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Risk Management in the Agri-food Sector

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ABSTRACT This paper incorporates the interdisciplinary New Institutional Economics in a comprehensive framework for analyzing risk management in the agri-food sector. First, it specifies the diverse types of agri-food risks (natural, technical, behavioral, economic, policy, etc.) and the modes of their management (market, private, public, and hybrid). Second, it defines the efficiency of risk management and identifies the factors (personal, institutional, dimensional, technological, and natural) of governance choice. Next, it presents stages in the analysis of risk management and the improvement of public intervention in the governance of risk. Finally, it identifies the contemporary opportunities and challenges for risk governance in the agri-food chain.

KEY WORDS: risk management; market, private, and public governance; agri-food chain

JEL Classification: D23, D81, L14, L22, L25, O17, Q12, Q13, Q18, Q52

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Introduction

The management of diverse risks (natural, market, criminal, policy, etc.) in the agrarian and food sectors are issues with particular topical interest (Babcock, 2004; CIPS, 2012; Deep & Dani, 2009; EU, 2011; Notarnicolaa et al., 2012; OECD, 2008; Olsson & Skjöldebrand, 2008; Ramaswami et al., 2008; RP-DRM, 2012; Schaffnit-Chatterjee, 2010; Shepherd et al., 2006; Trench et al., 2011; Tummala & Schoenherr, 2011; Weaver & Kim, 2000). Evolving uncertainty, risks and crises associated with the progression of natural environments, products, and technologies, social demands, policies, and globalization present new challenges to the current systems of risk management.

Risk management studies in the agri-food sector predominately focus on technical methods and capabilities to perceive, prevent, mitigate, and recover from diverse threats and risks (Barker, 2005; Beni et al., 2012; DTRA & IIBR, 2011; Hefnawy, 2011; Jaffee et al., 2008; Luning et al., 2006; Zhang & Li, 2012). Most economic publications apply a Neoclassical approach, study risks as commodities regulated by market supply and demand, and model farmers' "willingness to pay" for insurance contracts relative to agents' risk aversion, risk probabilities, and the magnitude of damages (Gerasymenko & Zhemoyda, 2009; OECD, 2011). Market and private failures are acknowledged, and needs for public intervention in agrarian insurance are increasingly recognized (Brewer, 2010; EU, 2011; OECD, 2008).

Risk management analysis largely ignores significant risks based on "human nature" (bounded rationality, opportunism), critical factors for managerial decision making such as institutional environment and transaction costs, and diverse alternative modes of management (market, private, collective, public). As a result, the efficiency and complementarities of risk management modes cannot be assessed properly. Despite advances in risk management technologies and "menus" of risk reduction, mitigation and coping strategies, numerous failures/challenges (production, safety, environmental,

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etc.) persist in the agri-food sector (Dani and Deep, 2010; EU, 2011; Humphrey and Memedovic, 2006; Luning et al., 2006; OECD, 2011; Sarkar et al., 2012). Consequently, attention is directed to the *system of governance* that eventually determines the exploration of technological opportunities and the state of agri-food security (Bacha et al., 2009; Bachev, 2010).

This paper incorporates interdisciplinary *New Institutional Economics* (Coase, 1960; Furuboth and Richter, 1998; North, 1990; Williamson, 1981; 1996) in a comprehensive framework for analyzing risk management in the agri-food sector. *First,* it specifies the types of agri-food risks and the modes of their management. *Second,* it defines the efficiency of risk management and identifies factors of governance choice. *Next,* it presents the stages in risk management analysis and improvements of public intervention. *Finally*, it identifies contemporary opportunities and challenges for risk governance in the agri-food chain.

1. Agri-food risks and modes of governance

Risk is *any current or future hazard (event) with a significant negative impact(s).* It is either *idiosyncratic* (accidental, low probability, unpredictable events) or *systematic* (high probability, "predictable" events). The risk/threat could be of *natural* (adverse weather, insect-related, catastrophes), *technological* ("pure" technical failures), or *human* (individual or collective actions/inactions), or a combination of these types. *Individual* behavior and actions that cause risks include *agent's ignorance* (lack of knowledge, information, training) and/or *errors*; *risk-taking strategy* (accepting above "normal" risk); *mismanagement* (inadequate planning, prevention, recovery); *opportunistic behavior* (pre-contractual cheating, post-contractual "moral hazard"); *criminal acts* (damaging/stealing or invading an individual's property); *terrorist attacks* (environmental contamination or other actions that aim to produce "mass terror"), etc. *Collective actions* are sources of risks that relate to: *economic dynamics and uncertainty* (changing demands, price volatility, competition, market "failures" and imbalances such as "lack" of labor, credit, inputs); *collective orders* (professional standards, strikes, trade and community rules and restrictions); or *public orders* (political instability and uncertainty, evolution in informal and formal norms, public "failures" such as bad, delayed, or under/over intervention, law and contract enforcements, mismanagement, "inefficiency by design"), etc.

The agri-food sector can *face* risks associated with each component **(dairy farms, food processors, traders)** or it could *cause* risks (risk *from* farming, from food processing, *from* food-distribution). Risk can be *internal* to agri-food chains such as hazards caused by one element affecting another *within* the sector. Risk can be *external* and associated with external factors (natural environment, government policy, international trade) and/or effecting external components (consumers, residents, industries, nature). Risk can be *private,* when it is assumed by individuals, collectives, entities, or industries, or it can be *public when it* affects large groups, communities, consumers, or future generations.

The magnitude of risk is large when an event has both a *great likelihood* of occurrence and substantial *negative consequences* - such as damage to humans and livestock (health and property), inferior yields and income, loss of market position, food and environmental contamination, etc. When risk is considerable, it would likely be associated with *significant costs* that often can hardly be expressed in monetary terms - human health hazards, degraded soil, and loss of biodiversity and eco-system services. Thus, "rational" agents that maximize their own welfare will be interested in *investing in risk prevention and reduction*.

In a *narrow* (technical) sense, ***risk management*** comprises individual, collective and public *action(s)* for reducing/eliminating risk and its consequences. In a *broader* sense, *risk management* is the specific *system of social order* ***(governance)*** that is responsible for the particular *behavior(s) of agents* and determining way(s) to assign, protect, exchange, coordinate, stimulate, and dispute risks, rights, resources, and activities (Bachev and Nanseki, 2008). In a particular (socio-economic, technological, natural) environment, the specific *system of risk governance* that is "put in place" is intimately responsible for the efficiency of the detection, prevention, mitigation, and reduction of threats/risks and their consequences.

Generic *forms* and *mechanisms* of risk governance are (Figure 1) as follows:

Private modes ("private and collective order") include diverse private initiatives and special contractual

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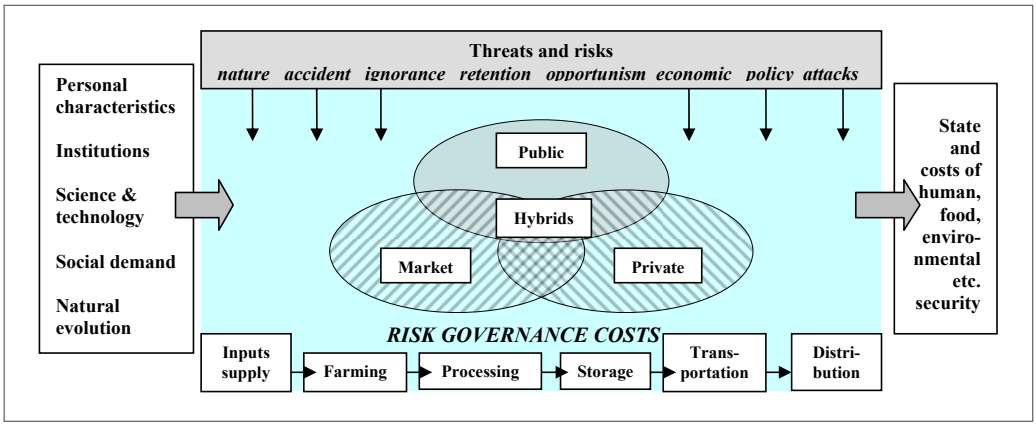

Figure 1. Generic risks, factors, stages, and modes of risk governance in the agri-food sector

and organizational arrangements tailored to the features of risks and agents, such as codes of behavior, diverse (relational, security, future) contracts, cooperatives, associations, business ventures, etc. *Market modes* ("invisible hand of market") include various decentralized initiatives governed by free market price movements and competition, such as risk trading (selling/buying insurance), future contracts and options, production/trade of special (organic, fair-trade, origins) products, etc. *Public modes* ("public order") include various forms of third-party public (government, international) intervention in market and private sectors, such as public information, regulations, bans, assistance, funding, assurance, taxation, provision, etc.

Sometimes, risk management can be conducted effectively though *"self-management"* such as production management, adaptation to industry and formal standards, "self-insurance" though stock investments, financial reserves, etc. Primitive forms of *on-farm* risk management through *production management* improvement are widespread: control and security enhancement, use of appropriate crop varieties (resistance to pests, diseases, and weather), structure of technology and production, product diversification, dislocation, etc. Similarly, *off-farm* enterprise/income diversification is a major risk management strategy for most European farms (Bachev and Tanic, 2011). Very often, risk management requires an effective *governance of relations* with other agents such as the exchange and regulations of rights, the alignment of conflicts, the coalition of resources, and collective or public actions on regional, national, and transnational scales. Thus, a risk could be "managed" through *market modes* (purchase of insurance, hedging with future price contingency contracts), *private modes* (contractual or literal integration, cooperation), *public forms* (state regulation, guarantee, compensation), or *hybrid* combinations of other forms.

2. Risk management efficiency

Risk governance modes have *different* efficiencies because they have dissimilar *potentials* to reduce the likelihood and impact of risks and involve different costs (Bachev, 2010). Market or collective governance has advantages over internal mode/"own protection" because market governance allows for the exploration of economies of scale/scope in preventing risks and managing negative consequences. However, risk trading or sharing is associated frequently with significant *transaction costs* for finding the best partners and prices, formulating/disputing terms of exchange, forming coalitions, and safeguarding against new risks from the opportunistic behavior of counterparts/partners. Consequently, *markets* and *private sectors "fail"* to effectively manage the existing/likely risks, and there is a need for *"state intervention"* in risk management (cooperation and assistance for farmers, public cost-sharing or provisions, mandatory assurance regulation). Thus, *"governance matters"* and applying proper risk management structure are important parts of the process of optimization (effective allocation) of resources.

Following Coase's logic (1960), if *property rights* were *well-defined* and *transaction costs* were *zero,*

then all risks would be managed in the most socially efficient way, independent of the specific mode of governance (although some types of risks would not exist or be significant, e.g., risks related to adverse human behavior). Then, agents would either sell their risk to specialized market agents or safeguard against risk through private contract terms or join risk-sharing organizations of interested parties. Risk-taking would be distributed (exchanged, shared) by agents according to their will, while total costs for risk prevention, assurance, reduction, and recovery would be minimized. The rational choice for an individual agent would be to eliminate significant risk altogether by selling risk to specialized market risk-takers. Market governance would optimize risk-taking, minimize "technological costs" for risk assurance and explore the recovery potential for economies of size/scope at national/transnational scales.

When property rights are not well-defined or enforced and transaction costs (associated with distribution, protection, and exchange of rights of individuals, groups, and generations) are high, then the *type of governance* is essential to cover the extent and costs of risk protection. For example, the internal (ownership) mode is often preferred over outside (market, contract) modes because of the comparative protective and costs advantages for "standard" natural/behavioral risk management. Frequently, enormous transaction costs can block the development of insurance markets or the emergence of mutually beneficial risk-sharing organizations. For instance, despite "common" interests and huge risk minimization potentials, collective risk-sharing organizations are rarely developed by smallholders.

Formal and informal institutional restrictions might make some modes of risk governance impossible. For example, risk-assuring monopolies/cartel arrangements are illegal in many countries, while most entrepreneurial risk-taking is endorsed (according to the "low risk-low profit" principle). Thus, not all modes of risk governance are always feasible in every socio-economic setting. However, if the costs of illegitimate forms are low, the possibility for disclosure is low and enforcement and punishment are insignificant, while benefits are considerable, then more effective "gray" or black governance prevails.

Individuals differ significantly in their capacity to recognize, adopt, and pay for prevention, and manage risk. For example, risk-taking farmers prefer risky but more productive forms (e.g., bank credit for new, profitable ventures). In addition, agents have quite different interests in effective management of particular risk(s) because they receive dissimilar benefits and costs from risk management.

There is no single *universal* form of management for diverse types of risks. According to the *specific features of each risk* (origin, probability, likely damages), there will be different most effective governance forms. For example, while low probability "standard" (natural, criminal) risk might be effectively governed with classical market contracts (purchase of insurance), most behavioral risks require special private modes (branding, long-term or interlink contracts, vertical integration), and high damage risk from terrorist attracts necessitates specialized public forms (intelligence, security enforcement). Hence, depending on the type *and severity of risk*, the *interests and personal characteristics of individuals*, and the *specific natural, economic and institutional environments*, there will be *different (most) efficient* forms of governing a particular type of risk. Consequently, some *governance mix* will always exist to manage the diverse risks associated with the agri-food sector.

Sometimes, *effective* risk management leads to the reduction or removal of a particular risk. Often, complete risk elimination is either costly ("unaffordable" by individuals/society) or practically impossible (when uncertainty and transaction costs are enormous). For example, certain natural risks will always exist despite the system of management. Moreover, it is practically impossible to write "compete" contracts (for trading risk) that include all probable future contingencies and subsequent rights and obligations for each party (Vierø, 2012; Williamson, 1996), and some transaction risk will always remain. Therefore, effective risk management is always connected with the needs for some *trade-off* between benefits from reducing particular risks (saved costs, minimized impacts) and related *costs for risk governance*. Thus, some "uncovered" risk will normally remain.

Individual modes can offer effective protection from different/*multiple* risks. Moreover, management of one type of risk might be associated with exposure to a new type of risk/cost, e.g., vertical integration eliminates "market risk" but creates risk

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from a partner's opportunism. The level of (overall) risk exposure is typically determined by the *"critical"* (most important) risk, and integral risk rarely equals the sum of the individual risks.

Frequently, there are a number of possible *(alternative)* forms of governance of a particular risk. For example, the "risk to the environment" might be managed by voluntary actions of farmers, environmental cooperation, private contracts with interested parties, assistance by third party organizations, public eco-contacts, and public regulations. Some forms of risk management are practically impossible or socially unacceptable, e.g., futures and insurance markets do not develop for many types of agro-food risks, and *private management* is the only option (Frank and Garcia, 2011); additionally, the management of many eco-risks require *collective actions* at local, eco-system, regional or transnational levels (Bachev, 2010; Sutherland et al., 2012). Many type of risk management are *publicly imposed*, e.g., there is harmonized *public management* of food safety risks in the EU, there are strict regulations of Genetically Modified Crops (GMC), the "precaution principle" is mandatory and carried out by states, "safety nets" are organized as public projects, etc.

Therefore, *comparative analysis* is to be employed to evaluate (technically, economically, socially) *feasible alternatives and select* the most efficient one that reduces the overall risk to an "*acceptable*" level and requires the minimum *total* (risk assurance *and* governance) costs. The analysis must include all current and future costs associated with risk management, such as the *current* technological and management costs (for adaptation, compliance, information, certification), risk insurance premiums, contracting and coalition costs, and the *long-term* (future) costs for recovering damages, including the associated *transaction costs* (disputes, expertise, low suits) for claiming losses. Most risk management analyses ignore the current and likely long-term transaction costs associated with risk management.

In any case, the *individual, group, community, sectoral, chain, national and international* efficiency of risk management must be distinguished. Often, the elimination of risk for one agent induces (new) risk for another agent. For example, agri-food price fluctuation causes income risk for producers but benefits speculators, and application of chemicals reduces the risk for farmers but produces significant negative effects (water, soil and air contamination) for residents, consumers, and affected industries. Furthermore, risk management is only a *part* of the overall governance of the diverse (production, consumption, transaction) activities of agents. For example, most managerial innovations in farming and the agri-food chain are driven by the motivation to economize and reduce transaction costs (Sporleder, 1992). Therefore, the *total efficiency* (benefits, disadvantages, cost saving and risk minimization potential) of various modes for *individual agents* and the *public* are to be taken into account. It is frequently the case that the minimization of risk-related costs is associated with an increase in production or transaction costs and vice versa. Similarly, the risk elimination costs of one agent frequently increase the security of another agent in the agri-food chain.

According to specific natural and socio-economic environments, personal characteristics of individuals, and social preferences, various *structures of risk governance* evolve in different sub-sectors, industries, supply chains, and societies. At one extreme, the system of risk management works well, and only "normal" (entrepreneurial) risk is left "ungoverned". In some cases, the *market* fails to provide adequate risk governance, but a variety of effective *private modes* emerge to fill the gap. Often, both market and private governance fail, but effective *public involvement* cures the problem. Nevertheless, there are situations when specific institutional and risk management cost structures lead to failures of market and private modes, and needed public intervention in risk governance. Consequently, a complete range of risks is left unmanaged, which has adverse effects on the size and sustainability of agri-food enterprises, market development, the evolution of production and consumption, the state of the environment, and social welfare.

Depending on the costs and the efficiency of the *specific* system of governance in a particular (sub)sector, region, country, supply chain etc., there will be *unlike outcomes* in terms of *"residual" risks* and dissimilar *states* and *costs of human, food, environmental, etc., security* in different regions and periods of time (Figure 1). For instance, when there is inefficient public enforcement of food, labor, and eco-safety standards (lack of political willingness, administrative capability), then enormous "gray" agrarian and food sectors develop with inferior, hazardous, and counterfeit components.

3. Factors of governance choice

The forms of risk management depend on the risk type, personal characteristics, institutional environment, progress in science and technology, culture, social education and preferences, evolution of the natural environment, etc. (Figure 1). ***Risk features*** such as the origin, probability of occurrence, likely damages, and scale are important factors for the choice of governance. For instance, local risk could be managed through private modes, while most market and environmental risks require collective actions at the regional, national or transnational level. For high probability and harmful risks, agents prefer more secure/expensive modes such as security investments, purchase of insurance, maintaining reserves, taking hostages, and interlinked organizations. However, many smallholders cannot afford the related costs and practice no or primitive forms of risk management, such as cash-and-carry deals and product diversification. In that case, there is the need for third party (government, international assistance) intervention, though insurance, support, safety nets, etc., to decrease the vulnerability of farmers.

Personal and behavioral characteristics of agents include interests, preferences, knowledge, capability, risk-aversion, reputation, trust, "contractual" power, and opportunism. For instance, some risks are not perceived (unknown) by private and public agents; therefore, no risk management is put in place. In some cultures, the cooperative is the preferred mode of organization; an experienced/trained farmer might design and manage a larger organization/hired labor and more outside (credit, insurance, inputs supply) contracts that are adapted to his needs. Additionally, a risk-taking entrepreneur prefers riskier, but more productive ventures.

Behavioral factors such as the *bounded rationality* and *opportunisms* of individuals are identified as being responsible for transaction costs and, thus, for organizational choice (Williamson, 1996). They are widely studied in insurance theory as sources of cheating on both sides of contracts (Derrig, 2002).

Agents do not possess complete information about the economic system (risks, price ranges/dynamics, trade opportunities, policy development) because the collection and processing of such information (multiple markets, future events, intention for cheating) is very expensive or impossible. To optimize decision-making, they allocate resources to "increasing imperfect rationality" (data collection, analyses, forecasts, training, consulting) and select forms (internal organization, "selling out" risk) that minimize the related risks/costs.

Agents are also prone to opportunism, and they frequently take advantage of opportunities to extract extra benefits/rent. If there was no opportunism, only risk that is related to bounded rationality (natural, technical) would remain and the consequences would be recovered easily with the cooperation and mutual benefits (risk sharing) of the parties. *Pre-contractual opportunism* ("adverse selection") occurs when some of the partners use "information asymmetry" to negotiate advantageous contract terms. *Post-contractual opportunism* ("moral hazard") occurs when a counterpart takes advantage of the impossibility of complete observation of activities (by another partner, third-party) or takes "legal advantage" of unforeseen changes in the exchange conditions (costs, prices, regulations). *Third form of opportunism ("free ride")* occurs in large organizations where individual benefits are not proportional to individual efforts/costs and everyone expects other people to invest in the organizational development and benefit from the new organization (Olson, 1969). Bounded rationality often makes it costly/impossible to distinguish opportunistic from non-opportunistic behavior (e.g., a farmer finds that purchased seeds were of poor quality during the harvest), and agents protect their rights, investments, and transactions from the hazards of opportunism through means such as ex-ante efforts to find reliable counterparts and design efficient modes for partner commitments and ex-post investments for overcoming (monitoring, controlling, stimulating cooperating) possible opportunism during contract execution (Williamson, 1996).

In the agri-food sector, opportunism is widespread before signing insurance contracts (not disclosing information for possible risks) or during contract execution (not taking actions for reducing damages when events occur or consciously provoking damages in order to get insurance premiums). These events increase the insurance prices and limit the utilization of insurance contracts by small enterprises. The insuree also "discovers" the insurer's opportunism after the occurrence of a harmful event and finding that the assurance terms (protected risks, extent of coverage, dam-

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ages assessments, costs) were not explained or adapted to the farmer's needs. For many farm-related risks, the markets evolve slowly or the insurance services are inaccessible to small operators. For some important risks, the insurance is not available "for purchase at all", e.g., the risk of lack of market demand, price fluctuations, opportunism of counterparts, etc. Farmers must develop other (private, collective) modes to safeguard investments and rights or lobby for public intervention in the assurance supply.

The institutional environment ("rules of the game") includes *formal* and *informal* rights and rules and system(s) of the enforcement of these rights and rules (North, 1990). Rights/rules are defined by laws, tradition, culture, religion, and ideological and ethical norms and enforced by state, convention, community pressure, trust, and self-enforcement. For instance, in many countries, some forms of risk governance are fundamental rights (on food, labor, eco-security/safety) and guaranteed by the state; public income support to farmers is "institutionalized"; standards (environment, food safety) differ even between individual regions, etc. The (external) institutional environment considerably affects transaction costs. For example, in recent years, thousands of European enterprises closed because it was impossible to adapt to the newly introduced EU standards for quality, safety, eco-preservation, animal welfare, certification, etc.

Under conditions of stable and efficient public regulation (rules, standards, price guarantees, quotas) and effective mechanisms for laws and contract enforcement, preference is given to standard (spotlight, classical) contracts. When rights/rules are not well-defined or are changing and absolute/contracted rights are effectively enforced, primitive forms of risk management (subsistence farming, personalized and over-integrated forms) dominate and there is high vulnerability to diverse risks. The East European transition was characterized by fundamental restructuring, "rule changes", ineffective public enforcement, and high exposure to "new" (natural, market, entrepreneurial, private, contractual, institutional, international) risks due to evolving private structures, unsustainable organizations, large gray economies, undeveloped or missing (credit, insurance, extension supply) markets, and individual (theft) and organized ("security service") risks that devastated private businesses and household welfare.

Dimensional characteristics of activities/transactions include uncertainty, frequency, and asset specificity, which were identified as critical factors by Williamson (1996), and appropriability was later added by Bachev and Labonne (2000). When the *recurrence* of transactions between the same partners is high, then both sides are interested in sustaining and minimizing the costs of their relations (avoiding opportunism, sharing risk, building reputation, setting incentive, adjustment, conflict resolution mechanisms). The continuation of relations with particular partner(s) and the design of a special mode have high economic value, and the development costs can be effectively recovered by frequent exchanges. When transactions are *occasional,* then the possibility for opportunism is great because the cheating side cannot be easily punished by turning to a competitor.

When the *uncertainty* surrounding the transactions increases, then the costs for carrying/secure activities increases (overcoming information deficiency, assuring risk). Bounded rationality is crucial, opportunism can emerge, and agents use special private forms for reducing transaction uncertainty such as the following: trading with origins; providing guarantees; rent-sharing or output-based compensation; collateral for credit; input-supply or marketing cooperative; and complete integration.

Transaction costs become very high when the *specific assets* for the relations with a particular partner are to be deployed. The costless alternative use of specific assets is impossible if transactions fail to occur, are prematurely terminated, or less favorable terms are renegotiated (before the end of the life-span of capital). Dependent investment/assets must be safeguarded by special forms such as long-term contracts, interlinks, hostage taking, joint investments, and quasi or complete integration. Often, investments in specific capital are not made, and activity/transactions do not occur or occur without comparative advantages with respect to productivity. If there is a high *symmetrical* (risk, capacity, product, timing, location) assets dependency of transacting sides (a "bilateral trade" regime), then there are strong mutual incentives to elaborate special private modes (interlinking credit, inputs, insurance supply against marketing, etc.). *Relational contracts* are applied when detailed terms of transacting are unknown at the outset (high uncertainty), and framework

(mutual expectations) rather than the specification of obligations is practiced. Partners (self)restrict themselves from opportunism and are motivated to settle emerging difficulties and continue their relations (as in the situation of frequent reciprocal trades). When *unilateral* dependency exists (unwanted "exchange", quasi or full monopoly), then the dependent side must protect their investments against possible opportunism (behavioral uncertainty/certainty) through integrating transactions (unified organization, joint ownership, cooperative) or by safeguarding them with interlinked contracts, exchanges of economic hostages, development of collective organizations for price negotiations, lobbying for government regulations, etc.

Activities/transactions are particularly difficult when the *appropriability of rights* for behavior, products, services, and resources is low. The costs for protection, detection, verification, and third-party/court punishment of unwanted exchanges are extremely high (bounded rationality). Agents either over-produce (negative externalities) or under-organize activities (positive externalities) unless they are governed by efficient private or hybrid modes such as cooperation, strategic alliances, long-term contracts, trade secrets, or public orders.

Progress in science and technology significantly improves risk management and facilitates the diversification of forms, e.g., the introduction of new (resistant) plant and livestock varieties; the mechanization and standardization of operations and products; and the application of information, forecasting, monitoring, storage, and transportation technologies that significantly improve risk management in the agri-food chain (COST, 2009; Hefnawy, 2011; Notarnicolaa et al., 2012). However, modern applications of science and technology are also associated with production/exposure to new types of risk, such as greenhouse gas emissions, genetic contamination, natural resource depletion, and over-dependence on technology.

Evolution of the natural environment – global warming, extreme weather, plant and animal diseases, drought, flooding and other natural disasters are posing new challenges for risk management in the agri-food sector (Hefnawy, 2011; OECD, 2011).

The identification of "critical factors" of risk management decisions, the range of feasible forms, and the efficiency (costs, benefits) of governance modes for individual agents, stages, subsectors, countries, food chains and public are subjects for special *micro-economic study.*

Comparative analysis is to be employed to compare the feasible forms and select the most efficient alternative that reduces the overall risk to an *"acceptable"* level and minimizes the *total* (risk assurance and governance) *costs*. Most elements of risk governance efficiency are difficult to quantify, such as individuals' characteristics, amounts of risk, levels of benefits and the costs associated with each mode. The "measurement problems" associated with the transaction benefits and costs are well-specified (Bachev, 2011b) and prevent the utilization of traditional (Neoclassical) models simply by adding a new "transaction" or risk management activity (Furuboth and Richter, 1998).

Extended *Qualitative (Discrete structural) analysis* can be used as operationalized by Williamson (1981). For assessing the efficiency of risk governing structures, the *features of risk* to be managed (probability, significance, acceptance level, collective action needs) and its *critical (institutional, technological, behavioral, etc.) factors* are to be matched with *comparative advantages* (potential) of *alternative modes* to inform, stimulate appropriate behavior, align interests, and overcome, reduce, control, share, dispute, and minimize overall costs of risk.

In a *specific* market, the institutional, technological and natural environment effective risk governance choice depends on a *combination* of risk features (probability of occurrence, likely magnitude of damages) and critical dimensions of activities/transactions (appropriability, assets specificity, and frequency), (Figure 2). High "standard" risks might be effectively managed through *free market* modes such as *standard/classical* insurance, inputs supply, marketing, etc. *contracts*. Highly probable and damaging risks with a good appropriability and frequency of transactions between the same partners require a *special* (e.g. relational*) contract*. The later form is also appropriate for the risks surrounding with low uncertainty, high assets specificity and appropriability, and occasional character of the relations between the counterparts.

Principally, risks combined with high specificity, appropriability and frequency might be effectively managed though a *vertical integration* (internal risk management, contract forward or backward integration for

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Critical dimensions of activity / Risk features				Appropriability				
				High				*Low*
				Assets Specificity				
				Low		*High*		
				Frequency				
				Low	*High*	*Low*	*High*	
Severity of damages	*High*	Probability /uncertainty	*Low*	**M/CC**	**M/CC**	**SC**	**VI**	**PO**
			High	**M/CC**	**SC**	**CO**	**CO**	
	Low		*Low*	**na**	**na**	**SC**	**VI**	**na**
			High	**M/CC**	**M/CC**	**TPI**	**VI**	**CO & TPI**

M – free market; **CC** – classical (standard) contract; **SC** – special contract; **VI** – vertical (internal) integration; **CO** – collective organization, **TPI** – needs for a third-party involvement; **PO** – needs for a public organization

Figure 2. Principle modes for risk governance in the agri-food sector

risk sharing or mitigation). Highly likely and menacing risks combined with a high assets specificity and a good appropriability call for a *collective organization* (cooperation, collective action). Moreover, such risk/costs sharing organization could be easily initiated and maintained since the condition of a high risk and assets dependency is in place.

However, serious transaction risk exists when assets specificity is combined with high uncertainty, low frequency, and good appropriability. In that case, the elaboration of a special structure for private transactions is unjustified, specific (risk-reducing) investments are not made, and the activity/restriction of activity fails to occur on an effective scale ("market and contract failure"). *Third-party* (private, NGO, public) *involvement* is necessary (assistance, arbitration, regulation) to make the transactions more efficient or possible. The unprecedented development of special origins, organic farming, and "fair-trade" systems are good examples; there are increasing demands (premium) for organic, original and fair-trade products associated with some forms of (natural, poverty, labor, quality) risk management, but their supply could not be met unless effective *trilateral* governance, including independent certification and control, is put in place. Similarly, for risks with a low appropriability a third party *(public)* intervention is necessary to secure the effective risk management. Moreover, while a high probability low danger risks need a *collective organization assisted by a third-party* ("quasi" public organization for risk sharing and mitigation), the high damaging risks necessitate a *public organization*.

4. Stages in analysis and improvement of risk management

The analysis and *improvement* of risk governance in the agri-food chain is to include following *steps*: **First,** the *existing* and *emerging* threats and risks are identified. The persistence of certain risks is a good indicator for ineffective management. Modern science offers quite reliable and sophisticated methods for assessing various risks *to* or *caused* by agri-food chain (DTRA & IIBR, 2011; Trench et al., 2011; Ueland et al.; 2012).

Second, the *existing* and *other feasible modes* of risks governance are specified, and their efficiency and prospects of development are assessed. *The efficiency* of individual modes shows their capability for risk detection, prevention, mitigation, and recovery at low costs, while *sustainability* reveals their "internal" potential to adapt to socio-economic, technological,

and environmental changes and associated threats and risks. A holistic framework for assessing the efficiency and evolution of governing modes is suggested by OECD (2011) and Bachev (2010). That stage identifies the *deficiencies* of dominating (market, private, public) modes to solve existing and emerging risks, and determines the *needs for (new) public intervention*. For instance, when appropriability associated with transaction/activity is low, there is no pure market or private mode to protect against the associated risks. Respecting others' rights or "granting" risk protection rights to others could be governed by "good will" and charity actions (e.g., the eco-sustainability movement initially evolved as a voluntary activity). However, voluntary initiatives can hardly satisfy entire social demands, especially if they require significant costs. The emergence of special large-member organizations for dealing with low appropriability to cover entire "social" risks is a very slow and expensive process, and it is unlikely to be sustainable in the long run (free riding). There is a strong need for *third-party public intervention* to make protection from risk possible or more effective, such as purely public organizations (public assurance for natural and economic disasters) or "quasi-public" modes (collective organizations assisted/ordered by third parties) for high probability, low damage risks (Figure 2).

Third, the *alternative* modes for public intervention to correct failures (market, private, public) are identified, their *comparative efficiency* is assessed, and the best one(s) is selected. The comparative assessment is to be made on (technically, economically, politically) *feasible* forms as mode(s) that minimize the *total* risk management (implementing *and* transaction) *costs* selected. The analysis is to take into account the overall *private* and *social* costs, including the *direct* and *indirect* (individual, third-party, tax payer, assistance agency) expenses, **and** *private* and *public transaction costs.* The latter costs often comprise a significant portion of the overall risk management costs and are usually ignored; these costs include the costs for coordination, stimulation, and mismanagement of bureaucracy; individuals' participation and use of public modes (expenses for information, paper work, fees, bribes); community control and reorganization of bureaucracy (modernization/liquidation of public modes), (opportunity) costs of public inaction, etc.

Initially, the existing/emerging problems (difficulties, costs, risks, failures) in the organization of market and private governance are specified. Appropriate pubic involvement is used to *create an institutional environment* for making private investments less dependent, decreasing the uncertainty surrounding market and private transactions, intensifying exchanges, and protecting private rights and investments such as when the State establishes and enforces quality, safety, and eco-standards, certifies producers, regulates employment relations, transfers management rights on natural resources, etc., thus increasing the efficiency of market and private risk management.

Next, the feasible modes for increasing appropriability are considered. Low appropriability is often caused by unspecified or badly specified private rights and obligations. Sometimes, the most effective government intervention is to *introduce and enforce new private and group (property) rights* on diverse types of risks and trading; natural resources; food safety; a clean environment; tradable quotas for products, inputs, and emissions; intellectual property; and origins. That intervention transfers the organization of transactions into market and private governance, liberalizes market competition, and induces private incentives (investments) in certain risk management.

In other instances, it is more efficient to establish *public regulations* for risk minimization for the utilization of resources, products, and services (standards for labor, product, environmental safety); the introduction of foreign species, GMC, and (water, soil, air, comfort) contamination; bans on inputs, products, and technologies; regulations for trading ecosystem service protection; trade regimes; mandatory risk and eco-training, and licensing of operators, etc.

In other instances, using incentives and restrictions of the *tax system* is the most effective method. Different types of tax preferences are used widely to create favorable conditions for the development of (sub) sectors and regions, forms of organization, population segments, activity types. For example, environmental taxation on emissions or products (inputs, outputs) can be applied to reduce use or emissions of harmful substances; tax reduction can be used to overcome negative consequences of natural disasters, etc.

In some cases, *public support* of private organizations is the best mode for intervention. Programs for

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modernization, enterprise adaptation, income support, environmental conservation, and public risk-sharing are common around the world. For instance, in the USA farm crop insurance has emerged as the most important farm program while insurance payments to farmers are the largest source of farm assistance (Zulauf and Orden, 2012).

Often, intervention that provides *public information, recommendations, and training* to farmers, entrepreneurs, residence, and consumers in risk management is the most efficient method.

In some cases, *pure public organization* (in-house production, public provision) is the most effective, and this type of organization includes critical infrastructure; food safety inspections; research, education, and extension; agro-meteorological forecasts; border sanitary and veterinary control; recovery from natural catastrophes, etc.

Specific modes are effective if applied with other modes of public intervention. The necessity of *combined intervention* is caused by complementarities (joint effects) of individual forms; the restricted potential of some less expensive forms to achieve certain (but not entire) socially preferred risk prevention/mitigation; possible extra benefits (e.g., "cross-compliance" requirements); specific critical dimensions of governed activity; risk and uncertainty (little knowledge, experience) associated with the likely impacts of new forms; the administrative and financial capability of the State to fund, control, and implement different modes; and dominating policy doctrine.

The level of effective public governance depends on the type of risk and the scale of intervention. There are public involvements that are to be executed at the *local* (ecosystem, community, regional) level, while others require *nationwide* governance. There are other risk management activities that are to be initiated/coordinated at the *international* (regional, European, worldwide) level due to the strong necessity for transborder actions or consistent (national, local) government failures. Often, the effective management of many risks requires *multilevel* governance with a system of combined actions at various levels that involve a diverse range of actors and geographical scales.

Public (regulatory, provision, inspecting) modes must have built-in mechanisms for increasing the competency (decrease bounded rationality, powerlessness) of bureaucrats, beneficiaries, interests groups and the public, and restricting possible opportunism (cheating, interlinking, abuse of power) by public officers and stakeholders. This increased competency can be accomplished by training, introducing new assessment and communication technologies, increasing transparency, and involving experts, beneficiaries, and interests groups in the management of the public modes at all levels.

Generally, *hybrid modes* (public-private partnership) are more efficient than *pure* public forms because of their coordination, incentives, control, and cost-sharing advantages. The involvement of farmers, beneficiaries, and interest groups increases efficiency, decreases information asymmetry, restricts opportunisms, increases incentives for co-investment, and reduces management costs. For instance, the enforcement of most labor, animal welfare, and eco-standards is often very difficult or impossible. Stimulating and supporting private voluntary actions are much more effective then mandatory public modes in terms of incentive, coordination, enforcement, and disputing costs.

If there is a strong need for third-party public involvement but effective (government, local authority, international assistance) intervention in risk management is not introduced in a timely manner, then significant risks to individuals and public persist while agrarian "development" is deformed.

Dealing with many risks in the agri-food sector/chain requires *multiform, hybrid, multilevel*, and *transnational* intervention, and the appropriate *governance mix* is to be specified.

Comparative analysis can improve the design of public intervention for specific conditions of food-chain components in a particular country/region in terms of increasing security and decreasing costs. The suggested approach also can predict likely cases of (new) public failures due to the impossibility of mobilizing political support and resources or the ineffective implementation of otherwise "good" policies. *Public failure* is feasible, and its timely detection enables risk managers to foresee the persistence/increase of certain risks and inform local and international communities about the consequences.

Risk management analysis is to be made at *different levels* - individual components (input supply, farm, processing, transportation, distribution), regional, sub-

sector, food-chain, national, and international, according to the *types of risks* and *scales of collective actions* necessary to mitigate risks. It is not a one-time exercise to complete the last stage with a perfect system of risk management. Rather, it is a *permanent process* to improve risk management along with the evolution of the socio-economic and natural environment, individual and community awareness, modernization of technologies, etc. Moreover, public (local, national, international) failure often prevails, which also brings us into the next cycle in the improvement of risk management.

For the application of this suggested approach, in addition to the traditional (statistical, industry, etc.) information, *new types of data* are necessary for diverse risks and forms of governance, critical factors for each agent, and levels of benefits and costs. Such data are collected through interviews with agri-food chain managers, stakeholders, and experts in these areas.

5. Contemporary opportunities and challenges for risk governance in the agri-food chain

Modern agri-food chains involve millions of actors with different interests, multiple stages, and diverse risks requiring complex, multilateral, and multilevel governance on a large scale. For instance, there are several million farmers, several hundred thousand different food processors and retailers, and 500 million consumers in the EU. The figures are much larger if the total number of global agents who are involved in the EU agri-food chain are taken into account.

The variety of existing and emerging *threats and risks* (natural, technological, behavioral, etc.) in the modern agri-food chains are identified (DTRA & IIBR, 2011; Humphrey and Memedovic, 2006; OECD, 2011). Diverse *market* and *private* modes evolved to address specific risks driven by ethics, competition, consumer demand, business initiatives, trade opportunities such as direct marketing, voluntary and industry standards, insurance schemes, guarantees, fair-trade, trade with brands, origins, and organic and quality products. Different *bilateral and multilateral private* forms are used widely to safeguard against risks, explore benefits, and facilitate exchange such as clientalisation, contractual arrangements, cooperation, and complete backward/forward integration. Special *trilateral forms* emerged to enhance security and the confidence of partners and consumers, including independent (third-party) certification and inspection. Trade internationalization is increasingly associated with *collective private* actions (standards, control mechanisms) on transnational and global scales (e.g., GLOBALGAP). Property (security/safety) rights modernization and market and private "failures" brought about the needs and modes for *public interventions* (assistance, regulations, provision) as the scope and stringency of publically imposed rules expand constantly to embrace new products, methods, dimensions (human, animal, plant, eco-health), hazards (GMC, nanotechnology, terrorism), and information requirements. Furthermore, the globalization of exchange and threats/risks increasingly require setting *transnational public order* (ISO, WHO, FAO, WTO). For example, there are common (traceability, precaution, communication) principles (food, veterinary, phytosanitary, feed, environmental etc.), legislation, and implementing and enforcing agencies (EFSA, ECDC, ECHA) for the agri-food chains and imports in the EU.

Consumers' concerns about food safety risks have increased significantly after major food safety "events"/crises in recent years (avian flu; mad cow and foot-and-mouth diseases; poultry salmonella; contamination of dairies, berries, and olive oil; natural and industrial disasters, etc.). For example, since 2005 the number of respondents "worrying about food-safety problems" in the EU increased, and as many as 48% of European consumers (in Bulgaria, approximately 75%) indicated that consumed food was "very or fairly likely" to damage their health (Eurostat, 2010).

There are a number of *(new) opportunities* for risk governance in the agri-food chain (Figure 3): *First,* advances and dissemination of *technical* food chain, training and risk management *methods* (microbiological, genetic, electrical, laser, robotic, immunological, chemical and biosensor, nanotechnology, ICT etc.), integral and food chain *approaches*, and research, monitoring, testing, decision making, and forecasting *capabilities* for risk-detection, assessment, prevention, and mitigation (COST, 2009; Trench at al., 2011). For instance, advances in detection, assessment, and mitigation methods and technologies associated with biological and chemical risks are presented by DTRA & IIBR (2011).

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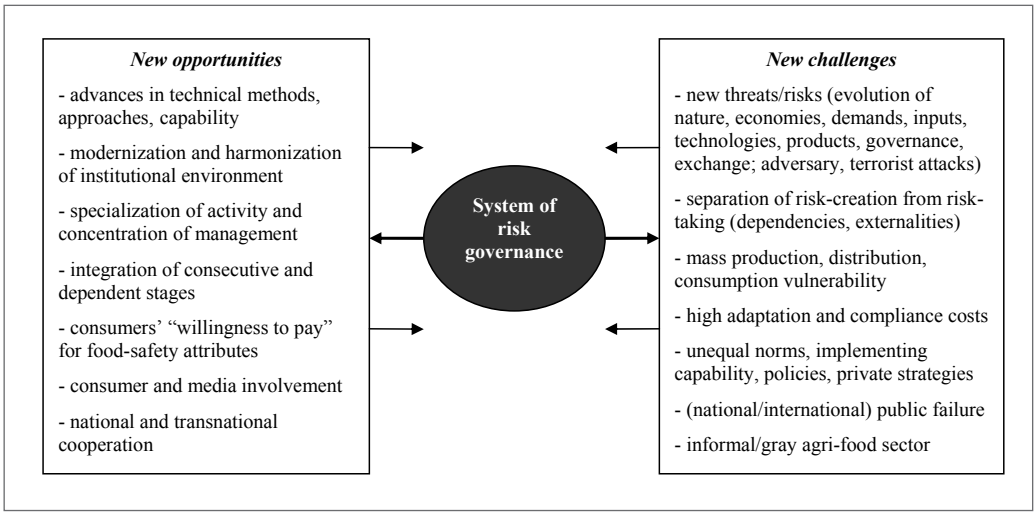

Figure 3. Opportunities and challenges for risks governance in the agri-food chain

Second, modernization and *international* harmonization of *institutional environments* (private, corporate, collective, NGOs, public food-safety and related standards, rules, enforcements). For instance, EU membership improves considerably the "rules of the game" in new member states; market access rules and/or "corporate responsibilities" induce transformations in the agri-food sector of exporting countries in Africa, Latin America, and Asia.

Third, considerable development of *specialization* of activities (including risk taking, monitoring, management) and *concentration of (integral) management* in food-production, processing, servicing, and distribution allowing centralized innovation and enforcement; time, scale, and scope economies; and easy third-party control. For instance, the market share of the three largest food retailers comprise between 27 and 91% in the EU states (Eurostat, 2010), and food safety training, certification, inspection, and information are large international businesses (Humphrey and Memedovic, 2006).

Fourth, quasi or complete *integration* of the consecutive or dependent stages in food chains are creating mutual interests and effective, long-term means for risk perception, communication, and management. For example, in Bulgaria the (raw) milk supply is closely integrated by (dairy) processors through on-farm (collecting, testing) investments and interlinks (inputs, credit, and service supply against milk delivery) contracts with smallholders, while dairy marketing is managed by branding (standards, bio labels) and long-term contracts (Bachev, 2011a).

Fifth, the increasing consumer "willingness to pay" for food safety attributes such as chemical and hormone bans, safety and inspection labels, and original and special products (Trench at al., 2011). The latter justify and make economically possible the pay back of costs for special governance.

Sixth, the growing involvement of *consumers* (representation, organizations) and *media* and the *national* and *transnational* (information, technical, managerial, training, certification) *cooperation* of partners and stakeholders are improving the options available to agents, inducing public and private actions, and enhancing risk management communication, efficiency, and speed.

Modern developments are also associated with a number of *(new) challenges* for risk governance in the agri-food chain: *i)* Emergence of new threats, risks, and uncertainty associated with the evolution of the *natural environment* (climate change, water stress, "new" plant, animal and human hazards) as well as new human-induced *economic, financial, food security and safety, water, environmental etc. crises,* on large *(transnational, global) scales.*

ii) Increasing new threats, risks, and uncertainty connected with *inputs, technologies,* and *product* differentiation and innovation. For example, the Fukushima nuclear accident severely affected the agri-food sector in Japan and beyond, and there are uncertainties associated with the growing application of nanotechnologies and GMCs, etc. (Eurostat, 2010).

iii) Increasing specialization and concentration of activity and organizations which *separate "risk creation"* (incidents, ignorance, opportunisms) and *risk taking* (unilateral dependencies, quasi-monopolies, spill-overs, externalities). Thus, risk assessment, pricing, communication, disputing, and liability through (pure) market and private modes are very difficult and costly. For instance, cheating, misleading, and pirating are common in food chain relations, including high information asymmetry, detection, disputing, and punishment costs. It is indicative that for food risk information, consumers in the EU place greater trust in "health professionals", "family and friends", "consumers associations", and "scientists" rather than "food producers" and "supermarkets and shops" (Eurostat, 2010).

iv) Widespread mass production, distribution, and consumption increase the *vulnerability* of the agri-food chain expanding scope and severity of natural, incidental, opportunistic, criminal, and terrorist risks. For instance, in Europe there is a growing number of official notifications based on market and non-member country controls, food poisoning, consumer complaints, company self-checks, border screenings, and rejections (Eurostat, 2010).

v) Increasing *adaptation* and *compliance costs* (capital, training, certification, documentation, etc.) for rapidly evolving markets and institutional environments that delay or prevent the reformation of small farms and food chain enterprises (Trench et al., 2011; Bachev, 2010). For instance, in Bulgaria, the adaptation of dairy and meat processors to EU standards continued for 10 years, and two-thirds of them ceased to exist before the accession of their country (Bachev, 2011a).

vi) Public and private food quality and safety standards, and the efficiency of their enforcement, differ considerably between industries, countries, and regions (Humphrey and Memedovic, 2006). That is result of *unequal norms* (GAPs, formal and informal rules) and *implementing* and *enforcing capability*, or deliberate *policies,* or private *strategies* (e.g., multinationals that sell the "same" products with different quality in different countries). "Double/multiple standards" are responsible for exchange inequality and dissimilar threats and risks exposure of individual agri-food systems.

vii) Wide spread "public failures" in food chain (risk) management such as bad, inefficient, delayed, or under/over interventions; gaps, overlaps, infighting, and contradictions among different agencies and rules; high bureaucratic costs; and unsustainable costs and underfunding. For instance, the Bulgarian Food Agency was established after a 5-year delay; the Acquis Communautaire are still not completely implemented (capability deficiency, mismanagement, corruption); and trust of the EU rather than national institutions prevails (Bachev, 2010). There are also numerous instances of *international* assistance or governance *failures* when institutions are "imported" rather than adapted or designed for specific local conditions (Bachev, 2010).

viii) Production, marketing, and consumption traditions, high food or governance costs, and deficiencies of will and capacity are responsible for the persistence of the high risk *informal/gray* agri-food sector around the globe without effective control and substandard, fake, and illegitimate products and activities. For instance, only one-third of Bulgarian dairy farms comply with EU milk standards, only 0.1% possesses safe manure pile sites, and half of the milk production is consumed by the producer at home, exchanged or directly sold (Bachev, 2010).

ix) Multiplying new threats and risks associated with *adversary* (competitor) and *terrorist* attacks, and emerging *governing* and *exchange forms* (street sales; internet, phone and mail order sales; shopping trips). These risks all require specific/non-traditional risk management methods and modes such as guards, policing, intelligence, multi-organizational and transnational cooperation, etc.

Conclusion

We have demonstrated that governance, along with technical, information and other issues, play a central role in risk management analysis and design. The entire spectrum of diverse types of threats and risks (natural, market, health, criminal, policy etc.), specific (natural,

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technological, and often neglected behavioral, dimensional, and institutional) factors, and the comparative benefits and costs (including commonly ignored third-party costs, transaction costs, and time) are to be taken into account in assessing efficiencies, complementarities and prospects of all feasible and alternative (market, private, public, hybrid) modes. We suggest the use of discrete structural analysis to match the features of a risk to be managed (such as probability, significance, acceptance level, and collective action needs) and its critical (institutional, technological, behavioral, etc.) factors with the comparative advantages of the alternative modes to inform, stimulate appropriate behavior, align interests, and overcome, reduce, control, share, dispute, and minimize the overall costs of risk.

Moreover, the system of risk management is to adapt/improve by taking advantage of the summarized new opportunities and overcoming/defending against evolving new challenges. We have demonstrated that more hybrid (public-private, public-collective) modes should be employed given their coordination, incentive, control, and cost advantages. (Pure) public management of most agri-food-chain risks is difficult or impossible (agents' opportunism, informal sectors, externalities). Often, the introduction and enforcement of new rights (food security, risk-management responsibility) and supporting private and collective initiatives (informing, training, assisting, funding) are much more efficient.

Finally, we argue that greater support must be given to multi and inter-disciplinary research on (factors, modes, impacts of) risk governance in the agri-food chain in order to provide effective support to national and international policies, the design of modes for public interventions, and individual, collective and business actions.

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