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# Greenhouse gas emissions mitigation and economic viability of sugar crops in China

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# Supplementary materials

**Table S1** Greenhouse gas emission factors for production and transportation of agricultural inputs in sugar crops production

| Parameters | Emission factor ($CO_{2\text{-eqv}}$) | Source |
|---|---|---|
| N fertilizer ($kg \cdot kg^{-1}$) | 1.53 | [1] |
| P fertilizer ($kg \cdot kg^{-1}$) | 1.63 | [1] |
| K fertilizer ($kg \cdot kg^{-1}$) | 0.65 | [1] |
| Pesticides ($kg \cdot kg^{-1}$) | 13.7 | [1] |
| Film ($kg \cdot kg^{-1}$) | 0.6 | [2] |
| Diesel ($kg \cdot kg^{-1}$) | 3.75 | [3] |
| Electricity from grid ($kg \cdot KW \cdot h^{-1}$) | 1.23 | [1] |

**Table S2** Relative N loss (ammonia loss, N leaching and $N_2O$ emissions) factors in sugarcane and sugar beet

| Crop | Regions | Ammonia loss (%) | N leaching (%) | $N_2O$ emissions (%) |
|---|---|---|---|---|
| Sugarcane | All related area | 19.3[a] | 22[b] | 1.21[4] |
| Sugar beet | Xinjiang | 0.670[5] | 0.675[6] | 0.77[7] |
| | Inner Mongolia | 0.318[8] | 0.675[6] | 0.77[7] |
| | Heilongjiang | 1.44[9] | 0.471[6] | 1.46[7] |
| | Mean | 0.809 | 0.607 | 1.00 |

Notes: [a, b]Data from unpublished results based on meta-analysis.

**Table S3** Yield and total cost in BAU (business-as-usual) and OC (optimized crop) scenarios

| Region | BAU | | OC | |
|---|---|---|---|---|
| | Yield ($t \cdot ha^{-1}$) | Total annual cost ($10^3$ $CNY \cdot ha^{-1}$) | Yield ($t \cdot ha^{-1}$) | Total annual cost ($10^3$ $CNY \cdot ha^{-1}$)[10] |
| Guangdong | 87.4 | 33.2 | 87.4 | 32.7 |
| Guangxi | 93.1 | 36.2 | 93.1 | 27.3 |
| Hainan | 73.1 | 28.3 | 73.1 | 20.6 |
| Yunnan | 68.2 | 28.4 | 68.2 | 18.3 |
| Xinjiang | 56.0 | 27.9 | 56.0 | 20.9 |
| Inner Mongolia | 62.6 | 25.4 | 62.6 | 16.8 |
| Heilongjiang | 90.0 | 17.2 | 90.0 | 17.1 |
| Average | 75.8 | 28.1 | 75.8 | 22.0 |

Note: The N fertilizer used was assumed to be urea due to its common use in China; the urea price was set with reference to urea trading website information[10].

**Table S4** Labor input and N rate for different provinces in BAU (business-as-usual) and OC (optimized crop) scenarios

| Region | BAU | | | OC | | |
|---|---|---|---|---|---|---|
| | N rate (kg·ha$^{-1}$) | Labor input (person-days ha$^{-1}$) | Diesel consumption (kg·ha$^{-1}$) | N rate (kg·ha$^{-1}$) | Labor input (person-days ha$^{-1}$) | Diesel consumption (kg·ha$^{-1}$)[5] |
| Guangdong | 474 | 137 | 24.8 | 240[11] | 137 | 24.8 |
| Guangxi | 470 | 204 | 28.4 | 270[11] | 137 | 40.5 |
| Hainan | 306 | 197 | 14.8 | 206[12,13] | 137 | 38.7 |
| Yunnan | 302 | 216 | 15.6 | 228[11] | 137 | 18.1 |
| Xinjiang | 303 | 109 | 45.0 | 150[14] | 74.9 | 54.4 |
| Inner Mongolia | 330 | 162 | 29.1 | 150[14] | 74.9 | 66.0 |
| Heilongjiang | 180 | 75 | 47.2 | 150[14] | 74.9 | 47.2 |

Notes: The increasing diesel consumption was calculated by the ratio of labor input to diesel consumption in each province over the last 5 years.

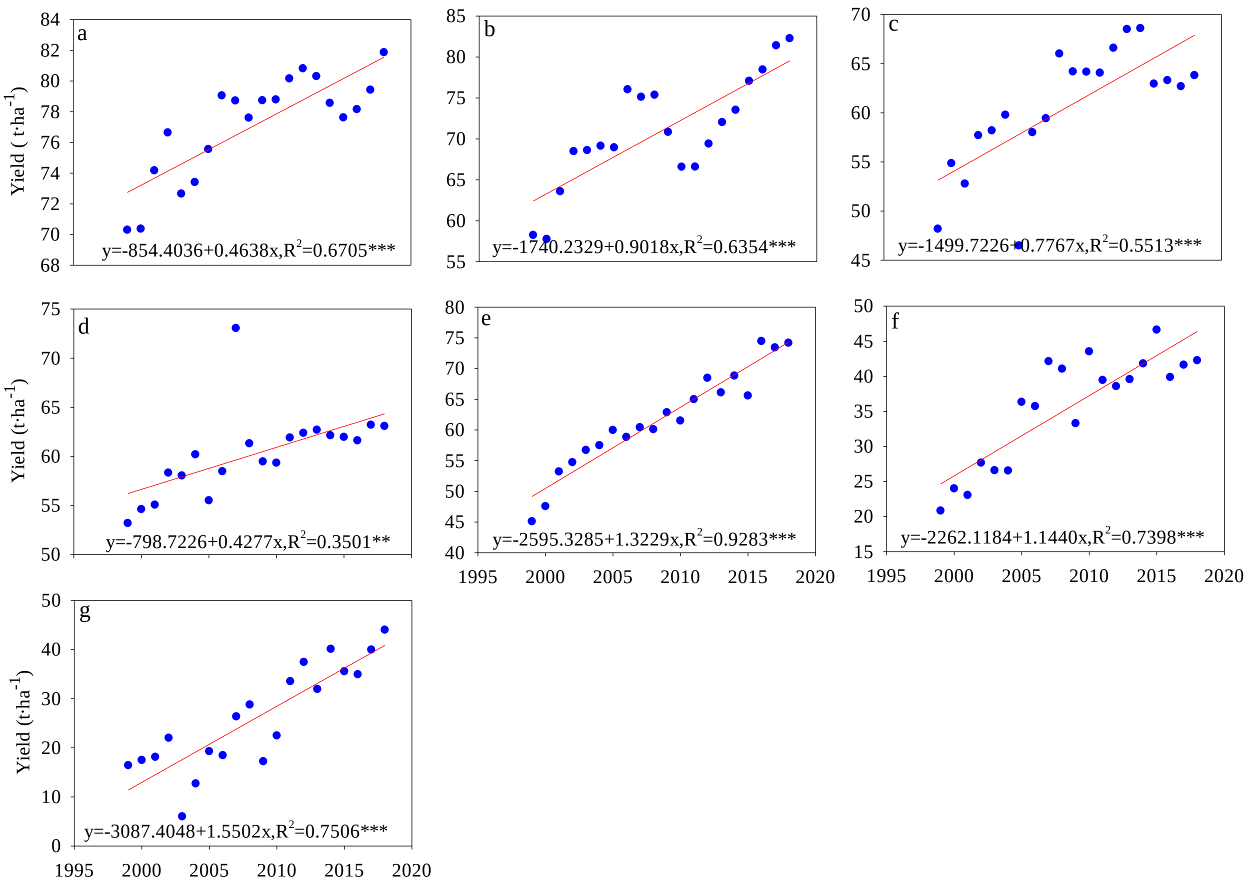


**Fig. S1** Change in yield of sugarcane in Guangdong (a), Guangxi (b), Hainan (c), and Yunnan (d), and sugar beet in Xinjiang (e), Inner Mongolia (f) and Heilongjiang (g) over the last 20 years. *, ** and *** indicate statistical significance at level $P < 0.05$, $P < 0.01$ and $P < 0.001$, respectively.

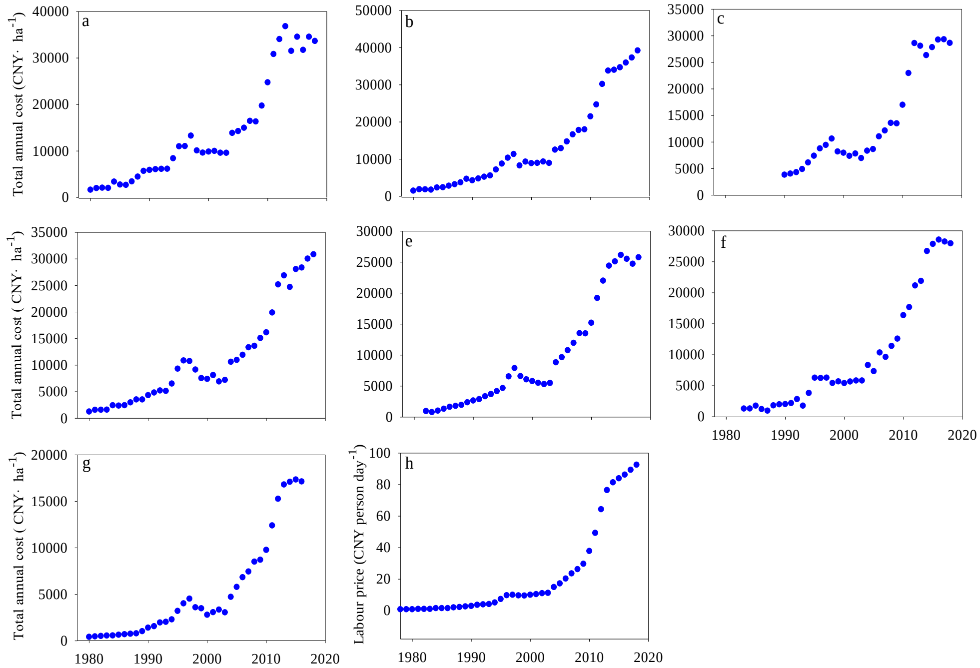


**Fig. S2** Total annual production cost and labor cost for sugarcane in Guangdong (a), Guangxi (b), Hainan (c) and Yunnan (d), and for sugar beet in Xinjiang (e), Inner Mongolia (f) and Heilongjiang (g) over the last 40 years.

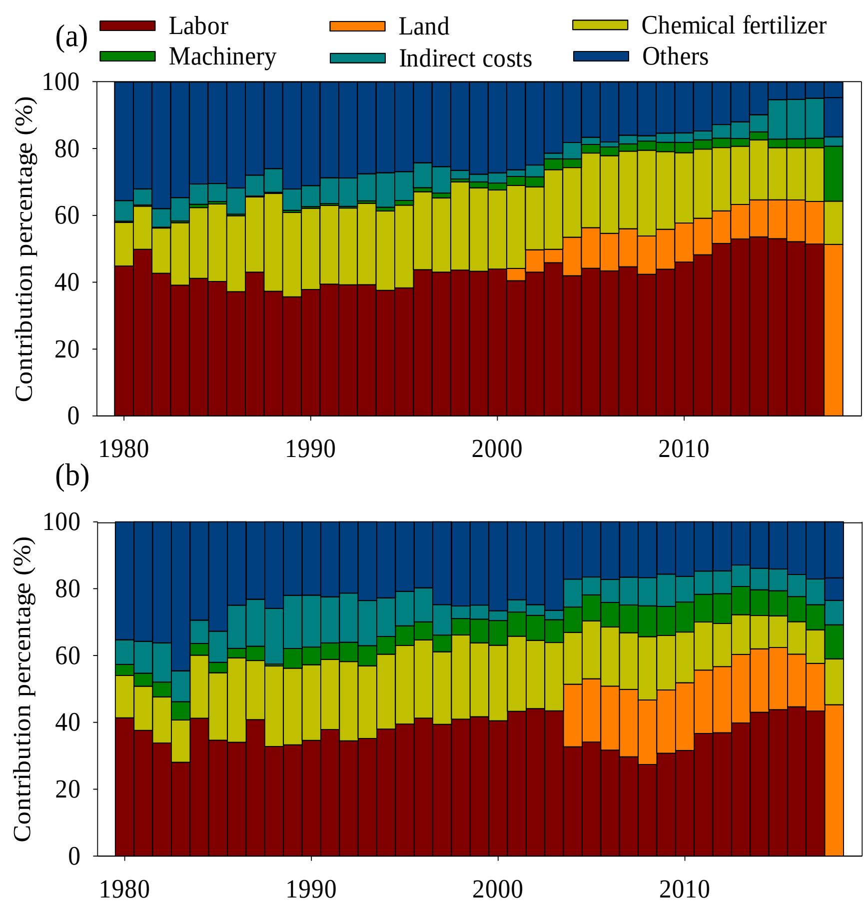


**Fig. S3** Contribution of inputs to total cost of sugarcane (a) and sugar beet (b) production in China during 1980–2018.

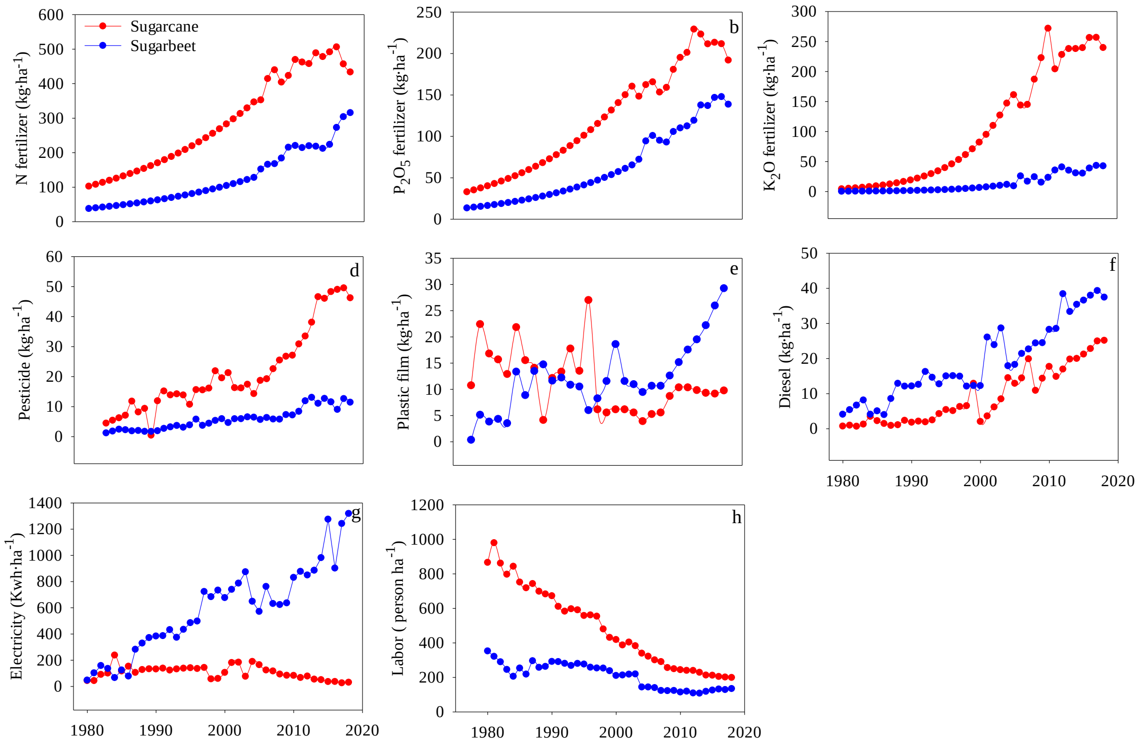


**Fig. S4** Change in input of N fertilizer (a), $P_2O_5$ fertilizer (b), $K_2O$ fertilizer (c), pesticide (d), plastic film (e), diesel (f), electricity (g) and labor (h) in sugarcane and sugar beet production in China from 1980 to 2018.

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