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Understanding and Developing Nomadic Duck Farming Systems in Indonesia

A follow-up to the HPAI Endemicity Study in Indonesia

Technical report

August 2020

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Contents

List of Tables

List of Figures

Executive Summary

Nomadic duck farming systems are an important source of income for people living in rural areas who do not have access to land or capital. Although there has been significant work undertaken in Indonesia to better understand and control diseases such as HPAI, there has been minimal work done in the nomadic farming sector. A previous study conducted in West Java identified that between 6% to 15% of the nomadic duck flocks had H5 antibodies and 42% were identified as HPAI positive. Improving nomadic farming systems and poultry health is essential to boost farm productivity and minimise the spread of important poultry diseases such as HPAI.

This study identifies the major issues facing nomadic farmers and provides recommendations on how to improve productivity, livelihoods and biosecurity.

Farmers choose to be involved in nomadic duck farming systems as it allows them to be part of the sector while requiring only small levels of capital and minimal training. Because of this, farmers tend to be young and mobile, with low levels of formal education. Although for most farmers this farming system was their main source of income, most would prefer to raise ducks in semi-intensive or intensive systems. This would allow them to seek other sources of income.

There are many issues that nomadic duck farmers regard as limiting their potential to maximize income and reduce disease spread. The main factors identified by 98 nomadic duck farmers in Purbalingga District of West Java were difficulties in accessing affordable and good quality feed, instability of egg production, lack of technical support, weather, and access to finance and capital. Using Factor Analysis, these issues were aggregated into 4 groups.

1. *External factors*. These are factors generally beyond the direct influence of the farm, factors that are not easy for the farmer to influence.
2. *Duck Farm Management*. Factors that can be defined as able to be managed by the farmer. These relate to access to feed and movement of ducks.
3. *Ducks lost*. These are basically non duck health issues that cause losses. They include deaths by predators or ducks eating the wrong feeds or simply being separated from the flock and not returning. These are miscellaneous duck loss issues
4. *Duck health*. These are duck morbidity and mortality issues caused by disease.

From this analysis is recommended that supporting government and other value chain actors work with the farmers to improve their management and reduce losses due to poor grazing management and duck transport stress. It is recommended that standard operating procedures on duck movement, duck transport and trade be developed and training provided on controlling ducks in the field, duck health, and feed management.

Introduction

The Highly Pathogenic Avian Influenza (HPAI) endemicity study in 2016−2018 succeeded in identifying the persistence of the HPAI virus (HPAIV) in the Purbalingga district of Central Java. The study confirmed the presence of the HPAIV in all poultry types, including nomadic ducks, in live bird markets. Follow-up activities were initiated which focused on improving biosecurity in live bird markets, poultry collector yards, and commercial poultry farms, however, this did not include developing and implementing improved biosecurity and management in nomadic duck farming systems.

Nomadic duck farming is unique as it involves the movement of flocks between farms and regions. Minimizing disease movement is difficult and this system has significant potential to contribute to HPAI persistence. A study conducted in West Java identified that between 6% to 15% of the nomadic duck flocks had H5 antibodies and 42% were identified as HPAI positive. (Sudarnika et al, 2018). A study in Central Java indicated a bird-level H5 seroprevalence rate of 2.6% for nomadic ducks without vaccination (Henning, 2010).

A social network study of nomadic ducks in Central Java identified significant contact between value chain actors. During the scavenging period, ducks have contact with other flocks and wild birds, while farmers interact with hatcheries, paddy field owners and transporters. A national control strategy for HPAI infection in nomadic duck systems has not yet been developed. Movement restrictions may reduce disease movement but may not be feasible. The first step in developing a useful strategy to improve productivity and prevent HPAI infection is to obtain a better understanding of the farming systems.

As there are significant economic benefits in nomadic duck production it will be necessary to ensure that any control strategy considered must also evaluate the financial and social implications to the farmer. Further research on the costs and benefits of alternative strategies is required. The objectives of the study are therefore:

1. To identify and prioritise the economic, social and bird health issues facing nomadic ducks farmers in study area;
2. To provide recommendations to value chain actors and policy makers to improve nomadic duck management and farmer welfare and reduce the risk of HPAI.

Material and methods

The study was conducted between February and July 2019 in Purbalingga District, Central Java Province. Purbalingga was chosen as this project is a follow-up study to the endemicity study that was previously conducted in the Purbalingga District.

The study consisted of two phases; a rapid assessment and a farmer survey. The purpose of the rapid assessment was to identify the motivations behind farmers involvement in this production system and to identify the potential issues influencing the efficiency and financial stability of nomadic duck farming systems.

The second phase was a formal survey of nomadic duck farmers. The objectives of the survey were to measure, prioritise and summarize constraints. Recommendations are provided based on the results of this analysis.

Information on the importance of a range of production constraints were identified using the proportional piling method (FAO, 2000). Farmers were asked to express their opinions concerning the issues they face when keeping nomadic ducks. They were provided with 100 beans and requested to distribute them between the potential issues. The more beans allocated to an issue, the more important that issue was to the farmer. Farmers could elect not to allocate a bean if they had not experienced a particular constraint or did not regard it as important. Data from this survey were analyzed using descriptive and factor analysis. It was important to remember that participants may have provided subjective answers based on their feelings, or on the answers they thought they should give, to overcome this the enumerators used probing techniques to minimize this potential bias.

The survey was conducted by staff from the Animal Health Surveillance sub-directorate of the Directorate General of Livestock and Animal Health Services (DGLAHS), Food and Agriculture Organization of the United Nations (FAO), local agricultural services of Purbalingga district, and students of the Field Epidemiology Training Program for Veterinarian (FETPV) program at Gajah Mada University.

The rapid assessment was carried out in January 2019 and the survey undertaken between February and July 2019. Each interview lasted between a half and one hour, with farmers only available to be contacted between 7am and 9am or 4pm and 6pm. The first language of most

farmers was Javanese so interviews were conducted with at least one enumerator who could speak the local language.

The survey team remained in particular districts during the 5 month data collection period as it was assumed that after a month the duck flocks would have moved on to other districts so in the next month different farmers were interviewed. Nomadic duck farmers who originated outside the district but transited through Purbalingga were included in the survey. Table 1 summarises the study timetable.

Table 1: Timeline of study activities

Activities	2019												2020
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan-Aug
Rapid assessment													
Survey													
Analysis													
Report writing													

Rapid assessment results

Six nomadic duck farmers and two paddy field owners were interviewed. Following is the summary of the rapid assessment results.

Motivation

The respondents stated that it is easy for them to raise nomadic ducks and this system provided them with a sustainable source of income. Since most farmers did not have a high school degree, it was difficult to compete for jobs in other sectors apart from agriculture. So, raising ducks was a good option which did not require a large capital investment.

Capital

Finance came from individual savings. Farmers found it difficult to obtain bank loans as they often had no collateral or guaranteed means of repaying the loan. Some farmers had not considered accessing a bank loan.

Although farmers believe that maintaining nomadic ducks did not require a large capital investment, most farmers would still prefer to raise ducks in the higher cost semi-intensive or

intensive systems. They believe that these alternative systems allow them the opportunity to undertake off-farm work.

Education

Some farmers had only attained elementary level education. They had never received formal poultry management training and their knowledge was obtained primarily from other family members who also worked in the sector.

Disease knowledge

Farmers learned duck farming and poultry health through trial and error. When the ducks got sick, they tended not to call a veterinarian, instead they attempted to diagnose the problem for themselves. Even though ducks were vaccinated, farmers did not know the type of vaccine that was used, they just followed what other farmers did.

Livelihoods

Keeping nomadic ducks was the main livelihood for the survey participants. Additional income came from sales of salted eggs, pullets and spent ducks. Some farmers had side jobs as agricultural workers in order to earn extra income.

Assets

Farmers did not own duck sheds. If they raised pullets, they either used simple fences or rented a space from neighbours. To move the ducks to new areas, farmers often shared transportation with other farmers. For daily travel, to buy inputs or visit home, farmers would use a motorbike.

Farmers tended to live with their extended family and shared responsibilities for raising pullets. If the ducks needed to be moved away from the home location, the farmer would leave the family and look after the ducks at the feeding sites.

Daily routines

Farmers usually move the ducks in the morning. The ducks are released into feeding areas such as rice fields or a river. At midday farmers would check the ducks and, in the afternoon, around 4pm, lead the ducks back to the enclosure. The farmers returned home every day if the feeding site was

not far from home. If they were far away, however, farmers may be away from home for 2 to 3 weeks.

The farmer usually worked with others to monitor ducks. If one farmer returned home, another farmer in the group would assist with supervision of the ducks.

Finding feeding sites can take days. Some farmers, however, had a regular site that they would go to and had an on-going commitment with landowners to return as required.

Production

Farmers can either purchase day old ducks (DoDs) or pullets. Buying 5-week-old ducks can reduce feed costs as at that age ducks are old enough to scavenge directly from the rice fields. If farmers chose to purchase younger ducks they must provide feed which is more expensive. The trade-off is that the younger ducks are easier to train and handle so this minimizes the chances of ducks being separated from the flock.

The DODs and pullets were bought from suppliers in Purbalingga, Solo, Brebes in Central Java or Mojokerto in East Java. The selection of the duck breed was not specific and was based on personal preference.

Pullets were fed in a shed for the first month, they were provided with complete feed for the first two weeks and then for the next two, to reduce the cost, farmers often provided feed mixed with dried cooked rice and grains. The farmers discontinued providing feed at 5 to 6 weeks of age, at this age, ducks were able to graze in the fields.

Ducks started laying eggs at 5-6 months of age. On average 100 ducks would produce around 70 eggs per day. It would be less if the duck was stressed or sick. The ducks were kept until they were 100 weeks old, they were then sold as spent ducks.

Marketing

Duck collectors or duck buyers would purchase eggs and spent ducks depending on local market demand. Every two days buyers would come to purchase eggs. During the survey period, the average price was IDR2,100/egg. These prices provided by the farmer were estimates only as they did not keep records of their sales.

Rice field farmer affected by nomadic duck flocks

Only two rice farmers were interviewed. The two respondents did not object to nomadic ducks being on their fields. Instead they admitted that they benefited from scavenging ducks that ate snails and other pests. They also received eggs from the farmers as a payment.

Nomadic duck farmers informed rice field owners before entering their fields. However, rice field owners generally still allowed ducks to scavenge on their land even if the duck farmers did not ask permission.

List of potential issues identified by the rapid assessment

Based on the results of the rapid assessment a list of potential factors affecting the efficiency and productivity of nomadic duck farming was constructed. There were 22 factors identified (Table 2). These issues and understanding of the farming system identified by the rapid assessment were used as a basis for the following survey which looked in more detail at the farm management, biosecurity, productivity and profitability.

Table 2: List of possible factors influencing nomadic duck productivity

Code	Variable name	Code	Variable name
F1	Mortality	F12	Difficulties in getting affordable feed
F2	Disease	F13	Lost asset
F3	Duck predator	F14	Problem staying overnight
F4	Lost duck	F15	Marketing problem
F5	Driving ducks	F16	Farmers did not get technical support
F6	Ducks prey on dangerous objects	F17	Difficulties in getting capital
F7	Transportation stress	F18	Weather problem
F8	Conflict with landowners	F19	Family support issues
F9	Difficulties in searching feeding sites	F20	Financial problem
F10	Lack of water sources	F21	Instability in egg production
F11	Difficulties getting good feed quality for ducks	F22	Rental cost issues

Survey results

Characteristics of respondents

Data from 98 respondents was collected. The respondents came from Banjarnegara (9 respondents), Banyumas (16), Cilacap (1), Pemalang (10), and Purbalingga (62) districts. The minimum age of the respondents was 19, the median 48, and maximum 88 years old (Table 3).

Table 3: Respondents occupation and the education

	Freq (n=98)	%
Occupation		
duck rearing only	51	52
duck rearing and agriculture worker	36	37
duck rearing and other	11	11
Education		
elementary school	58	59
junior high	15	15
senior high	11	11
no education	14	14

Half of the respondents worked only in duck farming. More than a third of the respondents worked as both a nomadic duck farmer and in another agriculture sector. The rest worked as nomadic duck farmers and in other businesses.

Nearly 60% of the respondents had received an elementary school education. A quarter of respondents had completed high school. There were some (14%) who had never been to school, while none of the respondents had received a post-school education.

Descriptive analysis

The first step in the analysis was to undertake a descriptive analysis of the beans that were allocated to each issue identified by the farmer (proportional piling). Each issue was compared based on total score (total beans selected by all respondents), average (number of beans divided by number of participants), minimum (the lowest number of beans allocated by a respondent) and maximum (the highest number of beans allocated by a respondent). The initial ranking (Table 4) is based on the total score, starting from the highest and ending with the lowest.

Obtaining affordable feed was identified as the major factor influencing their farming system marketing or selling issues were the least important. Apart from difficulties in getting affordable feed the other most important issues identified were; instability in egg production; farmers not receiving sufficient support; bad weather, and difficulty in accessing good feed quality for their ducks.

Table 4: Respondent ranking of factors affecting nomadic duck farming efficiency

Rank	Code	Variable	Score	%		
				Min	Avg	Max
1	F12	Difficulties in getting affordable feed	3260	0	33.3	100
2	F21	Instability in egg production	2912	0	30.0	84
3	F16	Farmers did not get technical support	2640	0	26.9	100
4	F18	Weather problem	2420	0	24.7	89
5	F11	Difficulties getting good feed quality	2304	0	23.5	100
6	F20	Financial problem	2278	0	23.2	86
7	F17	Difficulties in getting capital	2276	0	23.2	90
8	F10	Lack of water sources	2199	0	22.4	87
9	F7	Transportation stress	2135	0	21.8	100
10	F2	Disease	2043	0	20.9	100
11	F1	Mortality	1833	1	18.7	78
12	F5	Driving ducks	1698	0	17.3	100
13	F9	Difficulties search feeding sites	1384	0	14.1	86
14	F4	Lost ducks	1335	0	13.6	70
15	F3	Duck predator	1076	0	11.0	83
16	F6	Ducks prey on dangerous objects	1051	0	10.7	49
17	F14	Problem staying overnight	965	0	9.9	65
18	F8	Conflict with landowners	809	0	8.3	64
19	F13	Assets lost	597	0	6.1	55
20	F19	Family support issues	587	0	6.0	70
21	F22	Rental cost issues	447	0	4.6	53
22	F15	Marketing problem	436	0	4.5	52

Factor analysis

The next step in the analysis was to consider whether or not there were significant correlations between issues identified by the farmer. Factor analysis was used to categorise the issues into groups by testing the correlation between variables. The outcome complements the results from the descriptive analysis.

The first step in factor analysis is to examine whether all the factors can be included for analysis by testing for normality. Based on the One-Sample Kolmogorov-Smirnov Test, factors 22, 19, and 15 are removed because their distributions are not normal (Appendix 2). This implies that data on these variables may not be sufficiently accurate to be used or compared with other variables.

The second step is to test whether the remaining 19 variables are fit to be used in factor analysis. Table 5 provides the results of two tests that indicate the suitability of the data for structure detection. The Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy is a statistic that identifies the proportion of variance in variables that might be caused by underlying factors. High values (close to 1.0) generally indicate that a factor analysis may be useful, if the value is less than 0.50, the results of the factor analysis probably won't be very useful.

Bartlett's test of sphericity tests the hypothesis that the correlation matrix is an identity matrix, which would indicate that the variables are unrelated and, therefore, unsuitable for structure detection. Small (less than 0.05) significance level values indicate that a factor analysis may be an appropriate data analysis technique.

In this study a KMO value of 0.852 and a significance level of the Bartlett's Test of Sphericity less than 0.05 confirms that factor analysis can be used with this data (Table 5).

Table 5: KMO and Bartlett's tests for suitability of data to be used in factor analysis

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.852
Bartlett's Test of Sphericity	Approx. Chi-Square	771.875
	df	171
	Sig.	.000

The next test was anti-image correlation. The anti-image correlation matrix contains the negatives of the partial correlation coefficients, and the anti-image covariance matrix contains the negatives of the partial covariances. In a good factor model, most of the off-diagonal elements will be small. The measure of sampling adequacy for a variable is displayed on the diagonal of the anti-image correlation matrix. The results are as shown in statistical outputs in Appendix 2.

After the extraction, the variance of communalities for each factor are obtained (Table 6). The communalities measure the proportion of variance in a given variable explained by the other factors. So, for example F1 has a communality 0.698 meaning 70% of the variance in F1 explained by the other 19 factors.

Table 6: Communalities in factors identified by respondents

Code	Initial	Extraction
F1	1.000	.698
F2	1.000	.761
F3	1.000	.647
F4	1.000	.601
F5	1.000	.637
F6	1.000	.742
F7	1.000	.623
F8	1.000	.587
F9	1.000	.571
F10	1.000	.635
F11	1.000	.688
F12	1.000	.401
F13	1.000	.595
F14	1.000	.598
F16	1.000	.336
F17	1.000	.632
F18	1.000	.672
F20	1.000	.549
F21	1.000	.549

Extraction Method: Principal Component Analysis

Principal Component Analysis (PCA) was then used to unite common factors into groups or components. Factors can be combined that are in fact, related to each other, that is they tend to explain or be related to a similar range of factors. Eigenvalues are the variances of the factors. The first factor accounts for the most variance and the next factor will account for as much of the left-over variance as it can. Each successive factor will account for less and less variance. So, in this analysis, 34.2% of the variance is explained through Factor 1 and 60.6% is explained through factors 1 to 4 (Table 7).

Table 7: Total variance explained

Component	Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %
1	6.5	34.19	34.19
2	2.4	12.61	46.8
3	1.56	8.226	55.03
4	1.07	5.622	60.647

Extraction method: Principal Component Analysis

Four components were selected as they were the only four that had an initial Eigenvalue greater than 1. If a factor has a low Eigenvalue (theoretically less than 1.0) then it is contributing little explanation of variance and can be ignored. After identifying the components they were extracted using the sum of squared loadings.

The variables are then rotated to see which variables are grouped into the 4 components. Rotated factor loadings represent both how the variables are weighted for each factor and the correlation between the variables and the factor. Because these are correlations, possible values range from -1 to +1. The results are shown in

Table 8 and the results summarised in Figure 1.

Table 8: Rotated component matrix

Code	Component			
	1	2	3	4
F1				.793
F2				.839
F3			.576	
F4			.710	
F5		.702		
F6			.825	
F7		.741		
F8			.710	
F9		.623		
F10	.515			
F11		.701		
F12		.484		
F13			.737	
F14		.583		
F16	.548			
F17	.765			
F18	.772			
F20	.674			
F21	.611			

The issues can be grouped together into components titled;

1. *External factors*. These are factors generally beyond the direct influence of the farm, factors that are not easy for the farmer to influence.
2. *Duck Farm Management*. Factors that can be defined as able to be managed by the farmer. These relate to access to feed and movement of ducks.

3. *Ducks lost*. These are basically non duck health issues that cause losses. They include deaths by predators or ducks eating the wrong feeds or simply being separated from the flock and not returning. These are miscellaneous duck loss issues
4. *Duck health*. These are duck morbidity and mortality issues caused by disease.

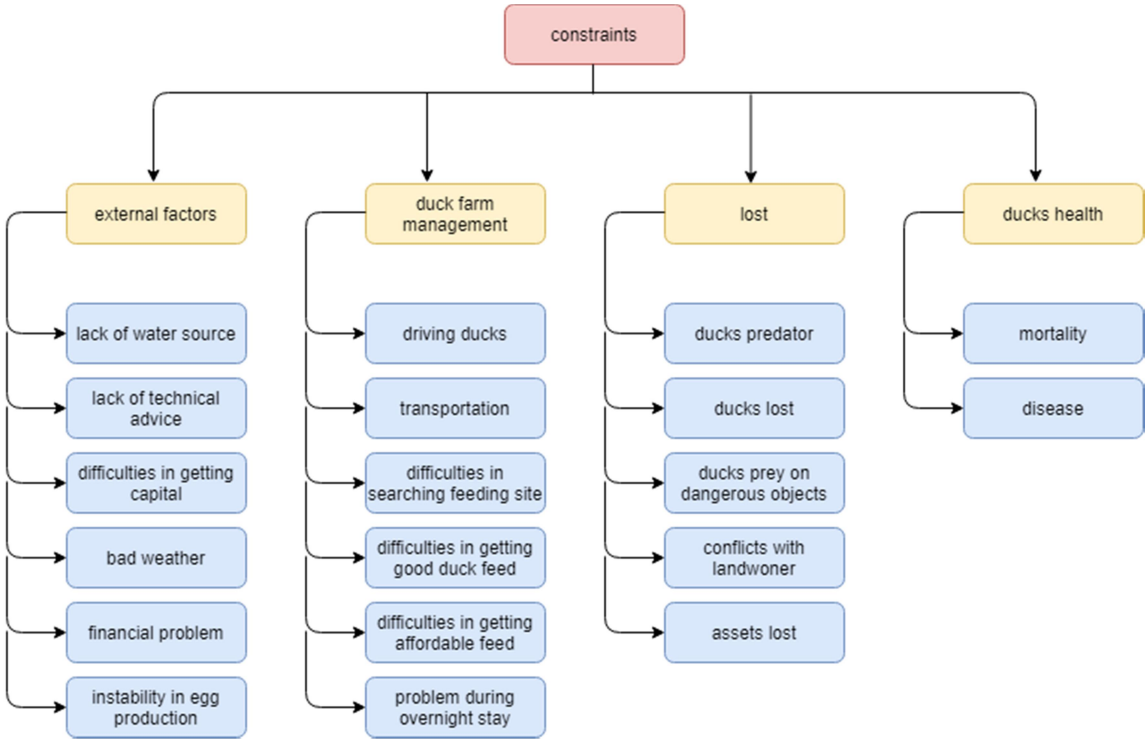

Figure 1: Grouping the factors into the four components

Summary and conclusion

The nomadic duck farming system and problems experienced by the farmers are not well understood. This project interviewed 98 nomadic duck farmers and asked them about their motivations in raising nomadic ducks and the issues affecting their livelihoods. Managing ducks that graze in rice fields does not require a large capital investment and duck management was relatively simple. However, there were issues that influenced the efficiency and profitability of their business. This project provided an opportunity to identify and address the issues that affected them as well as evaluating the role that this duck management system may play in the broader management of infectious poultry diseases such as HPAI.

This report identifies various factors that contribute to the efficiency and productivity of the farming system. There were 22 factors, 19 of which could be aggregated into 4 groups. The initial

descriptive analysis allowed each farmer to rank the individual factors by allocating 100 beans between the various factors. This meant that a factor, at one extreme, could have 0 beans allocated to it (not important at all) or the other extreme, 100 beans meaning that it was the only important factor, nothing else was important. The average allocation of beans was 33 per factor implying there was a wide range of attitudes to the different factors. Only one factor, 'mortality', was ranked by all farmers while 6 farmers ranked an individual factor as 100. These factors were; difficulties in getting affordable feed, lack of technical support, access to good quality feed, transportation stress, disease, and duck movement around fields.

Access to feed, whether it be purchased or grazed, seems to be a significant issue. Good quality purchased feed is difficult to access and costly while grazing options are limited due to seasonal cropping field needs. Accessing alternative grazing areas requires access to trucks and new areas and may stress the ducks. Releasing ducks in open fields also means a lack of biosecurity which can increase the disease risk. In this study, disease was identified as an important issue although sick waterfowl do not usually show clinical signs and many potential cases of disease remain undiagnosed. Better communication between technical staff and farmers could be beneficial. Lack of technical support is an important issue to be addressed so that they can not only improve their farming techniques but also be more aware of disease issues in their ducks.

Factor Analysis categorised the 22 sub-factors into 4 groups. These groups were titled external factors, duck farm management, ducks lost, and duck health.

'External factors' are the only variables that are generally beyond the influence of the farm. Lack of water is usually caused by the dry season or when rice field owners need to dry out their fields in order to burn the leftover stubble, this means the ducks must be removed. Also, since the farmers and ducks were housed in open fields, they are impacted directly by bad weather which then impacts the productivity of the ducks. For example, heavy rain can cause stress for ducks and instability in egg production.

Issues of access to finance and capital are included as external factors as farmers believe that access is just not available and there is nothing they can do. Although some banks in Indonesia do provide funds to asset-poor farmers, it may be that farmers are not aware of this or that the loan requirements are too difficult for them.

‘Duck farm management’ is a group of factors that have a direct influence on the farm and can be managed by the farmer. These factors include access to good quality affordable feed and duck movement processes. If these are not well managed, it may also affect the two other groups; ‘ducks lost’ and ‘duck health’. For example, if farmers have controlling duck grazing in the field, this may lead to ducks being separated from the flock and not returning. Also, it is possible in open fields that ducks consume a range of feedstuffs, some of which may be poisonous, which can cause illness or even death.

Although the Factor Analysis offers a high degree of flexibility for extraction, rotation and computing scores, it still has to meet requirements like most statistical procedures such as data sufficiency and normality. The quality of the data has been tested and the results presented in this report. While the data and, therefore, the analysis are good and valid, there are still some limitations in this analysis. First, only 19 factors could be used, so factors such as ‘family support’, ‘rental fee’, and ‘marketing’ could not be used. Secondly, even though individual factors have communed into groups a factor, some may not be grouped logically. For example, ‘losing assets’ and ‘conflict with land-owners’ may have no direct contribution to the group ‘ducks lost’ and may fit more logically into ‘external factors’. Thirdly, this analysis only summarizes the problems and does not answer the why question. To answer this, further analysis such as Path Analysis and Structured Equation Modelling (SEM) may help to measure relationships between variables or factors.

This study has identified and ranked the farmer’s perceptions of issues that they face raising nomadic ducks. The 22 factors identified have not only been ranked but also grouped into four groups, external factors, duck farm management, ducks lost, and duck health. This identification and aggregation will be a useful first step to extension workers, and other value chain actors in helping improve the efficiency and productivity of the nomadic farming system. Training and support activities should revolve around those factors that can be directly influenced by the farmer. Assistance should concentrate on the areas of access to quality and affordable feed, improving grazing management and minimising transport stress. The nomadic farming system provides a sustainable livelihood to farmers with limited access to land and capital. It should be supported and developed by government not only because of the livelihood benefits but also to minimise the risk of poultry disease movement in these farming areas.

Recommendations

Nomadic duck farming can continue to provide economic and social benefits to farmers who lack the capital and resources to manage ducks more intensively. There may also be benefits to rice farmers who can minimise pest control issues by allowing ducks into the paddy fields at the appropriate time. Nomadic duck farming, however, can lead to the maintenance and spread of HPAI and other poultry diseases as this system involves many possible opportunities for the mixing of birds over a large area. HPAI prevention and control in nomadic duck farms should, therefore, focus on restricting the movement and mixing of the flocks. This will, however, have significant effects on the livelihoods of the farmers.

With the support of the government, in order to maintain farmer income and welfare and reduce the potential for disease spread, the stakeholders in this sector can change their management practices. The following recommendations are made.

Table 9: Recommendations for assisting the development of nomadic duck farming systems

	Challenges	Opportunities
Low capital to invest in duck farming business	Limited access to information on bank loan; requirements for loan are not well known; low literacy on economy and investment	Local authority can consider facilitating the nomadic duck farmers to get better access to banks loans. This includes working with bank or relevant institutions to educate farmers regarding access to finance and loan types.
Poor quality and high cost of duck feed	High cost of duck feed causes farmer to feed the ducks in crop fields; poor quality duck feed; farmer cannot control the feed when ducks released in the crop fields; ducks may consume poisonous feeds	Research institution can consider developing good-quality affordable duck feed. Local authorities can also encourage local duck feed producers to provide the duck feed and help them monitor the quality. Animal health section also give training and awareness about good duck feed related to duck health to boost productivity.
Duck movement	Transportation stress affects duck health and egg productivity; farmers sharing transport so ducks are mixed; potential disease spread; truck transport travelled several places and may not be disinfected	Government can create SOPs to control poultry movement, use checkpoints for registration, truck cleaning and disinfection, conduct surveillance and virus monitoring in truck transports, and provide health certificates
Limited knowledge on best duck farming practice and duck health	Limited space or high cost to build duck cage so the ducks are housed in tents in open fields; ducks can be attacked by predators and affected by bad weather; farmer has limited knowledge of farm management; no biosecurity; sick or dead ducks are not reported	Animal health sections should educate the duck farmers on best duck farming practice and duck health, encourage them to have stationary farm rather than nomadic systems; duck best farming practice and duck health should include how to build effective duck cage, how to select good duck feed, advise them to vaccinate their duck and report if they suspect disease; farmers also are convinced that by having stationary systems, they are ensure that the ducks have enough water and can control the feeding, they also do not need to control duck in crop fields, and the egg production can continue over time and not be dependent on cropping needs or seasons.

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Appendices

Appendix 1: Survey form

Date: _____ 2019

Enumerator(s) name:

Time:

A. Profile of respondent		
1.	Name	
2.	Sex	☐ F ☐ M
3.	Age	years
4.	Last education	SD / SMP / SMA / PT / no education / other: ……. (circle that apply)
5.	District (farmer origin)	
6.	Sub-district (farmer origin)	
7.	Village (farmer origin)	
8.	Address (farmer origin)	
9.	GPS Southing (interview)	(degrees)
10.	GPS Easting (interview)	(degrees)
11.	Length of work in farm	Years (estimated)
12.	Occupation	☐ duck rearing only ☐ duck rearing and agriculture worker ☐ duck rearing and other: ……
13.	Role of work in duck farm (tick all that applicable)	☐ owner ☐ driving the duck ☐ feeding ☐ vaccinate / medicate ☐ other: ……..
14.	Flock size	Ducks (all ages)
15.	Egg production in a week	Eggs (estimated)

B. Identification of constraints Note: PP = proportional piling, denominator is the total beans		
F1	Mortality	PP: /
F2	Disease	PP: /
F3	Predator attacks (ex: civet, dog, etc)	PP: /
F4	Lost ducks (ex: stolen, missing)	PP: /
F5	Driving ducks (young duck difficult to drive)	PP: /
F6	Ducks prey dangerous objects	PP: /
F7	Transportation stress	PP: /
F8	Conflict with land owners	PP: /
F9	Difficult in searching feeding location	PP: /
F10	Lack of water source	PP: /
F11	Lack of good quality feed source	PP: /
F12	Difficult in getting cheap feed	PP: /
F13	Assets lost (ex: bike stolen, etc)	PP: /
F14	Problem during overnight stay	PP: /
F15	Marketing problem	PP: /
F16	Lack of technical advice (ex: disease diagnose, vaccination service, feeding advice, etc)	PP: /
F17	Difficult in getting capital (ex: bank loan, etc)	PP: /
F18	Problem with weather	PP: /
F19	Lack of support from family (ex: wife complain, lack of attention to children, etc)	PP: /
F20	Financial problem (ex: not enough earnings, etc)	PP: /
F21	Egg production is not stable	PP: /
F22	Land/cage rental charge problem (ex: expensive, etc)	PP: /

Appendix 2: Output statistics

a. Normality test

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The categories of F15 occur with equal probabilities.	One-Sample Chi-Square Test	.000[1]	Reject the null hypothesis.
2	The categories of F19 occur with equal probabilities.	One-Sample Chi-Square Test	.000[1]	Reject the null hypothesis.
3	The categories of F22 occur with equal probabilities.	One-Sample Chi-Square Test	.000[1]	Reject the null hypothesis.
4	The distribution of F1 is normal with mean 18.704 and standard deviation 14.78.	One-Sample Kolmogorov-Smirnov Test	.000[1]	Reject the null hypothesis.
5	The distribution of F2 is normal with mean 20.847 and standard deviation 19.26.	One-Sample Kolmogorov-Smirnov Test	.000[1]	Reject the null hypothesis.
6	The distribution of F3 is normal with mean 10.980 and standard deviation 12.33.	One-Sample Kolmogorov-Smirnov Test	.000[1]	Reject the null hypothesis.
7	The distribution of F4 is normal with mean 13.622 and standard deviation 12.98.	One-Sample Kolmogorov-Smirnov Test	.000[1]	Reject the null hypothesis.
8	The distribution of F5 is normal with mean 17.327 and standard deviation 20.14.	One-Sample Kolmogorov-Smirnov Test	.000[1]	Reject the null hypothesis.
9	The distribution of F6 is normal with mean 10.724 and standard deviation 11.48.	One-Sample Kolmogorov-Smirnov Test	.000[1]	Reject the null hypothesis.
10	The distribution of F7 is normal with mean 21.786 and standard deviation 20.15.	One-Sample Kolmogorov-Smirnov Test	.000[1]	Reject the null hypothesis.
11	The distribution of F8 is normal with mean 8.255 and standard deviation 11.95.	One-Sample Kolmogorov-Smirnov Test	.000[1]	Reject the null hypothesis.
12	The distribution of F9 is normal with mean 14.122 and standard deviation 16.83.	One-Sample Kolmogorov-Smirnov Test	.000[1]	Reject the null hypothesis.
13	The distribution of F10 is normal with mean 22.439 and standard deviation 19.93.	One-Sample Kolmogorov-Smirnov Test	.000[1]	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

[1]Lilliefors Corrected

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
14	The distribution of F11 is normal with mean 23.510 and standard deviation 21.74.	One-Sample Kolmogorov-Smirnov Test	.000[1]	Reject the null hypothesis.
15	The distribution of F12 is normal with mean 33.265 and standard deviation 22.99.	One-Sample Kolmogorov-Smirnov Test	.077[1]	Retain the null hypothesis.
16	The distribution of F13 is normal with mean 6.092 and standard deviation 11.07.	One-Sample Kolmogorov-Smirnov Test	.000[1]	Reject the null hypothesis.
17	The distribution of F14 is normal with mean 9.847 and standard deviation 14.09.	One-Sample Kolmogorov-Smirnov Test	.000[1]	Reject the null hypothesis.
18	The distribution of F16 is normal with mean 26.939 and standard deviation 24.63.	One-Sample Kolmogorov-Smirnov Test	.000[1]	Reject the null hypothesis.
19	The distribution of F17 is normal with mean 23.224 and standard deviation 23.92.	One-Sample Kolmogorov-Smirnov Test	.000[1]	Reject the null hypothesis.
20	The distribution of F18 is normal with mean 24.694 and standard deviation 19.87.	One-Sample Kolmogorov-Smirnov Test	.001[1]	Reject the null hypothesis.
21	The distribution of F20 is normal with mean 23.245 and standard deviation 21.94.	One-Sample Kolmogorov-Smirnov Test	.000[1]	Reject the null hypothesis.
22	The distribution of F21 is normal with mean 29.714 and standard deviation 21.02.	One-Sample Kolmogorov-Smirnov Test	.002[1]	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

[1] Lilliefors Corrected

b. Measures of Sampling Adequacy(MSA) coded in (a)

Anti-image Matrices

		F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F16	F17	F18	F20	F21
Anti-image Covariance	F1	.472	-.265	.018	.051	-.146	-.034	.017	-.045	.068	-.022	.060	-.042	-.061	.027	.120	-.023	.025	-.059	-.068
	F2	-.265	.469	-.102	-.080	.090	.008	-.065	.055	.001	-.022	.060	.017	.019	-.040	-.152	-.010	-.041	.045	.054
	F3	.018	-.102	.478	-.038	-.061	-.172	.054	-.004	-.040	-.098	.013	-.050	.077	-.071	.068	.001	.089	.091	.015
	F4	.051	-.080	-.038	.526	-.032	-.102	.010	-.011	.008	.001	.011	-.040	-.161	-.070	-.034	-.043	-.005	.014	.006
	F5	-.146	.090	-.061	-.032	.489	.054	-.150	-.022	.008	-.089	-.057	.023	.059	-.071	-.078	.040	-.043	-.040	.076
	F6	-.034	.008	-.172	-.102	.054	.375	-.060	-.173	-.018	-.010	-.007	.110	-.100	.056	-.022	-.010	-.020	.010	.032
	F7	.017	-.065	.054	.010	-.150	-.060	.550	.021	-.078	.001	-.070	-.143	.039	-.008	.007	.028	-.007	.025	-.087
	F8	-.045	.055	-.004	-.011	-.022	-.173	.021	.465	-.006	.028	.008	-.004	-.057	-.134	.050	.074	-.025	-.092	-.057
	F9	.068	.001	-.040	.008	.008	-.018	-.078	-.006	.537	-.100	-.078	-.004	-.059	-.085	.002	.086	-.031	-.064	.007
	F10	-.022	-.022	-.098	.001	-.089	-.010	.001	.028	-.100	.371	-.070	.016	-.053	.056	-.028	-.082	-.091	-.047	-.049
	F11	.060	.060	.013	.011	-.057	-.007	-.070	.008	-.078	-.070	.452	-.065	-.026	-.107	-.024	-.017	.048	.009	-.111
	F12	-.042	.017	-.050	-.040	.023	.110	-.143	-.004	-.004	.016	-.065	.642	-.056	-.030	.032	-.044	-.060	-.105	.025
	F13	-.061	.019	.077	-.161	.059	-.100	.039	-.057	-.059	-.053	-.026	-.056	.592	-.019	-.028	-.028	.063	.018	.016

	F14	.027	-.040	-.071	-.070	-.071	.056	-.008	-.134	-.085	.056	-.107	-.030	-.019	.451	-.001	-.054	-.002	-.018	-.046
	F16	.120	-.152	.068	-.034	-.078	-.022	.007	.050	.002	-.028	-.024	.032	-.028	-.001	.676	.063	-.107	-.107	-.055
	F17	-.023	-.010	.001	-.043	.040	-.010	.028	.074	.086	-.082	-.017	-.044	-.028	-.054	.063	.501	-.152	-.105	-.087
	F18	.025	-.041	.089	-.005	-.043	-.020	-.007	-.025	-.031	-.091	.048	-.060	.063	-.002	-.107	-.152	.453	-.021	-.078
	F20	-.059	.045	.091	.014	-.040	.010	.025	-.092	-.064	-.047	.009	-.105	.018	-.018	-.107	-.105	-.021	.542	-.017
	F21	-.068	.054	.015	.006	.076	.032	-.087	-.057	.007	-.049	-.111	.025	.016	-.046	-.055	-.087	-.078	-.017	.516
Anti-image Correlation	F1	.682[a]	-.563	.037	.102	-.304	-.081	.033	-.096	.134	-.053	.129	-.076	-.116	.059	.212	-.047	.054	-.118	-.138
	F2	-.563	.651[a]	-.215	-.160	.187	.019	-.128	.119	.002	-.053	.130	.032	.036	-.088	-.270	-.020	-.090	.089	.109
	F3	.037	-.215	.756[a]	-.076	-.127	-.406	.106	-.009	-.079	-.233	.028	-.091	.144	-.153	.120	.002	.191	.180	.031
	F4	.102	-.160	-.076	.901[a]	-.064	-.230	.018	-.023	.014	.001	.023	-.069	-.289	-.144	-.056	-.083	-.011	.026	.011
	F5	-.304	.187	-.127	-.064	.846[a]	.126	-.290	-.046	.016	-.209	-.121	.041	.109	-.151	-.136	.080	-.091	-.078	.151
	F6	-.081	.019	-.406	-.230	.126	.766[a]	-.132	-.413	-.040	-.026	-.017	.223	-.212	.137	-.044	-.023	-.049	.023	.072
	F7	.033	-.128	.106	.018	-.290	-.132	.885[a]	.041	-.143	.002	-.141	-.240	.068	-.017	.011	.053	-.014	.047	-.164
	F8	-.096	.119	-.009	-.023	-.046	-.413	.041	.834[a]	-.012	.066	.017	-.008	-.109	-.292	.090	.153	-.054	-.184	-.116
	F9	.134	.002	-.079	.014	.016	-.040	-.143	-.012	.912[a]	-.225	-.158	-.007	-.104	-.172	.004	.166	-.063	-.119	.013
	F10	-.053	-.053	-.233	.001	-.209	-.026	.002	.066	-.225	.907[a]	-.170	.032	-.113	.137	-.056	-.189	-.222	-.105	-.113

F11	.129	.130	.028	.023	-.121	-.017	-.141	.017	-.158	-.170	.901[a]	-.121	-.051	-.238	-.043	-.036	.107	.019	-.229
F12	-.076	.032	-.091	-.069	.041	.223	-.240	-.008	-.007	.032	-.121	.877[a]	-.091	-.056	.049	-.078	-.111	-.179	.043
F13	-.116	.036	.144	-.289	.109	-.212	.068	-.109	-.104	-.113	-.051	-.091	.854[a]	-.036	-.044	-.051	.121	.031	.029
F14	.059	-.088	-.153	-.144	-.151	.137	-.017	-.292	-.172	.137	-.238	-.056	-.036	.895[a]	-.002	-.114	-.004	-.037	-.096
F16	.212	-.270	.120	-.056	-.136	-.044	.011	.090	.004	-.056	-.043	.049	-.044	-.002	.810[a]	.108	-.193	-.176	-.092
F17	-.047	-.020	.002	-.083	.080	-.023	.053	.153	.166	-.189	-.036	-.078	-.051	-.114	.108	.864[a]	-.319	-.202	-.171
F18	.054	-.090	.191	-.011	-.091	-.049	-.014	-.054	-.063	-.222	.107	-.111	.121	-.004	-.193	-.319	.878[a]	-.043	-.161
F20	-.118	.089	.180	.026	-.078	.023	.047	-.184	-.119	-.105	.019	-.179	.031	-.037	-.176	-.202	-.043	.898[a]	-.031
F21	-.138	.109	.031	.011	.151	.072	-.164	-.116	.013	-.113	-.229	.043	.029	-.096	-.092	-.171	-.161	-.031	.903[a]

Appendix 3: Project photos

Survey team conducting interview

Summary of constraints in colour cards

Proportional piling exercises

Farmer driving the ducks in the feeding sites