THE EFFECT OF AVIAN INFLUENZA ON SECTOR 3 POULTRY FARMS IN EAST JAVA: PRELIMINARY RESULTS FROM A SURVEY

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Abstract

Avian Influenza caused losses to poultry producers in East Java in 2003 and 2004. Two surveys of poultry producers in affected districts were conducted in September 2005. One was of 125 broiler producers and the other of 125 egg producers. Based on results from these surveys the relationship between farmer and farm characteristics and likelihood of infection of poultry by Avian Influenza is examined using cluster analysis and probit analysis.

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1 Introduction

The avian influenza virus reached Indonesia in two waves, the first in 2003 and the second in 2004 (FAO, October, 2004). The disease caused productivity losses in the poultry industry and, being zoonotic, resulted in a consumer reaction with price falls in some poultry product categories of up to 60 per cent (Simmons, 2006). The disease also attracted high levels of media attention because of its potential to cause a human pandemic, a factor that has exacerbated the consumer reaction.

In this study farm-level aspects of the avian influenza (AI) epidemic around Blitar, the poultry centre of East Java are examined. The reactions of farmers to the disease in the last outbreak were addressed as well as the influence of AI on farm-level decision making and whether certain types of farm were more vulnerable to the disease than others. To this end, two surveys were conducted amongst Sector 3 poultry farms: a survey of egg producers and a survey of broiler producers.

The survey was designed and conducted in collaboration with the East Javanese division of Balai Pengkajian Teknologi Pertanian (BPTP), an Indonesian Ministry of Agriculture organization responsible for testing new agricultural technologies and disseminating technical information to farms. BPTP provided an experienced survey team with physical and social scientists experienced in dealing with the poultry industry.

Construction of the sample was complicated by the diversity of production and marketing arrangements in the Indonesian poultry industry. By species there are chickens, ducks, geese, quail and pigeons, all producing both meat and egg products, there are both wet[3] and processed markets, in terms of technology there FAO's Sectors 1, 2, 3 and 4[4] and, finally, contractual arrangements vary between farms. Funds for the survey were limited so the sample size was restricted to 250 households incorporating two groups with 125 households in each that were surveyed separately in September 2005. The first survey was of Sector 3 broiler producers living within one hour (by car) of the city of Blitar selling their produce in either wet spot markets or to contractors who resold it wet. The second sample was Sector 3 egg producers living within one hour (by car) of Blitar who sold their eggs in spot markets or to contractors for resale. Geographically, both samples were drawn from the *Kecamatan* of Jombang and Blitar and focussed on farms in the *Desa* of Diwek, Jogoroto, Mojowarno, Nglegok and Kademangan.

2. Description of Farmers and Farms

The household attributes in both samples were similar. Egg and broiler farmers were much the same in terms of age, gender, dependency ratios and educational levels. The most common household structure was two parents and two children. Around half of household members were male, average age of

[3] A wet market is either a fixed or temporary place where members of the public can buy small animals and birds that are: (a) live and slaughtered there, (b) live and taken home to be slaughtered, or (c) already slaughtered and sold as meat.

[4] Sector 1: Industrial integrated system with high level biosecurity and birds/products marketed commercially (e.g. farms that are part of an integrated broiler production enterprise with clearly defined and implemented standard operating procedures for biosecurity). Sector 2: Commercial poultry production system with moderate to high biosecurity and birds/products usually marketed commercially (e.g. farms with birds kept indoors continuously; strictly preventing contact with other poultry or wildlife). Sector 3: Commercial poultry production system with low to minimal biosecurity and birds/products usually entering live bird markets (e.g. a caged layer farm with birds in open sheds; a farm with poultry spending time outside the shed; a farm producing chickens and waterfowl). Sector 4: Village or backyard production with minimal biosecurity and birds/products consumed locally (FAO, 2005).

household heads was 40 years, 25% of household members were attending an educational institution and 30% were under 16 years of age. Household heads had 10.5 years formal schooling on average and the majority had training in livestock systems. Only three household heads were females, possibly widows.

Very few household heads earned income from non-poultry sources. Sixty per cent of households had a member, usually the wife or an older child, earning money away from the poultry enterprise including, in order of importance, day-labouring in agriculture, home industry, local retailing or working for government. Work tended to be seasonal or part time with only a few members employed on a fulltime basis away from the farm. Average off-farm cash income was Rp.11.5m p.a. (USD1156) for those so employed. Most of these earnings were in cash with only 8% in kind.

Broiler farms usually only had one shed and average farm capacity was 3856 broilers per cycle with up to eight cycles per year. Average shed ages were five years for broiler sheds and seven years for layer sheds reflecting fairly closely how long respondents had been in business. Around 90% of household heads owned their farms with the rest having equity partnerships with others.

Based on last year's production, 68% of broiler farms produced 10,000 to 30,000 broilers. Only three farms produced over 60,000 and the smallest produced 1,500. Average broiler weight was 1.8 kg with a range of 1.5kg to 2.2kg. None of these producers sell their broilers chilled or frozen and 78% of sales were via a contracting firm, 19% through an agent or middleman and about 3% were sold directly to consumers.

The mortality rate of broilers in each production cycle under normal conditions (without AI) in the starter stage varied across the sample from 0 to 30% with 80% of farmers reporting mortality rates from 1.1% to 5% and an average of 4.2%. The mortality rate at finisher stage under normal conditions varied from 0 to 20%, averaging 5%. Only one farm had the highest mortality rate of 20% while 66% of farmers reported rates from 2% to 5%.

Layer farms had up to 10 sheds with 60% having two or more. Layer sheds are usually smaller than broiler sheds with 65% of layer sheds having 100 to 500 layers and 23% having between 500 and 1000 birds with one farmer having a shed with 10,000 chickens, the largest. The average number of chickens per shed was 2,695. Production ranged from 24kg to 128,000 kg of eggs last year with average production of 25,500 kg and around 55% of the farms producing between 10,000kg and 25,000kg. Fifty three per cent of eggs sold from Rp.5,500 to Rp.6,500 per kg in the preceding year with an average price of Rp.5,914/kg. 65% of farmers sell to agents or middlemen, 19% sell to shops and about 15% sell to the firms they are contracted to for production.

The reported mortality rate of layers in each production cycle under normal conditions varied from 0.5% to 30% with an average of around 10% with 47% of farmers claiming rates between 5% and 10%.

The layers are culled from 18 to 88 months of age, with 80% culled between 21 and 24 months. Culls average 1.8kg and range from 1.6kg to 2.0 kg. Culled layers are sold to agents, middlemen & traders 95% of the time and only 3% are sold to shops. In the current market such culls bring from Rp.3,500/kg to Rp. 7,500/kg with 92% of sales between Rp.6000/kg and Rp.7,500 Rp./kg.

Culled layers were worth between Rp.6,000/kg and Rp.7,000/kg just before AI struck and, after AI struck, prices fell and became more volatile with 66% of sales between Rp.1,000/kg and Rp.3,000 Rp./kg. Broiler producers also reported their prices went through similar gyrations when AI struck falling by around 60%. These prices are currently back to around Rp.7,500/kg about the same as prior to the AI strike of 2003.

Labour Use

Thirty per cent of broiler producers spent around 30 hours per week working on their farms while 50% reported working full-time. In 40% of cases only one member of the family worked on the broiler enterprise and in 60% of cases two or more did. Fifty eight per cent of wives worked in the broiler enterprise with 38% of these working less than 10 hours per week, 26% 20 hours per week, 19% 30 hours per week and the rest full time. Most broiler farm families have one or two children and these children do not normally work in the poultry enterprise. Twenty five per cent of first children work on the farm with 48% of these working 20 hours per week and 28% working full-time. The percentage for second children working in the broiler enterprise is only 9% and only one worked as much as 20 hours per week. Third and fourth children, when they (rarely) occurred in the sample, did not work on the farm.

Sixty three per cent of broiler farmers employed from one to a maximum of four non-family workers. Fifty two per cent of these employed only one non-family worker while 42% of them hired a second. Seventy seven per cent of non-family workers work from 6 to 15 hours per week. Thirty three per cent of non-family workers were reported to have asked questions about AI, 67% never did and 16% of household heads thought casual workers were concerned they might catch AI. Of the 55% of broiler farmers whose farms were affected by AI, 20% employed more casual labour than usual to help after AI struck.

Amongst egg producers, 55% worked full-time on their poultry enterprises and 24% worked only 30 hours per week. Normally two or three family members work in the poultry enterprise with about 40% of available household time going into this activity. Around 90% of farmers' wives work in the poultry enterprise with 21% working less than 10 hours per week and 27% working full time. Ninety per cent of the layer farmers had children at home and 63% of these children never worked on the farm. Thirty one per cent of the broiler farms employed from one to a maximum of five non-family workers with 21% employing only one or two non-family people, 6% employing three people and 4% more than three.

The average non-family labour use across the layer sample was 7.5 hours per week. Amongst non-family workers in the layer industry, 36% asked questions about AI and 64% did not. Farmers estimated 14% of their workers were concerned they might catch AI. In case of an AI outbreak, 86% of the farmers said they did would employ extra workers while 14% said they would. Of the 25% of layer farmers whose farms were affected by AI, 56% said they employed more casual labour than usual to help after AI struck.

Contracting Arrangements

Of the 125 farms in the broiler sample, 105 had contracts to supply a firm with broilers which subsequently sold them live to consumers. 81% of these contracts had been going more than two years and, except for one case, contracted producers sold all their broilers to these firms with diversion outside the contract apparently being rare. Contracting firms bought from 1,000-12,000 broilers from each production cycle of around 38 days averaging around 3,700 with around 70% of farmers selling in the range of 2,000-5,000 broilers. Contracted farms often buy their DOCs (day old chicks) and feed from the contracting firms and most, 92%, bought all vaccines from the firm. These firms currently pay from Rp.6,000 to Rp.8,300 per kg for broilers, averaging Rp.7,100/kg with around 67% of farms receiving from Rp.7,000 to Rp.7,200 per kg. The harvesting age for these broilers, stated in the contract, varies from 35 to 40 days.

The contracting firm provided technical information on AI to 81% of contracted farmers and asked 72% of them to implement farm-level biosecurity after AI was discovered in East Java. In 17% of cases the contract was temporarily suspended when the AI crisis struck the district however only 9% of farmers were required to de-stock at this stage. After AI struck, contracting firms made 36% of the farmers have no chickens with 14% of these empty for only a week, 53% for a week to a month and 33% for more than a month. Most birds were not actually destroyed but, rather, grown out and sold to consumers, after which the farmers had to keep the sheds empty. 67% of contracted farms that actually destroyed birds did not receive compensation from the firm.

Contracting amongst egg producers was more unusual. Of 127 farms, only 18 were contracted to supply eggs to an agribusiness firm with 15 of these contracts being more than two years old. These producers generally sell all their eggs to the contractor except two farms that sold a relatively small number of eggs to others each week. On average, contractors sold 217 kg/week of eggs to the contracting firm. Some pullets were purchased from the contractor and all contracted farms purchased their feed from the firm. 13 of these farmers bought all their vaccines from the contracting firm. Contracting firms currently pay from Rp.6,000/kg to Rp.6,800/kg for eggs.

Seventy two per cent of contracted egg farmers got technical information on AI from contracting firms and 13 of the 18 contracted egg farmers were asked by their contractors to implement biosecurity after AI was discovered in East Java. One contractor suspended the contract following the AI outbreak and five farms de-stocked on instructions from the contractor. Since the growing cycle for layers is much longer than for broilers and these birds far more valuable, such de-stocking would have necessarily involved destruction of birds or their sale at reduced prices as culls. The firms did not pay for birds destroyed or de-stocked when AI struck.

3. Importance of AI on Sample Farms

Broilers

AI first struck the broiler districts between August and November 2003. At that time 6% of broiler farmers immediately vaccinated, 22% vaccinated after being told to vaccinate by an industry or government representative and 72% did no vaccination. Subsequently, 2% who had not vaccinated vaccinated following infection of their chickens. Also, after AI struck farms in their district, 37% of farmers adopted new bio-security measures in addition to measures they already had in place. Footbaths were put at the entrances to poultry sheds for workers and visitors and farmers discouraged or prevented visits to their farms. In addition, materials were disinfected and DOCs or other poultry coming onto the farm were quarantined or sprayed.

AI hit broiler farms in the survey from June 2003 to July 2004 in a fairly uniform distribution over time. Fifty seven farmers, 45%, said AI never hit their farms. On 80% of the farms that were infected, less than 2,000 birds had clinical symptoms. Farmers recognized symptoms in the chickens on 54% of farms affected by AI while the contracting agribusiness firm tested some of the chickens and then identified the disease in 30% of the affected cases.

Eighty per cent of farmers who had AI affecting their chickens destroyed only chickens with symptoms while 10% destroyed all their chickens and 10% didn’t destroy any. 80% of affected producers lost between 150 and 2000 birds directly from clinical symptoms of the disease with the maximum loss being 7,000 birds and average loss amongst affected farms being 1700 birds. Farmers destroyed up to 4500 birds to contain the disease with ‘stamping out’ policy however 86% of the sampled farmers did not destroy any birds without clinical symptoms. Broiler farmers received from Rp.400,000 to Rp.10m compensation from the government for the impact of AI on their farms.

Except for 5% of household heads, none of the people working on the broiler farms including family members had an anti-viral injection for AI. Also, no farmers wore protective clothing when outbreaks of AI occurred or provided such gear to their workers. Owners or employees (including family members) had training from Government officials about how to avoid infection by AI on 19% of farms,.

If the farmers discovered birds with clinical symptoms of AI on their farms today 14% would tell a government official, 12% would first tell other farmers and 4% would tell friends and family. The rest would tell some other, unspecified person.

In the original experimental design farmers were to be asked to rank animal diseases in terms of their perceived importance. The enumerators pointed out at the pilot stage of the survey farmers were ranking diseases they had most recent experience with highest. An alternative methodology was devised where farmers were read a list of 16 diseases (and an LL or "other" category) known to affect poultry in their district and a binary ranking of "important" or "not so important" was elicited for each disease. Farmers could indicate as many or as few were important as they pleased. The list included:

01 = Newcastle Disease (ND) / Tetelo
02 = Chronic Respiratory Disease (CRD) / Ngorok
03 = Fowl Cholera /berak hijau
04 = Pullorum /berak putih/kapur
05 = Infectious Bursal Disease (IBD)/Gumboro.
06 = Infectious Bronchitis (IB)
07 = Colibacillosis (E.coli)
08 = Runting and Stunting and Syndrome/ Kerdil
09 = Koksidiosis /Berak darah,
10 = Infectious Laryngotracheitis (ILT)/ Batuk berdarah
11 = Snot / Coryza / Pilek ayam
12 = Avian Influenza / Flu Burung
13 = Swollen Head Syndrome (Muka Bengkak)
14 = Egg Drop Syndrome (EDS)
15 = Worm
16 = Marek
17 = LL

The question was asked in relation to the first half of the production cycle, or starter period, and in relation to the second half, the completion period. The results are presented in a frequency bar chart in Figure 1 below. Only 11 of the listed diseases scored any ranking at all and these are reported on the horizontal axis in the figure. Avian influenza, disease number 12 in the list above, was ranked ninth at the starter stage.

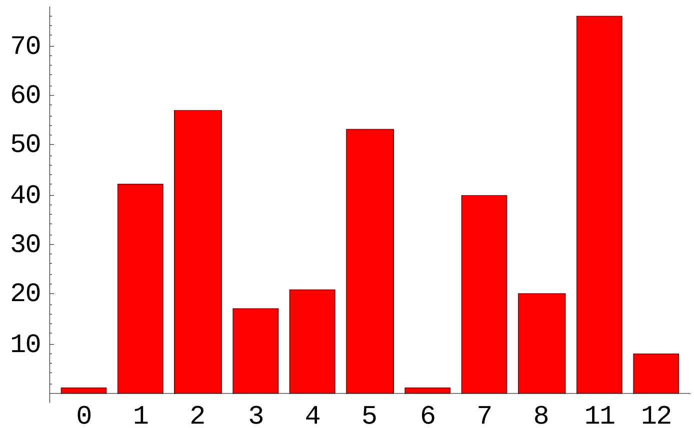

Figure 1: Bar Chart of Diseases Considered Important by Broiler Farmers in Starter Period of Broiler Production Cycle

The results for the finisher period are reported below in Figure 2. Again, avian influenza is ranked well down the list with eighth ranking.

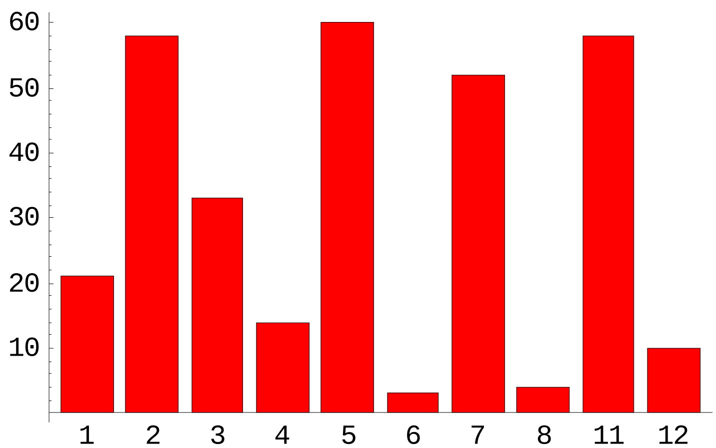

Figure 2: Bar Chart of Diseases Considered Important by Broiler Farmers in Finisher Period of Broiler Production Cycle

Layers

Egg farmers got news of AI arriving in their district between September and November 2003. Thirty per cent vaccinated for AI straightaway, 43% did not vaccinate at all and 27% vaccinated after being told to by an industry or government representative. In addition, 35% of farmers implemented new biosecurity measures in addition to measures they already had in place. After the disease had struck in the district 20% of farmers had footbaths at entrances to poultry sheds for workers and visitors and about 39% were discouraging or preventing visits to their farms. Forty six per cent had adopted disinfection of materials and quarantining of DOCs or other poultry.

AI hit farms in the sample between May 2003 and June 2004 in a fairly uniform distribution over the period. (Oddly, some got the virus before it officially hit their district which probably means there was a considerable lag before the outbreak became 'official' and was publicised.) About 75% of farmers said AI never hit their farms and, on 90% of the 25% affected farms, clinical symptoms were reported. AI was found in birds of all ages on affected farms.

Farmers themselves identified AI in their chickens 78% of the time. The contracting agribusiness firm that tested some of the chickens identified the disease in only one case while the government identified the disease on two farms, 'Someone else' found the AI symptoms on four farms. Of the 32 affected farms, only two farmers completely de-stocked after discovering they had AI. For the rest, 73% destroyed only chickens with clinical symptoms while 21% didn't destroy any chickens. Average losses on affected farms were 1,480 birds with a maximum loss of 13,000 birds. In terms of 'stamping out' policy, 16 farms destroyed an average of 912 birds. Only six of these farms received compensation from the government and this ranged from Rp.600,000 to Rp.10,000,000, averaging Rp.4,033,333.

No layer farmers or their workers (including family members) had an anti-viral injection for AI. Only two farmers reported that they or their workers used protective clothing when an outbreak occurred. About 18% of all farms in the sample had one person who had training from Government officials about how to avoid infection by AI. If the farmers discovered birds with clinical symptoms of AI on their farms today 16% would tell no-one, 25% would tell other farmers, 23% would tell friends and family, 14% would tell a government official and 21% would tell some other unspecified person.

Using the same numbering system for diseases as in Figures 1 & 2, egg farmers' perceptions of the importance of various chicken diseases are shown in Figure 3. Farmers identified 15 diseases as important with AI ranked eighth.

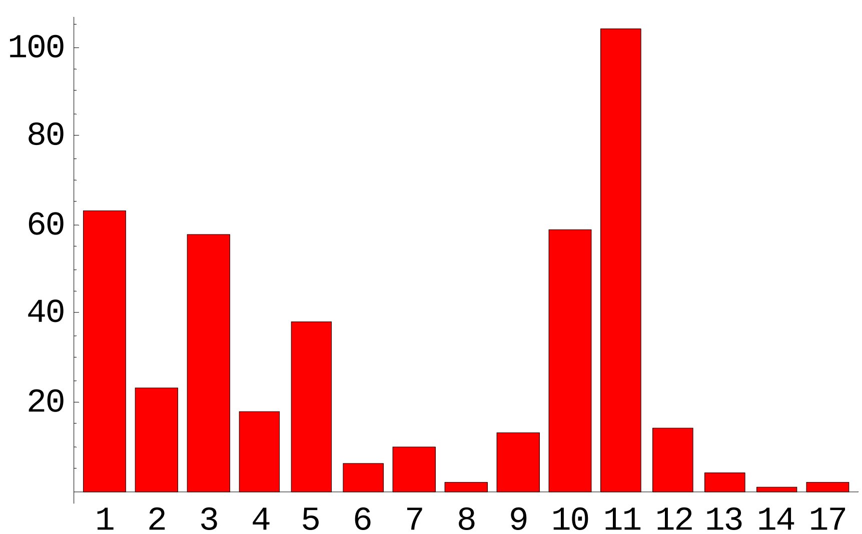

Figure 3: Bar Chart of Diseases Considered Important by Egg Farmers

4. Analysis of Broiler Data

Analysis of the survey data was conducted in two stages: cluster analysis followed by probit analysis. Cluster analysis is not useful for ascribing causality however it is useful for identifying distinct groups in cross-sectional data. There are many types of algorithms used for cluster analysis and in this study dissimilarities between groups were identified using a hierarchical, complete linkage approach based on Euclidean squared distance. This particular approach was adopted because it is often used socio-economic analyses with binary and continuous variables. The variables used in the analysis of the broiler data are described in Table 1.

Name	**Description**
incidence	Binary variable of whether or not clinical symptoms of AI were observed on the farm (1 for yes and 0 for no)
a6	Years of formal schooling of household head
a7	Binary variable of whether household head had special training in livestock systems (0 for yes and 1 for no)
b9	Off farm income in Rp.'000
d1	Number of years household head has been in this business
d8	Length of production cycle in days
d11	Number of broilers produced last year on the farm
d13	Mortality rate at starter age in per cent
d14	Mortality rate at finisher stage in per cent
e6	Farmer's subjective guess at breakeven price for broilers in Rp.'000/kg
dume7	Three binary variables for different sources of DOC
f8	Binary variable for whether non-family are members employed (0 for yes and one for no).
g1	Binary variable for whether farmer has production contract with agribusiness firm (0 for yes and 1 for no).
g2	Tenure of farm contract in years
h1	Binary variable for whether farmer obtained information from government extension service (0 for yes and 1 for no)
dumi2	Three binary variables for timing of vaccination of poultry after AI struck the district

Table 1: Broiler Variable Descriptions

The dendrogram was obtained using Stata Version 9 and shown in Figure 4. It is 'cut' horizontally at five groups called q1, q2, q3, q4 and q5 and having 60, 49, 6, 3 and 5 members respectively.

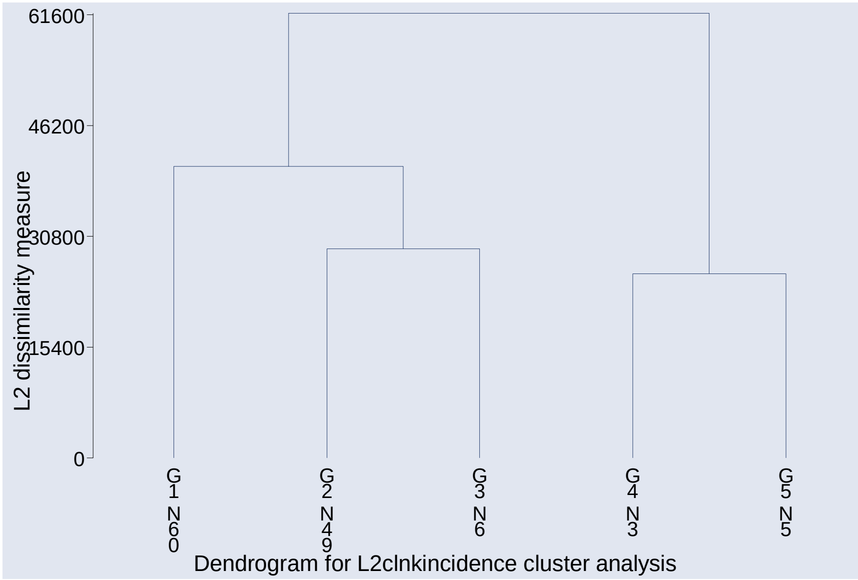

Figure 4: Dendrogram for Broiler Producers

The next stage of the cluster analysis was restricted to three groups because the fourth and fifth groups in the hierarchy were small with only 3 and 5 members respectively. The results for the means of each of the three groups are reported in Table 2.

Briefly, the three groups are distinct in the following ways. Group 1 has the least chance of being struck by AI, Group 3 has the largest chance and Group 2 is in the middle. Farms in Group 3, with the greatest chance of having clinical symptoms of AI, are larger operations and farmers in this group are more likely to have more education, more off-farm income and more training in livestock systems. It appears larger farms are more vulnerable to AI although having about the same general (non-AI) mortality rates as the farms in the other two groups. Interestingly, farms across the sample apparently have no scale economies with much the same breakeven prices reported across groups.

All farms in Group 3 employ off-farm labour and, unlike farmers in the other groups, all Group 3 members are likely to participate in contracts with agribusiness firms and none made use of government extension services. Farmers in this group were also more likely to use vaccination generally and more likely to have vaccinated after hearing AI was in their district than farmers in either of the other two groups.

DOCs are a favorite suspect for disease transmission and were included in the analysis with dummies representing sources of DOCs used by the farmers. Sources considered were breeding firms, the contracting agribusiness firm and shops or others using *dum2e7*, *dum3e7* and *dum4e7* respectively. The results here are weak at best and the reader should refer to the probit analysis over the page before drawing conclusions.

The groupings also provide insight into the effectiveness of vaccination. *Dum2i2* equaled one if the farmer vaccinated when AI first hit the district. Farmers in Group 3 were far more likely than farmers in other groups to have vaccinated at this stage and, since Group 3 had the highest infection rates, this particular vaccination practice presumably does not provide too much insurance against AI. *Dum3i2* equalled one if farmers vaccinated only when told to by industry or government officials and here the

Group 3 and Group 1 means are very similar so this practice does not seem to influence vulnerability either. The third dummy variable, *dum4i2*, equaled one when vaccination was undertaken after clinical symptoms occurred on the farm. This practice seldom actually occurred and seems to have been ineffective.

Variables	**Group 1 Means**	**Group 2 Means**	**Group 3 Means**
incidence	.4833333	.6	.75
a6	10.46667	10.74545	12.375
a7	.8333333	.8363636	.75
b9	3834.495	5612.182	10612.5
d1	4.225	6.627273	7.625
d8	38.15	38.25455	38
d11	12679.42	29691.82	54050
d13	4.801667	3.488182	3.625
d14	5.095833	4.814545	5.1875
e6	6487.333	6572.727	6550
dum2e7	.15	.0909091	.125
dum3e7	.7666667	.8727273	.875
dum4e7	.0833333	.0181818	0
f8	.5833333	.1818182	0
g1	.3	.0363636	0
g2	1.95	2.654545	2.75
h1	.5666667	.6181818	1
dum2i2	.0333333	.0909091	.125
dum3i2	.3	.1272727	.25
dum4i2	0	.0363636	0

Table 2: Results for Cluster Analysis of Broiler Data

Probit Analysis of Broiler Data

A probit analysis was conducted using the same data from Table 1 as used in the cluster analysis with *incidence* as the dependent variable (Judge, Carter Hill, Griffiths, Lutkepol and Lee, 1982). The log likelihood value of 65.43 corresponds to a Chi squared value of 0.0073 and the R^2 was 0.21. The predictive diagnostics for the model reported in Table 4 which shows failure to predict clinical symptoms correctly in 31 of the 121 cases.

The contributions made to likelihood of infection made by each variable are reported in Table 3 with coefficients that were significant at the 10% level marked with asterisks. As in the results from the cluster analysis, employment of non-family members increased vulnerability. The results for vaccination were more decisive than in the cluster analysis with vaccination now likely to reduce vulnerability. The variables for level of production, education and livestock training were not significant. A possible reconciliation with the cluster analysis is that employment of off-farm labour increases farm vulnerability to AI infection but is co-linear with farm production levels across the sample so results in larger farms being more vulnerable. Being essentially a descriptive tool, cluster analysis does not control for such co-linearity while, in contrast, probit analysis, essentially a form of regression analysis, provides such control. The conventional scientific wisdom is that wild birds spread the virus between regions and transmit it to domestic ducks and native chickens in Sector 1 that are uncaged. However there is little agreement on how the virus is transmitted from domestic ducks and native chickens in Sector 1 to the caged chickens on Sector 3 farms. This study shows casual labour may the transmission mechanism.

	dF/dx	**Std. Err.**	**z**	**P>|z|**	**x-bar**
a6	-.0077881	.0165568	-0.47	0.638	10.719
a7	.0877621	.1534893	0.57	0.566	.826446
b9	.000012	9.12e-06	1.32	0.187	5030.08
d1	-.0107407	.0158434	-0.68	0.498	5.49587
d8	.0471802	.031731	1.48	0.139	38.1818
d11	1.77e-06	5.37e-06	0.33	0.742	22908.4
d13	.006392	.0178193	0.36	0.720	4.1814
d14	-.0165973	.0188941	-0.88	0.380	5.00868
e6	.0002387	.0001476	1.61	0.107	6530.08
dum2e7	-.8255431	.1365822	-1.57	0.116	.123967
dum3e7	-.7643195	.2081858	-1.29	0.197	.818182
dum4e7	-.6510581	.0939488	-1.13	0.258	.049587
f8[*]	-.2106621	.1237527	-1.67	0.094	.371901
g1	.3540562	.2427855	1.12	0.264	.165289
g2	.0785746	.1209809	0.65	0.516	2.30579
h1	.1654712	.1203081	1.36	0.172	.619835
dum2i2	-.3521641	.1931659	-1.55	0.122	.066116
dum3i2[*]	-.2594328	.1395134	-1.79	0.074	.22314

Table 3: Probit Analysis of Broiler Data

incidence	0	1	Total
0	36	19	55
1	12	54	66
Total	48	73	121

Table 4: Predictive Power of Probit Model with Broiler Data

5. Analysis of Layer Data

A similar clustering exercise was conducted on the layer data however the distances between groups were too small to be interesting so the study proceeded straight to the probit analysis. The binary variable *incidence* was again used as the dependent variable and the state variables, similar but not the same as those used to analyse the broiler data, are reported in Table 5 below.

Name	Description
incidence	Binary variable of whether or not clinical symptoms of AI were observed on the farm
a6	Years of formal schooling of household head
a7	Binary variable of whether household head had special training in livestock systems (0 for yes and 1 for no)
b9	Off farm income in Rp.'000
d1	Number of years household head has been in this business
d5	Number of layers in last production cycle
d15	Weight of eggs produced in last cycle of production in kg
d22	Average mortality rate under normal conditions in per cent
e7	Farmer's subjective guess at breakeven price for eggs in Rp.'00/kg
$dum_i e8$	Binary variables for sources of DOC
f8	Binary variable for whether non-family are members employed (0 for yes and 1 for no)
g1	Binary variable for whether farmer has production contract with agribusiness firm (0 for yes and 1 for no)
g2	Tenure of farm contract in years
h1	Binary variable for whether farmer obtained information from government extension service (0 for yes and 1 for no)
dumii2	Three binary variables for timing of vaccination of poultry

Table 5: Layer Variables Used in Probit Analysis

The results for the probit analysis are reported in the Tables 6 and 7. The contributions of state variables to the likelihood of clinical symptoms being discovered on a farm, dF/dX, are reported in Table 6 along with standard errors, z values, confidence intervals and the mean value of each variable. The value of the log likelihood function was 43.35 yielding a probability of 0.002 based on a Chi Squared test and the R^2 was 0.31. Results for tests of predictive power are reported in Table 7. The model fails to correctly predict whether clinical symptoms did or did not occur 21 times in the sample of 120 farms. The model predicted six farms were affected by symptoms when in fact they were not and 15 farms were not affected when in fact they were. Given there were only 26 farms with clinical symptoms in the layer sample, this model is not very powerful and its interpretation requires caution.

Based on a 10% rule, significant variables are marked in Table 7 with an asterisk. It appears off-farm income, years of schooling, number of years a farmer has been in business and use of government extension services all reduce the likelihood of clinical symptoms being observed on the farm. Thus, more experienced, better educated farmers making use of government information services appear to be less vulnerable than others. Farm size, unit costs (breakeven price) and vaccinations had no effect on the vulnerability of farms to infection by the virus.

	dF/dx	Std. Err.	z	P>|z|	x-bar
a6[*]	-.0261	.0142	-1.81	0.071	8.26667
a7	-.0215	.1351	-0.17	0.868	.908333
b9[*]	-.0000175	.0000009	-1.70	0.090	3179.08
d1[*]	.0125	.0066	1.91	0.056	7.9
d5	.0000683	.000064	1.08	0.282	1219.83
d15	3.13e-06	2.79e-06	1.12	0.261	24144.2
d22	-.0041	.0053	0.78	0.436	9.17708
e7	.00007	.000086	0.89	0.372	5314.58
dum2e8[*]	-.3827	.1547	-2.6	0.009	.516667
dum3e8[*]	-.2160	.0871	-2.1	0.036	.283333
dum4e8[*]	-.1812	.0655	-1.92	.054	.158333
f8	.0075	.08926	0.933	0.708	.708333
g1	-.8992	2243	-1.42	0.155	.858333
g2	-.1989	0.170	-1.18	0.24	.416667
h1[*]	-.4117	0.236	-2.03	.042	.891667
dum2i2	.1027	.0975	1.12	0.262	.316667
dum3i2	.0851	.1208	0.77	0.44	.216667

Table 6 Results from Probit Analysis of Layer Data

incidence	0	1	Total
0	88	6	94
1	15	11	26
Total	103	17	120

Table 7 Predictive Power of Probit Model with Layer Data

6. Conclusions

The survey revealed these farmers did not see the disease as particularly important from a farm productivity standpoint. As discussed in Simmons (2006), they are far more concerned about consumer backlashes from AI inspired food scares than about productivity losses at farm-level.

The larger farms in the broiler industry seemed the most vulnerable suggesting, possibly, that the transmission mechanism from the outside world to the farm environment is casual labour which the larger broiler producers make more use of. This would be consistent with the observation that casual employees were not well informed about hazards arising from AI to themselves or farms generally. Such low income people could get exposure to the virus from *kampung* (native) chickens, domestic ducks or wild bird droppings at home. However, in this regard, there was no evidence that larger layer operations were more (or less) vulnerable to the virus than small ones or that casual labour influenced the vulnerability of layer farms to AI. In addition, layer farms appear to have benefited from contact with GOI extension services however this effect was not observed in the broiler sample.

7. References

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