Table S1. Co-occurrence of production shocks with component shocks. The value "Y/N" indicates whether a production shock co-occurred with a component shock or not. "all" indicates that shocks occurred in all components in the same year, while "none" indicates that no shocks were detected for all components.

	harvestable fraction (HF)		planted area (PA)		yield		HF & PA		yield & PA		HF & yield		all		none	
production shock	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
barley	71	921	139	290	101	704	10	12	10	11	67	155	6	2	199	36389
corn	195	2775	509	2267	590	1263	75	98	77	20	435	249	24	5	627	80489
cotton	85	608	81	321	80	349	12	16	12	6	33	35	2	2	204	20643
sorghum	44	871	157	366	61	607	10	20	2	4	42	117	0	0	158	37058
soybeans	93	2630	390	1033	737	1475	41	53	54	12	175	258	10	2	632	67096
spring wheat	14	356	98	165	138	487	3	4	17	5	42	44	0	0	137	18786
winter wheat	283	2772	484	1156	241	1916	91	51	32	42	104	311	13	4	642	87275

Table S2. Results of Mann Kendall monotonic trend test for the changing relative contribution of the three components through time. Values measure the monotony of the slope in Figure 3. An asterisk indicates that the trend is statistically significant (P<0.01, two-sided; harvestable fraction of corn: $p < 0.001$; yield of cotton: $p = 0.009$).

	planted area	harvestable fraction	yield
barley	0.01	-0.07	-0.02
corn	-0.16	0.39 *	-0.05
cotton	0.13	0.17	-0.32 *
sorghum	-0.09	0.01	0.12
soybeans	-0.05	-0.19	0.06
spring wheat	0.15	0.00	-0.16
winter wheat	0.14	-0.02	-0.09

Table S3. Description of climate variables.

Indicator type	Variable name	Abbreviation	Description
Climate variability	Mean temperature	tmp	Mean monthly temperature during the growing season
	Mean precipitation	pre	Mean monthly precipitation during the growing season
Climate extremes	Max temperature	TXx	Maximum value of daily maximum temperature during the growing season
	Minimum temperature	TNn	Minimum value of daily minimum temperature during GS
	Warm day frequency	TX90p	Percentage of days during the growing season with daily maximum temperature above the 90th percentile
	Cold night frequency	TN10p	Percentage of days during the growing season with daily minimum temperature below the 10th percentile
	Maximum 5-day precipitation intensity	Rx5day	Maximum 5-day consecutive rainfall intensity during the growing season
	Diurnal temperature range	dtr	Mean diurnal temperature range during the growing season
	Frost day frequency	frs	Mean monthly frost day (daily minimum temperature <0°C) frequency during the growing season
	SPI-6	spi-6	Mean SPI-6 (standard precipitation index for 6-month time interval) during the growing season
	SPEI-6	spei-6	Mean SPEI-6 (standardized precipitation evapotranspiration index for 6-month time interval) during the growing season

Table S4. The top-ranked feature in the importance rank for each random forest model. The features for barley indicate the dominance of climate conditions for spring barley.

Component factors	Planted area of this year	Harvestable fraction	Yield	Harvested area	Planted area of the next year
barley	TN10p_spr	dtr_spr	TX90p_spr	TN10p_spr	TN10p_spr
corn	TX90p	TX90p	TX90p	TX90p	tmp
cotton	TX90p	TX90p	TX90p	tmp	tmp
sorghum	TNn	TX90p	TX90p	TX90p	TX90p
soybeans	tmp	TXx	TX90p	tmp	tmp
spring wheat	TN10p	tmp	TX90p	TX90p	tmp
winter wheat	tmp	tmp	tmp	TX90p	tmp

Table S5. Comparison of explained variance (R^2) for all agricultural factors of corn. To test the sensitivity of our results to potential uncertainty in planting and harvesting dates, Random Forest regressions were applied with a shift in growing period (GP) of +/-1 month. GP-1 represents shifting corn's planting/harvesting dates by 1 month, and GP+1 represents shifting corn's planting/harvesting dates by +1 month.

	GP	GP-1	GP+1
harvestable fraction	0.18	0.17	0.17
planted area of the next year	0.27	0.28	0.29
planted area	0.28	0.29	0.3
harvested area	0.26	0.27	0.28
yield	0.38	0.39	0.38

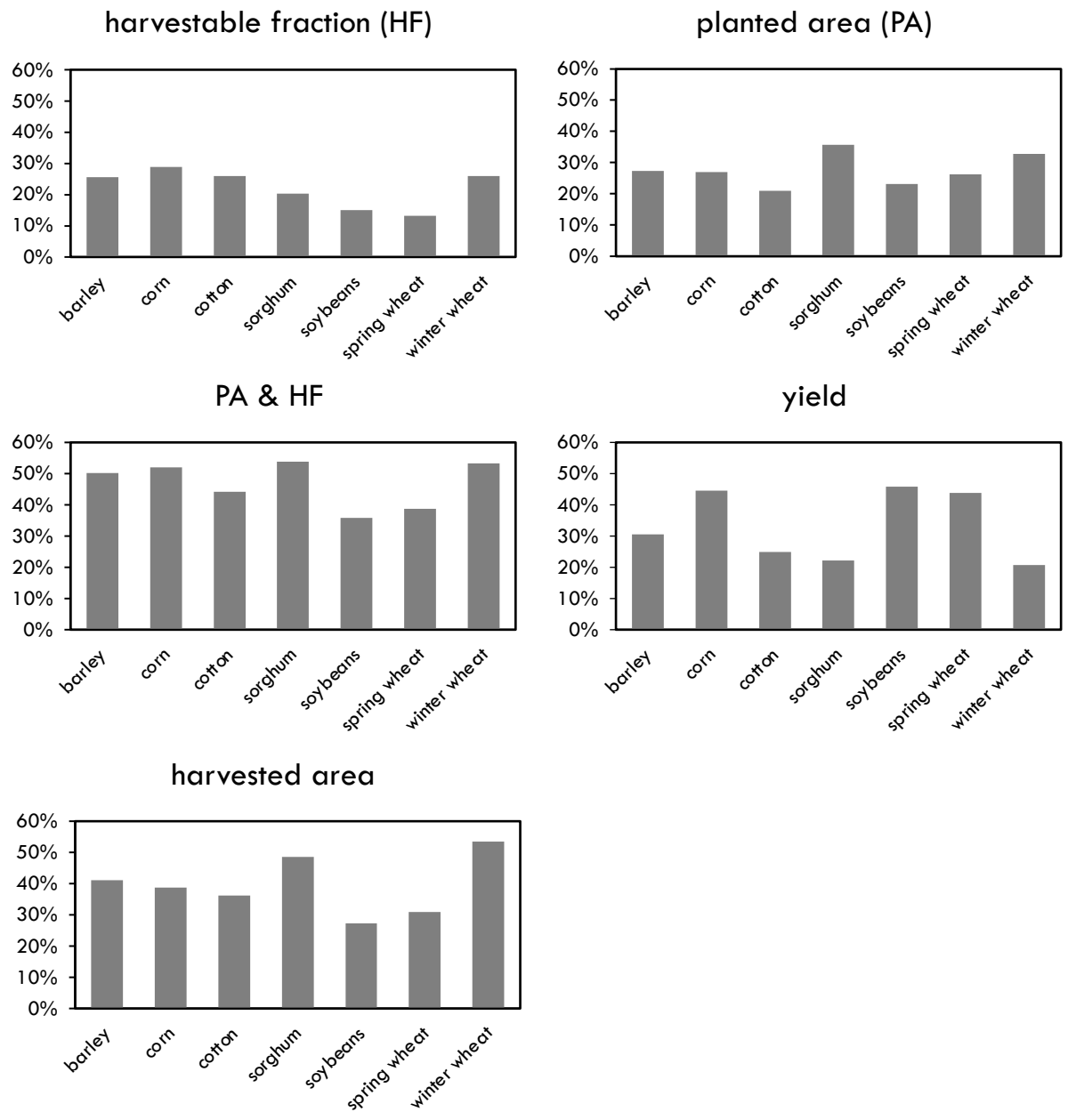


Fig. S1. Proportion of total production shocks co-occurring with the shocks in each individual component. "PA & HF" represents production shock co-occurrence with the area-related factors (i.e., planted area and harvestable fraction). The numbers can be lower than the sum of "planted area" and "harvestable fraction" as these two can co-occur. Note that the numbers in this plot differ slightly from those in Fig.2, as this figure represents the fraction of total production shocks, whereas Fig. 2 covers only the production shocks that have co-occurring shocks.

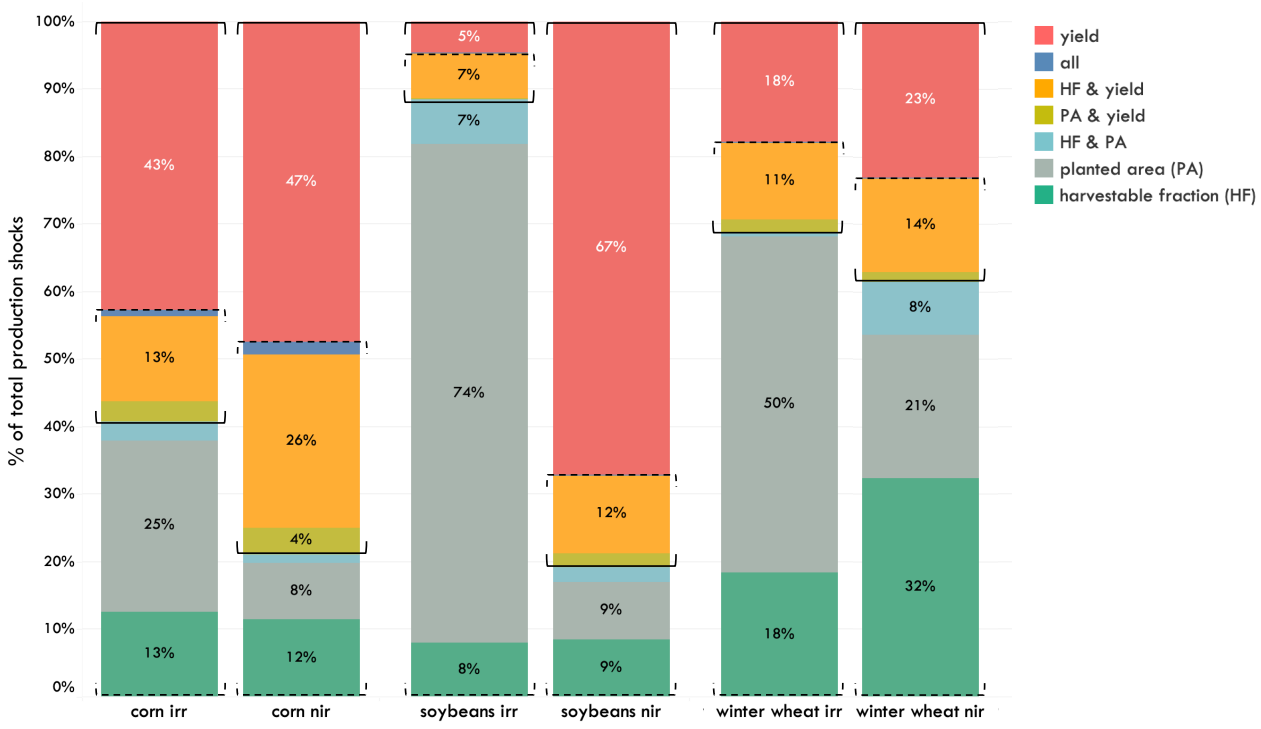


Fig. S2. Comparisons of the percentage of production shocks that coincide with their component shocks between irrigated and rain-fed conditions in corn, soybeans, and winter wheat. "irr" stands for irrigated condition, "nir" represents non-irrigated (i.e., rainfed) conditions. Shocks in multiple components could happen simultaneously. The solid brackets indicate yield-related shocks, and the dashed brackets include area-related shocks. The fraction of total detected production shocks that did not have co-occurring shocks with any of the three components are not shown in this figure.

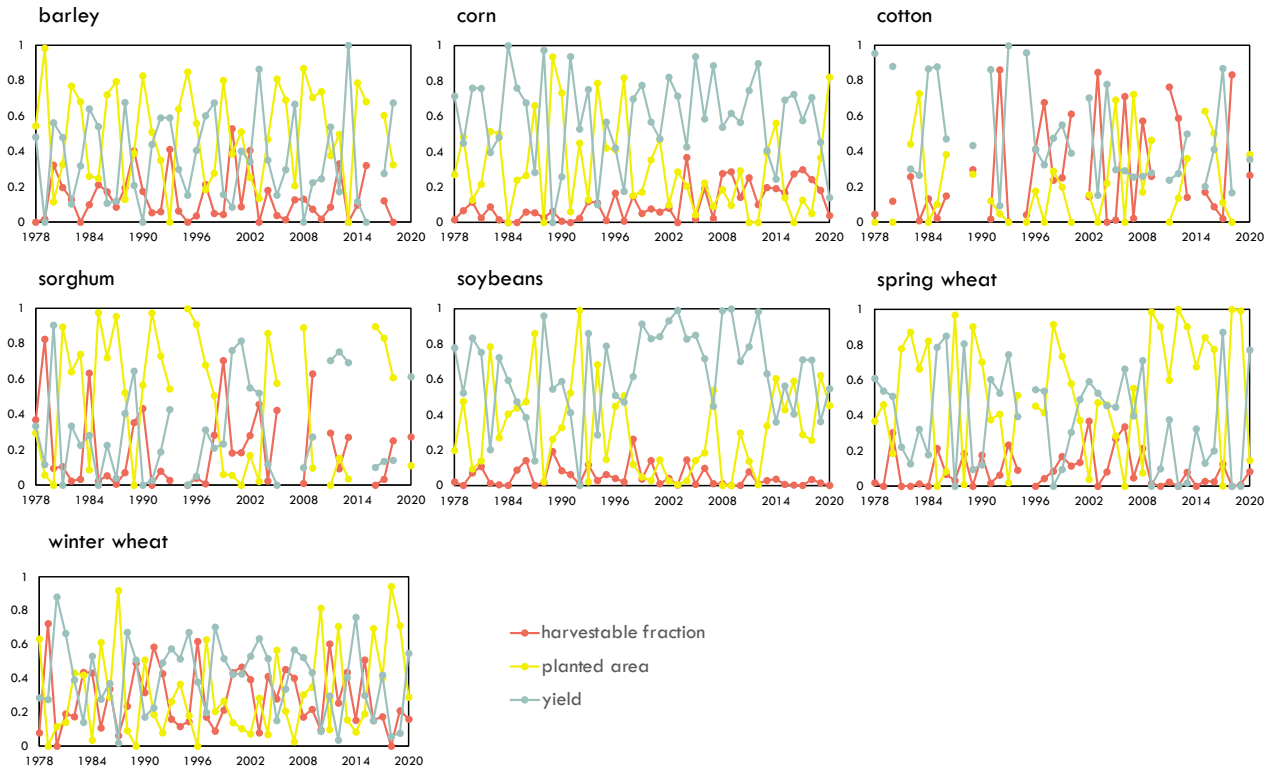


Fig. S3. Annual contribution from each component to shock-related production losses. This figure shows the line plot version of Fig. 2. The gap years (e.g., 1979 for cotton) mean that no production shock was detected across all counties for that crop in that year.

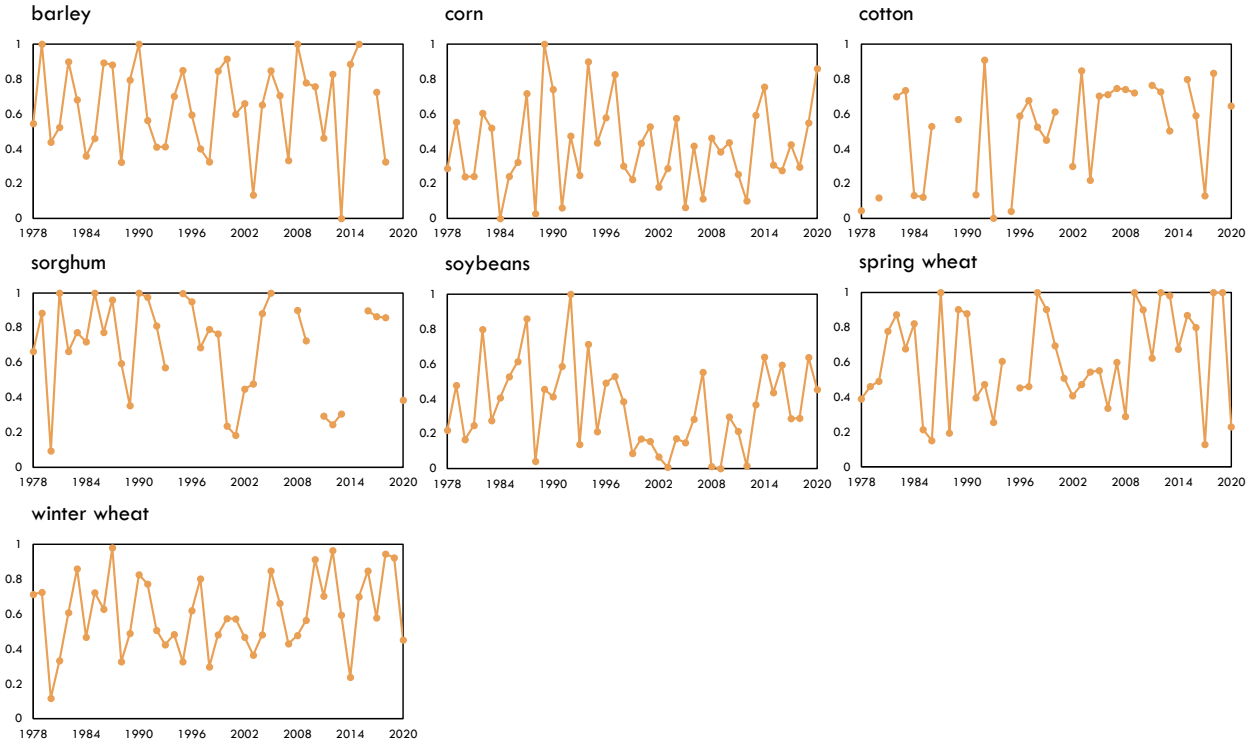


Fig. S4. Annual contribution of harvested area to shock-related production losses.

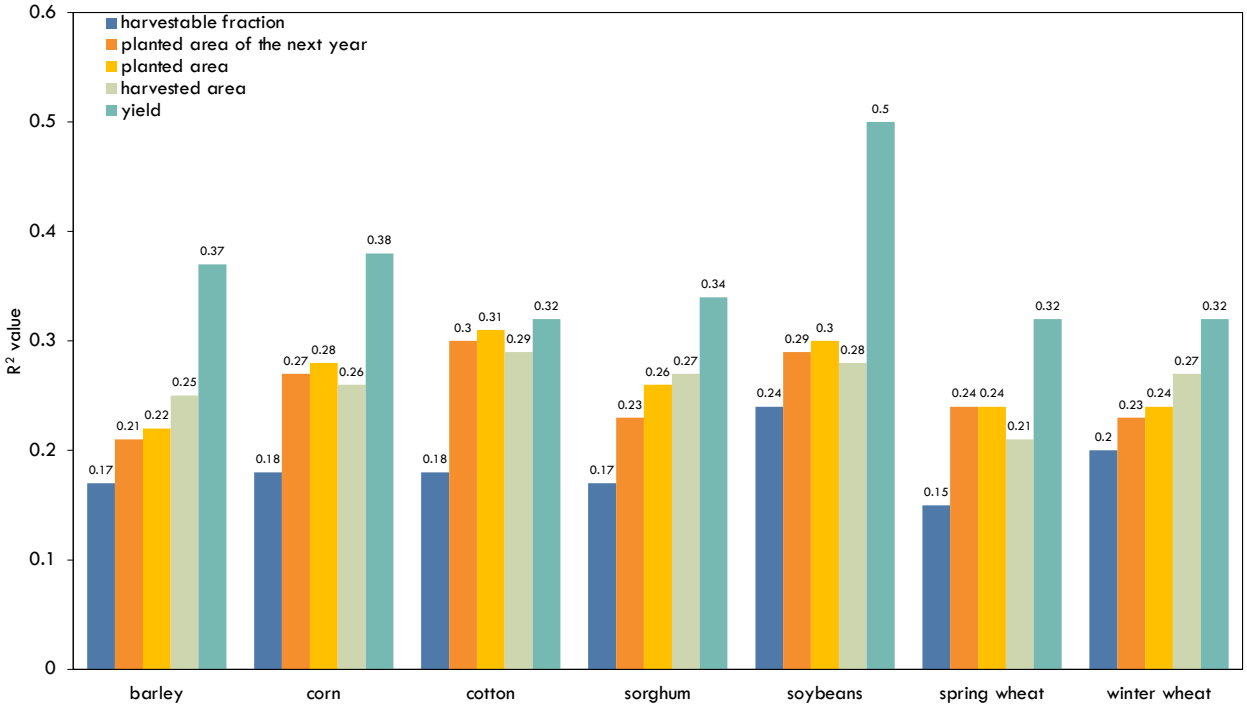
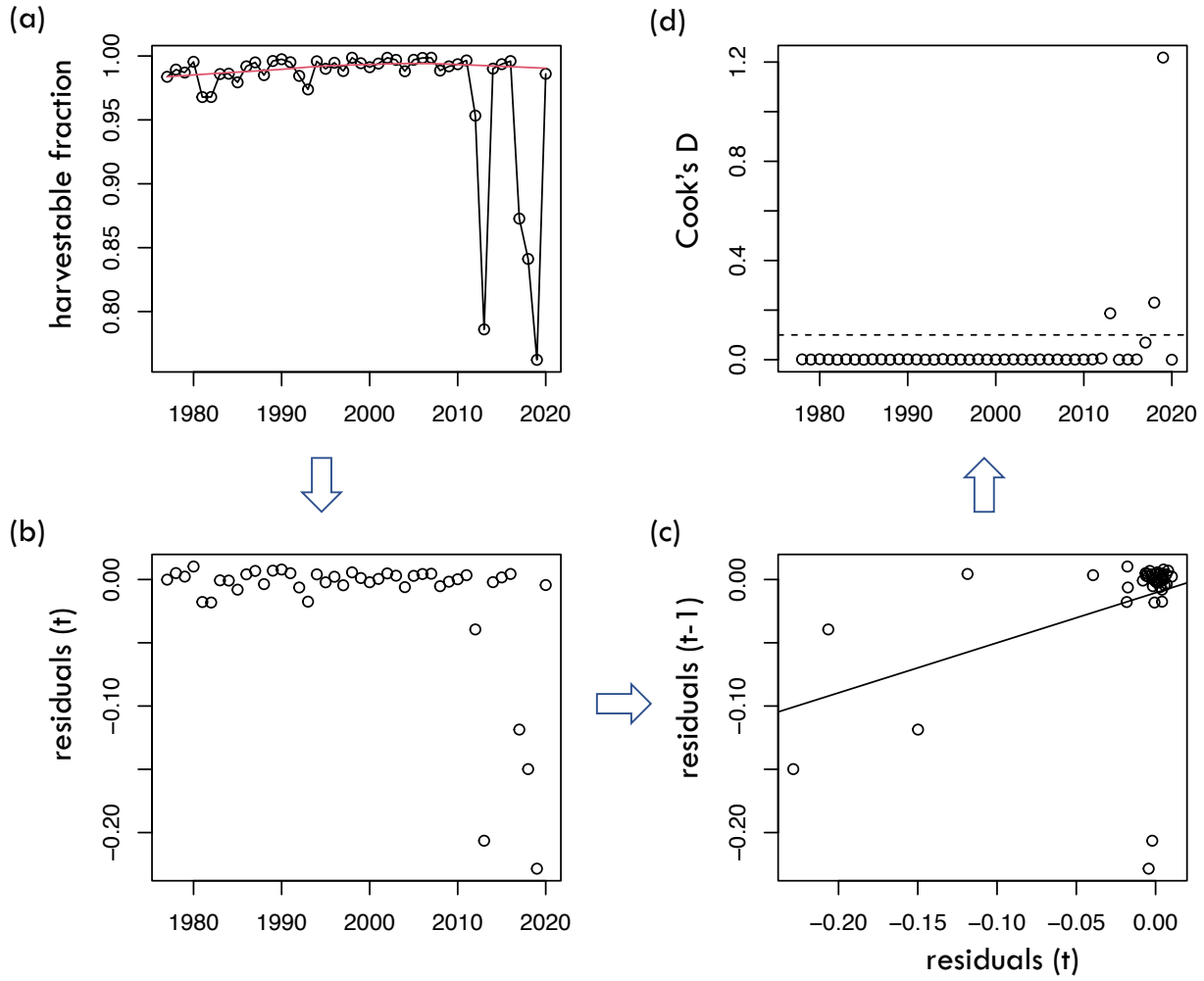


Fig. S5. Explained variance for all agricultural factors from Random Forest regressions.



63

64 **Fig. S6. An example of steps identifying harvestable fraction shocks for corn in Iowa**
65 **County in Wisconsin from 1978 to 2020.** The red line in (a) represents the *lowess*
66 smoothed line.
67

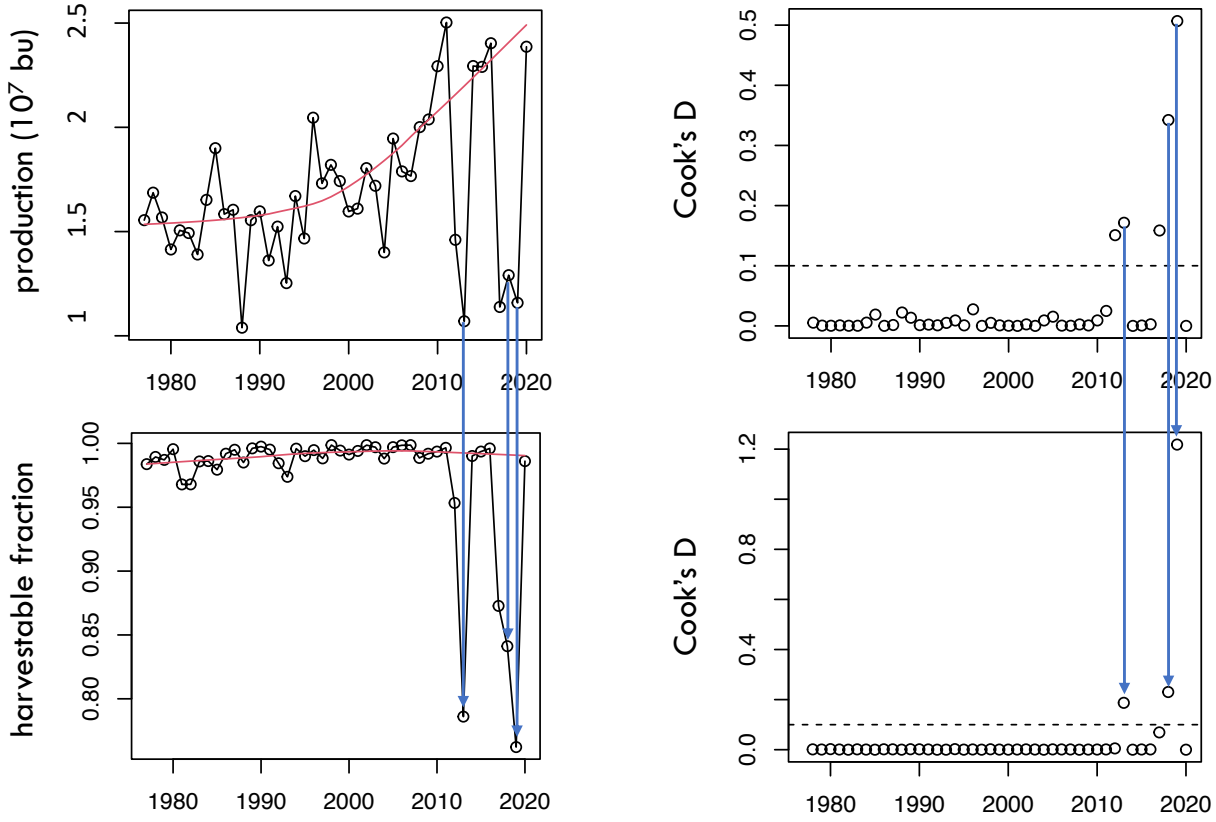


Fig. S7. An example of the process to identify shock co-occurrences for corn between production (upper panel) and harvestable fraction (lower panel) in Iowa County in Wisconsin. Downward blue arrows indicate the production shocks that coincide with harvestable fraction shocks.