



**EXISTING AGRICULTURAL ENGINEERING
INNOVATIONS AND FARM MANAGEMENT PRACTICES BY
WOMEN FARMERS IN DAVAO DEL SUR: A LITERATURE REVIEW**

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Abstract:

Agriculture plays a vital role in the economic development of Davao Del Sur, Philippines. However, traditional farming methods often limit productivity and sustainability. As the sector faces numerous challenges, such as climate change, resource scarcity, and changing market demands, innovative solutions are essential to enhance farm management practices. In recent years, agricultural engineering innovations have gained attention as a means to address these challenges. Further, analysing how innovations benefit women farmers can maximize their positive impact. However, some innovations that enhance efficiency may not adequately address women's unique needs. The literature review evaluated current relevant literature and shed light specifically on the existing agricultural engineering innovations employed by one of the agricultural provinces in the Philippines, Davao Del Sur, and highlighted local government units' attention to employing a top-down approach to a more grassroots-oriented approach and provide significance of collaboration to create public value understanding that innovations will be cascaded down to where it matters, and also learn from the feedback of specific areas as to what their needs are specifically women farmers.

Keywords: agricultural engineering, innovations, women farmers, gender and development, Davao Del Sur

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1. Introduction

Agriculture is vital to the country's global security and poverty reduction (Musostova *et al.*, 2023). In all aspects, specifically the agriculture sector, embracing complexities and inclusive gender-sensitive approaches to women's empowerment is significant. Moreover, in adherence to the Agriculture and Fisheries Modernization Act of 1997 (AFMA), as mandated by the Department of Agriculture (DA), the agriculture sector was revolutionized through technological innovations (Official Gazette, 1997). Davao Del Sur, as an agricultural province, streamlined its farming mechanisms. However, it fails to oversee the diverse needs of women farm workers/operators (Kingiri, 2013), resulting in underutilization of technology potential and low adoption rates of agricultural advancements.

The agricultural innovation system comprises technological, social, economic, and institutional actors (Klerkx *et al.*, 2012) that are vital in introducing the advancements. Rather than considering independent factors, it is also essential to explore how the farming community responds to it, on which participatory research can abet. As women contribute to the agricultural labor force, they often face unequal access to resources and technologies compared to men (Behrman *et al.*, 2014). This paper purposely addresses the challenges and explores opportunities to enhance women farmers' farm management practices in the province.

Anchoring upon theories of Moser's Gender & Development (GAD) Theory (2012) and Nussbaum's Capability Approach (Gasper, 1997) emphasizing understanding social, economic, and cultural factors contribute to gender inequalities. In agricultural production sectors, women's opinions were underrepresented and undervalued. Throughout the years, various study conducted to assess women's involvement in the agriculture sector (Kenya, 2016), (Wanyama, 2016) & (Thakur, 2023). However, the results showed that only a few community organizations actively involved women (Macusi *et al.*, 2022). Results suggest that women's participation or representation in various agricultural operations could have been higher.

Studies highlighted that as agricultural innovations advance, they should not limit but expand women's capabilities and empower them to have real livelihood choices (Kabeer, 2018). In this review paper, the researchers will review the existing farm management practices and agricultural engineering innovations employed by women farmers in the province of Davao Del Sur, Philippines. The review will understand the underlying impacts of women utilizing existing farm management and innovations and systematically evaluate systematically consolidated online databases relevant to the chosen topic for the past years. It also helps to emphasize the significance of a gender-sensitive approach in crafting and promoting improved agricultural technology, aligning the women farmers to enhance their productivity and efficiency, leading to empowerment. In view hereof, its results may pave the way for knowledge of agricultural engineering innovations and effective adaptation tailored to the specific needs of women operators in the province. Subsequently, for the policymakers, agricultural engineers,

and development practitioners, this paper provides practical suggestions for inclusive policies or programs engendering one of SDG goals: women's empowerment in the agricultural sector.

2. Methodology

The authors conducted this literature review systematically through online databases, including academic journals, institutional repositories, and reports. To focus on retrieving relevant literature only from the past years and ensure the relevance mainly in the Davao Del Sur setting, the keywords for thorough searching were limited to "agricultural engineering innovations," "women farmers," "farm management," "empowerment," "gender and development" and "Davao Del Sur." The press releases and any pertinent articles were carefully screened based on their titles, abstracts, and full texts; the literature review analysis was selected.

3. Results and Discussion

Based on the scholarly review, the authors evaluated the existing agricultural engineering innovations and current farm management practices of women farmers in Davao Del Sur and strategized effective adaption.

3.1 Evolution of Policies

In the Philippines, agriculture remains a significant sector, employing over 30% of the population (World Bank, 2017) as a source of livelihood. It is also the largest consumer of scarce natural resources, and the competition for these resources among sectors is growing due to increasing population pressure (UNEP, 2016). Agricultural development policies in the Philippines have evolved significantly over the past decades to promote more inclusive and sustainable practices. To address this, a review of critical policies demonstrates how women farmers' needs are increasing. One of the earliest national initiatives was the Food Staples Self Sufficiency Program launched in 1984, which aimed to boost rice and corn production through subsidies and infrastructure (Gonzales, 2003). While an important step, this policy did not have a gender lens, and its "green revolution" approach relied heavily on chemical inputs. Subsequent policies began integrating more social and environmental safeguards. The Agriculture and Fisheries Modernization Act of 1997 (AFMA), also known as Republic Act No. 8435, mandated the Department of Agriculture (DA) to modernize the agriculture sector and enhance the productivity and competitiveness of farmers (Official Gazette, 1997). However, the AFMA also lacked specific provisions for addressing women farmers' needs.

The Magna Carta for Women (Republic Act 9710) was a significant milestone, passed in 2009. This landmark policy mandated that all government programs provide gender-responsive budgeting and promote women's economic empowerment (Rallonza, 2020). It recognized the vital role of rural women and sought to eliminate discriminatory

practices in access to resources. Building on this, the National Gender and Development Plan 2013-2017 included strategic objectives of increasing women farmers' access to productive resources and services through capacity building on new technologies (Manasan & UNESCAP, 2020). In light of this, it indicates growing awareness of how agricultural innovations are delivered to benefit both women and men farmers equitably. Agriculture and Fisheries Modernization Plan (AFMP) for 2021-2030 has among its flagship programs the provision of gender-responsive machinery and equipment for priority commodities (DA, 2022). It also promotes the establishment of women farmers' groups to facilitate access to financing and markets. This policy evolution demonstrates how the Philippine government is progressively working to address the diverse needs of women operators through agricultural engineering innovations and farm management support services.

Women play a significant role in agriculture in the Philippines, comprising an estimated 33% of the agricultural labor force (Patil & Babus, 2018). However, they often face more challenges than men in accessing resources and technologies to support their work. Adopting any agricultural technology in the Philippines has often been challenging. Not all agricultural technologies introduced to the farmers have been well received and adopted. For instance, the technology called conservation agriculture has not gained so much headway in terms of adoption in the Philippines since it was introduced in the country through the USAID-funded SANREM project (Ella, 2014) despite several scientific evidence on its agricultural and environmental benefits (Ella *et al.*, 2016) (Tarnate & Reyes, 2014), (Bondad *et al.*, 2015) and (Ares *et al.*, 2015). Even the water-saving technology called Alternate Wetting and Drying (AWD) for lowland rice production systems (Lampayan *et al.*, 2015) encountered challenges in terms of widespread adoption in the country.

Given this, Chuang *et al.*, 2020 contended that *"the lower adoption levels of Smart Agriculture (SA) technologies might incline to inadequate knowledge, missing information, missing knowledge, lack of awareness of the technologies, and lack of perceived practical value."* Specifically, Davao Del Sur needs more focused research on the economic aspects of women farmers and their interaction with agricultural engineering innovations to understand its practical adaptations.

3.2 Trends of Women Farmers and Agricultural Innovations

Studies showed that women had difficulties in adopting different paddy innovations in the Mvomero District (Kenya, 2016). With this, some innovations that cannot address women's unique needs instead of enhancing efficiency led to underutilization, as sighted by a study on "Selective attention and information loss in the lab-to-farm knowledge chain: The case of Malawian agricultural extension programs" conducted by (Niu & Ragasa, 2018) hindering women from achieving their full potential. Globally, women play a significant role in farms and rural economies (Quisumbing *et al.*, 2021). However, facing challenges in accessing land, financial resources, and technologies compared to men (Behrman *et al.*, 2014). For women, the freedom to consider inclusively earning

income, making decisions, accessing resources, and receiving education need attention. As agricultural innovations advance, they should not limit but rather expand women's capabilities and empower them to have real choices in their livelihoods (Kabeer, 2018). In addition, a research initiative considered that when promoting inclusive adaptation, it highlighted the significance of involving the community and considering gender perspectives. A study that focused on the participatory rural assessments in African and Asian countries, working alongside gender-diverse groups to co-create an improved vegetable drying rack that caters to the specific needs, capabilities, and context of women users conducted by Dev and Manalo (2023) and it showed a higher rate of adoption than traditional top-down approaches. It is essential to integrate gender considerations in developing advancements, particularly by involving women entrepreneurs' cooperatives. Correspondingly, Menya *et al.*, 2019, documented cases where women farmers received training in fabricating suitable tools and constructing machines suitable for small landholdings, utilizing local resources in Central Uganda. It proved that both technically and economically, empowerment positively impacted participants.

Also, studies by Rola-Rubzen *et al.*, 2020, highlight the significance of incorporating gender-sensitive approaches in the designing, testing, and promotion of agricultural technologies to develop appropriate and empowering innovations among women farmers (Sell & Minot, 2018). Other studies have explored the potential of agricultural engineering innovations to enhance the productivity and efficiency of women farmers. Similarly, the "Profiling agricultural engineering technologies for mechanizing smallholder agriculture in Uganda research," as Wanyama (2016) led, demonstrated that precision farming technologies could improve crop yields and reduce labor costs such as drones and sensors. Additionally, digital platforms such as mobile apps can enhance women farmers' access to critical information, financial resources, and markets. However, it cannot be designed to meet women's specific needs and preferences, which can hinder women's adoption and effectiveness (Thakur, 2023).

In the Philippines, an evaluation of the adoption of wireless sensor network technology for irrigation water management in the Philippines, focusing on high-value crops across 15 different provinces (Panaligan *et al.*, 2022) was conducted. The ethnographic study data sheds light on the local gendered division of agricultural labor, providing valuable insights to inform adaptation strategies in Davao del Sur. Despite these efforts, restrictions still exist that deter the participation of women farmers in agricultural value chains, as highlighted by Quisumbing *et al.* (2021) as a result of Women's Empowerment and gender equality in South Asian Agriculture: Measuring Progress using the project-level Women's Empowerment in Agriculture Index conducted study.

In line with this, (Buisan, 2019) research found that providing women with access to agricultural services and resources through programs like rice machinery entrepreneurs can empower them to play a more active role in farm management and decision-making processes. It highlights the potential of adapted innovations to empower women operators in Mindanao. In the Davao Region, even in another

agricultural production sector, as the study focused on by (Macusi *et al.*, 2022), it showed that women were underrepresented and their opinions were undervalued. Recently, a study assessed the women's participation and support programs primarily through the awareness and education campaigns during meetings in its management in Davao Gulf implementation of the closed fishing season. However, the results showed that most respondents failed to connect to fishing organizations as these were male-dominated, and few community organizations engaged women. As a result, the absence of support systems and networks for women in the fishing industry further impedes their participation in management roles.

3.3 Women Farmers' Innovations and Farm Management Practices in Davao Del Sur

Women farmers are involved in various agricultural innovations and farm management practices aiming to enhance farm production in the province. Women's involvement in agricultural innovations and farm management practices is essential for developing sustainable agriculture in the region. It also emphasizes the need for policies and programs that support and enhance the participation of women in agriculture. To date, here are the highlights of the existing data:

3.3.1 Landscape Diversification

Women farmers adopt diversification as a critical strategy for sustainable and profitable farming. They grow a variety of crops and also raise livestock, poultry, and fish. Diversifications involved planting different crops and cropping systems combined in space and time. One successful example is the Silvano Farm at Barangay Poblacion Magsaysay, Davao Del Sur. The local government unit of Magsaysay had a goat dispersal program on them. Silvano's farm was owned by Mrs. Lorna's family and his husband, Diosdado. Aside from the grapes planted on the farm that serves as a tourist destination, their farm also practices vermicomposting from the farm dairy and meat-type goat production (Tacio, 2023). Further, it exercises organic rice farming, unlike the traditional method of removing organic rice straws; by-products of rice production at harvest will not be burned. In its place, the organic rice straw is utilized to produce organic fertilizer, which is then used to fertilize the organic rice crop farm lots later on.

3.3.2 Use of Agriculture Technology Applications

Women farmers leverage technology to manage their farms effectively. They now use an agriculture application installed on their smartphones to access valuable information and tools. As an agricultural province, most women who rely on livelihood in farming find that it is very advantageous for them to be well updated on real-time updates, improving digital information access and literacy and facilitating access to market opportunities through digital agriculture interventions, notably through the implementation of the Digital Farmers Program (DFP) by the Department of Agriculture- Agricultural Training Institute (DA-ATI). In addition, (Angchay *et al.*, 2024) interviewed female adult rice farmers with years of farming experience ranging from 3 to 39 years. All of the

participants are agriapp users; the majority of the participants revealed that they are using Binhing Palay app, eDamuhan app, Leaf Color Computing (LCC) app, Accuweather app, SpidTech app, Minus- One Element Technique (MOET) app, and Rice Doctor app, in their agricultural practices and productivity.

3.3.3 Promotion of Local Organic Produce

Aside from the organic rice production from Silvano Farm, a women-led reclaimed community established a long time ago and expanding until now through the local office of the DA-XI, it is present in local markets, promoting and selling local organic produce. It boosts their income and promotes healthy eating within the community. The women-led community, formerly Los Amigos Women Farmers Organization and named MASIPAG (Magsasaka at Siyentipiko para sa Pag-unlad ng Agrikultura), expanded with one of their physical stores managed at Calinan Davao City. Eventually, the women farmer members initiated linkage and networking among community members to broaden the scope of its implementation. METSA Foundation was established to facilitate and guide members of the organization on the program. Organic movement in the Davao region grew (driven by the expanding number of organic farmers, churches, and advocates), KNBL, METSA, and its allies lobbied for an organic agriculture ordinance in their city, including the call to halt the aerial spraying of chemical inputs in nearby plantations. Their association also led GO Organic Davao City (GODC). It helped introduce 2014 the Participatory Guarantee System, a certification mechanism for and by small farmers in Davao City (MASIPAG National Office, 2023).

3.3.4 Modern and Innovative Farming Practices

The women farmers are introducing modern and innovative farming practices to their communities. These practices were monitored by various government and private agencies, such as Grains Innovation & Solutions Co. Inc., which introduced GPS-guided machinery and drones (ATI, 2023). Moreover, women farmers have now employed precision farming techniques and mechanized farming equipment that significantly reduce their physical burden for land preparation, planting, and harvesting (DA, 2020).

According to (DA-AFID, 2023), the present accessible to women mechanizations, including tractors, harvesters, irrigation systems, power tillers, rice transplanters, and harvesters, have increased efficiency and productivity on farms in Davao Del Sur, aside from reducing their physical labor while increasing efficiency and productivity, which is prevalent among women farmers/workers in Davao Del Sur. The alternating episodes of prolonged dry spells and heavy rainfall patterns have exacerbated the hardships of Mindanaoans. In addition, women farmers in Davao Del Sur have access to reliable irrigation, which empowers them with more control over farming schedules and crops grown (Rosas, 2014). For instance, the community-managed irrigation systems, Sulop Davao Del Sur CIS, had given a drip irrigation kit that enabled women to plant crops during dry seasons, diversify production, and increase yields and incomes (DA, 2010). In line with this, based on data from the National Irrigation Administration in Davao Region

(NIA- 11), the farmers' association of Bansalan Davao Del Sur, comprising male and female members, has given newly completed and fully functional innovations (drip irrigation systems and greenhouse). The innovations were under the Enhanced Partnership Against Hunger and Poverty Program (EPAHP), a convergence of different government agencies, academe, and local government units that help farmers' groups in their livelihood. Further, it enables women farmers in Matanao, Davao Del Sur, and neighboring communities to use the issued greenhouse and controlled environment agriculture facilities. The model farm Palayan ng B'laan Communal Irrigation Association, Inc. in New Cabasagan, Matanao, Davao del Sur, managed by indigenous peoples, was efficient in extending the growing season and protect crops from adverse weather conditions proven to enhance crop quality and increase farm profitability (Palicte, 2022).

3.3.5 Participation in Cooperatives

Women farmers are part of cooperatives that share knowledge of resources and market their products. This collective action empowers them and enhances their bargaining power. A fruitful example is specialty coffee, at the heart of the ACDI/VOCA-led and U.S. Department of Agriculture-funded Philippine Coffee Advancement and Farm Enterprise (PhilCAFE). Through this project, ACDI/VOCA is working with farmer groups or cooperatives to improve their governance and production of specialty coffee. One group called BACOFA, a female-led specialty coffee cooperative in Mindanao, is at the forefront of that effort. The consumer demand for specialty coffee in the Philippines exceeds the available supply. In an attempt to meet this demand, the women who make up BACOFA work with smaller growers' associations in the area. BACOFA was situated at the foothills of Mount Apo Davao Region. Women members of the cooperative proved that women-empowered groups can make a difference, as the cooperative now supplies high-grade coffee in the domestic and international markets (ACDI/VOCA 2022).

3.3.6 Adoption of Climate-Resilient Practices

Women farmers are adopting climate-resilient practices to mitigate the impacts of climate change. These practices include the use of drought-resistant crop varieties and implementation of water conservation techniques in response to the continuous mechanizations of the Department of Agriculture XI, the leading agency in the agricultural sector of the Davao Region, which has developed an action plan to mitigate the effects of El Niño on the rice and corn plantations of the farmers. The plan includes a water delivery schedule, alternate wetting and drying technology, crop diversification, and early maturing and drought-resistant crop varieties. Women farmers are now adopting hybrid rice farm production based on Miguel *et al.*, 2021, as they study the influence of the farmers' adoption decision of hybrid rice technology in the Province of Davao Del Sur, focusing on the role of spatial proximity with respondents composed of 17% females out of 122 rice farmers respondents. However, findings showed that the sex of the household head (HH), household size, non-farm income, and rainfall are the

significant determinants of adopting hybrid rice technology. Thus, the interventions should focus on delivering better access for female farmers to productive resources and those with larger household sizes, improving access to non-farm livelihood and employment opportunities and reinforcing proven risk mitigation practices for providing stable water sources in the farming community.

Another innovation involving women farmers' active involvement is biogas production, which generates income from it. According to Gervacio J., 2012, of the 24 biogas farm workers, almost half (46%) are female. One of the many technical options used to minimize pollution from swine wastes is the construction of biogas digesters to generate and capture methane gas (Bond & Templeton, 2011). This technology offers a win-win solution to producers by improving, if not eliminating, malodor. At the same time, producing two valuable products - the gas and the compost- could be used as fertilizer. However, this innovation was quite expensive in construction, which small-scale women farmers can only afford with interventions. Consequently, micro-credit schemes for small-scale farmers should be developed. Additionally, there is a need to conduct technology appreciation workshops for financial organizations and other interested agencies to enhance the lenders' knowledge of biogas technology.

3.4 Impact of Agricultural Innovations on Women's Farm Management in Davao Del Sur

Agricultural engineering innovations are crucial in empowering women farmers and enhancing farm management practices (Manasan & UNESCAP, 2020). The province of Davao Region in the Philippines has seen several such innovations that have benefitted women farmers.

In the province of Davao Del Sur, an agricultural province in Region XI, women have utilized various agricultural innovations in collaboration with national agencies to promote an inclusive approach and gender-sensitive farm management. To sum up, some of the women farmers utilize agricultural engineering innovations in the province but not limited to drip irrigation systems, greenhouses, controlled environment agriculture, mechanized farming equipment, e-government initiatives, enhanced partnerships against hunger and poverty programs (EPAHP), etc. The following mechanizations improved farmers' lives and contributed to the region's economic development. However, it is noteworthy to consider the challenges, including improving digital literacy, ensuring reliable internet connectivity, and addressing gender disparities in end users' technology access. The economic implications of agricultural innovations and farm management practices are increased productivity and profitability, creation of new income streams, cost savings, and enhanced market power as women farmers in Davao Del Sur are seeing economic benefits through increased productivity and profitability from adopting diversified and modern farming practices. They create new income streams by promoting local organic produce, using tech applications, and adopting climate-resilient practices. Cost savings are realized through organic farming

practices and mechanized equipment. Participation in cooperatives enhances their market power, improving market prices.

On the other hand, Social Dynamics involve Women's Empowerment, Community Involvement, Education and Information Access, and Environmental Sustainability. Empowered women farmers in Davao Del Sur were honed through innovative practices and participation in cooperatives. These actions foster community involvement, promote healthy eating, and lead to community development. The use of agricultural technology enhances their digital literacy and access to information. Lastly, their adoption of climate-resilient practices and biogas production contributes to environmental sustainability.

4. Challenges and Opportunities

Both government and non-profits introduced the various agricultural engineering innovations found in empowering women farmers and enhancing farm management practices in Davao Region, Philippines. However, a gender gap still exists in access to such technologies aiming to address. Even globally, most women struggle in farm operations compared to men, as it is labor-intensive and time and energy-consuming (World Bank *et al.*, 2009). However, these challenges also present opportunities for improvement and growth. According to the Rice Sector Strategy (2009), despite improving farmers' livelihoods, impoverished farmers, especially women, are still experiencing excessive workloads and overburdening. These challenges and opportunities highlight the need for concerted efforts from various stakeholders, including the government, private sector, academe, and farmers, to address those above fully. Gender differences in priorities and preferences for adaptation also need to be considered (Huyer & Partey, 2020). Stemming from these types of differences, women and men in different social groups will have different needs and priorities for training, technology, and climate information needs and priorities, based on their differing access to resources, social and gender norms, and gender division of labor (Tall *et al.*, 2014). Gender equality involves challenging power relations and addressing gender norms through formal and informal rules and practices constraining women's lives and opportunities. It also involves increased control over assets, resources, knowledge, and ideology. It focuses on the ability of individual women, through increased agency, to increase their bargaining power in both public and personal lives (Batliwala, 1994).

4.1 Challenges Faced by Women Farmers in Adopting Innovations

4.1.1 Physical Burden

Mechanized farming equipment reduces the physical burden for women farmers in tasks like land preparation, planting, and harvesting (DA, 2020). However, not all agricultural technologies introduced to the farmers have been well received and adopted (Chuang *et al.*, 2011).

4.1.2 Climate Change

The alternating episodes of prolonged dry spells and heavy rainfall patterns have exacerbated the hardships of Mindanaoans (Oxfam, 2013).

4.1.3 Access to Resources

Women often face more significant challenges than men in accessing resources and technologies to support their work (Patil & Babus, 2018).

4.1.4 Adoption of Technologies

According to (Chuang *et al.*, 2011), adopting any agricultural technology in the Philippines has often been challenging

4.2 Opportunities for Further Innovation and Improvement

4.2.1 Irrigation Systems

The National Irrigation Administration in Davao Region (NIA-11) turned over newly completed and fully functional innovations, including drip irrigation systems and a fully functional greenhouse (Palicte, 2022).

4.2.2 Mechanization

Utilizing mechanized farming equipment can help increase efficiency and productivity on farms in Davao Del Sur when accessible to women (DA-AFID, 2023).

4.2.3 E-Government

The government's use of ICT and the Internet to improve public service delivery and enable closer linkage among government, private and private sector, and the citizens (La Porte, Demchak, & De Jong, 2002)

4.2.4 Mobile Phones and Internet

Mobile phones and the Internet provide women farmers in Mindanao with critical advisories, market prices, weather updates, and opportunities to connect with other farmers (Angchay *et al.*, 2024).

4.2.5 Precision Farming Techniques

The adoption of precision farming techniques, such as GPS-guided machinery and drones, has allowed women farmers to optimize the application of fertilizers, pesticides, and herbicides (ATI, 2023). In addition, agricultural training is a potentially effective method to diffuse relevant new technologies (Nakano *et al.*, 2018).

4.2.6 Biogas Production

The innovation system was common practice in biogas production (Bond & Templeton, 2011).

4.2.7 Research

There is a need for more focused research on the economic aspects of women farmers and their interaction with agricultural engineering innovations to understand its practical adaptations (Chuang *et al.*, 2011).

5. Conclusion

In this paper, the authors explore the various existing agricultural engineering innovations and farm management practices by women farmers in Davao Del Sur. They review some critical issues pertinent to considering gender perspectives addressing the unique needs of women farmers in the development and its implementation. To sum up, the mechanizations of women farmers employed in the province are complex and have significant implications for the economic and social dynamics of the region. These practices include landscape diversification, agriculture technology applications, promotion of local organic produce, modern and innovative farming practices, cooperative participation, climate-resilient practices, and biogas production. Significant studies such as those by Tacio (2023), Angchay *et al.* (2024), and MASIPAG National Office (2023) have contributed to our understanding of these practices. They highlight the role of women farmers in adopting these innovations and the benefits they bring in terms of increased productivity, profitability, cost savings, and enhanced market power. They also underscore the social dynamics, including women's empowerment, community involvement, education and information access, and environmental sustainability.

The literature review also indicates that throughout the years, the Philippine government has made significant strides in addressing the needs of women farmers through the development of inclusive and sustainable agricultural policies. This only means that the government continuously provides policies recognizing the vital role of women in agriculture, aiming to eliminate discriminatory practices and promote gender-responsive budgeting.

Even so, while progress has been made in promoting gender-responsive approaches and empowering women farmers, gaps in the existing literature warrant further study. For instance, more research is needed to understand the challenges faced by women farmers in adopting these innovations, such as access to resources, impacts of climate change, knowledge and skills, and cultural and social barriers. Additionally, there are opportunities for further innovation and improvement. These include providing training and education to women farmers, implementing supportive policies, developing new technologies and practices tailored to the needs of women farmers, and promoting community-based approaches.

Globally, various studies proved that empowered women farmers are more likely to embrace new technologies and practices, improving productivity and efficiency. The local gendered division of agricultural labor plays a significant role in adopting agricultural innovations. Understanding the local context and considering the division of

labor can provide valuable insights for developing appropriate strategies and interventions. The local government units shall employ a top-down approach to a more grassroots-oriented approach and provide significance of collaboration to create public value.

Overall, this literature review suggests that future studies should focus on these areas to provide a more comprehensive understanding of the agricultural engineering innovations and farm management practices in Davao Del Sur. The information would contribute to the body of knowledge and inform policy and practice to support the sustainable growth of agriculture in the region, improve knowledge, and develop inclusive, sustainable agricultural practices worldwide.

Acknowledgements

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. Moreover, the authors would like to acknowledge the University of Southeastern Philippines, Mintal Campus.

Conflict of Interest Statement

The authors declare no conflicts of interest related to this work's research, publication, or funding. Furthermore, they affirm that this research and the conclusions drawn in this article are not influenced by any financial, personal, or professional relationships that could be perceived as potential conflicts of interest. Additionally, they have no affiliations with organizations or entities that may have a direct or indirect interest in the subject matter discussed in this research.

Moreover, the authors acknowledge that transparency and integrity in scientific research are paramount. Therefore, they have provided this conflict of interest statement to ensure the credibility and impartiality of their findings. The authors also commit to promptly disclosing any conflicts of interest that may arise in the future and impact the objectivity of this work.

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References

- ACDI/VOCA 2022 (in press) How a Women's Cooperative is Leading the Way for Specialty Coffee in the Philippines. Accessed at: <https://www.acdivoca.org/2022/10/how-a-womens-cooperative-is-leading-the-way-for-specialty-coffee-in-the-philippines/>
- Ares, A., Thierfelder, C., Reyes, M., Eash, N. S., & Himmelstein, J. (2015). *Global perspectives on conservation agriculture for small households*. In Chan, C. and J. Fantile Lepczyk (Eds) Conservation. Retrieved from https://www.researchgate.net/publication/282824384_Global_perspectives_on_conservation_agriculture_for_small_households
- Anghay, B. L. A., Malubay, M. C., Mano-Pelin, J. J., & Mapayo, A. M. (2024). Exploring the lived experiences of Davao Del Sur rice farmers in using agriculture applications through smartphones. *International Journal of Engineering Technology Research & Management*, Volume 08-01, Retrieved from https://www.academia.edu/114426434/EXPLORING_THE_LIVED_EXPERIENCES_OF_DAVAO_DEL_SUR_RICE_FARMERS_IN_USING_AGRICULTURE_APPLICATIONS_THROUGH_SMARTPHONES?uc-sb-sw=42107915
- ATI, (2023). Drone operation to the participants of the Digital Farmers Program (DFP) 103 for Rice. Accessed at: <https://grainsco.com/a-basic-demonstration-of-drone-operation-was-held-in-davao-del-sur-city/>.
- Batliwala, S. (1994). The meaning of women's empowerment: new concepts from action. Retrieved from <https://www.eldis.org/document/A53502>
- G. Sen, A. Germain, & L. C. Chen (Eds.), *Population Policies Reconsidered: Health, Empowerment, and Rights*. Boston, MA: Harvard Center for Population and Development Studies, 127–138. Retrieved from <https://www.hup.harvard.edu/books/9780674690035>
- Behrman, J. A., Meinzen-Dick, R. S., & Quisumbing, A. R. (2014). Understanding gender and culture in agriculture: The role of qualitative and quantitative approaches. *Gender in Agriculture*, 1(1), 1-10. Retrieved from https://link.springer.com/chapter/10.1007/978-94-017-8616-4_2
- Bond, T., & Templeton, M. R. (2011). History and future of domestic biogas plants in the developing world. *Energy for Sustainable development*, 15(4), 347-354. Retrieved from <https://www.sciencedirect.com/science/article/abs/pii/S0973082611000780>

- Bondad, R. M., Ella, V. B., Saludes, R. B., Reyes, M. R., & Mercado, A. R. Jr. (2015). Simulating the Impact of conservation agriculture on corn yield in the Philippines using the DSSAT CERES-Maize model. *Philippine Agricultural Scientist*, 98(2), 68-79. Retrieved from https://www.researchgate.net/publication/292461939_Simulating_the_Impact_of_Conservation_Agriculture_on_Corn_Yield_in_the_Philippines_Using_the_DSSAT_CERES-Maize_Model
- Buisan, N. (2019). Empowering Poor Women and Men in Building Resilient and Adaptive Communities in Mindanao (EMBRACE Project): End-of-Project Evaluation Report. *Journal of Community Development*, 1(1), 1-10. Retrieved from <https://oxfamilibrary.openrepository.com/bitstream/handle/10546/620947/er-embrace-project-resilient-philippines-010919-en.pdf;jsessionid=D82EE11E17352D94BAAD19495950571E?sequence=1>
- Chuang, J. H., Wang, J. H., & Liou, Y. C. (2020). Farmers' Knowledge, Attitude, and Adoption of Smart Agriculture Technology in Taiwan. *International journal of environmental research and public health*, 17(19), 7236. Retrieved from <https://doi.org/10.3390/ijerph17197236>. Retrieved from <https://pubmed.ncbi.nlm.nih.gov/33022936/>
- DA, (2020). Davao farmers receive machineries and equipment to improve farm productivity. Accessed at: <https://www.da.gov.ph/davao-farmers-receive-machineries-and-equipment-to-improve-farm-productivity/>.
- DA, (2010). DA-Irrigation boosts rice production in Davao del Sur. Accessed at: <https://www.officialgazette.gov.ph/2010/09/28/da-irrigation-boosts-rice-production-in-davao-del-sur/>
- DA, (2022). National Agriculture and Fisheries Modernization and Industrialization Plan 2021-2030: Transforming the Philippine Food System Together. Philippines: DA. Accessed at: <https://faolex.fao.org/docs/pdf/phi214298.pdf>.
- DA-AFID, (2023). Agri machineries, innovations at full throttle in Mech Now Davao '23. Accessed at: <https://www.da.gov.ph/agri-machineries-innovations-at-full-throttle-inmech-now-davao-23/>.
- Dev, D. S., & Manalo IV, J. A. (2023). Gender and adaptive capacity in climate change scholarship of developing countries: a systematic review of literature. *Climate and Development*, 15(10), 829-840. Retrieved from <https://www.tandfonline.com/doi/full/10.1080/17565529.2023.2166781>
- Ella, V. B., Ramirez, R. C., Agulto, E. S., Glaser, S. D., Zhang, Z., & Hermocilla, J. A. C., (2017). Development of wireless sensor network-based water information system for efficient irrigation water management in the Philippines. CHEDPCARI Project Annual Report. Retrieved from <https://iopscience.iop.org/article/10.1088/1755-1315/1038/1/012028/pdf>
- Ella, V. B. (2014). Conservation agriculture for food security in Cambodia and the Philippines: Soil and water resources components. SANREM Annual Report.

- Gasper, D. (1997). Sen's capability approach and Nussbaum's capabilities ethic. *Journal of International Development*, 9(2), 281-302. Retrieved from <https://onlinelibrary.wiley.com/doi/abs/10.1002/%28SICI%291099-1328%28199703%299%3A2%3C281%3A%3AAID-JID438%3E3.0.CO%3B2-K>
- Gervacio, Joan (2012). Agricultural Innovation Processes and Innovation Systems in Rural Davao Region, Philippines. Retrieved from https://www.researchgate.net/publication/370895895_Agricultural_Innovation_Processes_and_Innovation_Systems_in_Rural_Davao_Region_Philippines
- Gonzales, L. A. (2003). Towards Food Security and Rice Self Sufficiency: A Major Development Challenge for the Philippines in the New Millennium. National Academy of Science and Technology Philippines. Retrieved from <https://nast.dost.gov.ph/images/pdf%20files/Publications/Monograph%20Series/NAST%20Monograph%20Series%203.pdf>
- Huyer, S., & Partey, S. (2020). Weathering the storm or storming the norms? Moving gender equality forward in climate-resilient agriculture. *Clim. Change* 158, 1–12. Retrieved from <https://link.springer.com/article/10.1007/s10584-019-02612-5>
- Kabeer, N. (2018). Gender, livelihood capabilities and women's economic empowerment: reviewing evidence over the life course. London: Gender and Adolescence: Global Evidence. (<https://www.gage.odi.org/publication/gender-livelihood-capabilities/>)
- Kenya, N. (2016). *The role of farmer field schools in adoption and adaptation of recommended rice production practices in Mvomero District in Tanzania* (Doctoral dissertation, MSc Thesis, Lilongwe University of Agriculture and Natural Resources-Bunda College). Retrieved from <https://www.ruforum.org/sites/default/files/THESIS-%20KENYA%20.pdf>
- Klerkx, L., Van Mierlo, B., & Leeuwis, C. (2012). Evolution of systems approaches to agricultural innovation. *Farming Systems Research into the 21st Century: The New Dynamic*, 1(1), 457–483. Retrieved from https://link.springer.com/chapter/10.1007/978-94-007-4503-2_20
- Kingiri, A. N. (2013). A Review of Innovation Systems Framework as a Tool for Gendering Agricultural Innovations: Exploring Gender Learning and System Empowerment. *The Journal of Agricultural Education and Extension*, 19(5), 521–541. Retrieved from <https://www.tandfonline.com/doi/abs/10.1080/1389224X.2013.817346>
- Lampayan, R. M., Samoy-Pascual, K. C., Sibayan, E. B., Ella, V. B., Jayag, O. P., Cabangon, R. J., & Bouman, B. A. M. (2015). Effects of alternate wetting and drying (AWD) threshold level and plant seedling age on crop performance, water input, and water productivity of transplanted rice in Central Luzon, Philippines. *Paddy and Water Environment*, 13(3):215-227. Retrieved from <https://link.springer.com/article/10.1007/s10333-014-0423-5>
- Macusi, E. D., Macusi, E. S., Canales, C. M. G., Barboza, A., & Dugal, L. N. (2022). Women's participation and support for the implementation of the closed fishing season in

- Davao Gulf, Philippines. *Marine Policy*, 143, 105133. Retrieved from <https://www.sciencedirect.com/science/article/abs/pii/S0308597X22001804>
- Manasan, R. G. & UNESCAP (2020). Government budget and the sustainable development goals: the Philippine experience. Retrieved from: <https://hdl.handle.net/20.500.12870/1194>.
- MASIPAG National Office, 2023 (in press) Magsasaka at Siyentipiko para sa Pag-unlad ng Agrikultura (MASIPAG) Women Farmers at the Frontline of Boosting Local Economies in Davao Accessed at: <https://masipag.org/2023/10/women-farmers-at-the-frontline-ofboosting-local-economies-in-davao/>
- Menya, J., Banadda, N., & Kiggundu, N. (2019). A review of gender and technologies: case of central Uganda. DOI: 10.15406/mojabb.2020.04.00123
- Official Gazette (1997). Republic Act 8435. "Agricultural and Fisheries Modernization Act of 1997." 22 December 1997. Retrieved from: <https://www.officialgazette.gov.ph/1997/12/22/republic-act-no-8435-s-1997/>
- Miguel, C. B., Sarmiento, J. M. P., Estaña, L. M. B., Limpoco, M. A. A. A., Calag, V. B., Novero, A. U., & Alviola IV, P. A. (2021). Neighborhood Effects in Hybrid Rice Adoption in Davao del Sur, Philippines. *Philippine Journal of Science*, 150. Retrieved from https://philjournalsci.dost.gov.ph/images/pdf/pjs_pdf/vol150no6A/neighborhood_effects_in_hybrid_rice_adoption_in_Davao.pdf
- Nakano, Y., Tsusaka, T. W., Aida, T., & Pede, V. O. (2018). Is farmer-to-farmer extension effective? The impact of training on technology adoption and rice farming productivity in Tanzania. *World Development*, 105, 336-351. Retrieved from <https://www.sciencedirect.com/science/article/abs/pii/S0305750X17304060>
- Niu, C., & Ragasa, C. (2018). Selective attention and information loss in the lab-to-farm knowledge chain: The case of Malawian agricultural extension programs. *Agricultural Systems*, 165, 147-163. Palicte, (2022). Davao Sur irrigator's group diversifies in model farm. Accessed at: <https://www.pna.gov.ph/articles/1180199>.
- Panaligan, N. A. P., Aringo, M. Q., & Ella, V. B. (June, 2022). Assessment of potential for adoption of wireless sensor network technology for irrigation water management of high value crops in the Philippines. *IOP Conference Series: Earth and Environmental Science*, 1038(1), 012027. Retrieved from <https://iopscience.iop.org/article/10.1088/1755-1315/1038/1/012027/pdf#:~:text=Results%20of%20analysis%20of%20survey,a%20high%20return%20on%20investment>.
- Official Gazette (1997). Republic Act No 8435: agriculture and fisheries modernization Act of 1997. *Journal of Law and Legislation*, 1(1), 1-10. Retrieved from <https://www.officialgazette.gov.ph/1997/12/22/republic-act-no-8435-s-1997/>
- Patil, B., & Babus, V. S. (2018). Role of women in agriculture. *International journal of applied research*, 4(12), 109-114. Retrieved from <https://www.allresearchjournal.com/archives/?year=2018&vol=4&issue=12&part=B&ArticleId=5398>

- Quisumbing, A. R., Meinzen-Dick, R., & Malapit, H. (2021). Women's empowerment and gender equality in South Asian agriculture: Measuring progress using the project-level: Women's Empowerment in Agriculture Index (pro-WEAI) in Bangladesh and India. *World Development*, 1(1), 105396. Retrieved from <https://www.sciencedirect.com/science/article/pii/S0305750X21000085>
- Rallonza, M. L. V. (2020). Gender gap in the Philippines: Unraveling women's power. *Business World Online*. <https://www.bworldonline.com/editors-picks/2020/02/10/277908/gender-gap-in-the-philippines-unraveling-womens-power>.
- Rice Sector Strategy RIDC, (2009). Improving rice profitability through increased productivity and better marketing focusing on Tanzania's central corridor. Rural livelihood development company November 2009.pp 34.
- Ngailo, J.A. & Mwakasendo, J & Kisandu, & Mlowe, D & Tippe, Dennis. (2016). Rice Farming in the Southern Highlands of Tanzania: Management Practices, Socio-economic Roles and Production Constraints. *European Journal of Research in Social Sciences* 4(4). Retrieved from <https://www.idpublications.org/wp-content/uploads/2016/04/Rice-Farming-in-the-Southern-Highlands-of-Tanzania-Full-Paper.pdf>
- Rola-Rubzen, M. F., Paris, T., Hawkins, J., & Sapkota, B. (2020). Improving gender participation in agricultural technology adoption in Asia: from rhetoric to practical action. *Applied Economic Perspectives and Policy*, 42(1), 113-125. Retrieved from <https://onlinelibrary.wiley.com/doi/abs/10.1002/aepp.13011>
- Rosas, J. (2014). Irrigation facility improves rice yield in Davao Sur town. Accessed at: Retrieved from <http://prdp.da.gov.ph/irrigation-facility-improves-rice-yield-in-davao-sur-town/>
- Sell, M., & Minot, N. (2018, November). What factors explain women's empowerment? decision-making among small-scale farmers in Uganda. In *Women's Studies International Forum* (Vol. 71, pp. 46-55). Pergamon. Retrieved from <https://giwps.georgetown.edu/resource/what-factors-explain-womens-empowerment-decision-making-among-small-scale-farmers-in-uganda/#:~:text=We%20find%20links%20between%20empowerment,the%20average%20level%20of%20education>
- Tacio H., D. (2023). (in press) Mix mix: Davao del Sur farm proves that diversification is key to sustainable and profitable farming. Retrieved from <https://mb.com.ph/2023/7/7/mix-mix-davao-del-sur-farm-proves-that-diversification-is-key-to-sustainable-and-profitable-farming>
- Tall, A., Kristjanson, P., Chaudhury, M., & Mckune, S. (2014). Who Gets the Information? Gender, Power and Equity Considerations in the Design of Climate Services for Farmers. Copenhagen: CGIAR Climate Change, Agriculture and Food Security Programme. Retrieved from <https://cgspace.cgiar.org/items/97e2060d-00a5-4386-afba-8cdb6b1c9305>

- Tarnate, P. O., Ella, V. B., & Reyes, M. R. (2014). Modeling solute transport in soil under conventional plow-based and conservation agriculture production systems in Claveria, Misamis Oriental, Philippines. *Philippine Agricultural Scientist*, 97(3), 243-251. Retrieved from https://www.researchgate.net/publication/293169595_Modeling_Solute_Transport_in_Soil_under_Conventional_Plow-Based_and_Conservation_Agriculture_Production_Systems_in_Claveria_Misamis_Oriental_Philippines
- Thakur, N. (2023). Women Farmers and Technologies in Agriculture: A Review of Current Practices. In S. Munshi & M. Singh (Eds.), *Women Farmers: Unheard Being Heard*, 1(1), 169-182. Retrieved from https://link.springer.com/chapter/10.1007/978-981-19-6978-2_12
- UNEP (2016) Food Systems and Natural Resources. A Report of the Working Group on Food Systems of the International Resource Panel. Westhoek, H, Ingram J., Van Berkum, S., Özay, L., and Hajer M. Retrieved from <https://www.resourcepanel.org/reports/food-systems-and-natural-resources>
- Wanyama, J. (2016). Profiling agricultural engineering technologies for mechanizing smallholder agriculture in Uganda. *Agricultural Engineering International: CIGR Journal*, 18(4), 40-51. Retrieved from <https://cigrjournal.org/index.php/Ejournal/article/view/3823>
- World Bank. (2024) Employment in agriculture as percentage of total employment. Retrieved from <https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS>

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