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**FEASIBILITY OF INCOME INSURANCE IN EUROPEAN AGRICULTURE**

**Miranda P.M. Meuwissen and Ruud B.M. Huirne**

Department of Economics and Management, Wageningen Agricultural University, Hollandseweg  
1, 6706 KN Wageningen, The Netherlands

**Contact author**

Miranda P.M. Meuwissen, Department of Economics and Management, Wageningen Agricultural  
University, Hollandseweg 1, 6706 KN Wageningen, The Netherlands

Telephone: +31 (0)317 483836 / 484065

Telefax: +31 (0)317 482745

E-mail: [MIRANDA.MEUWISSEN@ALG.ABE.WAU.NL](mailto:MIRANDA.MEUWISSEN@ALG.ABE.WAU.NL)

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## **AJAE Manuscript Abstract**

Liberalization of agricultural markets leads to new risks for European farmers. This paper studies the feasibility of income insurance schemes for European crop and livestock farmers. Different insurance topics, such as governmental reinsurance and the use of mutual insurance funds, are described and analyzed, using individual farm level data of different areas and commodities. In this paper it is argued that 'income' insurance in European agriculture should be restricted to yield-only insurance schemes that are organized per commodity and per region and in which governments play the role of 'lender of last resort'.

## **Key words**

Income variability, income insurance, crop and livestock farming

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## **Introduction**

Income from farming is usually considered as rather volatile due to a whole series of stochastic factors that affect production and prices. Throughout the years, various risk management tools have been used to reduce, or to assist farmers to absorb, some of these risks. Also the Common Agricultural Policy of the European Union (EU) has taken away some of the risks, for example by assuring the prices of many agricultural products. However, price and production risks are likely to increase in the future. International trade agreements can be expected to lead to price liberalization and to more exposure of farmers to competitive market forces. Furthermore, as trade is expanded, new quality requirements are likely to be defined for farm products, such as stricter rules for use of fertilizers, herbicides and medicines for animals. As a result, production risk is also likely to increase. Such developments affect the variability in income from farming. As a consequence, there may be a need for complementary measures that stabilize and safeguard incomes without interfering significantly with markets for agricultural products. One possibility

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Miranda Meuwissen and Ruud Huirne are respectively a PhD-student and associate professor at the Department of Economics and Management, at the Wageningen Agricultural University in the Netherlands.

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to address income stabilization is providing insurance schemes. The goal of this study is to examine whether there might be a case for farm income insurance in the EU in the future.

## **Materials and methods**

In the research, an extended literature review was carried out first. Experiences with gross revenue insurance schemes in the US and Net Income Stabilization Accounts (NISA) in Canada were studied. Furthermore, a workshop with twenty selected experts from insurance, reinsurance and financial companies from six EU member states was organized. Goal of the workshop was to discuss the idea of different types of income insurance schemes to see whether income insurance might be a feasible and practical concept. And, if so, for which commodities and risks, and in what form. The workshop consisted of four parts from which the first focused on various income measures, the second on moral hazard and adverse selection problems, the third on the role of governments, and the fourth on insurable commodities and risks. Each part of the workshop consisted of the completion of a questionnaire followed by a group discussion.

In discussing individual insurance schemes, it is essential to have available individual farm data, because aggregated data from large areas would hide individual farm yield fluctuations. A large panel data set, containing individual farm yield data from the period 1989-1995 (FADN Information European Commission), was analyzed. The data set includes annual data from six EU member states (Denmark, France, Germany (BRD), Greece, Italy and the Netherlands) and six agricultural commodities (wheat, potatoes, sugar beet, beef, milk and piglets). The total data set consists of 49 regions and about 13,000 farms. Furthermore, also price data were analyzed (Eurostat; Amsterdam Exchange Market). Based on the data analyses, cumulative and lognormal

distribution functions were estimated for yields and prices respectively, to be used in a Monte Carlo simulation model (using @Risk and Excel). Monte Carlo simulation is considered an appropriate and very flexible method of investigating aspects that are stochastic of nature, such as yields and prices that determine income from farming.

### **Insurable risks**

In the insurance literature, there seems not to be a clear definition of *uninsurable* risks. However, the following three factors are often identified as impediments to the successful operation of a private insurance market: asymmetric information, systemic risks and shortage of accurate data (Jaffee and Russell).

Asymmetric information refers to a situation in which one party has more or better information than the other party. Asymmetric information manifests itself in two ways in insurance: moral hazard and adverse selection. *Moral hazard* occurs when an individual purchases an insurance policy and as a result of having purchased that policy, alters his/her behavior (production or management practices) so as to increase the potential magnitude of a loss and/or the probability of a loss. Tools insurers use to handle moral hazard are the use of deductibles, co-payments, no-claim bonuses, and to check if the insured really observes his/her obligations of taking proper care to prevent accidents and limit the damage if an accident occurs. *Adverse selection* occurs when potential insurance purchasers have more or better information about their potential magnitude of loss and/or probability of loss than does the insurer. Ways to reduce adverse selection are to assign insurance purchasers to various risk classifications based on thorough information about their

magnitude and probability of loss, or even to exclude high-risk people, areas etc. from insurance (Borch; Barnett, Skees and Black).

A risk is called systemic if multiple insureds suffer losses at the same time from one peril, so exposing the insurer to a very large potential loss (Barnett, Skees and Black). Private sector insurance companies have problems to maintain adequate reserves and to get enough reinsurance capacity in dealing with risks that are systemic. However, opportunities exist to enlarge the reinsurance capacity by using capital markets (Canter, Cole and Sandor; Miranda and Glauber).

Concerning the availability of accurate data, these are necessary to base actuarially sound premiums on, and to calculate the size of indemnity payments. If an income insurance scheme is developed for all EU member states, it is important that data are available and reliable, and measured uniformly within regions, member states or even the EU, so that data are (or can be made) comparable between member states.

### **Basic results from data analyses**

From the large panel data set containing individual yield data, for each farmer the average yield and the coefficient of variance (CV) is calculated. The same is done for the group as a whole. Concerning the CVs of yields for the group as a whole, these are calculated for the absolute data ( $CV_{abs}$ ) and for the data after expressing them relatively to farm averages ( $CV_{rel}$ ). Table 1 shows the results for a few commodities and regions.

#### **INSERT TABLE 1**

Table 1 shows that the variability of yields within farms is higher than 15-20%, which would be a reasonable deductible, for most commodities and regions.

Concerning the variability of potato, wheat and sugar beet prices, analyses show that the CV is highest for potatoes (ranging from 18.0% in Luxembourg to 46.1% in Belgium) and lowest for sugar beet (ranging from 2.8% in Italy to 17.9% in Finland). For potatoes, no price support is available in the EU, in contrast to sugar beet.

## **Defining an insurance concept for European agriculture**

### *A general set-up*

Although the literature and our data analyses show that yields and prices vary considerably over time and among regions, we argue that insuring total family income as such is not possible. In the first place, because total family income includes off-farm income, fixed costs (rent and interest) and variable costs (e.g. feeding costs). Insuring these factors will involve significant problems of fraud, moral hazard and adverse selection. In the second place, because total family income is influenced by prices. In insuring prices it is very difficult to determine whether the price fluctuation is caused by an insured peril, because price fluctuations are usually caused by multiple factors. Besides the problems mentioned, for all aspects it applies that accurate, reliable and comparable data to base premiums and indemnities on might not be (sufficiently) available throughout the EU. This is especially true for prices, since futures markets (at which prices can be measured objectively) are not (yet) well developed in the EU. This is a further argument not to insure total family income. For these reasons we argue that 'income' insurance should be restricted to *yield-only* insurance.

We further argue that these yield-only insurance schemes should be organized *per commodity* and *per region*. Per (homogeneous) region, because at regional level production circumstances

are relative homogeneous, and, concerning the coverage of excess losses, this can then (largely) be arranged at the regional level, which prevents that low risk regions pay for high-risk regions. The size of regions can vary for different commodities and do not need to be restricted to member states. Per commodity, because the (input, production and output) differences among commodities (over time and among regions) are too large. Furthermore, insurance schemes per commodity enable farmers to create their own most efficient risk management portfolio, because they can choose which commodity they want to insure and against what level (given the degree of specialization of the farm, the relative importance of off-farm income etc.).

A yield-only insurance scheme for a particular commodity could be set up as a multiple peril insurance scheme that covers *named perils*. A named peril insurance scheme is here preferred to an all risk scheme, because obtaining reinsurance for a named peril insurance is easier than for an all-risk insurance, among others, because in an all-risk insurance perils yet unknown at the moment the insurance is written cannot be excluded from insurance. The perils covered in the yield-only insurance refer to external causes that have a large impact on the farm's results (catastrophe at farm level) and that are currently not yet covered (such as fire, hail and storm). Such risks may involve one single farm (incident), but may also involve multiple farms (catastrophe at regional level, i.e. systemic risks). Examples of such risks include floods, droughts and epidemic diseases.

### *The role of governments*

Participants of the workshop argued that governments (national governments as well as the European Commission) should play a (limited) financial role in any insurance scheme, because they create rules that influence the losses, and because it is then easier to get reinsurance capacity at the traditional reinsurance markets. For these reasons, and because the yield-only insurance



covers risks that have systemic characteristics, for which at this moment not enough reinsurance capacity exists, we argue that the role of governments could be one of ‘lender of last resort’, meaning that they do not have to step in for every Euro of loss, but only if losses are very large.

### *Commercial versus mutual schemes*

The type of yield-only insurance scheme described above can be introduced as a commercial insurance scheme, but also as a so-called mutual insurance fund. We define a mutual insurance fund as a fund that is operated by farmers themselves. Farmers decide what losses are indemnified and, as a result, how much premium is to be paid. A fund does not need to build reserves for the ‘big hit’; farmers pay a small premium to cover administrative costs and reinsurance (i.e. the ‘infrastructure’), the fund then gives a guarantee to indemnify losses, and, if necessary, farmers have to pay a surcharge to finance a loss. With mutual insurance funds, the role of insurance companies is restricted to that of administrator and reinsurer. An advantage of using pure mutual insurance funds is the possibility of surcharging. Surcharges confront farmers directly with large losses in a certain year, which is a direct incentive to avoid or reduce the risk next year, and/or to reduce the amount of losses the next time the peril takes place. Surcharges, furthermore, reduce the importance of the availability of accurate data. Another advantage of a mutual insurance fund is the increased potential for social control, especially if a fund is set up at a regional level. Also, in a mutual fund, differentiation of premiums and indemnities for high-risk farmers has a broader basis because it is not the insurance company but colleague farmers who impose these measures. In addition, because premiums are (mainly) paid ‘a-posteriori’ instead of ‘a-priori’ capital can be used on the farm. Using commercial insurance schemes, at the other hand, has advantages too. First, commercial insurers have experience in writing insurance policies. Second, money for losses is gathered ‘a-priori’, which prevents that farmers confronted with losses in a certain year

do not encounter large surcharges in the same year. In practice, a mixture of these two approaches gets increasingly popular, i.e. combining the advantages of mutuals and those of a commercial insurance scheme.

#### *Future perspectives: gross revenue insurance schemes?*

A condition for a gross revenue insurance scheme to work properly is the existence of a well functioning futures and options market. In Europe, the use of these markets is not (yet) widespread. However, the attention being given to agricultural futures markets in Europe is increasing, among others, due to declining agricultural subsidization (MacSharry and GATT) and the specialization of farms. The introduction of one European currency (Euro) in 2002 will further stimulate this development. If the use of futures and options markets is more widespread in the future, prices can be measured in an inexpensive way (low transaction costs) and independently of the management marketing decisions of a particular farmer. Only in such case, the price risk can be included in an insurance scheme, for example a gross revenue (price times yield) insurance. If such schemes are introduced, special attention should be given to livestock commodities, because of the existence of price cycles (e.g. for pigs), and to specialty products, because small changes in production can have large influences on prices.

#### **Simulation results**

To further support the above mentioned ideas of income insurance, a Monte Carlo simulation model is developed. With the model, the effect of yield-only and gross revenue insurance schemes on the stability of the individual farmer's income is illustrated. Implications for

insurance funds are studied as well. In this paper, results for yield-only insurance schemes are presented.

#### *Implications for individual farmers: simulation results*

The effect of a yield-only insurance on the stability of the farmer's income is illustrated by calculating the CV of the net return to labor and management (NR) and the frequency of net returns being lower than 50% of the mean (in table 2 indicated by '<50%') in a situation with and without insurance. Assuming a guarantee level of 80% and an election price of 0.8 times the market price, table 2 shows the implications of yield-only insurance schemes. Loss costs are the basis for insurance premiums and are calculated by multiplying the probability of the insurance fund incurring a loss by the average yield to be guaranteed. The loss costs are calculated using the relative data underlying the  $CV_{rel}$  shown in table 1.

#### INSERT TABLE 2

Table 2 shows that the yield-only insurance reduces the CV of the net return to labor and management by about 15%. Furthermore, the chances of outcomes lower than 50% of the average net return are reduced to zero in all cases.

The results in table 2 are calculated using the historical seven-year data as a starting point. In a seven-year data set, the occurrence of catastrophes is likely to be underrepresented. To simulate the effect of yield-only insurance schemes in the case of catastrophic events on the farm, a Poisson distribution is introduced in the simulation model. The Poisson distribution is typically used to represent situations in which a number of individual events occur in a given unit of time. Figure 1 shows the relative net return to labor and management (with and without insurance) for a potato farmer in the Netherlands, assuming that on average a farmer is confronted with a catastrophic event every two-year period, and that, if in a specific year 1, 2 or more than 2

catastrophic events occur on the farm, the yield decreases by 70%, 85% and 90% respectively. This is really a worst-case situation.

#### INSERT FIGURE 1

The expected value of the net return to labor and management is kept the same for the curve with and without insurance. Farmers indifferent to risks will be indifferent to the two options, because they base their choice on the expected value. Risk-averse farmers prefer the situation with insurance, with the preference positively correlated with the degree of risk-aversion (Hardaker, Huirne and Anderson).

#### *Implications for insurance funds: simulation results*

Premiums based on the loss costs are actuarially sound (assuming zero administrative costs and profit), meaning that in the long run the indemnities paid are equal to the premiums received. However, the ratio between indemnities paid and premiums received can vary considerably over time, among others due to the type of risks insured. Assuming that the occurrence of catastrophic events (that were introduced in the model in the previous section) do not occur independently but correlated (i.e. risks are systemic), figure 2 shows, as an example, the cumulative distribution function of premiums (P) minus indemnity payments (I) for a fund for wheat in Pays de la Loire (France). The correlation of yields between farms is assumed to be 0.8. The curve with  $r=0$  reflects the situation with independent risks.

#### INSERT FIGURE 2

As figure 2 shows with the long tail to the left, the probability of a shortage of money (i.e.  $P-I$ ) is larger if risks are systemic. At the other hand, there are also more situations in which the receipts are much larger than the expenditures.

## **Conclusions and suggestions for further research**

In this paper it is argued that ‘income’ insurance in European agriculture should be restricted to yield-only insurance schemes that are organized per commodity and per region and in which governments play the role of ‘lender of last resort’. If such schemes are introduced as mutual insurance funds, problems of moral hazard, adverse selection and shortage of data can be overcome because of the increased role of social control, the familiarity with production circumstances among colleague farmers , and the possibility of surcharges respectively.

Because this study was limited in time and the first in this field in a European context, further research could be carried out, among others to investigate the interest of farmers in yield-only insurance schemes that cover systemic risks such as floods, droughts and epidemic diseases, and to the interest of insurance companies to set up (mutual insurance funds for) such schemes. In addition, research in the field of linkages between good farming practices, (a basis level of) insurance that covers catastrophic events, and the provision of mortgages should be conducted. Furthermore, research should be carried out to the definition of homogeneous areas in which production results are correlated and in which prospects for area-based insurance schemes may exist. More generally, research should be carried out to opportunities to replace publicly funded risk management programs with more market-based solutions. This includes the development of futures and options markets to cover price risks, the insurance of systemic risks for which currently ad hoc disaster programs are put in place for, and more market based agreements with governments if they provide financial back-up.

## References

- Barnett, B.J., J.R. Skees, and J.R. Black. *New Risk/New Alternatives: Farming with a Lower Safety Net*. Forthcoming book, 1998.
- Borch, K.H. *Economics of insurance*. Advanced textbooks in economics, Vol. 29. Amsterdam, The Netherlands: Elsevier Science Publishers B.V., 1990.
- Canter, M.S., J.B. Cole, and R.L. Sandor. "Insurance Derivatives: A New Asset Class for the Capital Markets and a New Hedging Tool for the Insurance Industry." *J. Derivatives* (Winter 1996):89-104.
- Hardaker, J.B., R.B.M. Huirne, and J.R. Anderson. *Coping with Risk in Agriculture*. Wallingford, UK: CAB International, 1997.
- Jaffee, D.W., and T. Russell. "Catastrophe Insurance, Capital Markets, and Uninsurable Risks." *J. Risk and Insurance* 64(1997):205-30.
- Miranda, M.J., and J.W. Glauber. "Systemic Risk, Reinsurance, and the Failure of Crop Insurance Markets." *Amer. J. Agr. Econ.* 79(February 1997):206-15.

Table 1 Results from individual farm yield data analysis

	Total group of farms				CV within farms <sup>1)</sup> (%)
	n	Average yield (100 kg/ha)	CV <sub>abs</sub> <sup>1)</sup> (%)	CV <sub>rel</sub> <sup>1)</sup> (%)	
<b>Potatoes</b>					
The Netherlands	43	423	22.4	13.1	12.2
Baden-Württemberg (Germany)	44	234	41.3	31.6	29.5
Denmark	24	289	37.5	29.1	26.6
<b>Wheat</b>					
Makedonia-Thraki (Greece)	284	31	33.4	28.3	25.6
Pays de la Loire (France)	104	59	24.9	19.4	17.8
Piemonte (Italy)	107	48	26.4	22.1	20.0
<b>Sugar beet</b>					
Marche (Italy)	255	420	26.9	23.2	21.1
Makedonia-Thraki (Greece)	65	710	25.0	19.8	18.6
Picardie (France)	112	644	16.6	13.3	12.4

1) Coefficient of variance (CV) = (sd/mean)\*100%

Table 2 Implications of yield-only insurance for individual farmers (500 @Risk iterations)

	No insurance		With insurance		
	CV NR (%) <sup>1)</sup>	<50% (%)	CV NR <sub>ins</sub> (%) <sup>1)</sup>	<50% (%)	Loss costs (%)
<b>Potatoes</b>					
The Netherlands	13.5	0	12.6	0	0.5
Baden-Württemberg (Germany)	31.7	32	27.1	0	4.3
Denmark	29.3	48	24.4	0	4.3
<b>Wheat</b>					
Makedonia-Thraki (Greece)	28.4	42	23.4	0	3.9
Pays de la Loire (France)	19.5	13	16.5	0	1.7
Piemonte (Italy)	22.2	20	18.6	0	2.4
<b>Sugar beet</b>					
Marche (Italy)	23.3	12	20.7	0	1.9
Makedonia-Thraki (Greece)	19.8	3	17.5	0	1.6
Picardie (France)	13.3	1	12.0	0	0.5

1) Coefficient of variance (CV): (sd/mean)\*100%

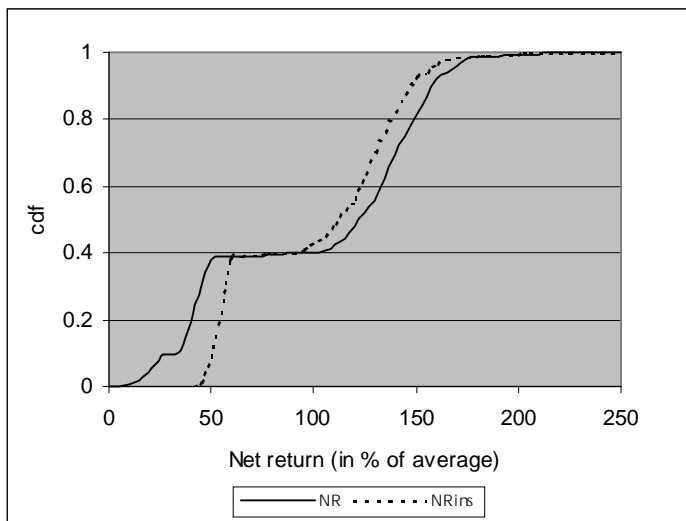


Figure 1 Net return (with and without insurance) for a potato farmer in the Netherlands

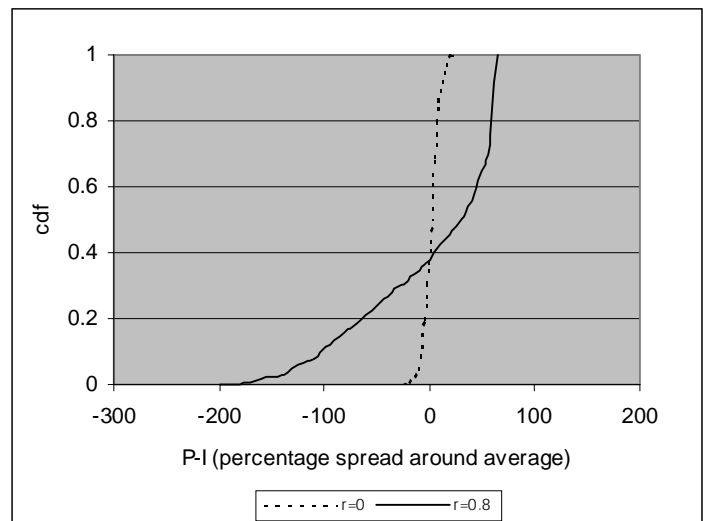


Figure 2 Premiums received (P) minus indemnities paid (I) for a fund for wheat (pool of 100 farms) in Pays de la Loire