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主　論　文　の　要　旨

論文題目	Evolution of the Smallholder Swine Production in the Philippines: Catch Up with Green Growth? (フィリピンにおける小規模養豚の展開：グリーン成長できるか)
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論　文　内　容　の　要　旨

The dissertation is structured into seven chapters, and is summarized as follows:

Chapter 1:　Introduction

Green growth (key aspects: low pollution, social inclusion, and resource efficiency) is a path to economic growth that makes use of natural assets or resources in a sustainable manner. The swine sector in the Philippines is a vital source of economic growth. However, swine farm production, as generally practiced, is not environmentally sustainable. It features that 64 percent of swine farms are smallholders, while 36 percent being commercial farms. It is still said that swine production causes serious environmental problems. Therefore, there is a need to incorporate environmental impacts into productivity growth evaluation.

In response to the problem statements, three objectives of the dissertation are:

To determine the environmental productivity growth in swine production. (Chapter 4)

To examine factors affecting environmental productivity in swine production. (Chapter 5)

To examine a spectrum of constraints to the implementation of environmental regulatory policies that increase the environmental productivity of smallholder swine farms and recommend potential solutions. (Chapter 6)

Chapter 2: Literature Review

Based on the literature covered by this study, there are research gaps to livestock production in general, and swine production in particular on determining environmental productivity of swine farms.

Few published papers had taken the undesirable input effects into productivity change analysis, particularly in the study of the livestock sector. Since literature on using the Malmquist Total Factor Productivity Index for environmental impacts in agricultural studies is relatively limited, this dissertation contributes to the literature on using the Malmquist Productivity Index

(MPI) in three ways: 1) it attempts to incorporate undesirable inputs into productivity change measurement by introducing new environmental factors such as biological oxygen demand and nitrogen and phosphorus loadings from swine waste; 2) it applies input-oriented MPI that incorporates environmental impacts to a balanced panel data and includes a comparison of swine farms according to scale and production arrangement 3) no micro-level study has yet investigated this aspect and none so in the context of green growth.

Although constraints to mainstreaming green growth in terms of innovation, adoption, and dissemination of green technology have been looked into by some studies, these constraints were not examined in an integrated manner.

Chapter 3: Features of Swine Production in the Philippines

The trend over the past two decades indicates that swine production could be moving more toward farrow-to-finishing[1] and grow-to-finishing types of production systems. On the other hand, the trend in animal inventory shows a scaling up of production with the increasing share of commercial swine farms (36 percent) and the decreasing share of smallholder swine farms (64 percent). Contract farming has emerged to be an institutional innovation with respect to production arrangement. All these changing structures in swine production have implications on challenges for achieving green growth because of the intensity in inputs and increase in waste generated from the increase in animal population. In terms of swine waste disposal and treatment, only 50 percent to 60 percent of swine farms then and now have installed biogas digesters and lagoons because these waste treatment facilities are costly, swine farms may not have access to information regarding cheaper waste treatment facilities, or environmental regulations are not strictly implemented and so swine farms do not have incentive to adopt technologies to reduce or minimize waste.

Chapter 4: Determining Environmental Productivity Growth in Philippine Swine Production

The dissertation used the only systematic and comprehensive data set on swine production that was collected in 2002 by Costales et al. (2003) in their survey of 100 smallholder and commercial swine farms in the top two swine-producing regions in the Philippines: Central Luzon and South Luzon. A verification survey on the continued existence of swine farms that were interviewed in 2002 was conducted by the author from May to July, 2015 using the same 2002 survey instrument. However, only 40 out of the target 100 original swine farms in Central Luzon and South Luzon were still around and still raising pigs. The 40 sample swine farms in the period of 2002 and 2015 form the balanced panel data set of this dissertation.

To achieve the first objective of this dissertation, the MPI non-parametric approach is used through the Data Envelopment Analysis. Main finding is that in the period of 2002 to 2015, only one-third of 40 sample swine farms experienced environmentally sensitive productivity growth at

[1] Farrow-to-finishing (FF) production system raise swine animals of up to ~90 -110 kg per head. Grow-to-finishing (GF) production system does not have sows in the herd since swine farms only purchase or acquire weanlings that they will raise up to ~40 - 60kg or up to ~90 -110kg per head.

the frontier. This was largely the result of efficiency improvements rather than technological improvements. Thus, the environmentally sensitive productivity growth had declined. Seventy percent of the 40 sample swine farms, especially small independent swine farms, seemed to be constrained in gaining access to available technological innovations that can increase their productivity growth level.

Chapter 5: Changing Structure of Philippine Swine Production and Green Growth

Based on two OECD-proposed green growth indicators - i.e., environmental and resource productivity of the economy and the natural asset base -, the Nutrient Mass Balance Calculation Approach is used to estimate organic nitrogen (N) and phosphorus (P) loadings that can be potentially assimilated by swine farms through crop production. Based on the results of process for choosing specific form of panel data model, the Random Effects Model regression is used to examine the effects of factors such as changing structure of swine production and green technology on the two green growth indicators. The 40 sample swine farms incurred negative N and P nutrient balances implying there is still environmental pollution because cropland to assimilate nutrients is insufficient. Absence or lack of technology and markets transforming swine manure into useful by-products that lower nutrient balances of swine farms is vital implication. Results of REM model regressions on factors affecting green growth indicators – N, P, and BOD (Biological Oxygen Demand) loading – confirm the crucial role of green technology such as waste treatment facilities (WTFs) to reduce the level of green growth indicators. Contract swine farms, relative to independent swine farms, generated significantly lower levels of BOD loading. Thus, production arrangement has some influence on the level of green growth indicators. Commercial swine farms contributed to higher levels of pollution due to larger volume of waste generated by larger herd size. However, with the presence of waste treatment facilities, which is a modifying variable in interaction terms of the regressions, commercial swine farms are actually associated with lower levels of N loading. Results of interaction of WTP with production arrangement and livestock training in REM model regressions point to further empirical investigation. This is in order to confirm the interplay of access to information, green technology, and assistance of extension workers by swine farmers as crucial factors that can significantly influence the levels of green growth indicators.

Chapter 6: Mainstreaming Green Growth in Philippine Swine Production: Constraints and Potential Solutions

The Impact Pathway Approach modified from Catelo et al. (2015) is used to trace the route(s) by which environmental regulatory policy related to green growth would take to reach smallholder swine farms.

Institutional, social, and technical constraints

The Laguna Lake Development Authority (LLDA) Board Resolution (BR) No. 169 or "Approving the Policy Guidelines Governing the Operation of Backyard/Small-Scale Hog Farms in the Laguna De Bay Region" is a public sector-led program. The measure of 'output' is according to their internally defined scope of work or perceived targets. If implementers view their work as

monitoring environmental compliance by industrial and commercial firms (and farms) and by waste-emitting households, and consider smallholder swine farms as insignificant contributors to lake water pollution, then smallholder swine farms are shut out of the picture. In this institutional set-up, even if smallholder swine farms have the willingness to try some innovations, the organization tasked to disseminate the innovation has no incentive to do so. Therefore, the implementation of LLDA BR No. 169 will fail.

The Promotion of Biogas Digester as stipulated in the Bureau of Animal Industry (BAI) Administrative Order No. 2 or the National Animal Waste Resource Management Program (NAWRMP) of 2015 is a public sector-led program. The technologies, both the first-generation and second-generation biogas digesters, were lifted from existing models, form, and scale and were still indivisible. Thus, even with modifications of biogas digester technology, the price of prototype was unaffordable for smallholder swine farms.

The Introduction of Portable Diagnostic Test Kits and Genomics or Gene Markers Innovation in Swine Production is a case of potential technological intervention. However, there remain to be many uncertainties on how the impact pathway will eventually play out. There is still a lot of missing links in the form of numerous constraints that had been identified. This is a case where maturity and form of technology commercialization has yet to be tested.

Potential Solutions

1. Farmer's Field School on Sustainable Pig Farming (FFS SPF)
2. Deep Litter Flooring System (DLFS)
3. International Training Center on Pig Husbandry-Local Government Unit-Cooperative (ITCPH-LGU-Cooperative) Approach
4. ITCPH alumnus in 1994
5. Sorosoro Ibaba Development Cooperative-Local Government Unit-Farmer/Producer (SIDC-LGU-Farmer/Producer) Tri-partite

Chapter 7: Conclusions and Recommendations

It is extremely difficult for smallholder swine farms to catch up with green growth. Besides the institutional constraints that have to be addressed, there are several preconditions to overcome the social and technical constraints and enable smallholder swine farms to realistically catch up with green growth. They would need access to:

1. Information on and demonstration of affordable and practical technology and waste minimization practices;
2. Regular and sustained visits by agricultural extension workers who will facilitate trainings on feeding and manure management technologies
3. Technological skills to operate, maintain, and repair waste minimization and treatment facilities
4. Microcredit financing schemes that are well facilitated
5. Farmer groups, cooperative, or contract farming to enable them to reduce transaction costs in many aspects of swine production, technology adoption and innovation