

The supply chain of Javan spitting cobra (*Naja sputatrix*) utilization in cobra satay businesses in Jakarta, Indonesia

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Abstract. Utama SE, Santosa Y, Masyud B. 2024. The supply chain of Javan spitting cobra (*Naja sputatrix*) utilization in cobra satay businesses in Jakarta, Indonesia. *Biodiversitas* 25: 2086-2092. One frequently utilized reptile is the Javan spitting cobra (*Naja sputatrix*). Apart from Indonesia, countries that utilize cobras are China and India. One form of actual utilization for the community's economy from cobra utilization is the cobra satay business. The high economic potential threatens the cobra population in the wild. Moreover, trade in the supply chain can have a negative impact ecologically and economically, so it is necessary to approach the supply chain of the cobra business to understand the cobra supply chain, considering the roles of participants, distribution processes, the number and specifications of cobras utilized, the source of cobras, and the incurred losses within the supply chain. This research was conducted using the snowball sampling method, with in-depth interviews. Interviews with vendor were conducted at their shops in Jakarta, and interviews with agent and collector were conducted at their homes in Karawang. It enabled the identification of the supply chain of the cobra satay business consisting of vendor in Jakarta and collectors, agents, and hunters in Karawang. The data collected were the number, specifications, and prices of each supply chain link, as well as the form of cobra utilization from traders. An estimated $\pm 1,560$ cobras are used in the cobra satay business annually, with a minimum total length of 70 cm for the cobras. The results showed that the percentage of dead cobras in the supply chain was 5%-35%, which resulted in a reduction in income of Rp25,000 - Rp125,000 for agents, Rp40,000 - Rp240,000 for collector, and Rp200,000 - Rp2,000,000 for vendor.

Keywords: Conservation, economic, snowball sampling, supply chain, wildlife trade

INTRODUCTION

Much wildlife trade occurs in biodiversity-rich developing countries where people depend on natural resources (Robinson et al. 2018). Indonesia, as a country with a high level of biodiversity, has the potential to enhance its economy through the utilization of wildlife. As a commodity from wildlife utilization, reptiles contributed approximately Rp4.9 trillion to the country's foreign exchange earnings in 2018 (Directorate of Biodiversity Conservation of Species and Genetic 2022). This indicates the significant economic potential of reptiles. Furthermore, this value is expected to continue growing due to population growth, increased consumer purchasing power, globalization, and changing lifestyles (Nijman 2010; Kusriani 2021).

Reptiles have been recognized as a source of food and traditional medicine (Alves et al. 2013; de Souza and Alves 2014; Hussain and Tynsong 2021; Mardiasuti et al. 2021; Xiao et al. 2021). Reptiles are typically used to consume various parts such as meat, fat, bile, genitalia, bones, liver, and blood (Mukherjee et al. 2017; Mardiasuti et al. 2021). Reptiles are favored as a food source and traditional medicine because they have high protein, low-fat content, essential amino acid, and abundant nutrients (Dominguez et al. 2019; Mazaratti et al. 2023). Essential amino acids are considered effective in supporting the major physiological system. Besides that amino acids can be the anti-cancer and

anti-aging properties (Husain et al. 2019). Reptiles are believed to potentially treat various ailments, including skin diseases, respiratory diseases, digestive diseases, eye diseases, musculoskeletal diseases, and even tumors and cancer (Valencia-Aguilar et al. 2013; Mukherjee et al. 2017; Mardiasuti 2021).

The high economic value of reptile utilization indicates a significant demand for reptiles. However, this can have negative implications if not utilized in a sustainable manner. Therefore, sustainable harvesting is necessary for the sustainable utilization of cobras. According to Parjoni (2012), sustainable harvesting is the largest amount of wildlife resources that can be harvested each year through natural population growth, and the main problem of sustainable harvesting is the absence of data on population development in nature (Mardiasuti and Soehartono 2003). There is also a lack of data on the actual utilization of monitor lizards and cobras.

Javan spitting cobra is a species often utilized, with an export quantity of approximately 2,200,915 snakes (Hierink et al. 2020). Its species is frequently traded, particularly in the cobra satay business operating in the Special Capital Region of Jakarta (DKI Jakarta). Apart from Indonesia, countries that utilize cobras are China and India (Mukherjee et al. 2017; Yuan et al. 2023). The cobra satay business, is a street vendor that sells cobra snakes as the main menu. It represents a form of utilizing the cobra that can enhance

their value by making cobra snakes into various products. It involves a supply chain that extends from Poachers to consumers, driven by the local community as an economic resource (Sulistyo 2020). The supply chain in wildlife trade consists of vendors, distribution centers, manufacturing, and sources (Phelps et al. 2016). While the products flow from sources to vendors via various transportation and quantities of products (Keskin 2023)

Also, If not done properly, trade-in supply chains can have negative ecological and economic impacts (Keskin et al. 2023). Therefore, to ensure sustainable utilization, it is essential to adopt systemic methods for all supply chain elements (Govindan and Hasanagis 2018). It also can encourage collaboration among the government, business entities, and communities to achieve sustainable utilization with tangible societal benefits (Aguirre et al. 2021). Therefore, this study investigated the supply chain of the cobra business in DKI Jakarta to determine the participant roles, the distribution of the supply chain process, the number and specifications of cobras used, the cobra sources, and the supply chain incurred losses.

MATERIALS AND METHODS

Data collection

The research was conducted from July to August 2023 using snowball sampling. Snowball sampling is a nonprobability survey selection method commonly used to locate rare or difficult-to-find populations and inaccessible samples (Johnson 2014; Naderifar et al. 2017). In snowball sampling, after gaining access to the preliminary sample, that participant begins introducing others to participate in the research. The approach in this research was to purchase cobra satay from the vendor, get contact with collectors, and get contact with agents from collectors. The study was conducted with one cobra satay vendor in the Mangga Besar of DKI Jakarta, one collector, and two agents in Karawang, with in-depth interviews and field observations.

Through in-depth interviews, interviews with vendor were conducted at their shops in Jakarta, and interviews with agent and collector were conducted at their homes in Karawang. Vendor, collector, and agent were asked about their role in the supply chain. Additionally, respondents were asked about the amount utilized and the estimated death of cobra in the supply chain process to determine the cobra quantity used. Furthermore, respondents were asked about cobra's purchase and sale prices to determine the losses along the supply chain. In addition, field observations were also conducted related to utilization in the supply chain, observing how cobras are stored, transported, and utilized, by going directly to the vendor shop, and the homes of agent and collector.

Data analysis

Data from interviews and field observations were analyzed descriptively, followed by the use of secondary data from other researchers publications. The interview data, including numbers, specifications, and prices, were compiled using Microsoft excel. This helped determine the number

of participants in the supply chain, the quantity and specifications of cobras utilized, their sources, and the losses incurred in the supply chain. Loss calculations were performed by multiplying the number of dead snakes at each stage of the supply chain by their maximum purchase price. Field observations were carried out to understand the processes of snake collection, transportation within the supply chain, and utilization. Secondary data were then descriptively analyzed to enrich and clarify the insights gained from the primary data.

RESULTS AND DISCUSSION

Supply chain process

The supply chain involves interrelated activities and decision-making to meet consumer needs. In a supply chain, there is a flow and transformation of goods from the raw material to the end consumer stages, which also involves the flow of information and money (Chin et al. 2015). The activities within the supply chain involve converting natural resources, raw materials, and other components into finished products consumed by consumers (Altekar 2023). The supply chain view visually illustrates the actors involved in the supply chain and how they are interconnected to form the supply chain flow, as depicted in Figure 1.

The supply chain in the cobra satay business consists of poachers, agents, collector, and vendor. The poacher is tasked with capturing the cobra snake that will later be delivered to the agent. The agent will then sell the cobras to the collector, who will adjust the price according to the needs of the trader. The collector will receive orders for cobras from traders, and will purchase the snakes from agents, if one agent does not fulfill the order then the collector will look for snakes from other agents. And traders order cobras from collectors. The cobras are processed and then sold to consumers. This aligns with Parjoni et al. (2012), who revealed that the cobra supply chain comprises poachers, agents, collectors, and vendors. Poachers capture cobras and sell their catches to agents, and the agents will purchase, sort, and collect cobras; the collectors will later buy them. The collector is responsible for receiving orders from vendors, purchasing snakes from agents, and delivering the cobra to the vendors. In this supply chain, collectors serve as the central activities. According to Herzegovina et al. (2021), collectors act as intermediaries between actors in the supply chain. Furthermore, vendors act as cobra processors into various products and sell these products to consumers. Phelps et al. (2016) state that vendors have various tasks, such as processing products and engaging directly with consumers.

Cobra trade also occurred among the same supply chain actors in this research because of the social proximity factor between actors in the supply chain. According to Van Uhm and Wong (2019), close kinship and family relationships built on trust and cooperation are important in facilitating wildlife trade. Family, kinship, and ethnic ties are often the basis of communication, financial flows, and logistical support (Van Uhm and Wong 2019; Costa 2021). Kinship ties reduce market transaction costs, improve information

flows, decrease opportunism risk, screen potential exchange partners through codes of ethics, and reduce opportunism by increasing and redistributing the losses a party may suffer from cheating (Parella 2021). Kinship ties serve as the foundation of trust before establishing trade relationships. The established emotional attachment creates a belief in the moral integrity of the individuals trusted within the partnership (Ayari and Boulila 2023).

The cobra supply chain is relatively simple due to the easily accessible distances and locations of each supply chain actor. According to Keskin et al. (2023), the structure of the wildlife trade flow is influenced by the wildlife source, access, and the distance between each trade chain. This is demonstrated in Figure 1, which shows the wildlife source and the location of each supply chain actor.

Poachers are usually located close to agents and collectors in the cobra supply chain. The cobra snake hunters conducted their hunting activities in agricultural and plantation areas near their residences, specifically within the Wadas Karawang Region, West Java. The hunters do not engage in hunting outside this area because, within the agricultural and plantation areas, there is an abundant food source, such as rodents, which become prey for these snakes (Boeadi et al. 1998; Parjoni 2012). The area becomes a habitat for cobras; even though it is still close to human areas, cobra snakes are found mostly in areas adjacent to human activities. The proximity location of the cobra to human existence is because it has high adaptability (Widodo et al. 2019).

The number of cobras captured is usually adjusted according to the orders placed by vendors. Vendors order cobra from collectors and pass them on to other supply chain actors; many trades in wildlife start with vendors placing animal orders to collectors (Warchol et al. 2003). In the cobras' supply chain, there are around 60 cobras collected by agents from poachers each week; these cobras are subsequently delivered to vendors according to the orders the collector demands. Typically, the orders received for cobra are around 30 demanded within a weekly cobra satay business cycle; the collector then sends the remaining 30 cobras to other vendors.

Consequently, the estimated number of cobras used in the cobra satay business reaches approximately 1,560 annually. Meanwhile, the remaining cobras from this supply chain are sold to other cobra satay vendors. According to Herzegovina et al. (2020), the annual utilization of cobras in Jakarta City amounts to 37,320 individuals; therefore, at least there are 24 cobra satay vendors.

The cobra's supply is also adjusted according to the seasons. According to poachers, capturing cobras becomes difficult during mating seasons. The cobra breeding season occurs during the dry season between August and October (O'Shea 2005); additionally, cobras are difficult to find. According to Patria et al. (2022), cobras are more active during the rainy than in the dry seasons. This can also be due to the main food of snakes, such as reptiles and small mammals, also becoming more active during the rainy season, so snakes are also more active in the rainy season (Ochoa et al. 2020). Cobra hunting is not carried out year-

round, particularly during the rice harvesting season when many hunters become farmers (Parjoni 2012).

Nonetheless, cobra supply remained available during business operations, and the business was not disrupted due to a shortage of cobra snake supply. This can be attributed to the fact that the hunting of cobras from their natural habitat is adjusted according to vendors' demands, thus preventing the cobras from being stored for too long. The cobras are stored by agents who collect the cobra from hunters on a waring sack (Figure 2.A) before being placed in storage tanks (Figure 2.B).

Specification of Javan spitting cobra in the supply chain

In the supply chain process, not all cobra can be utilized due to specific specifications in the supply chain. These specifications consist of total length (cm), Snout Vent Length (SVL), which is the length from the snout to the cloaca (cm), body weight (g), age class, and sex. The study used 20 cobras, with the measurement results for cobras shown in Table 1

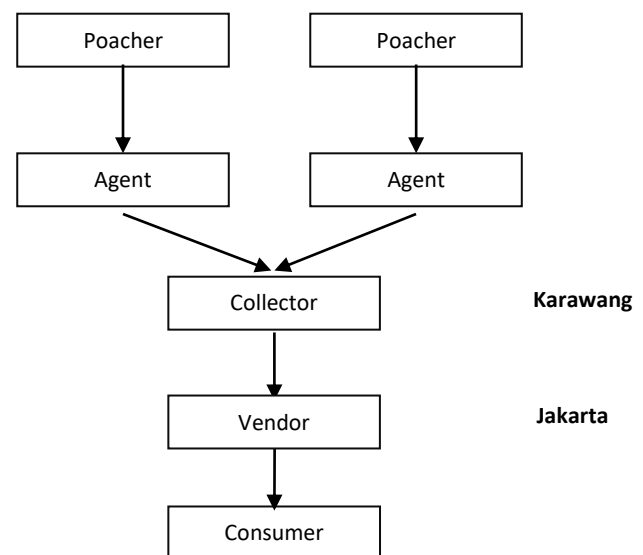


Figure 1. Supply chain of cobra satay business



Figure 2. A. Cobra in waring sack; B. Storage tanks for cobra

Table 1. Javan spitting cobra (*N. sputatrix*) specification on supply chain

Size	Total length (cm)	SVL (cm)	Mass (g)	Sex		Age group	
				Male	Female	Adult	Juvenile
Max	133.0	118.0	1200.0	16	14	26	4
Min	74.0	68.0	302.0				
Average	105.7	94.9	640.9				
Male Average	106.3	95.3	659.2				
Female Average	105.1	94.4	620.0				

Table 2. Prices of cobra on the supply chain

Supply chain	Prices (Rp.)
Poachers - Agent	15,000/cobra
Agent - Collector	18,000-25,000/cobra
Collector - Vendor	30,000-40,000/cobra
Vendor - Consumer	100,000-200,000/cobra

The average total length of the cobra is 105.7 cm, with an average weight of 640.9 grams and an average SVL (Snout-Vent Length) of 94.9 cm. Cobras can grow up to 1.8 m in total length (Andriwibowo et al. 2022). The SVL of males (95.3 cm) is longer than that of females (94.4 cm). In contrast, Boeadi et al. (1998) found that SVL male cobra (95.7 cm) are shorter than females (101.3 m). However, even though male cobras tend to grow longer, have longer tails, and are overall bigger than females, females have a longer SVL (Boeadi et al. 1998). Differences in size in different locations can be attributed to the level of disturbance and prey availability (Twining et al. 2017; Natusch et al. 2019a).

According to the interviews, the collectors do not accept cobra with a total length of less than 70 cm; therefore; local collectors suggested avoiding capturing small snakes to ensure their continuous regeneration and sustainability. Moreover, vendors do not favor small snakes due to their limited meat content. Vendors also believe that smaller snakes have fewer medicinal properties. Consumers also prefer more enormous cobras rather than tiny ones. This indicates that snake sizes are influenced by market demand or demand-driven (McNamara et al. 2016). This relates to price and quantity determined by optimizing consumer satisfaction; wildlife suppliers will be produced to meet this demand level (McNamara et al. 2016). The size restriction also effectively protects some wildlife with a high reproductive rate and allows the population to grow (Dee et al. 2014).

As for age classes, cobras are considered sexually mature if they have a minimum SVL of 90,8 cm for males and 82,8 cm for females (Boeadi et al. 1998). However, the study revealed that 26 adult cobras and 4 juvenile cobras were found; this indicates that the cobra supply chain also trades in juvenile cobras.

The capture of juvenile cobras can lead to economic and ecological disadvantages. Capturing the juveniles before they attain sexual maturity will cause a significant decline in the reproductive stock and reduce biological recruitment levels

in the population, thus causing depletion due to the lack of population sustainability (Santana et al. 2020). The predominance of adult animals found suggests that many individuals in the population still have the potential to reproduce, either before or after reaching the harvestable size range (Khadiejah et al. 2019). Capturing juvenile cobras can also lead to economic losses because they are typically cheaper than fully grown adult cobras due to their smaller size. According to Najmudeen and Sathiadhas (2008), capturing juvenile animals negatively impacts the economy in the present and future. This is due to the lower current income from capturing juvenile animals, their lower prices, and the loss of potential future income.

In the Cobra supply chain, there is no specific preference regarding sex. In research, female cobras are found more frequently with a ratio of 1.2:1. Another study revealed that cobras' sex ratios are not significantly different at 1:1 (Natusch et al. 2019b). The higher occurrence of females might be due to males being less active; males are more active during the mating season (Natusch et al. 2019b)

Specification of Javan spitting cobra (*N. sputatrix*) in the supply chain

The supply chain also shows price differences at each level; the cobras prices are sold by quantity. The variations in cobra prices can be observed in Table 4.

From the results of interviews with agents, the price of cobras is determined based on their length category, with class a being >110 cm in length, class b ranging from 90-110 cm, and class c between 70-90 cm. However, the price from hunters to agents remains fixed and is not adjusted according to the length size categories, set at Rp15,000 per snake. Therefore, if a snake falls below the market criteria, agents still do not accept it, and these snakes that do not meet the criteria are released back into the wild.

The prices from the agent to the regional collector are as follows: Rp25,000 per snake for class a, Rp20,000 per snake for class b, and Rp18,000 per snake for class c. The prices from the regional collector to the cobra satay vendors are Rp40,000 per snake for class a, Rp35,000 for class b, and Rp30,000 for class c.

The prices from the vendor to the consumer increased significantly, with class a priced at Rp200,000, class b at Rp150,000, and class c at Rp100,000 per snake. Furthermore, the consumer will obtain its meat prepared as satay (Figure 3a), as well as bile and blood, which will be mixed with rice wine called "arak" and consumed directly (Figure 3b). The snakes can also be sold just for their meat to be served in satay form to consumers at Rp40,000 per portion.

Moreover, consumers believe that consuming cobras can cure skin diseases, eye conditions, endocrine system disorders, respiratory issues, digestive system problems, and circulatory disorders, enhance immunity, boost vitality, and also body warmth (Mardiastuti et al. 2021; Mukherjee et al. 2017; Yuan et al. 2022).

These prices are higher compared to the findings of Parjoni (2012), which reported that the price of cobras from regional collectors to vendors ranged from Rp12,000-Rp16,000 for class a, Rp5,000-Rp8,000 for class b, and Rp2,000-Rp3,000 for class c. Additionally, the prices from vendors to consumers were Rp30,000-Rp40,000. These price variations may be attributed to regional differences, scarcity, and supply and demand mechanisms (Kovak 2013; Sterman and Dogan 2015; Sas-Rolfes et al. 2019).

Furthermore, the domestic price of wild animals, particularly cobras, is relatively high due to their food and traditional medicine utilization. In addition, cobra is a luxury food item and shows social status (Xiao et al. 2021). Consumers can buy cobra snakes even though the price is high because they are rare and prestige items to show their social status; this is associated with personal knowledge and social perceptions. (Hinsley and Sas-Rolfes 2020; Xiao et al. 2021).

Moreover, within the cobra trader industry, apart from the meat, bile, and blood processed into satay and cobra potion, various cobra parts are also processed into different product variations, each with different price ranges. For example, dried gallbladders are sold for Rp100,000 per bottle containing 10 pieces, then cobra bone capsules are sold at Rp40,000 per bottle with 10 capsules. Additionally, the fat is transformed into oil and ointment, sold at Rp40,000 per bottle for the oil and Rp50,000 per bottle for the ointment. Furthermore, there are dried male genitalia or "tangkur" sold at Rp40,000 per bundle, each containing 10 pieces. Product variations affect consumer purchasing preferences, the increase in consumer purchasing preferences significantly affects the increase in product selling value (Sukirman and Arwani 2021).

In terms of ethics, where consumers are interested in animal welfare in various products that can be a reference in buying or not buying these animals (Swan and Conrad 2014; Hampton et al. 2021). Ethical understanding does not really affect the cobra trade, especially in Jakarta, this is because the cobra trade is used for treatment. According to Liu et al. (2016) consumer preferences and behavior play an important role in the consumption of wildlife, especially for treatment. Factors that influence consumer behavior are complex and include consumption needs and motivations, perceptions, behavioral learning, attitudes, and socio-cultural factors (Liu et al. 2016). Another example is the medicinal use of bears in Vietnam (Davis et al. 2019).

Also, the price of cobras can determine losses within the supply chain if cobras die in the supply chain before reaching the consumer; within the cobra supply chain, several cobras experience mortality at each stage. This happened because, usually the cobras are traded while they are alive. At the same time, animals in storage tend to experience a decline in quality, susceptibility to diseases, and even death (Pourmohammadzia 2022).

Moreover, the respondent interviews indicate that approximately 1-5 cobras die per week at the agent stage, resulting in income reduction ranging from Rp25,000 to Rp125,000 weekly. These deaths are often associated with overcrowded holding areas, excessive heat, and stress. According to the agents, cobras can survive in holding areas for up to 2 months with only water consumed. However, their survival span reduces to just one week if the storage area becomes excessively hot or they are exposed to direct sunlight for prolonged periods.

At the collector stage, incidents of cobra deaths during transportation are also reported. For example, the collectors use motorcycles (Figure 2) from Karawang to Jakarta, with an estimated travel time of 2-3 hours leading the death. Typically, 1-6 cobras die, resulting in income reduction ranging from Rp40,000 to Rp240,000 weekly, assuming the agents' highest purchase price. Snakes that die at agents and collectors are fed to catfish farmers.

Upon reaching the cobra satay vendor, losses due to cobra deaths are also prevalent. These deaths are usually attributed to overcrowded storage, inappropriate transportation, and excessive heat. Snakes are delivered from the collector in Karawang to the vendor in Jakarta for a distance of ± 83 km, which is put into boxes, and transferred using a motorcycle that can take 2 hours 22 minutes - 4 hours, which is influenced by the weather and the density of vehicles on the road. This can increase stress to the cobra, thus increasing the mortality of the cobra (Warwick 2014). The snakes at the vendor are kept in storage boxes made of wood and iron nets until consumers purchase them with cramped confinement (Figure 4). Unsold snakes can contribute to increased mortality for cobra. The number of cobra deaths in vendors ranges from 1-10 weekly, resulting in income reduction between Rp200,000 to Rp2,000,000, assuming the highest purchase price from the collectors. Dead cobras at the satay vendor are usually gathered and disposed of in a waste disposal site, thus reducing income in the supply chain by Rp265,000-Rp2,365,000.

The number of cobras that died during the supply chain process in a week ranged from 3-21 snakes, resulting in a mortality percentage within the cobra supply chain of 5% - 35%. This rate is lower than the mortality rate estimation revealed by Wyatt et al. (2022), ranging from 30% - 90% from wildlife trade (Wyatt et al. 2022).

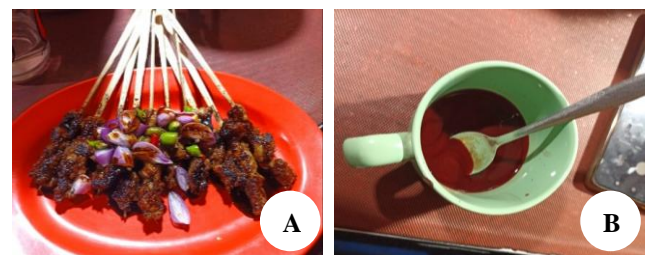


Figure 3. The utilization of cobra snake: A. Cobra satay; B. Cobra potion bile and blood



Figure 4. Javan spitting cobra (*Naja sputatrix*) storage in vendor

Animals in the supply chain die because of painful capturing methods, diseases, inappropriate transportation, cramped confinement, and insufficient nourishment (Peng and Broom 2021; Miranda-de la Lama et al. 2014; Godde et al. 2021).

This indicates a death in the supply chain causes economic losses in addition to causing ecological damage. However, there is no specific program conducted by the DKI Jakarta government on wildlife trade, especially cobras. A program that can be implemented by the government is by integrating the supply chain to reduce cobra mortality. However, there is no specific program conducted by the government in the wildlife trade, especially cobras. A program that can be carried out by the government is to integrate the supply chain to reduce cobra mortality, such as providing quotas, tightening the capture to adults only, and a good animal management system (Jennings et al. 2016). Therefore, a sustainable supply chain must be considered, integrating the poaching, storage, processing, transportation, and retail stages (Kazancoglu et al. 2018).

It can be concluded that the main cause of losses mostly occurs due to issues with storing the cobras; this can be attributed to overly confined spaces that exceed their capacity. Therefore, a collection system and standardized cobra storage are needed to minimize deaths during storage and transportation.

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