S2_Table: Thematic Analysis of Grain Supply Chain Literature Focusing on Agents and Outcomes

Focus	Paper Type	Article Number	Objective Function	Method Used	Empirical Data	Level (S, T, O)	Stages of ASC	Beneficiary	#Echelons	Stakeholders									Type of risk / uncertainty	Risk management strategies and resilience in GSC						
										Farmers Type	Transporters	Storage Providers	Processors	Intermediaries	Retailers & Distributors	Customers / End [illegible]	Government & Regulator	Others		Robustness	Redundancy	Flexibility	Responsiveness	Adaptability	Collaboration & Coordination	Transparency
Cost Optimisation and Infrastructure Efficiency	M	84	↑ profit, ↓ post-harvest loss	Bi-level Robust Optimisation Model	✓	S, T, O	Prod, Dist, Inv	O	Three	F**			✓						Ops, Disrupt Y, Mkt, D	✓		✓		✓		
	M	115	↑ profit	MILP	✓	S, T, O	Prod, Dist, Inv	O	Multi	F			✓	✓		✓			Mkt D, Lo, Prod, $, Y			✓	✓		✓	✓
	M	89	↑ profit, ↓ disruption costs	Stochastic Mathematical Formulation, MILP	✓	O	Prod, Dist, Inv	O	Three	S		✓	✓			✓			D, S, Disrupt		✓	✓	✓			
	D	91	↑ farm profitability	LP, MIP	✓	S, T, O	Prod, Dist, Inv	F	One	F	✓	✓				✓			Y, Qual, Mkt, Lo, Ops		✓	✓				
	M	50	↑ farmer's harvest profit	Simulation, MILP	✓	T, O	Prod, Dist, Inv	F	Multi	F	✓	✓					✓		$, Y, Qual, Lo				✓	✓		
	M	69	↑ profit	MILP, Deterministic Time-Expanded Network Flow Model	✓	T, O	Dist, Inv, S&M	O	Multi	F	✓	✓	✓				✓		Ecol, Mkt, Fin		✓	✓			✓	
	D+ M	64	↑ profit	MAS Framework, ICA Framework		S, T	Prod, S&M	O, F	Two	P			✓	✓					Prod, Mkt, $, D, S, Y, Qual			✓	✓		✓	✓

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	M	57	↑ profit	Dynamic Programming Algorithm	✓	T, O	S&M	F	Multi	F						✓	✓					✓	✓				
	D+M	56	↑ total profit	Stochastic Optimisation Model	✓	S, T, O	BO	F	Three	F, S						✓			Mkt Y, $			✓		✓	✓	
	M	66	↑ profit, ↓ weather risk	Mathematical Model, Centralised & Decentralised Decision Model		S	BO	F	Two	F				✓					Environ, S, D	✓	✓	✓	✓		✓	
	M	103	↑ total profit	ABM		S, T	Dist, Inv	F	One	F, FG									Autonomy, Coordination, $, Cost, Prod		✓				+	
	M	114	↓ total cost	MINLP	✓	S, T	Prod, Dist, Inv	O	Three	F		✓					✓		D, S, Lo		✓	✓		✓		
	M	94	↓ total cost	Bi-level Optimisation Model	✓	T, O	Dist, Inv	F	Multi	S					✓				D S			✓		✓		
	M	49	↓ transport cost	MILP	✓	S, T	Dist, Inv	O, F	Three	F	✓	✓	✓						D, S, Cost, $, Lo			✓		✓		

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										Farmers Type	Transporters	Storage Providers	Processors	Intermediaries	Retailers & Distributors	Customers / End ...	Government & Regulator	Others		Robustness	Redundancy	Flexibility	Responsiveness	Adaptability	Collaboration & Coordination	Transparency
	M	88	↓ total cost	MILP	✓	S, T	Dist, Inv	F	Multi	F	✓	✓	✓						Lo, Qual Lo, S, Fin					✓	✓	✓
	M	113	↓ total cost	Mathematical Model	✓	S, T	Dist, Inv	O	Multi	✓	✓						✓		Prod, D, S, Info, Indiv, SC		✓	✓		✓	✓	
	M	93	↓ total cost	MINLP	✓	S, T, O	Dist, Inv	O, F	Two	F	✓	✓				✓	✓		D, S, Lo, $			✓	✓		✓	
	M	60	↓ transport cost	MINLP	✓	T, O	Dist, Inv	O	Two		✓	✓			✓				D, Lo, Disrupt	✓		✓				
	M	106	↓ transport cost	MILP	✓	O	Dist	F	Two	F	✓											✓	✓			✓
	M	118	↓ transport cost & overtime deliveries	Bi-objective Mathematical Model	✓	T, O	Dist	O	Two	P	✓					✓			Lo, D	✓		✓	✓	✓	+	
	M	53	↓ transport and storage cost	LIP	✓	S, O	Prod, Dist, Inv	O	Multi	P	✓	✓				✓			D, Lo	✓		✓	✓			
	M	59	↓ transport cost	Two-stage stochastic robust approach	✓	S	Prod, Dist, Inv	O, F	Multi	S	✓	✓	✓						D, S, Lo, Cost, Environ, Qual	✓		✓				
	D+ M	104	↓ transport cost deviations	Transport Model, Goal Programming Models	✓	S, O	Dist	O, F	Multi	F				✓			✓		Ops, Lo	✓		✓			✓	

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	M	54	↓ handling cost	Analytical Model, ABM	✓	S, O	Dist, Inv	F	Multi	F	✓	✓							Lo, Qual Environ			✓^		✓		
	M	71	↓ handling cost	ABM	✓	O	Dist, Inv	O	Multi	F		✓					✓		Qual				✓	✓		✓
	M	55	↓ handling cost	Hybrid Optimisation-Simulation Model	✓	O	Dist	F	Multi	F	✓	✓							Qual			✓	✓	✓		
	M	48	↓ delivery time	Declarative Model		O	Dist	O, F	Multi	P	✓				✓				D, Lo	✓		✓	✓	✓	✓	
	M	121	↓ total logistics cost	Dynamic Stochastic Simulation	✓	S, T	Dist	O	Two		✓			✓					Lo S, D		✓	✓		✓	✓	
	M	100	↓ logistic cost	EOQ, MILP	✓	T	Dist	O	Multi	F	✓	✓					✓	✓	Lo, Cost			✓			✓	
	M	92	↓ transport & logistics costs	TraNSIT Simulation	✓	S, T, O	Dist	O	Multi	E							✓♦	✓	Lo	✓					✓	
	D	95	↓ total travel distance and time	GIS based VRP, PSO		O	Dist	O			✓	✓							Lo			✓	✓	✓		
	D	96	↓ distribution cost	Goods Tracking Model, GIS based VRP		O	Dist	O			✓	✓							Lo, Qual, Disrupt			✓	✓			

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System Efficiency and Performance	M	83	↑ SC Efficiency& Profits, ↓ costs	Stochastic LP	✓	T		O	Three	P	✓		✓		✓	✓			Environ, Mkt	✓		✓	✓			
	M	122	↑ SC Efficiency, ↓ costs	TraNSIT Simulation	✓	S,T,O	Dist	O	Multi	E							✓♦	✓	Environ, Lo	✓					✓	
	M	70	↑ ASC Performance (↓delivery time, ↑quantity fill rate)	Coloured Petri Nets (CPNs), Simulation, Optimisation Model	✓	S, O	Prod, Dist, Inv	F	Multi	F, E					✓				D, Environ, Lo, Prod	✓						
	D	82	↑ ASC performance (↑ decision making, ↓ operational challenges)	MCDM, ISM	✓	S, T, O	Prod, Dist, Inv	O, F	Multi	F				✓		✓	✓		$, Inst, Lo, D, S			✓		✓	✓	✓
	M	112	↑ quality, safety & structural evolution	ABM		S	Prod, Dist	F	Two	F					✓				Qual				✓	✓		✓
	D	117	↑ product safety criteria in trade	MCDM	✓	S	Dist	O	Multi					✓			✓					✓		✓		
	M	67	↑ market understanding,	Econometric Analysis	✓	S, T, O	Dist	O	Two	P	✓					✓	✓		D, Environ,			✓	✓			

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										Farmers Type	Transporters	Storage Providers	Processors	Intermediaries	Retailers & Distributors	Customers / End ...	Government & Regulator	Others		Robustness	Redundancy	Flexibility	Responsiveness	Adaptability	Collaboration & Coordination	Transparency
			↓ risk & volatilities																Inst, Mkt, Lo, Pr							
	M	123	↑ system performance	Mesoscopic Model, Simulation		S, T, O	Prod, Dist	O	Multi	S			✓		✓	✓				✓	✓					
	D	65	↑ flexibility	CLP, MP		S, T, O	Dist, Inv	O	Multi	P			✓		✓				D, Lo, Qual, Disrupt		✓	✓			✓*	
	D	45	↑ ASC leagility	QFD, AHP	✓	S, T, O	Prod, Dist	O	Three	S			✓		✓	✓			D, S, Qual, Lo	✓		✓		✓##		
	D	125	↑Production, ↓ dependency	Mixed Method	✓	S, T	Prod, Inv, S&M	O,F	One	P						✓	✓	✓	S, $, Pol			✓	✓	✓	✓	
Sustainability	D	51	↓ Cost & CO2 emissions	bi-objective Decision Support Model	✓	S, T, O	Prod , Dist, BO	O	Multi		✓	✓					✓		Proc, D			✓		✓		
	D	81	↑ sustainability, ↓ risks	Mixed Method, fuzzy-DEMATEL approach	✓	S, T, O	Prod, Dist, Inv	O, F	Multi	F			✓	✓			✓		Environ, Infra, Ops, Lo, Tech Environ, D, S, Inst		✓	✓	✓		✓	

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										Farmers Type	Transporters	Storage Providers	Processors	Intermediaries	Retailers & Distributors	Customers / End	Government & Regulator	Others		Robustness	Redundancy	Flexibility	Responsiveness	Adaptability	Collaboration & Coordination	Transparency
	M	116	↑ sustainability	CSP, SD		S, T	Prod, Dist, S&M, BO, SocAcpt	O, F	Multi	P	✓	✓	✓		✓	✓	✓		Econ, Environ, Social Reg	✓		✓		✓	✓+	✓
	M	120	↑ sustainability, ↓ costs	MILP	✓	S	Prod, Dist	O, F	Three	F	✓	✓	✓						D, MKt, Environ, Social	✓		✓		✓		
	D	110	↑ sustainable ASC drivers, ↓ risks	IT2F DEMATEL-QFD model	✓	S, T, O	Prod, Dist, Inv	O	Multi	S						✓	✓	✓	Corruption, Lo, Environ, Qual Ops					✓	✓	✓
	M	119	↑sustainability	Multi objective MILP	✓	S, T	Prod, Dist	O, F	Two	S	✓		✓		✓	✓			Econ D, $, Ecol	✓		✓	✓	✓	✓+	
	D	62	↑ sustainable supply chain performance	Scenario-based Simulation, AHP, TOPSIS, MCDM	✓	S, T, O	Dist	O	Multi	S			✓		✓	✓			Disrupt S, D, Mkt, Environ				✓		✓	✓
Risk and	M	58	↓ transport cost & non resiliency	Hybrid Stochastic Fuzzy-Robust Optimisation Programming	✓	S, T, O	Dist	O, F	Multi	S		✓	✓			✓			D, S, Lo, Social, Cost	✓	✓	✓		✓		

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	M+ D	44	↓ export costs	DES	✓	S, T, O	Dist	O, F	Three	P	✓			✓			✓		Lo, Infra						✓	✓
	D	61	↓ operation costs, ↑ network resilience	Multi-echelon Supply Chain Network Simulation, MILP		S, T, O	Prod, Dist, Inv	O	Multi	F					✓	✓			Disrupt, D, S		✓	✓			✓	
	D	47	↑SC Resilience, ↓ shocks	Spatial Econometric & Statistical Methods	✓	S	Prod, Dist, Inv, BO	O, F	Multi	E	✓	✓	✓	✓			✓	✓	Environ, Disrupt Ecol, Pol	✓		✓			✓+	
	M	76	↑ network resilience	FMOLP	✓	S, T,O	Prod, Dist, Inv	O	Multi	E	✓	✓			✓		✓		Disrupt, Qual D	✓		✓	✓			
	D	86	↑ Agri-Food system resilience	Mixed Method	✓	S, T, O	Prod, Dist, Inv	O, F	Multi	F			✓		✓				Disrupt, D, Labour, Lo, Inst, Consumer		✓	✓	✓		✓	
	D	38	↑ASC Resilience, ↓ disruption impact	Dynamic Game Theory Model, Ecological Modelling Analogy		S, T, O	Dist	O	Multi	S			✓		✓	✓			Disrupt, Pandemic , Cyber-attack, Geo-pol, Lo		✓	✓^ ^				

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	D	78	↑SC Resilience, ↓ monopoly	Parameterisation, Monte-Carlo simulations		S	Prod, Dist, S&M	O, F	Multi	✓			✓	✓	✓	✓	✓	✓	Mkt, Pol, Disrupt Reg		✓	✓	✓		✓ +	
	D	101	↑ ASC Resilience	Qualitative Approach, Thematic Analysis, TISM, MICMAC Analysis, Comparative Analysis	✓	S, T, O	Dist ,Inv, BO	O, F	Multi	F						✓	✓♦		Ops, Disrupt, Geo-Pol, Pandemic		✓	✓	✓		✓	
	D	127	↑ ASC resilience to economic uncertainty	Wavelet Techniques	✓	S	S&M	O, F		F, S			✓		✓				Econ, Geo-pol			✓		✓	✓	
	D	97	↑ ASC Resilience	ISM, Fuzzy-DEMATEL, Delphi Technique	✓	S, T	BO	O		S			✓		✓		✓		Disrupt, Disaster, Reg, Pandemic, Environ			✓		✓	✓+	
	M	72	↑ ASC Network Resilience	Bi-level Optimisation Model, Numerical Simulation		T, O	Prod, Dist, Inv	O,F	Multi	S					✓			✓	Ops D, S, Environ, Disrupt, Econ, Social	✓	✓	✓	✓		✓	

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	D	44	↑ agriculture resilience	MCDM framework, Monte Carlo Simulation		S	Dist	O	Three								✓♦	✓	S, D, Lo, Pandemic		✓	✓	✓	✓		
	D	77	↑SC Resilience, ↓ cost	Stochastic Programming	✓	S, T	Prod, Dist, Inv	O,F	Multi	S	✓	✓	✓			✓	✓		Pol, Disrupt Disrupt	✓		✓		✓	✓	
	D	74	↑ strategic resilience, ↓ risks	Qualitative Approach		S	Prod, Dist, Inv	O	Multi								✓♦	✓	Disrupt, Ecol, Qual, Ops		✓	✓	✓	✓##		
	D+ M	109	↑ system resilience & efficiency	ABM		T, O	Prod, Dist, Inv	O	Three	P			✓		✓	✓			Mkt, Prod, Lo, Pandemic					✓#		
	M	85	↑ systems resilience	Supply Chain Dynamics Model, Simulation		S	Prod, Dist		Multi									✓		✓				✓		
	M	63	↑ ASC Collaboration, ↓ barriers	Tripartite Evolutionary Game Model	✓	S	BO	O, F	Three	C			✓		✓				Org						✓	
	D	124	↑ farming system resilience	Mixed Method	✓	S	Prods	O, F	Multi	F, FF	✓	✓	✓	✓	✓	✓	✓♦		Ecol, Social, Econ	✓	✓			✓#		

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	M	68	↑ Contract Farming incentives and Resilience	Non-profit Index Principal-agent Model		S, O	Prod	O, F	Two	F, E									Fin, Indiv					✓	✓+	
Strategic and Behavioural Dynamics	M	52	↓ total costs and carbon footprint; ↑ the social welfare	Multi-objective Mathematical Model, DES, Meta Goal Programming	✓	S, T, O	Prod, Dist, Inv	O, F	Multi	F	✓	✓	✓		✓				D, P, Lo			✓^	✓			
	M	104	↑decision making (↑ collaboration, ↓ complexity)	Multi-agent Simulation		S, T	Prod, BO	O, F	Multi	S					✓	✓			D, S, Ops			✓		✓	✓	✓
	D	80	↑ farm resilience through social networks	Mixed Method	✓	S, O	SocAcpt	F	Vertical	F							✓		Indiv, Social			✓			✓	
	M	107	↑ smooth structural transition in ASC	ABM		S	BO	O	Three	F			✓		✓				Environ, Mkt, SC *Knightian							✓
	M	75	↑entrepreneurial effectiveness, ↓complexities	ABM		S	BO		Multi					✓					Mkt, Tech Reg			✓	✓	✓		

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	D	102	↑ economic profitability, ensure crop quality, Fulfil sustainability criteria	DES, Optimisation Approach, Scenario Analysis, Performance Measurement Tools	✓	S, T, O	Prod, Dist, Inv	O, F	Three	F*, C		✓		✓					D, Qual, Sat					✓	✓	✓
	D	79	↑ processor's profit post disaster	MP		S, O	Prod, Dist, Inv	O	Three				✓		✓				Environ, M, Lo, Infra, Ops, Mgmt, Inst, Pol		✓	✓	✓	✓		
	M	87	↑ Expected Utility in Coordinated ASC	Mathematical Model, Numerical Simulation, Game Theory		S, O	Prod, Dist, Inv	O,F	Two	F					✓				Prod, Fin				✓	✓	✓	
	M	99	↑ preference elicitation, ↓bias	CCE	✓	T, O	Prod, Dist	O	Two	F						✓							✓	✓		
	M	98	↑ contract profitability	TCE	✓	T, O	Prod, S&M, BO	F	Two	F			✓						Prod, $, Qual					✓	✓	

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	D	126	↑Adoption & decisional autonomy	DCE	✓	S, T	Prod, S&M, BO, SocAcpt	F	One	P			✓						Mkt, Pol Tech			✓	✓		✓+	
	M	111	↑policy effectiveness, ↓ contractual risk & market uncertainty	ABM		S, T, O	BO	O, F	Two	F				✓					Indiv Market				✓	✓	✓	
	M	107	↑ Agri-Environmental Policy adoption Incentives	DCE	✓		SocAcpt	F	Two	F								✓					✓	✓		

Note:	
Papers	(M+D) means found in Round 2 search, (D+M) found in Round 1 search
Decision Levels	Strategic (S), Tactical (T), Operations (O)
Stages of ASC	Production (Prod), Distribution (Dist), Inventory (Inv), Sales & Marketing (S&M), Business Operations (BO), Social Acceptance (SocAcpt)
Beneficiaries	Farmers (F), All Others (O)
Farmers Type	Producer (P), Supplier (S), Farmer (F), Farmer Group (FG), Farming Enterprise (E), Farming Cooperative (C), Farming Families (FF), Contract and Non-Contract Farmers (F*), Non-Cooperative Farmers (F**)

Types of Risk /uncertainty	Production (Prod), Yield (Y), Procurement (Proc), Market (Mkt), $ (Price), Operations (Ops), Demand (D), Supply (S), Logistics (Lo), Disruption (Disrupt), Infrastructure (Infra), Quality (Qual), Satisfaction (Sat), Environment (Environ), Ecological (Ecol), Management (Mgmt), Institutional (Inst), Political (Pol), Regulatory (Reg), Individual (Indiv), Technology (Tech), Financial (Fin), Information (Info), Organisation (Org), Economical (Econ) ; * Knightian (unknowable unknowns)
Methods used	Agent Based Model (ABM), Analytic Hierarchy Process (AHP), Calibrated Choice Experiment (CCE), Coloured Petri Nets (CPNs), Constraint Logic Programming (CLP), Critical Systems Practice (CSP), Decision-Making Trial and Evaluation Laboratory (DEMATEL), Discrete Event Simulation (DES), Economic Order Quantity (EOQ), Fuzzy Multi Objective Linear Program (FMOLP), Interval Type-2 Fuzzy (IT2F), Internet-based Combinatorial Auction (ICA) Framework, Linear [Integer] Programming (L[I]P), Mathematical Programming (MP), Matrice d'Impacts Croisés-Multiplication Appliquée à un Classement (MICMAC), Mixed Integer Programming (MIP), Mixed-Integer [Non-Linear] Programming (MI[N]LP), Multi-agent System (MAS) Framework, Multi Criteria Decision Making (MCDM), Numerical Simulation (NS), Particle Swarm Optimization (PSO), Quality Function Deployment (QFD), Structural Equation Modelling (SEM), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), Total Interpretive Structural Modelling (TISM), Transaction Cost Economics (TCE), Vehicle Routing Problem (VRP), Windowed Scalogram Difference (WSD).
Stakeholders	✓♦: Regulatory Stakeholders with other R&D Institutions and Associations
Risk management strategies and resilience in GSC	✓*: Collaboration along with traceability; (+) Coordination, ✓ + Collaboration discussed along coordination; ✓^ Flexibility along with risk recovery/management, ✓^^ Flexibility with agility; ✓#: Adaptability with transformability; ✓## Adaptability with agility