A MODEL FOR DETERMINING PREMIUM RATES IN INDEX-BASED CROP INSURANCE

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A R T I C L E I N F O

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A B S T R A C T

The paper deals with index-based crop insurance as a tool for managing flood and drought risks in agriculture. We introduce a novel model for determining premium rates in index-based crop insurance which combines the loss cost method and the average yield method. The proposed model was applied to data related to the production of selected crops in Serbia to calculate unique premium rates for index-based insurance for cereals, industrial crops and fodder plants. The paper also outlines the prerequisites for index-based crop insurance to become technically, operationally, and financially feasible in Serbia. We propose the introduction of mandatory index-based crop insurance, along with necessary legislative amendments and subsidization of insurance premiums.

Introduction

The last three decades have been marked by a rise in the frequency and intensity of catastrophic risks globally, leading to substantial material losses and numerous human casualties (Swiss Re, 2023). Climate change, resulting in an increasing occurrence of floods, droughts, frost, and other weather-related risks, disproportionately impacts the agricultural sector more than any other economic activity. With the growing global population, the risk of hunger due to food scarcity poses an escalating threat to sustainable development. Given the aforementioned reasons, the issue of insuring agricultural crops gains considerable importance in today's world.

The contribution of insurance to sustainable development has been given special

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emphasis in the 2030 Agenda for Sustainable Development (United Nations, 2015). In developed economies, agricultural insurance has a long-standing tradition, with established operational models and a remarkable market penetration. Nevertheless, the situation regarding the availability and penetration of crop insurance is markedly different in underdeveloped and developing countries, which heavily depend on the agricultural sector and are generally most threatened by natural disasters (Kočović et al., 2016; Fedajev et al, 2016; Luković & Stojković, 2020; Sulyok et al., 2022; Sima & Gheorghe, 2015). The primary reason for the underdevelopment of conventional agricultural insurance is the inability of the majority of rural population to bear the cost of insurance premium due to their poor financial status. Likewise, with low demand, insurers lack the necessary financial capacity to offer insurance against natural hazards at affordable rates, resulting in a limited supply (Cvijanović et al., 2018). As a result, alternative forms of agricultural insurance are being developed worldwide, serving the needs of rural communities. One of them that is becoming more prominent both in theoretical discussions and practical considerations, is index-based crop insurance.

Index-based insurance is a new insurance product where indemnification is not necessarily contingent upon the occurrence of an economically harmful event. Insurance payouts are triggered when a selected parameter reaches a predetermined threshold. Index-based insurance is most commonly used for insuring crops and is primarily intended for poorer segments of the population. The sum insured is determined at a low level and is independent of the magnitude of the risks that may occur. It will be paid out to every policyholder in the area if the realized average yield falls below a predefined percentage (area-yield index insurance), or if the realized value of the index, which may correlate with adverse weather conditions, exceeds or falls short of a predefined threshold (weather index crop insurance), regardless of whether damage occurred or not.

The scientific literature on index-based crop insurance is rapidly growing. Majority of studies are focused on the ability of different indices to reduce basis risk in index-based crop insurance, which refers to the disparities between index-dependent payouts and actual losses (Bucheli et al., 2021; Okpara et al., 2017; Hohl et al., 2020; Fedajev et al., 2023; Dusmanescu et al., 2014). Other studies primarily deal with farmers' willingness to pay for index-based crop insurance (Ali, 2013; Lin et al., 2015; Fonta et al., 2018; Adjabui et al., 2019). The determination of premium rates for index-based crop insurance has been discussed to a limited extent in the literature. In rare studies addressing this issue, damages are modeled using indices, and the pure premium is calculated based on historical index values rather than actual losses (Benso et al., 2023).

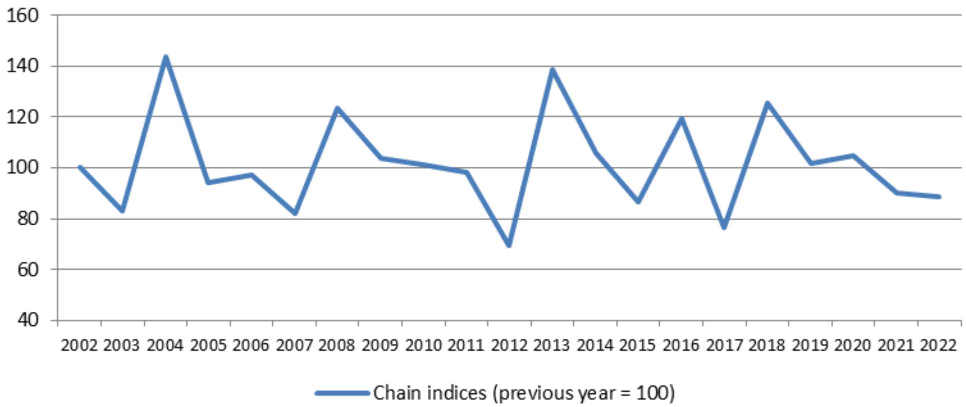
This study adds to the existing literature by introducing a novel model for determining premium rates in index-based crop insurance. This model combines elements of the average yield method commonly employed in indemnity-based crop insurance with the loss cost method. The insurance premium is calculated by applying the derived premium rate to the specified sum insured, which is paid out when the corresponding threshold of the chosen index is reached. As a weather parameter, we have opted to use the Standardized Precipitation Index (SPI), which is monthly calculated based on the most up-to-date precipitation data. The application of the proposed model for determining premium rates in index-based crop insurance was simulated using data on the yields of selected crops in Serbia.

Modified index-based insurance, respecting legal constraints, is currently offered only by one insurance company in Serbia, with a 40% premium subsidy provided by the government. The insurance coverage is limited to mercantile and seed maize, mercantile and seed soy and mercantile sugar beet (Žarković et al., 2016). In addition to proposing a new model for determining premium rates in index-based crop insurance, the contribution of this paper also lies in exploring the possibilities and limitations of broader implementation of this type of insurance in Serbia.

Index-based insurance as a tool for managing flood and drought risks in agriculture

Floods and droughts are major sources of risks for the agricultural sector, as shown by farmers' experience in terms of damage caused by natural disasters (Kozarević & Ćetković, 2022; Luković et al., 2023). Excessive rainfall leading to flooding or prolonged periods of drought can result in significant financial losses for farmers. These losses may stem from lower yields, crop damages, impaired livestock well-being, diminished soil fertility for future agricultural activities, and disruptions of regular farming practices, causing delays in planting or harvesting. Reduced agricultural production due to floods or droughts has a detrimental impact on the entire economy, manifested through lower economic output, inflation driven by fluctuations in food prices, supply chain disruptions as agricultural products are crucial inputs for various industries, a deterioration in the trade balance, and increased government expenditures.

Figure 1. Chain indices of crop production in Serbia



Source: Statistical Office of the Republic of Serbia, 2003-2023

The crop production indices in Serbia (*Figure 1.*) indicate that the largest yield declines occurred in years with extreme droughts (2003, 2007, 2012), as well as in years with significant floods (2017) or immediately following them (e.g., floods in 2014 led to land degradation and inability to use it for the next season). Climate change is projected to increase rainfall variability at a global scale, leading to significant fluctuations between periods of drought and heavy precipitation (Zhang et al., 2021). Hence, there is a growing need for suitable mechanisms for managing flood and drought risks in agriculture, among which insurance has an important role.

The penetration rate of agricultural insurance in developing countries is very low, and the risks of drought and floods are typically not covered by conventional indemnity-based insurance. Providing agricultural insurance against floods and droughts is challenging for a number of reasons. First, the likelihood of occurrence of extreme flood or drought events is hard to quantify given their rare frequency. Second, it is not easy to attribute and value the damage they cause (Hazell, 1992). Delineating agricultural damages resulting from floods or droughts is difficult as they can manifest both directly (e.g., crop losses) and indirectly (e.g., business disruptions due to damaged infrastructure). Moreover, potential damages vary significantly based on the timing of floods or droughts during the crop production cycle and their duration, complicating the modeling of these risks and the pricing of insurance products. Third, traditional indemnity-based agricultural insurance suffers from adverse selection and moral hazard. Farmers in areas susceptible to floods and droughts are often aware of the imminent risks, unlike their counterparts outside perceived flood/drought zones who tend to underestimate the potential for severe flooding and drought. Hence, a voluntary insurance scheme may predominantly attract farmers in high-risk areas. In agricultural insurance, moral hazard can arise when farmers take more risks in the presence of insurance coverage than they would in the absence of such coverage (Schnitkey & Sherrick, 2014). Fourthly, catastrophic floods and droughts affect a large number of farmers simultaneously, resulting in claims that surpass the insurers' capacities. Hence, insufficient risk dispersion hinders the financial sustainability of agricultural insurance against floods and droughts (Lotsch et al., 2010).

An index-based insurance holds the potential to overcome many of these challenges, providing an avenue to improve the feasibility and accessibility of insurance in the agricultural sector. Weather index crop insurance indemnifies the insured based on the level of a specific weather parameter (i.e., meteorological index) measured over a predetermined period at a particular weather station, rather than damage to the crop. Insurance can be designed to provide protection against either excessively low or excessively high index values. For instance, both too little or too much rainfall can be expected to result in crop damages. Hence, compensation can be triggered either when the realized value of the index surpasses a predetermined threshold or when the index falls below the threshold. Adverse selection and moral hazard problems become irrelevant because payouts are linked to external index beyond the control of both farmers and insurers. With no need for actual damage assessment, cost savings are achieved, allowing insurers to offer their products at lower prices. Also, payouts can proceed without delay, as soon as the impact of the weather event on the index is assessed (Carter et al., 2017; Pantović et al., 2022). Therefore, index-based insurance ensures that financial resources for mitigating losses are available immediately upon the occurrence of a natural disaster, precisely when they are most needed by the affected farmers.

Materials and methods

The aim of the study is to create a specific model for determining premium rates in index-based crop insurance, combining the loss cost method and the average yield method, as well as to define the prerequisites for its practical implementation. The gross premium rate, expressed as a percentage of the sum insured, comprises two elements: the pure premium and the expense loading. The pure premium covers losses and loss-adjustment expenses and is calculated based on statistical data on insured cases within the observed homogeneous risk group over several years (Kočović et al., 2021: 408). Expense loading is meant to cover the insurance company's expenses, including acquisition and administrative costs.

The loss cost method (also known as pure premium method) is used as a standard rate-making approach in non-life insurance (Brown, Gottlieb, 2007). In accordance with the loss cost method, loss cost ratio is calculated by dividing sum of incurred losses with the exposure to risk, i.e. amount of insurance coverage (sum insured):

$$Loss\ cost\ ratio = \frac{Sum\ of\ incurred\ losses}{Sum\ insured} \quad (1)$$

Incurred losses in crop insurance are implied by the yield data. In this study yield is expressed in terms of revenue, i.e. by multiplying the physical yield by the purchase price of agricultural product. The model assumes that the indemnity equals the damage. Following the average yield method, sum of incurred losses for each year during the preceding ten-year period is determined as the negative deviation between the actual annual yield and the 10-year historical average yield of specific crop categories:

$$Sum\ of\ Incurred\ losses_s = max[\mu_t - x_s, 0], \quad s = t-1, \ldots, t-10 \quad (2)$$

where x_s denotes the historical yield of the crop category in year s, and the 10-year historical average yield of the same crop category is being calculated in the current year t as:

$$\mu_t = \frac{\sum_{s=t-1}^{t-10} x_s}{10} \quad (3)$$

Assuming further that all harvested areas were insured, meaning that the total actual yield in one year equals the sum insured, this leads to a formula for calculating the loss cost ratio for each individual year s and crop category:

$$Loss\ cost\ ratio_s = \frac{max[\mu_t - x_s, 0]}{\mu_t}, s = t-1, \dots, t-10 \quad (4)$$

The pure premium for insuring a given crop category in year t is equal to the arithmetic average of the loss cost ratios for the previous 10 years:

$$Pure\ premium_t = \frac{\sum_{s=t-1}^{t-10} Loss\ cost\ ratio_s}{10} \quad (5)$$

Adjusting the indicated pure premium for the expense loading leads to the following formula for calculating the gross rate for insuring a given crop category in year t:

$$Gross\ premium\ rate_t = \frac{Pure\ premium_t}{1 - Expense\ loading} \quad (6)$$

where $Expense\ loading$ includes the insurance company's expenses, calculated as a percentage of a gross rate.

Using the proposed model, premium rates for index-based insurance were calculated for three categories of crops: cereals, industrial crops and fodder plants, specifically for Serbia. We employed data on annual crop production for the previous ten-year period (2013-2022) at producers' prices of the current year (Statistical Office of the Republic of Serbia, 2023). For the sake of comparability over time, all monetary values for each year in this study were deflated to the base year 2013 by using consumer price index for Serbia (World Bank, 2023). Thus, the inflation effect on the value of crop production during the observed period has been eliminated.

In order to implement index-based crop insurance against floods and droughts in Serbia, it is necessary to introduce appropriate assumptions regarding the weather parameter, the insured amount, the mandatory nature of index insurance, and premium subsidy.

The chosen weather parameter for index-based crop insurance against floods and droughts is the Standardized Precipitation Index (SPI), developed by McKee et al. (1993). It is widely recognized as one of the most representative and commonly used indicators for monitoring precipitation conditions (Wang et al., 2022). The SPI indicator quantifies precipitation conditions in a given area, based on a comparison of observed total precipitation amounts for an accumulation period of interest (commonly 1, 3, 6, 9, 12, 24, or 48 months) with the long-term precipitation time series for that period. SPI is calculated on a monthly basis with a moving window of the chosen accumulation period. Historic rainfall record (for at least 30 years) is typically fitted to a gamma distribution, which is then transformed into a normal distribution such that the mean and the standard deviation of SPI for that area and period are zero and one, respectively.

The SPI values can be interpreted as the number of standard deviations by which the observed precipitation level deviates from the long-term mean. Following McKee et al. (1993) and Angelidis et al. (2012), calculation of SPI is as follows.

The gamma distribution's probability density function is defined as:

$$g(x) = \frac{1}{\beta^{\alpha}\Gamma(\alpha)} x^{\alpha-1} e^{-\frac{x}{\beta}} \quad (7)$$

where α and β are shape and scale parameters, respectively, x is the amount of precipitation and $\Gamma(\alpha)$ is a gamma function. The cumulative probability $G(x)$ is obtained by integrating the probability density function with respect to x:

$$G(x) = \int_0^x g(x)dx = \frac{1}{\beta^{\alpha}\Gamma(\alpha)} \int_0^x x^{\alpha-1} e^{-\frac{x}{\beta}} dx \quad (8)$$

The gamma distribution is undefined when the variable x equals zero. Since it is possible to have multiple zero values in a precipitation data, the cumulative probability function of gamma distribution with the $x = 0$ case is modified to:

$$H(x) = q + (1-q)G(x) \quad (9)$$

where q is the probability that the precipitation amount is equal to zero.

The cumulative probability distribution is transformed into the standard normal distribution to obtain the SPI, following the approximate conversion method suggested by Abramowitz & Stegun (1965):

$$SPI = \begin{cases} -\left(t - \frac{c_0+c_1t+c_2t^2}{1+d_1t+d_2t^2+d_3t^3}\right), t = \sqrt{\ln\left(\frac{1}{(H(x))^2}\right)} \ for\ 0 < H(x) < 0.5 \\ t - \frac{c_0+c_1t+c_2t^2}{1+d_1t+d_2t^2+d_3t^3}, t = \sqrt{\ln\left(\frac{1}{(1.0-H(x))^2}\right)} for\ 0.5 < H(x) < 1.0 \end{cases} \quad (10)$$

where $c_0 = 2.515517, c_1 = 0.802853$, $c_2 = 0.010328$, $d_1 = 1.432788$, $d_2 = 0.189269$, and $d_3 = 0.001308$.

Based on SPI values for a given area and accumulation period, precipitation conditions are classified in seven distinct regimes, as shown in *Table 1.* The SPI values between -1.0 and 1.0 correspond to normal precipitation conditions. A decline in SPI below -1.0 indicates rainfall deficits (i.e., meteorological droughts), while values above 1.0 indicate increasing excess rainfall. Index-based crop insurance is intended to provide protection primarily against catastrophic droughts and floods. According to the presented classification scheme, extremely dry/wet conditions occur when the SPI value is below -2.0 or above 2.0. The probability of occurrence for each of these events is 2.3%. Hence, SPI values of 2.0 and -2.0 have been selected as thresholds in the proposed model of index-based insurance. Upon reaching the drought or flood trigger, the sum insured is paid out, regardless of whether damage to insured crops has occurred.

Table 1. Classification of precipitation conditions based on SPI

Range of SPI values	Precipitation regime	Cumulative probability	Probability of event (%)
2.0 < SPI	Extremely wet	0.977 - 1.000	2.3
1.5 < SPI ≤ 2.0	Very wet	0.933 – 0.977	4.4
1.0 < SPI ≤ 1.5	Moderately wet	0.841 – 0.933	9.2
-1.0 < SPI ≤ 1.0	Normal precipitation	0.159 – 0.841	68.2
-1.5 < SPI ≤ -1.0	Moderately dry	0.067 – 0.159	9.2
-2.0 < SPI ≤ -1.5	Very dry	0.023 – 0.067	4.4
SPI ≤ -2.0	Extremely dry	0.000 – 0.023	2.3

Source: European Drought Observatory, 2020

The sum insured is defined at EUR 1,000. The payout is made no more than once a year regardless of how many times the SPI index threshold is reached throughout the year, whether due to drought or flood.

The assumed expense loading included in the gross rate is 30%. The insurance premium amount is determined by applying the calculated gross rate to the specified sum insured.

In order to be sustainable, index-based insurance in Serbia should be mandatory. With a 50% premium subsidy provided by the government, this insurance would be affordable for the impoverished rural population.

Results and discussion

The main result of the study is a novel model for calculating premium rates in index-based crop insurance, which combines the loss cost and average yield methods. The calculation of the premium rate for index-based crop insurance for cereals using the proposed model in the case of Serbia is shown in *Table 2*. Sum of incurred losses for each year is determined as the negative deviation of the realized yield of cereals expressed in constant prices (base year 2013) from the ten-year average cereal yield according to formula (2). As outlined in (5), the pure premium is determined by averaging the annual loss cost ratios, calculated according to (4). The gross premium rate for index-based crop insurance for cereals, calculated by adding the assumed 30% expense loading to the derived pure premium of 6.1%, is 8.8%. In this type of insurance, all policyholders would pay a premium at a uniform aggregate tariff rate for all cereals, regardless of the risk zone in which the municipality to which their agricultural enterprise belongs is located, and regardless of the type of cereal they produce. This fosters solidarity and gives the insurance a social dimension.

Table 2. The calculation of the premium rate for index-based insurance for cereals

Year	Historical annual yield in constant prices (base year 2013, RSD million)		Sum of incurred losses (negative deviation from the 10-year average yield, RSD million)	Loss cost ratio
2013		174,602.0	0.0	0.0%
2014		175,129.5	0.0	0.0%
2015		134,859.1	19,979.2	12.9%
2016		157,484.0	0.0	0.0%
2017		105,389.3	49,449.0	31.9%
2018		142,655.8	12,183.5	7.9%
2019		141,514.5	13,324.8	8.6%
2020		163,614.9	0.0	0.0%
2021		183,099.9	0.0	0.0%
2022		170,034.1	0.0	0.0%
10-year average yield		154,838.3	**Pure premium**	6.1%
			Gross premium rate	8.8%

Source: Authors' calculations based on Statistical Office of the Republic of Serbia (2023) and World Bank (2023)

Similarly, applying the proposed model, we derived the pure premium and gross premium rate for index-based insurance of industrial crops (*Table 3.*) and fodder plants (*Table 4.*) in the case of Serbia.

Table 3. The calculation of the premium rate for index-based insurance for industrial crops

Year	Historical annual yield in constant prices .(base year 2013, RSD million)		Sum of incurred losses (negative deviation from the 10-year average yield, RSD million)	Loss cost ratio
2013		51,487.0	5,256.5	10.8%
2014		53,283.3	4,460.2	7.7%
2015		46,858.9	10,884.6	18.8%
2016		56,312.5	1,431.0	2.5%
2017		54,142.9	3,600.5	6.2%
2018		56,815.9	927.5	1.6%
2019		56,343.4	1,400.0	2.4%
2020		60,908.7	0.0	0.0%
2021		75,130.2	0.0	0.0%
2022		66,151.9	0.0	0.0%
10-year average yield		57,743.5	**Pure premium**	5.0%
			Gross premium rate	7.2%

Source: Authors' calculations based on Statistical Office of the Republic of Serbia (2023) and World Bank (2023)

Table 4. The calculation of the premium rate for index-based insurance for fodder plants

Year	Historical annual yield in constant prices .(base year 2013, RSD million)		Sum of incurred losses (negative deviation from the 10-year average yield, RSD million)	Loss cost ratio
2013		16,626.0	6,836.7	29.1%
2014		23,205.0	257.7	1.1%
2015		16,959.0	6,503.7	27.7%
2016		25,856.1	0.0	0.0%
2017		19,440.6	4,022.2	17.1%
2018		26,030.9	0.0	0.0%
2019		29,936.1	0.0	0.0%
2020		35,108.0	0.0	0.0%
2021		22,186.5	1,276.2	5.4%
2022		19,279.0	4,183.7	17.8%
10-year average yield		23,462.7	**Pure premium**	9.8%
			Gross premium rate	14.1%

Source: Authors' calculations based on Statistical Office of the Republic of Serbia (2023) and World Bank (2023)

In order for index-based crop insurance to become technically, operationally, and financially feasible in Serbia, specific prerequisites must be fulfilled.

The choice of the SPI indicator as a weather parameter for index-based crop insurance is driven by several factors. Because it is normalized, the SPI indicator is equally effective in analyzing both extremely dry and extremely wet conditions (Svoboda et al., 2012). This makes it suitable for application in index-based insurance against drought as well as against flood. Empirical studies show a strong correlation between the yields of various agricultural crops and the values of this index (Vicente-Serrano et al., 2012; Zurovec & Cadro, 2012; Okpara et al., 2017; Hohl et al., 2020), often attributing better performance to it compared to other indices (Guttman, 1998; Mpelasoka et al., 2008; Luković & Pantović, 2023). Moreover, the prevailing indices investigated in the index-based crop insurance literature are rainfall-based, such as SPI (Abdi et al., 2022). Rainfall is typically unevenly distributed over time and territorially. Due to its standardization, the SPI indicator can be used to compare precipitation anomalies for any location and for any accumulation period (European Drought Observatory, 2020). Additionally, since it is based on only one parameter (precipitation), the SPI is less complex to compute than other indices that also take into account variations in other parameters such as temperature, soil moisture, etc. Furthermore, by not relying on soil moisture conditions, the SPI can be effectively utilized in both summer and winter (Hayes at al., 1999). The SPI has already been successfully implemented in index-based insurance in agriculture. In Argentina, a pilot insurance program used SPI to compensate dairy farmers for reduced milk production in the event of drought (SPI < -2.0) or excessive rainfall (SPI > +2.0) (Mercosur Group, 2016). Finally, the SPI is already being calculated monthly in Serbia based on data from meteorological stations and using a reference period from 1961 to 2005 (Republic Hydrometeorological Service of Serbia, 2009). This is a prerequisite for its use in the proposed index-based insurance model.

The suggested insured sum of EUR 1,000 is essential for this insurance to be applicable in practice and achieve a positive technical result. The insured yield value of each agricultural producer opting for this type of insurance must not be less than EUR 1,000. The maximum amount of sum insured is set at this level to ensure affordability of this insurance, providing partial compensation to farmers immediately after a disaster when it is most needed, and to facilitate the adoption of this insurance in Serbia in line with economic capabilities of agricultural sector.

In index-based insurance, payouts are triggered not by the occurrence of specific economically harmful events, but by the crossing of a predefined threshold by a parameter, such as the SPI index in our case. To enable the implementation of this insurance type in Serbia, amendments to current legal regulations are necessary. These amendments would allow for deviations from the principle of indemnification in index-based insurance, permitting payouts even when no damage has occurred or when the damage is negligible. Until the relevant regulations are amended, modified index-based insurance can be applied, ensuring that payouts are made only to policyholders who have actually suffered losses.

Additionally, index-based insurance in Serbia should be mandatory in order to be sustainable. This insurance would cover all registered agricultural households in Serbia engaged in the crop production, with a minimum production value of EUR 1,000. The premium rate calculation was performed under the assumption of broad coverage across both space and time, which would enable the leveling of flood and drought risks at the lowest level. This can only be achieved if this type of insurance is mandatory.

Experiences from other countries show that without significant premium subsidies, uptake rates of index-based crop insurance remain low (Miranda & Gonzalez-Vega, 2011). The subsidization of index-based insurance premiums by the government and local authorities is necessary to make this type of insurance acceptable for rural population in terms of the premium costs they need to bear. The government should subsidize 50% of the premium to make this insurance affordable for farmers and sustainable until sufficient reserves are established.

In order to accurately determine precipitation accumulation, which forms the basis of the SPI index, it is necessary to have a sufficient number of meteorological stations. Having enough meteorological stations across the entirety of Serbia is crucial for accurately calculating the SPI index, which is updated monthly.

Finally, to ensure sufficient premium rates and the sustainability of the crop insurance market, it is essential to establish a unified database for agricultural losses (Stojanović et al., 2019). A limiting factor for the application of the proposed model for determining premium rates in index-based crop insurance is the inability, based on available data, to discern the extent to which yield shortfalls relative to the average yield are attributable to floods or droughts. Developing a unified database of agricultural losses from various risk sources would enhance the accuracy of calculating premium rates for flood and drought insurance in accordance with the proposed model. Additionally, it would facilitate the development of new insurance products to cover other risks affecting agriculture.

Conclusions

Increasingly frequent natural disasters tend to disproportionately affect impoverished rural populations. Floods and droughts result in escalating financial losses for farmers. Poor countries provide financial support according to their means, which are significantly constrained. In such circumstances, finding adequate financial mechanisms for managing flood and drought risks in the agricultural sector becomes imperative for sustainable development. Unfortunately, the penetration rate of traditional indemnity-based crop insurance in underdeveloped and developing countries is very low. For these reasons, this paper aims to shed light on index-based crop insurance and explore the possibilities and limitations of its broader implementation in Serbia. We have introduced a novel model for determining premium rates in index-based crop insurance and outlined prerequisites necessary for this insurance to become operational, technically sound, and financially viable in Serbia.

The proposed model for calculating premium rates in index-based crop insurance represents a combination of the loss cost method and the average yield method. The model is versatile and could be applied in any country, with adjustments to its parameters based on statistical data regarding precipitation amounts and hazard zones specific to that country. Prerequisites for successful and widespread implementation of index-based crop insurance in Serbia include legislative changes, introducing mandatory elements, subsidizing insurance premiums, and establishing a unified database of agricultural damages.

The study can be further deepened by examining the use of alternative indices that might capture drought and flood risks faced by farmers. Another research possibility is investigating methods to improve the accuracy of the chosen SPI index by incorporating machine learning algorithms. Also, a useful topic for future research would be to explore the feasibility of incorporating climate change scenarios into the premium calculation process. Finally, it would be valuable to examine the potential integration of index-based insurance with other financial instruments, such as loans or savings products, to create comprehensive risk management strategies for farmers.

Conflict of interests

The authors declare no conflict of interest.

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