



## Live pig markets in eastern Indonesia: Trader characteristics, biosecurity and implications for disease spread



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### ABSTRACT

Classical swine fever has been negatively impacting pig production in Nusa Tenggara Timur province in eastern Indonesia since its introduction in the 1990s, with live market trade contributing to disease spread. To understand market trader knowledge and practices regarding pig management, biosecurity, pig movements and pig health (specifically CSF), a repeated survey was conducted with pig sellers and pig buyers at 9 market sites across West Timor and the islands of Flores and Sumba. A total of 292 sellers and 281 buyers were interviewed in 2009 during two periods (rounds), a high-demand month (September) and a low-demand month (November). Information was collected via questionnaire. The majority of traders were male (sellers: 89%; buyers: 87%) with the highest level of completed education being primary school (sellers: 48%; buyers: 41%). The primary occupation of most respondents was farming: 90% of sellers and 87% of buyers were smallholder pig farmers and tended to sell their own home-raised pigs at market (52%). Pigs were sold for monetary gain either for primary (52%) or extra income (44%). Markets tended to be selected based on a good reputation (62%), a location close to residence (62%) and having the desired pig type (59%). Pig sales through markets were reported to be highest from August to October with 31% of sellers trading pigs at two or more markets. Prices at market were significantly higher on Sumba compared to West Timor and cross-bred pigs were significantly more expensive than indigenous pigs. Understanding of CSF and biosecurity was limited: 85% of sellers and 83% of buyers had no prior knowledge of CSF. Fifty-four percent of sellers reported no use of any biosecurity practices at market. Most respondents (88%) were able to recognise at least one clinical sign of a sick pig. Informal pig movements were also identified: 18% of pig buyers purchased pigs directly from other farmers. This study has provided baseline information on market trader activities at live pig markets in NTT that can contribute to the formation of sustainable strategies for improving pig health. Since NTT is the poorest province in Indonesia and pigs play a vital socioeconomic role in this province, market management and farmer education is needed to improve the pig market chain and contribute to socioeconomic development.

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### 1. Introduction

The trade of livestock is a vital part of the economy for many developing countries (Perry et al., 2005). Animals provide a major source of protein, income and assets for poor rural families (Perry

et al., 2005; Windsor, 2011). Within Nusa Tenggara Timur (NTT), a province located in eastern Indonesia, the demand for live pigs remains high for various celebratory events including weddings, funerals and traditional ceremonies (Christie, 2007; Johns et al., 2009). Within the province the ability of livestock markets to provide live pigs for purchase is vital (Johns et al., 2009).

The management practices employed at livestock markets have the potential to influence infectious disease spread (FAO, 2010). The introduction of animals from different source locations, the direct contact between animals of unknown health status, combined with minimal effective biosecurity, presents a significant risk (Boklund et al., 2008; Natale et al., 2009; FAO, 2010). Market premises tend to

*Abbreviations:* CSF, classical swine fever; GLMM, generalised linear mixed model; ICC, intra-cluster correlation coefficient; IDR, Indonesian rupiah; NGO, non-government organization; NTT, Nusa Tenggara Timur; REML, restricted maximum likelihood.

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act as hubs within a movement network, bringing animals from different disease prevalence regions into one location, thus facilitating disease transmission (Robinson and Christley, 2007). Studies have confirmed that the use of biosecurity methods, particularly at markets (due to their high throughput of livestock), can greatly assist in minimising disease spread (Roman et al., 2006; Donaldson, 2008). Simple disinfection of a marketplace each day before the intake of livestock can assist in minimising disease transmission between animals (Kiss et al., 2006).

An infectious disease of pigs that is particularly relevant when investigating the potential for disease spread through the pig marketing chain in eastern Indonesia is classical swine fever (CSF). Similar to other pig diseases of concern in this region, CSF is transmitted by direct contact and via fomites, but it is of greater concern because it is highly contagious and causes substantial socio-economic loss, including impacts on smallholder farmers (Blome et al., 2010; Madzimure et al., 2013). The importance of CSF is demonstrated by its ranking as a priority animal disease in Indonesia and the national plan to eradicate it by 2020 (Ministry of Agriculture, 2013), a plan with high emphasis on NTT because it is the province with the highest pig population in Indonesia (Dinas Peternakan Propinsi, 2014). First introduced to Indonesia in 1994, believed to be through pig movements from Malaysia, this pestivirus disease with the first confirmed case in Sumatra (Christie, 2007) spread rapidly eastwards across the archipelago. Entry to NTT province was confirmed in 1998 and occurred via movement of pigs from other areas of Indonesia and from Timor Leste (then the Indonesian province of East Timor) (Christie, 2007). Smallholder farmers continue to be severely impacted by this disease, with annual reports continuing to increase (Dinas Peternakan Propinsi, 2014). The high demand for pigs across NTT province still drives the movement of pigs and newly infected islands have been reported as recently as 2011 (Dinas Peternakan Propinsi, 2014). A risk assessment conducted by Leslie (2012) demonstrated a high probability of CSF infected pigs at live pig markets; with actions such as pre-entry inspection to prohibit entry of sick pigs and increased vaccination coverage of the general pig population shown to reduce the probability of infection.

The objective of this study was to describe the practices of pig sellers and pig buyers at selected market sites in NTT province in relation to pig management, biosecurity practices, live pig movement, and knowledge of pig health and CSF. By understanding practices along the market chain, high-risk activities can be targeted for mitigation strategies to improve control of disease spread and therefore reduce economic and social impact.

## 2. Methods

A repeated survey was conducted in the eastern Indonesian province of NTT on West Timor and the islands of Flores and Sumba. Nine live animal markets (Fig. 1) were selected across the province (three on each island) where face-to-face interviews were conducted with pig sellers and pig buyers during two interview periods: September 2009 and November 2009 (University of Sydney Human Ethics Approval No: 08-2009/11866).

### 2.1. Study area

The selected study area was NTT province in eastern Indonesia. West Timor and the islands of Flores and Sumba were selected as study sites because pig production in these areas is a substantial part of smallholder farming and approximately 70% of the provincial human population resides on these islands (Statistics Indonesia, 2010). NTT is an archipelago comprising 566 islands with a total land area of 47,349 km<sup>2</sup> (only 2.5% of Indonesia's total). The

predominant religions in the area are Roman Catholic and Protestant. Agriculture is the primary income source for the majority of households, and is mostly subsistence farming. Live pig markets play an important role in pig trade, providing a formal trade route for inter- and intra-island movement. The seasons – a wet season spanning from December to March and a dry season from April to November – influence pig movements along the market chain due to transportation challenges. Both time periods were investigated to understand different risks of disease spread and therefore to help target control strategies.

### 2.2. Selection of interview rounds

The study was conducted across two interview rounds to incorporate a high and a low demand period for pigs. This was to allow for the identification of any annual trends in relation to the number of pigs entering and leaving a marketplace, as well as the number of pig sellers and buyers depending on cultural and seasonal variations. Information on cultural activities and seasonal influences were obtained from local experts (local and government veterinarians from each island). Based on such expert opinion, September was selected as the most appropriate month for the high-demand period and November for the low-demand period.

There is high pig demand and larger numbers of pigs moved from June to September across all three islands. In West Timor, this time period is considered 'wedding season', in Flores there are abundant communion celebrations during September and in Sumba farmers sell their pigs ahead of the approaching dry season due to the resulting limited feed sources. November was a low-demand month due to households preparing for Christmas celebrations by fattening previously purchased pigs and few traditional ceremonies during this month in Sumba.

### 2.3. Selection of markets and pig traders

Purposive selection was used to recruit appropriate market sites for the study. Market selection was based on the following criteria: large numbers of pigs being moved through the market (>20 on a selling day); markets located in Flores, Sumba or West Timor; from local knowledge classified as an important and well known market for pigs (expert opinion from the Provincial Livestock Animal Health Department); and accessible by vehicle. It was necessary to select markets using this process because there was no sampling frame of live pig markets available from the Provincial Livestock Services. Moreover, due to the limited resources in this area, it was important to select key markets involved in the movement of large pig numbers to investigate potential hubs for disease spread, so as to focus on disease control strategies (Table 1).

At each market location, the target was to complete 16 questionnaires with sellers and 16 with pig buyers, totalling 288 seller and 288 buyer interviews across both interview rounds. Preliminary estimates from experts suggested that the number of pig sellers at a marketplace ranged from approximately 5 to 25 individuals. By interviewing 16 sellers per market per round, it was assumed that >50% of sellers present at a market site would be interviewed. Due to budget restraints, the maximum number of interviews that could be conducted was 288 sellers and 288 buyers (with targets of 96 sellers and 96 buyers per island across the two survey rounds).

If the target number of 16 sellers was not present at a particular market, a complete census of sellers was undertaken. Additional buyer questionnaires were then completed to obtain a total of 32 interviews per site per visit. During each market visit, the total number of sellers and buyers were estimated through observations ("head counts") to calculate the proportion of the total represented by the 32 individuals interviewed. For the nine selected markets, information about the number of sellers present on a market day

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