COMPENSATION OPTIONS FOR QUARANTINE COSTS IN PLANT PRODUCTION

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2022

Vortrag anlässlich der 62. Jahrestagung der GEWISOLA
(Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaues e.V.)

Resilienz von regionalen und globalen Wertschöpfungsketten der Agrar- und Ernährungswirtschaft
07. bis 09. September 2022

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Abstract

Quarantine plant pests cause considerable economic damage due to direct plant losses, costs of eradication and contamination measures. Although these losses can threaten the existence of a farm, to date no country has a universal compensation solution embodying all agricultural sectors. In this paper, we aim at suggesting improvements to the existing compensation scheme in Germany since the status quo lacks financial resilience and is considered to be unable to provide sufficient help for farmers. For achieving this, we reviewed the most common compensation schemes such as ad hoc aid, mutual fund, and private insurance. Additionally, we conducted a discrete choice experiment to elicit farmers' preferences for different components of financial support in case of a quarantine. As a potential solution for Germany, we suggest a privately organized compensation system funded by the state as the most cost-effective for setting up and, at the same time, affordable for farmers way of spreading the pest risk.

Keywords

Discrete choice experiment, Quarantine pest, Compensation

1 Introduction and problem statement

The recent Covid-19 pandemic has visualized in a drastic manner how costly quarantine measures are that target at stopping the spread of a human disease. This experience may help to recall that livestock and plant diseases as well can cause enormous economic losses to the agricultural sector, which call for quarantine measures. A case in point is a quarantine pest *Xylella fastidiosa* whose outbreaks according to the estimation of SÁNCHEZ et al. (2019) cause annual production losses in the EU equal to €4.2-6.9 billion. It is expected that climate change and trade intensification will further increase the likelihood of emergence of quarantine pests in the EU (GODEFROID et al., 2019). Already today, the management of the occurrence of quarantine organisms is highly regulated in the EU. The Plant Health REGULATION (EU) 2016/2031 and Control REGULATION (EU) 2017/625 prescribe in detail reporting, testing, erasing and monitoring procedures that farms have to implement if quarantine organisms occur. These measures are then surveilled by plant protection. The Federal Research Centre for Cultivated Plants (Julius Kühn-Institut) supports the Federal States by providing risk analyses on emerging and established plant pests. The regulations also determine to what extent financial losses, which arise from implementing quarantine measures, can be compensated by public institutions. In this regard, the treatment of livestock and plant diseases differs significantly. In Germany, public livestock insurance schemes (Tierseuchenkassen) have been established long since on a state level that cover financial losses resulting from culling of animals or trade bans (FRENTRUP et al., 2010). However, a counterpart for quarantine organisms that affect plant production does not exist in Germany. Instead, German farmers can apply for the ad hoc state support granted upon a voluntary application. State and local authorities are responsible for the administration of pest outbreaks with includes damage assessment, settlement of claims, prescription of quarantine measures and compensation payment. This situation is perceived as unsatisfactory by many stakeholders, because of tedious administrative procedures and uncertainty about the amount as well as the timing of financial compensations.

Against this backdrop, this paper aims at describing and assessing options for the compensation of financial losses due to the emergence of quarantine organism in plant production. To this

end, we will browse existing programs and compensation schemes implemented elsewhere in the EU and the U.S. and we will gather experiences that have been made with these programs. The set of potential compensation options comprises various types of ad hoc disaster aid, insurances or mutual funds. Based on a systematic literature review we derive relevant design parameters for the development of quarantine pest compensation schemes in plant production, such as coverage of losses, deductibles, preconditions for loss adjustment, voluntariness of participation or organizational responsibility. In a further step, we assess the relevance of these design parameters empirically through a discrete choice experiment. Here we take the perspective of farmers, i.e. we focus on the recipients of financial compensation. The contribution of our paper to the extant literature on pest risk management and insurance design is twofold: First, we review and analyze the existing compensation schemes in different countries, both within and outside the EU. This experience helps to determine benefits and downsides of hypothetical compensation approaches discussed in the literature and distill their individual components that we later use as attributes in the choice experiment. The second contribution is the empirical estimation of farmers' willingness to pay (WTP) for compensation schemes against quarantine induced losses. While several studies elicit the WTP for agricultural insurance products in general (e.g. SHERRICK et al., 2003, YE et al., 2017, HUANG et al., 2020) to the best of our knowledge no empirical work exists that focuses on quarantine risks in plant production. The findings of our study are useful for improving the status quo of loss compensations and for designing compensation schemes taking into account farmers' demand.

2 Compensation options for quarantine pest losses – an overview

Both within and outside the European Union there are different compensation solutions for quarantine pest occurrence (Table 1). One of the most common approaches is the *ad-hoc financial support* from the state. As a rule, such payments are provided unconditionally upon application. In Europe, there is a regulation according to which the EU co-finances 50% of eligible costs incurred due to quarantine measures, and in special cases up to 75% (REGULATION (EU) 2021/690). Some European countries extended this support by means of the federal budget, e.g. Switzerland, some countries adopted this rule without any amendments (Poland, Slovenia). Germany makes use of the EU regulation as well and grants monetary compensation for eliminated plants that were neither infected nor suspected of being infected (PflSchG § 54 (1)). Whether any further support should be provided, lies in the responsibility of each federal state individually. The same applies to the officially prescribed eradication measures. This creates a lot of uncertainty for farmers since quarantine measures and corresponding monetary help are defined on a case-by-case basis.

Table 1: Existing compensation options for quarantine pest losses

Option	**Insurance**	**Mutual fund**	**Ad-Hoc Support**
Organisation	Private groups (on solidarity basis)		state
Funding	private / public-private mix		public
Example	Europe, USA	Netherlands (PotatoPol), France (FMSE)	Germany, Poland, Slovenia, Switzerland

Source: Authors' illustration

Insurance is a risk management tool that redistributes risk by pooling individuals threatened by the same danger. Rural development programs of EU countries allow to subsidize insurance by financing up to 70% of the premium costs if losses are higher than 20% of average annual production in the recent years and the cause of damage are plant or animal diseases, or adverse climatic and environmental events (see REGULATION (EU) 1305/2013). Agricultural insurance in the EU member states is very heterogeneous with regard to providers, risk coverage, type and number of insured risks, and subsidization. For instance, in comparison to Italy or Spain,

Germany does not provide subsidies for agricultural insurance. To date, no country has plant pest insurance encompassing all sectors. In Germany, in the case of QSO, horticultural companies and nurseries have the option to purchase supplementary packages to existing insurance (Gartenbau-Versicherung VVaG, supplement to HORTISECUR G/F) or as an individual product (Münchener Magdeburger Agrar/MIRASCON). In the USA, producers of avocados and citrus fruits in certain regions have the option of taking out supplementary insurance to existing policies as well.

Another compensation solution adopted for the case of quarantine losses in some countries is a *mutual fund*. The budget of a mutual fund is built upon contributions of its members and sometimes additionally subsidized by the state. Members who suffer from losses caused by plant pests get compensation from this budget. The EU introduced a regulation (REGULATION (EU) 1305/2013) that establishes a legal framework for mutual funds in Europe and grants financial support to the funds grounded in the EU member states. France has already made use of this regulation and created the public-private mutual fund (FMSE) that offers compensation programmes both for livestock and plant sectors. The important peculiarity of this fund is a compulsory participation for all producing farmers. The FMSE offers two types of memberships: the basic compulsory and an extended voluntary. The first type of participation does not presuppose compensation in case of pest entry. In the Netherlands, potato producers organized a private fund PotatoPol that covers crop damages and costs of eradication measures. Nowadays PotatoPol is fully financed by member contributions, though in the first years after establishment it was publicly subsidized.

The overview of existing compensation schemes for quarantine pests exhibits heterogeneous responses on the quarantine pest risks in different countries. The fact that none of these schemes (apart from FMSE) offers broad multi-sectoral insurance and either exists as a supplement to other programmes or covers only one sector or functions only with public funding, shows the specificity of the quarantine risk. FMSE is exceptional in the sense that this mutual fund includes all agricultural sectors. Yet, the budget of the fund is secured through compulsory membership fees and subsidies from the EU and the French state. The probability of pest entry is difficult to calculate because there are a lot of biological and human factors at play. This, in turn, hinders the calculation of risk premium which is a significant component of any insurance. This mechanism partly explains the variety of compensation solutions on the one hand and the absence of comprehensive universal insurance against quarantine pests on the other.

3 Evaluation of compensation options through Discrete Choice Experiments

The discrete choice experiment (DCE) is widely used in the agricultural economics literature. Especially in risk management the DCEs help to elicit farmers' preferences for various insurance schemes. Numerous studies focused on weather-risk crop insurance. YE et al. (2017) conducted a choice experiment to explore the demand for crop insurance in developing countries using the example of China. In the same context, AKTER et al. (2016) addressed the issue of the gender pay gap. The lens of DCE was applied on crop insurance in developed countries as well, such as the US (SHERRICK et al., 2003) or Germany concerning the changing subsidization (MÖLLMANN et al., 2019). HUANG et al. (2020) zoomed in to the potato sector in China, whereas DOHERTY et al. (2021) placed emphasis on insurance against extreme weather events. There are studies investigating preferences for animal disease insurance both in developed (HEIKKILÄ et al., 2016) and emerging countries (CHANTARAT et al., 2009). However, to the best of our knowledge, risk management in the field of crop pests remains understudied. Neither there are studies aiming at suggesting general compensation options for the case of quarantine pest occurrence nor the research on preferences for specific components of such schemes exist. With the present study, we intend to fill this research gap. Additionally, in comparison to previous papers, we carry out more extensive DCE with respect to the attributes included.

3.2 Discrete Choice Experiment

In order to elicit preferences for characteristics of a potential compensation scheme, we employed a discrete choice experiment method. DCE allows to study preferences for hypothetical products by describing them through their attributes (ADAMOWICZ et al., 1998; LOUVIERE and LANCSAR, 2009). Each attribute has several levels which allows for variability of options. During an experiment, respondents face several choice situations or choice sets, in which they are asked to choose only one alternative. The number of alternatives per choice set is unlimited, however it is important to take the cognitive abilities of respondents to process information into account. A too long survey can cause boredom or tiredness, which as a consequence leads to a high dropout ratio or attribute non-attendance and unprecise answers. (SWAIT and ADAMOWICZ, 2001; YAO et al., 2015; FLYNN et al., 2016). On the other hand, the higher number of choice sets yields more information and, as a result greater statistical efficiency. By defining the number of choice sets, one has to consider number of alternatives and attributes. There are studies arguing for more than two alternatives per choice set empirically proving that this does not reduce accuracy of answers (PINNELL and ENGLERT, 1997; VON HAEFEN et al., 2005; CHUNG et al., 2011).

To study how different characteristics of a compensation scheme influence the decision of farmers, we applied multinomial logit model (MNL) which has the following form (MCFADDEN, 1974):

$$\pi_{ij} = \frac{\exp(\beta_j' X_{ij} + \gamma' Z_i)}{\sum_k^s \exp(\beta_j' X_{ik} + \gamma' Z_i)}, k = 1, \dots s,$$

where s is a number of choice sets; X_{ij} is a vector of alternative-specific attributes for the alternative j chosen by the individuum i; β_j and γ are vectors of regression coefficients to be estimated; Z_i is a vector of individual-specific variables that include personal and farm characteristics of a participant i. The MNL model implies the assumption that the error term is independently and identically distributed for all i. In order to simplify the interpretation, we interacted the individual-specific variables on the dummy variable *SQ* for the change of status quo which equals one, if a respondent chooses alternative one or two in a choice set, and zero otherwise.

For estimating the regression, we employed the package *mlogit* in R.

3.3 Choice Design

An example of a choice set presented within the experiment is shown in Table 2. Each choice set contained three alternatives one of which, status quo, was constant over the whole experiment. Inclusion of the status quo is crucial since otherwise the participants are forced to choose an alternative that they might not prefer. Such forced choice is problematic also because it does not comply with the reality (LANCSAR et al., 2017). The description of the status quo option was derived from the present regulations of the European Union (COMMISSION IMPLEMENTING REGULATION (EU) 2019/2072).

Table 2: Attributes and their levels

	Compensation option 1	Compensation option 2	Status Quo
Organizational form	state	private	• Only value precautionary eliminated plants compensated; • voluntary participation; • unconditional
Participation type	compulsory	voluntary	
Coverage	medium	low	
Participation cost	0.003	0.002	
Deductible	10%	no	
Prerequisite for compensation	verifiable hygiene measures	no	
I choose:	☐	☐	☐

Source: Authors' illustration

The alternatives were unlabeled, so the participants had to choose between an abstract compensation option one or two. The main disadvantage of a labeled DCE is that participants tend to devote less attention to attributes and make their decision based on an alternative name instead (DE BEKKER-GROB et al., 2010). Since the focus of the present study lies on eliciting preferences for single attributes, we chose the unlabeled form.

The alternatives were described through six attributes (Table 3): organizational form, participation type, coverage, participation costs, deductible and prerequisite for compensation. The attributes were defined based on the preliminary analysis of the existing compensation schemes in other countries. For instance, a compensation scheme in France is state-organized, while in Netherlands potato producers founded a private mutual fund that currently operates without public funding. The qualitative interviews with farmers that were conducted before designing the DCE contributed to shaping the attribute list as well. The attribute for participation cost stands for insurance premium but we intentionally named it this way since the word "premium" directly refers to private insurance. This association could have influenced the decision of farmers and distort the results. The range of values for the participation costs was derived based on the existing insurance products against quarantine pests in Germany offered by Gartenbauversicherung VVaG and Münchener & Magdeburger Agrar AG.

Considering that each of the six attributes has two or three levels, all possible combinations of levels result in $(2*2*3*4*3*2)^2 = 82\,944$ choice sets. Since it is unrealistic to expect participants to process such an amount of information, the number of choice sets was reduced to 24 by means of D-efficient (D-error = 1,12) algorithm (ZWERINA et al., 1996). The efficient design was created using *idefix* package in R. All choice sets were divided into three equal groups, so each participant got only one group consisting of eight choice sets randomly assigned. Choice sets were shown in a random order without an option to get back to the already answered question. This helped to avoid interconnection between the answers. We allowed for the attribute level overlap which means repeating levels among alternatives within one choice set (JONKER et al., 2019). This decreases the complexity of an experiment and prevents participants from using simplification strategies such as considering only the first and last attribute or making a decision solely based on a price attribute.

Table 3: Example of a choice set

Attribute	Levels
Organizational form	• State • Private
Participation type	• Voluntary • Compulsory
Coverage	• Low: value of eliminated plants • Medium: value of eliminated plants + cost of quarantine measures • High: value of eliminated plants + cost of quarantine measures + income loss
Participation cost	• 0.002 of insured amount • 0.003 of insured amount • 0.004 of insured amount • 0.005 of insured amount
Deductible	• no • 10% of losses • 20% of losses
Prerequisite for compensation	• no • verifiable hygiene measures

Source: Authors' illustration

The experiment was conducted online, created on the basis of LimeSurvey.org. In the beginning, the participants got short notice on the purposes and structure of the experiment. We intentionally did not employ any tools to overcome hypothetical bias. Hypothetical bias is a problem that appears in experimental economics and reposes in the systematic overstatement of the willingness to pay. The reason for this lies in the hypothetical nature of economic experiments so that respondents do not take questions seriously. There are several ways to reduce hypothetical bias, such as cheap talk (CUMMINGS and TAYLOR, 1999), real talk (ALFNES et al., 2010), honesty priming (GSCHWANDTNER and BURTON, 2020), solemn oath (JACQUEMET et al., 2013) or follow-up question on response uncertainty (BLOMQUIST et al., 2009). However, none of these methods was proven to be a universally efficient tool against bias. In fact, the presence of this problem can be dependent on the sample and studied topic (MURPHY et al., 2005). We believe that due to the urgency of the pest problem for German farmers, the hypothetical bias is not relevant for the present study. In addition to this, all methods for combating hypothetical bias extend the duration of the experiment which in turn can increase the dropout ratio.

4 Data and Descriptive Statistics

4.1 Data

The present study focuses on compensation options in case of quarantine pest occurrence in Germany, therefore the study sample consists of German farmers. Respondents were acquired mainly through newsletters of farmer unions of different sectors such as winery or horticulture and advertisement in a technical newspaper for horticultural producers. In addition to this, to reach farmers who do not actively use digital information sources, we sent 400 postcards to pre-selected farmers. We diversified this pool based on region and sector for achieving as

homogenous distribution as possible and avoiding overrepresentation of certain groups. However, we acknowledge that we worked with a convenience sample which means that the respondents were recruited primarily based on accessibility (CLARK, 2007). One of the main hurdles for applying random sampling in this study is the sensitivity of the topic. In some sectors, there is generally low willingness to participate in any surveys related to quarantine pests because farmers are afraid of appearing in this context. The reason for this is that some quarantine organisms cause long-lasting negative consequences and are difficult to eradicate. Therefore, it was inevitable to enlist the support of agricultural institutions because they possess the necessary level of trust required to attract enough respondents. As an additional incentive, we gave away five vouchers that were raffled off among all participants after the experiment was closed. The financial incentive was supposed to decrease the dropout ratio and motivate respondents to finalize the experiment since they had to leave their email addresses for participation in the giveaway on the last page of the survey.

4.2 Descriptive statistics

The experiment was conducted in September and October in 2021 completely online in German. A total of 341 responses were received. Not all the questionnaires were filled in completely, thus after cleaning the data we were left with 155 complete unique answers. In the second part of the experiment, after completing the eight choice sets, the respondents received questions on personal and farm characteristics, as well as on their risk attitude.

All respondents are involved in a farming activity in Germany, either as owner and operational manager (81%) or as an employee (19%). For 93% is the farming the main occupation. 21% of respondents are female, the average respondent age is 49 years old. 44% of the experiment participants have a college degree or higher. Half of the farms generate annual revenue of 50000 €/ha which is higher than the sector average in Germany. The reason for this difference is an overrepresentation of some sectors in the sample that does not correspond to reality. By sectoral division, 37% of respondents are employed in horticulture, 23% are coming from the plant nursery sector, 11% are involved in crop farming. The fruit and vegetable, as well as wine cultivation amount for the rest 29%. Again, this sectoral division does not represent the agricultural realm in Germany. This can be partly explained by the convenience sample but also by differences in the perception of the problem that varies depending on the sector. For instance, the German plant nursery association actively informs their members on potential consequences and prevention techniques against quarantine pests, while in other sectors farmers are not that well-informed on this issue.

As some studies on a similar topic have shown, not only socio-economic factors influence a choice of the compensation scheme, but also risk and risk attitude of farmers (e.g. HELLERSTEIN et al., 2013; MENAPACE et al., 2016). Hence, we asked farmers to assess their risk attitude and the likelihood of pest entry on their field. Both parameters were measured on the 10-points Likert scale (1 – risk-averse, 10 – risk-lover and 1 – unlikely, 10 – very likely, respectively). Though there are other ways for measuring risk attitude in the literature, such as lottery or auction, we stick to the simplest method of measuring the risk attitude. This approach is, firstly, still reliable for revealing the risk attitude (DOHMEN et al., 2011). Secondly, more complex methods are time-consuming and thus can lead to an increase in the dropout ratio. According to the results, farmers are risk-neutral on average which contradicts the findings of other studies that farmers tend to be risk-averse (e.g. BOUGHERARA et al., 2017). The average pest entry likelihood lies by 5, which is that farmers anticipate the occurrence of quarantine organisms as likely. The average for this number ranges from 3.65 to 5.5 depending on the sector. 15% of respondents currently have insurance against quarantine pests.

5 Regression results

11% of respondents always selected the status quo alternative. These results can be a sign of the presence of status quo (SQ) bias – the disproportional preference for the currently existing alternative. MEYERHOFF and LIEBE (2009) provide a number of reasons why the SQ bias appears in choice experiments: loss aversion, complexity of tasks or protest voting. However, these observations were not excluded from the choice set because we believe that neither of these reasons applies to this experiment. In reverse, the status quo alternative might have a significant advantage in comparison to other compensation options for some respondents due to the fact that it is free.

The estimates in the MNL model show the contribution of parameters to the utility U_{ij} of individual *i*, therefore we cannot interpret coefficients directly. However, the sign of each estimate provides valuable information on the direction of an effect. The estimation results are presented in Table 4. The ASCs for both alternatives are negative which means that the respondents have a general preference for the status quo. Since the DCE was unlabeled there is no substantial difference in interpretation between the two estimates. Almost all attribute estimates have expected and economically reasonable signs. Farmers prefer publicly organized compensation options with voluntary participation. The prerequisites for compensation and 20%-deductible negatively affect the overall utility, whereas the full compensation increases the utility. However, the estimation results for the attributes deductible with the level 10% and medium coverage of losses are difficult to explain from economic perspective. Though both coefficients are statistically insignificant.

The socio-economic variables interacted on a dummy for a status quo (=0 if status quo alternative chosen) show the change in the utility of an individual with a certain characteristic with regards to switching from a status quo alternative to a new compensation scheme. If a farmer has insurance against quarantine pests, the probability of choosing one of the suggested alternatives increases. The same trend applies to the perception of pest entry: the higher respondents assess the likelihood of pest entry, the more likely they are to decide against the status quo. Women, as well as older people, are less likely to prefer a new compensation scheme. On the contrary, the higher the educational level is, the higher is the probability to prefer one of the alternatives different from the current system. Farms with higher revenue and ecological farms are more likely to preserve the status quo, whereas farm owners are more likely to choose a change of the present compensation program compared to employees. Last but not least, sector differentiation reveals that all farmers are generally for the change of the status quo.

Table 4: Estimation results of MNL

Variable	Estimated coefficients
ASC (Alternative 1)	-1.537*** (0.51)
ASC (Alternative 2)	-1.695*** (0.51)
Organisational form (1=state)	0.159*** (0.04)
Participation type (1=voluntary)	0.079* (0.04)
Coverage_medium	-0.0009 (0.055)
Coverage_high	0.452*** (0.069)
Participation cost	-105.35*** (39.2)
Deductible_10	0.036 (0.058)
Deductible_20	-0.27*** (0.07)
Prerequisite for compesation	-0.145*** (0.045)
Probability of pest entry	0.033 (0.03)
Risk attitude	0.26*** (0.05)
Insurance	1.266*** (0.255)
Sex	-0.154 (0.19)
Age	-0.35*** (0.08)
Education (1=undegraduate or higher)	0.995*** (0.18)
Main occupation	1.67*** (0.33)
Revenue	-0.33*** (0.098)
Ecological farming (0=conventional)	-1.14*** (0.25)
Farm owner (0=employee)	0.359 (0.26)
Weinery	1.49*** (0.43)
Plant nursery	1.22*** (0.36)
Fruit cultivation	0.49 (0.47)
Crop farming	1.12*** (0.37)
Ornamental crops	1.024*** (0.37)
Vegetable cultivation	1.75*** (0.45)
***p < 0.01; **p < 0.05; *p < 0.1; Standard error in brackets	

Source: Authors' illustration

For translating the estimated coefficients into monetary terms, we calculated willingness to pay for attributes (WTP) (Table 5). Since the price coefficient in the experiment was measured as a share of an insured amount, the WTPs are expressed in the same units. For this reason, the values in Table 5 might seem to be extremely low. These values demonstrate how much an average German farmer is ready to additionally pay for a certain characteristic of a compensation scheme. As expected, the broadest coverage has the highest WTP which is understandable because this is the core point of any insurance. The state organization of the compensation is more important for respondents as voluntary participation. Comparing WTPs with the existing market price for insurance against quarantine pests (equals 0.002 of the insured amount, Gartenbauversicherung VVaG), we find out that farmers are willing to pay 65% of a current price less if there is a prerequisite for compensation at place. In the same manner, a 20%-deductible has negative effect on the price. The general WTP for any alternative different from the status quo option is negative.

Table 5: Willingness to pay for attributes

Attribute	Willingness to pay (share of insured amount)
ASC (Alternative 1)	-0.01125
Organisational form	0.00135
Participation type	0.00073
Coverage (medium)	-0.0000004
Coverage (high)	0.0041
Deductible (10%)	0.00033
Deductible (20%)	-0.0024
Prerequisite for compesation	-0.0013

Source: Authors' illustration

6 Discussion and Conclusion

The current compensation system in Germany is criticized for being too bureaucratic and inflexible. In addition to this, there is a considerable level of uncertainty associated with the amount and conditions for compensation because often they depend on the current budget and single decisions of local authorities. The need to define quarantine measures in each case individually also affects the duration of the application procedure which takes sometimes too long and thus can be critical for the farm's existence. Some disadvantages of the ad hoc financial support are especially relevant in the event of a large-scale disaster and include a disproportionate financial burden on a local budget or suboptimal quarantine and compensation measures induced by public pressure. GÖMANN et al. (2015) stress that the existence of state compensation can also impede the emergence of private insurance solutions. Nevertheless, the choice experiment has shown that farmers are not willing to switch to alternative forms of compensation unless the desirable attributes are in place. To such attributes belong type of organization (state or private), participation form (compulsory or voluntary), coverage, price, deductible, and preconditions for compensation. Respondents tend to retain the state-provided compensation scheme. They prefer voluntary participation and maximal coverage without additional prerequisites.

In comparison to the state support, private insurance grants swift and unbureaucratic financial help tailored for each case individually. Due to the fact that the insurance conditions are negotiated in advance, farmers have better financial planning and more clarity in the quarantine case. However, the supply of insurance products against plant pests is limited because the probability of occurrence and potential extent of damage are difficult to quantify due to the lack of data. Furthermore, in the absence of reinsurance options, insurance companies will charge high premiums or offer coverage only in combination with other products, making such policies unattractive to many farmers.

Unlike insurance companies, a mutual fund, as another compensation form for economic damage caused by plant pests, is managed and financed by its members and usually embodies farms from only one sector or geographic region. A unique advantage of this system is that members have direct control over their finances and specifically over the surplus remaining at the end of a year. However, in order to ensure the financial resilience of such a fund, the number of members has to reach the required minimum. Based on empirical evidence, MEUWISSEN et al. (2013) identified that this minimum amounts to 30% of a sector. Compared to insurance, premium payments may be subjected to more fluctuations. Especially unstable is a mutual fund right after formation since the critical mass of members is not attained yet.

Concerning all benefits and drawbacks of compensation options mentioned above, we conclude that although the current system of ad hoc support has to be reformed, alternatives are difficult

to establish on a purely private-sector basis. A possible solution can be a publicly subsidized private mutual fund or insurance. In this case, financial resources assigned in the status quo to the ad hoc support can strengthen the financial stability of a new compensation scheme. The setup and administration costs are considerably lower compared to the state mutual fund grounded from scratch. Additionally, the state can grant an indemnity guarantee to reduce reinsurance costs. To which extent these suggestions help to reduce the premium requires a closer examination that is not covered within the scope of the present study. Nevertheless, the cooperation of private and public institutions is necessary to ensure a smooth transition from the ad hoc state support to the new compensation system. Moreover, given the peculiarities of financial damages caused by quarantine organism in plant production it seems doubtful, whether separate insurance solutions for these risks will emerge. From a policy perspective, it appears more promising to pursue a holistic approach to risk management in agriculture, in which compensations of quarantine risks become part of more comprehensive insurance contracts that cover multiple yield risks, such as weather risks. This, however, requires coordination of different ventures that are currently conducted by the German Government and by single federal states aiming at financial support of risk management tools in agriculture.

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