estimated Costs of Crop Production in  Iowa 2019; Illinois Crop Budget 2019 | Combined herbicides, fungicides, and  pesticides; assumed to include fuel and  machinery costs; total application over season |
| Labor costs | $ ha-1 | 88.96 | 127.51 | 222.39 | Iowa Farm Custom Rate Survey 2019 | Not including harvesting |
| Cash rental cost of land | $ ha-1 | 570.81 | 574.11 | 580.70 | NASS Quick Stats 2016-2018 | Price paid, survey data |
| Cost of harvesting corn | $ ha-1 | 96.37 | 133.68 | 222.39 | Iowa Farm Custom Rate Survey 2019 | Complete harvesting, includes fuel and  labor costs |
| Cost of soil preparation | $ ha-1 | 24.71 | 38.05 | 55.30 | Iowa Farm Custom Rate Survey 2019 | Method: disk tilling, tandem; once per season |
| Market price of oat | $ kg-1 | 0.10 | 0.10 | 0.12 | NASS Quick Stats 2016-2018 | Price received, survey data |
| Assumed oat yield | kg ha-1 | 3954 | 4519 | 4833 | NASS Quick Stats 2016-2018 | Survey data |
| Estimated revenue from  oat | $ ha-1 | 392.30 | 473.85 | 557.49 | - | Grain price times yield |
| Cost of seed for oat | $ kg-1 | - | 0.42 | - | NASS Quick Stats 2014 | Price paid, survey data |
| Oat seeding rate | kg ha-1 | 126 | 157 | 188 | Illinois Agronomy Handbook, Chapter 4:  Small Grains and Grain Sorghum,  Nafziger, 2012 | Converted from 64 to 96 lb per acre |
| Estimated cost for  seeding oat | $ ha-1 | 52.88 | 66.10 | 79.32 | - | Cost of seed times seeding rate |
| Cost of planting oat | $ ha-1 | 32.12 | 45.34 | 60.86 | Iowa Farm Custom Rate Survey 2019 | Method: drilling small grain |
| Cost of pesticides for oat | $ ha-1 | - | 44.97 | - | Estimated Costs of Crop Production  in Iowa 2019 | Combined herbicides, fungicides, and  pesticides; assumed to include fuel and  machinery costs; total application over season |
| N fertilizer application  rate to oat after corn | kg ha-1 | 34 | 84 | 135 | University of Minnesota 2019 | - |
| Estimated cost of N  fertilizer for oat after  corn | $ ha-1 | 17.05 | 50.97 | 94.89 | - | Cost of N fertilizer times application rate;  one application per season |
| Cost of harvesting oat | $ ha-1 | 61.78 | 78.83 | 88.96 | 2019 Iowa Farm Custom Rate Survey | Small grain combining; includes fuel costs  for equipment and labor costs |
| Percent yield increase  from previous crop | % | - | 0.045 | - | Liebman et al., 2008 | Average yield increase of 4.5% for corn  following legumes |
| Estimated revenue  from corn-after-alfalfa | $ ha-1 | 1670.20 | 1743.34 | 1834.69 | - | Grain price times yield |
| Cost of pesticides for  corn-after-alfalfa | $ ha-1 | - | 41.05 | - | Liebman et al., 2008 | Average decrease in pesticide application  cost of 79% for corn-after-alfalfa |
| N fertilizer application  rate to corn following  alfalfa | kg ha-1 | 0 | 17 | 34 | Iowa State University 2015 | For one year of alfalfa, good stand, for  first year of corn |
| Estimated cost of N  fertilizer for corn-after-  alfalfa | $ ha-1 | 0.00 | 10.19 | 23.72 | - | Cost of N fertilizer times application rate;  one application per season |
| Market price of alfalfa  hay | $ Mg-1 | 98.11 | 121.62 | 144.40 | NASS Quick Stats 2016-2018 | Price received, survey data |
| Assumed alfalfa yield | Mg ha-1 | 7.24 | 7.66 | 8.32 | NASS Quick Stats 2016-2018 | Survey data |
| Estimated revenue from  alfalfa | $ ha-1 | 710.35 | 931.52 | 1200.96 | - | Grain price times yield |
| Cost of pesticides for  alfalfa | $ ha-1 | - | 44.97 | - | Estimated Costs of Crop Production in Iowa 2019 | Combined herbicides, fungicides, and  pesticides; assumed to include fuel and  machinery costs; total application over season |
| Cost of seed for alfalfa | $ kg-1 | 7.19 | 8.76 | 10.34 | NASS Quick Stats 2014 | Legume, alfalfa, public and common seed or  proprietary seed, price paid, National: $326  to $469 per cwt |
| Alfalfa seeding rate | kg ha-1 | 13.45 | 15.13 | 16.81 | Iowa State University 2004 | - |
| Estimated cost for  seeding alfalfa | $ ha-1 | 96.67 | 132.60 | 173.84 | - | Cost of seed times seeding rate |
| Cost of planting alfalfa | $ ha-1 | 32.12 | 45.34 | 60.86 | Iowa Farm Custom Rate Survey 2019 | Method: drilling small grain |
| Cost of harvesting  alfalfa | $ ha-1 | 158.15 | 205.84 | 247.11 | Iowa Farm Custom Rate Survey 2019 | Mowing/conditioning: $14|$15.30|$20 per acre;  haying baling, small square: $0.50|$0.68|$0.80  per bale; 5 ton hay per acre at 100 lb per bale;  assume one cutting per year; includes fuel  costs for equipment and labor costs |
| Total net revenue of  corn-after-soybean  (one growing season) | $ ha-1 | -125.57 | 219.29 | 453.31 | - | - |
| Total net revenue of oat  (one growing season) | $ ha-1 | -879.57 | -582.92 | -355.56 | - | - |
| Total net revenue from  alfalfa (one growing  season) | $ ha-1 | -674.82 | -236.91 | 184.56 | - | - |
| Total net revenue of corn  (one growing season of  corn after three years  of alfalfa) | $ ha-1 | 100.08 | 431.50 | 651.86 | - | - |

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| Table S6. Alfalfa-alfalfa-alfalfa-corn-soybean-oat input variables and their units, minimum, mean, and maximum values where applicable, data sources, and important notes. If the data source for an input variable reported one value, only a mean value is presented. The total net revenue values are given at the bottom for each crop in the rotation. Min = minimum reported value; Max = maximum reported value. | | | | | | |
| Definition | Units | Min | Mean | Max | Source | Notes |
| Market price of corn  grain | $ kg-1 | 0.13 | 0.13 | 0.14 | NASS Quick Stats 2016-2018 | Price received, survey data |
| Assumed corn yield | kg ha-1 | 12302 | 12574 | 12742 | NASS Quick Stats 2016-2018 | Survey data |
| Percent yield increase  from previous crop | % | - | 0.045 | - | Liebman et al., 2008 | Average yield increase of 4.5% for corn  following legumes |
| Estimated revenue from  corn-after-alfalfa | $ ha-1 | 1670.20 | 1743.34 | 1834.69 | - | Grain price times yield |
| Cost of seed for corn | $ seed-1 | - | 0.003538 | - | NASS Quick Stats 2014 | Price paid, survey data, $283 per 80,000  kernels |
| Corn seeding rate | seeds ha-1 | - | 86487 | - | Iowa State University 2007 | Converted from optimal rate of 35,000 seeds  per acre |
| Estimated cost for  seeding corn | $ ha-1 | - | 305.95 | - | - | Cost of seed times seeding rate |
| Cost of planting corn | $ ha-1 | 35.21 | 50.41 | 74.13 | Iowa Farm Custom Rate Survey 2019 | Method: drilling small grain |
| Cost of N fertilizer | $ kg-1 | 0.51 | 0.61 | 0.71 | USDA Market News: Iowa Production  Cost Report, IFBF Agriculture  Analytics and Research 2017 | Anhydrous ammonia; min: $0.23 lb-1 N,  max: $0.323 lb-1 N, 2017 |
| N fertilizer application  rate to corn following  alfalfa | kg ha-1 | 0 | 17 | 34 | Iowa State University 2015 | For one year of alfalfa, good stand, for first  year of corn |
| Estimated cost of N  fertilizer for corn-after-  alfalfa | $ ha-1 | 0.00 | 10.19 | 23.72 | - | Cost of N fertilizer times application rate;  one application per season |
| Cost of applying N  fertilizer | $ ha-1 | 19.77 | 30.89 | 44.48 | Iowa Farm Custom Rate Survey 2019 | Assumed to include costs of operating  machinery and fuel but not materials; one  application per season |
| Cost of pesticides for  corn-after-alfalfa | $ ha-1 | - | 41.05 | - | Liebman et al., 2008 | Average decrease in pesticide application  cost of 79% for corn-after-alfalfa |
| Labor costs | $ ha-1 | 88.96 | 127.51 | 222.39 | Iowa Farm Custom Rate Survey 2019 | Not including harvesting |
| Cash rental cost of land | $ ha-1 | 570.81 | 574.11 | 580.70 | NASS Quick Stats 2016-2018 | Price paid, survey data |
| Cost of harvesting corn | $ ha-1 | 96.37 | 133.68 | 222.39 | Iowa Farm Custom Rate Survey 2019 | Complete harvesting, includes fuel and  labor costs |
| Cost of soil preparation | $ ha-1 | 24.71 | 38.05 | 55.30 | Iowa Farm Custom Rate Survey 2019 | Method: disk tilling, tandem; once per season |
| Market price of oat | $ kg-1 | 0.10 | 0.10 | 0.12 | NASS Quick Stats 2016-2018 | Price received, survey data |
| Assumed oat yield | kg ha-1 | 3954 | 4519 | 4833 | NASS Quick Stats 2016-2018 | Survey data |
| Estimated revenue  from oat | $ ha-1 | 392.30 | 473.85 | 557.49 | - | Grain price times yield |
| Cost of seed for oat | $ kg-1 | - | 0.42 | - | NASS Quick Stats 2014 | Price paid, survey data |
| Oat seeding rate | kg ha-1 | 126 | 157 | 188 | Illinois Agronomy Handbook, Chapter 4:  Small Grains and Grain Sorghum 2012 | Converted from 64 to 96 lb per acre |
| Estimated cost for  seeding oat | $ ha-1 | 52.88 | 66.10 | 79.32 | - | Cost of seed times seeding rate |
| Cost of planting oat | $ ha-1 | 32.12 | 45.34 | 60.86 | Iowa Farm Custom Rate Survey 2019 | Method: drilling small grain |
| Cost of pesticides for oat | $ ha-1 | - | 44.97 | - | Estimated Costs of Crop Production  in Iowa 2019 | Combined herbicides, fungicides, and  pesticides; assumed to include fuel and  machinery costs; total application over season |
| N fertilizer application  rate to oat after soybean | kg ha-1 | 0 | 39 | 90 | University of Minnesota 2019 | - |
| Estimated cost of N  fertilizer for oat after  soybean | $ ha-1 | 0.00 | 23.78 | 63.26 | - | Cost of N fertilizer times application rate;  one application per season |
| Cost of harvesting oat | $ ha-1 | 61.78 | 78.83 | 88.96 | 2019 Iowa Farm Custom Rate Survey | Small grain combining; includes fuel costs  for equipment and labor costs |
| Market price of soybean  grain | $ kg-1 | 0.33 | 0.35 | 0.37 | NASS Quick Stats 2016-2018 | Price received, survey data |
| Assumed soybean yield | kg ha-1 | 3515 | 3620 | 3766 | NASS Quick Stats 2016-2018 | Survey data |
| Estimated revenue from  soybean | $ ha-1 | 1170.69 | 1284.85 | 1384.78 | - | Grain price times yield |
| Cost of seed for soybean | $ seed-1 | - | 0.000479 | - | Michigan State University 2017 | $67 for 140,000 seeds |
| Soybean seeding rate | seeds ha-1 | - | 345947 | - | Iowa State University 2013 | Converted from optimal rate of 140,000  seeds per acre |
| Estimated cost for  seeding soybean | $ ha-1 | - | 165.56 | - | - | Cost of seed times seeding rate |
| Cost of planting soybean | $ ha-1 | 37.07 | 47.20 | 62.64 | Iowa Farm Custom Rate Survey 2019 | Method: drilling small grain |
| Cost of pesticides for  soybean | $ ha-1 | - | 109.79 | - | Estimated Costs of Crop Production in Iowa 2019; Illinois Crop Budget 2019 | Combined herbicides, fungicides, and  pesticides; assumed to include fuel and  machinery costs; total application over season |
| Cost of harvesting  soybean | $ ha-1 | 86.49 | 127.38 | 210.04 | Iowa Farm Custom Rate Survey 2019 | Complete harvesting, includes fuel and  labor costs |
| Market price of alfalfa  hay | $ Mg-1 | 98.11 | 121.62 | 144.40 | NASS Quick Stats 2016-2018 | Price received, survey data |
| Assumed alfalfa yield | Mg ha-1 | 7.24 | 7.66 | 8.32 | NASS Quick Stats 2016-2018 | Survey data |
| Estimated revenue from  alfalfa | $ ha-1 | 710.35 | 931.52 | 1200.96 | - | Grain price times yield |
| Cost of pesticides for  alfalfa | $ ha-1 | - | 44.97 | - | Estimated Costs of Crop Production  in Iowa 2019 | Combined herbicides, fungicides, and  pesticides; assumed to include fuel and  machinery costs; total application over season |
| Cost of seed for alfalfa | $ kg-1 | 7.19 | 8.76 | 10.34 | NASS Quick Stats 2014 | Legume, alfalfa, public and common seed  or proprietary seed, price paid, National:  $326 to $469 per cwt |
| Alfalfa seeding rate | kg ha-1 | 13.45 | 15.13 | 16.81 | Iowa State University 2004 | - |
| Estimated cost for  seeding alfalfa | $ ha-1 | 96.67 | 132.60 | 173.84 | - | Cost of seed times seeding rate |
| Cost of planting alfalfa | $ ha-1 | 32.12 | 45.34 | 60.86 | Iowa Farm Custom Rate Survey 2019 | Method: drilling small grain |
| Cost of harvesting  alfalfa | $ ha-1 | 158.15 | 205.84 | 247.11 | Iowa Farm Custom Rate Survey 2019 | Mowing/conditioning: $14|$15.30|$20 per  acre; haying baling - small square:  $0.50|$0.68|$0.80 per bale; 5 ton hay per acre  at 100 lb per bale; assume one cutting per  year; includes fuel costs for equipment  and labor costs |
| Total net revenue of corn  (one growing season of corn after three years  of alfalfa) | $ ha-1 | 100.08 | 431.50 | 651.86 | - | - |
| Total net revenue of oat  (one growing season of  oat after soybean) | $ ha-1 | -847.94 | -555.74 | -338.51 | - | - |
| Total net revenue from  alfalfa (one year) | $ ha-1 | -674.82 | -236.91 | 184.56 | - | - |
| Total net revenue of  soybean (one growing  season of soybean  after corn) | $ ha-1 | -235.74 | 95.25 | 301.39 | - | - |

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| Table S7. Continuous alfalfa input variables and their units, minimum, mean, and maximum values where applicable, data sources, and important notes. If the data source for an input variable reported one value, only a mean value is presented. The total net revenue values are given at the bottom for each crop in the rotation. Min = minimum reported value; Max = maximum reported value. | | | | | | |
| Definition | Units | Min | Mean | Max | Source | Notes |
| Labor costs | $ ha-1 | 88.96 | 127.51 | 222.39 | Iowa Farm Custom Rate Survey 2019 | Not including harvesting |
| Cash rental cost of land | $ ha-1 | 570.81 | 574.11 | 580.70 | NASS Quick Stats 2016-2018 | Price paid, survey data |
| Cost of soil preparation | $ ha-1 | 24.71 | 38.05 | 55.30 | Iowa Farm Custom Rate Survey 2019 | Method: disk tilling, tandem; once per season |
| Market price of alfalfa hay | $ Mg-1 | 98.11 | 121.62 | 144.40 | NASS Quick Stats 2016-2018 | Price received, survey data |
| Assumed alfalfa yield | Mg ha-1 | 7.24 | 7.66 | 8.32 | NASS Quick Stats 2016-2018 | Survey data |
| Estimated revenue from  alfalfa | $ ha-1 | 710.35 | 931.52 | 1200.96 | - | Grain price times yield |
| Cost of pesticides for  alfalfa | $ ha-1 | - | 44.97 | - | Estimated Costs of Crop Production  in Iowa 2019 | Combined herbicides, fungicides, and  pesticides; assumed to include fuel and  machinery costs; total application over season |
| Cost of seed for alfalfa | $ kg-1 | 7.19 | 8.76 | 10.34 | NASS Quick Stats 2014 | Legume, alfalfa, public and common seed or  proprietary seed, price paid, National: $326  to $469 per cwt |
| Alfalfa seeding rate | kg ha-1 | 13.45 | 15.13 | 16.81 | Iowa State University 2004 | - |
| Estimated cost for seeding  alfalfa | $ ha-1 | 96.67 | 132.60 | 173.84 | - | Cost of seed times seeding rate |
| Cost of planting alfalfa | $ ha-1 | 32.12 | 45.34 | 60.86 | Iowa Farm Custom Rate Survey 2019 | Method: drilling small grain |
| Cost of harvesting  alfalfa | $ ha-1 | 158.15 | 205.84 | 247.11 | Iowa Farm Custom Rate Survey 2019 | Mowing/conditioning: $14|$15.30|$20  per acre; haying baling - small square:  $0.50|$0.68|$0.80 per bale; 5 ton hay per  acre at 100 lb per bale; assume one cutting  per year; includes fuel costs for equipment  and labor costs |
| Total net revenue from  alfalfa (one year) | $ ha-1 | -674.82 | -236.91 | 184.56 | - | - |