
South Korean pig production performance and management improved from 2017 to 2020

Improvements in zootechnical performance, biosecurity management, and animal health management

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To keep a viable pig sector in South Korea and a high self-sufficiency in pig meat, zootechnical performance, biosecurity management, and animal health management of South Korean pig farmers should be improved. Can training of South Korean farmers and training of their advisors increase the speed at which the pig sector in South Korea improves beyond the autonomous development? For all three topics, a small autonomous improvement was observed from 2017 to 2020. However, we cannot draw statistically reliable conclusions whether the two types of training increased the speed because of too few participants. Performance and management were measured in two surveys. A baseline survey, held before the first training, yielded 241 respondents and an endline survey, held after the last training, yielded 187 respondents. Of 107 respondents, we could link baseline and endline, of which eight participated in a training and 17 had their advisor in a training. Statistical analyses were performed on all respondents and on the 107 linked respondents. These included descriptive statistics and analyses of differences in responses between baseline and endline and in development between respondents with and without training and with and without their advisor in training (Wilcoxon signed-rank test, paired t-test, McNemar test, Mann-Whitney U test, depending on variable type).

Key words: Pig, South Korea, farmer training, advisor training, zootechnical, biosecurity, animal health, performance, management, learning

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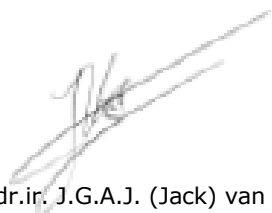
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Preface

To keep a viable pig sector in South Korea and a high self-sufficiency in pig meat, zootechnical performance, biosecurity management, and animal health management of South Korean pig farmers should be improved. Therefore, the public-private partnership project 'Enhancing the South Korean pig supply chain' between Dutch and South Korean partners was started in 2017. In this project, training of South Korean pig farmers and training of their advisors was implemented as learning and knowledge sharing interventions. The effectiveness of these two types of training in increasing the speed at which the pig sector in South Korea improves zootechnical performance, biosecurity management, and animal health management beyond the autonomous development was assessed. This report describes the autonomous performance and management improvement from 2017 to 2020 of a sample of South Korean pig farmers that participated in a survey. It also compares the performance and management improvement between pig farmers with and without a training and between pig farmers with and without their advisor in a training.

We like to thank all partners in the project that contributed to this project. Especially, we like to thank Mrs. Young Ki Hwang, Mr. Woo Seok Jeon, and Mrs. Jae Eun Lee from the South Korean Agency of Education, Promotion and Information Service in Food, Agriculture, Forestry and Fisheries (EPIS) and Director Mr. Hyoung Keun Lee, Mrs. Su-bin Kwon, and Mrs. Hyewon Choi from the South Korean National Agricultural Cooperative Federation (NACF) for arranging all practicalities of the baseline and endline survey in South Korea and for helping with data entering, cleaning and interpretation. Our thanks also go out to all pig farmer advisors of the South Korean pig cooperatives that took the baseline and endline survey from pig farmers, and to all the pig farmers that participated in the survey. We also like to thank Mr. Bennie van der Fels of Wageningen Livestock Research for arranging the pig farmer and pig farmer advisor trainings in the Netherlands as well as all who contributed to these trainings.



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Summary

S.1 Can pig farmer training and pig farmer advisor training increase the speed of performance and management improvement of South Korean pig farmers?

To keep a viable pig sector in South Korea and a high self-sufficiency in pig meat, zootechnical performance, biosecurity management, and animal health management of South Korean pig farmers should improve. Therefore, two types of training, i.e., training of South Korean pig farmers and training of their advisors, were implemented in the public-private partnership project 'Enhancing the South Korean pig supply chain' between Dutch and South Korean partners from 2018 to 2020. The main research question was whether pig farmer training and pig farmer advisor training can increase improvement of zootechnical performance, biosecurity management, and animal health management of the primary pig sector in South Korea beyond the autonomous development. How is the autonomous development in zootechnical performance, biosecurity management, and animal health management of South Korean pig farmers? How effective is training of South Korean pig farmers in increasing improvement? How effective is training of the South Korean pig farmer advisors in increasing improvement?

S.2 Autonomous performance improvement, but not possible to reliably assess whether training increased this

Can pig farmer training and pig farmer advisor training increase the speed at which the pig sector in South Korea improves zootechnical performance, biosecurity management, and animal health management beyond the autonomous development?

- From 2017 to 2020, we observed an autonomous improvement on zootechnical performance (increase in number of pigs marketed per sow per year), biosecurity management (increase in cleaning and disinfection frequency) and animal health management (increase in number of correct answers to questions about animal health) of pig farmers participating in our survey.
- We cannot draw conclusions on whether either pig farmer training or pig farmer advisor training increased the speed of improving zootechnical, biosecurity management, and animal health management in South Korea. Outbreaks of African Swine Fever and COVID-19 resulted in too few farmers participating in a training (8) and too few farmers of which the advisor followed a training (17) to find statistically reliable results.
- Pig farmers and their advisors were highly satisfied with the trainings and saw added value of participating in consecutive knowledge exchange innovations such as study clubs, which is a first step in acquiring new knowledge, using the acquired knowledge, and ultimately in improving pig farmer performance and management.

S.3 Methodology

Two types of training were held, one for South Korean pig farmers (in June 2018, September 2018, November 2020) and one for South Korean pig farmer advisors (October 2017, October 2018, July 2019). All trainings were held in the Netherlands. Each training lasted five days and included a visit to a Dutch pig farm and lectures of researchers and company experts about multiple topics, such

as animal health, biosecurity, feeding management, operational farm management, data management, housing and climate, economic performance for sows, piglets and finishing pigs.

To measure zootechnical performance, biosecurity management, animal health management, use of a management information system, and applied learning activities of South Korean pig farmers, a survey was held using a questionnaire with questions about these topics. For the baseline survey before the first training was held, local South Korean pig cooperatives selected the respondents from their members. For the endline survey after the last training, they returned to the pig farmers that completed the baseline survey, if possible. Responses were received of 241 pig farmers in the baseline survey and 187 in the endline survey. Baseline and endline responses of 107 pig farmers could be linked, of which eight participated in a training in the Netherlands, and 17 had their advisor follow a training in the Netherlands.

Statistical analyses were performed on the answers of all respondents in both the baseline and endline, and on the answers of the 107 respondents for which the baseline and endline could be linked. Analysis of all responses included a descriptive analysis and analysis of the difference in distribution of answers between baseline and endline (for nominal variables a two-sided Fisher's exact test; for ratio variables a Mann-Whitney U test). The analysis of the linked answers of the 107 farmers consisted of 1) descriptive analysis of characteristics of the respondents, 2) analysis of the autonomous development from baseline to endline of the 86 farmers in this group that did not participate in a training in the Netherlands and of which the advisor also did not participate in a training in the Netherlands (descriptive analysis of development, analysis of the difference between baseline and endline (ordinal variables: Wilcoxon signed-rank test, continuous variables: paired t-test combined with Wilcoxon signed-rank test; binary variables: McNemar test)) and 3) analysis of differences in development from baseline to endline between the farmers that participated in a training or not and of which their advisor participated in a training or not (descriptive analysis, analysis of difference in baseline and endline answers (nominal and ordinal variables: Fisher's exact test; ordinal variables: Mann-Whitney U test), and analysis of the difference in distribution of the development from baseline to endline (nominal and ordinal variables: Fisher's exact test; ordinal variables: Mann-Whitney U test)).

1 Can pig farmer training and pig farmer advisor training increase the speed of performance and management improvement of South Korean pig farmers?

1.1 Current situation

In 2020, South Koreans consumed around 2.0 million tonnes of pig meat (USDA, 2021), or 38 kg per capita per annum. In 2020, the South Korean pig sector comprised 6,133 farms, keeping 11.2 million pigs of which around 1.0 million sows (USDA, 2021). The last decade, annual South Korean pig meat production fluctuated between 1.1 million tonnes (in 2012) and 1.4 million tonnes (in 2020). This resulted in an annual self-sufficiency rate for pig meat of between 66 and 72%. Thus, South Korea needed to import between 480,000 and 750,000 tonnes of pig meat per year. The main supplier was the US, other big suppliers were Canada, Germany, and Chile. The imported meat is relatively cheap compared to pig meat produced in South Korea, putting the South Korean market price under pressure. This threatens viability and future of South Korean pig production.

Poor zootechnical performance on pig farms leaves ample room to increase pig meat production in South Korea. In 2020, professional pig farms produced an estimated average of 17.9 slaughter pigs marketed per sow per year (MSY) (based on number of slaughterings from FAOStat and number of sows from USDA (2021)). For comparison, in 2020 pig farms in the Netherlands had an estimated average MSY of 29.5 (based on number of slaughterings from FAOStat and number of sows from anonymous management information system data). The same data show that, in the last decade, the improvement in MSY in South Korea (2.7, from 15.1 in 2010 to 17.9 in 2020) was also lower than in the Netherlands (3.1, from 26.4 in 2010 to 29.5 in 2020). Major reasons for the low zootechnical performance are poor veterinarian and biosecurity management at farm level and recurring outbreaks of contagious animal diseases, such as food and mouth disease, and African Swine Fever (ASF) (Hoste, 2015). Animal diseases such as PRRS and PEDV, are common on farms (Hoste, 2015). PEDV, the high mortality diarrhoea disease, is present in around a quarter of all Korean pig farms. Comparable to the Netherlands, the high density in pigs in South Korea has led to large environmental problems (manure, gaseous emissions) and increased costs for farmers to mitigate these. The above mentioned also resulted in markedly higher primary production costs in South Korea, estimated at €2.59/kg slaughter weight in 2020 (own calculations, based on KOSIS (2021) and InterPIG data), compared to those of €1.57 in the Netherlands (own calculations, based on InterPIG data).

1.2 Desired situation

The desired situation for South Korea is to keep a viable pig sector and a high self-sufficiency in pig meat through improved zootechnical performance. Average zootechnical performance improves over time, because individual farmers take actions on their own farm. An option to speed up improvement of zootechnical performance is to improve animal health and biosecurity management at farm level through raising awareness about the importance of managing interventions and all processes on the farm well. Therefore, South Korean companies and the South Korean government are looking towards pig sectors in countries in Europe with a high level of zootechnical performance as an example, with a specific interest in the Netherlands. The Dutch pig sector is one of the most advanced in the world, because entrepreneurs in the Dutch pig supply chain have highly advanced knowledge of zootechnical, animal health, and biosecurity issues. Both South Korea and the Netherlands have a high pig density, which is an important risk factor for animal diseases. Furthermore, because both need to import most

feed ingredients, this is an important driver of feed costs, which make up around 60% of the primary production costs.

The high performance level in the Netherlands can be attributed to regular implementation of innovations and knowledge sharing between pig farmers and between pig farmers and other links in the supply chain such as feed, breeding, housing, equipment, and slaughter companies, and to tight economic production circumstances. By sharing knowledge, innovations, and experiences with peers, farmers learn new approaches to improve performance, for example through benchmarking performance with other farmers and discussing observed differences, potential reasons, and potential solutions to improve performance. However, sharing knowledge, innovations, and experiences depends on the degree of openness among farmers, which in turn relates to trust and culture. Such a system for sharing innovations and knowledge between and with pig farmers is currently underdeveloped in South Korea. Implementing such a system could improve the zootechnical performance of South Korean pig farmers, thereby helping to keep a viable pig sector and to increase the self-sufficiency rate in pig meat.

In 2017, Wageningen Economic Research initiated the public private partnership project 'Enhancing the South Korean pig supply chain' together with South Korean and Dutch partners to test whether different knowledge exchange interventions could improve pig farmer zootechnical performance, biosecurity management, and animal health management in South Korea. Figure 1.1 shows the structure of this project. Learning styles and social competences of South Korean pig farmers were identified in work package I. Knowledge exchange interventions were set up aiming at different learning styles. Implemented knowledge exchange interventions included open days on a newly developed Pig Development Centre (PDC) as a showcase of innovative Dutch pig husbandry systems (mastery learning) (work package II), training of pig farmers in the Netherlands (instruction/coaching learning) (work package III), training of pig farmers advisors in the Netherlands (instruction/coaching learning) (work package III), establishing pig farmers study clubs in South Korea (cooperative learning) (work package III), and information sharing arrangements in the supply chain (all learning styles) (work package IV). The effectiveness of the knowledge exchange interventions to improve performance and management was assessed in work package V. The overarching work package VI focused on project management and communication. This report presents the results from work package V. Due to outbreaks of ASF and COVID-19, the study clubs could only start a few weeks before the end of the project and only one open day could be held at the PDC, which was held online. Information sharing arrangements in the supply chain were developed, but these were not implemented before the endline survey was held. Data to reliably assess the effectiveness of study clubs, open days, and information sharing arrangements in the supply chain to increase performance and management could not be gathered. Therefore, these knowledge exchange interventions are not covered in this report.

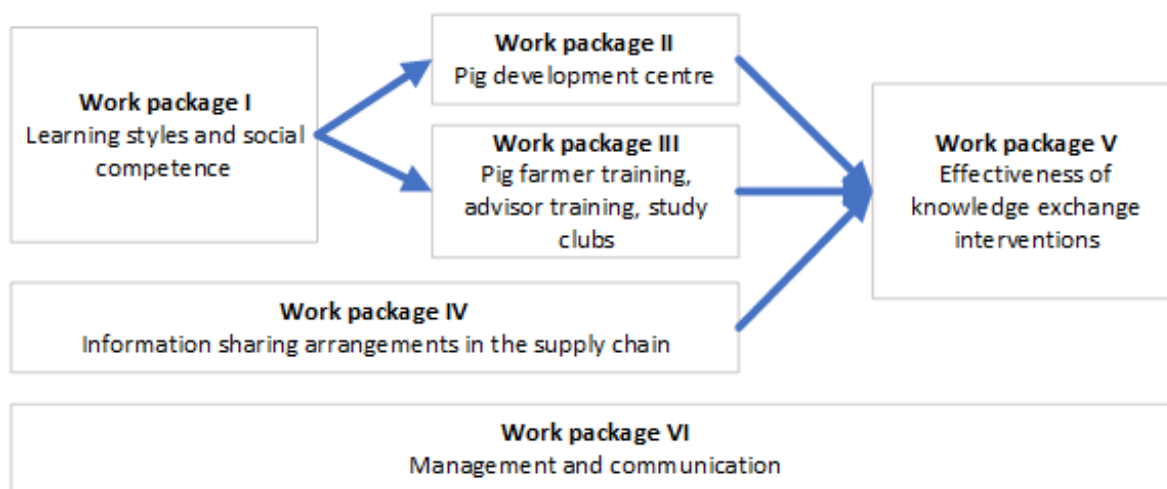


Figure 1.1 Structure of the public private partnership project 'Enhancing the South Korean pig supply chain'

1.3 Main research question and sub-questions

The main research question is: Can pig farmer training and pig farmer advisor training raise improvement of zootechnical performance, biosecurity management, and animal health management of the primary pig sector in South Korea beyond the autonomous development?

This main research question is divided into two sub-questions:

1. How is the autonomous development in zootechnical performance, biosecurity management, and animal health management of South Korean pig farmers?
2. How effective are pig farmer training and pig farmer advisor training in improving zootechnical performance, biosecurity management, and animal health management beyond the autonomous development?

1.4 Message

From 2017 to 2020, an autonomous improvement on zootechnical performance, biosecurity management and animal health management of the pig farmers that participated in the survey was observed. In 2020, compared to 2017, MSY was higher, cleaning and disinfection frequency was higher, and farmers had more correct answers on questions about animal health. However, we cannot draw conclusions on whether training in the Netherlands increased the speed of improving zootechnical performance, biosecurity management, and animal health management in South Korea. Outbreaks of ASF and COVID-19 resulted in too few farmers participating in a training in the Netherlands (8) and in too few farmers of which the advisor followed a training in the Netherlands (17) to find statistically reliable results.

2 Material and methods

2.1 Questionnaire to measure performance and management improvement

To measure zootechnical performance, biosecurity management, animal health management, use of a management information system (MIS), and applied learning activities of South Korean pig farmers, a survey was held using a questionnaire with questions about these topics. Questions about zootechnical performance included the number of piglets born per sow per year (PSY), the number of slaughter pigs marketed per sow per year (MSY), weaning age, weaning weight, and weight at 75 days. Questions about biosecurity management included hygiene control in pig houses by using coveralls, using specific boots, hand washing, or showering for employees and visitors when entering the stables, and the frequency of pen cleaning and disinfection. Questions about animal health management included the recognition of diseases and knowledge about their treatment (piglet diarrhoea, diarrhoea in a 50 kg pig, and PRRS in a sow), the visit frequency of the veterinarian, and the number of empty days between rounds in the finishing barn. The questionnaire included one question about the frequency of use of the MIS per week. Questions concerning applied learning activities covered whether the pig farmer had performed different learning activities in the last three years. Finally, the questionnaire included questions about general farmer characteristics, such as living area, age, gender, education, number of finishers, and number of sows. Answering categories were predefined for most questions. Questions about weaning age, weaning weight, weight at 75 days, number of empty days between rounds, and frequency of MIS use were open.

The questionnaire included questions about more topics than mentioned above, but these topics have no or only a marginal impact on zootechnical performance. Therefore, these topics were not included in this report. For completeness, this included the topics of learning styles and social competence, challenges and risks, support and training, income and investment, trust in other people, and environmental management. The topic of learning styles and social competence was addressed in the social competence study part of the project (Lans et al., submitted). The topics of challenges and risks and of support and training were used to develop the content of the trainings given in the project.

The survey was held twice. The first baseline survey was held at the end of 2017 and beginning of 2018, before any training was implemented. The second endline survey was held 3 years later at the end of 2020 and beginning of 2021, after all the trainings were done. Pig farmer advisors of regional South Korean cooperatives, which were all member of the project partner South Korean National Agricultural Cooperative Federation (NACF), took the surveys at the farm. Some of the farmers that participated in the training in the Netherlands that had not been visited with the survey, completed the survey themselves without an advisor and handed the completed survey in prior to the training.

To be able to link the data of a farmer from the baseline survey to the data from the endline survey of the same farmer, the cooperatives were asked to assign a unique respondent number to each respondent. This number was to be used in the endline survey for the same pig farmer. The South Korean Agency of Education, Promotion and Information Service in Food, Agriculture, Forestry and Fisheries (EPIS) put the responses in an MS Excel database. The data in this MS Excel database were anonymised to ensure that the researchers could not trace data to individual farmers. The anonymised data were sent to the researchers in the Netherlands for analysis.

2.2 Respondents: 241 in 2017 baseline, 187 in 2020 endline

For the baseline survey, the local South Korean pig cooperatives selected the respondents from their members. They were instructed to have a bias towards younger pig farmers, because these were expected to be more open to participating in the knowledge sharing interventions planned in the project than older pig farmers. In addition, it can be expected that younger pig farmers will continue with pig farming for a longer period than older pig farmers. Each responding farmer was assigned a unique respondent number in the baseline. The cooperatives were requested to take the endline survey from the pig farmers that had completed the baseline survey. For each respondent in the endline survey, the cooperatives were asked to include the unique respondent number assigned in the baseline survey to that respondent. For part of the respondents in the baseline survey, the contact details were not recorded or lost. Therefore, these respondents could not be traced back by the researchers for their participation in the endline survey. The cooperatives might have contacted other pig farmers to increase the response rate in the endline survey.

Responses were received of 241 pig farmers in the baseline survey and of 187 pig farmers in the endline survey. The number of respondents in the endline survey is lower, because in 2020 some were no longer active pig farmers, some could not be reached, and some were not willing to participate in the endline survey. It should be noted that not all respondents completed all questions.

Baseline and endline responses of 107 pig farmers could be linked through the unique respondent number. Not all endline results could be linked to a baseline result, because some cooperatives did not record the contact details of the pig farmer linked to each unique respondent number, and some cooperatives could not retrieve the contact details anymore. Because of this, pig farmers in the endline of which the data could not be linked to the baseline might not have been interviewed in baseline. Therefore, the not-linked data can only be used to provide an indication of a general development in zootechnical performance, biosecurity management, and animal health management.

2.3 Knowledge exchange interventions: Training of pig farmers and training of their advisors

Two types of training were held, for pig farmers and for pig farmer advisors. All trainings were held in the Netherlands. They all lasted 5 days and included lectures of researchers and company experts on animal health and welfare management, biosecurity management, sow management, breeding, farm planning and batch management, farrowing management, weaner management, climate management, and colostrum intake and feeding management. They also included visits to a Dutch pig farm.

Three pig farmer trainings were held:

- 28 May - 1 June 2018
- 10-14 September 2018
- 16-20 November 2020. This last training was very close to the endline survey and of several pig farmers no baseline survey was taken, therefore a potential impact of this training could not be included in the analysis.

Three pig farmer advisor trainings were held:

- 16-27 October 2017
- 22-26 October 2018
- 1-5 July 2019

Of the 107 farmers with linked baseline and endline results, eight participated in a training in the Netherlands, and the advisor of 17 farmers participated in a training in the Netherlands. Four farmers participated themselves in a training in the Netherlands and their advisor as well. Thus, 86 of the linked farmers did not participate in a training in the Netherlands nor did their advisor.

2.4 Statistical analyses

Two types of statistical analyses were performed, one on the answers of all respondents in both the baseline and endline, and one on the answers of the 107 respondents for which the baseline and endline could be linked. The statistical analysis of all the responses was used to identify general performance and management developments from 2017 to 2020. It included a descriptive analysis and tests for differences in distribution of answers between the baseline and endline. The descriptive analysis consisted of frequency tables of the general characteristics of the respondents. The test for differences used depended on the characteristics of the variable. For nominal variables (region, gender, hygiene measures) and ordinal variables with answers in categories (age, education, number of sows, number of finishers, PSY, visit frequency of the veterinarian, frequency of disinfection between rounds, and extent of learning activities (Likert scale from 1 'not and very low degree' to 5 'very high degree')), a two-sided Fisher's exact test was used to test for a difference in the answer frequency distribution between baseline and endline. For MSY, a Kolmogorov-Smirnov independent samples test was used due to insufficient memory for Fisher's exact test. For ratio variables (weaning age, weaning weight, weight at 75 days, empty days between rounds, frequency use of MIS, correct answers with health questions), a Mann-Whitney U test was used to compare the distribution of answers between baseline and endline.

The statistical analysis of the linked answers of the 107 farmers consisted of 1) a descriptive analysis of characteristics of the respondents, 2) an analysis of the autonomous development from baseline to endline of the 86 farmers in this group that did not participate in a training in the Netherlands and of which the advisor also did not participate in a training in the Netherlands and 3) an analysis of the differences in development from baseline to endline between respondents that participated in a training or not and between respondents of which the advisor participated in a training or not:

1. The descriptive analysis of the characteristics of respondents consisted of frequency tables of the general characteristics of the respondents with and without farmer and farmer advisor training.
2. The analysis of the autonomous development of the 86 farmers consisted of a) a descriptive analysis of the development from baseline to endline of the farmers, and b) an analysis of the difference in distribution of baseline and endline responses for these 86 farmers. The descriptive statistics of development from baseline to endline consisted of frequency distributions of the number of respondents that showed a decrease, no change, or increase for nominal variables and for the ordinal variables visit frequency of the veterinarian, frequency of disinfecting between rounds, and extent of learning activities. For the ordinal variables PSY and MSY as well as for the ratio variables the actual development was used. The analysis of the difference consisted of a Wilcoxon signed-rank test for ordinal variables, paired t-test in combination with Wilcoxon signed-rank test for ratio variables because of a hint of non-normality (measured with p-p plot), and McNemar test for binary variables (hygiene measures).
3. The analysis of the difference in development consisted of a) a descriptive analysis of the development from baseline to endline of the farmers, b) a test for difference in baseline and endline answers between farmers with and without training in the Netherlands and for farmers with and without advisor training, and c) a test for the difference in distribution of the development from baseline to endline between farmers with and without each training. To identify differences in baseline and endline answers between farmers with and without training in the Netherlands and for farmers with and without advisor training, a Fisher's exact test (instead of chi-squared) was used for nominal and ordinal variables, because the expected frequency was less than 5 in more than 10% of the cells in the tables, and a Mann-Whitney U test for ordinal variables. To identify differences in development from baseline to endline between farmers with and without training in the Netherlands, and for farmers with and without advisor training, a two-sided Fisher's exact test (instead of chi-squared) was used for nominal and ordinal variables, because the expected frequency was less than 5 in more than 10% of the cells, and a Mann-Whitney U test for ratio variables. We did not correct for differences in general characteristics between respondents with and without each type, because the number of respondents with each type of training was too low to find reliable statistical results.

Statistical analyses were performed in IBM SPSS Statistics 25.

3 Small autonomous improvement in performance and management over all respondents from 2017 baseline to 2020 endline

3.1 General characteristics of all respondents

In the 2017 baseline survey, responses of 241 pig farmers were received, and in the 2020 endline survey, responses of 187 pig farmers (Table 3.1). In both surveys, pig farmers came from different regions. The regions differed between baseline and endline, because for part of the respondents in the baseline survey the contact details were not recorded or lost, and other farmers were contacted to participate in the endline to increase the response rate. The geographical distribution of pig farmers across South Korea in both surveys differed from the distribution of all pig farmers. Compared to the geographical distribution of all pig farmers, relatively many pig farmers participated in the surveys from Chungnam (26.5 and 29.7% of respondents compared to 18.1% on national level (KOSIS, 2021)), Gyeongnam (31.1 and 33.5% compared to 11.3%) and Jeju (14.2 and 16.2% compared to 4.2%). In contrast, relatively few pig farmers participated from Gyeonggi (4.3 and 14.2% compared to 20.2%), Jeonbuk (0.0 and 2.7% compared to 13.6%), Jeonnam (0.5% compared to 8.7%) and Gyeonbuk (0.9 and 2.7% compared to 11.6%). Around 60% of the respondents in both surveys were 50 years or older. The age in the endline was significantly higher than in the baseline. Almost all respondents had an educational level of high school or higher and the distribution did not differ between the two surveys. In both surveys, the number of sows on the farm was relatively uniformly distributed over the size categories and no difference was observed. In the baseline, about 58% of the respondents had over 1,500 finishing pigs. In the endline, this was about 69%, significantly higher than in the baseline.

Table 3.1 General characteristics of pig farmers in South Korea that participated in one or both rounds of a survey on zotechnical performance, animal health management, and biosecurity management with the baseline (241 respondents) in 2017/2018 and the endline (187 respondents) in 2020/2021

Characteristic		Respondents (%)	
		Baseline	Endline
Region	Seoul City	0.0	0.0
	Gyeonggi	14.2	4.3
	Gangwon	0.0	11.4
	Chungbuk	4.6	4.9
	Chungnam	29.7	26.5
	Gyeonbuk	0.9	2.7
	Jeonbuk	2.7	0.0
	Daegu City	2.3	0.0
	Gyeongnam	31.1	33.5
	Jeonnam	0.5	0.5
	Jeju	14.2	16.2
		Difference at p=0.000 ¹	
Gender	Male	90.4	88.1
	Female	9.6	11.9
		Difference at p=0.519	

Characteristic		Respondents (%)	
		Baseline	Endline
Age	<20	0.0	0.0
	20-29	3.2	1.1
	30-39	13.2	9.2
	40-49	21.4	20.5
	50-59	35.0	22.7
	60-69	23.2	36.8
	>70	4.1	9.7
Difference at p=0.001			
Education level	Elementary school	2.8	2.3
	Middle/Junior High school	6.0	4.0
	High School	44.2	42.0
	Junior College	20.7	16.7
	University	26.3	35.1
Difference at p=0.435			
Number of sows	<50	3.8	1.6
	50-99	11.7	12.4
	100-149	22.9	21.6
	150-199	24.2	22.2
	200-299	17.5	27.0
	≥300	20.0	15.1
Difference at p=0.179			
Number of finishers	<200	1.4	0.7
	200-499	7.4	8.7
	500-999	12.1	0.0
	1,000-1,499	21.4	21.3
	1,500-2,499	31.2	32.7
	≥2,500	26.5	36.7
Difference at p=0.000			

¹ Likelihood-ratio chi-square test due to insufficient memory for Fisher's exact test.

3.2 Zootechnical performance: Increased MSY

Table 3.2 provides the responses on the questions about the respondents' zootechnical performance in the baseline and endline. For PSY, most respondents were in the category between '21.0-22.9' (31% in baseline, 25% in endline). Only about 13% of the respondents indicated to have a PSY of 25.0 or more in the baseline. In the endline, this was higher at about 19%. No significant difference in the distribution of PSY between baseline and endline was observed.

For MSY, most respondents were in the category '17.0-18.9' in the baseline (37%) and in the category '19-20.9' in the endline (28%). The percentage of respondents in the category of a MSY of 23.0 or more increased from 1% in the baseline to 20% in the endline. The fraction of respondents with a MSY of 19.0 or higher increased from 28% in the baseline to 58% in the endline. This indicates that in the endline respondents had a significantly higher MSY than the baseline respondents ($p=0.000$).

The mean weaning age of the piglets was around 25 days in both surveys. Mean weaning weight of 6.6 kg in the endline was significantly higher than that of 6.2 kg in the baseline. Finally, the mean weight at 75 days was significantly lower in the endline (27.9 kg) than in the baseline (28.7).

Table 3.2 Zootechnical performance, biosecurity management, and animal health management of pig farmers in South Korea that participated in a two-round survey with the baseline in 2017/2018 and the endline in 2020/2021 and p-value for the difference between baseline and endline (significant at $p < 0.05$ bold)

Variable	Answer category	Respondents (%)		p-value
		Baseline	Endline	
Zootechnical performance				
PSY	n	228	182	
	<17.0	3.5	3.8	0.530
	17.0-18.9	11.4	12.1	
	19.0-20.9	18.0	19.2	
	21.0-22.9	31.1	24.7	
	23.0-24.9	23.2	21.4	
	≥25.0	12.7	18.7	
MSY	N	227	184	
	<15.0	9.3	6.5	0.000¹
	15.0-16.9	26.4	15.8	
	17.0-18.9	36.6	20.1	
	19.0-20.9	14.1	27.7	
	21.0-22.9	12.3	10.3	
	≥23.0	1.3	19.6	
Mean (st.dev. / N)				
Weaning age		25.1 (3.0 / 235)	24.8 (2.5 / 181)	0.078
Weaning weight		6.2 (1.3 / 210)	6.6 (0.9 / 166)	0.007
Weight at 75 days		28.7 (5.6 / 204)	27.9 (3.8 / 259)	0.022
Biosecurity management				
Visit frequency of veterinarian	n	238	183	
	Every week	3.8	4.9	0.001
	Every 2 weeks	10.9	8.7	
	Every month	43.3	25.7	
	Less than once a month	42.0	60.7	
Cleaning & disinfection frequency	n	239	186	
	After each round	72.4	81.7	0.045
	Less often	25.1	17.7	
	never	2.5	0.5	
Hygiene measures ¹	Use coveralls	94.5 (235)	95.7 (186)	0.655
	Use specific boots	95.0 (238)	90.3 (186)	0.085
	Hand washing	18.4 (234)	17.8 (185)	0.899
	Visitor shower	14.5 (214)	19.5 (185)	0.227
Mean (st.dev. / N)¹				
Empty days		3.5 (2.6 / 235)	3.5 (2.7 / 184)	0.949
Animal health management				
Mean (st.dev. / N)				
Animal health knowledge	Cause piglet diarrhoea	4.0 (0.6 / 240)	3.9 (0.9 / 185)	0.603
	Prevent piglet diarrhoea	2.9 (1.0 / 240)	3.4 (0.9 / 185)	0.000
	Cause 50 kg pig diarrhoea	1.7 (0.7 / 240)	1.8 (0.9 / 186)	0.569
	Infection route 50 kg pig diarrhoea	2.8 (1.0 / 240)	3.1 (0.9 / 186)	0.003
	Symptoms PRRS sow	3.2 (0.8 / 240)	3.2 (1.0 / 186)	0.542
	Diagnosis PRRS sow	3.5 (0.8 / 240)	3.7 (0.9 / 186)	0.160
	All topics (30 questions)	18.1 (2.4 / 240)	19.0 (3.0 / 185)	0.027
MIS use				
Mean (st.dev. / N)				
MIS use	Number of times per week	0.8 (1.3 / 240)	1.9 (1.7 / 118)²	0.000

Variable	Answer category	Respondents (%)		p-value
		Baseline	Endline	
Learning activities		Mean (st.dev. / N)		
Compare practices with other pig farmers		3.0	3.2	0.119
Consult other pig farmers		3.2	3.3	0.036
Consulting family members		2.7	3.0	0.038
Consulting an expert		3.6	3.6	0.030
Experimenting		2.1	2.9	0.000
Attending courses		3.3	3.1	0.378
Looking for information in books, magazines, internet		3.3	3.2	0.171
Exchanging information with pig farmers		3.0	3.3	0.001
Joining a cooperation		3.7	3.6	0.000

¹Kolmogorov-Smirnov independent samples test due to insufficient memory for Fisher's exact test. ²In the endline survey, only 118 farmers provided their frequency of use of the MIS. It is not known if the other respondents did not have a MIS or did not want to provide an answer.

3.3 Biosecurity management: Higher cleaning and disinfection frequency, less visits of veterinarian

Table 3.2 provides the responses on the questions about the respondents' biosecurity management in the baseline and endline. For over 85% of the respondents, the veterinarian visited the farm once a month or less. The fraction of respondents that received a visit from a veterinarian less than once a month increased from 42% in the baseline to 61% in the endline. In the endline, veterinarians visited the farms significantly less often than in the baseline. About 72% of the respondents cleaned and disinfected the pens after each round in the baseline and almost 82% in the endline. Cleaning and disinfection frequency of the pens was significantly higher in the endline than in the baseline. Around 95% of the respondents indicated to use coveralls and specific boots, whereas only between 15 and 20% indicated to use hand washing and visitor showers. No significant ($p > 0.05$) difference was observed for these hygiene measures between baseline and endline.

3.4 Animal health management: More pig health knowledge

Table 3.2 provides the responses on the questions about the respondents' animal health management in the baseline and endline. The respondents had the highest number of correct answers for the cause of piglet diarrhoea highest (4.0 and 3.9) and diagnosis of PRRS in sows (3.5 and 3.7). They had the lowest mean number of correct answers out of five questions about the cause diarrhoea in a 50 kg pig (1.7 in baseline and 1.8 in endline). For the other three topics, they had around 3 correct answers out of five. Over all six topics, the respondents had between 18 and 19 correct answers out of 30 answers. On average, respondents had the same or more correct answers on the animal health related questions in the endline than in the baseline. The mean number of correct answers was significantly higher in the endline for two topics, prevention of piglet diarrhoea (3.4 compared to 2.9 correct answers of a possible 5 correct answers) and the infection route for diarrhoea of a 50 kg finishing pig (3.1 compared to 2.8). No difference in the mean correct number of answers was observed for the other four topics. The mean number of correct answers over the six topics was 0.9 higher ($p < 0.05$) in the endline than in the baseline (19.0 compared to 18.1 of a possible 30 correct answers).

3.5 More use of management information system

Table 3.2 provides the responses on the question about the weekly use of a MIS in the baseline and endline. The mean number of times per week pig farmers used MIS more than doubled from 0.8 times in the baseline to 1.9 times in the endline ($p < 0.05$).

3.6 More learning activities

Table 3.2 provides the responses on the questions about the learning activities in the previous three years in the baseline and endline. Joining a cooperation (3.7 on a scale of 1 to 5) and consulting an expert (3.6) were the most applied learning activities. Experimenting (2.1) and consulting family members (2.7) were the least applied learning activities. In the endline, all learning activities were performed to a larger extent (5 activities) or to the same extent (3 activities) than in the baseline, except for joining a cooperation, which was performed to a lower extent.

4 Small autonomous improvement in performance and management of linked respondents without interventions from 2017 to 2020

4.1 General characteristics of linked respondents

Table 4.1 provides the general characteristics in the baseline and endline of the 86 respondents for which we could link the baseline and endline responses and that were not involved in the trainings implemented in the project. The regional distribution is not representative for the whole population of pig producers in South Korea (see Section 3.1). Over 60% of the linked respondents came from Gyeongnam and around 34% from Jeju. In the baseline, two of the other three respondents indicated to come from Daegu city and one did not complete the question, whereas in the endline these three indicated to come from Gyeonbuk. Around 92% of the respondents were male. Three respondents had a different gender in the endline than in the baseline, and this was coupled with a non-logical change in age group category between endline and baseline (e.g., a lower age group or an increase of more than one age group) or a decrease in education level. This suggests that a different person was interviewed at the same farm. The enumerators that collected those data confirmed that in a few cases another person was interviewed on the same farm in the endline than in the baseline, for example the wife instead of the husband. Therefore, we keep these responses in the results. About 70% of the linked respondents were over 50 years old, which is more than 10 percentage points higher than in the total sample in the baseline and endline (see Table 3.1). In both surveys, almost all respondents had an educational level of high school or higher. About 14% of the respondents increased their education level, but the distribution was not significantly different between the baseline and endline. The number of sows on the farm was relatively uniformly distributed over the size categories, similar to the total sample in the baseline and endline. About 77% of the respondents were in the same category with number of sows in the baseline and endline, 19% had more sows in the endline compared to the baseline, and 5% indicated a decrease. In the baseline, 58% of the respondents had over 1,500 finishers on their farm and this was over 85% in the endline. Around 42% of the respondents had more finishers in the endline compared to the baseline and 53% remained in the same category. The distribution over the categories did not differ significantly between baseline and endline. The linked 86 respondents increased relatively more in number of finishers compared to the total sample, with almost 85% of the linked respondents having 1,500 finishers or more in the endline compared to 69% in the total sample, while both had 58% in the baseline.

Table 4.3 General characteristics of 86 pig farmers in South Korea that participated in both rounds of a survey on zootechnical performance, biosecurity management, and animal health management (baseline in 2017/2018 and endline in 2020/2021) and that did not participate in a training in the Netherlands nor had their advisor participate in a training in the Netherlands

Characteristic	Answer category	% of respondents		Development baseline to endline		
		Baseline	Endline	Cat. change	Respondents (%)	p-value
Region	n	85	86			
	Seoul City	0.0	0.0	Same region	97.6	1.000
	Gyeonggi	0.0	0.0	Different region	2.4	
	Gangwon	0.0	0.0			
	Chungbuk	0.0	0.0			
	Chungnam	0.0	0.0			
	Gyeonbuk	0.0	3.5			
	Jeonbuk	0.0	0.0			
	Daegu City	2.4	0.0			
	Gyeongnam	63.5	62.8			

Characteristic	Answer category	% of respondents		Development baseline to endline		
		Baseline	Endline	Cat. change	Respondents (%)	p-value
Gender	Jeonnam	0.0	0.0			
	Jeju	34.1	33.7			
	n	85	84			
	Male	92.9	91.7	Same gender	97.6	0.157
	Female	7.1	8.3	Different gender	2.4	
Age	n	86	85			
	<20	0.0	0.0	Younger	2.4	0.157
	20-29	1.2	0.0	Same age group	62.4	
	30-39	11.6	7.1	Older	35.3	
	40-49	20.9	21.2			
	50-59	33.7	23.5			
	60-69	25.6	35.3			
	>70	7.0	12.9			
Education level	n	86	85			
	Elementary school	0.0	0.0	-1	2.4	0.263
	Middle/Junior High school	2.3	1.2	0	83.5	
	High School	54.7	48.2	+1	8.2	
	Junior College	22.1	18.8	+2	5.9	
	University	20.9	31.8			
Number of sows	n	86	85			
	<50	0.0	0.0	-1	4.7	0.160
	50-99	11.6	9.4	0	76.5	
	100-149	25.6	20.0	+1	12.9	
	150-199	22.1	20.0	+2	3.5	
	200-299	25.6	30.6	+3	2.4	
	≥300	15.1	20.0			
Number of finishers	n	85	76			
	<200	1.2	0.0	-1	5.3	0.489
	200-499	3.5	0.0	0	52.6	
	500-999	15.3	0.0	+1	26.3	
	1,000-1,499	22.4	15.8	+2	13.2	
	1,500-2,499	34.1	38.2	+3	2.6	
	≥2,500	23.5	46.1			

4.2 Zootechnical performance: Higher PSY, MSY, and weaning weight

Table 4.2 describes the PSY and MSY in the baseline and endline and the development from baseline to endline of the 86 linked respondents. The development is presented as the number of categories the linked respondent did change from baseline to endline. For example, a linked respondent that changed from the category '17.0-18.9' in the baseline to the category '19.0-20.9' in the endline has a development of +1 category change.

For PSY, most linked respondents were in the category between '21.0-22.9' in baseline (31%), whereas most linked respondents had a PSY of 25.0 or higher in endline (32%). The fraction of linked respondents with a PSY of 23.0 or higher increased from 42% in the baseline to 55% in the endline. About 37% of the linked respondents showed such an increase in PSY of up to 3 categories, 54% remained in the same category, and 10% showed a decrease in PSY. This indicates that in the endline the linked respondents had a significantly higher PSY than in the baseline ($p=0.000$).

For MSY, most linked respondents were in the category '17.0-18.9' in the baseline (39%) and in the category '19.0-20.9' in the endline (29%). The percentage of linked respondents in the category of a MSY of 23.0 or higher increased from 0% in the baseline to 33% in the endline. The fraction of linked respondents with a MSY of 19.0 or higher increased from 21% in the baseline to 74% in the endline.

Almost 80% of the linked respondents showed an increase in MSY from baseline to endline and only 1% a decrease. This indicates that in the endline linked respondents had a significantly higher MSY than in the baseline ($p=0.000$).

Table 4.3 describes the mean weaning age, mean weaning weight, and mean weight at 75 days in the baseline and endline and the mean development from baseline to endline of the 86 linked respondents. The mean weaning age was around 25 days and did not differ significantly between the baseline and endline. The mean weaning weight of 6.3 kg in the endline was significantly higher than the 6.1 kg in the baseline ($p=0.003$). The mean weight at 75 days was around 28 kg and did not differ significantly between the baseline and endline.

Table 4.4 Baseline and endline results and development from baseline to endline for ordinal questions of the 86 pig farmers that participated both in the baseline in 2017/2018 and in the endline in 2020/2021 and that did not participate in a farmer training in the Netherlands nor had their advisor participated in a training in the Netherlands (significant at $p<0.05$ bold)

Variable	Answer category	% responses		Development baseline to endline		p-value		
		Baseline	Endline	Development category	% responses			
Zootechnical performance								
PSY	n	83	84	n	82	0.000		
	<17.0	4.8	3.6	-2	1.2			
	17.0-18.9	7.2	2.4	-1	8.5			
	19.0-20.9	15.7	13.1	0	53.7			
	21.0-22.9	30.1	23.2	+1	23.2			
	23.0-24.9	24.1	22.6	+2	12.2			
	≥ 25.0	18.1	32.1	+3	1.2			
MSY	n	85	85	n	84	0.000		
	<15.0	17.6	2.9	-1	2.4			
	15.0-16.9	22.4	11.8	0	19.0			
	17.0-18.9	38.8	8.2	+1	33.3			
	19.0-20.9	8.2	29.4	+2	21.4			
	21.0-22.9	12.9	11.8	+3	19.0			
	≥ 23.0	0.0	32.9	+4	4.8			
Biosecurity management								
Visit frequency of veterinarian	n	86	82	n	82	0.000		
	Every week	7.0	4.9	more often	8.5			
	Every 2 weeks	9.3	3.7	same	32.9			
	Every month	68.6	29.3	less often	58.5			
	Less than once a month	15.1	62.2					
Cleaning & disinfection frequency	n	86	85	n	85	0.003		
	After each round	54.7	75.3	more often	31.8			
	Less often	44.2	24.7	same	57.6			
	never	1.2	0.0	less often	10.6			
Hygiene measures ¹		% yes (n)	% yes (n)	n Yes->yes	n Yes->no	n No->yes	n No->no	
	Use coveralls	94.1 (85)	98.8 (86)	79	0	5	0	0.063
	Use specific boots	91.7 (84)	92.9 (85)	70	6	7	0	1.000
	Hand washing	10.7 (84)	12.9 (85)	1	8	10	64	0.815
	Visitor shower	11.9 (84)	20.0 (85)	5	5	11	62	0.210

Table 4.5 Baseline and endline results and development from baseline to endline for ratio variables of the 86 pig farmers that participated both in the baseline in 2017/2018 and in the endline in 2020/2021 and that did not participate in a farmer training in the Netherlands nor had their advisor participated in a training in the Netherlands (significant at $p < 0.05$ bold)

Variable	Answer category	Baseline		Endline		Development baseline to endline		
		Mean	St. dev.	Mean	St. dev.	Mean	St. dev.	p-value
Zootechnical performance								
Weaning age		25.2	2.7	24.8	2.6	-0.4	2.5	0.158
Weaning weight		6.1	0.7	6.3	0.6	0.2	0.6	0.003
Weight at 75 days		27.9	4.7	28.2	3.7	0.3	4.3	0.520
Biosecurity management								
Empty days between rounds		3.8	2.0	3.7	2.9	-0.3	3.0	0.446
Animal health management								
Animal health knowledge	Cause piglet diarrhoea	4.1	0.5	3.8	1.0	-0.4	1.0	0.002
	Prevent piglet diarrhoea	3.1	0.9	3.6	0.8	0.5	1.2	0.000
	Cause 50 kg pig diarrhoea	1.8	0.6	2.0	0.4	0.2	0.7	0.003
	Infection route 50 kg pig diarrhoea	3.0	1.0	3.1	1.0	0.1	1.1	0.267
	Symptoms PRRS sow	3.0	0.7	3.1	0.8	0.0	1.0	0.676
	Diagnosis PRRS sow	3.4	0.8	3.7	0.8	0.3	1.2	0.015
	All topics (30 questions)	18.4	2.3	19.3	3.1	0.9	2.7	0.002
MIS use								
MIS use (times per week)		0.6	1.0	1.6	1.0	1.1	0.9	0.000
Learning activities								
Compare practices with other pig farmers		3.0	1.2	3.4	0.8	0.3	1.4	0.029
Consult other pig farmers		3.1	1.1	3.5	0.7	0.4	1.3	0.006
Consulting family members		2.7	1.2	3.0	1.1	0.3	1.5	0.091
Consulting an expert		3.7	0.9	3.7	0.7	-0.0	1.0	0.747
Experimenting		1.2	1.6	2.7	1.1	1.5	1.7	0.000
Attending courses		3.2	0.9	3.2	1.1	-0.0	1.1	0.760
Looking for information in books, magazines, internet		3.2	0.6	3.2	0.8	0.1	1.1	0.765
Exchanging information with pig farmers		3.9	1.1	3.4	0.8	0.5	1.4	0.001
Joining a cooperation		4.2	1.2	3.8	0.7	-0.4	1.3	0.003

4.3 Biosecurity management: Less visits of veterinarian and more cleaning and disinfection

Table 4.2 describes biosecurity management in the baseline and endline and the development from baseline to endline of the 86 linked respondents. The development is presented in categories 'more often', 'same', and 'less often' (visit frequency veterinarian, cleaning & disinfection frequency) or change in yes/no-response (hygiene measures). Visit frequency of the veterinarian was once a month for 69% of the linked respondents and less than once a month for 15% in the baseline (Table 4.2). In contrast, in the endline visit frequency was once a month for 29% and less than once a month for 62%. For 59% of the linked respondents, the veterinarian visited the farm less often in the endline than in the baseline, whereas for about 9% this was more often. Veterinarians visited the farms of the linked respondents significantly less often in the endline than in the baseline.

About 55% of the linked respondents cleaned and disinfected the pens after each round in the baseline, and this increased to 75% in the endline. About 44% cleaned and disinfected less often, and this declined to 25% in the endline. About 32% of the linked respondents increased the cleaning and

disinfection frequency, whereas 11% decreased this. Overall, cleaning and disinfection frequency was significantly higher in the endline than in the baseline.

Cleaning and disinfection frequency of the pens was significantly higher in the endline than in the baseline. Of the linked respondents, 94-100% indicated to use coveralls and 92-93% to use specific boots in both the baseline and endline. In contrast, only 11-13% indicated to apply hand washing and 12-20% to apply visitor showers. No significant difference between baseline and endline was observed for these hygiene measures.

Table 4.3 describes the mean number of empty days between rounds in the baseline and endline and the mean development from baseline to endline of the 86 linked respondents. The mean number of empty days between finishing rounds was around 3.7-3.8 in both surveys. No significant difference between baseline and endline was observed.

4.4 Animal health management: More knowledge

Table 4.3 describes the mean number of correct answers on the animal health questions in the baseline and endline and the mean development from baseline to endline of the 86 linked respondents. The linked respondents had the highest number of correct answers for the cause of piglet diarrhoea highest (4.1 and 3.8) and diagnosis of PRRS in sows (3.4 to 3.7). They had the lowest number of correct answers out of five questions about the cause diarrhoea in a 50 kg pig (1.8 in baseline and 2.0 in endline). For the other three topics, they had around 3 correct answers out of five. Over all six topics, the linked respondents had 18 to 19 correct answers out of the 30 answers.

Comparing the number of correct answers in the endline to that in the baseline, the mean number of correct answers on the five questions about prevention of piglet diarrhoea increased from 3.1 to 3.6, about the cause of diarrhoea in a 50 kg finishing pig from 1.8 to 2.0, and about the diagnosis of PRRS in sows from 3.4 to 3.7. The mean number of correct answers on the questions about the cause of piglet diarrhoea declined from 4.1 in the baseline to 3.8 in the endline. For the other two topics, no difference in the mean number of correct answers between baseline and endline was observed. The mean number of correct answers of the in total 30 answers over the six topics was 0.9 higher ($p=0.002$) in the endline than in the baseline (increase from 18.4 to 19.3).

4.5 More use of management information system

Table 4.3 describes the mean number of times the farmer used the MIS per week in the baseline and endline and the mean development from baseline to endline of the 86 linked respondents. The mean number of times per week linked respondents used the MIS more than doubled from 0.6 times in the baseline to 1.6 times in the endline.

4.6 More learning activities

Table 4.3 provides the responses on the questions about the learning activities in the previous three years in the baseline and endline. In the baseline, joining a cooperation (4.2 on a scale of 1 to 5), exchanging information with pig farmers (3.9), and consulting an expert (3.7) were the three most applied learning activities. In the endline, these were joining a cooperation (3.8), consulting an expert (3.7), and consulting other pig farmers (3.5). Experimenting (1.2 in baseline, 2.7 in endline) and consulting family members (2.7 and 3.0) were the least applied learning activities in both the baseline and endline. In the endline, all learning activities were performed to a larger extent (4 activities) or to the same extent (4 activities) than in the baseline, except for joining a cooperation, which was performed to a lower extent.

5 Not possible to reliably assess whether farmer training and farmer advisor training improved performance and management

It was not possible to draw statistically reliable conclusions about the effectiveness of the farmer trainer and the farmer advisor training in increasing the speed of performance and management improvement, because too few respondents participated in the farmer training (8) and too few respondents had their advisor in a training (17). In addition, for part of the trainings the period between training and endline was too short to expect any impact on performance and management. These trainings were postponed until just prior to the endline survey due to outbreaks of ASF and COVID-19 in South Korea. Nevertheless, results of the analyses about the effectiveness of the trainings can be interesting, for example to formulate hypotheses for future research. Section 5.1 presents the results of the analyses about the effectiveness of the farmer training and Section 5.2 about those of the farmer advisor training.

5.1 Too few pig farmers in farmer training

Of the 107 pig farmers for which the baseline and endline results could be linked, eight participated in the farmer training in the Netherlands and 99 did not (Table 5.1). The eight respondents with farmer training came from six different regions (Table 5.1). The 99 respondents without farmer training came from five regions, with over 60% from Gyeongnam and around 30% from Jeju. The respondents are not representative for the whole population of pig producers in South Korea (see Section 3.1). The majority, around 90%, of the respondents with and without farmer training were male. Respondents with farmer training were significantly younger than respondents without farmer training. Younger farmers were specifically targeted to participate in the training. Most respondents with training (67.5% in baseline and 75.0% in endline) had a university level education, whereas of those without training the majority had high school level education (52.5% and 46.9%), but this difference was not significant at 5%. Half of the respondents with training had over 300 sows, whereas between 15 and 20% of respondents without training had over 300 sows, but this difference was not significant at 5%. In the baseline, 75% of respondents with farmer training and 62.2% of respondents without training had more than 1,500 finishing pigs. In the endline, 85% of respondents in both groups had more than 1,500 finishing pigs. The distributions in the baseline and endline did not differ between the groups.

To assess effectiveness of the training

Table 5.1 provides the development from baseline to endline of the respondents with and without farmer training. For the development concerning region, gender, and age, we refer to the explanations given in Section 4.1. Due to the low number of responses, we keep responses of farmers that changed region or had a non-logical development in education or age in the results. Most respondents, 75.0% of those with farmer training and 83.7% of those without, had the same educational level in the baseline and endline. Twenty-five per cent of respondents with training and 13.3% of those without had a higher educational level in the endline than in the baseline. This development in educational level did not significantly differ between respondents with and without training. Most respondents, 62.5% of those with training and 74.5% of those without training, had the same number of sows in both surveys, and 12.5% and 19.4% showed an increase in number of sows, respectively. The development in number of sows did not differ significantly between the groups. The development in number of finishing pigs was like that of sows, with 55 to 60% of the respondents in both groups having the same number of finishing pigs in both surveys and around 40% showing an increase. The development in number of finishing pigs did not differ significantly between the groups.

Table 5.6 General characteristics of 107 pig farmers in South Korea that participated in both baseline and endline survey on zootechnical performance, animal health management, and biosecurity management (baseline in 2017/2018 and endline in 2020/2021), specified to farmers with and without farmer training in the Netherlands (significant at $p < 0.05$ bold)

Characteristic		Responses (%)						
		Baseline		Endline		Development baseline to endline		
		With farmer training	Without farmer training	With farmer training	Without farmer training	Development Category	With farmer training	Without farmer training
Region	n	8	98	7	99	n	7	98
	Seoul City	0.0	0.0	0	0.0	Same region	100.0	98.0
	Gyeonggi	37.5	3.1	42.9	3.0	Different region	0.0	2.0
	Gangwon	0.0	0.0	0	0.0	Difference at $p=0.871$		
	Chungbuk	0.0	3.1	0	3.0			
	Chungnam	12.5	0.0	0	0.0			
	Gyeonbuk	12.5	0.0	14.3	3.0			
	Jeonbuk	0.0	0.0	0	0.0			
	Daegu City	0.0	2.0	0	0.0			
	Gyeongnam	12.5	62.2	14.3	61.6			
	Jeonnam	12.5	0.0	14.3	0.0			
	Jeju	12.5	29.6	14.3	29.3			
		Difference at $p=0.000$		Difference at $p=0.000$				
Gender	n	8	98	7	96	n	7	95
	Male	87.5	91.8	71.4	91.7	Same gender	85.7	96.8
	Female	12.5	8.2	28.6	8.3	Different gender	14.3	3.2
		Difference at $p=0.521$		Difference at $p=0.137$		Difference at $p=0.251$		
Age	n	8	99	8	98	n	8	98
	<20	0.0	0.0	0	0.0	Younger	0.0	3.0
	20-29	50.0	1.0	12.5	0.0	Same age group	25.0	62.2
	30-39	50.0	12.1	37.5	8.2	Older	75.0	34.7
	40-49	0.0	22.2	37.5	21.4	Difference at $p=0.076$		
	50-59	0.0	33.3	0	24.5			
	60-69	0.0	25.3	12.5	34.7			
	>70	0.0	6.1	0	11.2			
		Difference at $p=0.000$		Difference at $p=0.003$				
Education level	n	8	99	8	98	n	8	98
	Elementary school	0.0	0.0	0	0.0	-2	0.0	1.0
	Middle/Junior High school	0.0	2.0	0	1.0	-1	0.0	2.0
	High School	25.0	52.5	12.5	46.9	0	75.0	83.7
	Junior College	12.5	21.2	12.5	19.4	+1	25.0	8.2
	University	62.5	24.2	75	32.7	+2	0.0	5.1
		Difference at $p=0.135$		Difference at $p=0.123$		Difference at $p=0.381$		
Number of sows	n	8	99	8	98	n	8	98
	<50	0.0	1.0	0	1.0	-2	0.0	1.0
	50-99	0.0	10.1	12.5	8.2	-1	25.0	5.1
	100-149	12.5	23.2	12.5	18.4	0	62.5	74.5
	150-199	37.5	25.3	12.5	22.4	+1	12.5	14.3
	200-299	0.0	24.2	12.5	30.6	+2	0.0	3.1
	≥ 300	50.0	16.2	50	19.4	+3	0.0	2.0
		Difference at $p=0.155$		Difference at $p=0.389$		Difference at $p=0.377$		
Number of finishers	n	8	98	7	88	n	7	88
	<200	0.0	1.0	0	0.0	-1	0.0	6.8
	200-499	12.5	4.1	0	0.0	0	57.1	54.5
	500-999	12.5	13.3	0	0.0	+1	14.3	25.0
	1,000-1,499	0.0	19.4	14.3	14.8	+2	14.3	11.4
	1,500-2,499	37.5	36.7	14.3	38.6	+3	14.3	2.3
	$\geq 2,500$	37.5	25.5	71.4	46.6	Difference at $p=0.448$		
		Difference at $p=0.475$		Difference at $p=0.366$				

5.1.1 Zootechnical performance: group without training improved PSY and MSY more

Table 5.2 describes the PSY and MSY in the baseline and endline and the development from baseline to endline of the linked respondents with and without farmer training in the Netherlands. The percentage of respondents with a high PSY (23 or higher) was higher for the respondents with farmer training than for those without farmer training in both the baseline (87.5% versus 42.1%) and endline (75.0% versus 57.3%). In contrast, the percentage of respondents with a low PSY (up to 19) was lower for the respondents with training (0.0%) than for those without training (7.3%). In both survey rounds, the distributions did not differ significantly between the two groups. Looking at the development from baseline to endline, the respondents without training showed significantly more improvement in PSY than those with training in the Netherlands. The difference in PSY category in the baseline might partially explain this, because it is easier to improve if you have a lower PSY than if you have a higher PSY.

In the baseline, the respondents with farmer training had a significantly higher MSY than those without farmer training ($p=0.000$). In the endline, the MSY distributions did not differ significantly anymore between the two groups. This indicated that the respondents without training showed significantly more improvement in MSY than the respondents with training in the Netherlands. The difference in MSY category in the baseline might partially explain this, because it is easier to improve if you have a lower MSY than if you have a higher MSY.

Table 5.3 describes the weaning age, weaning weight, and weight at 75 days in the baseline and endline and the development from baseline to endline of the linked respondents with and without farmer training in the Netherlands. Mean weaning age and mean weaning weight did not differ significantly between the respondents with and without training in both survey rounds. Mean weight at 75 days was higher for the respondents with training than for those without, but in the endline no significant difference was observed. The development in weaning age, weaning weight, and weight at 75 days from baseline to endline did not differ between the respondents with and without farmer training.

Table 5.7 Baseline and endline results and development from baseline to endline for ordinal questions of 107 pig farmers that participated both in the baseline survey in 2017/2018 and in the endline survey in 2020/2021, specified to farmers with and without farmer training in the Netherlands (significant at $p<0.05$ bold)

Variable	% responses							
	Baseline		Endline		Development baseline to endline			
	Farmer with training	Farmer without training	Farmer with training	Farmer without training	Development category	Farmer with training	Farmer without training	
Zootechnical performance								
PSY	n	8	95	8	96	n	8	94
	<17.0	0.0	4.2	0.0	3.1	-2	0.0	1.1
	17.0-18.9	0.0	8.4	0.0	4.2	-1	50.0	7.4
	19.0-20.9	12.5	15.8	0.0	11.5	0	25.0	52.1
	21.0-22.9	0.0	29.5	25.0	24.0	+1	12.5	25.5
	23.0-24.9	62.5	24.2	62.5	24.0	+2	12.5	12.8
	≥25.0	25.0	17.9	12.5	33.3	+3	0.0	1.1
		Difference at $p=0.186$		Difference at $p=0.362$			Difference at $p=0.034$	
MSY	n	7	97	8	97	n	7	96
	<15.0	0.0	16.5	0.0	6.2	-2	14.3	0.0
	15.0-16.9	0.0	22.7	0.0	11.3	-1	42.9	2.1
	17.0-18.9	14.3	37.1	0.0	8.2	0	28.6	19.8
	19.0-20.9	0.0	9.3	62.5	27.8	+1	14.3	33.3
	21.0-22.9	57.1	14.4	25.0	11.3	+2	0.0	22.9
	≥23.0	28.6	0.0	12.5	35.1	+3	0.0	16.7
		Difference at $p=0.000$		Difference at $p=0.263$		+4	0.0	5.2
		Difference at $p=0.000$						

Variable		% responses										
		Baseline		Endline		Development baseline to endline						
		Farmer with training	Farmer without training	Farmer with training	Farmer without training	Development category	Farmer with training	Farmer without training				
Biosecurity management												
Frequency of visit of veterinarian	n	8	98	8	95	n	8	94				
	Every week	12.5	6.1	0.0	4.2	more often	25.0	10.6				
	Every 2 weeks	25.0	10.2	37.5	9.5	same	50.0	34.0				
	Every month	37.5	67.3	37.5	28.4	less often	25.0	55.3				
	Less than once a month	25.0	16.3	25.0	57.9		Difference at p=0.126					
		Difference at p=0.166		Difference at p=0.081								
Cleaning & disinfection	n	8	99	8	98	n	8	98				
	After each round	100.0	57.6	100.0	77.6	more often	0.0	30.6				
	Less often	0.0	41.4	0.0	22.4	same	100.0	59.2				
	never	0.0	1.0	0.0	0.0	less often	0.0	10.2				
		Difference at p=0.052		Difference at p=0.201			Difference at p=0.086					
Hygiene measures		% yes (n)	% yes (n)	% yes (n)	% yes (n)		n less	n same	n more	n less	n same	n more
	Use coveralls	100 (8)	94.9 (98)	100.0 (8)	100.0 (98)		0	8	0	0	92	5
		Difference at p=1.000		No statistics, are same			Difference at p=1.000					
	Use specific boots	100 (8)	92.8 (97)	100.0 (8)	93.9 (98)		0	8	0	6	83	7
		Difference at p=1.000		Difference at p=1.000			Difference at p=1.000					
	Hand washing	62.5 (8)	9.3 (97)	0.0 (8)	13.3 (98)		5	3	0	8	76	12
		Difference at p=0.001		Difference at p=0.592			Difference at p=0.001					
	Visitor shower	62.5 (8)	12.4 (97)	25.0 (8)	20.6 (97)		3	5	0	6	76	13
		Difference at p=0.003		Difference at p=0.672			Difference at p=0.003					

Table 5.8 Baseline and endline results and development from baseline to endline for ratio variables of the pig farmers that participated both in the baseline survey in 2017/2018 and in the endline survey in 2020/2021, specified to farmers with and without farmer training in the Netherlands (significant at $p < 0.05$ bold)

Variable	Baseline					Endline					Development baseline to endline						
	Farmer with training		Farmer without training		Differ- ence p-value	Farmer with training		Farmer without training		Differ- ence p-value	Farmer with training		Farmer without training		Differ- ence p-value		
	Mean	St. dev.	Mean	St. dev.		Mean	St. dev.	Mean	St. dev.		Mean ¹	St. dev.	Mean	St. dev.			
Zootechanical performance																	
Weaning age	24.5	2.4	25.2	2.7	0.495	23.6	3.0	24.9	2.6	0.221	-0.5	2.2	-0.3	2.4	0.264		
Weaning weight	6.6	0.8	6.1	0.7	0.137	6.7	0.9	6.3	0.6	0.369	0.3	1.1	0.2	0.6	0.305		
Weight at 75 days	32.1	4.8	27.9	4.5	0.049	30.3	3.7	28.3	3.7	0.137	-0.7	6.9	0.4	4.1	0.471		
Biosecurity management																	
Empty days between rounds	5.0	2.5	3.8	2.2	0.244	3.2	2.6	3.6	2.8	0.901	-2.3	3.3	-0.3	3.0	0.258		
Animal health management																	
Animal health knowledge Cause piglet diarrhoea	4.4	0.5	4.1	0.4	0.117	4.3	1.0	3.9	1.0	0.189	-0.1	1.3	-0.3	1.0	0.513		
Prevent piglet diarrhoea	3.0	1.3	3.1	0.9	0.808	4.0	0.8	3.6	0.8	0.142	1.0	1.4	0.5	1.1	0.436		
Cause 50 kg pig diarrhoea	1.4	1.1	1.8	0.6	0.096	2.3	1.2	2.0	0.5	0.079	0.9	1.1	0.2	0.7	0.031		
Infection route 50 kg pig diarrhoea	3.0	0.8	3.1	1.0	0.603	3.4	0.9	3.2	1.0	0.715	0.4	0.9	0.1	1.1	0.570		
Symptoms PRRS sow	3.3	0.9	3.1	0.7	0.832	3.5	0.9	3.2	0.9	0.434	0.3	1.0	0.1	1.0	0.553		
Diagnosis PRRS sow	3.6	0.5	3.4	0.8	0.593	4.0	0.9	3.7	0.8	0.386	0.4	0.9	0.3	1.1	0.710		
All 30 questions	18.6	2.2	18.6	2.3	0.909	21.4	3.2	19.5	3.1	0.109	2.8	3.5	1.0	2.7	0.146		
MIS use																	
MIS use per week	1.3	1.3	0.6	0.9	0.1	1.5	0.8	1.7	1.3	0.837	0.8	1.7	1.2	1.2	0.324		
Learning activities																	
											n less	n same	n more less	n less	n same more		
Compare practices with other pig farmers	3.5	0.9	3.0	1.0	0.446	3.8	0.7	3.4	0.8	0.519	2	2	4	16	49	33	0.383
Consult other pig farmers	3.4	1.3	3.1	0.9	0.059	3.1	1.0	3.5	0.7	0.345	3	3	2	12	54	32	0.155
Consulting family members	2.6	1.3	2.7	1.1	0.362	3.1	1.1	3.0	1.1	0.870	2	2	4	20	42	36	0.633
Consulting an expert	3.4	1.1	3.7	0.9	0.527	3.8	1.0	3.7	0.7	0.125	3	1	4	23	50	24	0.062
Experimenting	3.1	1.1	1.8	1.1	0.008	3.0	1.3	2.7	1.1	0.769	3	1	4	12	28	58	0.165
Attending courses	2.8	0.9	2.2	0.9	0.162	3.1	1.6	3.2	1.0	0.121	2	0	6	9	12	77	0.235
Looking for information in books, magazines, internet	3.3	1.3	3.1	0.8	0.144	3.4	0.7	3.3	0.7	0.590	2	3	3	22	45	30	0.898
Exchanging information with pig farmers	3.4	1.2	2.9	1.0	0.296	2.7	1.4	3.5	0.8	0.057	2	3	2	14	35	49	0.314
Joining a cooperation	2.9	1.5	4.2	1.1	0.008	3.1	1.1	3.8	0.7	0.004	2	2	4	50	28	18	0.138

¹ The mean development endline minus baseline can differ from the mean endline minus mean baseline, because not all farmers provided a response in the baseline or in the endline and the mean in the baseline and mean in the endline are, thus, based on a different number of responses.

5.1.2 Biosecurity management: group without training increased hand washing and visitor showering more

Table 5.2 describes the frequency visit of the veterinarian, the cleaning and disinfection frequency, and applied hygiene measures in the baseline and endline and the development from baseline to endline of the 107 linked respondents with and without farmer training in the Netherlands. For most of the respondents in the baseline and endline and with and without training, the veterinarian visited once a month or less. In the endline, veterinarian visits were less frequent than in the baseline. However, the frequency distributions in each survey and the development from baseline to endline did not differ significantly between respondents with and without training.

In the baseline, all respondents with training cleaned and disinfected the pens after each round, whereas 57.6% of the respondents without training did so. However, this difference was not significant. In the endline, the percentage of respondents without farmer training that cleaned and disinfected after each round increased to 77.6%. Respondents without training increased the cleaning and disinfection frequency more than those with training at a significance level $p=0.08$.

Almost all respondents with and without training in the baseline and endline indicated to use coveralls and specific boots. In contrast, in the baseline hand washing and visitor showering was used by 62.5% of the respondents with training and with around 10% of the respondents without training. In the endline, for the respondents with training both hand washing and visitor showering was lower than in the baseline, whereas it was higher than in the baseline for respondents without training. This development was significantly different between the two groups.

Table 5.3 describes the number of empty days between rounds in the baseline and endline and the development from baseline to endline of the linked respondents with and without farmer training in the Netherlands. In both the baseline and endline, the mean number of empty days between rounds did not differ significantly between the respondents with and without training. Respondents with training reduced the number of empty days between rounds from 5.0 to 3.2, whereas those without training reduced it from 3.8 to 3.6. However, these developments did not differ significantly between the two groups.

5.1.3 Animal health management: similar development of groups with and without training

Table 5.3 describes the mean number of correct answers on the animal health questions in the baseline and endline and the mean development from baseline to endline of the linked respondents with and without farmer training in the Netherlands. The respondents in both surveys and with and without training had the most correct answers about the cause of piglet diarrhoea and the diagnosis of PRRS in sows, whereas they had the lowest number of correct answers about the cause of diarrhoea in a 50 kg pig. The mean number of correct answers did not differ between the respondents with and without training. The mean number of correct answers in the endline was higher than in the baseline for both respondents with and without training for all categories, except for the cause of piglet diarrhoea. In this category, the respondents had the most correct answers in the baseline (between 3.9 and 4.4 out of 5.0), so it was difficult to improve this. The largest increase in correct answers was seen for prevention of piglet diarrhoea and the cause of diarrhoea in a 50 kg pig. The development in number of correct answers in each category and in total did not differ between respondents with and without training, except for the cause of diarrhoea in a 50 kg pig which was significantly higher for respondents with training than for those without it.

5.1.4 Similar development in use of management information system of groups with and without training

Table 5.3 describes the mean number of times the farmer used a MIS per week in the baseline and endline and the mean development from baseline to endline of the linked respondents with and without farmer training in the Netherlands. In the baseline, respondents with training used a MIS about twice as much as respondents without training. In contrast, in the endline both groups used a MIS about the same number of times per week. Both groups showed an increase in the number of times per week they used a MIS. This development did not significantly differ between the two groups.

5.1.5 Learning activities: similar development of groups with and without training

Table 5.3 describes the responses on the questions about the learning activities in the previous three years in the baseline and endline and the development from baseline to endline of the linked respondents with and without farmer training in the Netherlands. In the baseline, respondents with training applied the learning activities consulting family members, attending a course, and joining a pig cooperation less often than the other six learning activities, which were all applied at a similar rate. The most applied learning activities of respondents without training were joining a cooperation and consulting an expert. Their least applied learning activities were experimenting, attending a course, and consulting a family member. Experimenting was applied significantly more often in the group with training than in the group without it, whereas joining a cooperation was applied significantly less. Both groups applied the other learning activities at the same rate. Both groups applied most of the learning activities more often in the endline compared to the baseline. Respondents with training applied exchanging information with other pig farmers, consulting other pig farmers, and experimenting less in the endline, and respondents without training joining a cooperation. In the endline, joining a pig cooperation was applied significantly less by the group with training than by the group without training. No difference was observed between the two groups in the development from baseline to endline.

5.2 Too few farmers with their advisor in a training

Of 17 of the 107 pig farmers for which the baseline and endline results could be linked, the advisor participated in a training in the Netherlands (Table 5.4). The 17 respondents with their advisor in a training came from four different regions (Table 5.4). The 90 respondents without advisor training came from five regions, with 62% from Gyeongnam and 34% from Jeju. This regional distribution is not representative for the whole population of pig producers in South Korea (see Section 3.1). The vast majority, around 90%, of the respondents with and without advisor training were male. The age did not differ significantly between the groups with and without their advisor in a training. Most of the respondents with training (67.5% in baseline and 75.0% in endline) had a university level education, whereas of those without training the majority had high school level (52.5% and 46.9%), but this difference was not significant at 5%. In the baseline, about 30% of the respondents with their advisor in training had over 300 sows, whereas that was about 17% of the respondents without their advisor in training. In the endline, in both groups between 20% and 25% had over 300 sows and this difference was not significant. In the baseline, 88% of the respondents with their advisor in training had more than 1,500 finishing pigs, significantly more than the 58% of the respondents without their advisor in training. In the endline, around 85% of the respondents in both groups had more than 1,500 finishing pigs.

To assess the effectiveness of the farmer advisor training in the Netherlands, Table 5.4 also provides the development from baseline to endline of the respondents with and without their advisor having participated in a training. For the development concerning region, gender, and age, we refer to the explanations given in Section 4.1. Due to the low number of responses, we keep responses of farmers that changed region or had a non-logical development in education or age in the results. Most respondents in both groups, around 82-83%, had the same educational level in the baseline and the endline, and around 10 to 15% increased their educational level. This development in educational level did not significantly differ between the respondents with and without their advisor in a training. Most respondents, 59% of those with their advisor in training and 76% of those without their advisor in training, had the same number of sows in both surveys, and 24% and 18% showed an increase in number of sows, respectively. The development in number of sows did not differ significantly between the two groups. Of the respondents with their advisor in training, around 25% showed an increase in number of finishing pigs, whereas this was around 42% of the respondents without their advisor in training. The development in number of finishing pigs did not differ significantly between the two groups.

Table 5.9 General characteristics of 107 pig farmers in South Korea that participated in both baseline and endline survey on zootechnical performance, animal health management, and biosecurity management (baseline in 2017/2018 and endline in 2020/2021), specified to farmers with and without their advisor having participated in a training in the Netherlands (significant at $p < 0.05$ bold)

Characteristic		Responses (%)						
		Baseline		Endline		Development baseline to endline		
		With advisor training	Without advisor training	With advisor training	Without advisor training	Development Category	With advisor training	Without advisor training
Region	n	17	89	16	90	n	16	89
	Seoul City	0.0	0.0	0.0	0.0	Same region	100.0	97.8
	Gyeonggi	35.5	0.0	37.5	0.0	Different region	0.0	2.2
	Gangwon	0.0	0.0	0.0	0.0	Difference at $p=1.000$		
	Chungbuk	17.6	0.0	18.8	0.0			
	Chungnam	5.9	0.0	0.0	0.0			
	Gyeonbuk	0.0	1.1	0.0	4.4			
	Jeonbuk	0.0	0.0	0.0	0.0			
	Daegu City	0.0	2.2	0.0	0.0			
	Gyeongnam	41.2	61.8	43.8	61.1			
	Jeonnam	0.0	1.1	0.0	1.1			
	Jeju	0.0	33.7	0.0	33.3			
		Difference at $p=0.000$		Difference at $p=0.000$				
Gender	n	17	89	15	88	n	15	87
	Male	88.2	92.1	93.3	89.8	Same gender	93.3	96.6
	Female	11.8	7.9	6.7	10.2	Different gender	6.7	3.4
		Difference at $p=0.0634$		Difference at $p=1.000$		Difference at $p=0.196$		
Age	n	17	90	17	89	n	17	89
	<20	0.0	0.0	0.0	0.0	Younger	5.9	2.2
	20-29	11.8	3.3	5.9	0.0	Same age group	58.8	59.6
	30-39	23.5	13.3	23.5	7.9	Older	35.3	38.2
	40-49	23.5	20.0	23.5	22.5	Difference at $p=0.630$		
	50-59	23.5	32.2	23.5	22.5			
	60-69	17.6	24.4	23.5	34.8			
	>70	0.0	6.7	0.0	12.4			
		Difference at $p=0.415$		Difference at $p=0.074$				
Education level	n	17	90	17	89	n	17	89
	Elementary school	0.0	0.0	0.0	0.0	-2	5.9	0.0
	Middle/Junior High school	0.0	2.2	0.0	1.1	-1	0.0	2.2
	High School	29.4	54.4	29.4	47.2	0	82.4	83.1
	Junior College	17.6	21.1	17.6	19.1	+1	11.8	9.0
	University	52.9	22.2	52.9	32.6	+2	0.0	5.6
		Difference at $p=0.083$		Difference at $p=0.373$		Difference at $p=0.289$		
Number of sows	n	17	90	17	89	n	17	89
	<50	5.9	0.0	5.9	0.0	-2	5.9	0.0
	50-99	0.0	11.1	0.0	10.1	-1	11.8	5.6
	100-149	5.9	25.6	11.8	19.1	0	58.8	76.4
	150-199	47.1	22.2	29.4	20.2	+1	23.5	12.4
	200-299	11.8	24.4	29.4	29.2	+2	0.0	3.4
	≥ 300	29.4	16.7	23.5	21.3	+3	0.0	2.2
		Difference at $p=0.013$		Difference at $p=0.281$		Difference at $p=0.160$		
Number of finishers	n	17	89	16	79	n	16	79
	<200	0.0	1.1	0.0	0.0	-1	12.5	5.1
	200-499	11.8	3.4	0.0	0.0	0	62.5	53.2
	500-999	0.0	15.7	0.0	0.0	+1	18.8	25.3
	1,000-1,499	0.0	21.3	12.5	15.2	+2	6.3	12.7
	1,500-2,499	47.1	34.8	31.3	38.0	+3	0.0	3.8
	$\geq 2,500$	41.2	23.6	56.3	46.8	Difference at $p=0.701$		
		Difference at $p=0.023$		Difference at $p=0.871$				

5.2.1 Zootechnical performance: group with advisor in training increased weaning weight more

Table 5.5 describes the PSY and MSY in the baseline and endline and the development from baseline to endline of the linked respondents with and without their advisor in a training in the Netherlands. In both the baseline and the endline, the distributions of PSY and MSY of the respondents with their advisor in training did not significantly differ from those of the respondents without their advisor in training. Looking at the development in PSY from baseline to endline, about 55% of the respondents with their advisor in training and around 25% of those without showed an increase, and 38% and 52%, respectively, had the same PSY in the endline as in the baseline. The development did not differ significantly between the groups. For MSY, in both groups around 70% showed an increase, and 20-25% had the same MSY in the endline as in the baseline. This development did not differ significantly between the groups.

Table 5.6 describes weaning age, weaning weight, and weight at 75 days in the baseline and endline and the development from baseline to endline of the linked respondents with and without their advisor in a training in the Netherlands. In the baseline, no difference was observed between the two groups for these three variables. In the endline, mean weaning age did also not differ significantly, but mean weaning weight and mean weight at 75 days was higher for the respondents with their advisor in training than for those without. Looking at the development from baseline to endline, weaning age increased for the group with their advisor in a training, whereas it decreased for those without. This difference was not significant. For mean weaning weight and mean weight at 75 days, both groups showed an increase. The increase was higher for the groups with their advisor in a training, but this was only significant for weaning weight.

Table 5.10 Baseline and endline results and development from baseline to endline for ordinal questions of 107 pig farmers that participated both in the baseline survey in 2017/2018 and in the endline survey in 2020/2021, specified to farmers with and without their advisor having participated in a training in the Netherlands (significant at $p < 0.05$ bold)

Variable	% responses							
	Baseline		Endline		Development baseline to endline			
	With advisor training	Without advisor training	With advisor training	Without advisor training	Development category	With advisor training	Without advisor training	
Zootechnical performance								
PSY	n	16	87	16	88	n	16	86
	<17.0	0.0	4.6	0.0	3.4	-2	0.0	1.2
	17.0-18.9	12.5	6.9	12.5	2.3	-1	6.3	11.6
	19.0-20.9	18.8	14.9	0.0	12.5	0	37.5	52.3
	21.0-22.9	18.8	28.7	12.5	26.1	+1	37.5	22.1
	23.0-24.9	37.5	25.3	37.5	25.0	+2	18.8	11.6
	≥25.0	12.5	19.5	37.5	30.7	+3	0.0	1.2
		Difference at $p=0.728$		Difference at $p=0.159$			Difference at $p=0.595$	
MSY	n	15	89	16	89	n	15	88
	<15.0	6.7	16.9	6.3	5.6	-2	0.0	1.1
	15.0-16.9	20.0	21.3	6.3	11.2	-1	6.7	4.5
	17.0-18.9	26.7	37.1	6.3	7.9	0	26.7	19.3
	19.0-20.9	13.3	7.9	25.0	31.5	+1	33.3	31.8
	21.0-22.9	26.7	15.7	12.5	12.4	+2	26.7	20.5
	≥23.0	6.7	1.1	43.8	31.5	+3	0.0	18.2
		Difference at $p=0.373$		Difference at $p=0.964$		+4	6.7	4.5
	Difference at $p=0.495$							

Variable	% responses								
	Baseline		Endline		Development baseline to endline				
	With advisor training	Without advisor training	With advisor training	Without advisor training	Development category	With advisor training	Without advisor training	Without advisor training	
Biosecurity management									
Frequency visit of veterinarian	n	16	90	17	86	n	16	86	
	Every week	0.0	7.8	0.0	4.7	more often	31.3	8.1	
	Every 2 weeks	25.0	8.9	52.9	3.5	same	37.5	34.9	
	Every month	50.0	67.8	23.5	30.2	less often	31.3	57.0	
	Less than once a month	25.0	15.6	23.5	61.6		Difference at p=0.022		
		Difference at p=0.124		Difference at p=0.000					
Cleaning & disinfection	n	17	90	17	89	n	17	89	
	After each round	82.4	56.7	94.1	76.4	more often	17.6	30.3	
	Less often	17.6	42.2	5.9	23.6	same	76.5	59.6	
	never	0.0	1.1	0.0	0.0	less often	5.9	10.1	
		Difference at p=0.116		Difference at p=0.187			Difference at p=0.554		
Hygiene measures		% yes (n)	% yes (n)	% yes (n)	% yes (n)	n less n same	n more n less	n same n more	
	Use coveralls	100.0 (17)	94.4 (89)	100.0 (17)	100.0 (89)	0	17	0	0 83 5
		Difference at p=1.000		No statistics, all use			Difference at p=0.589		
	Use specific boots	100.0 (17)	92.0 (88)	100.0 (17)	93.3 (89)	0	17	0	6 74 7
		Difference at p=0.595		Difference at p=0.586			Difference at p=0.404		
	Hand washing	11.8 (17)	13.6 (88)	11.8 (17)	12.4 (89)	2	13	2	11 66 10
		Difference at p=1.000		Difference at p=1.000			Difference at p=1.000		
	Visitor shower	23.5 (17)	14.8 (88)	18.8 (16)	21.3 (89)	3	11	2	6 70 11
		Difference at p=0.470		Difference at p=1.000			Difference at p=0.326		

Table 5.11 Baseline and endline results and development from baseline to endline for ratio variables of the pig farmers that participated both in the baseline survey in 2017/2018 and in the endline survey in 2020/2021, specified to farmers with and without their advisor having had training in the Netherlands (significant at $p < 0.05$ bold)

Variable	Baseline					Endline					Development baseline to endline						
	With advisor training		Without advisor training		Differ- ence p-value	With advisor training		Without advisor training		Differ- ence p-value	With advisor training		Without advisor training		Differ- ence p-value		
	Mean	St. dev.	Mean	St. dev.		Mean	St. dev.	Mean	St. dev.		Mean ¹	St. dev.	Mean	St. dev.			
Zootechnical performance																	
Weaning age	24.9	2.6	25.1	2.7	0.880	25.3	2.6	24.7	2.6	0.371	0.3	1.3	-0.4	2.5	0.325		
Weaning weight	6.4	0.6	6.1	0.7	0.192	7.0	0.5	6.3	0.6	0.001	0.6	0.4	0.2	0.7	0.015		
Weight at 75 days	28.8	2.7	28.1	4.8	0.234	30.3	2.8	28.2	3.7	0.026	1.5	3.7	0.2	4.3	0.296		
Biosecurity management																	
Empty days between rounds	3.8	3.0	3.9	2.1	0.846	2.7	2.3	3.7	2.8	0.211	-1.1	3.1	-0.3	3.0	0.982		
Animal health management																	
Animal health knowledgeCause piglet diarrhoea	4.1	0.3	4.1	0.5	0.770	4.5	0.5	3.8	1.0	0.008	0.4	0.6	-0.4	1.0	0.006		
Prevent piglet diarrhoea	2.9	1.1	3.1	0.9	0.649	3.7	0.9	3.6	0.8	0.750	0.8	1.2	0.5	1.2	0.529		
Cause 50 kg pig diarrhoea	1.8	0.5	1.7	0.7	0.695	2.1	1.1	2.0	0.4	0.232	0.3	1.1	0.3	0.7	0.815		
Infection route 50 kg pig diarrhoea	3.4	0.7	3.0	1.0	0.340	3.2	1.0	3.2	1.0	0.708	-0.1	1.2	0.2	1.1	0.499		
Symptoms PRRS sow	3.2	0.5	3.1	0.8	0.727	3.9	0.9	3.1	0.9	0.001	0.7	0.9	0.0	1.0	0.014		
Diagnosis PRRS sow	3.8	0.7	3.4	0.8	0.056	3.9	0.8	3.7	0.8	0.290	0.2	0.8	0.3	1.2	0.662		
All 30 questions	19.2	1.7	18.4	2.3	0.238	21.4	2.8	19.3	3.1	0.011	2.2	3.2	0.9	2.7	0.070		
MIS use																	
MIS use per week	0.53	0.49	0.68	1.02	0.756	2.46	1.98	1.57	0.99	0.166	1.8	2.1	1.0	1.1	0.466		
Learning activities																	
											n less	n same	n more less	n same	n more less		
Compare practices with other pig farmers	2.9	1.0	3.1	1.0	0.919	3.5	0.8	3.4	0.7	0.593	2	8	7	16	43	30	0.827
Consult other pig farmers	3.2	1.0	3.1	1.0	0.124	3.2	1.0	3.5	0.7	0.094	3	9	5	12	48	29	0.870
Consulting family members	2.4	1.1	2.8	1.1	0.319	2.6	1.2	3.0	1.0	0.383	3	8	6	19	36	34	0.889
Consulting an expert	3.5	0.7	3.7	0.9	0.240	3.7	0.6	3.7	0.7	0.520	3	8	5	23	43	23	0.883
Experimenting	1.9	1.1	1.8	1.2	0.480	2.9	1.2	2.7	1.1	0.185	2	5	10	13	24	52	1.000
Attending courses	2.1	1.0	2.3	0.8	0.133	3.1	1.2	3.2	1.1	0.639	2	0	15	9	12	68	0.357
Looking for information in books, magazines, internet	2.7	0.8	3.2	0.9	0.127	3.4	0.6	3.2	0.8	0.902	0	8	9	24	40	24	0.012
Exchanging information with pig farmers	2.7	1.1	3.0	1.0	0.624	3.4	1.1	3.4	0.9	0.327	3	4	10	13	34	41	0.486
Joining a cooperation	3.9	1.2	4.1	1.2	0.731	3.5	0.9	3.8	0.7	0.059	7	5	4	45	25	18	0.822

¹ The mean development endline minus baseline can differ from the mean endline minus mean baseline, because not all farmers provided a response in the baseline or in the endline and the mean in the baseline and mean in the endline are, thus, based on a different number of responses.

5.2.2 Biosecurity management: group with advisor in training increased veterinarian visit frequency more

Table 5.5 describes the frequency visit of the veterinarian, the cleaning and disinfection frequency, and applied hygiene measures in the baseline and endline and the development from baseline to endline of the linked respondents with and without their advisor participating in a training in the Netherlands. In the baseline, for 75% to 85% of the respondents in both groups the veterinarian visited at least once a month. In the endline, the veterinarian visited still about 75% of the respondents with their advisor in a training at least once a month, but it dropped substantially to 40% for the respondents without their advisor in a training. The development from baseline to endline differed significantly between the groups.

In the baseline, 82% of the respondents with their advisor in training cleaned and disinfected the pens after each round, whereas just 57% of the respondents without their advisor in training did so. However, this difference was not significant. In the endline, both groups had a higher cleaning and disinfection rate than in the baseline, with 94% and 76% cleaning and disinfecting after each round for the group with and without the advisor in training, respectively. No significant difference in development from baseline to endline was observed between the groups.

Almost all respondents with training and without their advisor in a training in the baseline and endline used coveralls and specific boots. In contrast, hand washing and visitor showering were only used by between 10% and 25% of the respondents in both groups and in both surveys. No significant difference in development from baseline to endline was observed between the groups.

Table 5.6 describes the mean number of empty days between rounds in the baseline and endline and the development from baseline to endline of the linked respondents with and without the advisor in a training in the Netherlands. In the baseline, the mean number of empty days between rounds did not differ significantly between the respondents with and without their advisor in a training in both the baseline and endline. Respondents with their advisor in a training reduced the mean number of empty days from 3.8 to 2.7, whereas those without their advisor in a training reduced it from 3.9 to 3.7. These developments did not differ significantly.

5.2.3 Animal health management: group with advisor in training increased knowledge more

Table 5.6 describes the mean number of correct answers to the animal health questions in the baseline and endline and the mean development from baseline to endline of the linked respondents with and without their advisor participating in a training in the Netherlands. The respondents in both surveys and in both groups had the most correct answers about the cause of piglet diarrhoea and the diagnosis of PRRS in sows, whereas they had the lowest number of correct answers about the cause of diarrhoea in a 50 kg pig. In the baseline, no significant differences in mean number of correct answers were observed. However, in the endline the mean number of correct answers about the cause of piglet diarrhoea and the diagnosis of PRRS in sows as well as the total number of correct answers was significantly higher for the group with their advisor in a training than for the group without. For almost all categories, the mean number of correct answers was higher in the endline than in the baseline. The development from baseline to endline in mean number of correct answers about the cause of piglet diarrhoea and the diagnosis of PRRS in sows differed significantly between the groups.

5.2.4 No difference between groups in development of use of management information system

Table 5.6 describes the mean number of times the farmer used a MIS per week in the baseline and endline and the mean development from baseline to endline of the linked respondents with and without their advisor having had a training in the Netherlands. In the baseline, respondents with their advisor in a training used a MIS about the same number of times per week as respondents without their advisor in a training. In contrast, in the endline the group with their advisor in a training used a MIS about 1.5 times as much per week than the group without their advisor in a training. Both groups

showed an increase in the number of times per week they used a MIS. This development did not significantly differ between the two groups.

5.2.5 Learning activities: similar development of groups with and without their advisor in training

Table 5.6 describes the responses on the questions about the learning activities in the previous three years in the baseline and endline and the development from baseline to endline of the linked respondents with and without their advisor participating in a training in the Netherlands. In the baseline, the extent to which respondents had used each of the learning activities varied between a mean score of 1.8 to 4.1 (out of a possible 5). Both groups used joining a cooperation and consulting an expert the most, and experimenting, attending a course, and consulting family members the least. In the endline, the mean score varied less over the learning activities, between 2.6 and 3.8, and all activities were used in the same magnitude. Both groups applied all learning activities more in the endline compared to the baseline, except for joining a cooperation which both applied less. Joining a cooperation was applied most in the baseline, so it might have been difficult to increase the application rate. No difference was observed between the two groups in the development from baseline to endline, except for looking for information in books, magazines, internet which showed a larger increase for the group with their advisor in a training compared to the group without.

6 Discussion: impact of situation in South Korea during the study and future research topics

This report showed that all the South Korean pig farmers that participated in the survey and those of them that participated in the farmer training or had their advisor in a training improved zootechnical performance, biosecurity management and animal health management from 2017 to 2020. In 2020, compared to 2017, MSY was higher, cleaning and disinfection frequency was higher, and farmers had more correct answers on questions about animal health. However, we cannot draw conclusions on whether training in the Netherlands can increase the speed of improving zootechnical performance, biosecurity management, and animal health management in South Korea. Outbreak of ASF and COVID-19 resulted in too few farmers participating in a training in the Netherlands (8) and in too few farmers of which the advisor followed a training in the Netherlands (17) to find statistically reliable results. These outbreaks also delayed and prevented implementation of several knowledge exchange arrangements that were planned within the project, especially those that require the physical gathering of people in one location. The implementation of the third farmer training in the Netherlands was delayed from the middle of 2019 to November 2020. This was very close to the endline survey and of several pig farmers no baseline survey was taken, therefore a potential impact of this training is not expected to be identified in the results. Study clubs could only start a few weeks before the end of the project and only one open day could be held at the PDC, which was held online. Therefore, data to reliably assess the effectiveness of study clubs and open days to increase performance and management could not be gathered and the effectiveness of these knowledge exchange arrangements could not be assessed in this project.

After the outbreak of ASF in 2019, the South Korean government reformed the infectious animal disease control law to reduce the risk of spreading diseases between pig farms by enhancing biosecurity on pig farms. This can have contributed to the autonomous improvement in biosecurity management and zootechnical performance found in our study.

We could not statistically reliably assess whether pig farmer training or pig farmer advisor training in the Netherlands improved South Korean pig farmer performance and management, because of the low number of respondents in either of these trainings. However, in satisfaction surveys held at the end of each training, participating pig farmers and advisors indicated to have high satisfaction with the training. Furthermore, several pig farmers that participated in a training later also took part in study clubs as a follow-up to the training. This indicates that the pig farmers saw added value in participating in these knowledge exchange innovations. Being satisfied with the trainings and other knowledge exchange interventions and voluntarily participating in them is an important first step in using acquired knowledge and ultimately in improving performance and management.

For almost all the questions in our survey, data on national level were not available. So, it is not possible to compare the respondents with the national average. Korean statistics provide data about the development in MSY. Average MSY was 16.2 in 2017 and 17.9 in 2020 (KOSIS, 2021). In our survey, we asked for MSY in categories. In the baseline, 26.4% indicated to have a MSY between 15.0 and 16.9, 64.3% a MSY of 17.0 or higher, and 9.3% a MSY of less than 15.0 (Table 3.2). In the endline, 20.1% of the respondents indicated to have a MSY between 17.0 and 18.9, 57.6% a MSY of 19.0 or more, and 22.3% a MSY of less than 17.0 (Table 3.2). This indicates that the participants in our survey had a higher MSY than the national South Korean average. Because national data were not available for most of the questions, it was not possible to compare the development in performance and management of respondents with farmer training or with their advisor in training to the national average development.

We compared development in performance and management of respondents with farmer training or with their advisor in training to the development of farmers in the survey without these trainings. In this, we did not correct for differences in general characteristics between the groups of linked respondents with and without each type of training, because the number of respondents with each type of training was too low to find reliable statistical results. For four of the six general characteristics we did not find significant differences between the respondents with and without each type of training. However, for two characteristics significant differences were observed: geographical distribution and age between linked respondents with and without farmer training, and geographical distribution and number of finishing pigs between linked respondents with and without their advisor in training. Such differences between the groups of linked respondents with and without each type of training could cause a difference in development in performance and management. Therefore, in future studies with a higher number of respondents the statistical analysis should include a correction for such differences between groups, for example using propensity score matching.

From the start of the outbreak of COVID-19 in the beginning of 2020, no travel of the Dutch researchers to South Korea was possible anymore. Instead, communication was done through on-line meetings and email. This complicated communication and exchange of information between the Dutch and Korean partners in the project. This could have negatively influenced the implementation and quality of activities, especially for those that were developed based on experience from the Dutch partners, such as the survey and knowledge exchange arrangements implemented in South Korea.

The responses in the baseline could be linked to the responses in the endline for 107 pig farmers, because some cooperatives did not record the contact details of the pig farmer linked to each unique respondent number, and some cooperatives could not retrieve the contact details in the endline survey. Although this sample size is sufficient for statistical analyses on the whole sample population, it appeared to be insufficient to identify statistical results for potential sub-populations within this sample of pig farmers.

All pig farmer and advisor trainings held in the Netherlands lasted for five days and included lectures of researchers and company experts on multiple topics, such as animal health, biosecurity, feeding management, sow management, economics, management information system use. The trainings also included visits to a Dutch pig farm, to show Dutch pig farming in practice. Thus, only a limited amount of time could be spent on each of the topics. Hardly any time was available for deep discussions, practical exercises, or advice tailored to the need of an individual pig farmer or advisor. In this project, we could not assess the effectiveness of trainings, due to the low number of participants. However, we did see some significantly higher improvements in performance and management variables from 2017 to 2020 of pig farmers participating in a training or of pig farmers of which the advisor participated in a training than those who did not. The question is whether this observed difference in development is due to the training or due to randomness. The underlying question is, if the limited amount of time on each topic, is sufficient for a Korean pig farmer to actively change his or her management to such an extent, that the actual performance would have been changed within the timespan of the project.

7 Conclusion and recommendations

7.1 Conclusion: improved zootechnical performance, biosecurity management, and animal health management, but not possible to reliably assess whether training increased this

From 2017 to 2020, an autonomous improvement on zootechnical performance, biosecurity management and animal health management of the pig farmers that participated in our survey was observed. In 2020 compared to 2017, MSY was higher, cleaning and disinfection frequency was higher, and farmers had more correct answers on questions about animal health. However, we cannot draw statistically reliable conclusions about the effectiveness of training of South Korean pig farmers and of training of their advisors to increase improvement in performance and management beyond the autonomous development. Outbreaks of African Swine Fever and COVID-19 resulted in too few farmers participating in a training (8) and in too few farmers of which the advisor followed a training (17) to draw statistically reliable conclusions about differences in performance and management development from baseline to endline between pig farmers with and without a training, nor between pig farmers with and without their advisor in a such a training. Pig farmers and their advisors were highly satisfied with the training and, after that, they voluntarily participated in other knowledge exchange innovations such as study clubs. This is a first step in acquiring new knowledge, using the acquired knowledge, and ultimately in improving performance and management.

7.2 Recommendations: suggestions to improve future research

We recommend:

- To arrange a larger number of participants in knowledge exchange arrangements than realised in this study, to increase the statistical power of the results.
- To implement a larger number of each of the knowledge exchange arrangements than in this study, to increase the statistical power of the results.
- To rather address less topics in a training and spend more time on each of these topics including practical training than to address many topics, and all only briefly.

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