ESTIMATING AGRICULTURAL DAMAGE IN POLAND AMID GROWING CLIMATE RISKS: TRADITIONAL, INSURANCE-BASED, AND TECHNOLOGICAL METHODS

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Abstract: *Agriculture is one of those sectors of the economy where the risk of conducting business is particularly strongly linked to the impact of natural, climatic, and biological factors. Unlike many other sectors, where the entrepreneur can largely control the production process, agricultural production remains dependent on weather conditions, soil quality, water availability, the course of the growing season, the occurrence of plant and animal diseases, and pressure from game animals. For this reason, damage in agriculture should not be equated solely with the physical destruction of a specific asset, but also with the loss of expected production output, a decline in crop quality, a reduction in farm income, or the necessity of incurring additional expenses to restore production to a state that allows for its continuation (Lipińska, 2014).*

The problem of estimating agricultural damage takes on particular significance amid the increasing frequency and intensity of adverse weather events. Drought, hail, flooding, spring frosts, torrential rains, hurricanes, or the adverse effects of overwintering can lead to losses of a highly varied nature, ranging from local damage, limited to a single farm or plantation, to mass events affecting significant areas of agricultural production. The literature emphasises that climate risks are among the primary categories of threats on farms, and their

significance is growing as weather conditions change and crop production becomes more variable (Czekaj, 2016). A specific example of this type of risk is the adverse effects of overwintering, which may not become apparent until the start of the next growing season, making it difficult to unequivocally determine the moment the damage occurred and its actual extent (Gawrońska, 2014).

Accurate determination of the extent of the damage is of fundamental importance for both the agricultural producer and the entities involved in the loss compensation process. For the farmer, the outcome of the assessment determines the amount of compensation due, the possibility of obtaining public aid, the ability to maintain financial liquidity, and the ability to continue production in the next season. For an insurance company, an accurate assessment of damage is a prerequisite for maintaining a balance between the protective function of insurance and the economic stability of its portfolio. For public administration and aid agencies, however, it serves as the basis for rationally directing funds to those farms that have actually suffered losses requiring support. In this sense, agricultural damage assessment is not only technical but also economic, legal, and social.

The traditional model of damage assessment is based primarily on reporting the damage, conducting an on-site inspection, determining the area affected by the loss, assessing the extent of crop damage, and preparing documentation that serves as the basis for payment of compensation or another form of compensation. This type of procedure remains particularly important in cases of individual and localized damage, especially wildlife damage, where it is necessary to establish a link between the animals' actions and the specific damage to the crop (Flis, 2019). At the same time, the practice of assessing damage caused by animals to agricultural crops shows that this process can give rise to numerous disputes regarding the timing of the damage report, the extent of the damage, the amount of the potential harvest, and the liability of the entity obligated to pay compensation (Flis, 2019).

A separate but closely related issue to damage assessment is the functioning of agricultural insurance. Crop and livestock insurance constitute one of the fundamental tools for mitigating the effects of production risks on farms; however, their effectiveness depends on the scope of coverage, the affordability of premiums, the level of public subsidies, the structure of the contract, and the method of claims settlement (Kozak & Weremczuk, 2019). In the Polish context, subsidized insurance plays a significant role, as it is intended to increase the prevalence of insurance coverage in agriculture; however, the literature indicates that this system continues to face barriers related, among other things, to limited coverage, the problem of drought risk, and insufficient interest among some agricultural producers (Janowicz-Lomott &

Łyskawa, 2016). This means that the mere existence of an insurance system does not eliminate the problem of damage assessment; on the contrary, it makes the quality of this process a condition for the effectiveness of the entire loss compensation mechanism.

In recent years, increasing attention has been paid to the potential to supplement traditional damage assessment methods with index-based and technological approaches. Index-based insurance, especially with regard to drought, is based on the assumption that the payment of benefits can be linked to a specific parameter, such as precipitation levels, temperature, soil moisture, or another indicator reflecting production conditions, rather than an individual assessment of damage on each farm (Kaczała & Łyskawa, 2012). This approach can reduce claims-settlement costs, accelerate benefit payments, and minimise disputes, though it also raises the issue of basis risk—that is, the discrepancy between the index value and the actual loss incurred by a specific farmer (Kaczała, 2017). At the same time, methods that utilize drones, satellite imagery, vegetation indices, and geographic information systems are being developed, enabling more objective and faster assessment of losses across large areas (Iwahashi et al., 2023). Equally important are solutions utilizing radar and optical data as well as spatial analysis tools in the assessment of flood damage in agriculture (Nazir et al., 2025).

The aim of this article is to present and evaluate selected methods for estimating agricultural damage in Poland, with particular emphasis on crop damage, hunting damage, the crop insurance system, and the potential for using modern index-based and remote sensing tools. This objective stems from the need to view damage assessment not as a single technical activity, but as a complex decision-making process in which the interests of farmers, insurers, public administration, and institutions responsible for agricultural risk management intersect.

The main research problem of the article can be formulated as a question: are traditional methods of agricultural damage assessment sufficient in the context of the growing scale of climate risks, or do they need to be supplemented with index-based, digital, and remote sensing methods? The thesis adopted is that reliable estimation of agricultural damage is a prerequisite for fair compensation for losses, the effective functioning of agricultural insurance, and the rational allocation of public aid; however, in the context of increasing climate risks, traditional visual inspection methods should be supplemented with index-based and technological solutions.

The article employs a literature review, a regulatory-institutional analysis, and a comparative method. The literature review helps clarify the concept of agricultural damage, the types of risk, and the basic mechanisms for loss compensation. The regulatory and institutional analysis facilitates a discussion of the importance of agricultural insurance and

damage assessment procedures, while the comparative method contrasts the traditional visual inspection model with index-based and technological solutions. The structure of the article follows this framework: the first part discusses the concept, types, and causes of agricultural damage; the second presents traditional and insurance-based methods for estimating such damage; and the third identifies practical problems and modern trends in the development of the loss assessment system.

Keywords: *agricultural damage, damage assessment, crop insurance, climate risk, remote sensing.*

1. Concept, types, and causes of agricultural damage

1.1. The Concept of Damage in Agricultural Production

Damage in agriculture is a concept more difficult to grasp than one might assume from a simple reference to the classical understanding of property damage. This is because a farm does not function like a typical production facility, where most process parameters can be precisely planned, controlled, and replicated. Agricultural production is a biological process, extended over time, dependent on the rhythms of nature, weather patterns, soil quality, water availability, and a series of agrotechnical decisions made under conditions of uncertainty. This is precisely why agricultural damage is not limited to the physical destruction of crops, animals, buildings, or machinery. It can also mean the loss of expected yield, a decline in its quality, increased production costs, disruption of the farming cycle, or a reduction in the agricultural producer's income (Lipińska, 2014).

This distinction is crucial for further discussion. If a crop is damaged by hail, the issue is not solely how many plants were physically destroyed. Equally important is the question of what yield could reasonably have been expected from that crop, what portion of that yield was lost, whether the remaining produce retained its market value, and whether the farmer will have to incur additional expenses to mitigate the effects of the event. In the case of orchards or vegetable crops, qualitative damage may sometimes be more significant than quantitative damage, as a product that formally exists may lose the characteristics necessary to sell it in the intended quality class.

The literature notes that damage in agricultural production should be analysed in close connection with farming risk. It is not an event detached from the entire production process, but rather the materialization of one of the risks that constantly accompany agricultural activity (Lipińska, 2014). For this reason, estimating damage requires not only determining the loss but also reconstructing the likely course of production that would have occurred had the damaging event not occurred. This hypothetical element is one of the most difficult aspects of loss assessment. It requires comparing the actual situation not with an abstract ideal of a full yield, but with the yield achievable on a specific farm, given specific production technology, site, variety, and local conditions.

However, not every yield reduction can be equated with a loss eligible for compensation. Agriculture is, by its very nature, subject to variability in results. Two plantations of the same crop, managed in the same municipality, may yield different results due to soil class, local rainfall patterns, sowing date, fertilization, disease pressure, or the quality of agrotechnical practices. Therefore, in the assessment process, it is necessary to distinguish the effects of a random event from normal production risk, as well as from agrotechnical errors or the producer's negligence. Otherwise, the assessment of damage ceases to be an evaluation of a specific loss and becomes an attempt to compensate for a general production failure. This issue is particularly significant in crop insurance, where the insurer’s liability is tied to the occurrence of a specific risk covered by the policy (Malik, 2016).

From an economic perspective, agricultural damage is thus multi-layered. At the first level, there is physical damage: destroyed plants, damaged fruit, a flooded field, a frozen plantation. At the second level, there is a production impact, i.e., the loss of part or all of the crop. At the third level—the income effect—which includes a decline in revenue, increased costs, loss of liquidity, or limited ability to finance the next production cycle. Only by considering these levels collectively can one understand why estimating agricultural damage is a more complex process than simply valuing damaged property.

This is particularly evident in cases where damage manifests with a delay. The negative effects of overwintering may result from events occurring during the winter, but their actual impact on plant density and yield potential can only be assessed after the resumption of vegetation (Gawrońska, 2014). Similarly, drought does not always leave an immediate, dramatic mark. It often acts gradually, weakening plants, limiting tillering, seed set, or grain filling. In such situations, simply inspecting the plantation at a single point in time may not be sufficient to reliably determine the actual loss.

Agricultural damage should therefore be understood not as a single event, but as the result of a disruption in the production process. This approach better reflects the realities of farming and helps explain why assessment procedures must combine agricultural, economic, legal, and insurance expertise. An appraiser, commission, or claims adjuster does not assess solely what they see on the day of the inspection. They must relate the condition of the plantation to its previous history, yield potential, local conditions, and the nature of the event that is alleged to have caused the loss.

1.2. Types of Agricultural Damage

The classification of agricultural damage is not merely a matter of organisation. The method of classifying the damage determines the reporting procedure, the entity responsible for its assessment, the method of documenting losses, the possibility of obtaining compensation, and the source of funding for the compensation. The assessment of damage caused by hail in an insured plantation differs from that of damage caused by wild boars in cornfields, and again from losses caused by a drought affecting a significant part of the country. This diversity means that the concept of agricultural damage must be considered from several overlapping perspectives: subject-matter, causal, spatial, and institutional.

The most obvious distinction is based on the subject of the damage. From this perspective, one can distinguish damage to crop production, livestock production, farm fixed assets, and production infrastructure. In practice, the most attention is devoted to damage to agricultural crops, as these are most frequently the subject of insurance policies, compensation proceedings, commission assessments, and disputes between farmers and the entities responsible for compensating for losses (Malik, 2016).

Damage to crop production can take many different forms. Sometimes it is immediately visible: after a hailstorm, a hurricane, flooding of a field, or the destruction of crops by wildlife. In other situations, it develops gradually and becomes apparent only in later stages of the growing season. This group includes, in particular, drought damage, damage resulting from overwintering, and losses resulting from frosts, which can disrupt flowering or fruit set, even though the plant itself is not completely destroyed. From an assessment perspective, it is therefore particularly important to determine whether the damage affects plant density, plant condition, yield potential, the quality of the future crop, or the market value of the product.

Damage in animal production is of a somewhat different nature. It may involve the loss of animals, a deterioration in their health, a decline in milk, meat, or reproductive performance, the need to cull part of the herd, or an increase in treatment and maintenance costs. Although this article focuses primarily on damage in crop production, the connection between the two areas of the farm cannot be overlooked. A drought that limits forage production can affect the profitability of cattle farming, and a flood that destroys pastureland can disrupt the farm's entire feed balance. Damage in one production segment therefore often spills over into other areas of agricultural activity.

Damage to a farm's fixed assets constitutes a separate category. This includes farm buildings, warehouses, silos, machinery, equipment, vehicles, irrigation systems, power installations, and other technical infrastructure. At first glance, estimating these losses may seem simpler than estimating crop losses, since a damaged asset has a specific replacement or market value. In practice, however, the issue of production consequences arises here as well. Damage to a combine harvester during the harvest season, destruction of an irrigation system during a drought, or flooding of a warehouse can have consequences far beyond the mere loss of the item's value. In agriculture, time is of the essence: delayed sowing, a protective treatment applied too late, or the inability to harvest at the optimal time can increase losses.

Based on the cause, damage can be classified as climatic, biological, environmental, technical, or animal-related. Climate-related damage is of greatest significance for crop insurance, as insurance contracts typically specify the risks covered, such as drought, hail, frost, flood, hurricane, torrential rain, or adverse effects of overwintering (Malik, 2016). This approach to structuring insurance coverage means that correctly identifying the cause of the damage is just as important as determining its extent.

Biological losses resulting from plant or animal diseases or from pest pressure are more difficult to incorporate into a simple compensation model. Their development often depends on many factors: weather conditions, the farm's phytosanitary status, seed quality, the timeliness of protective treatments, and the producer's own decisions. Consequently, determining which part of the loss stems from a random factor and which from production management can be complicated. It is precisely the multifactorial nature of many agricultural losses that constitutes one of the main barriers to a reliable and mutually acceptable assessment.

Game damage holds a special place. It is not a classic form of weather damage, but in practice, it has significant economic implications for many farms. They occur when game animals destroy crops, eat plants, trample plantations, dig up the soil, or damage agricultural produce. Their distinctiveness stems not only from the cause of the damage itself but also from a different liability regime and assessment procedure. It is necessary to establish a link between the actions of specific animal species and the specific damage to the crop, and then to determine the amount of the loss under conditions where the interests of the farmer and the party obligated to compensate for the damage may diverge (Flis, 2019). The literature emphasises that wildlife damage has both economic and legal dimensions, as it concerns both crop losses and the liability associated with managing game populations on agricultural lands (Flis, 2010).

It is also worth distinguishing between local damage and mass damage. The former usually affects a single farm, plantation, or small area. It may result from hail, wildlife damage, local flooding, or infrastructure failure. Estimating such damage, though not always easy, can be done through individual inspections. The situation is different in the case of drought, widespread flooding, or a cold snap. In such cases, the number of farms affected by losses is so large that the traditional model of assessing each loss individually becomes costly, time-consuming, and logistically challenging. It is precisely in the context of mass damage that the need to utilise meteorological, spatial, satellite, or index-based data becomes particularly evident.

Yet another breakdown stems from the compensation mechanism. Some losses may be covered by crop and livestock insurance, some by public aid, some by liability for hunting-related damage, and some remain the farmer's own economic risk. The system of subsidised crop insurance is intended to increase the availability of insurance coverage, but its effectiveness depends on farmers' actual participation in the system, the scope of insured risks, the level of premiums, and the efficiency of the claims settlement process (Janowicz-Lomott & Łyskawa, 2016). Thus, the classification of damage is not neutral: it determines whether the loss will be recognized, who will assess it, and from which source it may be covered.

Types of agricultural damage should therefore be treated as part of a larger risk management system. The same crop may be simultaneously exposed to drought, hail, disease, wildlife damage, and agrotechnical errors. A farmer, insurer, or assessment committee rarely encounters a perfectly clear-cut situation where a single event fully explains the entire loss. In practice, assessment requires separating various causes and effects and then assigning them economic significance. This is a task far more complex than simply stating that the yield is lower than expected.

1.3. Causes of Agricultural Losses

The causes of agricultural damage are numerous, but they share the common feature of affecting the production process in ways that are often difficult to predict and not always fully controllable by the producer. A farmer can choose the variety, sowing date, fertilisation level, plant protection method, or cultivation technology, but cannot eliminate the risk of drought, hail, frost, flooding, or strong winds. It is precisely this dependence on external factors that gives the problem of agricultural damage lasting economic and social significance.

The largest category consists of damage caused by climatic factors. The literature on crop insurance notes that climatic hazards are among the primary risks faced by farms, and that their significance increases with weather variability (Czekaj, 2016). This is not solely about spectacular disasters. For a farmer, a prolonged lack of rainfall, a few hours of frost during a critical stage of plant development, heavy rain during harvest, or a local hailstorm destroying a single plantation—while fields a few kilometers away remain unscathed—can be equally devastating.

Drought is one of the most difficult risks to assess. It does not appear suddenly and does not always leave a clear trace. Its effects build up gradually: plants grow more slowly, transpire less, produce fewer buds, fill the grain less effectively, or end their growing season earlier. The final effect is often only visible at harvest, when the yield is significantly lower than expected. The difficulty, however, is that a lower yield alone is insufficient to determine the extent of the damage. It is also necessary to demonstrate the extent to which it resulted from water deficiency and the extent to which it resulted from soil quality, production technology, prior damage, or other circumstances. For this reason, drought is also one of the most problematic risks in the crop insurance system (Malik, 2016).

Hail works differently. It is sudden, violent, and often very localised. It can destroy leaves, stems, ears, fruits, or flowers within minutes, while leaving neighbouring fields virtually undamaged. In cereal crops, hail damage may result in a loss of part of the yield, but in fruit or vegetable production, deterioration in market quality is equally significant. Fruit damaged by hail may still exist as a biological product, but it loses the market value typical of dessert fruit. Such cases demonstrate that when assessing agricultural damage, one cannot limit oneself to simply asking about the quantity of the crop. Its quality and marketability must also be evaluated.

Spring frosts are among those phenomena whose impact depends not only on temperature but also on the plant's developmental stage. The same temperature can have completely different effects on a plant in dormancy and on a plant in the flowering stage. In fruit growing, a few hours of low temperature can determine the size of the harvest for the entire season. However, the damage is not always fully assessable the day after the event. Sometimes it is only after some time that it becomes clear whether flowers have been damaged, fruit set has been reduced, or the crop has been deformed.

A similar problem concerns the adverse effects of overwintering. These can be caused by freezing, frost heave, frost damage, prolonged snow cover, sudden temperature fluctuations, or unfavourable winter conditions. A particular difficulty is that the damaging event occurs in winter, while its effects on production only become apparent after vegetation resumes (Gawrońska, 2014). A plantation that looks bad immediately after winter may partially regenerate. Conversely, a plantation that appears intact may show signs of weakness in the coming weeks, resulting in reduced yields. A final assessment therefore requires time, experience, and caution.

Floods and waterlogging cause damage of a different nature. Water can directly destroy crops, but it can also cause plant silting, nutrient leaching, root damage, soil erosion, and prevent timely treatment. In the case of floods, the spatial scale is also a problem. If the event covers a large area, individual visual inspections of each plantation become logistically difficult and costly. For this reason, satellite, radar, and optical data, as well as spatial analysis tools, are playing an increasingly important role in flood damage assessment, enabling faster identification of flooded and potentially affected areas (Nazir et al., 2025).

Strong winds and hurricanes are also among the causes of damage. Their effects can impact both crop production and farm assets. In field crops, wind can cause lodging of cereals, stem breakage, seed shedding, or hinder harvesting. In orchards, it can damage trees, knock down fruit, and destroy support structures. On the farm, it can also damage roofs, greenhouses, plastic tunnels, technical installations, or power lines. Such damage is rarely one-dimensional. It often combines crop loss with infrastructure repair costs and delays in ongoing production operations.

Damage caused by game animals constitutes a separate category. Wild boars, deer, fallow deer, and roe deer can destroy crops, eat plants, trample plantations, dig up the soil, or damage agricultural produce. In this case, the difficulty of estimation lies not only in determining the portion of the crop lost. It is equally important to attribute the damage to a specific cause and to determine the liability of the party obligated to remedy it. The procedure for assessing damage caused by animals to agricultural crops is therefore not only technical in nature but also legal and contentious, as it concerns the relationship between the agricultural producer and the entities responsible for game management (Flis, 2019).

However, not all damage is a simple consequence of external factors. In practice, agrotechnical and organisational errors also play a role, as they can increase crops' susceptibility to damage or make it difficult to determine the actual cause of the loss. Delayed sowing, improper variety selection, insufficient fertilisation, lack of plant protection, poor drainage, or improper soil structure can make a crop less resilient to drought, frost, or excess water. From an assessment perspective, this is a particularly sensitive issue. A farmer may perceive a loss as the result of a random event, while an insurer or claims adjuster will investigate whether the extent of the damage was exacerbated by farm management practices.

The multifactorial nature of damage is one of the most important characteristics of agricultural production. It is rare for the final yield to result from a single, easily isolated event.

Drought can weaken plants and increase their susceptibility to disease. Frosts can exacerbate the effects of prior water stress. Prolonged rainfall can hinder plant protection, and subsequent cooling can further inhibit their growth. For this reason, estimating agricultural damage is not so much a simple measurement of loss as an attempt to reconstruct the process that led to that loss.

Modern agriculture amplifies this complexity. On the one hand, technological advances allow for better monitoring of crop conditions and the use of weather data, satellite imagery, and decision-support systems. On the other hand, the intensification of production, farm specialization, and higher inputs per hectare mean that a single damaging event can have very serious financial consequences. The more capital-intensive the production, the greater the importance of quickly, reliably, and mutually agreeably determining the extent of the loss.

Consequently, the causes of agricultural damage should be analyzed not merely as a list of events, but as a system of risks affecting the farm. Drought, hail, flooding, frost, wildlife damage, or winterkill are not merely terms in an insurance contract or a commission report. They are concrete disruptions to the production process, the effects of which depend on local conditions, crop type, the plants' developmental stage, farm management practices, and the time elapsed after the event. Only such a perspective allows us to properly address the issue of damage assessment methods—that is, how to translate production losses into compensation in a manner that is as objective, fair, and economically rational as possible.

2. Traditional and insurance-based methods for estimating agricultural damage

2.1. Procedure for estimating damage to agricultural crops

Assessing agricultural damage is a process in which agronomic expertise intersects with formal, economic, and legal requirements. It is not enough to simply state that the crop has been damaged. It is also necessary to determine when the event occurred, what caused it, what area was affected by the damage, what the condition of the plantation was before the event, what yield could reasonably have been expected, and to what extent the event reduced the value of production. In this sense, damage assessment is an attempt to translate a natural phenomenon into an economic category.

The starting point is usually the farmer's damage report. This is an important moment not only formally but also in terms of evidence. The longer the interval between the event and the inspection, the more difficult it is to distinguish the effects of the damage itself from subsequent changes in the plantation's condition. Damaged plants may partially regenerate or deteriorate further due to weather, disease, or agrotechnical treatments. In the case of damage caused by animals to agricultural crops, the procedure is based on a report, an inspection, and a subsequent determination of the extent of the losses, with the ability to link the damage to the activity of specific animal species being of significant importance (Flis, 2019).

Visual inspection is the most recognizable element of traditional damage assessment, but it should not be equated with the entire process. A well-conducted visual inspection includes not only an assessment of the damage but also an analysis of plant density, developmental stage, uniformity of damage, soil conditions, traces of the event, and the plantation's regenerative potential. Damage to young crops, which may partially regrow, is assessed differently than damage occurring immediately before harvest, when the possibility of restoring the yield is already negligible.

In practice, one of the most difficult steps is determining the yield that could have been achieved had the damage not occurred. This cannot be an ideal or wishful yield. It should be based on the farm's actual conditions: soil class, weather conditions prior to the event, level of agricultural practices, the condition of the plantation, and local average yields. If this benchmark is set too high, the compensation will be detached from economic reality. If it is set too low, the farmer will not receive compensation commensurate with the actual loss. This hypothetical reconstruction of the yield is one reason the assessment of agricultural damage gives rise to disputes.

Equally important is determining the percentage of crop damage. In the case of surface damage, an appraiser or commission determines what portion of the plantation was affected by the event. In the case of partial damage, however, it is necessary to assess the extent to which damage to the plants will reduce yield. There is not always a simple correlation between the appearance of the plantation and the economic loss. A plant may look bad immediately after the event but recover some of its production potential. It may also look relatively good, even though damage during the flowering or grain-filling stage has already reduced yield.

Assessing damage is particularly difficult when causes overlap. A crop weakened by drought may be further damaged by hail. A crop thinned out after winter may respond less well to a spring water shortage. Corn damaged by wild boars may simultaneously show the effects of agrotechnical errors or previous weather conditions. Traditional assessment requires, in such situations, separating the influence of individual factors, though in practice, the boundary between them is not always clear-cut. It is precisely here that the assessor's experience is of the greatest importance, but at the same time, the greatest risk of subjectivity arises.

Damage documentation serves an organisational and evidentiary function. It should allow for the reconstruction of the assessment process, indicate the basis for findings, and justify the accepted level of losses. In the case of agricultural damage, the documentation cannot be limited to a brief statement that the crop was damaged. It should show the scope of the inspection, the areas covered by the assessment, the parameters used for calculations, and how biological damage was translated into economic value. Without this, the assessment loses transparency, and the parties to the proceedings can more easily challenge its outcome.

In the traditional assessment model, time plays a crucial role. Some damages should be assessed as quickly as possible, before traces of the event disappear. Others require reassessment after a specific period has elapsed, when the event's impact on the crop can be determined more reliably. The negative effects of winter damage cannot always be assessed immediately after the snow melts, as the orchard's actual condition only becomes apparent once vegetation resumes (Gawrońska, 2014). Similarly, in the case of frosts in orchards, the full extent of the loss is often only visible after assessing fruit set.

The advantage of traditional assessment is its directness. The assessor can see the specific orchard and take into account local conditions and the farm's particular circumstances. This feature is very important in agriculture, as two fields located close to each other may differ in soil class, water conditions, variety, sowing date, and level of agrotechnology. This is precisely why visual inspection remains the primary tool for assessing local damage.

However, a weakness of this model is its limited scalability. When damage affects thousands of farms, as in the case of drought or widespread flooding, individually assessing each plantation becomes costly and time-consuming. There is also the issue of consistency in assessments. Different appraisers may interpret a similar plantation condition differently, and farmers may compare their reports with their neighbors' results. As a result, traditional assessment, while necessary, does not always provide sufficient speed and consistency in crisis situations.

2.2. Assessment of Game Damage

Game damage is one of the most contentious categories of agricultural damage. Its specific nature stems from its arising at the intersection of two uses of rural space: agricultural production and game management. The farmer views the field as the basis of income, a place of investment, and a source of expected yield. Game animals treat the same space as a place for foraging and movement. When damage occurs, the dispute is not merely about the value of lost corn, wheat, or potatoes. It also concerns responsibility for the consequences of the animals' presence in the agricultural landscape.

The procedure for assessing hunting damage must first determine the cause. Not every instance of crop damage constitutes hunting damage. It is necessary to establish that the damage was caused by animals subject to the relevant liability regime, and not by other factors such as disease, weather, agricultural errors, or livestock. Flis emphasizes that in cases of animal-caused damage to agricultural crops, visual inspection, identification of characteristic feeding or trampling traces, and determination of the actual extent of the damage are of significant importance (Flis, 2019).

In practice, damage caused by wild boars is particularly common. Their activity can lead to soil erosion, crop destruction, grain loss, and damage to corn, meadows, and pastures. Deer, fallow deer, and roe deer, on the other hand, cause damage by gnawing, trampling, and crushing plants. While signs of wildlife presence may be visible, translating them into the economic value of the loss is not always straightforward. Some plants may regrow, parts of a plantation may be only partially destroyed, and the actual impact of the damage on the yield depends on when it occurs.

In assessing game damage, it is particularly important to distinguish between a preliminary inspection and a final assessment. A preliminary inspection allows one to confirm the occurrence of damage, its approximate extent, and its cause. The final assessment, on the other hand, is intended to determine the actual extent of the loss, usually closer to harvest time, when the impact of the damage on the crop can be better assessed. This approach makes sense from an agronomic perspective, as not all damage visible in the early stages of plant development directly translates to an identical loss in the final yield. At the same time, it prolongs the entire process and may increase tension between the parties.

Hunting damage clearly demonstrates how important trust in the procedure is. A farmer may believe that the party obligated to compensate for the damage has an incentive to underestimate its extent. Conversely, the tenant or manager of the hunting district may argue that part of the losses stems from other causes or that the farmer failed to take measures to mitigate the damage. Under such conditions, technical knowledge alone is insufficient. Transparency, proper documentation, and the ability to verify findings are essential.

The economic dimension of hunting damage is not limited to the value of crops physically destroyed by animals. For a farm, the costs of replanting, the need to change crop rotation, loss of forage, delays in fieldwork, or reduced crop quality may also be significant. The literature indicates that wildlife damage should be analyzed not only as a problem of individual compensation claims but also as a phenomenon embedded in the broader economic and legal conditions of rural areas (Flis, 2010).

Prevention is also significant. Mitigating wildlife damage may involve fencing, deterrents, buffer zones, proper game management planning, cooperation between farmers and hunting clubs, and a rapid response to reports of increased wildlife pressure. It should be noted, however, that preventive measures come at a cost and are not always effective. If the costs of securing plantations are high and liability for damage is dispersed, the conflict of interest may intensify.

From this article's perspective, game damage is important for yet another reason. It highlights the limitations of a purely formal approach to assessment. Even the best procedure will not work well if the parties do not accept its outcome or consider the process to be unfair. Therefore, in the case of hunting damage, not only the method of calculating compensation but also the manner in which the proceedings are conducted—timeliness, party participation, the quality of the justification, and the ability to verify the assumptions made—becomes particularly important.

2.3. Damage Assessment in the Agricultural Insurance System

Agricultural insurance is one of the fundamental instruments for mitigating the effects of risk on farms. It does not eliminate the risk itself, as it cannot prevent drought, hail, frost, or flooding. Its function is to economically mitigate the consequences of an event that has disrupted production. In this sense, insurance shifts part of the financial burden of the loss from an individual farm to a broader risk-sharing community, organised by an insurance company and, in the case of subsidised insurance, supported by public funds.

The importance of crop insurance in Poland stems from agriculture's high exposure to weather risks. Kozak and Weremczuk point out that crop insurance is a risk management tool whose development in Poland has been supported by a system of premium subsidies designed to increase the availability of coverage for agricultural producers (Kozak & Weremczuk, 2019). However, the subsidy mechanism alone does not solve all problems. Insurance coverage is effective only when farmers actually purchase policies, the scope of coverage addresses the most significant risks, and the claims settlement process results in the payment of benefits perceived as adequate.

In the insurance system, loss assessment plays a central role. It determines how an event covered by the contract is translated into a specific compensation amount. The insurance company must determine whether a covered risk occurred, whether the damage arose during the period of coverage, what the area of the damaged crop was, what level of loss can be attributed to this event, and whether any exclusions of liability apply. The farmer, on the other hand, expects the assessment to reflect the actual loss on the farm. The tension between these perspectives is natural, but it can be mitigated by clear contract terms, transparent methodology, and good documentation.

The Polish crop insurance system is closely linked to public intervention. Premium subsidies are intended to encourage farmers to purchase insurance coverage and reduce the need for emergency aid after disasters. Janowicz-Lomott and Łyskawa note, however, that the operation of subsidised crop insurance in Poland faces barriers regarding the universality of coverage and the system's effectiveness (Janowicz-Lomott & Łyskawa, 2016). The problem, therefore, lies not only in how to assess the damage after it occurs, but also in how many producers are actually enrolled in the coverage system.

Drought remains a particularly difficult risk. In the classic insurance model, the task is to determine the extent to which water scarcity translates into yield loss on a specific farm. This is a difficult task because drought is spatial, gradual, and dependent on local soil conditions. Two farms located in the same village may suffer different losses if one has heavier soils and the other has light, well-drained soils. Malik points out that risk assessment in mandatory crop insurance must take into account the specific nature of individual risks and their impact on the structure of insurance liability (Malik, 2016).

Insurance is both a financial and a psychological tool. For a farmer, a policy can mean a sense of security, but also a cost that must be incurred before a loss occurs. If a farmer considers the premium too high, the scope of coverage too narrow, and the claims settlement procedure unpredictable, they may opt out of insurance or limit it to a minimum. Witkowska emphasizes that insurance mitigates risk in agricultural operations, but its significance depends on actual use by farms and farmers' awareness of risk management (Witkowska, 2023).

Local experiences show that farmers' decisions regarding crop insurance vary and depend on many factors: type of production, previous experience with damage, premium levels, availability of subsidies, risk assessment, and trust in the insurer. A study on crop insurance, using the municipality of Sicienko as a case study, indicates that the use of insurance coverage is strongly linked to producers' local experiences and their assessment of its cost-effectiveness (Zawisza & Rode, 2022). This is directly related to damage assessment, as a farmer who previously deemed the claims settlement process unfair may lose trust in the system as a whole in subsequent seasons.

An important element of insurance loss assessment is the consideration of deductibles, co-payments, and liability thresholds. From an economic perspective, they serve to limit minor claims and prevent the system from being overburdened by the costs of settling small losses.

From a farmer's perspective, however, they may be perceived as reducing the real value of coverage, especially when the loss is severe but does not exceed a certain threshold, or when the payout is significantly reduced. Therefore, the mere existence of a policy does not guarantee full compensation for the loss.

Damage assessment in agricultural insurance requires a balance. An overly liberal assessment of losses can lead to increased system costs, higher premiums, and reduced access to coverage. An overly restrictive assessment, on the other hand, undermines the point of insurance from the farmer's perspective. In the long run, both extreme approaches are detrimental. The insurance system requires both technically sound valuation and public acceptance of procedures.

In this context, the role of the state takes on particular significance. Public subsidies for premiums, the legal framework for insurance, potential disaster relief, and requirements regarding insurance coverage create a system of incentives and obligations that influences the behavior of agricultural producers. Janowicz-Lomott analyses subsidised crop and livestock insurance as a form of public-private partnership in which responsibility for risk management is shared among farmers, insurers, and the state (Janowicz-Lomott, 2023). This approach captures the essence of the problem well: agricultural damage is a private loss to a specific farm, but its widespread nature can have public significance.

Traditional and insurance-based methods of damage assessment should not be pitted against one another. In many cases, insurance claims settlement still relies on on-site inspections, expert appraisals, and field documentation. The difference lies in the fact that, within the insurance system, this process is embedded in the contract terms, risk definitions, liability limits, and rules for calculating benefits. This means that two agronomically similar losses can lead to different financial outcomes if the scope of insurance coverage differs.

The fundamental problem, therefore, is not a choice between the traditional and insurance methods, but rather how to ensure their consistency, transparency, and effectiveness. Farmers should understand the principles by which their losses are assessed. Insurers should have a methodology in place to limit subjectivity and abuse. The government should design the support system so as not to undermine the incentive to purchase insurance, yet at the same time not leave farms without assistance in the event of catastrophic events. This naturally raises the question of new tools: weather indices, spatial data, drones, and remote sensing, which can supplement traditional procedures where their limitations become most apparent.

3. Practical Issues and Modern Approaches to Agricultural Damage Assessment

3.1. Problems and limitations of traditional damage assessment

Traditional agricultural damage assessment has one key advantage: it allows one to see a specific crop in a specific place and at a specific time. An appraiser or commission can assess not only visible damage but also the overall condition of the crop, the plants' developmental stage, soil conditions, signs of wildlife activity, and the effects of hail, frost, flooding, or other events. For many years, this directness formed the basis for the reliability of the assessment process. This is because agriculture varies greatly from place to place, and even two fields located close to each other may differ in soil class, production technology, rainfall patterns, and yield potential.

However, the very feature that constitutes the strength of the traditional model is also the source of its limitations. Visual inspections are time-consuming, costly, and dependent on the availability of individuals with the appropriate expertise. In the case of localized damage, such as hailstorms, wildlife damage, or flooding of a single plantation, the field procedure can be relatively effective. The situation is different for widespread phenomena. Droughts, floods, frosts, and widespread winter damage affect many farms, resulting in so many claims that individually assessing each instance of damage has become logistically difficult. Consequently, the risk of delays, oversimplifications, and inconsistencies in assessments increases.

One of the most serious problems is subjectivity. Estimating crop damage is not a mechanical measurement but an assessment that requires experience and interpretation. It is necessary to determine what yield could have been achieved, what portion of the loss is attributable to the insured event, whether the plantation had a chance to recover, and whether the observed damage will actually affect the farm’s economic performance. Two people assessing the same plantation may reach different conclusions, especially when the damage is partial, spread out over time, or caused by several overlapping factors.

This is particularly evident in the case of drought. It does not leave as obvious a trace as hail or wildlife trampling. Its effects develop gradually and depend on soil type, the plants’ stage of development, previous weather conditions, and the agricultural practices employed. A lower yield may result from water shortages, but it may also stem from delayed sowing, fertilization errors, disease pressure, or low site potential. Under such conditions, simply stating that the year was dry is not sufficient to determine the extent of damage on a specific farm. Assessing insurance risks in agricultural crops, therefore, requires a precise distinction between the risk covered by insurance and other causes of yield reduction (Malik, 2016).

A similar issue arises with damage whose effects become apparent only after a delay. The negative effects of winter damage are a good example of a risk where the timing of the damaging event and the timing of a reliable assessment of losses do not coincide. A crop may look poor immediately after winter but partially recover; it may also appear intact yet, in the following weeks, reveal weakness that leads to a decline in yield (Gawrońska, 2014). In such cases, estimating too early increases the risk of error, and estimating too late—to a dispute over which factors are actually responsible for the final condition of the crop.

Another weakness of the traditional model is the difficulty in determining the reference yield. Compensation or other restitution requires comparing the actual yield with the yield that could reasonably have been expected. The latter, however, cannot be observed. It is a hypothetical construct based on historical data, experience, the plantation's condition prior to the damage, local conditions, and production technology. The less documentation available on the farm, the greater the scope for discretion. The farmer may refer to the best yield from previous years, the insurer to regional averages, and the commission to its own assessment of the plantation's potential. Each of these approaches can lead to a different outcome.

The issue of documentation cannot be overlooked either. In practice, agricultural damage is often documented under time pressure, with a large number of claims, and in emotionally charged conditions, because for the farmer, crop loss represents a real threat to income. If the report is too brief, fails to indicate the method of calculation, does not describe the condition of the plantation, or does not outline the assumptions made, it becomes a source of subsequent disputes. The transparency of documentation is therefore significant not only formally but also socially: it allows the party dissatisfied with the outcome to understand why a specific level of loss was determined.

Hunting-related damage highlights yet another dimension of this problem. In such cases, the dispute often begins as early as the stage of determining the cause of the damage. A farmer may point to wild boar, deer, or roe deer, while the entity responsible for the assessment may claim that part of the loss is attributable to other circumstances. The procedure itself, therefore, requires not only calculating the lost crop yield but also identifying animal tracks, assessing the extent of their impact, and determining when the damage occurred (Flis, 2019). The greater the divergence of interests between the parties, the more important the quality of the proceedings, the parties' participation in the on-site inspection, and the ability to verify the findings become.

The limitations of traditional assessment do not mean it should be discarded. On the contrary, in many cases, it remains irreplaceable. No weather index or satellite image can fully replace an assessment of local farm conditions if the damage is atypical, localized, or dependent on agrotechnical details. The issue is rather that the classic model should be supplemented where the scale, complexity, or recurrence of phenomena exceeds the capabilities of individual on-site inspections. This applies especially to mass-scale climate risks, where the speed, consistency, and objectivity of the assessment become just as important as the detail of the on-site expert evaluation.

3.2. Index-based insurance as an alternative to traditional claims settlement

One of the most promising avenues for exploring new methods of loss compensation is index-based insurance. Its logic differs from traditional claims adjustment. In the traditional model, the actual loss on a specific farm must be determined and then translated into the amount of compensation. In the index-based model, the benefit is linked to the value of a predefined index, such as precipitation levels, temperature, soil moisture, a drought index, or plant condition measured via remote sensing. If the index exceeds a set threshold, the benefit is paid.

The greatest advantage of this approach is speed. The insurer does not have to send an appraiser to every farm each time to assess the loss individually. The payout can be based on data from meteorological networks, agrometeorological models, or satellite observations. For the farmer, this means potentially faster access to funds when they are most needed—often even before the next production cycle begins. With regard to drought, which typically affects large areas and generates numerous claims, limiting traditional claims adjustment can have significant organisational implications.

Kaczała and Łyskawa analyse farmers' attitudes toward index-based drought insurance, noting that such solutions may address the challenges associated with traditional drought claims settlement (Kaczała & Łyskawa, 2012). Drought is, in fact, a risk particularly well-suited to index-based thinking: it has a spatial dimension, is linked to measurable weather parameters, and often affects many farms simultaneously. If data on precipitation, temperature, and soil moisture are reliable, it becomes possible to create a mechanism that automatically identifies conditions of high risk of loss.

Index-based insurance can also reduce conflicts. In the classic model, disputes often centre on what percentage of the crop was lost and whether the adopted reference yield was appropriate. In the index-based model, the parties know in advance which parameter determines the payout. If the contract terms are transparent and the data is considered objective, there may be less room for dispute. This does not mean, however, that conflict disappears entirely. Rather, it shifts to an earlier stage: the construction of the index, the selection of monitoring stations, the determination of the payout threshold, and the assessment of whether a given indicator truly reflects farm losses.

The most serious limitation of index-based insurance is the basis risk. This arises because the index and the farmer's actual loss do not perfectly align. A situation may arise in which a farmer suffers a significant loss, but the index does not reach the payout threshold. The opposite may also occur: the index may indicate eligibility for a payout even though a specific farm has suffered only a minor loss. The greater the variation in local soil and microclimatic conditions, the more difficult it is to construct an index that is fair to everyone. This limitation is particularly significant in Poland, where even slight differences in soil quality and water retention can markedly alter the effects of the same rainfall deficit.

This does not, however, mean that the underlying risk disqualifies index-based insurance. Rather, it means that designing such policies requires great care. The index should be understandable to the farmer, based on reliable data, linked to actual production risk, and adapted to local conditions. An overly simple index may be cheap and easy to use, but it may be unfair. One that is too complicated may better reflect reality but become incomprehensible and difficult for users to accept. In agricultural insurance, trust in the method is almost as important as its mathematical elegance.

Kaczała, in analysing the determinants of demand for crop insurance, highlights the importance of the insurance product's design, producers' awareness, and the perceived utility of the coverage (Kaczała, 2017). This conclusion has direct implications for index-based insurance. Even the most technically sound product will not be widely adopted if farmers do not understand how it works or fear that payouts depend on an abstract index detached from the condition of their fields. Education, transparency, and the ability to compare the index with real-world farm experiences are prerequisites for success here.

Index-based insurance does not have to replace traditional damage assessment. A hybrid model seems more convincing. In cases of widespread damage, especially drought, the index can serve as an initial filter, triggering a payout or qualifying an area for further assessment. In borderline, atypical, or disputed cases, it could be supplemented with on-site inspections. Such a solution could combine the speed and objectivity of index data with the flexibility of expert assessment.

It is also worth noting that index-based insurance changes the philosophy of compensation. Traditional indemnity seeks to replicate the loss of a specific farm as faithfully as possible. An index-based benefit, however, is parametric in nature: it is paid out when conditions statistically associated with a high probability of loss occur. This is a subtle but very important difference. A farmer who expects full, individual compensation may be disappointed. A farmer who treats an index-based product as a quick tool for stabilising cash flow may recognise its value.

From an agricultural policy perspective, index-based insurance can be particularly useful where the traditional system is overburdened. This applies to catastrophic, recurring, and geographically widespread risks. However, they should not be introduced as a technocratic alternative detached from farm practices. Their effectiveness depends on data quality, index design, trust levels, communication simplicity, and integration with existing insurance and public aid systems.

3.3. Use of Digital Technologies, Drones, and Remote Sensing

The second important direction in the development of agricultural damage assessment is the use of digital technologies. Agriculture is becoming increasingly dependent on data: meteorological, satellite, soil, production, and economic. Since agricultural damage disrupts the production process, the more reliable information about that process that can be gathered, the greater the chance of an objective assessment of losses. Remote sensing, drones, geographic information systems, and vegetation indices do not replace agricultural knowledge, but they can significantly broaden the scope of observation.

Drones are particularly valuable for assessing local and regional-scale damage. They allow for a quick aerial view of a plantation, capture the spatial distribution of damage, compare different sections of a field, and document the crop's condition at the time of inspection. When combined with multispectral cameras, they enable an analysis of plant health that is not fully visible to the human eye. Iwahashi and colleagues used vegetation indices obtained from an unmanned aerial vehicle to assess drought damage for crop insurance purposes, demonstrating that UAV data can support a more precise assessment of plant condition (Iwahashi et al., 2023).

The significance of vegetation indices lies in their ability to translate plant light reflectance into information about their physiological state. Plants weakened by drought, flooding, disease, or mechanical damage may exhibit different spectral characteristics than healthy plants. This makes it possible to detect variations in plantation condition, identify the areas most affected by stress, and document the spatial distribution of damage. In traditional visual inspections, the expert sees only parts of the field; technology allows us to see the whole picture.

Satellites provide an even broader perspective. Their advantage is particularly evident in the case of widespread phenomena: drought, flooding, extensive frosts, or hailstorms affecting multiple municipalities. Satellite data allows for the monitoring of large areas in a repeatable and comparable manner. They can show changes in plant condition over time, identify flooded areas, indicate vegetation anomalies, and support decisions regarding the allocation of aid or the initiation of insurance claims. Radar data is particularly important in flood damage assessment because it can also be used in cloudy conditions, which often accompany flood events. Research on assessing flood-induced agricultural damage demonstrates the utility of combining SAR and optical data with Google Earth Engine tools to identify areas affected by losses (Nazir et al., 2025).

Digital technologies also serve as evidence. Drone photos, damage maps, satellite imagery, and weather data can supplement damage reports. They enable better documentation of plantation conditions, reduce the risk of arbitrariness, and facilitate subsequent verification of findings. In disputes between a farmer and an insurer or the entity responsible for compensation, the ability to refer to an objective spatial record can be of great importance.

However, one should not idealize the technology. A satellite image or a drone photo does not, by itself, answer the question of the value of the damage. It shows the condition of the plants, the extent of flooding, differences in plantation condition, or the pattern of damage, but it still requires interpretation. One must know which crop is in the field, its stage of development, the previous conditions, and whether a decline in the vegetation index is due to damage, natural plant maturation, agrotechnical treatments, or disease. The data is only useful when grounded in agronomic knowledge.

There is also the issue of accessibility and standardisation. Not every farm uses digital tools. Not every insurer has the infrastructure to quickly analyze spatial data. It is not always clear which data source should be decisive, what resolution is sufficient, and how long documentation should be retained. If technology is to become part of the damage assessment system, standards are needed: regarding data collection, quality, interpretation, archiving, and use in appeals procedures.

Another major challenge is the relationship between technological data and traditional expert assessment. One can imagine a situation in which a satellite image indicates poor plant health, but a field inspection suggests a cause other than the reported damage. The opposite situation is also possible: the damage is evident to the farmer and the appraiser, but it was not well captured by the available satellite image due to the timing of the pass, cloud cover, or insufficient resolution. Therefore, technologies should be treated as supporting tools, not as an automatic substitute for assessment.

The most promising approach is an integrated model. In such a model, a damage report would trigger an analysis of weather and spatial data, enabling a preliminary determination of the event's extent and likely intensity. Then, depending on the type of damage, its scale, and the potential claim value, either an on-site inspection or a simplified data-driven procedure would be conducted. In the case of widespread damage, technology could identify priority areas and reduce the number of cases requiring a full on-site visit by an appraiser. For localized damage, it could strengthen documentation and reduce disputes.

This approach aligns with the direction of change in agricultural risk management. Traditional assessment relied primarily on human experience in the field. Modern assessment should combine this experience with data. The farmer knows their field, the assessor knows the assessment methodology, the insurer knows the coverage terms, the administration has public aid instruments at its disposal, and technology allows for viewing the damage on a broader scale. Only by combining these perspectives can a system be created that is more resilient to the growing number of extreme events.

It is not, therefore, a matter of simply digitising existing procedures. It is about a qualitative shift: from assessments based solely on individual observations to assessments supported by spatial data, indices, digital documentation, and comparative analysis. In the face of mounting climate risks, this direction seems not only desirable but necessary. Without it, the damage compensation system will increasingly be delayed, costly, and prone to disputes.

Modern technologies do not solve all the problems of agricultural damage assessment, but they allow for a different emphasis. They can increase response speed, improve documentation, reduce subjectivity, and support the assessment of mass damage. However, they do not eliminate the need for sound methodology, clear rules of liability, and an understanding of the biological nature of agricultural production. They are most valuable when they do not replace humans but help them make better, more informed, and fairer decisions.

Conclusion

The analysis indicates that estimating agricultural damage is far more complex than merely identifying physical damage to crops or farm assets. This is because agricultural damage encompasses not only a material dimension but also production, income, and organizational dimensions, as it disrupts biological and seasonal farming processes (Lipińska, 2014). For this reason, its proper assessment requires a combination of agrotechnical, economic, legal, and insurance knowledge.

The objective of this article, which was to present and evaluate selected methods for estimating agricultural damage in Poland, was achieved by discussing traditional inspection procedures, insurance compensation mechanisms, and modern index-based and technological solutions. The analysis confirms the accepted thesis that traditional assessment methods remain necessary, especially for local, game-related, and disputed damages, as they allow for the specific conditions of the farm and the actual state of the plantation to be taken into account (Flis, 2019). However, they are insufficient for mass damage, such as drought, flooding, or widespread frost, where individual on-site inspections are costly, time-consuming, and difficult to conduct uniformly.

The results of the analysis indicate that a hybrid model that combines field assessments with meteorological, index-based, and spatial data is particularly important. Index-based insurance can reduce claims settlement costs and accelerate benefit payments, especially in the case of drought, although its effectiveness depends on the proper design of the index and the mitigation of underlying risk (Kaczała & Łyskawa, 2012). In turn, drones, remote sensing, and vegetation indices can increase the objectivity of loss documentation and facilitate the assessment of damage covering large areas (Iwahashi et al., 2023; Nazir et al., 2025). However, these technologies should not replace expert assessment but rather complement it.

From a practical standpoint, the most important challenge remains the creation of transparent, uniform, and mutually accepted procedures for damage assessment. Farmers should understand the basics of determining the extent of losses, insurers should have methodologies that limit discretion, and the government should support solutions that strengthen farm protection without undermining responsibility for risk management. An effective loss compensation system, therefore, requires cooperation among agricultural producers, insurance companies, and public administration (Janowicz-Lomott & Łyskawa, 2016).

A limitation of this article is its review-based nature. Further research should focus on an empirical assessment of the effectiveness of specific estimation methods, particularly a comparison of the results of traditional visual inspections with remote sensing data, as well as an analysis of farmers' acceptance of index-based insurance. In the context of growing climate risk, the development of such solutions will be of significant importance not only for individual farms but also for the stability of the entire agricultural risk management system.

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