

# Empowering smallholder livestock raisers in a changing climate

Low carbon footprint approaches for the Philippines



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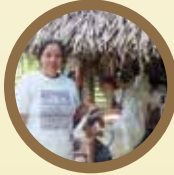
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# Foreword

# Preface

As part of IIRR's work in the Philippines, it engages in several agroforestry and climate-smart agriculture programs in order to help bolster social protections for economically poor families who own small farms that serve as their primary sources of adequate food and nutrition. Its programs seek to help farmers diversify crops in order to both improve their diets, as well as their climate resilience and adaptation. Accordingly, to help better farmers' nutrition and combat food insecurity, IIRR has introduced small livestock – including chickens, ducks, and pigs – to 60 family farming households. This provision has both enabled the farmers to enjoy a more well-rounded diet and has helped garner them additional income. Indeed, 30 of the farmers have earned PHP 4,000 to PHP 28,000 from selling their livestock.

This program has, in turn, sparked questions regarding how to further fortify such farms in the face of climate change, particularly in vulnerable regions like the Philippines. We thus set out to better understand the challenges faced by smallholder farmers raising chickens, ducks, and pigs, as well as possible solutions to enhance these farms' climate resilience by reviewing relevant research highlighting the probable climate impacts on such farms in the Philippines, the particular context of women's struggles in the field given that they are often the primary caretakers of such animals, current management practices by smallholder farms in the Philippines, and possible strategies to mitigate climate impacts given the constraints placed upon smallholder farms in rural areas. Due to the variation in management practices and possible solutions, this paper highlights research performed on smallholder farms in the Philippines.

This paper was prepared with the guidance and support of Julian Gonsalves, Marie Aislinn E. Cabriole, Maita Ordoñez, and Emilita Monville-Oro.

**Marilee Goad**

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# Improving coastal resilience and ecosystem services through biodiversity restoration

## (Guinayangan Municipality, Quezon, Philippines)

This project is supported by the Darwin Initiative, a UK government grants scheme to help protect biodiversity and the natural environment in developing countries. The project initiated in the first quarter of the year 2021 is demonstrating how a small municipality can restore and improve coastal ecological resilience and reduce poverty. Mangrove and coastal ecosystems will be rehabilitated by creating more bio-diverse and multi-strata bio-shields, that support livelihoods and protect local communities from climate change risks. To reduce habitat destruction, fishing communities will be empowered to shift to climate resilient agriculture systems and practices that are gender-sensitive and agro-biodiversity rich. The local government, education sector, and the community are key actors and partners.



# Empowering smallholder livestock raisers in a changing climate



## Introduction

Over 80%, or around 475 million, of the world's farms constitute smallholder systems, utilizing less than 2 hectares of land in their operations, and these supply much of Asia and sub-Saharan Africa, highlighting the essential role such farms play in combating malnutrition and food insecurity.<sup>1</sup> Indeed, the viability of reducing the grave consequences of worldwide malnutrition and hunger depends largely on the fate of smallholder systems, itself bound up inextricably with the impacts of climate change. Yet these systems remain the most vulnerable to climate impacts as a consequence of their geographic locations, socioeconomic and demographic backgrounds, and policies surrounding their lives and labor, as exemplified by smallholder systems in the Philippines whose livelihood depends upon the production of pigs, chickens, and ducks – particularly as run by women.<sup>2,3</sup>

Climate change threatens food security worldwide. With an average temperature increase projected to rise to almost 3°C by the end of the century, exceeding 1.5°C above pre-industrial levels, crop yields may

<sup>1</sup> Shenggen Fan and Christopher Rue, "The Role of Smallholder Farms in a Changing World," in *The Role of Smallholder Farms in Food and Nutrition Security*, ed. Sergio Gomez y Paloma, Laura Riesgo, and Kamel Louhichi (Cham: Springer International Publishing, 2020), 13–28, [https://doi.org/10.1007/978-3-030-42148-9\\_2](https://doi.org/10.1007/978-3-030-42148-9_2).

<sup>2</sup> John F. Morton, "The Impact of Climate Change on Smallholder and Subsistence Agriculture," *Proceedings of the National Academy of Sciences* 104, no. 50 (December 11, 2007): 19680–85, <https://doi.org/10.1073/pnas.0701855104>.

<sup>3</sup> Imee Esguerra et al., *Going Back to Basic: Plant, Raise & Sustain the Chemical Pesticide Free Integrated Backyard Farming*, 2022.

decrease by about 15-20%<sup>4</sup> with an estimated 80 million more people expected to join the 828 million people already suffering from hunger in 2021.<sup>5</sup> Livestock production may face particular challenges through the compounded effect of non-climate related stressors, such as increased population growth, rising incomes, and increased demand for livestock products, which will further exacerbate climate-related pressures, leading to repercussions in availability, access, utilization, and stability of food sources, further undermining food security.<sup>6</sup> While some studies suggest a shift among smallholder systems towards raising livestock in order to combat the precarity of crop production due to the consequences of climate change, they will likely confront increased pressures in the face of both climate and non-climate stressors.<sup>7</sup>

Livestock farming itself plays a critical role in the Philippines' agricultural sector, accounting for approximately 18.23 percent of the the gross output value in agriculture with farms consisting of smallholder or commercial production systems.<sup>8</sup> Estimates suggest smallholders account for 25% of agricultural land in the Philippines<sup>9</sup> and imply millions of backyard farms exist as compared to the 188 officially registered commercial farms.<sup>10</sup>



<sup>4</sup> "Turn Down the Heat: Climate Extremes, Regional Impacts, and the Case for Resilience," Stand Alone Books, world, accessed July 11, 2023, <https://elibrary.worldbank.org/doi/epdf/10.1596/978-1-4648-0055-9>.

<sup>5</sup> <https://www.facebook.com/RFI.English>, "Climate Change Threatens 'truly Terrifying' Future, UN Rights Chief Says," RFI, July 4, 2023, <https://www.rfi.fr/en/international/20230704-climate-change-threatens-truly-terrifying-future-un-rights-chief-says>.

<sup>6</sup> "Chapter 5 : Food Security – Special Report on Climate Change and Land," accessed July 6, 2023, <https://www.ipcc.ch/srcl/chapter/chapter-5/>.

<sup>7</sup> Jacquelyn F. Escarcha et al., "Livelihoods Transformation and Climate Change Adaptation: The Case of Smallholder Water Buffalo Farmers in the Philippines," *Environmental Development* 33 (March 1, 2020): 100468, <https://doi.org/10.1016/j.envdev.2019.100468>.

<sup>8</sup> Ortega et al., "Perspectives of the Livestock Sector in the Philippines."

<sup>9</sup> Object Object, "A Rough Estimate of the Proportion of Global Emissions from Agriculture Due to Smallholders," accessed July 6, 2023, <https://core.ac.uk/reader/132689800>.

<sup>10</sup> Ortega et al., "Perspectives of the Livestock Sector in the Philippines."

Furthermore, though Philippine legislation has attempted to ensure equity between men and women in access to land and other resources, women remain less likely to own the land used or have access to productive resources, such as training, extension services, pest control management, calamity assistance, and financial assistance.<sup>11</sup> If granted the same level of support as their male counterparts, estimates suggest it would increase food production by women in the Philippines of around 25% and total national food production by 1.5 to 3%. This parallels estimates indicating worldwide improved access to productive resources to women smallholders would increase farm yields around the globe by 20 to 30%.<sup>12</sup> Inequitable and insufficient support for women smallholders in the Philippines renders them further susceptible to climate impacts.

Climate change<sup>13</sup> disproportionately impacts the most vulnerable, including rural agrarians in regions most at risk of extreme weather events, such as Southeast Asia and the Philippines in particular. It is essential that future interventions to sustain agriculture and strengthen food security therefore develop adaptation and mitigation measures with the smallholder farmer in mind, highlighting the significance of gender disparities that make women especially vulnerable to climate impacts.

**Note: Smallholder Systems**, also known as small-scale semi-subsistence, or backyard systems, as defined on the basis of population, consist of farms with less than 20 adult animals or less than 41 young animals or a combination of 20 adult and 22 young animals.<sup>14</sup> Commercial production systems are any systems that exceed these numbers. However, myriad definitions exist and have shifted considerably, even as defined by FAO, with the most recent assessments taking into consideration the amount of land available, differing by country-specific definitions (e.g., 42 hectares in Guatemala but 1.2 hectares in Vietnam<sup>15</sup>) with a territorial and socioeconomic assessment. As such, this paper employs the definition more broadly, generally encompassing those farms that have limited land, depend largely upon family labor with limited reliance on temporary hired labor, and the use of agriculture and livestock often intended to sustain family units.

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<sup>11</sup> "Women's Land Rights, Gender-Responsive Policies and the World Bank (Philippines)," Asian Farmers Association for Sustainable Rural Development (blog), June 18, 2015, <https://asianfarmers.org/womens-land-rights-gender-responsive-policies-and-the-world-bank-philippines/>.

<sup>12</sup> "Explainer: Why Women Need to Be at the Heart of Climate Action," UN Women – Headquarters, March 1, 2022, <https://www.unwomen.org/en/news-stories/explainer/2022/03/explainer-why-women-need-to-be-at-the-heart-of-climate-action>.

<sup>13</sup> UNFCCC. 2011. "United Nations Framework Convention on Climate Change." [https://unfccc.int/files/press/backgrounders/application/pdf/press\\_factsh\\_science.pdf](https://unfccc.int/files/press/backgrounders/application/pdf/press_factsh_science.pdf).

<sup>14</sup> Arth David Sol Ortega et al., "Perspectives of the Livestock Sector in the Philippines: A Review," *Acta Agraria Debreceniensis*, June 1, 2021, 175–88, <https://doi.org/10.34101/actaagrar/1/9101>.

<sup>15</sup> Clara Aida Khalil et al., "DEFINING SMALL-SCALE FOOD PRODUCERS TO MONITOR TARGET 2.3. OF THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT," n.d. <https://www.fao.org/3/i6858e/i6858e.pdf>



# Climate change in the Philippines and general impacts on agriculture

The Philippines, an archipelago of more than 7,000 islands, is home to over 109 million inhabitants.<sup>16</sup> The majority of its residents are impoverished and reside in rural areas.<sup>17</sup> It is a mountainous nation with a large agricultural sector situated in Southeast Asia, a region that is home to an ecosystem rife with tropical forests and rich biodiversity, particularly in the “coral triangle” shared by the Philippines and Indonesia.<sup>18</sup> Yet it is also one of the most vulnerable areas to climate impacts, increasingly prone to rising cyclone intensity and sea levels, heat waves, drought, and landslides.<sup>19 20</sup>

According to the Germanwatch Global Climate Risk Index, the Philippines ranks 4th among countries most impacted by climate change from 2000-2019<sup>21</sup> and is expected to withstand some of the most severe disaster risk levels globally with increasing global temperatures and the further intensification of climate change.<sup>22</sup> The increased thermal stress, ocean warming and acidification, and extreme weather

<sup>16</sup> “Philippines Country Profile,” BBC News, November 4, 2011, sec. Asia, <https://www.bbc.com/news/world-asia-15521300>.

<sup>17</sup> “FAOSTAT,” accessed July 25, 2023, <https://www.fao.org/faostat/en/#country/171>.

<sup>18</sup> Shaw, R., Y. Luo, T.S. Cheong, S. Abdul Halim, S. Chaturvedi, M. Hashizume, G.E. Insarov, Y. Ishikawa, M. Jafari, A. Kitoh, J. Pulhin, C. Singh, K. Vasant, and Z. Zhang, 2022: Asia. In: *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 1457–1579, doi:10.1017/9781009325844.012.

<sup>19</sup> Siw Fasting et al., “Climate Governance and Agriculture in Southeast Asia: Learning From a Polycentric Approach,” *Frontiers in Political Science* 3 (2021), <https://www.frontiersin.org/articles/10.3389/fpos.2021.698431>.

<sup>20</sup> Arief Anshory Yusuf, *Hotspots! Mapping Climate Change Vulnerability in Southeast Asia* (IRSA, 2010).

<sup>21</sup> “Cri-2021\_table\_10\_countries\_most\_affected\_from\_2000\_to\_2019.Jpg (4267×2133),” accessed June 30, 2023, [https://www.germanwatch.org/sites/germanwatch.org/files/2021-01/cri-2021\\_table\\_10\\_countries\\_most\\_affected\\_from\\_2000\\_to\\_2019.jpg](https://www.germanwatch.org/sites/germanwatch.org/files/2021-01/cri-2021_table_10_countries_most_affected_from_2000_to_2019.jpg).

<sup>22</sup> World Bank Group and Asian Development Bank, *Climate Risk Country Profile: Philippines* (World Bank, 2021), <https://doi.org/10.1596/36370>.

events exacerbated by climate change threaten both its marine and land inhabitants. Climate change has begun to significantly alter the weather patterns in the region, yielding hotter summers with a decrease in precipitation and consequent increased droughts, as well as changes to monsoon season alongside oceanic oscillations, ocean acidification, and sea level rise. The confluence of extreme weather events and unpredictability thereof have wide-ranging impacts, particularly in its agricultural sector.

Increased flooding alongside water scarcity presents one of the first major challenges to agriculture. According to future projections conducted by the World Food Program (WFP), seasonal rainfall may surpass past averages by around 40% throughout the country, leading to increased frequency and severity with significant impacts on rice and vegetable production.<sup>23</sup> Flooding, alongside elevated temperatures, may create a more hot and humid climate, changing soil composition, and providing a more hospitable environment for certain pests and pathogens with deleterious effects on crops. For instance, rice may suffer increased incidence of fungal and bacterial infections, such as rice sheath blight, rice blast, and bacterial leaf blight. Maize will likely see increased incidence of mycotoxins, harmful to plant, animal, and human health. Banana production will also sustain increased incidence of fusarium wilt and black sigatoka. Heavy rains and flooding remove topsoil, thereby contributing to land degradation and reducing soil fertility, further decreasing crop yield.<sup>24</sup>

Droughts will likewise grow in intensity and gravely impact crop yield. Variability in weather will result in differences between regions, but some regions in the Philippines may expect to endure droughts of up to eleven months.<sup>25</sup> Drought may lead to evotranspiration, inducing a loss of soil moisture and nutrients, reducing its fertility and therefore both crop yield and capacity for smallholder farmers to conduct their livelihoods on said land. Water scarcity can further alter livestock meat and egg shell quality, as well as increase incidence of disease and death.<sup>26</sup>

Heat stress caused by elevated temperatures will also represent a major obstacle, increasing plant disease incidence, altering the geographic distribution of many animal diseases, and leading to significant impacts on plant, animal, and human health. Resulting crops will be of lower quality in terms of nutritional value. Animals suffering from heat stress will experience growth restriction, yield lower quality meat and byproducts, and



<sup>23</sup> "Philippine Climate Change and Food Security Analysis | World Food Programme," November 11, 2021, <https://www.wfp.org/publications/philippine-climate-change-and-food-security-analysis>.

<sup>24</sup> Daniel Assefa Tofu, Teshale Woldeamanuel, and Firafis Haile, "Smallholder Farmers' Vulnerability and Adaptation to Climate Change Induced Shocks: The Case of Northern Ethiopia Highlands," *Journal of Agriculture and Food Research* 8 (June 1, 2022): 100312, <https://doi.org/10.1016/j.jafr.2022.100312.s>

<sup>25</sup> Arnold R. Salvacion, "Mapping Meteorological Drought Hazard in the Philippines Using SPI and SPEI," *Spatial Information Research* 29, no. 6 (December 1, 2021): 949–60, <https://doi.org/10.1007/s41324-021-00402-9>.

<sup>26</sup> Mohamed I. El Sabry et al., "Water Scarcity Can Be a Critical Limitation for the Poultry Industry," *Tropical Animal Health and Production* 55, no. 3 (May 22, 2023): 215, <https://doi.org/10.1007/s11250-023-03599-z>.

decreased reproductive capacity. Indeed, chronic heat stress produces meat that is dark, firm, dry, and more prone to bacterial growth and shedding, thereby decreasing shelf life and presenting food safety concerns.<sup>27</sup> By 2050, average temperatures may reach or exceed 30°C regularly, engendering conditions of heat stress with a huge impact on rural areas dependent on livestock, with projections suggesting those provinces most at risk may include Apayao, Abra, Kalinga, Mountain Province, Ifugao, Benguet, and Nvera Vizcaya, as well as mainland Luzon and the islands of Mindoro.<sup>28</sup>

Future climate predictions suggest areas will shift in favorability regarding rice, maize, and banana production (e.g., Luzon is expected to become more favorable for rice, but not Mindanao). Indeed, certain vegetables, particularly roots and tubers, may increase in production, while cereals may demonstrate greatly reduced production, disrupting food supplies and negatively impacting livestock farmers who rely heavily on cereals for animal feed.

By 2050, projections indicate the livestock sector in the Philippines should grow with an 86% increase in poultry production and a 42% increase in swine production, in part spurring a higher demand for maize production for animal feed from 68% in 2020 to 89% in 2050, demands at odds with the negative trends in both sectors predicted to occur due to climate change impacts.

Those impacts will also spur price volatility, further exacerbated by agricultural instability. Typhoons in the Philippines have already contributed to a rise in inflation of 3.3% with increases in the price of basic goods, including rice and vegetables, fueled in part by food shortages stemming from the impacts of the storms.<sup>29</sup> Projections indicate they will continue to influence economic activity.<sup>30</sup> Rural agrarians will feel the brunt of such economic shocks with climate change impacts rendering some areas nonarable and further exacerbating the widespread poverty already affecting their demographic.

At least 2.4 million of those working in the agricultural sector in the Philippines live below the poverty line, and 63% of the damages caused by extreme weather events from 2010-2019 affected the agricultural industry.<sup>31</sup> Typhoon Rai in December 2021 incurred \$550 million worth of damage to the country, with 420,000 hectares of farmland ruined and



<sup>27</sup> Paula A. Gonzalez-Rivas et al., "Effects of Heat Stress on Animal Physiology, Metabolism, and Meat Quality: A Review," *Meat Science* 162 (April 2020): 108025, <https://doi.org/10.1016/j.meatsci.2019.108025>.

<sup>28</sup> "Philippine Climate Change and Food Security Analysis | World Food Programme."

<sup>29</sup> "November Inflation Quickens to 3.3% as Typhoons Push Food Prices up – PSA," *cnn*, accessed August 9, 2023, <https://www.cnnphilippines.com/business/2020/12/4/November-2020-inflation-PSA.html>.

<sup>30</sup> Eric Strobl, "The Impact of Typhoons on Economic Activity in the Philippines: Evidence from Nightlight Intensity," *SSRN Electronic Journal*, 2019, <https://doi.org/10.2139/ssrn.3590202>.

<sup>31</sup> Rebecca Tan and Regine Cabato, "As Disaster Hits the Philippines Again, a Farmer's Sorrow Reveals the Stakes," *Washington Post*, September 26, 2022, <https://www.washingtonpost.com/world/2022/09/26/philippines-noru-karding-typhoon-climate/>.

390,000 farmers and fishermen left without the sources of their livelihood. Consequent price shocks affect the rural poor the most, many of whom are smallholder farmers. Natural disasters, such as typhoons, also disrupt traffic, thereby hindering access to goods and disrupting supply chains, exacerbating once more any market shocks.

Agricultural instability, propelled by extreme climate events, worsens food insecurity and resource scarcity, which can then provoke violence and conflict. Analyses of conflict-related incidents and seasonal variation in the Philippines suggest a correlation between increased dry-season rainfall and reduced conflict intensity.<sup>32,33</sup> The alternative scenario of seasonal variations associated with damage to crops, such as excessive rains during wet seasons and drier dry seasons, also demonstrated a correlation with increased conflict, particularly as initiated by insurgents. Indeed, prior research has demonstrated an association of increased rates of interpersonal violence and civil conflict with increased temperatures or extreme rainfall.<sup>34</sup> Climate change and conflict further drive livelihood, financial, and agricultural losses that compound economic instability and push many agrarians towards migration, with structural inequalities leading to impacts felt especially strongly by women.<sup>35</sup>

With increasing demand for meat driven by population growth and a rise in income among certain groups, alongside a sector whose practices must morph to accommodate changing environmental conditions, livestock production represents an area especially susceptible to climate change. As described in the 6th IPCC assessment report, however, research remains limited regarding the climate impacts of livestock production more generally and in Southeast Asia and the Philippines in particular.<sup>36</sup> A myriad of non-climate stressors already impact smallholder systems and are likely exacerbated further by climate impacts, blurring the two together in some instances. The interconnectedness of farmers and livestock in the context of smallholder systems creates a dynamic in which the health of both parties is crucial for both the success of the farm and food safety, making it critical to provide them with the tools to adapt to and mitigate the consequences of climate impacts. Any interventions must then employ climate smart agricultural practices.



<sup>32</sup> Benjamin Crost et al., "Climate Change, Agricultural Production and Civil Conflict: Evidence from the Philippines," *Journal of Environmental Economics and Management* 88 (March 2018): 379–95, <https://doi.org/10.1016/j.jeem.2018.01.005>.

<sup>33</sup> Joshua Eastin, "Hell and High Water: Precipitation Shocks and Conflict Violence in the Philippines," *Political Geography* 63 (March 1, 2018): 116–34, <https://doi.org/10.1016/j.polgeo.2016.12.001>.

<sup>34</sup> Solomon M. Hsiang, Marshall Burke, and Edward Miguel, "Quantifying the Influence of Climate on Human Conflict," *Science* 341, no. 6151 (September 13, 2013): 1235367, <https://doi.org/10.1126/science.1235367>.

<sup>35</sup> Alvin Chandra et al., "Gendered Vulnerabilities of Smallholder Farmers to Climate Change in Conflict-Prone Areas: A Case Study from Mindanao, Philippines," *Journal of Rural Studies* 50 (February 1, 2017): 45–59, <https://doi.org/10.1016/j.jrurstud.2016.12.011>.

<sup>36</sup> Intergovernmental Panel On Climate Change (Ipcc), *Climate Change 2022 – Impacts, Adaptation and Vulnerability: Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, 1st ed. (Cambridge University Press, 2023), <https://doi.org/10.1017/9781009325844>.



# Particular impacts felt by women in smallholder systems

The impacts of climate change will pose particular challenges for women as smallholder farmers. The gender disparities that exist globally in terms of access to resources and social capital ensnare women in conditions that make it harder for them both to achieve higher productivity on their farms and to adopt innovative practices for climate change adaptation.<sup>37</sup> Furthermore, as climate change sparks circumstances increasing the precarity and instability of agricultural work and income thereby derived, it has also shifted the composition of its workforce as many men seek work elsewhere, leaving women behind to run the farms.<sup>38</sup> Such a trend suggests the need for a more gender-sensitive approach to climate adaptation policies, which necessitates an understanding of the context in which women operate.

In the Philippines, though they constitute a large part of the agricultural workforce, women often receive less economic and social support as compared to their male counterparts. Indeed, the dominant cultural perception still paints women as farmers' wives rather than farmers themselves.<sup>39</sup> Their contributions to agricultural production and animal husbandry often go unnoticed and undervalued, much of their unpaid labor – including household management and care work like cleaning, cooking, childcare, and other such services – rendered invisible.<sup>40 41</sup> Men still tend to dominate the public sphere of production –

<sup>37</sup> Mary Nyasimi and Sophia Huyer, "Closing the Gender Gap in Agriculture under Climate Change," 2017.

<sup>38</sup> Emily M. L. Southard and Heather Randell, "Climate Change, Agrarian Distress, and the Feminization of Agriculture in South Asia," *Rural Sociology* 87, no. 3 (September 2022): 873–900, <https://doi.org/10.1111/ruso.12439>.

<sup>39</sup> Journal of Environmental Science and Management et al., "Involvement of Women in Farm Decision-Making and Adaptive Capacity to Extreme Events of Farming Households in Ligao City, Albay, Philippines," *Journal of Environmental Science and Management* 21, no. 2 (2018), [https://doi.org/10.47125/jesam/2018\\_2/09](https://doi.org/10.47125/jesam/2018_2/09).

<sup>40</sup> Ashok K. Mishra, Aditya R. Khanal, and Samarendu Mohanty, "Gender Differentials in Farming Efficiency and Profits: The Case of Rice Production in the Philippines," *Land Use Policy* 63 (April 1, 2017): 461–69, <https://doi.org/10.1016/j.landusepol.2017.01.033>.

<sup>41</sup> Mary Harman Parks, Maria Elisa Christie, and Isidra Bagares, "Gender and Conservation Agriculture: Constraints and Opportunities in the Philippines," *GeoJournal* 80, no. 1 (February 1, 2015): 61–77, <https://doi.org/10.1007/s10708-014-9523-4>.

those activities garnering income outside the household – while women are still expected to manage the domestic sphere, or reproductive production.<sup>42</sup> Women therefore face numerous constraints in realizing more potential as farmers.

First and foremost, women have less access to land itself, often gaining access only through their husbands.<sup>43</sup> Even in instances in which women inherit their land from their families, they may opt to transfer it to their husbands, with some suggesting that the ownership itself is not necessarily a priority given that it remains within their family.<sup>45</sup> Legally, restrictions upon such ownership as relates to prior experience with farming, the payment of taxes, and access to credit likewise hinders women from owning more land. Ordinances regarding pasturing animals further restricts the possible livestock ownership of those who do not own sufficient land. Ownership of the land, of course, has implications in terms of decision-making regarding its use. Further, government projects meant to aid smallholder farmers are often directed primarily at men, even when they involve farms run by both men and women.<sup>46</sup>



Though women have relatively equal access to school education as compared to men in the Philippines, they also have less access to opportunities for more agricultural training and extension services, such as attendance of workshops – in part due to domestic obligations, such as raising children, which require others, such as their husbands, to aid in such chores should the women pursue further training.<sup>47</sup> This further enshrines a gendered division in terms of who gains access to agricultural training and to whom such training is targeted.

A gendered division of labor thus exists on farms with women shouldering domestic tasks and agricultural activities considered more suitable for their gender (e.g., planting, weeding). Much of the labor on farms in the Philippines remains non-mechanized, leading to some gender divisions in terms of labor as a consequence of health problems women may experience from hard labor.<sup>48</sup> Raising pigs and chickens, however, constitutes labor deemed acceptable for women as these animals are considered easier to control than larger livestock, such as cattle. In fact, a number of smallholder systems raising pigs and

<sup>42</sup> Joan Ureta et al., *Gender Perspectives in Smallholder Farming Practices in Lantapan, Philippines*, 2015, <https://doi.org/10.5716/WP15726.PDF>.

<sup>43</sup> Harman Parks, Christie, and Bagares, "Gender and Conservation Agriculture."

<sup>44</sup> Sonia Akter et al., "Women's Empowerment and Gender Equity in Agriculture: A Different Perspective from Southeast Asia," *Food Policy* 69 (May 1, 2017): 270–79, <https://doi.org/10.1016/j.foodpol.2017.05.003>.

<sup>45</sup> Harman Parks, Christie, and Bagares, "Gender and Conservation Agriculture."

<sup>46</sup> Esguerra et al., *Going Back to Basic*.

<sup>47</sup> Akter et al., "Women's Empowerment and Gender Equity in Agriculture."

<sup>48</sup> Akter et al., "Women's Empowerment and Gender Equity in Agriculture."

poultry report that women represent the primary caretakers of the animals, feeding them and cleaning their pens, while their husbands typically spend their time on other activities.<sup>49 50</sup>

Though some interviews of farmers throughout the country suggest shared decision-making among men and women in terms of agricultural decisions,<sup>51 52</sup> most studies indicate the sphere of decision-making is highly gendered. Men often make decisions regarding farm management, while women tend to the household, making all decisions related to its operations.<sup>53 54</sup> Yet an evolution in that structure may be at play as the unpredictability inherent to agriculture coupled with a rise in conditions in the Philippines spurred by climate change that have reduced its profitability has also led to an increasing number of men migrating to find other streams of income, including work abroad.<sup>55</sup> The women left behind are thus



<sup>49</sup> Tamsin S. Barnes et al., "Combining Conventional and Participatory Approaches to Identify and Prioritise Management and Health-Related Constraints to Smallholder Pig Production in San Simon, Pampanga, Philippines," *Preventive Veterinary Medicine* 178 (May 1, 2020): 104987, <https://doi.org/10.1016/j.prevetmed.2020.104987>.

<sup>50</sup> Esguerra et al., *Going Back to Basic*.

<sup>51</sup> Akter et al., "Women's Empowerment and Gender Equity in Agriculture."

<sup>52</sup> Rio Maligalig et al., "Off-Farm Employment Increases Women's Empowerment: Evidence from Rice Farms in the Philippines," *Journal of Rural Studies* 71 (October 1, 2019): 62–72, <https://doi.org/10.1016/j.jrurstud.2019.09.002>.

<sup>53</sup> Akter et al., "Women's Empowerment and Gender Equity in Agriculture."

<sup>54</sup> Management et al., "Involvement of Women in Farm Decision-Making and Adaptive Capacity to Extreme Events of Farming Households in Ligao City, Albay, Philippines."

<sup>55</sup> Adam Lukasiwicz, "Migration and Gender Identity in the Rural Philippines," *Critical Asian Studies* 43, no. 4 (December 1, 2011): 577–93, <https://doi.org/10.1080/14672715.2011.623523>.

charged with farm management, though they may seek help from relatives. Many of these women face steep learning curves, having never before run farms. However, the necessity of running the farms themselves changes the decision-makers and therefore the practices adopted by those farms. One woman on a rice farm whose husband sought work abroad revealed that she had devised a plan to raise pigs because she viewed it as more profitable, while her husband had previously invested very little in the expansion of the farm. Other women likewise bought more land, though this was made possible through the money sent home by their husbands. Still, many women left behind described it as a harder role to take on given that they are still expected to manage the domestic sphere, while men are often only asked to be principally responsible for one sphere of production.



Beyond shifts in the dynamics of farm management, climate change may also exacerbate other obstacles women must confront. In the wake of natural disasters, women are at increased risk of gender-based violence and sexual exploitation, especially when displaced, and face inadequate access to healthcare services when pregnant.<sup>56</sup> Intimate partner violence is already a common phenomenon in many rural communities, exacerbated by periods of stress, including economic instability, conflict, disasters, and increased temperatures, which may likewise entail economic abuse that may further hinder women's health and capacity as smallholder farmers.<sup>57 58 59 60</sup> In the event their husbands remain, employment outside of the farm, or more roles within farm management, thus affords women further empowerment and confidence in their decision-making, allowing them access to more self-sufficient means of economic security.<sup>61 62</sup>

Gender-sensitive approaches to climate-smart agriculture must thus take into account the many barriers women encounter as smallholder farmers – including access to land, relevant education, extension services, capital, government support, and protection from violence.

<sup>56</sup> "More Support Needed for Women and Girls in Super Typhoon-Ravaged Philippines | UN News," February 7, 2022, <https://news.un.org/en/story/2022/02/1111392>.

<sup>57</sup> "Partner Violence as a Risk Factor for Mental Health among Women from Communities in the Philippines, Egypt, Chile, and India," accessed September 14, 2023, <https://doi.org/10.1080/15660970412331292351>.

<sup>58</sup> Diddy Antai, Justina Antai, and David Steven Anthony, "The Relationship between Socio-Economic Inequalities, Intimate Partner Violence and Economic Abuse: A National Study of Women in the Philippines," *Global Public Health* 9, no. 7 (August 9, 2014): 808–26, <https://doi.org/10.1080/17441692.2014.917195>.

<sup>59</sup> Yixiang Zhu et al., "Association of Ambient Temperature With the Prevalence of Intimate Partner Violence Among Partnered Women in Low- and Middle-Income South Asian Countries," *JAMA Psychiatry* 80, no. 9 (September 1, 2023): 952–61, <https://doi.org/10.1001/jamapsychiatry.2023.1958>.

<sup>60</sup> Sónia Maria Martins Caridade, Diogo Guedes Vidal, and Maria Alzira Pimenta Dinis, "Climate Change and Gender-Based Violence: Outcomes, Challenges and Future Perspectives," in *Sustainable Policies and Practices in Energy, Environment and Health Research: Addressing Cross-Cutting Issues*, ed. Walter Leal Filho et al., World Sustainability Series (Cham: Springer International Publishing, 2022), 167–76, [https://doi.org/10.1007/978-3-030-86304-3\\_10](https://doi.org/10.1007/978-3-030-86304-3_10).

<sup>61</sup> Rio Maligalig et al., "Off-Farm Employment Increases Women's Empowerment: Evidence from Rice Farms in the Philippines," *Journal of Rural Studies* 71 (October 1, 2019): 62–72, <https://doi.org/10.1016/j.jrurstud.2019.09.002>.

<sup>62</sup> Esguerra et al., *Going Back to Basic*.



# Climate impacts caused and felt by agriculture

It is important to note that livestock, while impacted by climate change, also contribute to the greenhouse gas emissions (GHGs) that lead to an altered climate. Livestock production has led to increased deforestation, soil erosion, water scarcity, air and water pollution, biodiversity loss, and the dissemination of disease.<sup>63</sup>

Pigs and poultry produce large quantities of nitrogen and phosphorus via excretion<sup>64</sup> through feces and urine, adding to an imbalance in the environment with negative impacts on soil structure and composition, thereby altering the makeup of plant species and communities, which further threatens food security.<sup>65</sup> Crop production for the purposes of livestock feed, particularly in terms of commercial feed, contributes to GHGs, as well, but insufficient research renders the degree of impact still uncertain, with estimated ranges from 28-82% of all emissions related to pig and poultry production. Mitigation of impact, then,

involves environmentally sustainable feed and supplements to mitigate nitrogen and phosphorus excretion, such as enzyme supplementation or low-protein diets. Unsanitary conditions or disease likewise increase the environmental impact of livestock production via feed insufficiency and nutrient excretion. However, mitigations may involve opting to raise animals more capable of environmental adaptation under climate change and the consumption of more locally grown food rather than commercial food<sup>66</sup>, which better approximates the conditions already in existence in most smallholder systems in the Philippines – that is, both the use of animals more adaptable to climate change (often native breeds), as well as the use of locally grown food for their consumption.

<sup>63</sup> Wendy M Rauw et al., “Prospects for Sustainability of Pig Production in Relation to Climate Change and Novel Feed Resources,” *Journal of the Science of Food and Agriculture* 100, no. 9 (2020): 3575–86, <https://doi.org/10.1002/jsfa.10338>.

<sup>64</sup> Ines Andretta et al., “Environmental Impacts of Pig and Poultry Production: Insights From a Systematic Review,” *Frontiers in Veterinary Science* 8 (2021), <https://www.frontiersin.org/articles/10.3389/fvets.2021.750733>.

<sup>65</sup> Josep Peñuelas and Jordi Sardans, “The Global Nitrogen-Phosphorus Imbalance,” *Science* 375, no. 6578 (January 21, 2022): 266–67, <https://doi.org/10.1126/science.abl4827>.

<sup>66</sup> Rauw et al., “Prospects for Sustainability of Pig Production in Relation to Climate Change and Novel Feed Resources.”

# Livestock management

## General background

### Pigs

The Philippines ranks among the top producers of pork worldwide with estimates suggesting that smallholder systems comprise over 60% of pigs raised in the Philippines. The industry itself, including commercial producers, represents the second largest contributor to the agricultural sector after rice, providing 60%<sup>67</sup> <sup>68</sup> of the total meat consumption by Filipinos<sup>69</sup>, though a wealth disparity exists in terms of which demographics consume more.<sup>70</sup> It is also a culturally important source of meat with many rural provinces maintaining the tradition of roasting a pig (lechon) to celebrate special occasions.

The majority of smallholder farmers raising pigs are poor rural inhabitants with low educational levels who earn most of their income from crops and at least a quarter of their income from pig production, permitting supplemental income for emergency expenses.<sup>71</sup> <sup>72</sup> <sup>73</sup> They generally depend



<sup>67</sup> Tamsin S. Barnes et al., "Combining Conventional and Participatory Approaches to Identify and Prioritise Management and Health-Related Constraints to Smallholder Pig Production in San Simon, Pampanga, Philippines," *Preventive Veterinary Medicine* 178 (May 1, 2020): 104987, <https://doi.org/10.1016/j.prevetmed.2020.104987>.

<sup>68</sup> Divine Thea C. Bernardes et al., "Biosecurity and Readiness of Smallholder Pig Farmers against Potential African Swine Fever Outbreak and Other Pig Diseases in Baybay City, Leyte, Philippines," *Scientia Agropecuaria* 11, no. 4 (October 2020): 611–20, <https://doi.org/10.17268/sci.agropecu.2020.04.17>.

<sup>69</sup> Dr Laarni Z Cabantac, "Swine Industry Prospect in the Philippines," n.d.

<sup>70</sup> Admin-Phmp, "Pork: Filipinos' Most Favorite Meat - Philippine Morning Post," January 30, 2021, <https://philippinemorningpost.com/pork-filipinos-most-favorite-meat/>.

<sup>71</sup> Jesse Villanueva and Rommel Sulabo, "Production, Feeding and Marketing Practices of Native Pig Raisers in Selected Regions of the Philippines," *Global Advanced Research Journal of Agricultural Science* 7 (December 1, 2018): 383–92.

<sup>72</sup> Barnes et al., "Combining Conventional and Participatory Approaches to Identify and Prioritise Management and Health-Related Constraints to Smallholder Pig Production in San Simon, Pampanga, Philippines."

<sup>73</sup> Professor, College of Agriculture, Laguna State Polytechnic University (Siniloan Campus), Siniloan, Laguna, Philippines. and EdithaR. Perey, "DETERMINANTS OF SUSTAINABILITY OF BACKYARD PIG FARMING IN THE PHILIPPINES.," *International Journal of Advanced Research* 5, no. 4 (April 30, 2017): 1055–64, <https://doi.org/10.21474/IJAR01/3914>.



upon other sources of income, including crop production, such as coconut farming, fishing, and non-farming-related employment.<sup>74</sup> Many smallholder farmers who raise pigs depend upon the income derived from raising pigs to fund their children's education, though some farmers only raise pigs for personal use.<sup>75</sup> <sup>76</sup> The rearing of swine often involves the entire family and does not typically involve hired labor.<sup>77</sup>

Raising pigs offers certain advantages. Given high quality feed, they are superior to cattle, goats, and sheep in terms of efficient meat production, though the same is not true when given lower quality feed.<sup>78</sup>

They also tolerate many different types of feed and eat many crop byproducts, livestock and poultry offal, kitchen leftovers, and grains damaged by rain or wildfire. Their ability to consume forage represents a low-cost feed option, greatly reducing costs in maintaining them.<sup>79</sup> Other advantages include the

fact that sows produce around two litters per year, providing more offspring to raise, and pigs' manure can serve as a fertilizer for crops.

Still, swine production is a capital-intensive activity, with around 70% of the costs devoted to commercial feed and vaccines<sup>80</sup>, and the capacity to see any return on investment obstructed by the time required by pigs to grow at an acceptable rate to be placed on the market (around 3 to 5 months).<sup>81</sup> Commercial feed can prove too expensive for many farmers, its price often driven up through inflation.<sup>82</sup> Lack of access to credit or liquid assets further hinders smallholder farmers' ability to raise pigs, sustain the practice, or reinstate their activity in the wake of natural disasters. Indeed, many farmers cite financial constraints as the key motivator behind cessation of their operations. The WFP has recommended the use of cash-based transfers to help invest in smallholder systems, particularly during extreme climate events in order to sustain livelihoods and bolster food security.<sup>83</sup> Cooperatives may provide another avenue by which to

<sup>74</sup> "Cost-Benefit Analysis of Native Pigs as a Climate-Smart Agriculture Option in the Philippines," July 26, 2021, <https://ccafs.cgiar.org/resources/publications/cost-benefit-analysis-native-pigs-climate-smart-agriculture-option>.

<sup>75</sup> Keshav Lall Maharjan and Carlos C. Fradejas, "A Study of the Problems Confronting the Backyard Pig Raisers in Batangas Province of Southern Luzon," *Journal of Rural Problems* 41, no. 1 (2005): 236–41, <https://doi.org/10.7310/arfe1965.41.236>.

<sup>76</sup> Tarni L. Cooper et al., "Beyond Numbers: Determining the Socioeconomic and Livelihood Impacts of African Swine Fever and Its Control in the Philippines," *Frontiers in Veterinary Science* 8 (2022), <https://www.frontiersin.org/articles/10.3389/fvets.2021.734236>.

<sup>77</sup> "Cost-Benefit Analysis of Native Pigs as a Climate-Smart Agriculture Option in the Philippines."

<sup>78</sup> Admin-Phmp, "Pork."

<sup>79</sup> "Cost-Benefit Analysis of Native Pigs as a Climate-Smart Agriculture Option in the Philippines."

<sup>80</sup> "Cost-Benefit Analysis of Native Pigs as a Climate-Smart Agriculture Option in the Philippines."

<sup>81</sup> Professor, College of Agriculture, Laguna State Polytechnic University (Siniloan Campus), Siniloan, Laguna, Philippines. and Perey, "Determinants of sustainability of backyard pig farming in the Philippines."

<sup>82</sup> Maharjan and Fradejas, "A Study of the Problems Confronting the Backyard Pig Raisers in Batangas Province of Southern Luzon."

<sup>83</sup> "Philippine Climate Change and Food Security Analysis | World Food Programme."

permit the sustainability of smallholder activity, providing credit, as well as improved access to market, education, information, technology (e.g., biogas), and veterinary services.<sup>84,85</sup> Governmental provision of low-interest loans may also help sustain their activity, as well as increased climate finance devoted to smallholder farms, which currently represents a very small portion of climate finance.<sup>86</sup>

Beyond financing, farmers cite low live weight prices from traders, high vaccine prices, disease and lack of technical knowledge and technology as major barriers to pig production.<sup>87,88</sup> Indeed, African Swine Fever and COVID-19 have, through health and economic impacts, negatively affected many farmers' production and led to a decrease in the number of smallholder farmers raising pigs.<sup>89,90</sup> The major hurdles to sustainable and affordable pig raising for the farmers, then, include the impacts of climate change (typhoons, elevated temperatures, drought), the increasing cost of feed and veterinary services and drugs (exacerbated by climate impacts), intensification of production with less suitable land available for production and greater spread of disease, and disease itself.<sup>91</sup> Diarrhea represents one of the most significant disease concerns noted by many farmers.<sup>92</sup> Lastly, studies have consistently shown that many smallholder systems lack adequate education surrounding proper pig husbandry techniques, as well as good record keeping.<sup>93,94</sup>



<sup>84</sup> Maharjan and Fradejas, "A Study of the Problems Confronting the Backyard Pig Raisers in Batangas Province of Southern Luzon."

<sup>85</sup> Professor, College of Agriculture, Laguna State Polytechnic University (Siniloan Campus), Siniloan, Laguna, Philippines. and Perey, "Determinants of sustainability of backyard pig farming in the Philippines."

<sup>86</sup> "Climate Finance Neglects Small-Scale Farmers – New Report," IFAD, accessed August 12, 2023, <https://www.ifad.org/en/web/latest/-/news/climate-finance-neglects-small-scale-farmers-new-report>.

<sup>87</sup> Villanueva and Sulabo, "Production, Feeding and Marketing Practices of Native Pig Raisers in Selected Regions of the Philippines."

<sup>88</sup> Cooper et al., "Beyond Numbers."

<sup>89</sup> Admin-Phmp, "Pork."

<sup>90</sup> "Cost-Benefit Analysis of Native Pigs as a Climate-Smart Agriculture Option in the Philippines."

<sup>91</sup> Cabantac, "Swine Industry Prospect in the Philippines."

<sup>92</sup> Barnes et al., "Combining Conventional and Participatory Approaches to Identify and Prioritise Management and Health-Related Constraints to Smallholder Pig Production in San Simon, Pampanga, Philippines."

<sup>93</sup> Bernardes et al., "Biosecurity and Readiness of Smallholder Pig Farmers against Potential African Swine Fever Outbreak and Other Pig Diseases in Baybay City, Leyte, Philippines."

<sup>94</sup> "Cost-Benefit Analysis of Native Pigs as a Climate-Smart Agriculture Option in the Philippines."



## Poultry: Chickens and ducks

While commercial production systems in the Philippines often concentrate their activities on broiler and layer chickens, smallholder systems primarily focus their operations instead on native chicken and duck production.<sup>95</sup> Many smallholder farmers of native breed chickens in the Philippines opt to raise the animals for their own consumption, relying on other crops, such as chili peppers, gabi, corn, coconut, banana, cassava, tomato, rice, or eggplant, or livestock for their income.<sup>96</sup> <sup>97</sup> However, the sale of eggs, meat, and live chickens may help supplement some farmers' income.<sup>98</sup> Smallholder poultry production systems may thus aid in providing enhanced food security and poverty reduction to lower-income households. Home consumption and slaughter also favors the use of the entire carcass, including organs and bones, which are also rich in nutrients.<sup>99</sup> Poultry may thus strengthen food security in some of the most vulnerable households, particularly as associated costs with raising poultry is among the lowest for livestock.

Since most farmers chiefly rely upon crop production, poultry farmers employ integrated farming systems, which helps protect against price and climate shocks. Many smallholder systems allow their poultry to scavenge for food, so the birds often eat food less fit for human consumption, such as plant seeds, worms, and insects.<sup>100</sup> Their insect consumption aids in pest control and management. They may also use the birds' feces as fertilizer, which can improve soil composition and by extension, crop production.

Barriers to poultry production include inherent low production rates, disease, feed prices, insufficient biosecurity measures, inadequate nutrition, and the costliness or lack of access to veterinary services.<sup>101</sup>

<sup>95</sup> Christie Chang, "Cross-Sector Comparisons of Poultry Production in The Philippines," February 1, 2004.

<sup>96</sup> Michaelito Naldo et al., "SMALL-SCALE NATIVE CHICKEN PRODUCTION SYSTEMS IN MOUNTAIN BARANGAYS OF AYUNGON, NEGROS ORIENTAL, PHILIPPINES" 47 (June 1, 2021): 20–28.

<sup>97</sup> Naldo et al.

<sup>98</sup> Mulugeta Y Birhanu et al., "Smallholder Poultry Production in the Context of Increasing Global Food Prices: Roles in Poverty Reduction and Food Security," *Animal Frontiers* 13, no. 1 (February 1, 2023): 17–25, <https://doi.org/10.1093/af/vfac069>.

<sup>99</sup> J. T. Wong et al., "Small-Scale Poultry and Food Security in Resource-Poor Settings: A Review," *Global Food Security* 15 (December 1, 2017): 43–52, <https://doi.org/10.1016/j.gfs.2017.04.003>.

<sup>100</sup> Wong et al.

<sup>101</sup> Wong et al.

Those farmers raising ducks often do so for balut or penoy, which constitutes 80% of total duck egg production.<sup>102 103</sup>

Balut consists of fertilized duck eggs that are harvested after being artificially incubated for 15 to 18 days, 10 days short of hatching, yielding partially hatched embryos.<sup>104</sup> Penoy comprises the eggs that remain unfertilized from the process. Cooked balut is a popular street food in the country.

The industry is largely dominated by smallholders in part because the birds are relatively low cost to raise, can survive a variety of climates, subsist on diverse types of food, grow faster than chickens, and are largely resistant to many avian diseases, especially Newcastle disease. Excellent foragers, they are highly adaptable and well-suited as free-range animals that can feed on azolla, weeds, pests, such as the invasive golden apple snail, making them useful livestock to have on or near rice paddies. Through their foraging, they are able to help quell weeds and pests in rice paddies, helping to improve food security in production systems threatened by a changing climate. Their feeding behavior also improves soil composition of rice fields. Duck manure can serve as fertilizer and fish feed in fishponds.

Elevated temperatures spurred by climate change have, however, increased disease incidence and decreased productivity rates among ducks with declines in egg laying to 50-60%, subjecting farmers to financial losses.<sup>105</sup> Other constraints on production are similar to those for pigs and chickens – reduced scavenging areas, lack of access to credit, emerging diseases, insufficient technical knowledge, predation, climate impacts, and high costs of and/or limited access to feed, medicine, veterinary services.



<sup>102</sup> Clarita Dagaas and Christie Chang, "The Philippine Duck Industry: Issues and Research Needs," February 1, 2004.

<sup>103</sup> R. Richard Churchil and A. Jalaludeen, "Duck Farming: Opportunities, Constraints and Policy Recommendations," in *Duck Production and Management Strategies*, ed. A. Jalaludeen, R. Richard Churchil, and Elisabeth Baéza (Singapore: Springer Nature, 2022), 617–57, [https://doi.org/10.1007/978-981-16-6100-6\\_16](https://doi.org/10.1007/978-981-16-6100-6_16).

<sup>104</sup> "Time to 'Give a Duck': The Philippines Duck Industry," accessed August 16, 2023, <https://www.thepoultrysite.com/articles/time-to-give-a-duck-the-philippines-duck-industry>.

<sup>105</sup> "Time to 'Give a Duck.'"

# Management

## Breeds chosen

When choosing which types of pigs to raise, smallholder farmers often opt for more native breeds. While exotic breeds of pigs and their crosses tend to be highly productive, indigenous pigs raised in the Philippines, including Abra, Quezon, BAI-Tiaong Black, Kalinga, and Marinduque,<sup>106</sup>

have higher crude protein and ash content, as well as lower calorie levels from fat and cholesterol, yielding a healthier meat.<sup>107</sup> Deforestation, slash and burn systems, and excessive hunting have decreased the number of wild swine, but native breeds have gained popularity among smallholder systems as a consequence of their low input and environmental adaptability, and demand has increased for such meat. Increased demand also stems from a preference for native breeds for lechon, or roasted pig.<sup>108</sup> Native pigs often prove more climate resilient, particularly in their ability to adapt to thermal stress as well as disease resistance, important factors when confronted by increasingly elevated temperatures and an altered climate in the Philippines.<sup>109 110</sup> Exotic pig production tends to overuse both antibiotic and antihelminthic agents, increasing resistance to said agents, while native pigs tend to prove more resistant with many farmers opting to utilize ethnobotany, though the degree to which that is due to the breed or knowledge base of and resources available to the farmer remains unclear.<sup>111</sup> When using crop-livestock integration, feeding pigs with local crop byproducts, and using their manure as fertilizer, native pig production offers less of an environmental impact than the conditions often associated with exotic pig production. The less productive and intensive nature of native pig production does, however, incur more financial risk to those most vulnerable to unpredictable climate impacts.



<sup>106</sup> Cabantac, "Swine Industry Prospect in the Philippines."

<sup>107</sup> Ortega et al., "Perspectives of the Livestock Sector in the Philippines."

<sup>108</sup> Cabantac, "Swine Industry Prospect in the Philippines."

<sup>109</sup> Yoya Vashi et al., "Comparative Assessment of Native, Crossbred and Exotic Pigs during Different Seasons (Winter, Spring and Summer) Based on Rhythmic Changes in the Levels of Serum Cortisol, Lactate Dehydrogenase Levels and PBMC HSP70 mRNA Expression Pattern," *Biological Rhythm Research* 49 (January 11, 2018): 1–10, <https://doi.org/10.1080/09291016.2017.1410019>.

<sup>110</sup> Kadirvel Govindasamy et al., "Thermal Stress-Related Physiological, Behavioral, and Serum Biochemical Responses in Indigenous Pigs Adapted to Eastern Himalayan Region," *Frontiers in Veterinary Science* 9 (2022), <https://www.frontiersin.org/articles/10.3389/fvets.2022.1034635>.

<sup>111</sup> "Does Backyard-Keeping of Native Sows by Smallholders in Quezon, Philippines, Offer Sustainability Benefits Compared to More Intensive Management of Exotic Sow Breeds? - JARTSVol121No1S043.Pdf," accessed August 15, 2023, <https://kobra.uni-kassel.de/themes/Mirage2/scripts/mozilla-pdf.js/web/viewer.html?file=/bitstream/handle/123456789/11510/JARTSVol121No1S043.pdf?sequence=1&isAllowed=y#pageMode=thumbs>.

Native chickens are also popular choices to raise among smallholder poultry producers. Sustainable livestock production necessitates climate resilience among livestock raised, and studies of indigenous chickens suggest<sup>112</sup> an increased resilience and genetic diversity<sup>113</sup> with better adaptability to environmental challenges among native breeds with increased heat tolerance and egg production, as well as better response to water restriction,<sup>114</sup> a correlation cited by a number of smallholder<sup>115</sup> systems in citing their preferences for raising native breeds. Since they have evolved to adapt to the climates in which they reside, these poultry also demonstrate increased disease resistance and ability to scavenge and avoid predators.<sup>116</sup> Native poultry provide high-quality meat and eggs with a rich supply of essential macro- and micronutrients to help enhance nutrition and food security.<sup>117</sup> Conservation of native breeds is paramount, then, for both local ecosystems and climate resilience, offering smallholder farmers better odds at achieving sustainable poultry production. Lastly, for those farmers who sell their poultry, a strong consumer preference exists for the particular taste of native chickens despite an associated increased price compared with exotic breeds.<sup>118</sup>

The most common type of duck selected by smallholder farmers is the native Pateros duck, also known as itik, which has a traditional folk dance dedicated to it.<sup>119</sup><sup>120</sup> Other ducks include the Khaki Campbell, Indian Runner, Tsaiya, Muscovy, and Pekin. Muscovy ducks are particularly good for meat production, excellent scavengers and adapt better than many chickens to hot climates.<sup>121</sup> The native Pateros duck, however, produces large eggs and is more suitable for such production, laying up to 200 eggs annually.



<sup>112</sup> Almas A Gheyas et al., "Integrated Environmental and Genomic Analysis Reveals the Drivers of Local Adaptation in African Indigenous Chickens," *Molecular Biology and Evolution* 38, no. 10 (October 1, 2021): 4268–85, <https://doi.org/10.1093/molbev/msab156>.

<sup>113</sup> Wong et al., "Small-Scale Poultry and Food Security in Resource-Poor Settings."

<sup>114</sup> El Sabry et al., "Water Scarcity Can Be a Critical Limitation for the Poultry Industry."

<sup>115</sup> Naldo et al., "Small-scale native chicken production systems in mountain barangays of Ayungon, Negros Oriental, Philippines."

<sup>116</sup> Wong et al., "Small-Scale Poultry and Food Security in Resource-Poor Settings."

<sup>117</sup> Wong et al.

<sup>118</sup> Dagaas and Chang, "The Philippine Duck Industry."

<sup>119</sup> "Duck Raising."

<sup>120</sup> "Time to 'Give a Duck.'"

<sup>121</sup> Churchil and Jalaludeen, "Duck Farming."



## Feed

Most of the food given to pigs on smallholder farms consists of foraged food and leftovers, which includes such crops as madre de agua, sweet potato, taro (gabi) tubers, banana pulp, water spinach, trichantera, other leafy vegetable greens, carrots, boiled rice and vegetable scraps.<sup>122 123 124</sup> Potatoes are a very common source of nutrition for the pigs, while leafy greens and carrots tend to be offered during the wet season. Some farmers do use commercial feed alongside foraged food, or combination commercial feed with bran (rice, wheat, or corn), and a very small percentage opt to feed their pigs only commercial feed, believing it superior in quality. However, the price of commercial feed can be unstable and high, and foraged food presents a more sustainable form of feed.



Chickens likewise often receive vegetable scraps, such as rice, corn, palay, grated cassava, feed byproducts (rice bran, rice middling), and kitchen leftovers.<sup>125</sup> A few farmers elect to give their poultry commercial feed. Farmers often also provide their chickens with food believed to confer medicinal properties.<sup>126</sup> For instance, the flowers of chili peppers are sometimes fed to chickens as they are believed to offer essential nutrients and other medicinal benefits, such as deworming.

Ducks are often fed rice hull, insects, fish, weed, corn, dried coconut, freshwater snails, and commercial feed.<sup>127 128</sup> As free range animals, they often tend to rely more on foraging for their feed, serving as a lower-cost option as compared to commercial feed and providing a more environmentally-sustainable method of pest management.

<sup>122</sup> "Cost-Benefit Analysis of Native Pigs as a Climate-Smart Agriculture Option in the Philippines."

<sup>123</sup> Jenny-Ann L.M. Lee et al., "A Longitudinal Study of Growing Pigs Raised by Smallholder Farmers in the Philippines," *Preventive Veterinary Medicine* 70, no. 1 (August 12, 2005): 75–93, <https://doi.org/10.1016/j.prevetmed.2005.02.016>.

<sup>124</sup> L.M. Lee et al.

<sup>125</sup> Rogelio Lopez et al., "MANAGEMENT PRACTICES OF NATIVE CHICKEN (*Gallus Gallus Domesticus* Linn.) PRODUCTION IN PALAWAN, PHILIPPINES" 4 (January 1, 2014): 109–20.

<sup>126</sup> Naldo et al., "SMALL-SCALE NATIVE CHICKEN PRODUCTION SYSTEMS IN MOUNTAIN BARANGAYS OF AYUNGON, NEGROS ORIENTAL, PHILIPPINES."

<sup>127</sup> Dagaas and Chang, "The Philippine Duck Industry."

<sup>128</sup> "Time to 'Give a Duck.'"

## Housing

Adequate pig housing is easy to access, with ground or floors that drain well and good ventilation and shade, at a sufficient distance away from residential structures to avoid both odor and disease spread.<sup>129</sup> If they contain floors, concrete floors are easier to clean and thus help reduce disease spread, though are more expensive than earthen floors. In terms of longevity and sustainability, concrete pigpens with GI sheets can endure for up to 10 years, while nipa or bamboo pigpens last for about 3 years.<sup>130</sup>

According to the few studies performed in the Philippines, the majority pen their pigs in some manner with many using pens with concrete floors.<sup>131</sup> <sup>132</sup> Few tether their pigs. A small percentage keep a separate area for piglets. Many kept pigs dwell in close proximity to the family residence, which poses some biosecurity risks.

The majority of chickens in smallholder systems are free range.<sup>133</sup> Some are provided shelter made of bamboo, nipas, and buho. Nesting sheds are also often employed, typically with a roof but no walls.

Though ducks are generally free range, corrals constructed of palm leaves, canvas, bamboo, or netting should be provided to help ward off predators.<sup>134</sup>

In all instances, climate-suitable housing may prove increasingly important to combat heat stress as outlined in the following section.



<sup>129</sup> "Farm Structures ... - Ch10 Animal Housing: Cattle Housing (Pig Housing)," accessed August 14, 2023, <https://www.fao.org/3/S1250E/S1250E13.htm>.

<sup>130</sup> "Cost-Benefit Analysis of Native Pigs as a Climate-Smart Agriculture Option in the Philippines."

<sup>131</sup> Barnes et al., "Combining Conventional and Participatory Approaches to Identify and Prioritise Management and Health-Related Constraints to Smallholder Pig Production in San Simon, Pampanga, Philippines."

<sup>132</sup> L.M. Lee et al., "A Longitudinal Study of Growing Pigs Raised by Smallholder Farmers in the Philippines."

<sup>133</sup> Lopez et al., "MANAGEMENT PRACTICES OF NATIVE CHICKEN (*Gallus Gallus Domesticus* Linn.) PRODUCTION IN PALAWAN, PHILIPPINES  
MANAGEMENT PRACTICES OF NATIVE CHICKEN (*Gallus Gallus Domesticus* Linn.) PRODUCTION IN PALAWAN, PHILIPPINES."

<sup>134</sup> "Time to 'Give a Duck.'"

## Heat stress in pigs

Increased temperatures will likely have significant impacts on pig health and reproduction. Under thermal stress, swine tend to eat less during hot hours and eat more during cool hours with water consumption demonstrating the inverse association, resulting in decreased weight gain and negative reproductive outcomes, including a higher number of stillbirths and lower birth weights.<sup>135</sup> Heat also facilitates intestinal *E. coli* resistance to antibiotic therapy and increases rates of fungal growth in feed, leading to higher incidence of *mycotoxicosis*. Furthermore, rectal temperatures above 43°C lead to death.

Heat stress in pigs significantly alters metabolism and meat production due to the diversion of nutrients in order to maintain a cooler body temperature.<sup>136</sup> The absence of sufficient sweat glands in pigs necessitates their reliance upon changes in respiration, nutrient utilization, and physical activity in order to cool down. Genetic selection favoring animals with phenotypes that lend themselves to increased production traits (e.g., improved milk yield and fertility) result in livestock less well-equipped to handle heat stress, while native breeds are often found to be more adaptable to local conditions.<sup>137</sup>



Heat stress in pigs affects reproductive cycles by changing hormonal secretions and concentrations, impairing oocyte formation,<sup>138</sup> and decreasing fertility, leading to less pregnancies, disrupted pregnancies, and increased fat and altered postnatal immune response<sup>139</sup> among piglets, reducing the quality of meat.<sup>140</sup> Heat stress likewise had adverse effects on intestinal barrier function, with some degree of mitigation of such dysfunction demonstrated via supplementation with supra-nutritional level of yeast selenium (0.5 ppm), vitamin E (100IU/kg), cinnamon, Betaine (1 g/kg), and isoquinone alkaloids.

Housing is both an important challenge and solution to heat stress. Planting trees and shrubs near pig housing provides shade, decreasing direct sunlight and reducing the risks of heat stress.<sup>141</sup> Allowing

<sup>135</sup> Get link et al., "Impacts of Climate Change on Pig," January 4, 2013, <https://www.foodandenvironment.com/2013/01/impacts-of-climate-change-on-pig.html>.

<sup>136</sup> Edith J Mayorga et al., "Heat Stress Adaptations in Pigs," *Animal Frontiers* 9, no. 1 (January 3, 2019): 54–61, <https://doi.org/10.1093/af/vfy035>.

<sup>137</sup> Somsy Xayalayath and Jozsef Rátky, "REPRODUCTIVE PERFORMANCE OF INDIGENOUS PIG BREEDS IN SOUTHEAST ASIA -A REVIEW," May 11, 2021.

<sup>138</sup> Sanghoon Lee et al., "Heat Stress Impairs Oocyte Maturation through Ceramide-Mediated Apoptosis in Pigs," *The Science of the Total Environment* 755, no. Pt 1 (February 10, 2021): 144144, <https://doi.org/10.1016/j.scitotenv.2020.144144>.

<sup>139</sup> Jay S. Johnson et al., "In Utero Heat Stress Alters the Postnatal Innate Immune Response of Pigs," *Journal of Animal Science* 98, no. 12 (December 1, 2020): skaa356, <https://doi.org/10.1093/jas/skaa356>.

<sup>140</sup> F. Liu et al., "Review: What Have We Learned about the Effects of Heat Stress on the Pig Industry?," *Animal, Manipulating Pig Production XVIII: Proceedings of the Eighteenth Biennial Conference of the Australasian Pig Science Association (APSA)*, 15-18 November 2021, Brisbane, Australia, 16 (June 1, 2022): 100349, <https://doi.org/10.1016/j.animal.2021.100349>.

<sup>141</sup> "Pig Housing: Avoiding Heat Stress - Dlg.Org," accessed August 13, 2023, <https://www.dlg.org/en/agriculture/topics/dlg-agrifuture-magazine/knowledge-skills/pig-housing-avoiding-heat-stress>.

pigs more floor space may correlate with decreased pregnancy loss. Though many pigs may be allowed to roam free, penned areas with adequate shade and water help mitigate both heat stress and disease spread.<sup>142</sup> The provision of shade via semi-covered pens, as well as the use of sprinklers, may further reduce heat stress, though earthen floors, as opposed to concrete, may prove more difficult to clean and therefore keep sanitary.

## Heat stress in poultry

Heat stress in poultry yields alterations in body temperature, reproductive cycles and fertility rates, egg shell quality, immune systems, quality of meat, and increased mortality rates.<sup>143</sup> Decreased food intake due to heat stress results in lower weight gain and decreased egg production.<sup>144</sup> It also may lead to altered colonization rates by bacteria, such as *Salmonella* and *Campylobacter*, with implications for food security, although the degree to which it may be a concern remains unknown.

Management of heat stress includes improved housing, such as litter rearing systems (LRS), cage rearing systems (CRS), and perforated plastic slate rearing systems (PSRS). LRS have proven more popular in lower- and middle-income countries and provide laying hens better conditions for improved immune responses and lower rates of infection. Ventilation and cooling systems likewise may aid in management, though pose challenges for smallholder systems in terms of cost and infrastructure. Adequate floor space for birds, reduction in bird density, grass and tree cover around housing structures, roofs of 10-12 m heights, and insulation may further reduce heat intensity.<sup>145</sup>

Beyond housing, nutritional supplementation, including the provision of cool drinking water and electrolyte solutions ameliorate heat stress.<sup>146</sup> The utilization of water containers less prone to leaking will also prove instrumental in increasing water consumption and combating water scarcity.<sup>147</sup> Supplementation with vitamins, including vitamins A, C and E, may also improve fertility and egg quality. Probiotics or



<sup>142</sup> "Farm Structures ... - Ch10 Animal Housing: Cattle Housing (Pig Housing)."

<sup>143</sup> Lucas J. Lara and Marcos H. Rostagno, "Impact of Heat Stress on Poultry Production," *Animals : An Open Access Journal from MDPI* 3, no. 2 (April 24, 2013): 356–69, <https://doi.org/10.3390/ani3020356>.

<sup>144</sup> Akshat Goel, "Heat Stress Management in Poultry," *Journal of Animal Physiology and Animal Nutrition* 105, no. 6 (2021): 1136–45, <https://doi.org/10.1111/jpn.13496>.

<sup>145</sup> G. D. Vandana et al., "Heat Stress and Poultry Production: Impact and Amelioration," *International Journal of Biometeorology* 65, no. 2 (February 1, 2021): 163–79, <https://doi.org/10.1007/s00484-020-02023-7>.

<sup>146</sup> Goel, "Heat Stress Management in Poultry."

<sup>147</sup> El Sabry et al., "Water Scarcity Can Be a Critical Limitation for the Poultry Industry."

Betaine<sup>148</sup>, a compound found in plants, animals and microorganisms, may help combat heat stress via the fostering of favorable intestinal microbiota. The absence of sweat glands in birds leads them to rely more on panting to help cool their body temperature, which conflicts with their ability to eat, so shifting feeding times to cooler hours may also increase food intake during hot periods.

Lastly, the selection of breeds that are more heat-resistant<sup>149</sup>, often represented by native breeds<sup>150</sup>, improves adaptability and survival rates. Early heat conditioning of chicks, a practice in which young birds are exposed to high temperatures (36-38°C) at an age of 24 hours to 5 days, likewise aids in improving heat tolerance and reducing mortality.<sup>151</sup>

Heat stress in ducks presents very similarly to heat stress in chickens with many similar recommended solutions.<sup>152</sup>

## Biosecurity measures

Deworming and vaccination remain prime opportunities to protect livestock and people from disease, but access to veterinary services or the funds to afford such measures remain limited among smallholder systems.<sup>153</sup> Vaccination and deworming rates therefore remain very low among smallholder systems.<sup>154</sup> When possible, vaccination helps to drastically decrease disease incidence, particularly among smallholder systems whose livestock populations are among the most vulnerable to outbreaks, and serves a vital role in helping diminish the economic losses caused by outbreaks, public health threats created, and zoonotic potential of many diseases.<sup>155</sup> Many farmers are aware of the benefits of vaccination, but cite access and cost as the major hindrances to pursuing vaccination in their livestock. Successful vaccination programs must then educate farmers and widely publicize dates when vaccinations are offered, taking into account seasonal



<sup>148</sup> S. O. Park and W. K. Kim, "Effects of Betaine on Biological Functions in Meat-Type Ducks Exposed to Heat Stress," *Poultry Science* 96, no. 5 (May 1, 2017): 1212–18, <https://doi.org/10.3382/ps/pew359>.

<sup>149</sup> Vandana et al., "Heat Stress and Poultry Production."

<sup>150</sup> Francesco Perini et al., "Emerging Genetic Tools to Investigate Molecular Pathways Related to Heat Stress in Chickens: A Review," *Animals* 11, no. 1 (January 2021): 46, <https://doi.org/10.3390/ani11010046>.

<sup>151</sup> Vandana et al., "Heat Stress and Poultry Production."

<sup>152</sup> Mohamed F A Farghly et al., "Ameliorating Deleterious Effects of Heat Stress on Growing Muscovy Ducklings Using Feed Withdrawal and Cold Water," *Poultry Science* 98, no. 1 (January 1, 2019): 251–59, <https://doi.org/10.3382/ps/pey396>.

<sup>153</sup> Bernardes et al., "Biosecurity and Readiness of Smallholder Pig Farmers against Potential African Swine Fever Outbreak and Other Pig Diseases in Baybay City, Leyte, Philippines."

<sup>154</sup> L.M. Lee et al., "A Longitudinal Study of Growing Pigs Raised by Smallholder Farmers in the Philippines."

<sup>155</sup> George M. Warimwe et al., "Using Cross-Species Vaccination Approaches to Counter Emerging Infectious Diseases," *Nature Reviews Immunology* 21, no. 12 (December 2021): 815–22, <https://doi.org/10.1038/s41577-021-00567-2>.

variations in climate and risk of diseases, agricultural activity, and local holidays.<sup>156</sup> The free and easily accessible provision of vaccinations leads to the highest percentage of livestock vaccinated in smallholder systems, which benefits from government support and can be aided by international organizations.<sup>157</sup>

Deworming helps curb parasitic infections among livestock, which threaten both animal and human health. Smallholder systems often elect not to use antihelmintics, or traditional deworming agents, due to cost and accessibility, and increasing antihelmintic resistance, particularly as exacerbated via climate change impacts, obstructs their capacity to act as useful control measures.<sup>158</sup>

Ethnoveterinary practices, or the use of medicinal plants as recommended by indigenous knowledge, may serve as measures to help control parasitic infection. Many smallholder systems in the Philippines have already adopted such practices, using plants such as *Areca catechu* (or betel nut) and *Leucaena leucocephala* (ipil-ipil) seeds to deworm poultry, or supplementing feed with plants they believe to help deworm animals, such as the flowers of chili peppers.<sup>159</sup>  
<sup>160</sup> <sup>161</sup> It is important to note that antihelmintic agents are themselves plant derivatives or the synthetic analogues of plant compounds.<sup>162</sup> While some research has tried to gauge the efficacy of ethnobotanical material for deworming, many have focused on in vitro rather than in vivo studies and have demonstrated limited reduction in worms. Some research has shown a degree of efficacy in using plants to combat parasitic infection. For instance, in vivo studies of the use of Pineapple (*Ananas cosmosus*) Fruit Peeing Juice, extract of korolla fruit, ipil-ipil, betel nut, papaya, garlic, oregano, turmeric, and pumpkin seeds suggest they help reduce



<sup>156</sup> Andy Hopker et al., "Livestock Vaccination Programme Participation among Smallholder Farmers on the Outskirts of National Parks and Tiger Reserves in the Indian States of Madhya Pradesh and Assam," PLOS ONE 16, no. 8 (August 27, 2021): e0256684, <https://doi.org/10.1371/journal.pone.0256684>.

<sup>157</sup> Meritxell Donadeu et al., "Strategies to Increase Adoption of Animal Vaccines by Smallholder Farmers with Focus on Neglected Diseases and Marginalized Populations," PLOS Neglected Tropical Diseases 13, no. 2 (February 7, 2019): e0006989, <https://doi.org/10.1371/journal.pntd.0006989>.

<sup>158</sup> Christian W. Sauermaun et al., "Climate Change Is Likely to Increase the Development Rate of Anthelmintic Resistance in Equine Cyathostomins in New Zealand," International Journal for Parasitology. Drugs and Drug Resistance 14 (December 2020): 73–79, <https://doi.org/10.1016/j.ijpddr.2020.09.001>.

<sup>159</sup> Lopez et al., "MANAGEMENT PRACTICES OF NATIVE CHICKEN (*Gallus Gallus Domesticus* Linn.) PRODUCTION IN PALAWAN, PHILIPPINES."

<sup>160</sup> Naldo et al., "SMALL-SCALE NATIVE CHICKEN PRODUCTION SYSTEMS IN MOUNTAIN BARANGAYS OF AYUNGON, NEGROS ORIENTAL, PHILIPPINES."

<sup>161</sup> "Medicinal Plants Used as Dewormers of Animals," Philstar.com, accessed August 17, 2023, <https://www.philstar.com/business/agriculture/2004/09/19/265208/medicinal-plants-used-dewormers-animals>.

<sup>162</sup> John B. Githiori, Johan Höglund, and Peter J. Waller, "Ethnoveterinary Plant Preparations as Livestock Dewormers: Practices, Popular Beliefs, Pitfalls and Prospects for the Future," Animal Health Research Reviews 6, no. 1 (June 2005): 91–103, <https://doi.org/10.1079/AHR2005099>.



and ducks often mingle with other flocks and wild birds, increasing exposure to disease, but vaccination and education may help reduce, though not eliminate, disease incidence.<sup>172</sup> It is important to note that containment of the animals runs counter to the nature of their free range behavior and benefits of their scavenging activity.

Food and water management is also an important measure to take into consideration. The use of swill feeding, or food waste that may contain uncooked meat, remains a common practice, despite the fact that consumption of uncooked meat or byproducts increases incidence of disease among livestock.<sup>173</sup> Clean food and water containers are also vital in preventing transmission of disease and halting bacterial and fungal growth, though poultry and ducks may drink from local, untreated water sources, again precluding the possibility of ensuring clean sources of water.<sup>174</sup>

The nitrogen, phosphorus, and potassium content of livestock excrement appeals to farmers as a crop fertilizer<sup>175</sup> but poses biohazard risks in mitigating disease spread. Many employ improper waste disposal techniques, often burying waste in holes close to pens, using chemicals to disguise the odor. Some farmers also dispose of waste in local rivers and canals<sup>176</sup>, exacerbating environmental impact by pig production, as well as impacting animal and human health via potential disease spread.<sup>177</sup> Biogas represents a possible method to dispose of waste that may aid in both mitigating



disease spread and reducing GHGs.<sup>178</sup> Made from a combination of livestock and food waste, it does require investment in infrastructure and technical knowhow, but may aid greatly in mitigating disease spread and decreasing pollution caused by livestock waste.<sup>179 180 181</sup>

<sup>172</sup> Peter L. M. Msoffe et al., "Implementing Poultry Vaccination and Biosecurity at the Village Level in Tanzania: A Social Strategy to Promote Health in Free-Range Poultry Populations," *Tropical Animal Health and Production* 42, no. 2 (February 1, 2010): 253–63, <https://doi.org/10.1007/s11250-009-9414-8>.

<sup>173</sup> Kedkovid, Sirisereewan, and Thanawongnuwech, "Major Swine Viral Diseases."

<sup>174</sup> Anne Conan et al., "Biosecurity Measures for Backyard Poultry in Developing Countries: A Systematic Review," *BMC Veterinary Research* 8, no. 1 (December 7, 2012): 240, <https://doi.org/10.1186/1746-6148-8-240>.

<sup>175</sup> Maharjan and Fradejas, "A Study of the Problems Confronting the Backyard Pig Raisers in Batangas Province of Southern Luzon."

<sup>176</sup> Barnes et al., "Combining Conventional and Participatory Approaches to Identify and Prioritise Management and Health-Related Constraints to Smallholder Pig Production in San Simon, Pampanga, Philippines."

<sup>177</sup> Professor, College of Agriculture, Laguna State Polytechnic University (Siniloan Campus), Siniloan, Laguna, Philippines. and Perey, "DETERMINANTS OF SUSTAINABILITY OF BACKYARD PIG FARMING IN THE PHILIPPINES."

<sup>178</sup> Justyna Kwaśny, Zygmunt Kowalski, and Marcin Banach, "Disposal Methods and Treatment of Wastes from Piggeries," *Chemik Science-Technique-Market* 67 (January 1, 2011): 687–96.

<sup>179</sup> Kwaśny, Kowalski, and Banach.

<sup>180</sup> "6. Livestock House and Biogas System," accessed August 17, 2023, <https://www.fao.org/3/t4470e/t4470e09.htm>.

<sup>181</sup> M. L. Rundengan et al., "The Potential of Biogas Production Based on Pig Waste in Minimizing Environmental Pollution," *AIP Conference Proceedings* 2628, no. 1 (June 5, 2023): 120006, <https://doi.org/10.1063/5.0152753>.

Lastly, the common, if incorrect, disposal of carcasses, such as near waterways, also increases risk of disease spread.<sup>182</sup> In fact, one of the most important biosecurity measures regarding ducks is the proper disposal of carcasses, which must be burned or buried rather than thrown away in water sources in order to avoid contagion via disease, such as viral enteritis.<sup>183</sup>

## Discussion

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Smallholder systems involved in raising pigs, chickens, and ducks are integral to food security and women's empowerment in rural communities in the Philippines. As animals that can forage and feed off of household leftovers or crops not used for human consumption, pigs, chickens, and ducks have the potential to provide a means to produce lower-cost livestock with high nutritional value and benefit to a farm's ecosystem, even offering a means of natural pest control. Still, they are not without their disadvantages and challenges, almost all of which will be exacerbated by the effects of climate change. In order to best guard against those impacts, then, it is vital to outfit farmers with the proper tools to allow them the capacity to use climate resilient practices so that they might protect their livelihoods and food security as much as possible.

Anticipatory action is key in mitigating the effects of climate change. Elevated temperatures require measures to protect against heat stress, including improved housing structures for animals offering sufficient shade whether through roofs or tree cover, ventilation, access to water, shifted feeding schedules to cooler hours, and the use of native breeds more adaptable to heat. To confront the possibility of drought, early warning systems and seasonal monitoring may allow for better decision-making among farmers regarding coping strategies and the use of cash transfers when drought triggers are noted.<sup>184</sup> Early warning systems and evacuation of people and livestock are likewise imperative in the face of typhoons. Early harvests and cash transfers given before the typhoon makes landfall may also help ease the economic burden for smallholder farmers.<sup>185</sup> Such strategies must also take into account the obstacles women often face in accessing such resources.

Diversification of income is also an important tool. Interventions such as the provision of seeds for crops capable of withstanding dry conditions may help foster said diversification, especially among farmers unable to otherwise afford other avenues to diversify their income.<sup>186</sup> It is important to note that drought

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<sup>182</sup> Cooper et al., "Beyond Numbers."

<sup>183</sup> Churchil and Jalaludeen, "Duck Farming."

<sup>184</sup> "Anticipatory Action for Climate Shocks | World Food Programme," April 11, 2023, <https://www.wfp.org/anticipatory-actions>.

<sup>185</sup> "Anticipatory Action in Practice: Acting Early Ahead of Typhoons in the Philippines," Anticipation Hub, accessed August 14, 2023, <https://www.anticipation-hub.org/download/file-3295>.

<sup>186</sup> "Anticipating Crises to Support Farming Communities in the Philippines," Food and Agriculture Organization of the United Nations, accessed August 14, 2023, <http://www.fao.org/fao-stories/article/en/c/1298992/>.



may also lead to an increase in conflict, further requiring anticipatory action, and may increase violence against women, making both the women running farms and their animals more vulnerable to further damage.

Crop integration systems with more heat-resistant plants, as well as those with ethnobotanical properties, may help smallholder farmers better adapt to changing climates and find low-cost feed options for their livestock, permitting them more sustainable measures to feed their animals when confronted with rising inflation rates, the high cost of commercial feeds, crop failures leading to difficulty in accessing outside feed, and disruptions to supply chains. Choosing livestock and crops that are mutually beneficial in terms of production (e.g., ducks in rice paddies) will help create more environmentally sustainable conditions with improved yields. Education and awareness surrounding crop integration systems, as well as appropriate biosecurity measures, will prove essential in helping farmers adapt to conditions. It is especially imperative to target women with such training, disseminating information about training events appropriately and considering measures to best afford them access, such as hosting events in spaces that allow for childcare. The formation of cooperatives may provide another avenue by which farmers could access the resources to adopt such systems with the improved provision of capital, tools, and training.

As the primary caretakers of pigs and poultry on farms in the Philippines, women must be considered first in any of these measures with an understanding that they typically lag behind their male counterparts in terms of access to land, capital, and training. To adequately address climate adaptation in these communities, then, measures must include a gender-sensitive approach rooted in knowledge of local cultural practices.





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**As climate change impacts grow more intense and decision makers seek ways to help vulnerable communities adapt, there are growing calls for the climate response to move from incremental to more far-reaching transformative change. Transformative adaptation tackles the root causes of vulnerability, increases climate resilience and mitigates the dangers of maladaptation. Yet transformative adaptation also poses a challenge for researchers, development practitioners, and policy-makers because it requires inter- and transdisciplinary approaches that build on local knowledge and institutions to forge pathways for systemic change. Furthermore, while innovative technological interventions are critical, it is the enabling social, institutional, and governance environment that drives the transformative process.**

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