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INTELLECTUAL PROPERTY RIGHTS IN AGRICULTURE: PLANT VARIETY PROTECTION AND FOOD SECURITY

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Abstract: This research explores the complex relationship between Intellectual Property Rights (IPRs) in agriculture, with a focus on plant variety protection and food security. In this context, the protection of plant varieties becomes key to enhancing agricultural productivity, addressing climate change challenges, and ensuring the sustainability of food supply. The implementation of intellectual property rights in agriculture also directly impacts the welfare of farmers and other stakeholders in the agricultural sector. Methodologically, this research adopts a normative approach, using a variety of data sources and relevant analyses within the legislative framework. Additionally, the research also elucidates the crucial role of institutions tasked with implementing plant variety protection measures within a broader IPR framework. The research findings indicate challenges and opportunities inherent in the implementation of plant variety protection measures, including legal and policy barriers, as well as opportunities for policy innovation and collaboration among government stakeholders, industry, and society. In conclusion, this research offers valuable insights into the complex dynamics between Intellectual Property Rights in agriculture, particularly plant variety protection, and food security. Furthermore, policy recommendations aimed at strengthening regulatory frameworks for plant variety protection, enhancing access to agricultural technology, and promoting multi-stakeholder collaboration are proposed. Considering the complexity of the relationship between various aspects of IPR, plant variety protection, and food security, further research can explore innovative solutions to overcome existing barriers and capitalize on emerging opportunities. This may involve a more detailed analysis of existing legal and policy frameworks, as well as exploring the practical implications of the policy recommendations outlined in the abstract. in ensuring the sustainability of agricultural systems and food security in the future.

Keywords: Intellectual Property Rights; Agriculture; Plant Variety Protection; Food Security

I. INTRODUCTION

Agriculture plays a crucial role in providing food for the world's population. In a global context, the agricultural sector is not just a provider of food but also the backbone of the economy for many countries. Millions of farmers around the world depend on this agricultural activity for their livelihoods. They are not only responsible for food production but also play a role in ensuring food security, ensuring an adequate food supply for the population, and preserving the environment. In many countries, agriculture is not only an economic activity but also a reflection of social and environmental sustainability. Sustainable agriculture encompasses not only productivity and profitability aspects but also considers social and environmental factors such as

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farmer welfare, sustainable natural resource use, and biodiversity conservation. In many cases, agriculture forms the foundation of local and regional economies, creating job opportunities, building infrastructure, and supporting community livelihoods (El Bilali, Hamid, Carola Strassner, 2021, p. 5). Therefore, it's crucial to recognize that agriculture is not just about food production but also about economic development, environmental sustainability, and social well-being.

Climate change threatens global food security through unstable weather, natural disasters, and shifting seasons. These disruptions lead to losses in agricultural productivity and food availability (C.M. Godde, D. Mason-D'Croz, D.E. Mayberry, 2021, p. 7). Extreme weather and unpredictable season patterns damage crops and agricultural infrastructure, while global temperature rise increases the risk of pests and plant diseases. To address these challenges, mitigation and adaptation efforts are necessary, including the development of climate-resistant crop varieties, more efficient water management, and agricultural diversification to protect food production from the increasingly serious impacts of climate change. In facing the challenge of climate change, protecting crop varieties is key to enhancing agricultural productivity. By safeguarding plant varieties from climate change threats such as extreme temperatures, droughts, or floods, agriculture can remain productive even in changing environmental conditions. Innovation in the development of crop varieties resilient to changing environmental conditions becomes crucial, as it allows farmers to confront new challenges posed by climate change without sacrificing harvest yields or production quality (Tétédé Rodrigue Christian Konfo, Ayédêguê Biaou Philippe Chabi, Abraham Amoussouga Gero, Camel Lagnika, Félicien Avlessi, Gauthier Biaou, n.d., 2024, p. 2).

Intellectual Property Rights (IPR), or more commonly referred to as Intellectual Property Rights (IPR), play a crucial role in driving innovation in agriculture. Protection of innovative outcomes such as plant varieties provides incentives for researchers and industries to invest in new research and development. With the protection of intellectual property rights, discoveries and innovations in crop variety development become more economically attractive. This encourages researchers to conduct further research and improve existing crop varieties or create new ones. Moreover, IPR protection also gives confidence to the agricultural industry that their investments in innovation will be safeguarded and provide adequate returns, which in turn stimulates more investment in agricultural research and development (Meghwal et al., 2023, p. 160). Thus, IPR protection not only fosters new innovations in agriculture but also supports the growth and sustainability of the sector through the development of superior and adaptive plant varieties.

In many countries, including Indonesia, food security is the primary focus of government policies. Ensuring that all layers of society have access to quality and safe food is a priority in efforts to improve social welfare and reduce inequality. Ensuring guaranteed access to sufficient and safe food is a fundamental human right, and the government has a responsibility to ensure that the food needs of the population are met (Niza-Ribeiro, 2022, p. 156). The government has both moral and legal obligations to ensure that the food needs of the population are met. This includes not only efforts to increase food production but also to ensure fair and efficient distribution and to oversee the standards of quality and safety of food circulating in the market (El Bilali, Hamid, Carola Strassner, 2021, p. 3). Additionally, effective food policies also include steps to improve food literacy among the population, provide training on sustainable farming practices, and address structural inequalities that may limit access to food.

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For the Indonesian context, food security is a primary concern because the country has a large and diverse population, and the agricultural sector plays a crucial role in the economy. Through appropriate policies, the government seeks to increase domestic food production, maintain price stability, and control the quality and safety of food circulating in the market. These efforts aim not only to reduce hunger and malnutrition but also to create a more equitable and fair social conditions for all citizens. Food policies focusing on food security and availability are crucial steps in advocating for basic human rights and improving overall social welfare. This also reflects the government's commitment to building an inclusive and sustainable society, where every individual has equal opportunities to access sufficient and quality food (Fallah Shayan, Niloufar, Nasrin Mohabbati-Kalejahi, Sepideh Alavi, 2012, p. 4). Plant variety protection has far-reaching implications beyond just increasing agricultural productivity; it also helps ensure adequate and quality food availability for the population.

Understanding the relationship between plant variety protection and food security is crucial in formulating effective agricultural policies. Through plant variety protection, farmers are encouraged to adopt more productive and environmentally resilient varieties, such as those resistant to detrimental environmental factors like climate change. This, in turn, helps enhance food security by creating crops that are more adaptable to evolving environmental challenges. By comprehending the importance of this relationship, agricultural policies can be formulated to promote innovation in crop variety development, protect genetic diversity, and foster sustainable and diverse food production.

Plant variety protection not only enhances agricultural productivity but also ensures an adequate and quality food supply. Protected varieties provide a solid foundation for stable and diverse food production, which is crucial for maintaining community food security. This relationship is pivotal in formulating effective agricultural policies as it drives innovation and adaptation to environmental changes. By analyzing the relationship between plant variety protection and food security, this research can provide better insights into how plant variety protection can contribute to providing quality and safe food for the community. This can assist in formulating policies aimed at improving the availability of healthy and adequate food for all layers of society.

So far, two similar studies have been published. The first is titled "The Role of Intellectual Property Rights in Agricultural Development: A Comparative Study of Legal Frameworks" (Muhammad Hamza Zakir, Sobia Bashir, Shehla Zahoor, Rafia Naz Ali, Faisal Shahzad, 2023, p. 490). This research compares the legal frameworks governing intellectual property rights in agriculture across various countries. It explores how patent law, plant variety rights, and copyright affect innovation in agriculture and their impact on the sustainability of agricultural systems and food security. The second study, "Legal Implications of Plant Variety Protection on Food Security: A Case Study of Developing Countries," examines the impact of plant variety protection on food security in developing countries (Susan Isiko Štrba, 2017, p. 195). The research analyzes existing legal frameworks and challenges in implementing plant variety protection in the context of the need for quality and safe food for the population.

Within the framework of international and national law, research is directed towards the question: "How can plant variety protection be strengthened to ensure the sustainability of agricultural systems and food security in the future?" This question leads to legal aspects related to plant variety protection, including international and national regulations governing intellectual

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property rights in agriculture. Research can explore the effectiveness of existing regulations, legal challenges faced in implementing plant variety protection, and the potential improvements or legal adjustments needed to ensure the sustainability of agricultural systems and food security in the future. The novelty of this research may include an interdisciplinary approach that combines aspects of international and national law with agricultural and food security issues. This research can explore new legal perspectives related to plant variety protection, considering the current challenges faced by the global agricultural system and efforts to enhance food security. Additionally, the research can propose innovative legal frameworks to improve plant variety protection, promote ecological sustainability, and address inequalities in access to food.

II. RESEARCH METHOD

This research utilizes a method of comparative legal analysis of the legal frameworks governing intellectual property rights in agriculture in Indonesia and the Philippines. This approach involves studying relevant literature, legal documents, and policies to understand the differences and similarities in the legal approaches used by these countries. Additionally, the research may involve conceptual analysis of key concepts such as intellectual property rights, food security, and agricultural sustainability (P. Ishwara Bhat, 2015, p. 149). This helps in understanding the theoretical implications of the research findings and formulating a strong conceptual framework. Furthermore, this method allows for a thorough examination of the legal systems and regulations surrounding intellectual property rights in agriculture, providing insights into the strengths, weaknesses, and potential areas for improvement in both countries. By comparing the legal frameworks of Indonesia and the Philippines, researchers can identify best practices, challenges, and potential avenues for harmonization or collaboration in enhancing plant variety protection and promoting agricultural sustainability and food security in the region.

Moreover, the conceptual analysis of key concepts contributes to a deeper understanding of the theoretical underpinnings of intellectual property rights in agriculture and their implications for food security and agricultural sustainability. This helps in developing a robust theoretical framework that can guide future research and policy development in this area. Overall, the combination of comparative legal analysis and conceptual analysis provides a comprehensive approach to examining the complex interplay between intellectual property rights, agricultural practices, and food security, ultimately aiming to contribute to more effective and equitable legal frameworks and policies in both Indonesia and the Philippines, as well as potentially informing broader regional or global initiatives in agricultural development and food security.

III. RESULTS AND DISCUSSION

3.1 The Concept of Intellectual Property Rights (IPR) in Agriculture

The concept of Intellectual Property Rights (IPR) in agriculture refers to the legal protection of innovations and intellectual works produced in the agricultural context. This includes various types of intellectual property rights, such as patents, plant variety rights, copyrights, and trademarks, applied to agricultural products, production processes, and agricultural technologies (Debdyuti Datta, K.S. Das, 2016, p. 980). Patent rights are granted for new inventions or technical discoveries beneficial in agriculture, such as new production methods, innovative farming tools, or effective pesticide formulations. Patents give the owner exclusive rights to make, use, and sell

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the invention for a specific period, thereby fostering innovation in agricultural technology. Patent rights provide legal protection to inventors or rights holders for new inventions or technical discoveries beneficial in agriculture. These could be new production methods, innovative farming tools, or effective pesticide formulations. By obtaining a patent, the owner has exclusive rights to produce, use, and sell the invention for a specific period, often lasting several years (Rupinder Tewari & Mamta Bhardwaj, 2021, p. 21)). This protection encourages innovation in agricultural technology by providing incentives to researchers and developers to invest time, energy, and resources in developing new solutions that can enhance efficiency, productivity, and sustainability in agriculture.

Copyright provides legal protection to creators or rights holders for creative works in the agricultural context, such as agricultural education materials, instruction books, or computer software used in farm management. This means that creators have exclusive rights to perform several actions regarding their works, including reproduction, distribution, and use. Copyright protects creative works in agriculture, including educational materials, instruction books, and agricultural management software (Edy Junaidi, Kadek Wiwik Indrayanti, 2023). The rights holder has exclusivity in reproducing, distributing, and using the work. This encourages creators to continue creating new content and benefit from their works.

Trademarks are legal rights that provide protection to the owner of agricultural product brands, brand labels, or business names associated with specific agricultural products. This allows the rights holder to have exclusivity in using the trademark in commercial activities. Trademark protection ensures that only the owner is allowed to use the trademark in the context of trade, thereby preventing others from using similar trademarks that could mislead consumers. By having a strong trademark, owners can distinguish their products from competitors' products and build a consistent and recognizable brand image in the market. This helps in building consumer trust in the quality and reliability of the agricultural products. Moreover, trademarks also provide additional commercial value to agricultural products, as well-known brands can enhance the attractiveness of products in the market and enable owners to market the products at higher prices (Natalya Pyzhikova, Tatyana Smirnova, Kristina Chepeleva, n.d., 2019, p. 178).

Exclusive rights to plant varieties are legal rights granted to plant breeders for new or improved varieties through plant breeding. These rights allow owners to have exclusive control over the use and distribution of these plant varieties. This creates incentives for breeders to invest in research and development of superior and adaptive plant varieties. By obtaining plant variety rights, owners can protect their breeding achievements from unauthorized use or unlawful reproduction by others. This ensures that breeders can benefit from the investment and efforts they have made in producing new quality plant varieties. Additionally, plant variety rights also ensure that breeders have exclusive rights to derive income from the sale of these plant varieties, which in turn can encourage increased innovation and research in plant breeding.

The interconnection between Plant Variety Protection (PVP) and Food Security is essential in understanding how Intellectual Property Rights (IPR) impact Food Security (Barron, Nadine, 2004, 2004, p. 20). PVP provides incentives for plant breeders to produce superior and adaptive varieties, which in turn contribute to increased productivity and sustainability of agricultural systems. With plant varieties that are more resistant to pests, diseases, and climate change, farmers can produce more stable and diverse yields, which form the basis for adequate and quality food provision. The implications of IPR on Food Security are highly significant. On one hand, plant

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variety protection through IPR enables breeders to obtain fair income from their investments and innovations, encouraging further research and development of better varieties. However, on the other hand, inadequate or inflexible IPR policies can hinder farmers' access, especially those in developing countries, to the plant varieties needed to meet their local food needs.

Therefore, it is important for Intellectual Property Rights (IPR) policies to consider their implications for Food Security holistically. A balance is needed between providing incentives for innovation and ensuring fair access to the necessary plant varieties. This can be achieved through the establishment of a framework that integrates plant variety protection with food security principles, supporting technology transfer and farmer capacity building, and strengthening international cooperation for the exchange of useful plant varieties. In this way, IPR can become an effective tool in strengthening global Food Security.

While plant varieties play a crucial role in addressing food security challenges, it's essential to acknowledge that they may have weaknesses or vulnerabilities. Despite efforts to develop resilient and productive varieties, no crop is immune to all threats or challenges. Some weaknesses in plant varieties may include susceptibility to certain pests or diseases, limited adaptability to specific environmental conditions, or reduced yield under certain circumstances. Additionally, factors such as climate change, evolving pest populations, and changing agricultural practices can contribute to the emergence of new challenges that plant varieties may not be adequately equipped to handle.

Recognizing and addressing these weaknesses is vital for ensuring the long-term sustainability and resilience of agricultural systems. This may involve ongoing research and development efforts to breed or engineer varieties with enhanced resistance to pests and diseases, improved tolerance to environmental stressors, and greater overall adaptability. Moreover, adopting diverse farming practices, incorporating agroecological principles, and promoting genetic diversity within agricultural systems can help mitigate the risks associated with weaknesses in plant varieties. By embracing a holistic approach to agricultural resilience, stakeholders can work towards ensuring food security in the face of evolving challenges.

Furthermore, proactive measures can be taken to mitigate the impact of weaknesses in plant varieties. This includes implementing integrated pest management strategies to reduce the reliance on chemical pesticides and minimize the development of pest resistance. Crop rotation, intercropping, and the use of cover crops can also help break pest and disease cycles, improving overall resilience in agricultural systems. Investments in agricultural research and extension services are critical for identifying and addressing weaknesses in plant varieties. By fostering collaboration between researchers, breeders, farmers, and policymakers, innovative solutions can be developed to enhance the performance and resilience of crop varieties.

Additionally, building resilience in agricultural systems requires a multifaceted approach that considers social, economic, and environmental factors. This includes supporting smallholder farmers with access to resources, knowledge, and technology to effectively manage risks and adapt to changing conditions. Overall, while weaknesses in plant varieties may pose challenges to food security, proactive and collaborative efforts can help mitigate these risks and build resilient agricultural systems capable of feeding a growing global population sustainably. By addressing weaknesses in plant varieties, we can work towards a more secure and sustainable food future for all.

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3.2 International Conventions related to Plant Breeders' Rights and Food Security

The United Nations Convention on Biological Diversity (UNCBD) is an international agreement agreed upon at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992. This convention aims to promote sustainable management and fair and equitable utilization of biodiversity worldwide. UNCBD aims to encourage the conservation of biodiversity, sustainable use of biological resources, and fair and equitable sharing of benefits derived from the utilization of genetic resources. The convention recognizes the importance of biodiversity for human survival and well-being, as well as the importance of the sustainable protection and use of biological resources. National policies should prioritize the conservation and restoration of natural habitats, including forests, wetlands, and other ecosystems that support biodiversity. This involves establishing protected areas, protecting endangered species, and rehabilitating degraded ecosystems.

Effective law enforcement systems and strong oversight mechanisms are crucial in protecting biodiversity from various threats, such as habitat destruction, illegal hunting, and illegal trade of protected species. Countries should invest in strengthening law enforcement institutions responsible for biodiversity protection, such as police agencies, forest rangers, and forestry authorities. This involves training, equipment, and other resources to ensure that these institutions have sufficient capacity to address environmental-related crimes. Countries should collaborate with other nations and international agencies to enhance cooperation in cross-border law enforcement related to biodiversity. In addition to the UNCBD, other conventions related to plant breeders' rights and food security include the International Convention for the Protection of New Varieties of Plants (ICPNVP), Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), and the United Nations Food and Agriculture Organization (UNFAO) (Eaton et al., 2004, p. 23).

The International Convention for the Protection of New Varieties of Plants (ICPNVP) is an international agreement aimed at providing legal protection for new plant varieties to breeders from various countries. This convention is based on principles of equality, fairness, and international protection of new plant varieties. It includes aspects such as fair and equal protection for all plant breeders, as well as respecting national sovereignty rights in the regulation and protection of plant varieties. ICPNVP provides a legal framework governing the protection of new plant varieties at the international level. Member countries of the convention are required to adopt a system for the protection of plant varieties at the national level that complies with the international standards set by the convention. In principle, ICPNVP promotes equality, fairness, and international protection for new plant varieties, as well as regulating fair and equal access to these varieties. It promotes international cooperation in the protection of new plant varieties and the resolution of related disputes. This convention is a crucial framework in promoting innovation and global food security (Syalsabilla Effendi & Yuniar Anisa Ilyanawati, 2023, p. 154).

The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) is a multilateral agreement agreed upon within the context of the World Trade Organization (WTO). TRIPS establishes minimum standards for the protection of intellectual property rights at the international level. It includes aspects such as patents, copyrights, trademarks, and trade secrets. TRIPS regulates patent protection for up to 20 years and grants exclusive rights to copyright owners. This agreement also regulates the use of compulsory licensing for generic drugs in health

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crisis situations (Dewi Sulistianingsih, n.d, 2022, p. 88). TRIPS encourages international cooperation and provides dispute settlement mechanisms. Although it provides stronger protection for intellectual property rights (IPRs) owners, TRIPS also presents challenges regarding access to essential medicines and technological innovation in developing countries. Nonetheless, TRIPS plays a crucial role in strengthening IPR protection worldwide and promoting knowledge-based economic growth.

The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) is an international agreement aimed at conserving and accessing plant genetic resources for the sustainability of agriculture and global food security. The substance of the ITPGRFA includes: fair and equitable sharing of benefits from the utilization of plant genetic resources; access to plant varieties for breeders; international cooperation in capacity building and technology transfer; and promotion of sustainable agriculture and natural resource sustainability. This convention provides access to plant varieties for breeders, enabling them to develop genetically superior new varieties. It promotes innovation in plant breeding, which can enhance crop productivity and resilience to environmental changes and disease threats. By promoting the responsible use of plant genetic resources and preserving plant genetic diversity, ITPGRFA contributes to natural resource sustainability and food security. Plant genetic diversity allows for the adoption of disease-resistant and environmentally resilient varieties, thereby enhancing food production sustainability.

The United Nations Food and Agriculture Organization (UNFAO) Convention addresses several important aspects related to agriculture and food. UNFAO supports sustainable agricultural practices, which include the use of environmentally friendly cultivation practices, sustainable natural resource management, and appropriate technology utilization. This involves providing access to resources and technology, enhancing farmers' skills and capacities, and ensuring that farmers have fair access to markets. The convention promotes sustainable management of natural resources such as land, water, and biodiversity (Gitz et al., 2016, 2018, p. 13). Overall, these agreements and organizations work together to ensure fair access to plant genetic resources, protect innovation and new discoveries in the agricultural sector, and promote sustainable farming practices. These are all important components in achieving sustainable and inclusive global food security. All of these conventions support efforts to achieve SDG 2 by promoting sustainable agriculture, increasing food production, and ensuring fair and equal access to food for all.

Indonesia has taken steps to enhance food security and the protection of plant varieties, including strengthening agricultural infrastructure, developing agricultural technology, reinforcing regulatory frameworks, enhancing farmers' capacity, and fostering international collaboration. However, further investment and concrete measures are still needed to ensure optimal readiness in facing these challenges. The government needs to continue strengthening agricultural infrastructure, supporting research and development of innovative agricultural technology, and reinforcing regulatory frameworks to protect plant varieties and implement international agreements related to intellectual property rights. Enhancing farmers' capacity through education, training, and access to technology is also a priority, while fostering closer collaboration with other countries and international organizations for knowledge and resource exchange. With these measures, Indonesia can be better prepared to address future challenges in food security and the protection of plant varieties.

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3.3 Plant Breeder's Rights and Food Security: The Philippines' Perspective

The Philippines is a member of various international agreements related to Intellectual Property Rights (IPR), including the Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement overseen by the World Trade Organization (WTO). The regulation of IPR is governed by Republic Act No. 8293, known as the "Intellectual Property Code of the Philippines (IPCP)", which includes Copyright, patents, trademarks, industrial designs, and geographical indications. The government agency responsible for the management and protection of intellectual property rights (IPR) in the Philippines is the Intellectual Property Office of the Philippines (IPOPHL). This institution is responsible for implementing laws and regulations related to IPR, including authority over registration and examination, law enforcement, and international cooperation (Barizah, 2017, p. 97).

Republic Act No. 8293 asserts that IPOPHL accepts applications for the registration of intellectual property rights and conducts examinations of these applications, both formally and substantively, to ensure that the registration requirements are met. In its task of managing the IPR database, upon receiving applications, IPOPHL carries out registration and examination to ensure that the registration requirements are met. This includes formal examination to ensure that all documents are complete and meet administrative requirements, as well as substantive examination to ensure that the inventions or works submitted meet the criteria set by IPR law. By performing these functions, IPOPHL plays a crucial role in managing information about intellectual property rights in the Philippines, facilitating the registration and protection process of IPR, and providing transparent and easily accessible public access to this information.

The law of the Philippines also regulates the protection of plant varieties. The plant variety protection system in the Philippines is governed by "Republic Act No. 9168," known as the "Philippine Plant Variety Protection Act" (PPVPA). This law provides a legal framework for the protection of new, unique, and stable plant varieties. Here are some key points in the PPVPA. Plant variety owners can register their varieties for legal protection (Salazar & Elca, 2021, 2021). IPOPHL will conduct a formal examination of the application to ensure that all administrative requirements are met. This includes checking the completeness of documents and payment of registration fees. After passing the formal examination, the application will then undergo substantive examination. This examination aims to assess whether the plant variety meets the criteria set for obtaining legal protection, such as uniqueness, uniformity, stability, and utility.

By registering plant varieties through IPOPHL, variety owners obtain legal protection that allows them to exploit the varieties exclusively in the Philippine market and protect themselves from unauthorized practices or variety theft. The registration of plant varieties and the legal protection thereof contribute positively to food policies in the Philippines by enhancing food security, resilience, and productivity, as well as improving the welfare of farmers and preserving food diversity. Here are some points that explain their relevance:

a) Food Quality

Plant varieties that are registered and legally protected tend to have better quality, higher productivity, and resilience to diseases or specific environmental conditions. Thus, the enhancement of registered plant varieties can improve food security in the Philippines by increasing food production and availability (Lestari, 2020, p. 5). Registered and legally protected plant varieties have typically undergone strict selection processes to ensure their quality. This may

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include improving desired characteristics such as taste, texture, color, and nutrition. An important aspect of plant breeding programs is the development of resistance to diseases and specific environmental conditions. Registered plant varieties tend to have better resistance to pest attacks, plant diseases, or environmental factors such as droughts or floods. This enhances production stability and reduces the risk of crop failure. With better quality, higher productivity, and improved resilience to disruptive factors, the enhancement of registered plant varieties can directly contribute to increased food production and food availability in the Philippines.

Therefore, the registration of plant varieties and their legal protection not only benefit the variety owners but also have the potential to significantly contribute to food security and resilience in the Philippines by increasing food production and quality available. With superior and diverse plant varieties, farmers can switch to new crops that have higher economic value or are resistant to specific environmental conditions. This can facilitate the diversification of agricultural production and help reduce dependence on a single type of crop or food source.

b) Food Diversity

The registration of plant varieties and their legal protection can be key to motivating the development and preservation of food diversity. This occurs because of the incentives provided to farmers and researchers to develop superior and genetically unique local plant varieties. Food diversity is an important asset in maintaining food security and agricultural ecosystem sustainability. However, local crops with local adaptation and unique traits are often overlooked in modern breeding efforts that focus more on varieties with greater market potential. This is where the role of registering plant varieties and providing legal protection becomes crucial (R.Helfer, 2002). With legal protection in place, farmers and researchers feel more secure about the benefits and rights to the plant varieties they develop. This provides a strong incentive for them to allocate resources and time to develop local varieties that have high economic value and resilience.

Additionally, legal protection also ensures that the results of breeding and research efforts are recognized and valued, both economically and scientifically. This can increase the motivation of farmers and researchers to engage in the preservation of genetic diversity in local plants that may not be developed without legal protection incentives. As a result, the registration of plant varieties and their legal protection is not only about advancing innovation in agriculture but also about preserving the important genetic diversity for the sustainability of food systems and ecology.

c) Food Security

With the increase of superior and resilient plant varieties against diseases, extreme weather, and climate change, the Philippines can strengthen their food security. This becomes crucial considering the country is often faced with challenges of natural disasters and climate change that can disrupt food production (Wijerathna-Yapa, Akila, 2022, p. 3). Amidst increasingly complex environmental challenges and vulnerability to frequent natural disasters such as tropical storms, floods, droughts, and landslides, efforts to enhance food security in the Philippines become highly important. One key strategy in achieving this goal is by developing plant varieties that are more resilient to extreme conditions that may arise due to climate change.

By employing advanced breeding technologies, agricultural scientists can produce plant varieties that have better resistance to diseases and pests, as well as can withstand extreme weather

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conditions such as droughts or floods. These superior plant varieties can not only provide more stable harvest yields but also reduce the risk of crop failures caused by unforeseen environmental factors. By having access to plant varieties that are resilient to diseases, extreme weather, and climate change, the Philippines can enhance their food security. More stable and reliable food production can help reduce communities' vulnerability to hunger and food shortages, as well as increase their resilience to frequent natural disasters. Therefore, investment in the development and use of superior plant varieties that are resilient to extreme conditions can be a strategic step for the Philippines in strengthening their food security amidst the challenges of climate change and frequent natural disasters.

d) Increased Agricultural Productivity

Legal protection of plant varieties can incentivize investment in agricultural research and development. This can help boost agricultural productivity in the Philippines, which in turn can reduce dependence on food imports and enhance the country's food self-sufficiency. Legal protection provides incentives for companies, research institutions, and farmers to invest in research and development of superior plant varieties. With intellectual property rights assured, investors will feel more secure about their investments in crop breeding efforts that can yield more productive, disease-resistant, and economically valuable varieties. By safeguarding plant varieties developed by local farmers, legal protection can help increase farmers' income and welfare. It can also encourage farmers' participation in biodiversity conservation efforts and preservation of traditional plant varieties. Increased Agricultural Productivity: Through investment in agricultural research and development, the Philippines can enhance the productivity of their agricultural sector. Superior and more productive plant varieties will yield larger harvests per hectare, helping meet the increasing food demand in the country.

Policy challenges to food security in the Philippines include dependence on food imports, uneven food distribution, vulnerability to natural disasters, lack of access to nutritious food, climate change, insufficient investment in agriculture, and lack of awareness about food health (ADB, 2016, p. 72). Solutions to address these challenges involve policies that support increased agricultural production, fair food distribution, infrastructure development, community resilience building, and nutrition education.

Policy on plant variety protection has the potential to contribute to addressing food security issues in the Philippines. Legal protection of plant varieties can incentivize investment in agricultural research and development. With the development of superior and more productive plant varieties, the Philippines can enhance their agricultural productivity, yielding more harvests from the same land. Plant varieties registered and legally protected often have properties that are more resilient to climate change, such as drought or flood resistance (Jane Payumo, Howard Grimes, Antonio Alfonso, Stanley P. Kowalski, Keith Jones, 2013, p. 136). By using plant varieties that are more adaptive to extreme environmental conditions, farmers in the Philippines can reduce the risk of crop failure due to climate change.

Diverse and disease-resistant plant varieties can help diversify food production in the Philippines. This can reduce dependence on a single type of crop and help communities achieve a more balanced diet. Through legal protection of plant varieties, farmers can be empowered to increase their income by using superior technology and plant varieties. This can enhance farmers' welfare and improve the economic resilience of farming households.

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3.3 Plant Breeder's Rights and Food Security: The Indonesian Perspective

In addition to regulations governed by the intellectual property rights (IPR) regime and ratified international conventions, Indonesia has enacted several regulations related to plant breeder's rights, plant variety protection, and food security, namely: a) Law 41 of 2009 concerning the Protection of Sustainable Food Crop Agricultural Land (Agricultural Land Protection Law); b) Law Number 13 of 2010 concerning Horticulture (Horticulture Law); c) Law 18 of 2012 concerning Food (Food Law); and d) Law 22 of 2019 concerning Sustainable Agricultural Cultivation Systems (Sustainable Agricultural Cultivation System Law).

The four laws play a crucial role in Indonesia's food security policy. The Agricultural Land Protection Law aims to safeguard agricultural land from conversion to non-agricultural use, which is essential to preserve land availability for food production. By preserving agricultural land, Indonesia can ensure the sustainability of food production sufficient to meet the needs of its population. By ensuring that agricultural land is protected from conversion, this law supports the sustainability of food production in Indonesia. It helps maintain long-term stability in food production and reduces the risk of food supply instability.

The Horticulture Law regulates the development and protection of horticulture, including the production of fruits, vegetables, and ornamental plants. By promoting horticultural development, Indonesia can enhance the diversification of food production, reduce dependence on staple food commodities, and expand food sources for the population. One of the positive impacts of promoting horticultural development is the diversification of food production. By expanding the types of crops produced, Indonesia can reduce reliance on staple food commodities such as rice and corn. This diversification is essential for improving food security and reducing the risk of fluctuations in food commodity prices. Overall, this regulation plays a crucial role in enhancing the diversification of food production, reducing dependence on staple food commodities, and expanding food sources for the Indonesian population. It is an important step in efforts to achieve sustainable food security in Indonesia (Limenta & Chandra, 2017, p. 247).

The Food Law is an important legal instrument in Indonesia's efforts to achieve food security. This regulation provides a legal framework for the Indonesian government to enhance food security, food safety, and ensure sufficient food availability for the entire population. The law covers aspects of production, distribution, access, and consumption of healthy, nutritious, and affordable food. It enables the government to implement policies and programs aimed at improving access to healthy, nutritious, and affordable food for the entire Indonesian population. This includes efforts to develop sustainable agricultural systems, enhance food infrastructure, and promote balanced and nutritious diets.

The Sustainable Agricultural Cultivation System Law regulates environmentally friendly and sustainable farming practices. By promoting sustainable farming practices, Indonesia can maintain long-term agricultural productivity without harming the environment. This is important to ensure food availability in the future while considering environmental sustainability (Adnyana, 2001, p. 40). Some practices encouraged by this law include the use of environmentally friendly technology, soil and water conservation, crop diversification, the use of organic fertilizers, and other agricultural practices that prioritize environmental sustainability. Implementing sustainable farming practices can help maintain the balance of agricultural ecosystems, improve soil fertility,

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reduce environmental pollution, and preserve biodiversity. Thus, sustainable agriculture not only contributes to long-term food security but also strengthens environmental and ecological resilience.

In Indonesia, the protection of plant varieties is regulated by Law Number 29 of 2000 concerning Plant Variety Protection. This law provides a legal framework for protecting intellectual property rights over newly discovered or developed plant varieties. Here are some key points regulated by this Law:

a) Registration

Plant variety owners must register their varieties with the Agricultural Research and Development Agency or designated institutions. The registration process involves technical and administrative testing to ensure that the variety meets the established standards. The registration process for plant varieties in Indonesia involves careful and measured steps to ensure that the registered varieties meet the set standards. In addition to laboratory testing, plant varieties will also be field-tested to evaluate their performance under actual farming conditions. These field tests help ensure that the plant varieties can grow and thrive well in real-world environments. Through this process, the Agricultural Research and Development Agency (or designated institution) ensures that the registered plant varieties have undergone rigorous evaluation and meet the established standards before being granted legal protection (Syalsabilla Effendi & Yuniar Anisa Ilyanawati, 2023, p. 153-161). This is an important step to ensure that only superior and high-quality plant varieties receive protection, thereby promoting innovation and development in agriculture.

b) Rights of the Owner

This law grants exclusive rights to the owner of plant varieties to produce, use, sell, offer for sale, trade, import, and/or export protected plant varieties for a certain period. Plant variety owners have exclusive rights to produce plants from the protected varieties. This means that only the owners are allowed to produce seeds or seedlings from the plant varieties they own. The exclusive rights are granted to the owner of the plant varieties to sell agricultural products from the protected varieties. These exclusive rights also include the ability to trade the protected plant varieties. Owners can trade seeds or seedlings of these varieties with other parties, both domestically and internationally.

By granting these exclusive rights to the owner of the plant varieties, the law aims to encourage innovation and investment in the development of superior plant varieties beneficial to agriculture. By offering legal protection for their investments and innovations for a certain period, this law encourages plant variety owners to continue their efforts in producing better plant varieties in terms of productivity, disease resistance, environmental adaptation, and product quality. This benefits not only the owners of the varieties but also positively impacts the agricultural sector as a whole by improving production efficiency, increasing food availability, and introducing innovations that can advance agriculture.

c) Utilization

Plant variety owners also have exclusive rights to use the protected plant varieties. This includes the right to cultivate, propagate, and exploit the plant varieties according to their needs. These rights give owners full control over the use of the plant varieties they own, as well as provide

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incentives for breeders and developers to invest in research and development of new plant varieties. Such legal protection aims to encourage innovation in the agricultural industry and ensure that variety owners can obtain fair economic benefits from their efforts in developing new varieties.

d) Sale of Agricultural Produce

In the dynamic world of agriculture, exclusive rights become crucial in ensuring sustainability and success for plant variety owners. One of these rights is the right to sell agricultural produce derived from protected plant varieties. When a variety owner has put significant effort into developing and protecting a new plant variety, they are entitled to reap the benefits of their hard work. From sweet fruits to fertile seeds, variety owners can sell various agricultural products produced from the plants they developed. This includes not only direct yields like fruits and grains but also processed products or derivatives derived from those plants. With the exclusive right to sell agricultural produce from protected plant varieties, variety owners can control the market and ensure that their products meet high-quality standards. They can set fair prices based on the value and quality of their plant varieties.

Beyond just the economic aspect, this right also provides incentives for variety owners to continue innovating and investing in research and development of new plant varieties. By receiving returns on investment from the sale of agricultural produce, variety owners are incentivized to continue their efforts in creating genetically superior varieties, more resistant to diseases, or better suited to specific environmental conditions. Thus, the exclusive right to sell agricultural produce from protected plant varieties is not only about market control but also about supporting innovation, economic growth, and sustainability in the agricultural industry (Network Omidyar & Boston Consulting Group, 2018).

e) Protected Market

In the competitive world of agriculture, plant variety protection plays a crucial role in ensuring that variety owners can reap the rewards of their efforts without worrying about unfair competition. This protection gives variety owners legal certainty that they have exclusive rights over the plant varieties they develop. One important aspect of these rights is the ability to sell agricultural produce without unfair competition from others trying to exploit the same varieties without permission. With strong legal protection, variety owners can confidently bring their products to market without fear of copyright infringement or illegal use of their plant varieties. They can maintain full control over the marketing of their products, ensuring they receive fair economic benefits from their hard work.

Moreover, this protection also fosters an environment conducive to innovation and the development of new plant varieties. Knowing that their rights will be protected by the law, variety owners are motivated to continue investing in research and development, introducing genetically superior varieties or those more suited to market demands. Thus, plant variety protection is not just about safeguarding the economic interests of variety owners but also about ensuring sustainability and growth in the agricultural industry as a whole. With a fair and transparent system in place, variety owners can confidently contribute to the advancement of sustainable and innovative agricultural production.

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f) Control over Quality and Pricing

The exclusive rights held by plant variety owners not only give them power over the use and sale of these varieties but also grant them control over the quality and pricing of the products produced (R. Helfer, 2002). This has significant implications for the agricultural market and consumer interests. With the power to control quality, variety owners can set high standards that products derived from their plant varieties must meet. They can ensure that only products of the highest quality are allowed to be sold in the market, thereby benefiting consumers by guaranteeing consistent and safe quality.

Additionally, the ability to set selling prices is also a significant power. Variety owners can adjust prices based on the value and quality of the products, ensuring that consumers pay a fair price commensurate with the value they receive. In other words, the set price will reflect the level of investment, risk, and innovation undertaken by the variety owners in developing superior plant varieties. However, it is important to remember that with great power comes great responsibility. Variety owners need to consider the social and economic impact of their decisions regarding product quality and pricing. Ultimately, their goal should not only be to make a profit but also to ensure the long-term sustainability of the agricultural industry and consumer satisfaction. Thus, these exclusive rights not only give variety owners control over the market but also impose significant responsibility on them to ensure high product quality and fair pricing.

g) Economic Incentives

The right to sell agricultural products derived from protected varieties provides strong economic incentives for variety owners to continue investing in research and development of new plant varieties (Lloyd Le Page, 2011, p. 65). By having exclusive rights to market products derived from these plant varieties, variety owners can ensure the return on their investment in developing genetically superior varieties. This provides a crucial financial boost for researchers and plant breeders to continue innovating and improving the quality of cultivated plants. Thus, the intellectual property rights system in agriculture not only protects the interests of variety owners but also drives progress in plant research and development, which in turn benefits agriculture as a whole and the welfare of farmers.

Moreover, the right to sell agricultural products from protected varieties also provides legal certainty to variety owners. With clear legal protection of their exclusive rights to the varieties they have developed, variety owners can safeguard their investments from infringement and misuse by others. This creates a conducive environment for innovation in agriculture, as industry players can confidently invest in plant research and development without fear of theft or abuse. Furthermore, the economic incentives provided by the right to sell agricultural products from protected varieties can also help expand farmers' access to superior varieties. By attracting variety owners to market products derived from new plant varieties, there is a possibility that these superior varieties will be more readily accessible to farmers, either through direct sales from the variety owners or through distribution agencies working in collaboration with them.

Overall, the right to sell agricultural products from protected varieties is an integral part of the intellectual property rights system in agriculture that plays a crucial role in driving innovation, improving plant quality, and enhancing the welfare of farmers as well as the sustainability of the agricultural system as a whole.

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h) International Cooperation

International cooperation plays a crucial role in the field of intellectual property rights in agriculture. By collaborating with other countries, governments, research institutions, and agricultural organizations can share knowledge, best practices, and resources to promote innovation, enhance food security, and ensure sustainable agricultural development worldwide. Through international agreements, conventions, and treaties, countries can harmonize their intellectual property rights frameworks, facilitating the exchange of plant genetic resources, promoting fair trade practices, and protecting the rights of breeders and farmers. Collaborative initiatives such as the International Union for the Protection of New Varieties of Plants (UPOV) and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) provide platforms for countries to work together in addressing global challenges related to plant breeding, conservation, and access to genetic resources (Eaton, *et al*., 2004, p. 25).

Moreover, international partnerships enable the sharing of scientific research, technologies, and innovations, accelerating the development of new plant varieties with improved traits such as higher yields, disease resistance, and climate resilience. By pooling resources and expertise, countries can tackle common agricultural issues, mitigate the impacts of climate change, and ensure the availability of diverse and nutritious food crops for future generations. In summary, international cooperation in intellectual property rights in agriculture fosters collaboration, innovation, and sustainability on a global scale, contributing to the collective effort to address food security challenges and promote the well-being of people and the planet.

The law governing the right to sell agricultural products from protected varieties not only provides economic incentives for variety owners to invest in research and development of new plant varieties but also facilitates international cooperation in the protection of plant varieties. With provisions allowing for adjustments to relevant international agreements, this law creates a strong legal foundation for countries to participate in cross-border cooperation in intellectual property protection in the agricultural sector. Through international cooperation, countries can exchange information and experiences in developing plant varieties, expand access to technologies and genetics that have the potential to enhance crop productivity and resilience.

Moreover, this cooperation can also include the harmonization of regulations and procedures related to the protection of plant varieties, thereby facilitating global market access for variety owners. Through international cooperation in plant variety protection, countries can also collaborate in addressing global challenges faced by agriculture, such as climate change, the spread of plant diseases, and food security (FAO, 2015, p. 35). By sharing knowledge and resources, countries can develop plant varieties that are more resilient to climate change, more adaptive to new environments, and more resistant to diseases and pests. International cooperation can also enhance farmers' access, especially in developing countries, to technology and innovation in agriculture. Through the transfer of technology and technical assistance from developed countries to developing countries, farmers worldwide can access superior plant varieties and more efficient farming practices, thus improving their productivity and welfare. Additionally, international cooperation in plant variety protection creates opportunities for industry players to expand their global market reach.

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Overall, laws that facilitate international cooperation in plant variety protection not only support growth and innovation in the agricultural sector at the national level but also promote global sustainability and welfare through cross-border collaboration in addressing challenges faced by modern agriculture.

3.4 Food Security: Challenges and Opportunities in the Future

Food security is the ability of a country or community to provide sufficient, safe, and nutritious food access for everyone, at the individual, household, and population levels, without compromising environmental sustainability. In the future, food security will face a number of challenges that need to be addressed, but it also provides opportunities for innovation and changes that can enhance the overall global food system. The main challenges in achieving food security in the future include: a) Climate change; b) Population growth; c) Limited resources; d) Food diversity and access sources; and e) Food loss and waste (Berry EM, Dernini S, Burlingame B, Meybeck A, 2015).

The increase in global temperatures, unstable weather patterns, and extreme events such as floods and droughts are serious challenges faced in maintaining food security worldwide. The impacts of climate change are not only felt by farmers but also by consumers who depend on stable and safe food supplies. In this composition, we will explore how these phenomena affect food production and threaten food security (Ishangulyyev, Rovshen, Sanghyo Kim, 2019, p. 39). Firstly, the increase in global temperatures affects crop growth and agricultural productivity as a whole. Higher temperatures can accelerate soil warming, reduce groundwater availability, and increase pressure on plants to obtain sufficient nutrients. Plants exposed to excessive heat are also vulnerable to heat stress, which can hinder growth and reduce yields. For example, crops like rice, wheat, and maize may experience significant yield reductions due to extreme temperatures.

Secondly, unstable weather patterns cause uncertainty in planting and harvesting seasons. Unstable weather can lead to sudden changes in rainfall and wind patterns, disrupting the scheduling of planting and harvesting. Sudden floods or prolonged droughts can damage already grown crops and hinder the growth of new ones. The impact is disruption in food production and the potential for food shortages. Furthermore, extreme events like floods and droughts can result in direct losses to crops and agricultural infrastructure. Floods can damage grown crops, wash away fertile soil, and cause erosion that threatens the fertility of agricultural land. On the other hand, droughts can deplete water resources, dry out the soil, and reduce water availability for agricultural irrigation. In both cases, farmers face financial losses and may struggle to recover their production. The consequence of these phenomena is an increased risk of food supply instability and rising food prices.

The continuously growing population is a significant factor influencing food security worldwide. With the increasing global population, the demand for food also rises proportionally. In this composition, we will explore how rapid population growth complicates efforts to provide adequate food supplies for everyone. With the population continually increasing, there is a need to produce more food to meet the nutritional and energy needs of the expanding society. This demand not only involves a greater quantity of various types of food but also increases the need for food security and equitable access to quality food. Although food production has significantly increased in recent decades, there remains a gap between population growth and food production capacity.

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Furthermore, rapid population growth also increases pressure on limited natural resources. More intensive food production often requires greater use of land, water, and energy. With the population continuing to expand, there is a risk of environmental degradation, loss of biodiversity, and ecosystem damage that can affect the sustainability of food production in the future. The consequence of rapid population growth is an increase in uncertainty in global food security. The availability and access to food become increasingly crucial, while challenges such as climate change, environmental degradation, and socioeconomic disparities further complicate efforts to provide adequate food supplies for everyone. Facing these challenges, holistic adaptation and mitigation measures are necessary. These include investment in sustainable agriculture to enhance land and water productivity, promotion of food security through inclusive policies, support for small-scale and local farmers, as well as education and public awareness about the importance of healthy and sustainable diets.

The limitations of natural resources such as land, water, and energy have significant impacts on food production worldwide. Amidst competition with other needs such as industry and urbanization, these constraints complicate efforts to meet the increasing demand for food. In this composition, we will explore how limitations in natural resources affect food production and how competition with other needs adds to its complexity. Limited land availability is one of the primary challenges in food production. Agriculture requires fertile land suitable for growing crops and raising livestock. However, agricultural land often competes with other uses such as urban development, industry, or other activities that convert land into non-agricultural use. As a result, available agricultural land may shrink, reducing the capacity for food production. Furthermore, water scarcity is a critical factor in food production. Irrigation is a crucial part of modern agriculture and requires sufficient access to clean water. However, clean water resources are increasingly limited due to pollution, climate change, and unsustainable usage.

In the context of competition with other needs such as industry and urbanization, the limitations of natural resources are further exacerbated. The use of land for urban infrastructure development, industry, or other needs often reduces the available land area for agriculture. Similarly, the increasing demand for water for industrial or domestic purposes can decrease the availability of water for agricultural irrigation. The result of the limitations of natural resources is increased pressure on global food security (Ernan Rustiadi, Andrea Emma Pravitasari, Yudi Setiawan, Setyardi Pratika Mulya, Didit Okta Pribadi, 2021). With resources becoming increasingly limited and demand continuing to rise, the challenges in meeting the world's food needs become more significant. Holistic and sustainable solutions are needed to manage natural resources wisely, improve efficiency in food production, and reduce conflicts over resource access. Measures such as the development of sustainable agriculture, increasing efficiency in water use in agriculture, and investment in renewable energy technologies can help address these challenges.

Factors such as extreme weather, plant diseases, and pests can result in suboptimal or even completely damaged harvests. Moreover, food loss occurs at the consumer level. Over-purchasing of food, improper storage, and failure to adhere to expiration dates are some factors that contribute to food being discarded in households. As a result, perfectly edible food is wasted, leading to resource wastage and increased environmental pressure. The impact of food loss throughout the supply chain is highly detrimental. Firstly, natural resources such as water, energy, and agricultural land are utilized to produce food that ultimately goes unconsumed. Additionally, organic waste

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from discarded food rots in landfills, producing greenhouse gases that contribute to climate change (Godde CM, Mason-D'Croz D, Mayberry DE, Thornton PK, 2021).

Environmental pressure also increases due to food loss. Increased agricultural production to compensate for lost food results in the use of more natural resources and agricultural inputs, including water, fertilizers, and pesticides. This can lead to soil degradation, water pollution, and loss of natural habitats. In addressing the issue of food loss, holistic actions are required throughout the entire food supply chain. Amidst these challenges, there are opportunities to enhance global food security:

a) Technology Innovation

The development of innovative agricultural technology is key to improving productivity and crop resilience amidst increasingly complex climate change challenges. In this composition, we will explore several innovative agricultural technologies, such as precision farming, biotechnology, and breeding resilient crops against climate change, and how these technologies can significantly contribute to improving food security (Bhupendra Chaudhary, 2020). Precision farming is an approach that utilizes information technology and sensors to monitor and manage spatial and temporal variability in the fields. Through the use of drones, soil sensors, and geographic information systems (GIS), farmers can monitor soil conditions, weather, and crops in real-time. Thus, agricultural inputs such as water, fertilizers, and pesticides can be provided timely and in the right doses, optimizing crop growth and reducing resource wastage.

Biotechnology has opened up new opportunities in the development of crop varieties that are more resilient to climate change and diseases. Through genetic engineering techniques, plants can be modified to enhance tolerance to extreme temperatures, drought, and pest attacks. Examples include the development of flood-resistant rice varieties or maize varieties that are more resistant to pests and diseases (Munaweera, et. al, 2022). Thus, farmers can produce more stable and guaranteed harvests even when facing extreme climate challenges. Breeding resilient crops against climate change is a traditional yet evolving approach in producing plant varieties that are more adaptive to changing environmental conditions. Through genetic selection, hybridization, and crossbreeding, plant breeders can develop varieties that have better resilience to extreme temperatures, drought, or floods. These climate-resilient crop varieties can withstand and yield good harvests even in less than ideal environmental conditions.

With the development of these innovative agricultural technologies, crop productivity can be significantly enhanced, while plant resilience to climate change is also strengthened. This has a significant positive impact on improving food security in various parts of the world, especially in regions vulnerable to climate change and natural disasters. However, it is important to remember that the use of innovative agricultural technology also requires a wise and sustainable approach in managing its environmental and social impacts. It is essential to consider sustainability aspects in the use of agricultural inputs, impacts on biodiversity, and implications for the livelihoods of local farmers. Thus, the development of agricultural technology should aim to create a more efficient, inclusive, and sustainable agricultural system for all stakeholders involved.

b) Food Diversification

Diversification of food sources is an important approach in maintaining food security and improving public health. In this composition, we will explore how food diversification can be

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achieved by expanding the choices of local food, reducing dependence on certain crops and food sources, and promoting consumption of more diverse and nutritious foods (Riyadi, *et al.*, 2015). Expanding the options of local food is a crucial step in diversifying food sources. Local plants and products often have good adaptation to the local environment and can thrive without excessive agricultural inputs. By promoting local farming, we can reduce dependence on food imports from other regions, which are vulnerable to climate change or economic crises. Additionally, expanding the choices of local food also supports environmental sustainability, as transportation and distribution of local food tend to be more environmentally friendly.

Reducing dependence on certain crops and food sources is an important step in mitigating the risk of food shortages caused by crop failures or environmental crises. By developing diverse cropping patterns or crop rotations, farmers can reduce the risk of crop loss due to pest attacks or diseases that target single crops. Promoting consumption of more diverse and nutritious foods is key to improving public health overall. By introducing and promoting consumption of various fruits, vegetables, grains, and plant-based proteins, we can provide more complete and balanced nutrition for the community. This also helps reduce dependence on animal proteins, which often require more natural resources to produce. By expanding the options of local food, reducing dependence on certain crops and food sources, and promoting consumption of more diverse and nutritious foods, we can create a more sustainable, diverse, and inclusive food system for everyone. Food diversification not only enhances food security but also supports environmental sustainability and public health overall. Therefore, it is important for all of us to support and promote food diversification in our daily lives (Fajar Rahmanto, Eko Priyo Purnomo, n.d, 2021, p. 22).

c) Empowering Farmers and Local Communities

Strengthening the capacity of farmers, promoting knowledge-based sustainable agriculture, and enhancing local food systems are crucial strategies in improving food security at the community level. In this composition, we will explore how this approach can significantly contribute to strengthening food security (Çakmakçı, Ramazan, Mehmet Ali Salık, n.d., 2023, p. 22). *Firstly,* strengthening the capacity of farmers is a key step in enhancing food security. Through training, education, and access to necessary resources such as quality seeds, innovative agricultural technologies, and fair markets, farmers can improve the productivity and sustainability of their agriculture. By strengthening the skills and knowledge of farmers, they can better address challenges such as climate change, plant diseases, and market changes, thereby enhancing the food security of the community. *Secondly,* promoting knowledge-based sustainable agriculture acknowledges the value and local wisdom in farming practices. Farmers often possess rich knowledge of local ecosystems, traditional crop varieties, and farming techniques suitable for local environmental conditions. By integrating this local knowledge with sustainable modern farming practices, such as the use of organic fertilizers, soil conservation, and natural pest control, farmers can enhance the productivity of their land sustainably.

Thirdly, strengthening local food systems is a crucial step in building resilient food security at the community level. By prioritizing the production, distribution, and consumption of local food, we can reduce dependence on food imports from outside the region and build a strong local economy. Moreover, local food systems provide better access to fresh, nutritious, and quality food

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to the community, while promoting environmental sustainability and social justice. By empowering farmers, promoting knowledge-based sustainable agriculture, and strengthening local food systems, we can create an environment where communities can independently manage their own food supplies. This not only enhances food security but also promotes inclusive economic development, environmental conservation, and social well-being at the local level.

d) International Collaboration

Collaboration between countries in the exchange of knowledge, technology, and resources is a key strategy in addressing global challenges in achieving food security. In this composition, we will explore how this collaboration can help overcome global challenges, including sharing knowledge about successful agricultural practices and infrastructure development support. The exchange of knowledge between countries can provide significant benefits in enhancing agricultural productivity and food security. Countries can share experiences about successful agricultural practices, crop varieties resilient to climate change, and innovative agricultural technologies. Through this collaboration, countries can learn from each other and adopt best practices to improve their food production sustainably (Yoselin Benitez-Alfonso, *at. al.*, 2023, p. 1250).

The exchange of technology between countries can accelerate innovation in agriculture and resource development. Advanced countries can share cutting-edge technology with developing nations, such as efficient irrigation technology, precision farming systems, or modern plant breeding techniques. Conversely, developing countries can provide local knowledge and natural resources needed for the development of new technologies. Thus, this collaboration creates a conducive environment for innovation and progress in global agriculture. Supportive infrastructure development is a crucial element in enhancing food security through international cooperation. Infrastructure such as efficient transportation networks, reliable irrigation systems, and integrated markets can improve farmers' access to markets and agricultural inputs, as well as accelerate food distribution from producers to consumers. Through joint investment in supportive infrastructure, countries can enhance food production efficiency and ensure better access for everyone.

Through international cooperation in the exchange of knowledge, technology, and resources, we can create a supportive environment to achieve global food security. Through this collaboration, countries can address challenges together, strengthen the global food system, and ensure adequate, safe, and nutritious food for everyone worldwide. Therefore, it is important for countries to continue to commit to building strong cooperative relationships in supporting global food security. The Plant Variety Protection Act can be one of the important instruments in supporting food security policies. Plant variety protection provides incentives for variety owners to invest in research and development of new plant varieties that are more productive, resistant to diseases, and suitable for changing environmental conditions. Thus, this can increase agricultural productivity, reduce vulnerability to fluctuations in food supply, and strengthen a country's food security. By having genetically superior plant varieties that are resistant to environmental challenges, farmers can increase their food production, even in extreme weather conditions or climate change. This can help reduce vulnerability to hunger and food shortages caused by climate change or natural disasters.

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Additionally, the Plant Variety Protection Act can also encourage diversification of food sources by facilitating the development of alternative plant varieties that are more resilient to climate change or specific environmental conditions. Food diversification can help reduce dependence on specific crops and food sources, as well as strengthen food security in facing global challenges. However, to effectively support food security policies, the Plant Variety Protection Act must be implemented and managed wisely. It is important to ensure that the rights of local farmers are also recognized and protected, and that plant varieties resulting from research and development investments are also available and affordable to smallholder farmers and local communities. Furthermore, food security policies should also involve various other aspects, such as access to fertile agricultural land, supportive infrastructure, agricultural education, and fair market access. By combining various strategies and policy instruments, including plant variety protection, countries can strengthen their food security and ensure an adequate, safe, and quality food supply for all their citizens.

In relation to this, the government needs to take concrete steps to improve food security. First, by investing in sustainable agriculture, including the development of climate-resilient crop varieties and farmer training. Second, by strengthening local food systems, including facilitating access to markets for local farmers. Third, by promoting the diversification of food sources through the consumption of fruits, vegetables, and plant-based proteins. Fourth, by protecting the rights of local farmers to ensure their participation in the food system. Fifth, by developing integrated climate change policies. Sixth, by strengthening international partnerships in the exchange of agricultural knowledge and technology. And finally, by implementing education and awareness programs for the importance of balanced nutrition and sustainable farming practices. With these measures, the government can strengthen its contribution to improving food security and building a more sustainable food system.

IV. CONCLUSION

The research highlights the importance of plant variety protection in enhancing agricultural productivity, addressing climate change challenges, and maintaining the sustainability of food supply. The implementation of intellectual property rights in the agricultural sector also directly impacts the welfare of farmers and other stakeholders. The research findings indicate challenges and opportunities in implementing plant variety protection, as well as potential improvements in the legal framework to ensure the sustainability of agricultural systems and food security in the future. In this context, the close relationship between Plant Variety Protection (PVP) and Food Security is crucial. PVP provides incentives for plant breeders to produce superior and adaptive varieties, which in turn contributes to increased productivity and sustainability of agricultural systems. However, inadequate intellectual property policies can hinder farmers' access to varieties needed to meet their local food needs.

The United Nations Convention on Biological Diversity (UNCBD) recognizes the importance of conserving biodiversity for human and environmental well-being. In the Philippines, intellectual property regulation is governed by the Intellectual Property Code, while in Indonesia, the Plant Variety Protection Law regulates the protection of new plant varieties. In facing future challenges, including climate change, population growth, and resource limitations, governments need to take concrete steps to improve food security. This includes investing in

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sustainable agriculture, strengthening local food systems, diversifying food sources, protecting farmers' rights, developing climate change policies, enhancing international partnerships, and implementing public education programs. With these measures, governments can strengthen their contribution to improving food security and building sustainable food systems.

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