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Risks and Risk Management in Agri-food Chains

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Abstract. Risks management studies in the agri-food sector predominately focus on the technical methods and the capability to perceive, prevent, mitigate, and recover from diverse risks. In most economic publications the risks are usually studied as another commodity regulated by the market supply and demand, and the farmers "willingness to pay" for an insurance contract modeled. At the same time, the risk management analysis largely ignore a significant "human nature" based (bounded rationality, opportunism) risk, critical factors for the managerial choice such as the institutional environment and the transaction costs, and diversity of alternative (market, private, collective, public, hybrid) modes of risk management. This paper incorporates the interdisciplinary New Institutional Economics and presents a comprehensive framework for analyzing the risk management in the agri-food sector. First, it specifies the diverse (natural, technical, behavioral, economic, policy etc.) type of agri-food risks, and the market, private, public and hybrid modes of their management. Second, it defines the efficiency of risk management and identifies (personal, institutional, dimensional, technological, natural) factors of governance choice. Third, it presents stages in the analysis of risk management and for the improvement of public intervention in the risk governance. Forth, it identifies the contemporary opportunities and challenges for the risk governance in the agri-food chain. Finally, it identifies challenges, assesses efficiency, and present responses of the agri-food risk management after the Fukushima nuclear accident in Japan in March 2011.
Keywords. Agri-food chain and risk management, Market, Private and public governance, Fukushima nuclear disaster.
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1. Introduction

Around the globe the issues of management of diverse (natural, technical, market, financial, criminal, policy etc.) risks in agrarian and food sectors are among the most topical in academic, business and policies debates (Babcock, 2004; CIPS, 2012; Deep & Dani, 2010; EU, 2009; OECD, 2008; Olsson & Skjöldebrand, 2008; Ramaswami et al., 2008; RPDRM, 2012; Schaffnit-Chatterjee, 2010; Shepherd et al., 2006; Trench et al., 2011; Weaver & Kim, 2000). In the last decades, newly evolving uncertainty, risks and crisis associated with the progression of natural environment, products and technology safety, social demands, policies, economy, and globalization, all they have put additional challenges on existing system of risk management in agri-food sector. For instance, the March 2011 Fukushima nuclear accident in Japan has been posing serious challenges to a well-developed risk management system in the country.

Most risks management studies in agri-food sector predominately focus on technical methods and capability to perceive, prevent, mitigate, and recover from diverse threats and risks (Barker, 2005; DTRA & IIBR, 2011; Hefnawy, 2011;

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Jaffee et al., 2008; Luning et al., 2006). In majority of economic publications a Neoclassical approach is applied, the risks is studied as other commodity regulated by market supply and demand, and farmers "willingness to pay" for an insurance contract in relations to agents risk aversion, risk probability and magnitude of damages modeled (Gerasymenko & Zhemoyda, 2009; OECD, 2011). Nevertheless, market and private failures are acknowledged, and the needs for public intervention in risk management increasingly recognized. At the same time, risk management analyses largely ignore a significant "human nature" (bounded rationality, opportunism) based risks, the critical factors for the managerial choice such as the institutional environment and the transaction costs, and the diversity of alternative (market, private, collective, public, hybrid) modes of risk management. As a result, the efficiency and complementarities of diverse agri-food risk management modes can not be properly assessed (Bachev, 2012a).

Despite the significant advancement in the risk management technologies and the "menu" of risk reduction, mitigation and copping strategies, a great number of failures and challenges (production, supply chain, food and human safety, environmental etc.) continue to persist in agri-food sector (Dani & Deep, 2010; EU, 2009; Humphrey & Memedovic, 2006; OECD, 2008; Luning et al., 2006). Consequently, a greater attention is directed to the *system of governance* which eventually determines the exploration of technological opportunities and the state of agri-food security (Bachev, 2010a; 2011c).

This paper incorporates the interdisciplinary *New Institutional Economics* (Coase, 1939; 1960; Furuboth & Richter, 1998; North, 1990; Williamson, 1981; 1996) and presents a comprehensive framework for analyzing the risk management in agri-food sector. *First*, it specifies the type of agri-food risks and the modes of their management. *Second*, it defines the efficiency of risk management and identifies factors for the governance choice. *Third*, it presents stages in the analysis of risk management and for the improvement of public intervention in the risk governance. *Forth*, it specifies the contemporary opportunities and challenges for the risk governance in the agri-food chain. *Finally*, it identifies challenges, assesses efficiency, and present responses of the agri-food risk management after the Fukushima nuclear accident in Japan in March 2011.

2. Framework for analyzing and improvement of agri-food risk management

2.1. Agri-food risks and modes of their governance

Risk related to agri-food sector is *any current or future hazard (event) with a significant negative impact(s).* It is either an *idiosyncratic*, accidental, low probability, unpredictable event/threat, or it is *systematic* - a high probability, "predictable" event/threat. The risk and threat could be of a *natural* origin - e.g. adverse weather, insect attract, catastrophic event etc. They may be of a *technological* origin - "pure" technical failures like tractor's flat tire, engine disorder etc. They are often of *human origin* - individual or collective actions/inactions, "human nature". Frequently, risks are a combination of previous three.

A great portion of risks in agri-food sector are caused or are consequences of a human actions or inactions. The *individual* behavior and actions causing risks may range from:

- *agent's ignorance* – "normal" human errors, lack of sufficient knowledge, information, and training;

- *risk-taking (retention) strategy of individuals* - accepting "higher than normal" risk;

- *mismanagement* - bad planning, prevention, recovery;
- deliberate *opportunistic behavior* - pre-contractual cheating and "adverse selection", post-contractual "moral hazard";
- *criminal acts* such as stealing property or yields, arson, invasion on individual safety;
- *terrorist attacks* – e.g. contamination of inputs and outputs aiming "mass terror" etc.

The *collective actions,* which are source of risks are commonly related to:

- *economic dynamics and uncertainty* - changing industry and consumers demands, market price volatility, international competition, market "failures" and disbalances such as "lack" of labor, credit, certain inputs etc.;
- *collective orders* - "free riding" in big organizations, codes of behaviors, industry standards, strikes and trade restrictions, community rules and restrictions;
- *public order* - political instability and uncertainty, evolution in informal and forma social norms and standards, public "failures" such as bad, delayed, under/over intervention, law and contracts enforcements, mismanagement, "inefficiency by design", etc.

The agri-food sector risk could be *faced* by an agri-food sector component - e.g. risk *on* a dairy-farm, *on* a food processor, *on* a trader. The risk could also be *caused* by the agri-food sector - risk *from* farming, from food processing, *from* food-distribution etc. The risk could be *internal* for the agri-food chain such as hazards cased by one element to another, and staying in or mitigating *within* the sector. It could also be *external* associated with hazard coming from outside factors (such as natural environment, government policy, international trade), and/or affecting external components (consumers, residents, industries, nature).

Finally, the risks could be *private,* when it is taken by individuals, collectives, economic entities (households, firms, cooperatives), industries. The risk is often *public* affecting large groups, communities, consumers, society, future generations.

The risk is big when there is *great likelihood* of a risky event to occur and that is combined with substantial possible *negative consequences.* The later may take a great variety of forms – e.g. damaged human and livestock health and property, inferior yields and income, lost market positions, food and environmental contamination etc. When risk is considerable it would likely be associated with *significant costs* which sometimes are hardly expressed in monetary terms - e.g. human health hazards, degradared soils, lost biodiversity and eco-system services etc. Thus the "rational" agents maximizing own welfare will be interested to *invest in risk prevention and reduction*.

In a *narrow* ("technical") sense the *risk management* comprises the individual, collective and public *action(s)* for reducing or eliminating risk and its negative consequences. In a *broader* sense the *risk management* is the specific *system of social order (governance)* responsible for a particular *behavior(s) of agents* and determining the way(s) of assignment, protection, exchange, coordination, stimulation and disputing diverse risks, rights, resources, and activities (Bachev, 2011c). In the particular socio-economic, technological and natural environment, the specific *system of risk governance* "put in place" is intimately responsible for the efficiency of detection, prevention, mitigation, and reduction of diverse threats and risks and their negative consequences (Bachev, 2012a).

The generic *forms* and *mechanisms* of risk governance are (Figure1):

- *private modes* ("private and collective order") - diverse private initiatives, and specially designed contractual and organizational arrangements tailored to particular features of risks and agents – e.g. private or collective codes of behavior, diverse (rational, security, future etc.) private contracts, cooperatives, associations, business ventures etc.

- *market modes* ("invisible hand of market") - various decentralized initiatives governed by the free market price movements and the market competition such as risk trading (selling and buying insurance), future contracts and options, production and trade of special (organic, fair-trade, origins) products etc.

- *public modes* ("public order") - various forms of a third-party public (Government, international) intervention in market and private sectors such as public information, public regulation, public ban, public assistance, public funding, public assurance, public taxation, public contract, pubic provision etc.

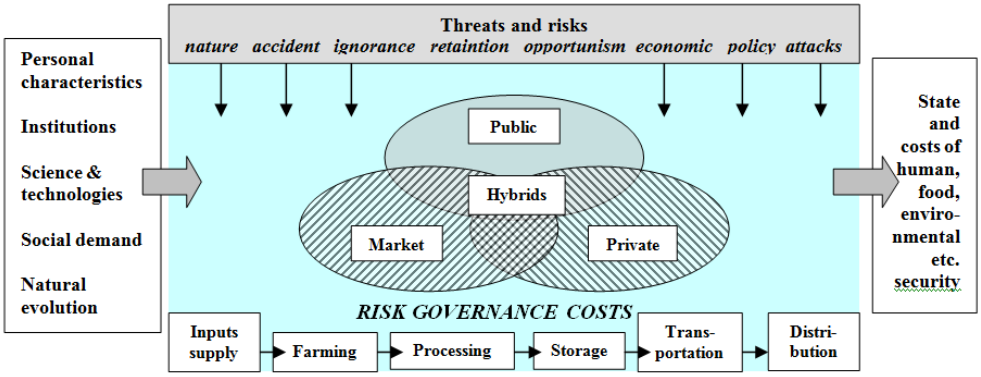


Figure 1. *Generic risks, factors, stages and modes of risk governance in agri-food sector*

Sometimes, the risk management in agri-food sector could be effectively done though *"self-management"* – e.g. production management, adaptation to industry and formal standards, "self-insurance" though keeping stocks, financial reserves etc. For instance, primitive forms of *on farm* risk management through improving *production management* are widespread such as control and security enhancement, application of appropriate (pest, disease, weather resist) varieties, technology and production structure, product diversification, dislocation etc. Similarly, *off-farm* enterprise (and income) diversification is a major strategy for risk management in most of the European farms (Bachev & Tanic, 2011).

However, very often, the risk management requires an effective *governance of relations* with other agents – exchange and regulations of rights, alignment of conflicts, coalition of resources, collective or public actions at regional, national and transnational scales etc. Accordingly, a risk could be "managed" through a *market mode* (e.g. purchase of insurance, hedging with future price contingency contracts), a *private mode* (contractual or literal integration, cooperation), a *public form* (state regulation, guarantee, compensation), or a *hybrid* combination of other forms.

2.2. Efficiency of risk management

The individual modes of risk governance are with *unequal* efficiency since they have dissimilar *potential* to reduce the likelihood and the (negative) impact of risk, and command different *costs* (Bachev, 2010a). Principally, the market or the collective governance has bigger advantages over the internal mode ("own protection") since they allow the exploration of economies of scale and scope in risk prevention and bearing (sharing) negative consequences[1]. However, the risk trading and/or sharing is often associated with significant *transaction costs* - for finding best partners, prices, formulating and disputing terms of exchange, coalition, safeguarding against new risk from opportunistic behavior of counterparts or partners etc. Consequently, *market* and *private sector "fail"* to govern effectively

[1] Most studies on risk management in agriculture focus on modeling farmers "willingness to pay" for a risk contract in relations to risk's probability and amount of likely damages (e.g. Gerasymenko & Zhemoyda, 2009).

the existing and likely risks in agri-food sector, and there is a need for a *"state intervention"* in risk management - assisting farmers cooperation, public costs-sharing or provision, mandatory insurance regulation etc.

Thus *"governance matters"* and applying a proper structure of risk management is an important part of the overall process of the optimization (effective allocation) of resources.

Following Coase's logic (Coase, 1960) if *property rights* were *well-defined* and *transaction costs* were *zero* then all risks would be managed in the most efficient (socially optimal) way independent of the specific mode of governance[2]. Then individual agents would either sell out their risk to a specialized market agent, or safeguard against the risk through terms of a private contract, or join a risk-sharing organization of interested parties. The risk-taking would be distributed between (exchanged, shared by) agents according to their will while the total costs for risk prevention, assurance, reduction, and recovery minimized. The rational choice for an individual agent would be to get rid of a significant risk altogether – to sell the risk out to a specialized market agent (a risk-taker). Such totally decentralized (market) governance would optimize the risk-taking and minimize the "technological costs" for risk assurance and recovery exploring the entire potential for economies of size and scope at national and/or transnational scales.

However, when property rights are not well-defined or enforced and transaction costs[3] are high then the *type of governance* is essential for the extent and costs of risk protection (Bachev, 2012a). For instance, an internal (ownership) mode is often preferred because of the comparative protective and costs advantages for "standard" natural or behavioral risk management over the outside (market or contract) modes. What is more, frequently the enormous *transaction costs* could even *block the development of insurance market* or the emergence of *mutually beneficial (collective) risk-sharing organization*. It is well known that despite "common" interests and the huge potential for risk minimization the collective organization for risk-sharing are not or hardly developed by stallholders.

Furthermore, the formal and informal *institutional restrictions* could make some modes of risk governance impossible - e.g. risk assuring monopolies and/or cartel arrangements are illegal in many countries while most entrepreneurial risk-taking is endorsed (the "low risk - low profit" principle). Thus, not all modes of risk governance are constantly feasible in any socio-economic settings[4].

What is more, *individual agents differ* significantly in their *capacity to recognize, take, pay for prevention, and manage a risk.* For instance, a risk-taking farmer prefers risky but more productive forms (e.g. bank credit for a new profitable venture); the bigger enterprise can better perceive (hire expertise, collect information) and invest in protection of risks and/or take (absorb negative consequences) of a larger risk, etc. Besides, the individual agents have quite different interests for an effective management of a particular risk(s) since they get unlike benefits and costs from the risk management – e.g. effective environmental management often create costs for farmers while benefit the residents and other industries.

[2] In such a world some kind of risks would not even exist or be of no importance - e.g. risks related to adverse human behavior (any opportunistic intention would be discovered at no costs and interests effectively safeguarded).

[3] Transaction costs are the *costs associated with the distribution, protection and the exchange of diverse rights and obligations of individual, groups, and generations* (Bachev, 2010a).

[4] Nevertheless, if costs associated with the illegitimate forms is not high (possibility for disclosure low, enforcement and punishment insignificant) while benefits are considerable, then the more effective governance prevail – large gray or black economies are widespread around the globe.

Last but not least important, there is no singe *universal* form for the management of divers type of risks and according to the *specific feature of each risk* (origin, probability, likely damages) there will be different most effective form of governance. For instance, while a low probable "standard" (natural, criminal) risk could be effectively governed by a classical market contract (e.g. purchase of insurance), most behavioral risks require special private modes (branding, long-term or interlink contracts, vertical integration), a high damaging risk from a terrorist attract necessities specialized public forms (intelligence, security enforcement) etc.

Hence, depending on the *kind and severity of risk*, and the *interests and personal characteristics of individuals*, and the *specific natural, economic and institutional environment*, there will be *different (most) efficient* forms of governing a particular kind of risk. Consequently, some *governance mix* will always exist to deal with divers risks associated with the agri-food sector (Bachev & Nanseki, 2008).

In many cases, an *effective* risk management leads to a considerable *reduction* or *removal* of a particular type of risk. However, often complete risk elimination is either very costly ("unaffordable" by individuals, communities, society) or practically impossible (when uncertainty associated with the future events is enormous, the transaction costs are very high etc.). For instance, certain natural risk will always exist despite the available system of risk management. Besides, it is practically impossible to write a "compete" contract (e.g. for insurance supply and trading risk) including all probable future contingencies, and the subsequent rights and obligations of each party. Consequently, some transacting risk will always retain. Therefore, an effective risk management is usually connected with the needs for some *trade-off* between the benefits from reducing a particular risk (saved costs, minimized negative impacts) and the related *costs for the risk governance*[5].

Furthermore, an individual mode of governance could offer an effective protection from different *(multiple)* risks. Besides, an effective management of one type of risk might be associated with exposure to a new type of risk/costs – e.g. the vertical integration eliminates the "market risk" but creates a risk from opportunisms of partners. Moreover, the level of the (overall) risk exposure is typically determined by the *"critical"* (most important) riskand the integral risk is rarely a sum of the individual risks. For instance, if there is a very high risk/threat for stealing the harvest, otherwise important risk for crop pest protection would not be added to the overall risk of the farm[6].

Frequently, there are a number of possible *(alternative)* forms of governance of a particular type of risk – e.g. "risk to the environment" could be managed as voluntary actions of individual farmers, environmental cooperation, private contracts with interested parties, assisted by a third party organization, public eco-contact, public regulation, hybrid forms etc. (Bachev, 2010a).

In certain cases, some forms of the risk management are practically impossible or socially unacceptable – e.g. insurance markets do not develop for many kind of agro-food risks and the *private management* is the only option; the management of many environmental risks and challenges require *collective actions* at local, eco-system, regional or transnational levels etc. In modern societies many type of risks management are *publicly imposed* – e.g. food safety risk is under *public management* and harmonized in the EU, there are strict regulations on GMC,

[5] Thus some "uncovered" risk would normally remain.

[6] That was the case in transitional Bulgarian conditions where due to ineffective low and security enforcement, the entire sub-sectors of agriculture (vineyards, orchards) has been abandoned by smallholders in certain regions of the country because of the extremely high risk/treat of stealing the harvest by organized or individual thieves.

"precaution principle" is mandatory for the environmental related projects and carried out by the state authority, "safety nets" are organized as public projects etc.

Therefore, a *comparative analysis* is to be employed to select among (technically, economically, socially) *feasible alternatives* the most efficient one – that which would reduce the overall risk to "*acceptable"* level, and which would require minimum *total* (risk assurance *and* risk governance) costs (Bachev, 2012a). The later must include all current and future costs associated with the risk management – the *current* technological and management costs (for adaptation, compliance, information, certification), risk insurance premium, contracting and coalition costs as well as the (current and future) *long-term* costs for adaptation and recovering damages including associated *transaction costs* (disputes, expertise, low suits etc.) for claiming experienced losses[7].

In any case an *individual, group, community, sectoral, chain, national and international* efficiency of the risk management have to be distinguished. It is often when elimination of a risk for one agent induce a (new) risk for another agent – e.g. the agri-food price fluctuation causes an income risk to the producers but benefits the speculators; the application of chemicals reduces risk for the farmers but produces significant negative effects (e.g. water, soil and air contamination) on the residents, consumers, affected industries etc.

Furthermore, the risk management is only a *part* of the overall governance of divers (production, consumption, and transaction) activities of agents[8]. That is why the total efficiency (benefits, disadvantages, costs saving and risk minimization potential) of the various modes for the individual agents and the public at large are to be taken into account[9].

According to the specific natural and socio-economic environment, the personal characteristics of individuals, and the social preferences, various *structure of risk governance* could evolve in different sub-sectors, industries, supply chains, and societies. In one extreme, the system of risk management would work well and only the "normal" (e.g. entrepreneurial) risk would be left "ungoverned". In some cases, *market* (free-market prices, competition) would fail to provide adequate risk governance but a variety of effective *private modes* would emerge to fill the gap - special contractual and organizational arrangements, vertical integration, cooperation. Often, both market and private governance may fail but an effective *public involvement* (regulation, assistance, support, partnerships) could cure the problem.

Nevertheless, there are situations when the specific institutional and risk management costs structure would lead to failures of market and private modes as well as of the needed public (Government, local authority etc.) intervention in risk governance[10]. Consequently, a whole range of risks would be left unmanaged which would have an adverse effect on the size and the sustainability of agri-food enterprises, the markets development, the evolution of production and consumption, the state of environment, and the social welfare (Bachev, 2010a).

Depending on the costs and the efficiency of the *specific* system of governance put in a particular (sub)sector, region, country, supply chain etc. there will be *unlike*

[7] Most analyses of the agri-food risk management usually ignore the current and likely long-term *transaction costs* associated with the risk management.

[8] E.g. most of the managerial innovations in farming and agri-food chain have been driven by the transaction costs economizing reason (Sporleder).

[9] Frequently minimization of the risk related costs is associated with an increase in production and/or transaction costs, and vice versa. Often the risk elimination costs of one agent brings about a higher security for another agent in agri-food chain etc.

[10] Principally, when market and private modes fail there is a strong *need for a public* intervention in agriculture (Bachev, 2011b).

outcome in terms of *"residual" risks*, and dissimilar *state* and *costs of human, food, environmental etc. security* in different regions and period of time (Figure 1). For instance, when there is inefficient public enforcement of food, labor, environmental etc. safety standards (lack of political willingness or administrative capability) then enormous "gray" agrarian and food sector develops with inferior, hazardous and counterfeit components.

2.3. Factors of governance choice

The forms of risk management in agri-food sector would depended on the risk type and features, the personal characteristics of agents, the institutional environment, the progress in science and technologies, culture, the social education and preferences, the evolution of natural environment etc. (Figure 1).

The risk features like origin, probability of occurrence, likely damages, scale etc. are important factor for the governance choice. For instance, local technical or behavioral risk could be effectively managed though a private mode while most of market and environmental risks require collective actions at regional, national or transnational level. For a high probability and harmful risks the agents will prefer more secure (and more expensive) mode – e.g. security investment, purchase of insurance, keeping reserves, taking hostages, interlinked organization. Nevertheless due to the lack of economic means many small size farmers can not afford related costs and practice no or primitive forms of risk management – cash and carry deals, product diversification etc. Here there is a need for a third party (Government, international assistance) intervention though insurance, support, safety net etc. schemes to decrease farmers vulnerability.

The personal and behavioral characteristics of agents (such as specific interests, preferences, knowledge, capability, risk-aversion, reputation, trust, "contractual" power, opportunisms) are important factor for the choice of management form. For instance, some risks are not perceived (unknown) by private and public agents and therefore no risk management is put at all; in some cultures, the cooperative is the preferred mode of agrarian organization; experienced and trained farmer could design and manage a bigger organization (based on hired labor) and more outside (credit, insurance, inputs supply etc.) contracts adapted to his specific needs; a risk-taking entrepreneur prefers riskier but more productive (specialized, high margin) ventures etc.

The *behavioral* factors such as individuals' bounded rationality and opportunisms have been identified as responsible for the transaction costs, and thus for the choice of organizational mode (Williamson, 1996). They are widely studied in the insurance theory as a source for cheating by both sides of contract (Derrig, 2002). The agents do not possess full information about the economic system (risks, price ranges and dynamics, trade opportunities, policy development) since collection and processing of such information is very expensive or impossible (multiple markets, future events, partners intention for cheating etc.). In order to optimize decision-making they have to spent on "increasing their imperfect rationality" (on data collection, analysis, forecasting, training, consultation) and selecting forms minimizing related risks/costs (internal organization, "selling out" risk etc.).

The agents are also given to opportunism and if there is an opportunity for some of the transacting sides to get non-punishably extra benefit/rent from the exchange he will likely to take an advantage of that[11]. A *pre-contractual* opportunism ("adverse selection") occurs when some of the partners use the "information asymmetry" to negotiate better contract terms. A *post-contractual opportunism*

[11] If there was no opportunism only risks related to the bounded rationality would remain (natural, technical) and consequences easily recovered with the cooperation and in a mutual benefit (risk sharing) of all parties.

("moral hazard") occurs when some counterpart takes advantage of impossibility for full observation on his activities (by another partner, a third-party) or when he takes "legal advantages" of unpredicted changes in exchange conditions (costs, prices, formal regulations etc.). The third form of opportunism ("free ride") occurs in development of large organizations where individual benefits are not-proportional to the individual efforts (costs) and everyone tend to expect others to invest in organizational development and benefit from the new organization in case of a success (Olson, 1969).

It is often costly or impossible to distinguish the opportunistic from the non-opportunistic behavior because of the bounded rationality - e.g. a farmer finds out that purchased seeds are not of high quality only during the harvesting time. Therefore, the agents have to protect their rights, investments, and transactions from the hazard (risk) of opportunism through: ex-ante efforts to find reliable counterpart and design efficient mode for partners credible commitments; and ex-post investments for overcoming (through monitoring, controlling, stimulating cooperation) of possible opportunism during the contract execution stage (Williamson, 1996).

In the agri-food sector the opportunism is widespread before signing an insurance contract (not disclosing the real information for possible risks) or during the contract execution period (not taking actions for reducing damages when risky event occurs; consciously provoking damages in order to get insurance premium etc.). That augments considerably the insurance prices and restricts the utilization of insurance contracts by small enterprises. On the other hand, insuree often "discover" the pre-contractual opportunism of the insurers only after the occurrence of harmful event finding out that not all assurance terms (protected risks, extend of coverage of damages, ways of assessing damages, extra hidden costs) had been well explained and/or adapted to farmers needs (Bachev, 2010b).

For many kinds of farm related risks the markets evolve very slowly and/or the insurance services are practically inaccessible by the majority of small operators. What is more, for many important risks an insurance is not available "for purchase at all" – e.g. the risk of lack of market demand for farm products, the fluctuation of prices, possible opportunism of the counterparts etc. That is why farmers have to develop other (private, collective) modes to safeguard their investments and rights or lobby for a public intervention in the assurance supply.

The institutional environment ("rules of the game")[12] is important factor for the management choice. For instance, in many countries some forms of risk governance are fundamental rights (on food, labor, environmental security and safety) and guaranteed by the state; a public income support to farmers is "institutionalized"; environment and food safety standards could differ even between different regions in the same state etc. Furthermore, the (external) institutional environment considerably affects the level of transaction costs – e.g. in recent years tens of thousands of European farms and processors have been closed due to the impossibility to adapt to (invest for) newly introduced EU standards for quality, safety, environmental preservation, animal welfare, certification etc.

Principally, in the conditions of stable and well-working public regulation (regulations, quality standards, price guarantees, quotas) and the effective mechanisms for laws and contract enforcement, a preference is given to the standard (spotlight and classical) market contracts. When rights and rules are not well defined or changing, and the absolute/contracted right effectively enforced, that lead to the

[12] That is *formal* and *informal* rights and rules, and the system(s) of their enforcement (North). They are defined by the (formal, informal) laws, tradition, culture, religion, ideological and ethical norms, and enforced by the state, convention, community pressure, trust, or self-enforcement.

domination of primitive form of risk management (subsistence farming, personalized and over-integrated forms) and the high vulnerability to diverse (natural, private, market, contractual, policy etc.) risks. The later was the case during the post communist transition in East Europe characterized by the fundamental restructuring, the "rules change" and ineffective public enforcement, a high exposure to "new" (natural, market, entrepreneurial, private, contractual, institutional, international etc.) risks by the newly evolving private structures, unsustainable organizations, large gray economies, undeveloped or missing (agrarian credit, insurance, extension supply etc.) markets, individuals (e.g. thefts) and organized (e.g. providers of "security services") risk introduction devastating the private businesses and the household welfare (Bachev, 2010a).

The dimensional characteristics of the activity and transactions (the *combination* of uncertainty, frequency, assets specificity, and appropriability)[13] are critical for the management choice. When *recurrence* of the transactions between the same partners is high, then both sides are interested in sustaining and minimizing costs of their relations (avoiding opportunism, sharing risk, building reputation, setting up incentive, adjustment, and conflict resolution mechanisms). Here continuation of the relations with a particular partner/s and designing a special mode for transacting has a high economic value and the costs for its development could be effectively recovered by frequent exchange. When a transaction is *occasional* (incidental) then the possibility for opportunism is great since the cheating side can not be easily punished by turning to a competitor (losing future business).

When *uncertainty* surrounding transactions increases, then costs for carrying out and secure transactions go up (for overcoming information deficiency, safeguarding against risk etc.). Since bounded rationality is crucial and opportunism can emerge the agents will use a special private form diminishing transaction uncertainty – e.g. trade with origins; providing guarantee; using share-rent or output-based compensation; an obligatory collateral for providing a credit; participating in inputs-supply or marketing cooperative; complete integration.

The transaction costs get very high when *specific assets* for the relations with a particular partner are to be deployed. Here a costless alternative use of the specific assets is not possible (loss of value) if the transactions fail to occur, are prematurely terminated, or less favorable terms are renegotiated (in contract renewal time before the end of the life-span of the specific capital). Therefore, the dependant investment/assets have to be safeguarded by a special form such as a long-term or tied-up contract, interlinks, hostage taking, joint investment, quasi or complete integration. Often, the later is quite expensive, investment in the specific capital not made, and the activity/transactions can not take place or occurs without (or loss of) comparative advantages in respect to the productivity (Bachev, 2011b).

If a high *symmetrical* (risk, capacity, product, timing, location etc.) dependency of the assets of the counterparts exists (a regime of "bilateral trade") there are strong incentives in the both parties to elaborate a special private mode of governance (e.g. interlinking the credit, inputs and insurance supply against the marketing of output). A special *relational contract* is applied when detailed terms of transacting are not known at outset (a high uncertainty), and a framework (the mutual expectations) rather than the specification of the obligations of counterparts is practiced. Here partners' (self)restrict from opportunism and are motivated to settle emerging difficulties and continue relations (a situation of frequent reciprocial trade).

When *unilateral* dependency exists (risk of unwanted "exchange", quasi or full monopoly), then the dependent side has to protect the investments against possible

[13] First three factors are identified by Williamson (1981), and the forth added by Bachev & Labonne, (2000).

opportunism (behavioral uncertainty/certainty) through integrating transactions (unified organization, joint ownership, cooperative); or safeguarding them with an interlinked contract, exchange of economic hostages, development of collective organization to outstand asymmetrical dependency (for price negotiation, lobbying for Government regulations) etc.

The activity and transacting is particularly difficult when *appropriability of rights* on behavior, products, services or resources is low. Because of the bounded rationality, the costs for the protection, detection, verification, and a third-party (court) punishment of unwanted exchange extremely high. The agents would either over-produce (e.g. negative externalities) or under-organize such activity (positive externalities) unless they are governed by an efficient private or hybrid mode - cooperation, strategic alliances, a long-term contract, trade secrets, or a public order.

The progress in science and technologies significantly improves the risk management and facilitate the diversification of its form. For instance, the introduction of new (resistant) plant and livestock varieties; the mechanization and standardization of operations and products; the application of information, forecasting, monitoring, storage, and transportation technologies, all they improve significantly the risk management in agri-food chain (COST, 2009; Hefnawy, 2011). The modern application of the science and technologies is also associated with the production and/exposure to the new type of risks – e.g. green-house gas emitions, genetic contamination, natural resource depletion, technical over-dependency etc.

Finally, the *natural environment and its evolution* are critical factors for the management choice. For instance, certain geographical regions (mountainous, river beds, tropics, etc.) are more prone then others for natural menace and risks like soil erosion, soil and water contamination, frosts, droughts, floods, pest attacks, diseases, wild animal invasions etc. What is more, evolution of the natural environment associated with a global worming, extreme weather, plant and animal diseases, drought, flooding and other natural disasters, is posing series of new challenges for the risk management in the agrarian and food sector (Hefnawy, 2011; OECD, 2011).

The identification of the *"*critical factors" of the risk management choice, the range of practically possible forms, and their efficiency (costs and benefits) for the individual agents, stages, subsectors, countries, food chains and public at large, is to be a subject for a special *micro-economic study.*

The *comparative analysis* is to be employed to select among the feasible forms the most efficient one reducing the overall risk to an *"acceptable"* level and minimizing the *total* (risk assurance and governance) *costs*. Most of the elements of the efficiency of the risk governance are hardly to quantify – e.g. the individuals' personal characteristics, the amount of the risk, the level of benefits and costs[14] associated with each mode etc. That is why a *qualitative (Discrete structural) analysis*[15] could be used. The later matches the *features of a risk* to be managed (the probability, significance, acceptance level, needs for collective action etc.) and its *critical (institutional, technological, behavioral etc.) factors* with the *comparative advantages* (the effective potential) of the *alternative modes* to inform, stimulate an appropriate behavior, and align the interests of associated agents, and to overcome, reduce, control, share, dispute, and minimize the overall costs of that risk.

In a *specific* market, institutional, technological and natural environment the effective risk governance choice will depend on the combination of the risk features

[14] The "measurement problems" associated with the transaction benefits and costs are well specified (Bachev, 2011b). They also prevent the utilization of the traditional (Neoclassical) models simply by adding a new "transacting", risk management etc. activity (Furuboth and Richter).

[15] The operationalisation of the Discrete Structural Analysis of the economic organization is done by Williamson (1981).

(probability of occurrence, likely magnitude of damages) and the critical dimensions of the activity/transactions (appropriability, assets specificity and frequency). Figure 2 presents a matrix with the principle forms for the effective risk governance in agri-food sector.

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

Figure 2. *Principle modes for risk governance in agri-food sector*
Notes: M – free market; CC – classical (standard) contract); SC – special contract; VI – vertical (internal) integration; CO – collective organisation, TPI – needs for a third-party involvement; PO – needs for a public organisation

For instance, likely probable and low damaging risks combined with a small assets specificity and appropriability usually do not necessitate (motivate, economically justify) *any risk management*.

A high "standard" risk could be effectively managed through a *free market* mode such as a 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 could be effectively managed though a *vertical integration* (internal risk management, contract forward or backward integration for 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.

A serious transacting risk exists when the situation of assets specificity is combined with a high uncertainty, low frequency, and good appropriability. The elaboration of a special governing structure for private transacting is not justified, the specific (risk reducing) investments not made, and the activity/restriction of activity fails to occur at an effective scale ("market and contract failure"). Here, a *third-part* (private, NGO, public) *involvement* in the transactions is necessary (assistance, arbitration, regulation) in order to make them more efficient or possible at all. The unprecedented development of the special origins, organic farming, systems of "fair-trade" are good examples in this respect. There is increasing consumer's demand (a price premium) for the organic, original, and fair-trade products associated with some forms of (natural, poor household, labor, quality etc.) risk management. Nevertheless the supply of the later products could not be

met unless effective trilateral governance including an 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*.

2.4. Stages in the analysis and improvement of risk management

The *analysis* and the *improvement* of the risk governance in the agri-food chain is to include following *steps* (Figure 3): *First*, identification of *existing* and *emerging* threats and risks in agri-food chain. The persistence of certain risks is a good indicator for ineffective management (Bachev & Nanseki, 2008). The modern science offers quite reliable and sophisticated methods for assessing various risks *to* or *caused* by the agri-food chain (DTRA & IIBR, 2011; Trench et al., 2011).

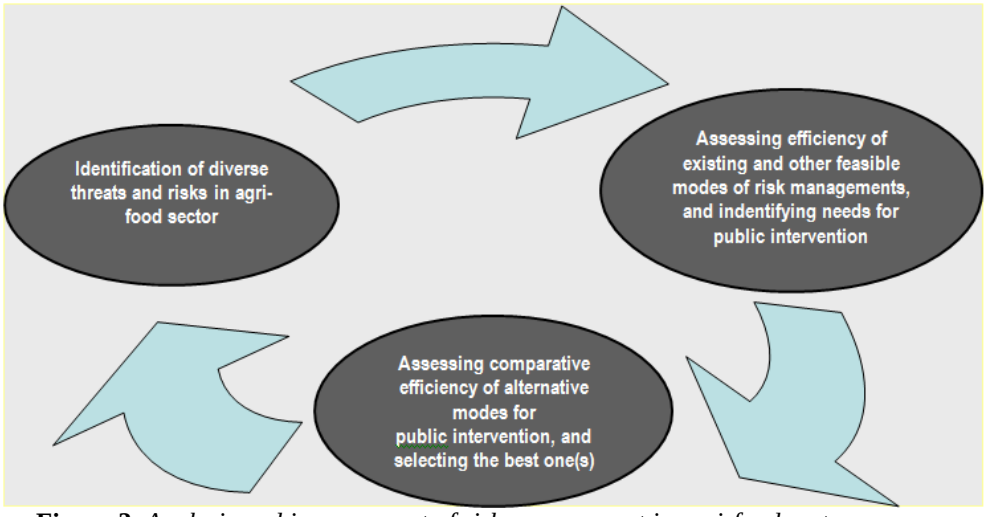


Figure 3. *Analysis and improvement of risk management in agri-food sector*

*Second***,** specification of *existing* and *other feasible modes* of risks governance, and assessing their efficiency, sustainability and prospects of development.

The *efficiency* of individual modes shows the capability for risks detection, prevention, mitigation and recovery at lowest costs while the *sustainability* reveals the "internal" potential to adapt to socio-economic, technological and environmental changes and associated threats and risks. A holistic framework for assessing the efficiency and the evolution of governing modes is suggested by OECD (2011) and Bachev (2010a).

That stage is to identify the *deficiencies* of dominating (market, private, and public) modes to solve the existing and emerging risks, and to determine the *needs for a (new) public intervention*. For instance, when appropriability associated with the transaction/activity is low, there is no pure market or private mode to protect from associated risks[16]. Emerging of a special large-members organization for dealing with low appropriability to cover the entire "social" risk would be very slow and expensive, and they unlikely be sustainable in a long run (free riding). Therefore, there is a strong need for a *third-party public intervention* in order to

[16] Respecting others rights or "granting" risk protection rights to others could be governed by the "good will" or charity actions (e.g. eco-sustainability movement initially evolved as a voluntary activity). In any case, the voluntary initiatives could hardly satisfy the entire social demand especially if they require significant costs.

make protection of such risk possible or more effective – either pure public organization (e.g. public assurance for high damage natural or economic disasters) or "quasi public" mode (collective organization assisted/ordered by a third party) for high probable lower damaging risks (Figure 2).

*Third***,** identification of the *alternative* modes for public intervention to correct (the market, private, public) failures, assessing their *comparative efficiency*, and *selection* the best one(s).

The comparative assessment is to be made on (technically, economically, politically) *feasible* forms as mode(s) minimizing the *total* risk management (implementing *and* transaction) *costs* selected. The analysis is to take into account the overall *private* and *social* costs – the *direct* and *indirect* (individual, third-party, tax payer, assistance agency etc.) expenses, and the *private* and *public transacting costs*. The later often comprise a significant portion of the overall risk management costs and are usually ignored by analysts – e.g. costs for the coordination, stimulation, mismanagement of the bureaucracy; for the individuals' participation and usage of the public modes (expenses for information, paper works, payments of fees, bribes); the costs for community control over and for the reorganization of the bureaucracy (modernization and liquidation of public modes), and the (opportunity) costs of public inaction, etc.

Initially, the existing and emerging problems (difficulties, costs, risks, failures) in the organization of market and private governance have to be specified. The appropriate pubic involvement would be to *create institutional environment* for: making private investments less dependent, decreasing uncertainty surrounding market and private transactions, increasing intensity of exchange, protecting private rights and investments etc. For instance, the State establishes and enforces quality, safety and eco-standards, certifies producers, regulates employment relations, transfers management rights on natural resources etc., and all that increases the efficiency of market and private risk management.

Next, practically possible modes for increasing appropriability have to be considered. The low appropriability is often caused by unspecified or badly specified private rights and obligations. In some cases, the most effective government intervention would be to *introduce and enforce new private and groups (property) rights* – on diverse type of risks and its trading; on natural and biological resources; on food safety and clean environment; tradable quotas for products, inputs, emissions; on intellectual property, origins etc. That intervention transfers the organization of activity/transactions into market and private governance, liberalizes market competition and induces private incentives (and investments) in certain agrarian risk management.

In other instances, it is more efficient to put in place *public regulations* for risk minimization: for utilization of resources, products and services (e.g. standards for labor, product, and environmental safety); introduction of foreign species and GM crops, and for (water, soil, air, comfort) contamination; ban on certain inputs, products or technologies; regulations for trading ecosystem service protection; trade regimes; mandatory risk and eco-training and licensing of operators, etc.

In other instances, using the incentives and restrictions of the *tax system* is the most effective form for intervention. Different sorts of tax preferences are widely used to create favorable conditions for the development of certain (sub)sectors and regions, forms of organization, segment of population, or types of activities. For instance, the environmental taxation on emissions or products (inputs, outputs of production) is applied to reduce use or emissions of harmful substances; tax reductions are used to assist overcoming the negative consequences of natural disasters by private agents etc.

In some cases, *public support* to private organizations is the best mode for intervention. Programs for modernization, enterprise adaptation, income support, environmental conservation, public risk-sharing etc. are common in most countries around the world.

Often providing *public information, recommendations, and training* to farmers, entrepreneurs, residence, and consumers in risk management is the most efficient form.

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

Usually, the specific modes are effective if they are applied alone with other modes of public intervention. The necessity of *combined intervention* (governance mix) is caused by: the complementarities (joint effect) of the individual forms; the restricted potential of some less expensive forms to achieve a certain (but not the entire) level of the socially preferred risk prevention and mitigation; the possibility to get extra benefits (e.g. "cross-compliance" requirement for participation in the public programs); the specific critical dimensions of governed activity; the risk and uncertainty (little knowledge, experience) associated with likely impact of the new forms; the administrative and financial capability of the Government to fund, control, and implement different modes; and the dominating policy doctrine.

The level of effective public intervention (governance) also depends on the kind of risk and the scale of intervention. There are public involvements which are to be executed at *local* (ecosystem, community, regional) level, while others require *nationwide* governance. And finally, there are risk management activities, which are to be initiated and coordinated at *international* (regional, European, worldwide) level due to the strong necessity for trans-border actions or the consistent (national, local) government failures. Very frequently the effective governance of many problems and risks requires *multilevel* governance with a system of combined actions at various levels involving diverse range of actors and geographical scales.

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

Generally, *hybrid modes* (public-private partnership) are much more efficient than the *pure* public forms given coordination, incentives, control and cost-sharing advantages. The involvement of the farmers, beneficiaries and interest groups increases the efficiency, decreases asymmetry of information, restricts opportunisms, increases incentives for private co-investment, and reduces management costs. For instance, the enforcement of most labor, quality, animal welfare, and environmental standards is often very difficult or impossible at all. Stimulating and supporting (assisting, training, funding) the private voluntary actions are much more effective then the mandatory public modes in terms of incentive, coordination, enforcement, and disputing costs (Bachev, 2010a).

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

Dealing with many problems and risks in the agri-food sector/chain would require *multiform, hybrid, multilevel*, and *transnational* intervention, and therefore the appropriate *governance mix* is to be specified as a result of the comparative analysis. The later let improve the design of the (new) public intervention according to the specific conditions of the food-chain components in the particular country or region in terms of increasing security and decreasing costs.

Suggested new approach also let predict likely cases of the (new) public failures due to the impossibility to mobilize a political support and resources or ineffective implementation of otherwise "good" policies in the particular conditions. Since *public failure* is feasible, its timely detection permits foreseeing the persistence/rising of certain risks, and informing the local and international communities about the consequences.

The risk management analysis is to be made at *different levels* – the individual component (inputs supply, farm, processing, transportation, distribution etc.), regional, sub-sectors, food-chain, national, and international according to the *type of risks* and the *scales of collective actions* necessary to mitigate the risks. It is not a one time exercise completing in the last stage with a perfect system of risk-management. It is rather a *permanent process* which is to improve the risk-management along with the evolution of socio-economic and natural environment, the individual and communities' awareness, and the modernization of technologies. Besides, the public (local, national, international) failure often prevails which brings us into the next cycle in the improvement of risk-management in the agri-food sector.

For the application of the suggested new approach, besides traditional statistical, industry etc. data, a *new type of data* are necessary for the diverse type of risks and the forms of governance, their critical factors for each agent, the level of related benefits and costs etc. Such data are to be collected though interviews with the agri-food chain managers, stakeholders, and experts in the area.

3. Contemporary opportunities and challenges for agri-food risk management

The modern agri-food chains involve millions actors with different interests, multiple stages, and divers risks requiring a complex, multilateral and multilevel governance at a large scale. For instance, in the EU the number of employed persons in the agri-food chain reaches 48 million working in almost 17 million different holdings and enterprises (Table 1) while final consumers comprises 500 millions[17].

Table 1. *Number of enterprises and persons employed in EU agri-food chain (1000)*

Number		Agriculture	Food and beverages activities			
			Manufacturing	Wholesaling	Retailing	Services
		2007	2008			
Holdings and enterprises	EU - 27	13 700.4	267.9	275.1	1 060.2	1 448.4
	Bulgaria	493.1	5.1	5.4	31.5	19.2
Regular farm labor force and persons employed	EU - 27	26 669.4	4 725.0	2 001.5	7 369.7	7 316.5
	Bulgaria	950.0	106.5	44.9	102.0	92.0

Source: Eurostat, 2011a.

[17] figures get much bigger if we take into account the total number of the global agents involved in the EU agri-food chains – farmers, processors, importers etc. from around the world.

Various existing and emerging (natural, technological, health, behavioral etc.) *threats and risks* along with the modern agri-food chains are well-identified (DTRA & IIBR, 2011; Eurostat, 2011a; Humphrey & Memedovic, 2006; OECD, 2011).

Diverse *market* and *private* modes have emerged to deal with the specific risks driven by the ethics, competition, consumer demand, business initiatives, and trade opportunities – e.g. direct marketing, voluntary codes (professional and corporate social, labor, environmental etc. responsibility), industry standards, insurance schemes, guarantees, fair-trade, trade with brands, origins, organic and quality products etc. (Figure 4).

Risks	Modes of governance		
	market	private	public
Natural disasters and extreme weather; Pests and diseases; Improper using pesticides and chemicals; Using contaminated water and soils; Improper animal health practices; Poor waste disposal; Using prohibited antibiotics; Using contaminated feeds; Animal-borne diseases; Improper handling and storage; Poor cooling system; Poor sanitation and hygiene; Using unhygienic containers, processing units, and transport facilities; Improper grading and packaging; Using prohibited food-additives; Inputs, resources and output contamination; Chancing social demands; Market price fluctuation; Market failures; Political and institutional instability; Ignorance of agents; Opportunistic behavior of counterpart, collation partner, a third party or public officer; Criminal intrusion; Terrorist attacks	Clientatlisation; Direct marketing; Informal branding; Insurance purchase; Organic production; Specific origins; Brands; Eco-system services; Special (quality, eco-) labeling; Outsourcing; Security services; Fair trade system; Standards insurance contract; Hedging with future price contacts	Improved inputs, technology, variety and structure of production; Product and income diversification; Self-insurance forms; Patronage and community insurance; Voluntary initiatives; Professional codes; Building (good) reputation; Guarantees; Private producers labels and brands; Private traders labels and brands; Private and collective origins and specialties; Private products recalls; Long-term contracts; Interlink contracts (inputs and service supply against marketing); Inputs and service cooperatives; Production cooperation; Joint-ventures; Internal audits; NGOs; Professional and consumer associations; Good Agricultural Practice; Good Hygienic Practice; Good Manufacturing Practice; Good Transport Practice; Good Trade Practice; GLOBALGAP; Private and collective food quality and safety management systems; Certification; Licensing; Third-party verification; Inputs supply integration; Integration into processing and marketing; Franchises; Risk pooling and marketing cooperatives; Vertical integration; Consumers cooperatives	Mandatory (products, process, labor, animal-welfare, environmental) quality and safety standards; Regulations/bans for using resources, inputs, technologies; Regulations organic farming; Quotas for emissions and using products/resources; Regulations for introduction foreign species/GMC; Regulations for plant and animal nutrition and healthcare; Licensing for using agro-systems and natural resources; Mandatory farming, safety, eco-training; Mandatory certifications and licensing; Compulsory food labeling and information; Public accreditation and certification; Mandatory records keeping and traceability coding; Public products recalls; Public food, veterinary, sanitary, border control; Public price and income support; Public preferential crediting; Public funding farms and processors adaptation; Public safety nets and disaster reliefs; Financial support to organic production, traditional and special products, private and collective actions; National GAPs, cross-compliance requirements; Public education, information, advise; Designating vulnerable/dangerous zones; Tax rebates, exception, breaks; Eco-taxation (emissions, products, wastes); Public eco-contracts; Public food and security research/extension; Assistance in farmers, stakeholders, security cooperation; Public promotion/partnerships of private initiatives; Public food security monitoring, assessments, foresights; Public food reserves and buffer stocks; Public prevention and recovery measures; Public compensation of (private) damages; Disposal of (old) chemicals, degradated lands and water purification; Protected Designation of Origin, Protected Geographical Indication, Traditional Specialty Guaranteed; European Rapid Alert System for Food and Feed; EU policies, support and enforcement agencies (EFSA, ECDC, ECHA, CFCA, OSHA, EEA); International Standardization Organization (ISO 22000); UN (FAO, WHO) agencies interventions (Codex Alimentarius; Early Warning Systems; Crisis Management Centers); Bilateral and multilateral trading agreements/rules (WTO); National and international anticrime/antiterrorists bodies

Figure 4. *Major risks and modes of governance along with modern agri-food chain*

Furthermore, different *bilateral and multilateral private* forms are widely used to safeguard against the risks, explore the benefits, and facilitate the exchange - e.g. clientalisation, contractual arrangements, cooperation, complete backward or forward integration etc.

Special *trilateral forms* have evolved to enhance security and partners and consumers confidence including an independent (a third-party) certification and inspection. Trade internationalization is increasingly associated with the *collective private* actions (standards, control mechanisms etc.) at a transnational and global scale (e.g. GLOBALGAP).

The property (security and safety) rights modernization, and the market and private "failures" brought about needs and modes for *public interventions* (assistance, regulations, provision) in the agri-food sector. Moreover, the scope and stringency of publicly-imposed rules expend constantly embracing new products,

methods, dimensions (human, animal, plant, eco-health), hazards (GMC, nanotechnology, terrorism), and information requirements.

Furthermore, the globalization of exchange, and threats and risks increasingly require setting up a *transnational public order* (e.g. ISO, WHO, FAO, WTO etc.). For instance, there are common (traceability, precaution, communication) principles, (food, veterinary, phytosanitary, feed, environmental etc.) legislation, and implementing and enforcing agencies (such as EFSA, ECDC, ECHA) for the agri-food chains in the EU (including for imported products).

Consumers concerns about the food-safety risks significantly have increased after the major food-safety "events"/crisis in recent years (e.g. Avian flu; Mad-cow and Foot-and-mouth diseases; poultry salmonella; contaminations of dairy, berries, olive-oil; natural and industrial disasters impacts etc.). For instance, since 2005 there has been an augmentation of the respondents "worrying about food-safety problems" in the EU and it comprise a significant share now (Figure 5); as much as 48% of the European consumers indicate that the consumed food "very or fairly likely" can damage their health etc. (Eurobarometer). In a new member state like Bulgaria this figure is 75%.

The number of cases and incidence rates of various foodborne and waterborne diseases is significant even in developed countries. For example, in the USA yearly 1 in 6 or 48 million people gets sick, 128,000 are hospitalized, and 3,000 die of foodborne diseases (CDC, 2011). In the EU there are also a number of confirm cases of foodborne diseases having a high incidence rate, most notably Giardiasis (167,025), Campylobacteriosis (190,579) and Salmonellosis (134,606) (ECDC, 2010).

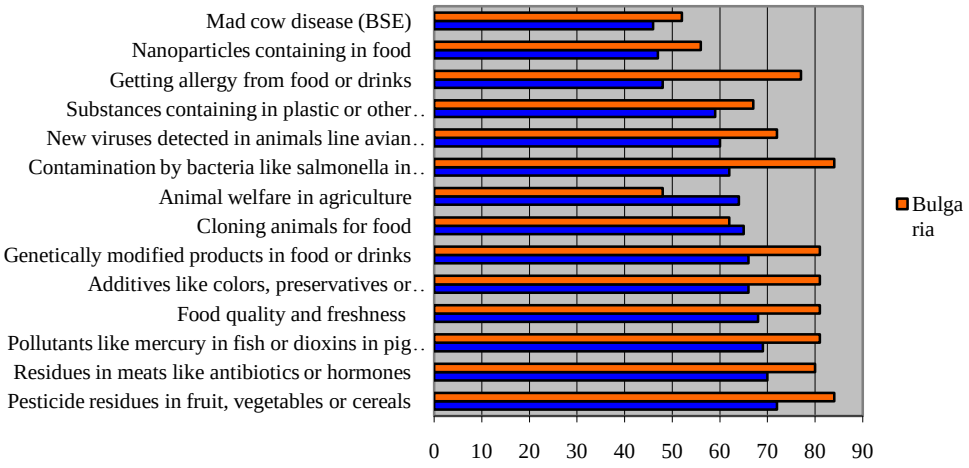


Figure 5. *Indicate if you are worried in relation with following food-safety problems (% of respondents)*
Source: *Eurobarometer*

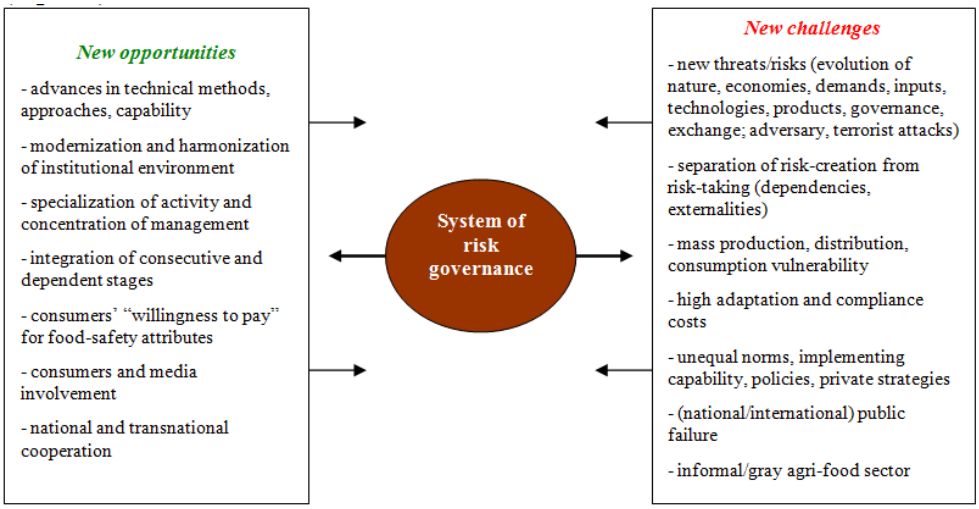


Figure 6. *Opportunities and challenges for risks governance in agri-food chain*

First, the advances and the dissemination of the *technical* food-chain, training and risk-management *methods* (such as microbiological, genetic, electrical, laser, robotic, immunological, chemical and biosensors, nanotechnology, ICT etc.), the integral and food-chain *approaches*, and the research, monitoring, testing, decision, and foresighting *capability* for the risk-detection, assessment, prevention, and mitigation (COST, 2009; Trench at al., 2011). For instance, the advancements in detection, assessment and mitigation methods and technologies associated with the biological and the chemical risks have been presented at a recent international conference (DTRA & IIBR, 2011).

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

Third, the considerable development of the *specialization* of activities (including in the risk-taking, monitoring, management) and the *concentration of (integral) management* in the food-production, processing, servicing, and distribution - centralized innovation and enforcement; time, scale, and scope economies; easy third-party control etc. For instance, the market share of the three largest food-retailers comprise between 27-91% in the EU states (Eurostat, 2011a); the food-safety training, certification, inspection, and information are big international business (Humphrey and Memedovic) etc.

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

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

Six, the growing *consumers'* (representation, organizations) and the *media* involvement, and the *national* and *transnational* (information, technical, managerial,

training, certification etc.) *cooperation* of partners and stakeholders improving agents choice, inducing public and private actions, enhancing risk-management communication, efficiency, and speed.

The modern development is also associated with a number of *(new) challenges* for the risk governance in the agri-food chain: *i/* the emergence of new threats, risks and uncertainty associated with the evolution of *natural environment* (e.g. climate change, water stress, "new" plant, animal and human hazards etc.) as well as the new human induced *economic, financial, food, food safety, water, environmental etc. crises* at large *(transnational, global) scales*. For instance, in the EU the household waste associated with the food (packaging, animal and vegetal wastes) is quite significant as merely its animal and vegetal components amounts to 23.8 million tones and comprises almost 11% of the all household waste[18], or 48 kg per capita (Eurostat, 2011b).

ii/ the increasing new threats, risks and uncertainty connected with the *inputs, technologies,* and *products* differentiation and innovation – e.g. Fukushima nuclear accident severely affected the agri-food sector in Japan and beyond (Behdani, 2012); there are uncertainties and safety concerns associated with the growing application of nanotechnologies and GMCs etc. (Eurostat, 2011a).

iii/ the increasing specialization and concentration of activity and organizations which *separates* the *"risk-creation"* (incident, ignorance, opportunistic behavior) and the *risk-taking* (unilateral-dependencies, quasi-monopolies, spill-overs, externalities etc.). That makes the risk-assessment, pricing, communication, disputing, and liability through the (pure) market and private modes very difficult and costly. For instance, cheating, misleading, and pirating are common in the food-chain relations - high information asymmetry, detection, disputing, and punishment costs (Bachev, 2010a). It is indicating that for the risk information consumers in the EU trust more to the "health professionals", "family and friends", "consumers associations", "scientists" rather than the "food producers" and "supermarkets and shops" (Figure 7).

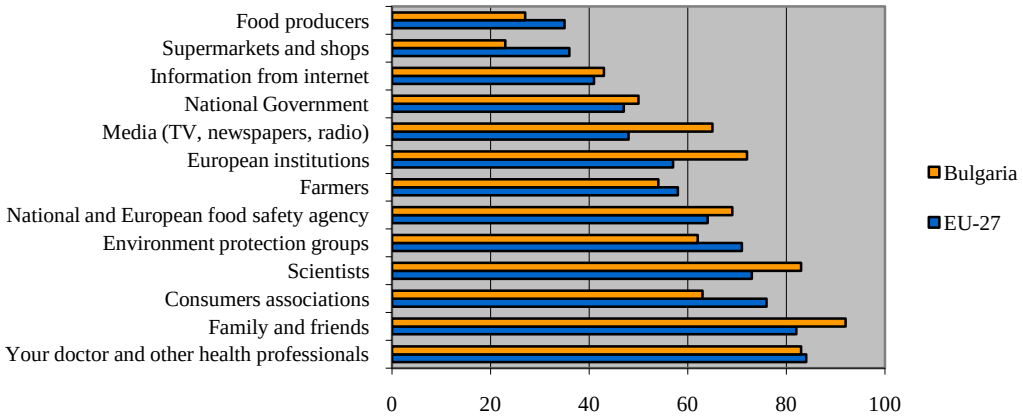


Figure 7. *In case a serious food-safety risk is found I would trust for risk information to (% of respondents)*
Source: *Eurobarometer*

iv/ the widespread mass production, distribution, and consumption increases the *vulnerability* of the agri-food chain expending the scope and the severity of natural, incidental, opportunistic, criminal or terrorist risks. For instance, in the EU there has been a progressive number of the official notifications based on the market and non-member countries controls, food-poisoning, consumer complaints, company own-checks, border screening and rejections approaching 8000 in 2009 (Eurostat, 2011a).

[18] these levels and shares are believed to be underestimates.

v/ the increasing *adaptation* and *compliance costs* (capital, training, certification, documentation etc.) for the rapidly evolving market and institutional environment which delay or prevent the reformation of smaller farms and food-chain enterprises (Trench et al., 2011; Bachev, 2010a). For instance, in Bulgaria the dairy and meat processors adaptation to the EU standards have continued 10 years while two-thirds of them ceased to exist before the country accession to the EU in 2007 (Bachev, 2011a).

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

vii/ the *wide spreading "public failures"* in the food-chain (risk) management – the bad, inefficient, delayed, under or over interventions; gaps, overlaps, infighting and contradictions of different agencies and rules; high bureaucratic costs; unsustainable and underfunding etc. For instance, the Bulgarian Food Agency and its Risk Assessment Center were established with a 5 years delay after joining the EU (in 2011); the EU Acquis Communautaire are still not completely implemented in the country (capability deficiency, mismanagement, corruption); trust to the EU rather than the national institutions prevails (Bachev, 2010a). There are also numerous instances of the *international* assistance or governance *failures* when institutions are "imported" rather than adapted or designed for the specific local conditions (Bachev, 2010a).

viii/ the production, marketing, and consumption traditions, the high food or governance costs, the will and capacity deficiency, all they are responsible for the persistence of a large risky *informal/gray* agri-food sector around the globe without an effective control, and substandard, fake, and illegitimate products and activities. For instance, merely one-third of the Bulgarian dairy farms comply with the EU milk-standards, only 0.1% possess safe manure-pile sites, a half of produced milk is home-consumed, exchanged or directly sold (Bachev, 2011a).

ix/ the multiplying new treats and risks associated with the *adversary* (e.g. by a competitor) and the *terrorist* attacks, and the emerging *governing* and *exchange forms* (e.g. street-sells; internet, phone and mail-orders; shopping-trips etc.). All they require specific non-traditional risk-management methods and modes such as guards; policing; intelligence; multi-organizational and transnational cooperation etc.

4. Modes and challenges of agri-food risk management in Japan after March 2011 Fukushima nuclear accident

On March 11, 2011 a strongest recorded in Japan earthquake off the Pacific coast of North-east of the country occurred which triggered a powerful tsunami and caused a nuclear accident in one of the world's largest nuclear plant (Fukushima Daichi Nuclear Plant Station). It was the first disaster that included an earthquake, a tsunami, and a nuclear power plant accident.

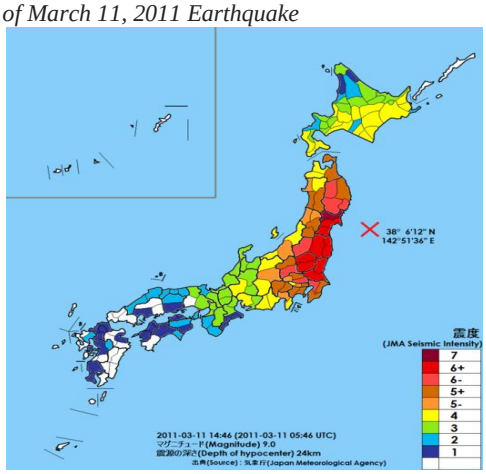
The 2011 disasters have had immense impacts on people life, health and property, social infrastructure and economy, supply chains; natural and institutional environment, etc. in North-eastern Japan and beyond. In this part of the paper we access the efficiency, responses and challenges of risk management system in Japanese agriculture and food sector.

4.1. Description of events and impacts

On March 11, 2011 a mega thrust with a magnitude of 9.0 Mw occurred off the Pacific coast of Japan (Map 1). It was the most powerful earthquake ever recorded in or

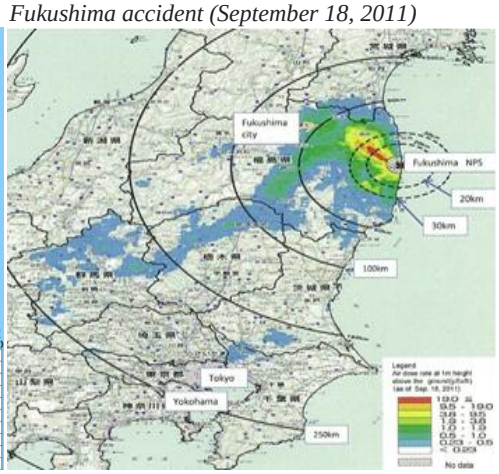
around Japan, and the forth most powerful earthquake in the world since 1900 (JMA, 2011). The earthquake triggered powerful tsunamis that spread over the wide area from Hokkaido to Okinawa. According to estimates an extensive coastal area surpassing 400 km was hit by tsunami higher than 10 m that submerged plane areas more than 5 km inland (Mori et al, 2011). The tsunami inundated a total area of approximately 561 km^2 or 4.53% of the total territories of the six Northeastern prefectures of Honshu island (GIAJ, 2011).

Map 1. *Epicenter and seismic intensity of March 11, 2011 Earthquake*



Source: Japan Meteorological Agency

Map 2. *Radioactive pollution caused by Fukushima accident (September 18, 2011)*



Source: Ministry of Environment, 2014

The earthquake and the tsunami caused a nuclear accident in one of the world's biggest nuclear power stations - the Fukushima Daiichi Nuclear Power Plant, Okuma and Futaba, Fukushima prefecture. The 14 meter high tsunami overwhelmed the plant's seawalls and damaged cooling systems and control rooms. Level 7 meltdowns occurred leading to releases of huge radioactivity into the environment (NISA, 2011).

According to the May 2012 nuclear power plant's estimates the cumulative radiation releases amounts 538.1 PBq of iodine-131, caesium-134 and caesium-137, out of which 520 PBq was released into the atmosphere between 12–31 March 2011 and 18.1 PBq into the ocean from 26 March – 30 September 2011 (TEPCO, 2012). Since the accident there have been continued spills of contaminated water at the plant grounds and into the sea. Radioactive contamination from the nuclear plant has spread in the region and beyond though air, rains, dust, water circulations, wildlife, garbage disposals, transportation, and affected soils, waters, plants, animals, infrastructure, and population. High levels of radiation were detected in large areas surrounding the nuclear plant and beyond (Map 2). Besides, numerous anomalous "hot spots" have been discovered in areas far beyond the adjacent region (MEXT, 2012). The highest radioactive contamination has been within 20-30 km from the Fukushima nuclear power plant where the authorities have been implementing a 20 km (800 sq km) exclusion zone and other restricted areas since March 12, 2011.

People living and working in different locations of affected regions have been exposed to diverse levels of radiation. For instance, surveys in most affected regions indicate that the annual radiation intakes from foods have been below 1 mSv/year and decreasing over time (Figure 8). According to large panel of experts the radiation uptake in such ranges is not harmful for the human health (MHLW). Nevertheless, some experts questioned the later. Furthermore, it is believed that the health effects of the radiation release have been "primarily psychological rather

than physical effects" since many consumers and producers alike "lose peace of mind" having food with (lower than official safety limit but nevertheless) radiation contamination.

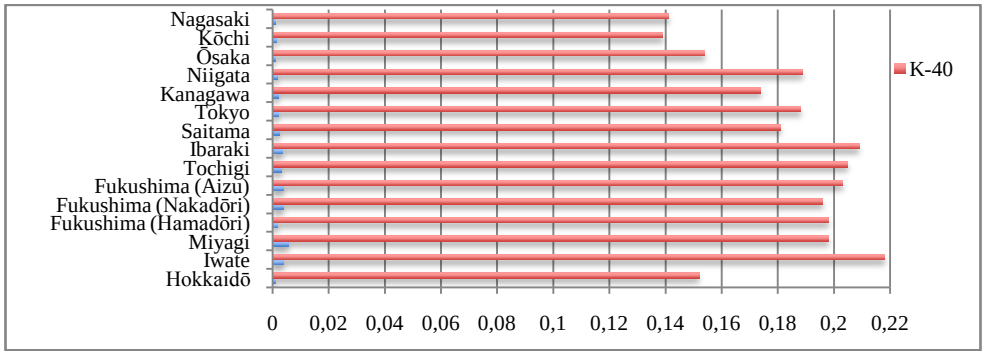


Figure 8. *Estimation on annual dietary intake of radionuclides for September-October 2012 in Japan (mSv/year)*
Source: Ministry of Health, Labor and Welfare

There has been a huge government budget for recovery, reconstructions, compensations and development (Government of Japan, 2012; Reconstruction Agency, 2016). Subsequently, there has been a sizeable or complete recovery of damaged infrastructure in the months after the disaster (Reconstruction Agency, 2016). The process of reconstructions has been associated with number of challenges such as: failure for timely evacuation from certain areas, slow response of authorities, lack of sufficient public information in the first stages of disasters, mistrust to public and private institutions, multiple displacements of many evacuees, divided communities and families, bad communication between different organizations, lack of financial resources, insufficient manpower and building materials, ineffective use of public funds, emotional conflicts between evacuees, insufficient and unequal compensation, substandard labor conditions for decontamination workers, increased number of criminal cases, numerous lawsuits against TEPCO and authorities, increasing costs and difficulties associated with decontamination and nuclear plant decommissioning, problems in finding temporary and permanent cites for storing radioactive waste, shortages of eclectic power, increasing energy supply costs, revisions in national energy, disaster prevention etc. policies, etc. (Akiyama et al. 2012; Fukushima Minpo News, February 17, March 13, 2014; Hasegawa, 2013; The Japan News, March 4, March 6, March 11, March 12, March 27, April 4, 2014; The Japan Times, March 13, 2014; NHK World, March 13, June 12, 2014; Manoliu, 2014).

4.2. Impact on agri-food chain

There have been a huge number of destructed agricultural communities, farms, and agricultural lands and properties from the March 2011 disasters. The total number of damaged Agricultural Management Entities of different type (private farms, corporate entities, cooperatives, local public bodies, etc.) reached 37,700 or around 16% of all Agricultural Management Entities in the affected eight prefectures.

Reported area of agricultural land damaged by the 2011 disasters in the six coastal and six inland prefectures is around 24,500 ha. Furthermore, there has been radioactive contamination of farmlands from the nuclear accident's fallout as contamination with cesium of paddy fields ranges from 67 up to 41,400 Bq/kg and other lands (arable, meadows, permanent crops) from 16 to 56,600 Bq/kg (MAFF). Damages on farms have been particularly big in areas around the Fukushima nuclear plant, where most agricultural land, livestock and crops were heavily

contaminated and destructed (Koyama, 2012, 2013; Watanabe, 2013). In the most affected evacuation areas farming activity has been suspended or significantly reduced, and majority of livestock and crops destroyed.

There are official estimates on some of the damages from the Fukushima nuclear disaster. For instance, the total product damages from the accident accounts for 2,568 billion yen in Fukushima prefecture, out of which 41.9% are in the evacuated and restricted areas (Table 2). These figures cover damage of products that cannot be sold, because of the restrictions on planning and distribution, and loss of the value caused by rumors. Nevertheless, above assessment does not include important "stock damage" (material funds, damage to production infrastructure, contamination of agricultural land, facilities for evacuation, and usage restrictions on machinery) as well as the loss of "society-related capital" (diverse tangible and intangible investments for creating production areas, brands, human resources, network structure, community, and cultural capital, ability to utilize resources and funds for many years). According to experts the later losses are quite difficult to measure and "compensate" (Koyama, 2013).

Table 2. *Agricultural product damages in areas affected by nuclear disaster in 2012*

	Vegetables	Livestock	Fruit	Rice	Evacuated/restricted area total	Fukushima prefecture
Evacuated/restricted area share (%)	42.4	68.0	48.9	35.9	-	100
Evacuated/restricted area (100 million yen)	225	346	135	371	1,077	2,568
Evacuated/restricted area ratio (%)	8.8	13.5	5.2	14.4	41.9	100

Source: Tohoku Department of Agricultural Administration, MAFF Statistics

What is more, thousands of farmers in Fukushima and neighboring regions have been continuing to suffer enormously from the radioactive contamination of farmlands and agricultural products, the official and/or voluntary restrictions on production and shipments, and the declined markets and prices for their products (JA ZENCHU, 2012; Koyama 2013a, 2013b; Ujiie 2011 and 2012; Watanabe, 2011; Wataname 2013).

According to a survey disaster affected negatively almost 55% of Japanese farms (Figure 9). In the worst hit Iwate, Miyagi, Fukushima, Ibaraki, Tochigi, Gunma, and Chiba prefectures more than 89% of all farms "are still affected" or "were affected in the past" from the earthquake, tsunami and nuclear accident.

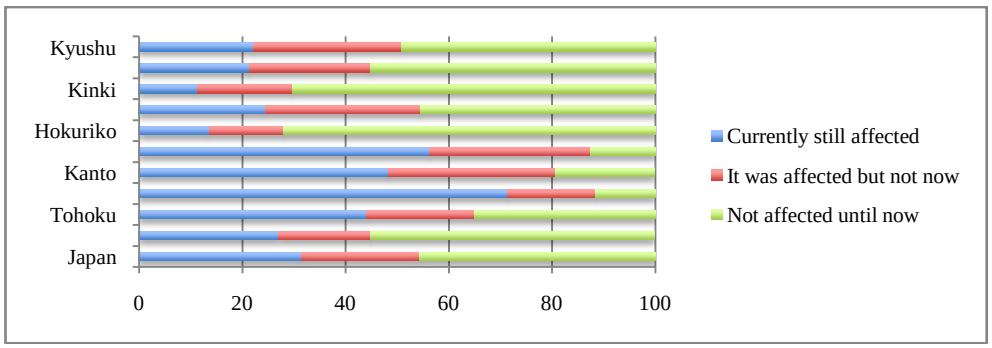


Figure 9. *Adverse effect of Great East Japan Earthquake on farm management in different regions of Japan (March 2012)*
Source: *Japan Finance Corporation*

The major reasons for the negative impacts of the triple disasters have been "decline in sell prices" and "harmful rumors" while the damaged inputs supply and

production affected less farms (Table 3). What is more, for farmers still affected by the disasters the importance of the first two factors increased considerably in 2012 comparing to the disaster year. There has been a great variation in the importance of different factors affecting producers in individual sectors of agriculture. For instance, "damaged production" has been a major factor for the most broilers producers, "damaged input supply" for the majority of pigs, upland crops, and open field vegetables producers, while "declined sell prices" and "harmful rumors" impacted farmers in all sectors. Furthermore, in 2012 the impact reduced sell prices further increased for most subsectors, while of the harmful rumors for all producers.

Table 3. *Reasons for those who are currently adversely affected in different regions (August, 2011; January 2012)**

	Damage to production		Damage input supply		Damage to distribution		Decline in sell prices		Harmful rumors	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Japan	24.5	23.2	41	27.1	44.4	33	65.8	74.4	52.8	60.5
Hokkaido	12.6	14.1	55.9	39.7	34.4	31.3	63.5	79.8	44.1	46.4
Tohoku	46.3	38.2	51.5	25.2	60.8	41	55.2	65.8	58.3	72
Kanto	34.1	26.1	28.8	17.6	45.2	27.8	69.6	72.8	72.9	76.1
Hokuriko	12.4	14.8	47.6	29.6	40	24.1	44.8	63	45.7	55.6
Tokai	7.6	7.3	30.5	18.2	41.9	34.5	86.7	87.3	35.2	43.6
Kinki	5.4	11.4	25	28.6	29.3	25.7	73.9	77.1	44.6	28.6
Chugoku-Shikoku	6.3	9.7	31.7	23.9	33.7	29.2	72.6	80.5	38	50.4
Kyushu	8.6	9.1	27.9	29.9	40.5	32.5	77.5	86.8	37.5	36

Source: Japan Finance Corporation. *multiple answers

After March 2011 the food industry in the disaster regions and throughout the country was also seriously affected by the production drops, business suspensions, distribution ruptures, etc. due to damaged plants, rolling blackouts, packaging material production shortages, gasoline shortfalls, etc. (MAFF, 2011). Regular surveys on food industries dynamics reviled that 71% of the country's food companies were "affected" by the March disasters, including more than 35% "still affected" at the beginning of 2014 (JFC, 2014).

Similarly, 57.9% of country's food companies have been negatively affected by the Fukushima nuclear disaster as about 35% still affected in the beginning of 2014 (Figure 10). The most severely affected have been the companies in Northern Kanto (83.4%) and in Tohoku's Iwate, Miyagi and Fukushima prefectures (81.9%). In the most impacted Fukushima prefecture 93.8% of all food companies have been adversely affected by the nuclear accident, including 92.6% of them "still affected" in the beginning of 2014 (JFC, 2014). On the other hand, food industries in Kyushu have been relatively less affected by the nuclear disaster as only 38.8% of the companies report negative impact on activity (including 20.5% still impacted).

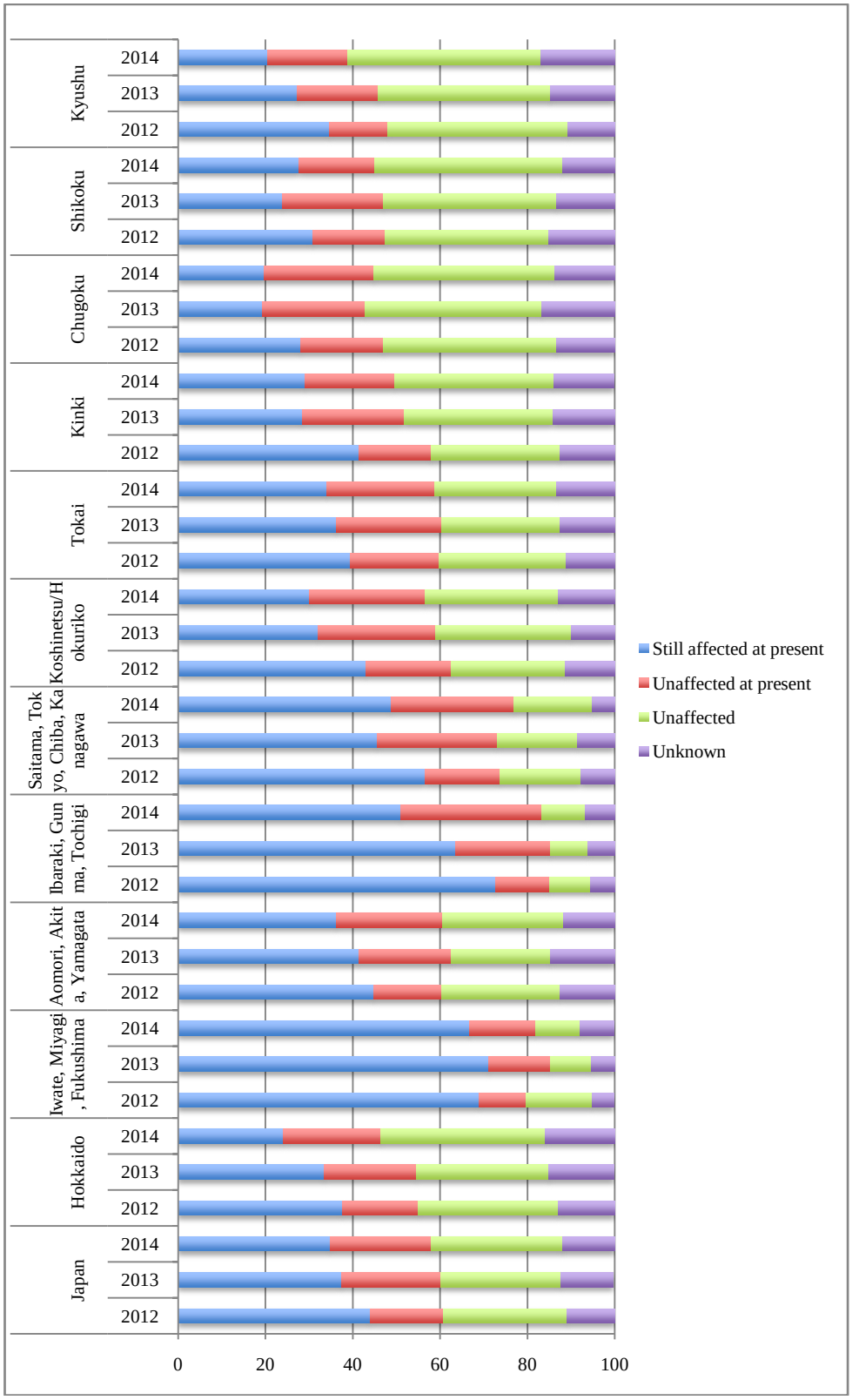


Figure 10. *Impact of Fukushima nuclear power plant accident on food industry in Japan (January, 2012, 2013, 2014)*
Source: Japan Finance Corporation

Fukushima nuclear disaster has affected mostly Demand from trade partners, Sales volume, and Procurement of ingredients and raw materials of many food

companies (Figure 11). However, while most food Manufactures and Wholesale traders suffered mainly from the decrease in the demand of trade partners, for the most the Restaurants operators and Retailers the Procurement of ingredients and raw materials has been predominately affected by the nuclear accident.

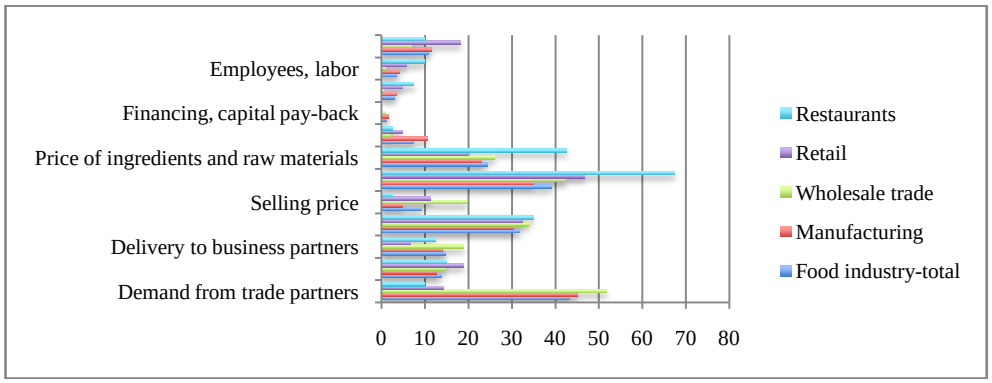


Figure 11. *Impact of Fukushima nuclear plant accident on overall management of food industry in Japan (January, 2014)*
Source: Japan Finance Corporation

There has been different speed of recovery in the affected food industries in different parts of the country. Until January 2013 more less than 50% of pre-disasters operations were reported in 46.1% of the earthquake and tsunami affected food companies, and in 47.6% of Fukushima nuclear accident affected food companies (Figure 12).

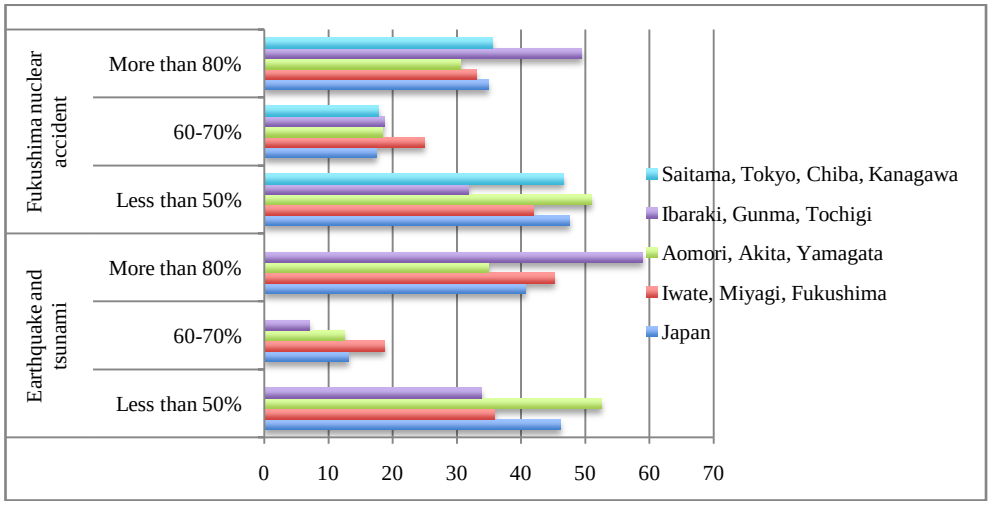


Figure 12. *Extent of food industry recovery from Great East Japan Earthquake effects (January, 2013)*
Source: Japan Finance Corporation

Before the March 2011 disaster only 6.8% of the food industry companies had Business Contingency Plans (Japan Financial Corporation, 2013). After the disasters 6.1% of the companies formulated such plans, 16.2% are considering to do so, and 22.6% have plans for development in the future. The biggest companies (10 or more billion yes of annual sales) are in more advance stage in formulation of BCP after the disasters.

4.3. Radioactive contamination of agri-food products

A large scale contamination of crops, livestock and agri-food products by radionuclides has happened as a result of the direct radiation exposure, the fallouts and distributed by wind and rains radioactive elements, the crop and livestock uptakes from leaves, soils, waters and feeds, the diffusion from affected inputs, buildings and equipment, the dissemination through transportation and wildlife, etc.

During the year after the nuclear accident officials tested 137,037 agri-food samples across the country and detected 1,204 cases (0.88%) exceeding the provisional safety limit in 14 prefectures (MLHW). The majority of highly contaminated items in Fukushima prefecture were vegetables, fishery products and meats, in Ibaraki and Chiba prefectures vegetables, in Miyagi prefecture beef, in Tochigi prefecture vegetables and meats, in Saitama prefecture and Tokyo tea leafs.

More than 3600 fishery products were tested in Fukushima prefecture during the first year after the accident, and 34.7% of them found above 100 Bq/kg (Fishery Agency, 2014). In the rest of the country from almost 5000 inspected fish samples 4.5% were above safety norm.

The mandatory and voluntary restrictions on shipment covered a number of products from designated areas of affected regions. In addition, there was a ban on rice planting on 8000 ha of paddies in evacuation (95%) and other contaminated areas (MAFF, 2012).

In order to meet growing public safety concerns since April 1, 2012 new more stringent official limits on radioactive elements in food items have been enforced in the country as longer transitional periods were set for some commodities like rice and beef (until September 30, 2012), and soybean (December 31, 2012).

In the last three years the number of (official, collective, private) food inspections has multiplied in the 17 most vulnerable prefectures and around the country. Most of the detected items were fishery products, wild animal meats, vegetables and mushrooms. In Ibaraki, Tochigi, Gunma, and Iwate prefectures there were also detected samples of drinking water exceeding safety standard. Official inspections results indicate that for all agricultural food products, but mushrooms and wild edible plants, the number of samples with radioactive cesium above safety limits is none or insignificant (Table 4).

Table 4. *Results of inspections on radioactivity levels in agricultural products in Japan**

Products	March, 2011 - March 31, 2012			April 1, 2012 - March 31, 2013		April 1, 2013 - March 31, 2014		April 1, 2014 - March 31, 2015	
	Number of samples	Above provisional limit	Above new limit	Number of samples	Above maximum limit	Number of samples	Above maximum limit	Number of samples	Above maximum limit
Rice	26,464	39	592	11 million	28	10.4 million	84	11 million	2
Wheat and burley	557	1	27	592	0	1,818	0	383	0
Vegetables	12,671	139	385	19,657	0	18,570	5	16,712	0
Fruits	2,732	28	210	4,243	0	4,478	13	3,302	0
Pulse	698	0	16	6,727	59	4,398	25	3,459	4
Other plants	498	1	16	1,613	0	3,094	14	1,049	0
Mushrooms and wild edible plants	3,856	228	779	7,583	194	6,588	605	8,557	103
Tea/Tea infusion**	2,233	192	1,562	446**	0**	867**	13**	206**	0**
Raw milk	1,937	1	7	2,052	0	2,453	0	1,846	0
Beef	91,973	157	1096	208,477	0	187,176	6	na	
Pork	538	0	6	693	0	984	1	na	
Chicken	240	0	0	385	0	472	0	na	
Egg	443	0	0	418	0	565	0	na	
Honey	11	0	1	66	0	124	0	na	
Other livestock	23	0	0	118	0	99	1	na	

Source: Ministry of Agriculture, Forestry and Fisheries * for crops in 17 northeastern and eastern prefectures, for livestock products all prefectures

Test data for marine fishery products radioactive contamination also indicate that the number of cases above safety limit has dropped considerably. In Fukushima prefecture, in the months after the accident, the share of highly-contaminated fish was 57.7% but it reduced by half after one year. In other prefectures the share of contaminated fish decreased from 4.7% to less than 1% in 3nd quarter of 2012.

Furthermore, a survey has found that the levels of radioactive cesium in home-cooked meals in Fukushima prefecture are mostly below the maximum allowable limit (Fukushima Minpo News, March 7, 2014). Out of 100 households surveyed during period November 2013 - February 2014 using meals prepared over two days, only 4 showed measurements slightly above the limit for radioactive cesium (the one with the highest level of 2.6 Bq/kg for Cesium 137 and 1.1 Bq/kg for Cesium 134). Household members were also tested for internal exposure to radioactive materials by a whole-body counter, and all screened persons (82) had counts below the 300 Becquerel threshold for human radiation exposure.

Currently there are still a number of products from certain areas of 17 prefectures, which are subject to mandatory or voluntary shipment restrains (MAFF). In Fukushima prefecture mandatory and voluntary restrictions cover a wide range of vegetables, fruits, livestock and fish products grown in heavily contaminated areas. In addition, there is still a ban on rice planting on 2,100 ha and overall production management restrictions on 4,200 ha paddies in the evacuation area. In other prefectures mandatory and voluntary shipment restrictions mostly concern mushrooms, wild plants, and fish.

Furthermore, for the most contaminated areas of Fukushima prefecture there are still requests for intake restraints for a wide range of non-heading leafy vegetables (such as Spinach, Komatsuna, Kakina etc.), heading leafy vegetables (Cabbage, Hakusai, Heading lettuce, Brussels sprout etc.), bud vegetables belonging to brassicaceae (Broccoli, Cauliflower, Stick Broccoli etc.), shiitake mushrooms grown on Raw Log (open field), wild mushrooms, and non cultured Yamame (MAFF, 2016).

Due to genuine or perceived health risk many Japanese consumers stop buying agricultural, fishery and food products originated from the affected by the nuclear accident regions. Even in cases when it was proven that food is safe some wholesale traders, processors and consumers restrain buying products from the contaminated areas (Futahira, 2013; Koyama, 2013; MAFF, 2012; Watanabe 2011, 2013). What is more, there was sharp decline in the demand and prices for the agricultural products mostly affected by the accidents such as vegetables, fruits, beef, etc.

Dynamics of demand has been a result of lack of sufficient capabilities in the inspection system, inappropriate restrictions (initially covering all shipments in a prefecture rather than from contaminated localities), revealed rare incidences of contamination in generally safe origins, low confidence in the official "safety" limits and inspections, lack of good communication, harmful rumors ("Fu-hyo"), and in certain cases not authentic character of traded products (Bachev and Ito, 2013). The "reputation damage" has been particularly important factor for the big agri-food producing regions like Fukushima, Ibaraki etc. which products have been widely rejected by consumers (Futahira, 2013; Fukushima Minpo News, May 11, 2014; Koyama, 2013; Watanabe, 2013).

Since autumn 2011 and 2012 radiation measurement tests for radiation level in all beef and package of rice have been carried out in Fukushima prefecture. Until April 30, 2013 more than 10.3 million bags of rice were checked by JA Fukushima,

and detected radiation in 99.78% of them were less than 25 Bq/kg while in only 71 bags (0.0007% of the total) it was above 100 Bq/kg (JA Fukushima Prefecture, 2013). Intensive safety checks have been also carried out on a great range of agri-food products by the authority, farmers, agricultural organizations, processors, retailers etc.

Despite all safety checks many consumers in the big cities and in the region alike continue to avoid Fukushima products (Takeuchi and Fujioka, 2013; Koyama 2013). In the end of March 2013 the rice sales from Fukushima was almost half of what it had been before the disaster while rice prices considerably lower. Fukushima labels and brands for agri-food produce which once representing top quality and safety after the accident brought rejections and significantly less than usual market value[19]. Some popular food chains such as Sukiya have introduced "no Fukushima beef" policy in their restaurants around the country, including in Fukushima prefecture.

Research has proved that consumers' attitude toward the agricultural products from the affected by the nuclear disaster regions has changed dramatically (Burch, 2012; Ujiie, 2011, 2012, 2013). Almost 38% of the surveyed in 2012 consumers indicated that they do not purchase fresh foods produced in the affected by accident areas, and only 8.4% said they buy (JFC, 2012). A different survey has found out that a half of consumers in Tokyo and Osaka would not buy Fukushima and Ibaraki products with "contamination less than the official criteria" and another 30% said they would not buy if products were "not contaminated at all" (Ujiie, 2012). A follow up 2013 survey reviles that while consumers still maintain the high risk conscious, the "origin of product" factor is playing less important role in their choice.

Even residents and producers of Fukushima prefecture tend to avoid buying local products, and local produce has not been used in school lunches[20]. A 2013 consumer survey shows that this is particularly true for some segment of population (e.g. family with children) as well as for certain products (such as mushrooms and seafood) in general.

Countrywide survey found out that more than a third of surveyed Japanese farmers and almost of 38% of food industry personnel indicate that "Sales slackened because consumers tended to refrain from buying food products" (MAFF). The later figures are much higher for the most affected by the disaster regions. Moreover, a substantial number of food industry companies point out that they "switched from agriculture, forestry and fisheries products in areas with radioactive contamination fears to those in other areas (in Japan) for our purchasing" and that amounts for more than 57% in Fukushima prefecture.

Many consumers in the affected regions and throughout Japan have seen their direct procurement (e.g. prices) and transaction (information, search, assurance etc.) costs for supply of needed safe agri-food relatively from alternative regions,

[19] in fact Fukushima products continue to top different competition and inspections. For instance, two farmers from the prefecture won gold awards while other participants other awards in the annual international rice tasting competition held in Shichikashuku, Miyagi Prefecture (Fukushima Minpo News November 25, 2013). Similarly, 3 brands of rice grown in the prefecture (Koshihikari and Hitomebore varieties from Aizu region and Hitomebore from Nakadori area) were among 38 brands designated as the top level "Special Grade A" in the Japan Grain Inspection (Fukushima Minpo News, February 14, 2014). Likely wise, for the second straight year Fukushima-brewed sake brands got the top award at the Annual Japan Sake Awards (Fukushima Minpo News, May 21, 2014). In the latest contest, 17 out of submitted 39 brands from Fukushima prefecture were awarded the Gold Prize, marking the largest number together with Yamagata Prefecture.

[20] Insofar the "grow local, eat local" movement not taken off in Fukushima Prefecture, and it is difficult to sell agricultural produce outside the prefecture (Koyama, 2013).

countries or guaranteed sources increased (Bachev and Ito, 2013). However, there are no detailed studies on these effects of the nuclear disaster yet.

Nevertheless, some research proves that a major way to minimize the transaction costs for supply of radiation safe product from a big number of costumers is to use "origin of product" selective governance (Uijie, 2012). A segment of consumers went even further to purchase only from the "guaranteed sources" like some Tokyo residents using direct sales contract to buy rice from Kyushu farms (Kakuchi, 2013). On the other hand, some Fukushima farmers see growing new crops (like cucumbers) and opting for direct sales to customers (rather than supermarkets) as a way to recover operations.

Some experts argue that both producers and consumers are victims of the "reputation damage" (Koyama 2013). According to 2013 survey 26.1% of the consumers do not even know that inspections of radioactive contamination are being conducted (Consumer Affair Agency, 2013).

In order to facilitate communication with consumers, promote and recover Fukushima agricultural products numerous initiatives have been undertaken by farmers, agricultural organizations, NGOs, authorities, business, retailers etc. such as: direct sells by farmers, on spot radiation tests, recovery markets, Farmers' Document and Farmers Café events, government "Eating for support" initiative, joint ventures with shops, promotion complains with participation of top officials, celebrities, journalists, and farmers in big cities, international fairs etc. (Fukushima Minpo News, January 27, 2014; Inoue, 2014; The Japan News, March 8, 2014; Koyama, 2013; NHK World, May 17, September 21, 2014; MAFF, 2014).

For instance, the fast-food chain Yoshinoya has set up a joint venture to produce and market food from the Fukushima prefecture to help region's recovery (Thompson and Matsutani, 2013). Company provides funds (investment of Y10m or $102,000) through a joint venture (Yoshinoya Farm Fukushima Co) held with local farmers who will grow rice, onions and cabbages in the region, produce which could then make it on to the tables of the 1,175 restaurants the chain operates in Japan.

Fight against "harmful rumors" that led to plummeting prices and sales of farm products have been also a high priority for local and national authorities. For instance, Fukushima prefecture is spending about 1.7 billion yen ($16.6 million) this fiscal year to fight rumors about radiation - fourfold budget increase over the previous year (Inoue, 2014). In 2012 the prefecture hired popular idol group Tokyo for commercials to appeal its agricultural produce in Tokyo area. In this year's survey of before-and-after results from the commercials the ratio of respondents who said they "do not want to buy" Fukushima produce dropped by about 10 points from 27% after viewing.

The central government also plans to do more to help revive industries suffering from groundless rumors following the nuclear accident. The Reconstruction Agency compiled new guidelines for helping local businesses which say that: the government will continue releasing the results of radioactivity tests on agricultural products from Fukushima prefecture; officials will continue to urge foreign countries to ease or abolish import restrictions on farm and fisheries products; they call on member companies of the Japan Business Federation (Keidanren) to use farm products from Fukushima prefecture as gifts and offer them at in-house sales events; officials will work to attract tourists, including students on school trips, from inside and outside Japan; and urged the related agencies to lead the way to help give the industries a boost (NHK, June 23, 2014).

Data show that in 2011 the daily intake per person for some of the most likely affected by the nuclear disaster food groups decreased comparing to the period before the accident (MHLW). For instance, consumption of mushrooms dropped

by 12.5%, seaweeds by 5.4%, pulses by 6.5%, etc. That change in the national consumption pattern is probably a consequence of the newly emerged consumers risk concern, higher procurement costs or other (unspecified) reasons.

The 2011 disasters also affected considerably the international trade with agricultural products. Around 40 countries imposed restrictions on agri-food import from Japan after the nuclear accident, including major importer such China, United States, Indonesia, Malaysia and South Korea. The European Union required food and animal feed from 12 prefectures to be checked prior the export to prove that radioactive iodine and cesium levels do not exceed EU standards. In addition, agri-food items from 35 other prefectures had to be shipped along with a certificate of origin to verify where the products were produced.

Few months after the nuclear crisis some countries (like Canada, Thailand) lifted or eased restrictions on Japanese food imports. Rice exports to China with government-issued certificates of origin and produced outside the prefectures Chiba, Fukushima, Gunma, Ibaraki, Niigata, Nagano, Miyagi, Saitama, Tokyo, Tochigi and Saitama became possible in April 2012. In October 2012, EU also substantially eased import restrictions from 11 prefectures but kept restrictions for products from Fukushima prefecture. Radioactive material tests certificates are usually required (MAFF, 2016). By March 1, 2013 as many as of 10 countries completely lifted radionuclide related restrictions on food products from Japan including Canada, New Zealand, Malaysia, Mexico, Peru, Chile, Columbia, Guinea, Myanmar, Malaysia and Serbia (Reconstruction Agency, 2014).

Due to the foreign countries' import restrictions and the experienced damages, the value of Japan's farm and livestock product exports declined substantially - in April-December 2011 the export plunged by 40.9 billion yen (11%) from the year before (MAFF, 2012). Furthermore, in January-March, 2012 the value of country's export of agricultural products was 89 million (12.77%) lower than for the same period before the disaster. Consequently, there was a considerable decease in the overall agricultural (including fields crops and livestock products) as well fishery products export in 2011. At the same time, there was a significant increase in the import of agricultural, forestry and fishery products as imports of farm products jumped 16% to 5.58 trillion yen in 2011.

In April-December 2012 it was registered a 5.98% growth in the export of agricultural products of the country (Figure 60). Moreover, a slight augmentation of the annual exports of agricultural and field crops products was reported but the export value was still bellow 2010 level. The overall import of agricultural and crop products decreased but it was still above the pre-disaster levels. At the same time fish products exports continue to enlarge.

There has been significant change in the purchase behavior of a great number of consumers after the March 2011 disasters. The July 2011 survey found out that a good share of consumers decreased the purchased amount of fresh (10.6%) and processed (9.8%) food, ornamental flowers (21.6%), confectionary (15.2%), etc. (JFC). On the other hand there is an increase in purchase mineral water (17.6%). These changes were more dynamic in the worst affected East Japan than in the other parts of the country.

In the months after the earthquake, the item most emphasized by the consumers at the time of purchase of fresh food was "production location" and for processed food the "origin of raw materials". However, for the majority of consumers there was not change of the place to buy fresh (88.5%) and processed (89.1%) food comparing to the pre-duster period (Japan Finance Corporation, 2011).

The consumer attitude to purchase food products from the affected by the nuclear disaster regions has evolved in post disaster years (Figure 13). Currently, relatively more and more consumers do not mind the impact of the nuclear disaster

when purchase agri-food produce. Nevertheless, still significant share of consumers do not buy fresh (31.8%) and processed (28.3%) products from that regions because of the impact of the nuclear disaster.

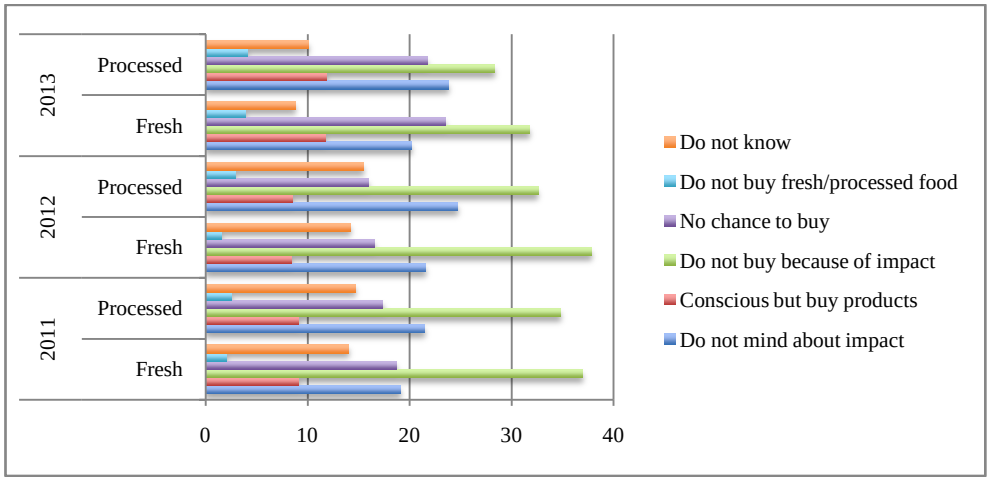


Figure 13. *Awareness when purchase fresh and processed food from the region after Fukushima nuclear power plant accident (July 2011, January 2012, January 2013)*
Source: Japan Finance Corporation

Recent data indicate that a good portion of Japanese consumers (36.5%) "often" or "sometimes" purchase purchase foodstuffs from affected by the 2011 disasters areas (JFC, 2014). The latest figure is much higher in Tohoku region then in the other parts of the country. There are also gender and age differences in willingness to buy from the affected regions. For instance, older generation and women tend to buy more from the affected regions than the younger generation and men (Japan Finance Corporation, 2014). Nevertheless, for a great proportion of the consumers it is important to select the region of agro-food products and they purchase "rarely" or "not at all" from the affected regions.

Diverse promotions about produce safety etc. increase consumer willingness to purchase products from the affected regions (Japan Finance Corporation, 2014). For most Japanese consumers who do not want to purchase food stuff from the effected regions even if there is promotion the main reasons is "worry about safety" .

All surveys show that there is increased awareness of the needs to keep foodstuff at home after the 2011 disasters (Japan Finance Corporation, 2014). Furthermore, around 29.5% of consumers report they kept food stockpiles at home event before the disaster, 21.5% are keeping such piles after the disaster (much higher percentage in worst affected Tohoku and Kanto regions), while 7.9% kept after the disaster but currently not (much higher in Tohoku region).

4.4. Effects on food regulation and inspection system

Up to the Fukushima nuclear plant accident there had been no adequate system for agri-food radiation regulation and inspection to deal with such a big disaster (MAFF, 2011). On the wake of the accident a number of measures were taken by the government to guarantee the food safety in the country.

Widespread inspections on radiation contamination were introduced and numerous shipment and consumption restrictions on agri-food products imposed. Within a week from the nuclear accident (March 17, 2011) Ministry of Health,

Labor and Welfare introduced Provisional regulatory limits for radionuclides in agri-food products[21] (Table 5).

Table 5. *Provisional regulatory limits for radionuclides in agri-food products (Bq/kg)*

Products	I-131	Cs-134 + Cs-137
Drinking water	300 (100)*	200**
Milk/Milk Products	300 (100)*	200**
Vegetables/Fish	2000	500**
Cereals/Meat/Eggs	-	500**

Notes: **for infants ** values take into account the contribution of radioactive strontium*
Source: *Ministry of Health, Labor and Welfare*

On 29 March 2011, the Food Safety Commission of Japan drew up a report guaranteeing that the ongoing measures based on provisional regulation values are effective enough to ensure food safety for consumption, domestic distribution and exportation. On 4 April 2011 MHLW decided to use the ongoing provisional regulation values for the time being and set up provisional regulation value for radioiodines in seafood on the next day.

In order to meet growing public safety concerns since April 1, 2012 new[22] official limits on radioactive cesium[23] in food items have been enforced in the country (Table 6). Four categories of Drinking water, Infant foods and Milk, and General foods are distinguished. New safety standards are more stringent than in international ones – e.g. maximum allowed radioactive substances in EU and USA in grains are accordingly 1250 Bq/kg and 1200 Bq/kg, in vegetables 500 Bq/kg and 1200 Bq/kg, in drinking water 100 Bq/l and 1200 Bq/kg, etc.

For some raw materials and processed food (like rice, beef, soybean) were set transitional measures and longer periods (until December 31, 2012 or "the best before date") for complete enforcement of the novel safety standards. The reason is that producers of such commodities need more time for preparation to prevent any confusion in distribution at the time of shift to new limits for radionuclides in food.

Table 6. *New Standard limits for radionuclides in food in Japan (Bq/kg)*

Food item	*Cs-134 + Cs-137*
Drinking water	*10**
Milk	*50**
General Foods	*100**
Infant-food	*50**

Notes: ** limit takes into account the contribution of radioactive strontium, plutonium etc.*
Source: *Ministry of Health, Labor and Welfare*

In addition, MAFF undertook a number of measures to improve food safety: provided advice on creation of food inspection plans and supporting inspection equipment installations in affected prefectures; commissioned laboratories to analyze agri-food contamination; implemented technical guidance regarding feeding and management of livestock (March 19, 2011); set up provisional tolerable levels for forage for producing milk and beef below the provisional regulation value for food (April 14, 2011); set up provisional tolerable levels for fertilizers and feed for preventing radioactive contamination of farmland soil from expanding and for producing agricultural and animal products below the

[21] based on intervention exemption level of 5 mSv/y and 50% contamination rate (MHLW, 2011).
[22] annual maximum permissible dose from radioactive cesium in foods reduced from 5mSv to 1mSv - the same level as Codex GLs (MHLW, 2012).
[23] Standard limits are not established for radioactive Iodine, which has been no longer detected (short half-life), and Uranium, which level is almost the same in the nuclear power plant site as in the nature environment (MHLW, 2012).

provisional regulation value for food (August 1, 2011); released a farmland soil radiation level map (August 30, 2011) and updated it covering a wider scope and more details (March 23, 2012); supported emergency radiation inspections for rice in Fukushima prefecture and conducted analysis of factors for radioactive contamination over the regulation level (November 2011); implemented restrictions on rice planting (April 22, 2011; February 28, 2012; March 25, 2013; March 7, 2014); revised provisional tolerable levels for producing animal and fishery products below the standards limits for radionuclides in foods (February 3 and March 23, 2012); published farmland decontamination technical book (August 2012), publish list of registered administrative and private laboratories for radionuclide inspections (April 1, 2013), etc.

Since June 2011 regular radiation tests have been carried out on great number of agri-food products [24] in 17 prefectures in Northeastern and Eastern Japan. In addition, since 2012 all rice bags[25] produced in Fukushima prefecture have been checked in the Agricultural Cooperative inspection cites to assure safety. Furthermore, there have emerged many private and collective inspections systems introduced by farmers and rural associations, food processors, retailers, local authorities, consumer organizations, independent agents etc. For instance, in Nihonmatsu-shi, Towa town, there was a sharp decline in well-developed before the nuclear accident tourism and agricultural sells. The local Rural Development Association introduced radiation measurement of farm products in June 2011. It has been done in own laboratory by equipment supplied by a private company and costs 500 yen per test for farmers. Due to timely introduction of safety inspection and proper product safety reporting (labeling) the number of costumers visiting that farmer market recovered almost fully as well as 80% of the sells on not restricted items (interview with the Chairman of the Association Mr.Muto, July 6, 2013). Municipality has also introduced 60 points for inspection of food for self-consumption, which is done free for producers.

Agricultural Cooperatives in Fukushima prefecture also conduct their own testing using analytical equipment (such as NaI scintillation spectrometer) either purchased or borrowed from a government agency (Watanabe 2013). Before shipping produce, member farmers bring crop samples to testing sites where measurement is done (about 30 minutes per crop) for free. What is more, many agricultural cooperatives in the prefecture have in place systematic testing regimes covering every farm and item, and all members are required to have their produce tested by the cooperative before shipping.

Many farmers groups and organizations from heavily-contaminated areas have been organizing own tests on soils (detailed maps) and other inputs (water, livestock feeds) as well as screen output to secure safety. For instance, a large scale tests to collect data[26] and find a solution on fighting rice contamination has been carried by a group in Nihonmatsu no comparable with all experiments done by national or local governments (NHK World, March 10, 2014). Another producer group from Nihonmatsu developed a way to put all information about their products (contamination, beta-carotene and sugar content sugar) as well as details about who grew what, into a QR code, a kind of bar code that people can scan with their cellphones (The Japan News, March 7, 2012).

[24] In late March 2014 the number of items was reduced from 98 to 65 because of low detection rate (Fukushima Minpo News, May 21, 2014).
[25] one baggage is 30 kg.
[26] e.g. they proved that crops at organic farms were free of contamination becouse well-mainatined fertile soil helps immobilize cesium.

According to the Fukushima Food Industry Organization many of the member companies bought own equipment for radiation checks of ingredients, water and final produces, or use outside safety checks to avoid risks, and/or deal with harmful humors, and secure customers. Likely wise, practically all heads of cattle are tested at meat processing plants in Tohoku and Kanto regions, and throughout Japan (Wayanabe, 2013).

Furthermore, big retailers (like Aeon, etc.) have also strengthened testing with a goal of selling cesium-free food only. Similarly, a mail-order company based in Tokyo (Cataloghouse Ltd.) allocated space for fresh food from Fukushima in its store in Tokyo in August 2011. It sells only products that clear safety standards and gives an explanation on labels. The store bought a testing machine (for 3.5 million yen) and checks the level of cesium in food in front of customers (Kakuchi, 2013). A numerous big processors and retailers have been also promoting products from the affected regions nationwide (The Japan Times, March 10, 2014).

Recovery, Sunday, evening, promotion etc. markets, Farmers' Document and Farmers' Café events etc. organized by farmers, authorities, NGOs, food chain partners etc. have been regularly held in Fukushima and around the country, where farmers sell directly their products confirmed as safe through voluntary screening (Koyama, 2013).

On the top of that, various voluntary restrictions on sale have been introduced by farmers, farmers' organizations, food industry, and local communities.

According to some farmers the biggest hurdle they face is the lack of a clear radiation risk standard that can be accepted by all (Kakuchi, 2013). In order to address consumer concerns on food safety some producers, processors and retailers started to use lower than the official norms for radiation. Simultaneously, there has been a progress in efficiency of radiation testing devices for farm and food products. All theses measures and actions taken at production, distribution and consumption stages have let the Fukushima agri-food products to become one of "most secure in the world" (Fukushima Minpo News, January 27, 2014). Nevertheless, many concern consumers continue to disbelieve in the existing inspection system and employ other ways to procure safe food (direct sales contracts, origins, imports, etc.) (Kakuchi, 2013; Ujiie, 2012).

There have been a number of challenges with the present system of safety inspection. Due to the lack of personnel, expertise, and high-precision equipment, the water, food and soil tests have not always been accurate, consistent and comprehensive. For instance, quite expensive high-precision instruments are not available everywhere to measure lower radiation levels set up by the new regulation – e.g. for drinking water capable of detecting a single-digit level of becquerels.

Food safety inspections are basically carried out at distribution stage (output for shipment or export)[27], and do not (completely) cover produces for farmers markets, direct sells, food exchanges and self-consumption. Nevertheless, Fukushima prefecture and municipalities have been strengthening their inspections for self-consumed agricultural products since 2013.

Furthermore, capability for radiation safety control in Fukushima prefecture is significantly higher than in other affected regions, while radiation contamination has "no administrative borders". In fact most food is regularly inspected in Fukushima prefecture and it is much safer than in other prefectures where such strict tests have not been not carried out at all.

What is more, many of the privately and collective employed testing equipment are not with high precision, and/or samples are properly prepared for analysis (e.g.

[27] Cropping itself has not been restricted and inspection carried at ex-post production- shipping stage.

by inexperienced farmers). Consequently, some of the sold and consumed products are labeled as "Not detected" despite existing contamination. Some tested agricultural products are further cooked or dried reaching higher levels of radiation at consumption stage. Uptake of radioactive materials with food by local residents increases especially during summer season when most of the fresh vegetables and fruits are consumed.

Moreover, there are untested wild plants and/or produced food, which are widely consumed by local populations. For instance, radioactive contamination in forestry trees leaves has been found far away in Nagano prefecture[28].

Furthermore, there are considerable discrepancies in measurements of radiation levels in air and food done in a specific location. For instance, in Nihontatsu-shi laboratories of the NGO and the Government are located across the street (50 m of each other) but they often register different radiation in environment and food.

Agri-food inspections, regulations and countermeasures are conducted in vertically segmented administration with "own" policies and not well-coordinated procedures. For instance, soil contamination surveys and inspection of agricultural produce is conducted by MAFF, monitoring of air radiation levels by MEXT, regulations on food safety standards and value determination by MHLW, decontamination and waste disposal by the Ministry of the Environment, training associated with food safety by Consumer Affairs Agency, and promotion of restoration plans and decontamination programs under the Reconstruction

Similarly, there are no common procedures and standards, nor effective coordination between monitoring carried out at different levels and by different organizations (national, prefectural, municipal, farmers, business, research etc.). Neither there is common framework for centralizing and sharing all related information and database, and making it immediately available to interested parties and public at large.

Officially applied area based system for shipment restrictions have been harming many farmers producing safe commodities. For instance, recent screenings of shiitake mushrooms grown on logs in two municipal areas of Fukushima prefecture have found that samples taken at cultivation facilities of four farmers do not contain radioactive substances above the national upper limit[29]. Consequently basis instead of a municipal area wide blanket lifting and permit mushroom shipments by selected farmers (Fukushima Minpo News, June 11, 2014).

Last but not least important, there have been on-going discussions among experts about "safety limits" and that lack of agreement additionally confuses producers and consumers alike. One of the interviewed by us experts – Mr.Satou, working at prefectural government agricultural department said "I regret to have easily believed the "myth of safeness of nuclear power plant" and not having prepared enough for the disaster - not having made safety standards of restriction for radioactive contamination, enough machines to inspect radiation in agricultural organization, and research about technologies for preventing radioactive contamination. Floods of information confused both producers and consumers after the accident. People did not trust government's information which was caused from the government's attitude after the accident, such as not announcing the data SPEEDILY" (June 6, 2013).

[28]Some people dispute that the radiation was there even before the accident, when inspections were not carried due to natural or manmade (e.g. nuclear tests in neighboring countries) radiation.

[29] Out of 65 shiitake samples harvested from greenhouses, 52.3% were measured below lowest detectable limit and the rest were far below the upper limit, showing a maximum reading of 6.6 Bq/kg (Fukushima Minpo News, June 11, 2014).

Nevertheless, there has been attempt to improve coordination and cooperation between different agencies. For instance, analysis on contamination of agri-food products is one of the major working areas of the Fukushima Future Center for Regional Revitalization. When unsafe food items are found the FATC is informed and the later take decision for ceasing shipments. Similarly, Soil screening project in Fukushima is coordinated by FCCU with participation of number of regional agencies and volunteers from the entire country.

Experts suggest existing system to be further improved by creating uniform inspection manuals and standards, enhancing coordination and avoiding duplication between different organizations, establishing inspection framework that cross prefectural borders, and a new management system that extend random sampling tests of circulating produce (shipment level) with management/control at production "planning" stage (Science Council of Japan, 2011; Koyama, 2013).

The later is to be based on detailed contamination maps of each agricultural field based on soil analysis, farmland certification system (similar to the local certification system based on "Guideline to indicate specially cultivated agricultural products") targeting to establish production practices (crop selection, land decontamination, inputs control) preventing contamination of agri-food products. Consequently, depending on the degree of radiation dose effective decision could be made whether to restrict cropping (high level), decontaminate (medium level), or encourage certain type of crops combined with further reduction measures (low level).

Another challenge associated with current inspection system is the costs. Fukushima prefecture costs for food testing, including sample purchases, amount to about 150 million yen each year (Fukushima Minpo News, May 11, 2014). Local government uses money withdrawn from its fund for residents' health management for food monitoring. When it began conducting tests (June 2011), the money in the fund that could be used for the screening process totaled about 2 billion yen while now (May 2014) they are about 600 million yen. Money is also used for projects and it is expected to be depleted in several years unless central government extends support. The prefectural government plans to maintain the number of tested items but it is unclear how much support it will get from the health ministry, which is moving toward decreasing the number of items subject to screening.

The Fukushima prefectural government is poised to continue the current practice of checking all packs of rice harvested in the prefecture for radioactive contamination after fiscal 2014 ending next March (Fukushima Minpo News, July 5, 2014). In addition, the prefectural government recently announced that it will screen for radioactive contamination all logs used for "shiitake" mushroom cultivation[30] as blanket log test will start with the Aizu region[31] (Fukushima Minpo News, September 26, 2014).

According to the Governor (Yuhei Sato) "we have yet to gain full understanding of the blanket checking program". The program costs about 700 million yen a year and the prefecture obtained the central government's agreement to continue until fiscal 2017 a national subsidy program for decontamination work associated with the nuclear accident. Nevertheless, the fund for financing the radioactivity-checking program is running short and that it has no idea how long to continue the program in its present form. It will review the program by taking into

[30] .It will be the third time for the local government to check all products and materials prior to shipment following rice and persimmons.

[31] It is plan to put the equipment into full operation in time for 2015 year's harvesting season in fall. New testing method will gradually expand in the rest of the prefecture to restore the prefecture as the largest producer of mushroom growing logs.

account the realities facing rice farmers and ongoing measures to dispel harmful rumors and other factors.

Producers have also expressed dissatisfaction over the MHLW's guidelines to reduce testing underlying that government perception is very different from that in the field (Fukushima Minpo News, May 11, 2014). According to official from the crisis management center of Fukushima Japan Agricultural Cooperatives "Effects of unfounded rumors are still strongly rooted. It is inconceivable to say we have a choice of not conducting the testing just because radioactive substances have not been detected. We need to carry out the testing at least until the stage in which trouble at the nuclear plant, including the contaminated water issue, does not occur at all".

What is more, some farmers started to be nervous about the efficiency of the applied methods. In some places they discuss to cease inspections, which are associated with significant costs (time for preparation of samples, shipment, payments for tests) with no adequate compensation received or recovery of farming progressing. An interviewed by us expert – Mr.Sunaga, retired officer from the prefectural government put it that way: "Cultivation management and inspections to secure safety is needed despite they are imposing heavy burden in short terms. However, there are worries how long we should continue these works. Farmer's willingness to continue is also declining because it is unclear when they can recover consumers trust (June 4, 2013).

Last but not least important, the public food safety policies have been also positively affected. For instance, the Great East Japan Earthquake and following nuclear disaster considerably impacted citizens' consciousness on food security in Japan. This disaster has prompted more 34.3% of the consumers to "become conscious of need of food storage" on the top of another 34.5% who "remained conscious with that need" (MAFF, 2012). A great part of the surveyed consumers have also strongly recognized the importance of different food supply arrangements (Figure 14).

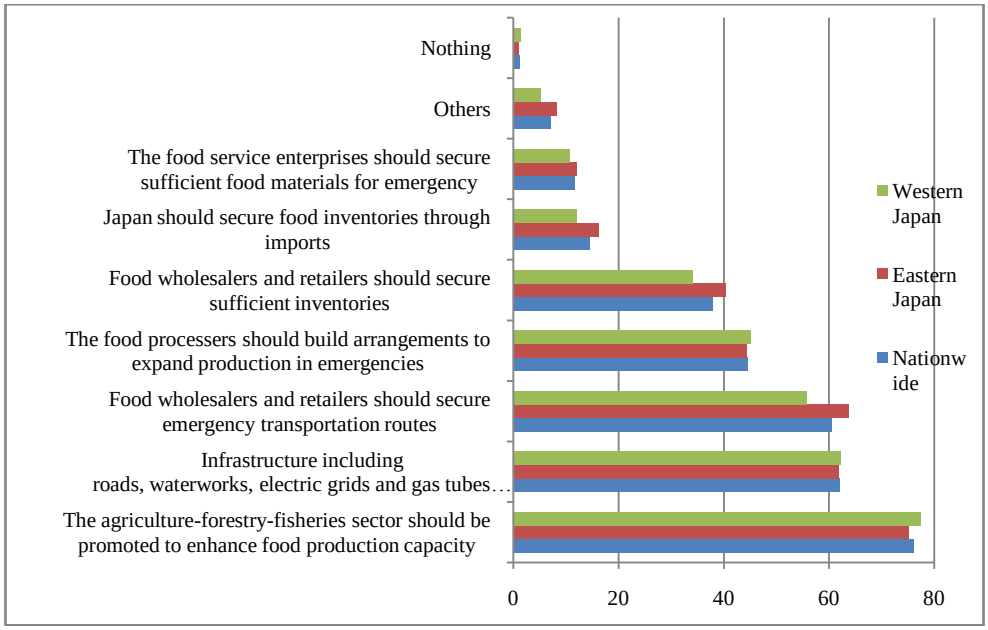


Figure 14. *Measures considered to be required for stable food supply in Japan (percent)*
Source: MAFF, 2012

There have been a number of challenges in public support response as well. Most important among them are: delay in establishing Reconstruction Agency (February 2012) for coordinating multiple recovery efforts in affected areas; lack of clear government guidelines for the nuclear disaster recovery, lack of detailed contamination map for all affected agricultural lands, using extension officers for obtaining samples for monitoring tests while suppressing their ability of management consulting, introducing technology, and forming areas of production badly needed by farmers in affected areas, etc. (Koyama, 2013).

4.5. Impact on technological and product innovations

There have been also positive effects on product, technological and organizational development and innovation in agriculture and related industries. The enormous public funding as well as the novel business possibilities (and restrictions) have created new opportunities for revitalization and expansion of farming and agri-business in the most affected regions and beyond trough technological and organizational modernization.

There have been huge incentives for investment in soil decontamination, emergency aid, agri-food safety, production recovery and modernization, product and technologies innovations and diversification, agri-food marketing, reconstructing of business and infrastructure, other public and private research and development projects. All they have been opening up more entrepreneurial, employment and income opportunities for agricultural and general population, and diverse form of business and non-for profit ventures.

Furthermore, according to experts there are many companies (especially from outside of affected areas) wanting to lease in abandoned farmland and start large-scale corporate farming. That will let consolidate and enlarge farm size, introduces large-scale machineries and innovations, explore economies of scale and scope, increase investment and efficiency, diversify and improve competitiveness of farming enterprises. In addition to a great variety of brand name rice with the name of the district where it was grown and its brand name, there have appeared new brand name rice associated with environmental conservation and social contribution. The later include Fukko-mai[32], which is Sasanishiki rice grown in the disaster area of the Great East Japan Earthquake (The Japan News, October 16, 2014). In Iwate prefecture farmers had to gave up tea production in the aftermath of the Fukushima nuclear disaster since long-term contracts were canceled by counterparts. Nevertheless, an innovator from Kunohe village managed to overcome challenges introducing a new special organically grown sweet tea ("ama-cha"), which is caffeine, tannin and calories free (NHK World, August 20, 2014). The new developed product with enhanced quality and packaging (tea bags) won a gold medal among 8000 products in UK and it is planed to appear next year on markets.

The plant "no-soil" factories have been developing in Japan for many years and now about 130 on them grow lettuce, herbs, tomatoes, strawberries, etc. (JFC, 2012). Expansion of this new technology has been perceived as an efficient way to overcome some of major challenges associated with the post-disaster recovery in the affected regions such as – degradated (salinized or radioactive) soils, destructed farms and equipment, lack of employment and income opportunities, aging farm population, insufficient integration in supply chain, etc. The plant factory technology has a number of advantages: capacity for stable year-round production; possibility to be installed on non-farmland areas (industrial parks, vacant stores etc.) in shopping districts; safe and high-quality agricultural produce with no or minimal pesticide use; employ novice farmers due to the light workload and the

[32] "Fukko" means happiness, but also has the implication of reconstruction from the disaster.

ease of standardizing procedures; comfortable work environment in which the elderly and people with disabilities can work with ease.

Comparative survey shows that the consumers' awareness of plant factory has increased in recent years (from 69% in 2009 to 76% in 2012) while the purchase experience also raised (from 9% to 17% accordingly) (JFC, 2012). Furthermore, consumers find superiority in the plant factory vegetables over the conventional farming in terms of safety, looks, ecology, etc. What is more, the financial institutions (e.g. JFC) provide long-term financing with fixed, low-interest rates, taking into account unique business characteristics such as long investment recovery periods and unstable incomes influenced by the weather risk (JFC, 2012). Besides, JFC also serves as a safety net for the agriculture, providing quick and flexible finance for disasters, etc.

Nevertheless, there a number of challenges associated with that new technology such as: high building and running costs, difficulties in establishment of cultivation technique, and securing of human resource development, difficulties to use existing food certification system (because fertilizers for nutriculture are used to the water prepared for breeding and cultivation)[33], etc. Under the new technology plant factory produce is a little more expensive (less competitive) than products grown outdoors or in greenhouses. Therefore, the key to success is to secure stable outlets for marketing the output through close vertical integration. Since food and food service industries need a stable supply of good quality produce it is extremely important to build business ties with vertical counterparts to secure outlets for the produce at the initial stage.

Another prospective technology applied in the disaster-hit area is "solar sharing" - a process in which farmers generate solar power on the same land where they grow crops. Generous feed-in tariffs (renewable energy payments) set by the government also support the project. While the proceeds from the crops and energy will be ploughed back into the project, the REV's creators hope the model will be mimicked by farmers whose livelihoods were decimated by the nuclear disaster.

Other innovations have been also experimented – e.g. various areas in Tohoku have been considering rapeseed as a source of bioenergy for the future (NHK World, July 29, 2013).

An increasing applications of ICT in agriculture have been also reported leading to precision technologies, higher farming productivity, efficient use of resources, enhanced food safety, and improved relations with counterparts and consumers (NHK World, July 15, 2013). The demand for proper measurements have induced numerous smart innovations for agriculture and related industries.

In the years after Fukushima nuclear accident an increase interests in renewable energy introduction has been reported, including in the sector "Agriculture". In most affected regions and nationwide the later has been motivated by the new opportunities of development (including Government support measures) as well as souring costs of energy supply. Recent survey has found that 11.6% of the Agricultural Management Entities already use renewable energy, 10.2% of them are planning to do so, while 57.3% of all report interests in introduction of renewable energy (JFC, 2014).

The highest rate of usage or planning of introduction of renewable energy is in Broilers, Dairy and Tea productions, while the lowest is in Rice cultivation. At the same time the largest shares of farms with "Interests" in renewable energy is among Rice, Vegetables in facilities and Mushrooms producers. On the other hand,

[33] Since March 2012, a new third-party certification system evaluating the safety of vegetables produced in plant factories has been introduced.

the greatest portion of producers with no interest in that issue is among the Hence farms.

There is a great variation in the interests in the type of renewables by producers in general and in different regions on the country. The "Solar" energy is reported by the greatest number of agricultural producers who use, plan to or are interested in introduction of renewable energy in all regions of the country. The Tea and Upland crop producers are particularly strongly using or interested in that energy source (97% and 95% of them accordingly) while the Broilers producers relatively less (82.1%). Almost every forth of the farms using, planning or interested in introduction of renewable also report Wind energy. The biggest interest to this energy source is shown by the farmers in Hokuriko region while the lowest interest in Kanto region. Above a third of interested farms from Tohoku region also indicate that source of energy. The application or interest to that energy source is the highest among Rice producers (31.3%) and lowest in Mushrooms producers (8.7%). The third most important source of energy in agriculture is Biomass and the biggest interest to that energy source which is shown by the farms in Tokai, Chugoku-Shikoku and Tohoku regions. Usage and interest to biomass is the highest among Pig, Broilers, and Dairy farms (58.7%, 57.1%, and 55% of them accordingly) and lowest in Tea producers (6.1%). Relatively good portions of producers in Hokuriki and Tohoku regions are also interested in Water as a renewable energy source. The application of or interests of hydro energy is the highest among rice producers (23.8%) and weakest in Hence farms (1.7%).

5. Conclusion

The analysis of the modes, efficiency and challenges of risk management in agri-food chain let us withdraw a number of academic, business and policies recommendations:

First, the governance (along with the technical, information etc.) issues are to take a central part in the risk management analysis and design. The type of threats and risks, and the specific (natural, technological, behavioral, dimensional, institutional etc.) factors, and comparative benefits and costs (including third-party, transaction, time) are to be taken into account in assessing the efficiencies, complementarities and the prospects of alternative (market, private, public and hybrid) modes. The system of the risk management is to adapt/improved taking advantage of the number of the new opportunities and overcoming/defending against the evolving new challenges summarized in the paper.

Second, more hybrid (public-private, public-collective) modes should be employed given the coordination, incentives, control, and costs advantages. The (pure) public management of the most agri-food-chain risks is difficult or impossible (agents opportunism, informal sector, externalities). Often the introduction and enforcement of new rights (on food security, risk-management responsibility etc.), and supporting the private and collective initiatives (informing, training, assisting, funding) is much more efficient.

Third, a greater (public) support must be given to multidisciplinary and interdisciplinary research on (factors, modes, impacts of) the risk governance in the agri-food chain in order to assist effectively the national and international policies, the design of modes for public interventions, and the individual, collective and business actions for the risk management.

Five years after the 2011 nuclear disaster in Japan a number of lessons for effective agri-food risk management can be withdrawn:

a/ the triple March 2011 disaster was a rare but a high impact event, which came as a "surprise" even for a country with frequent natural disasters and well-developed

disaster risk management system like Japan. It is necessary to "prepare for unexpected", and design, build and test a multi-hazard disaster risk management for the specific conditions of each country, region, sector, etc. Accordingly appropriate measures and sufficient resources (funding, personnel, stock piles, shelter cites, transportation means) have to be planed for effective prevention, early warning, mitigation, response, and post disaster relief and recovery from big disasters and accidents. Besides state resources it is important to mobilize huge private, community, NGOs, and international capabilities, expertise and means.

b/ the risk assessment is to include diverse (health, dislocation, economic, behavioral, ecological, etc.) hazards and complementary, (food, supply, natural, biological) chain, spin offs, and multilateral effects of a likely (natural, man made, combined) disaster. Modern methods and technologies are to be widely employed (mass and social networks, computer simulation, satellite imaging, etc.) for effective communication, preparation of disaster maps, assessment of likely impacts, planning of evacuation routs, relief needs, and recovery measures, secure debris and waste management, etc. It is crucial to involve multidisciplinary and multi-stakeholders teams in all stages of risk management to guarantee a holistic approach, "full" information and transparency, adequate assessment of risks, preferences and capabilities, and maximum efficiency.

c/ the risk management system is to be discussed with all stakeholders, and measures taken to educate and train individuals, organizations and communities for complex disasters and all contingencies. The individual responsibilities are to be well-specified and effective mechanisms for coordination of actions of authorities, organizations, and groups at different levels put in place and tested to ensure efficiency (speed, lack of duplication and gaps) during emergency. Individual and small-scale operators dominate in the agri-food sector of most countries around the world, and their proper information, training, and involvement is critical. The later is to embrace diverse agri-food and rural organizations, consumers, and population of each age group, which all commonly have no disaster management "culture", knowledge, training, and plans (particularly for large disasters like earthquakes, tsunamis, nuclear and industrial accidents).

d/ it is necessary to modernize the specific and overall formal institutional environment (property rights, regulations, safety standards, norms) according to the needs of contemporary disaster risk management. A particular attention is to be put on updating agri-food safety, labor, health, and animal welfare standards, and ensure adequate mechanisms, qualified agents, and technical instruments for effective implementation and enforcement. Establishment of an accessible cooperative, quasi public or public agricultural (crop, livestock, machineries, building, life and health) insurance system, including assurance against big natural, nuclear etc. disasters is very important for many countries for rapid recovery of affected agents and sectors. Modernization of the out of dated (often informal) lands, material, biological and intellectual property registration and valorization system is also important for effective post disaster compensation, recovery and reconstruction. That is particularly true for the great number of subsistent and "semi-market" holdings dominating the agro-food sector around the globe, which usually suffer significantly from disasters (often losing all possessions) but get no market valuation, insurance and/or public support.

e/ it is important to set up mechanisms to improve efficiency of public resource allocation, avoid mismanagement and misuse of resources as well as reduce individual agents' costs for complying with regulations and using public relief, support and dispute resolution (e.g. court) system. That would let efficient allocation of limited social resources according to agents needs and preferences, intensify and speed up transactions, improve enforcement (of rights, laws, standards) and conflict resolution, decrease corruption, and eventually accelerate recovery and reconstruction. In this

respect it is obligatory to involve all stakeholders in decision-making and control, increase transparency etc. at all levels and stages of disaster planning, management, and reconstruction. In the case of a post-disaster evacuation it is essential to secure proper (police, voluntary group) protection of private and public properties from thefts and wild animal invasion in disaster and evacuation zones.

f/ different agents and elements of agri-food chain are affected unlikely from a disaster and have dissimilar capability to recover. Most farming assets (multiannual crops, irrigation facilities, building, brands, biodiversity, landscape) are interlinked with the land, and if the later is damaged a rapid recovery (rebuilding, relocation, alternative supply) is very costly or impossible. Similarly, smaller-scale and highly specialized enterprises, small-member communities and organizations, and visitors and tourists to the disaster regions, are all more vulnerable and have less ability to protect, bear consequences and recover. All that require differential public support (intervention, compensation, funding, assistance) to various types of agents it order to provide emergency relief, accelerate recovery and diminish negative long-term consequences.

j/ there is also a strong "regional" specificity (interdependency) of agrarian, food and other rural assets. Subsequently, if a part of these assets/products is damaged or affected (e.g. destruction of critical transportation, communication, distribution, electricity and water supply etc. infrastructure; a nuclear, chemical, pathogen etc. contamination) the negative externalities impact all agents in the respective region (including undamaged lands, livestock, produce and services). In order to minimize damages it is important to properly identify (locate) risk and take prevention measures, recover rapidly critical infrastructure, strictly enforce quality (safety, authenticity, origin) of products and adequately communicate them to all interested parties (producers, processors, distributors, consumers, international community).

h/ good management of information and communication is extremely important in emergency, recovery, and post disaster reconstruction operations. The March 2011 disasters have proven that any delay, a partial release or controversies of official information have hampered the effective (re)actions of agents, and adversely affected public trust and behavior (e.g. buying products from disaster regions). Before, during and after a disaster all available (risk, monitoring, measured, projected) information from all reliable sources is to be immediately publicized in an understandable by everyone form through all possible means (official and community channels, mobile phones, social media, etc.). It is essential always to publish alternative (independent, private, scientific, international) information as well, including in foreign languages, which would build public trust and increase confidence. In Japan it has not been easy to find all available information related to the Match 2011 disasters in a timely and systematized way (updates, diverse aspects, unified measurement, time series, alternative sources), which make many foreigners and local alike skeptical about accuracy.

g/ a big disaster like the Match 2011 in Japan often provides an extraordinary opportunity to discuss, introduce and implement fundamental changes in (agricultural, economic, regional, energy, disaster management) policies, improve disaster management and food security, modernize regulation and standards, relocate farms and houses, consolidate lands and operations, upgrade infrastructure, restructure production and farming organizations, introduce technological and business innovation, improve natural environment, etc. All such opportunities are to be effectively used by central and local authorities through policies, programs, measures, and adequate public support given for all innovative private and collective initiatives in the area.

k/ it is important to learn from the past experiences and make sure that "lessons learned" are not forgotten. The impacts and factors of a disaster, disaster management, and post disaster reconstruction are to be continuously studied, knowledge

communicated to public, and "transferred" to next generation. It is critical to share "good" and "bad" experiences with disaster prevention, management and recovery with other regions and countries, in order to prevent that happening again. It is particularly important to share the advance Japanese experience at international scale through media, visits, studies, conferences, etc. and turn Tohoku in a disaster risk management hub for other regions and countries. It is essential not to copy but adapt the positive Japanese experiences to the specific (institutional, cultural, natural) environment and risks structure of each community, subsector, region, and country.

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