

From metrics to insights: Evaluating cereal farming sustainability in Catalonia using composite index approach

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The authors are fully responsible for both the content and the formal aspects of the electronic supplementary material. No editorial adjustments were made.

Electronic supplementary material (ESM)

Supplementary Table S1

Supplementary Table S2

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Supplementary Figure S1

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Table S1. Indicator formulas

Name	Unit	Formula
Profitability (<i>PI</i>)	ratio	(total revenue per hectare – total operational cost per hectare)/total revenue per hectare
Benefit cost (<i>BC</i>)	ratio	total revenue per hectare/total cost per hectare
Land productivity (<i>LDP</i>)	EUR/ha	gross farm income/total land usage
Profit ratio (<i>PR</i>)	ratio	net farm income/total land usage
Remuneration of factors (<i>RF</i>)	EUR/ha	labour, land and capital costs/total land usage
Return to cost (<i>RTC</i>)	ratio	farm net value added/(farm net value added ± SV) SV = (value added/total input ± value added/total input of reference) × total input
Farm contribution to GDP (<i>FCG</i>)	%	gross farm income/agricultural GDP of region
Economic potential (<i>EPI</i>)	ratio	to refer to Sulewski & Kłoczko-Gajewska (2018)
Modernization (<i>MOD</i>)	ratio	machinery and equipment cost per hectare /labour cost per hectare
Subsidy ratio (<i>SUB</i>)	EUR/ha	total subsidy received/total land usage
Working balance (<i>WB</i>)	%	total hours of family work/8 736 h of one year life cycle
Risk management (<i>RMI</i>)	ratio	all other kinds of activities income/cereal income
Rural development (<i>RD</i>)	EUR/ha	rural development payment subsidy received/total land usage
Insurance ratio (<i>INS</i>)	EUR/ha	total insurance payment/total land usage
Agri-footprint (<i>AFI</i>)	ratio	to refer to Dabkiene et al. (2021)
Greenhouse gas emission (<i>GHG</i>)	kg CO ₂ eq./ha	to refer to Lynch et al. (2015)
Eco-efficiency (<i>EER</i>)	ratio	total output value/land, water and energy value
Shannon Weaver (<i>SH</i>)	ratio	relative number of functional crop groups cultivated in a farm
Energy ratio (<i>ER</i>)	EUR/ha	farm value added/total energy consumption
Fertilizer intensity (<i>FERT</i>)	EUR/ha	fertiliser consumption/total acreage
Pesticide intensity (<i>PEST</i>)	EUR/ha	crop protection/total acreage

Source: Authors' elaboration

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Table S2. Correlation results of 21 selected indicators

	PI	GHG	INS	SUB	MOD	FERT	PEST	BC	LDP	PR	RF	RTC	FCG	EPI	WB	RMI	RD	AFI	EER	SH	ER
PI	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GHG	0.02	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
INS	-0.18	-0.26	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SUB	0.04	0.18	-0.18	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOD	-0.15	-0.20	0.14	0.05	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FERT	0.06	0.40	-0.23	0.11	0.12	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PEST	-0.06	0.29	-0.18	0.09	-0.14	0.23	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BC	0.81	0.09	-0.15	0.03	-0.21	0.07	-0.04	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-
LDP	0.54	-0.31	0.15	-0.31	0.06	-0.06	-0.23	0.60	1.00	-	-	-	-	-	-	-	-	-	-	-	-
PR	0.44	0.29	-0.15	-0.34	0.01	0.39	0.14	0.44	0.49	1.00	-	-	-	-	-	-	-	-	-	-	-
RF	0.07	0.11	-0.01	-0.07	-0.15	-0.00	0.05	0.12	-0.04	0.00	1.00	-	-	-	-	-	-	-	-	-	-
RTC	-0.06	-0.02	0.14	0.10	0.14	0.02	-0.04	-0.04	0.01	0.09	-0.22	1.00	-	-	-	-	-	-	-	-	-
FCG	0.14	0.03	-0.03	-0.02	0.46	0.25	0.04	0.12	0.31	0.39	-0.01	-0.02	1.00	-	-	-	-	-	-	-	-
EPI	0.36	0.13	-0.10	0.12	0.24	0.26	-0.05	0.42	0.25	0.32	-0.14	0.07	0.55	1.00	-	-	-	-	-	-	-
WB	-0.11	0.17	-0.08	0.03	0.14	0.01	0.15	-0.09	-0.14	-0.09	-0.17	-0.10	0.02	0.14	1.00	-	-	-	-	-	-
RMI	-0.12	-0.21	0.07	-0.04	0.30	0.18	0.14	-0.15	0.06	0.08	-0.04	0.08	0.26	0.04	-0.01	1.00	-	-	-	-	-
RD	-0.21	0.01	0.26	-0.20	-0.04	0.12	-0.02	-0.19	-0.11	-0.00	0.00	0.04	-0.08	-0.06	-0.07	-0.03	1.00	-	-	-	-
AFI	-0.05	0.69	-0.37	0.21	-0.15	0.58	0.53	-0.05	-0.51	0.24	0.17	0.11	-0.04	-0.01	0.07	0.01	0.12	1.00	-	-	-
EER	0.27	-0.16	0.07	0.08	0.01	-0.08	-0.26	0.29	0.39	-0.05	-0.05	0.01	0.07	0.22	-0.05	-0.29	-0.11	-0.40	1.00	-	-
SH	-0.01	0.01	-0.00	-0.06	0.03	0.03	-0.09	0.02	0.06	0.09	-0.04	-0.02	0.19	0.18	0.11	0.00	0.04	-0.14	-0.07	1.00	-
ER	0.35	0.26	-0.11	-0.03	-0.07	0.12	0.01	0.42	0.32	0.39	-0.13	-0.01	0.11	0.43	0.18	-0.12	-0.09	0.04	0.24	-0.06	1.00

Source: Authors' elaboration

Table S3. Total variance explained by the balanced indicators set

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor 1	1.76	0.34	0.40	0.40
Factor 2	1.42	0.68	0.33	0.74
Factor 3	0.73	0.07	0.17	0.91

Source: Authors' elaboration

Table S4. Rotated factor matrix of the balanced set

Indicator	Factor 1	Factor 2	Factor 3
<i>PI</i>	0.046	0.687	0.154
<i>EPI</i>	0.090	0.317	0.551
<i>LDP</i>	−0.338	0.767	0.071
<i>SUB</i>	0.175	−0.166	0.111
<i>WB</i>	0.043	−0.165	0.322
<i>RMI</i>	0.064	0.003	0.455
<i>RD</i>	0.099	−0.131	−0.043
<i>INS</i>	−0.372	−0.059	−0.065
<i>AFI</i>	0.886	−0.194	0.005
<i>ER</i>	0.081	0.362	0.494
<i>FERT</i>	0.643	0.096	0.191
<i>PEST</i>	0.499	−0.095	−0.042

Source: Authors' elaboration

Table S5. Final weights of the indicators in the balanced set

Dimension	Indicator	Weight
Economic	profitability (<i>PI</i>)	0.11
	land productivity (<i>LDP</i>)	0.13
	economic potential (<i>EPI</i>)	0.09
	subsidy ratio (<i>SUB</i>)	0.03
	working balance (<i>WB</i>)	0.05
Social	risk management (<i>RMI</i>)	0.08
	rural development (<i>RD</i>)	0.02
	insurance ratio (<i>INS</i>)	0.06
Environmental	agri-footprint (<i>AFI</i>)	0.15
	energy ratio (<i>ER</i>)	0.08
	fertiliser intensity (<i>FERT</i>)	0.11
	pesticide intensity (<i>PEST</i>)	0.08
Total		1

Source: Authors' elaboration

<https://doi.org/10.17221/462/2024-AGRICECON>

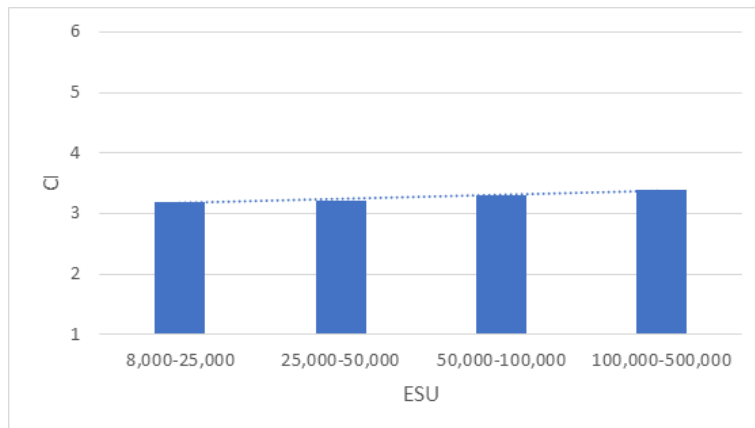


Figure S1. Average composite index (CI) for different economic sizes of sample farms in the balanced set

ESU – Economic size of holding expressed in 1000 euro of standard output.

Source: Authors' elaboration

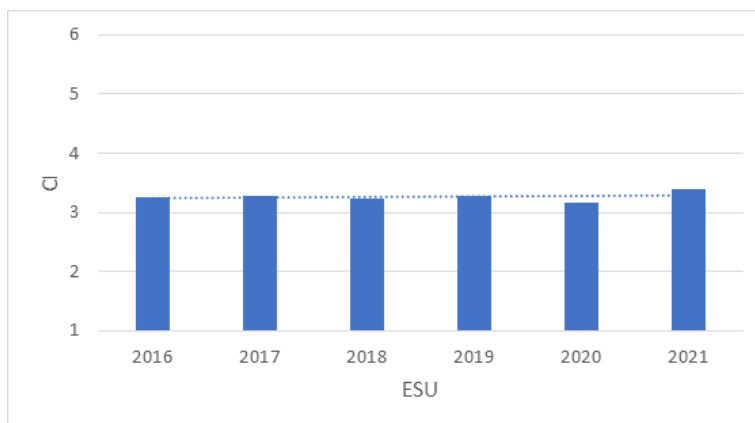


Figure S2. Average composite index (CI) over time in the balanced set

ESU – Economic size of holding expressed in 1000 euro of standard output.

Source: Authors' elaboration

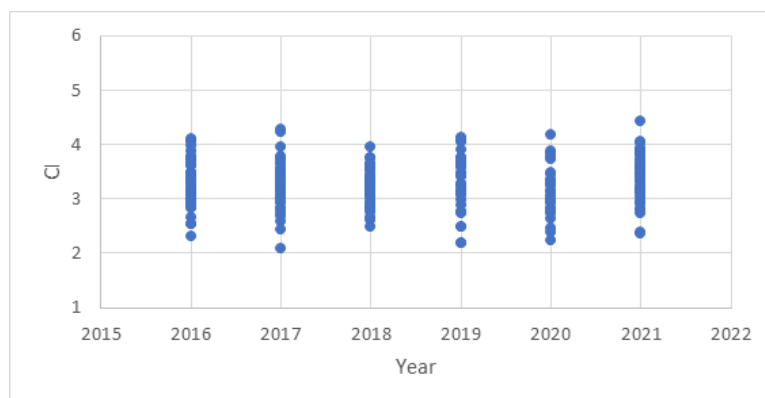


Figure S3. Distribution of composite index (CI) during sample time in the balanced set

Source: Authors' elaboration