The following supplement accompanies the article

Farmer beliefs about climate change and carbon sequestration incentives

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Supplement. Estimation details and additional discussion of results mentioned briefly in the main article.

Supplement 1. Summary of responses by tillage practice

Table S1 presents a summary of the number of responses and the percent of the sample for each of the responses pertaining to the number of no-till, conservation till, and conventional till area reported in total by the farmers. The survey separated farmland out by asking for the land area of each tillage type that was owned versus rented, as well as corn versus soybeans. The sample is representative of Indiana farmers, as it fairly closely matches recent data published by the National Agricultural Statistics Service. The Indiana State Department of Agriculture (2009) reports that in 2009 Indiana no-tilled 24% of all corn farmland planted (33% in this sample) and 64% of all soybean farmland planted (66% in this sample) (ISDAndiana 2009). It is worth noting that the total area farmed by survey respondentsin the survey was 206 794 ha (511 000 acres) when asking respondents, 'On July 1, 2010, how many total acres are in your farming operation?' However, summing across all categories of corn and soybeans, ~188 988 ha (467 000 acres) were reported (Table S1). The difference can be attributed to the fact that farmers may have included the area of other crops, besides corn and soybeans, together with marginal land in their farming operation when asked about total land area (e.g. wheat, hay, pasture, woodland, etc.) because of the question wording in the survey.

Table S1 does not convey the fact that individual farmers were found to use a combination of tillage practices on their operations, and the choice of tillage systems is likely determined by several factors, including the crop planted, physical characteristics of the land and other factors like field work opportunities that influence planting dates from year to year. To illustrate the combination of tillage practices used on a given farm operation, consider that 126 of the 181 respondents who reported that they have land in no-till soybeans report using conventional tillage practices on their corn farmland. Similarly, there were 41 total respondents who said they have land in no-till corn but zero no-till soybean land. In contrast to the majority of the 181 respondents who used no-till for soybeans and more intensive tillage techniques for their corn, 29

of the 41 'no-till corn farmers' reported no other corn land in conservation tillage or conventional tillage, and no land planted to soybean. This could reflect the conventional wisdom among many farmers that no-tilling soybeans is more feasible, but certainly reflects statewide and national data indicating that no-till soybeans are more prevalent than no-till corn (Indiana State Department of AgricultureISDA 2011, Horowitz et al. 2010). The survey only asks about land area and tillage practices for a single year, so for farmers who report all their land area in a single crop for 2010, we cannot be certain about the tillage practice or practices used for other crops in their rotation.

Table S1. Total land and number of respondents reporting different tillage techniques

	n	Corn (ha [acres])	%	n	Soybeans (ha [acres])	%
No-till						
Total[a]		**33 624 [83 087.71]**	**33.12**		**58 224 [143 874.29]**	**66.69**
Owned	213	12 689 [31 354.85]	12.5	325	21 693 [53 604.82]	24.85
Rented	160	20 935 [51 732.86]	20.62	253	36 531 [90 269.47]	41.84
Conservation till						
Total		**30 604 [75 625.73]**	**30.14**		**13 111 [32 396.88]**	**15.02**
Owned	152	13 366 [33 030.04]	13.16	97	5689 [14 057.21]	6.52
Rented	113	17 237 [42 595.69]	16.98	78	7422 [18 339.67]	8.5
Conservation till						
Total		**37 310 [92 196.50]**	**36.75**		**15 979 [39 484.40]**	**18.3**
Owned	201	16 395 [40 513.75]	16.15	118	6736 [16 644.30]	7.71
Rented	150	20 915 [51 682.75]	20.6	89	9243 [22 840.10]	10.59

[a]149 respondents were assumed to be practicing continuous no-till farming. This is the number of respondents who reported having both corn and soybeans employed in a no-till system and no other forms of tillage practices being used on their farm in 2010.

Supplement 2. Climate change scale internal consistency

Cronbach's Alpha (Cronbach 1951) is calculated using the – alpha … , item casewise – command in Stata (StataCorp 2009) using only those observations with a complete set of responses to all 8 questions that make up the scale being evaluated.

Table S2 reports Cronbach's Alpha for the entire scale, and for individual questions in the scale alpha values are interpreted as the reliability coefficient of the entire scale if the individual variable were removed from the scale (Hatcher 1994). The internal consistency of the entire set of questions is found to increase if either the 'natural' (item α =0.7847) or 'warming_will_help' (item α = 0.7819) questions were removed from the scale.

Table S2. Cronbach's Alpha calculated for climate change beliefs scale

Variable	**Item-test correlation**	**Alpha**
natural	0.4275	0.7847
anthropogenic[a]	0.707	0.7323
not_affect_farm	0.5363	0.7684
warming_will_help	0.3923	0.7819
invented	0.7913	0.7100
extreme[a]	0.6436	0.7444
media	0.7687	0.7161
policies	0.6488	0.7432
Test scale		0.7741

[a]Questions negatively correlated with other questions were reverse coded for calculation of Cronbach's Alpha

Supplement 3. Polychoric principal components analysis (PCA)

Table S3 reports the full results of the polychoric PCA of climate change beliefs. Factors one and two have eigenvalues greater than 1, while factor three is slightly below one. Based on the simple eigenvalue-one or Kaiser criterion (Kaiser 1960), only 2 factors or components would be retained. The third factor, however, is very close to one (eigenvalue = 0.941) and so it is retained in the interest of not being arbitrary in our analysis and interpretation.

Table S3. Polychoric PCA of climate change belief scale (implemented in Stata using the -polychoric- and – factormat … , pcf- commands together)

Factor	Eigenvalue	Proportion of Variance	Cumulative Variance
1	3.560	0.445	0.445
2	1.031	0.129	0.574
3	0.941	0.117	0.691
4	0.744	0.093	0.785
5	0.631	0.079	0.863
6	0.431	0.054	0.917
7	0.391	0.049	0.966
8	0.269	0.034	1.000

Variable loadings greater than 0.5 on an individual factor are marked with an asterisk in Table S4; interpretation of the rotated factor loadings in the main text (Fig. 1) is facilitated by plotting the loadings in the Factor1-Factor2 space. Consistent with the loading plot in Figure 1, the finding that the variable 'natural' loads alone on Factor 3 is evidence that there are likely only two true underlying factors present in our data, with three distinct groupings of the remaining variables.

Table S4. Oblique (oblimin) rotated factor loadings of climate change perceptions

Variable	Factor 1	Factor 2	Factor 3	Uniqueness
natural	0.0197	0.1181	0.8848 [a]	0.1786
anthropogenic	-0.8451 [a]	-0.0365	0.1761	0.3115
not_affect_farm	0.2007	0.6128 [a]	0.1158	0.4881
warming_will_help	-0.0409	0.857 [a]	0.0591	0.2720
invented	0.8153 [a]	0.0384	0.0884	0.2748
extreme	-0.7657 [a]	-0.1624	0.2731	0.3586
media	0.7876 [a]	-0.0298	0.2329	0.2480
policies	0.6672 [a]	-0.1691	0.3683	0.3360

[a]Factor loadings greater than 0.50

Supplement 4. Detailed ordered logit estimation results

The variables (see Table 2 in the main article) 'invented', 'media' and 'policies' all loaded together positively on Factor 1, and though the 'invented' model was not significant overall (Table S5), 'hectares' and having a bachelor's degree or higher level education ('bachelors+') were positively associated with the other 2 dependent variables. Indiana farmers in our sample who had 405 additional ha (1000 additional acres) of land were 3.2% more likely to strongly agree that the media is exaggerating the issue of climate change and 2.7% more likely to strongly agree they are more likely to be negatively impacted by policies to address climate change than by climate change itself. For these same 2 models, farmers with at least a bachelor's degree were 8.9 and 10.9% more likely to strongly agree, respectively, than those with only a high school diploma. Age was also found to have a significant negative relationship with agreement that the media is exaggerating climate change, though this effect was not practically significant.

The questions 'warming_will_help' and 'not_affect_farm' loaded together on Factor 2, and the results of the corresponding regression models are reported in Table S6. Consistent with the 'media' and 'policies' models, having a bachelor's or higher degree was estimated to increase the likelihood of believing that climate change will not affect how the respondent operates their farm, though the magnitude of the estimated marginal effect was >70% less than was found for the media and policies questions. Though statistically significant in the 'not_affect_farm' model, the estimated coefficient on age was too small to have an effect on this belief in practice. Farm size ('area') was significant but found to have the opposite sign compared to the previous models, such that having 405 additional ha (1000 additional acres) meant being 2.6% less likely to agree and 3.3% more likely to disagree that climate change will not affect how farmers operate their farms. Two variables that were not significant in the other models estimated were marginally significant for these two models. Owning all of the land farmed ('ownall'; $p = 0.062$) was found to increase the probability of believing that a general warming trend will help one's farming operation, and having no additional employment besides farming ('no_empl'; $p = 0.068$) was found to increase the probability of believing that climate change will not affect how farmers operate their farms.

The models 'anthropogenic' and 'extreme' that loaded together negatively on Factor 1 were found to be insignificant overall on the basis of the Likelihood Ratio χ^2 statistic ($p = 0.1345$ and $p = 0.3204$, respectively) reported in Table S7.

Note on interpretation of the ordered logit regressions

Tables S5–7 report the full results of the regressions of climate change scale questions on respondent demographics, according to the format recommended by Long (1997). Raw ordered regression coefficients β_k are interpreted as the unit change in the underlying latent variable y^* for a one unit increase in the explanatory variable x_k , holding all other variables constant. The y^*-standardized coefficients are β_k / Σ_{y^*}, where Σ_{y^*} is the unconditional standard deviation of the latent y^* and is interpreted as the standard deviation unit change in y^* for a one unit increase in x_k. The fully standardized coefficients β_k^s are the product of the y^*-standardized coefficients and Σ_k, the standard deviation of x_k , and are interpreted as the standard deviation unit increase in y^* expected from a standard deviation increase in x_k, holding all other variables constant. The average change in the marginal effect (ME) for continuous explanatory variables 'age' and 'area' are expressed in terms of the overall range of the data for that variable, and average MEs are reported for dummy variables 'ownall', 'north', 'central', 'no_empl', 'notcomplete' and 'bachelors+'. Variable descriptions not provided here are contained in Tables 1 and 2 in the main article.

Table S5 Ordered Logit estimation results for variables that load positively on Factor 1 from Polychoric PCA

Model (DEPENDENT VARIABLE from Table 1)	Explanatory Variable	Coefficient	y^* Standardized coefficient	Fully Standardized coefficient	Marginal Effects (ME)					
					Average Change: Δ Range or Δ ME	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
invented	age	0.00423	0.0023	0.0308	Δ Range: 0.0280	-0.0002	-0.0007	0.0000	0.0005	0.0005
	acres[a]	0.00013**	0.0001	0.0950	Δ Range: 0.2085	-0.0074	-0.0209	-0.0002	0.0141	0.0144
	ownall	0.00558	0.0031	0.0015	Δ ME: 0.0005	-0.0003	-0.0009	0.0000	0.0006	0.0006
n = 565	north[b]	0.23532	0.1286	0.0632	Δ ME: 0.0213	-0.0135	-0.0385	-0.0011	0.0260	0.0272
LR chi2(8) = 9.36	central[b]	0.19093	0.1044	0.0499	Δ ME: 0.0173	-0.0109	-0.0313	-0.0011	0.0211	0.0221
Prob > chi2 = 0.3130	no_empl	0.1293	0.0707	0.0353	Δ ME: 0.0116	-0.0076	-0.0213	-0.0001	0.0144	0.0146
LL = -837.21	notcomplete[c]	-0.34462	-0.1884	-0.0331	Δ ME: 0.0322	0.0232	0.0572	-0.0074	-0.0383	-0.0347
	bachelors+[c]	0.02684	0.0147	0.0068	Δ ME: 0.0024	-0.0016	-0.0044	-0.0001	0.0030	0.0031
media	age	-0.005	-0.0028	-0.037	Δ Range: 0.0332	0.0001	0.0004	0.0007	-0.0001	-0.0010
	acres[a]	0.0002**	0.0001	0.1188	Δ Range: 0.2516	-0.0023	-0.0117	-0.0214	0.0033	0.0322
	ownall	-0.0425	-0.0229	-0.0111	Δ ME: 0.0037	0.0006	0.0031	0.0056	-0.0009	-0.0084
n = 570	north[b]	0.263	0.1417	0.0696	Δ ME: 0.0228	-0.0037	-0.0187	-0.0346	0.0042	0.0528
LR chi2(8) = 24.79	central[b]	0.2997	0.1615	0.0772	Δ ME: 0.0258	-0.0042	-0.0210	-0.0394	0.0039	0.0606
Prob > chi2 = 0.0017	no_empl	-0.0858	-0.0462	-0.0231	Δ ME: 0.0075	0.0012	0.0062	0.0113	-0.0017	-0.0170
LL = -749.80	notcomplete[c]	-0.6971	-0.3756	-0.0657	Δ ME: 0.0663	0.0141	0.0645	0.0871	-0.0488	-0.1169
	bachelors+[c]	0.4319**	0.2328	0.1081	Δ ME: 0.0367	-0.0058	-0.0295	-0.0563	0.0030	0.0887
policies	age	-0.0181***	-0.0096	-0.1283	Δ Range: 0.1064	0.0003	0.0007	0.0028	-0.0003	-0.0035
	acres[a]	0.0001*	0.0001	0.1012	Δ Range: 0.23056	-0.0020	-0.0052	-0.0216	0.0020	0.0268
	ownall	-0.0751	-0.04	-0.0194	Δ ME: 0.0062	0.0011	0.0028	0.0117	-0.0012	-0.0144
n = 567	north[b]	0.308	0.1641	0.0805	Δ ME: 0.0251	-0.0042	-0.0112	-0.0473	0.0027	0.0601
LR chi2(8) = 35.35	central[b]	0.2089	0.1113	0.0533	Δ ME: 0.0170	-0.0029	-0.0076	-0.0321	0.0018	0.0408
Prob > chi2 = 0.0000	no_empl	0.2266	0.1208	0.0603	Δ ME: 0.0188	-0.0032	-0.0085	-0.0352	0.0035	0.0435
LL = -698.66	notcomplete[c]	-0.3244	-0.1729	-0.0303	Δ ME: 0.0284	0.0053	0.0138	0.0518	-0.0132	-0.0578
	bachelors+[c]	0.5403***	0.2879	0.1339	Δ ME: 0.0434	-0.0070	-0.0186	-0.0810	-0.0020	0.1086

*, **,*** denote 10%, 5% and ≤1% level of statistical significance, respectively

[a] Marginal effects for 'area' reported for a 405 ha (1000 acre) increase in the explanatory variable

[b] The base case for the 'north' and 'central' dummy variables is being located in the southern tier of counties in Indiana

[c] The base case for the 'notcomplete' and 'bachelors+' dummy variables for education is having a high school diploma

Table S6 Ordered Logit estimation results for variables that load on Factor 2 from Polychoric PCA

Model (DEPENDENT VARIABLE from Table 1)	Explanatory Variable	Coefficient	*y** Standardized coefficient	Fully Standardized coefficient	Marginal Effects (ME)					
					Average Change: Δ Range or Δ ME	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
warming_will_help	age	-0.00252	-0.0014	-0.0181	Δ Range: 0.0166	0.0001	0.0005	-0.0003	-0.0003	-2.07E-05
	acres[a]	0.0001	0.0000	0.0495	Δ Range: 0.0868	-0.0026	-0.0124	-0.0075	0.0069	0.0006
	ownall	0.3468*	0.1876	0.0909	Δ ME: 0.0304	-0.0128	-0.0631	0.0360	0.0369	0.0030
n = 568	north[b]	0.6633***	0.3588	0.1759	Δ ME: 0.0574	-0.0242	-0.1192	0.0656	0.0720	0.0059
LR chi2(8) = 19.99	central[b]	0.1142	0.0617	0.0296	Δ ME: 0.0101	-0.0043	-0.0210	0.0124	0.0119	0.0010
Prob > chi2 = 0.0149	no_empl	0.0233	0.0126	0.0063	Δ ME: 0.0021	-0.0009	-0.0043	0.0026	0.0024	0.0002
LL = -633.03	notcomplete[c]	0.5912	0.3199	0.0561	Δ ME: 0.0471	-0.0177	-0.1000	0.0374	0.0738	0.0065
	bachelors+[c]	0.1886	0.1020	0.0474	Δ ME: 0.0166	-0.0070	-0.0344	0.0199	0.0199	0.0016
NOT_AFFECT_FARM	age	0.0149**	0.008	0.107	Δ Range: 0.1000	-0.0004	-0.0030	0.0002	0.0023	0.0009
	acres[a]	-0.0002**	-0.0001	-0.1207	Δ Range: 0.2374	0.0049	0.0329	-0.0021	-0.0260	-0.0096
	ownall	0.1866	0.1000	0.0485	Δ ME: 0.0169	-0.0054	-0.0369	0.0018	0.0295	0.0110
n = 570	north[b]	0.1697	0.0909	0.0446	Δ ME: 0.0154	-0.0049	-0.0336	0.0018	0.0268	0.0100
LR chi2(8) = 31.05	central[b]	0.2138	0.1146	0.0549	Δ ME: 0.0193	-0.0061	-0.0422	0.0018	0.0338	0.0127
Prob > chi2 = 0.0001	no_empl	0.3172*	0.1700	0.0849	Δ ME: 0.0290	-0.0095	-0.0630	0.0045	0.0497	0.0182
LL = -766.58	notcomplete[c]	-0.138	-0.0740	-0.0133	Δ ME: 0.0128	0.0043	0.0277	-0.0031	-0.0214	-0.0076
	bachelors+[c]	0.3808**	0.2041	0.095	Δ ME: 0.0339	-0.0106	-0.0743	0.0009	0.0604	0.0235

*, **,*** denote 10%, 5% and ≤1% level of statistical significance, respectively

[a] Marginal effects for acres reported for a 1000 acre increase in the explanatory variable

[b] The base case for the north and central dummy variables is being located in the southern tier of counties in Indiana

[c] The base case for the notcomplete and bachelors+ dummy variables for education is having a high school diploma

Table S7. Ordered Logit estimation results for variables that load negatively on Factor 1 from polychoric PCA

Model (DEPENDENT VARIABLE from Table 1)	Explanatory Variable	Coefficient	*y** Standardized coefficient	Fully Standardized coefficient	Marginal Effects (ME)					
					Average Change: Δ Range or Δ ME	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
anthropogenic	age	0.00091	0.0005	0.0066	Δ Range: 0.0067	-0.0001	-0.0001	-0.0001	0.0002	0.0001
	area[a]	-0.00019***	-0.0001	-0.1420	Δ Range: 0.2806	0.0141	0.0201	0.0132	-0.0351	-0.0122
	ownall	-0.13526	-0.0737	-0.0357	Δ ME: 0.0133	0.0101	0.0143	0.0090	-0.0249	-0.0085
n=570	north[b]	-0.0025	-0.0014	-0.0007	Δ ME: 0.0002	0.0002	0.0003	0.0002	-0.0005	-0.0002
LR chi2(8) = 12.39	central[b]	-0.22473	-0.1224	-0.0586	Δ ME: 0.0221	0.0170	0.0238	0.0145	-0.0413	-0.0140
Prob > chi2 = 0.1345	no_empl	0.06479	0.0353	0.0176	Δ ME: 0.0064	-0.0048	-0.0068	-0.0044	0.0119	0.0041
LL = -797.06	notcomplete[c]	-0.09953	-0.0542	-0.0095	Δ ME: 0.009786	0.0076	0.0106	0.0062	-0.0184	-0.0061
	bachelors+[c]	-0.18277	-0.0995	-0.0463	Δ ME: 0.0180	0.0139	0.0194	0.0118	-0.0336	-0.0113
extreme	age	0.0066	0.0036	0.0480	Δ Range: 0.0482	-0.0003	-0.0006	-0.0007	0.0013	0.0003
	area[a]	-0.0001	0.0000	-0.0580	Δ Range: 0.1209	0.0034	0.0076	0.0083	-0.0155	-0.0038
	ownall	0.0437	0.0239	0.0116	Δ ME: 0.0043	-0.0019	-0.0042	-0.0047	0.0087	0.0021
n=568	north	0.0428	0.0234	0.0115	Δ ME: 0.0042	-0.0019	-0.0042	-0.0046	0.0085	0.0021
LR chi2(8) = 9.26	central	-0.1070	-0.0585	-0.0280	Δ ME: 0.0106	0.0048	0.0105	0.0112	-0.0214	-0.0051
Prob > chi2 = 0.3204	no_empl	-0.0980	-0.0535	-0.0267	Δ ME: 0.0097	0.0043	0.0095	0.0104	-0.0195	-0.0048
LL = -730.37	notcomplete[c]	-0.3939	-0.2152	-0.0367	Δ ME: 0.0380	0.0207	0.0420	0.0323	-0.0787	-0.0163
	bachelors+[c]	-0.34167**	-0.1867	-0.0869	Δ ME: 0.0336	0.0161	0.0344	0.0335	-0.0682	-0.0158

*, **,*** denote 10%, 5% and ≤1% level of statistical significance, respectively

[a] Marginal effects for 'area' reported for a 405 ha (1000 acre) increase in the explanatory variable

[b] The base case for the 'north and 'central' dummy variables is being located in the southern tier of counties in Indiana

[c] The base case for the 'notcomplete' and 'bachelors+' dummy variables for education is having a high school diploma

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