

## **Chapter 4**

### **Research results**

This chapter covers the results of a transdisciplinary Trichinellosis risk framework involving the descriptive results of two highlander villagers, including one that experienced an outbreak, and the results from the development of a Bayesian Belief Network model of Trichinellosis risk.

#### **4.1 Transdisciplinary Trichinellosis Risk Framework**

This section used a One Health approach to develop a transdisciplinary framework considering the interaction of highlanders with the pigs they grow and their environment as a single system. The research identified four subsystems to investigate Trichinellosis risk, including animal husbandry, food chain, environment, and economic conditions. Descriptive statistics were used to quantitatively describe the collected data (see Appendix F).

##### **4.1.1 General Information**

The in-depth household study was conducted in two highlander villages in Mae Ai District, Chiang Mai Province, including Huai Ma Fueang village and Huai Chan Si village which experienced an outbreak of Trichinellosis in 2004 (BOE, 2004). Fifty-four representative households were randomly selected from these two villages. Out of this number, twenty-three representative households raise

pig, and five and three households do not raise pig in Huai Ma Fueang village and Huai Chan Si village, respectively.

Most of the respondents (34 persons) are responsible for both pig rearing and food preparation, eleven persons prepare food only and nine persons raise pigs only. On average, they are almost 40 years old. There are approximately 5 persons in the family.

#### **4.1.2 Animal Husbandry-relevant Trichinellosis Risk Factors**

The data show that females are responsible for pig rearing in 26 households while males are responsible for pig rearing in 20 households. A majority of the pig raisers are Red Lahu (39 persons) and the minority includes Lisu (4 persons), Black Lahu (1 person) and Palong (1 person). Most of them are Buddhists (35 persons) while some of them are Christians (10 persons) and animist (2 persons). In addition, those who are Buddhists or Christians, they also follow their own ethnic culture, including values, beliefs and special celebrations. Most of these households raise pigs for both consumption and commercial purposes (36 households). Some of them raise pigs for self subsistence only (8 households). Among these households, most of them raise pigs for ritual uses (28 households). On average, they have 11 years of experience in pig rearing, but some of them have raised pigs for up to 35 years. It takes approximately 10 months for growing a pig until they can sell for approximately 4,200 Baht for 38 kilograms weight.

In considering the pigs these highlanders grow, they are all native pigs (black pigs). Some ritual ceremonies only allow black pigs as the oblation. One villager said that if they do not grow black pigs, when they need one for a ceremony

they have to buy it from somewhere else and they have to accept at any price. This is the reason why these people tend to raise pigs by themselves since it saves more money. They will buy more pigs (usually piglets) from neighbors or sometimes from others outside the village when they think there are not enough pigs for their ritual uses or special celebrations such as the New Year, weddings, funerals, etc. Raising pigs can be seen as a kind of investment, and they can invest in a pig with little money. Then a pig grows with time and they can sell it out when they need money for contingency situations or they can wait until it is grown and consume it and save money instead of buying it from another farmer. This is quite a wise decision for them in utilizing their time, land space and other resources available. The profits they will earn from pig rearing depend largely on how they manage these resources and the kinds of pig production modes they apply.

There are five kinds of pig production modes, including free range in which farmers allow pigs to wander around finding something to eat by themselves. For this kind of pig production mode, farmers do not need to construct a house for pigs and feed is rarely prepared for them. Usually piglets are allowed to wander around. Tethering pigs with ropes can be seen as another kind of pig production mode that farmers tie a pig with a rope, usually underneath the house for keeping it nearby and they have to prepare feed for it. The other two kinds are the fence located underneath the house and the fence located outdoors. Farmers construct fences for grounding pigs and feed needs to be prepared for them. The last kind of pig production mode is in pens. Farmers construct a pen as a house for pigs. The quality of the pen depends on the budget that farmers have. Most boars and sows are usually kept in pens. Most of these households keep pigs in pens (18 households)

following by in fenced areas underneath the house (5 households), tethering (1 household) and outdoor-located fenced area (1 household). Many of them apply a combination of various pig production modes such as a combination of outdoor-located fences and pens (4 households), a combination of fences underneath the house and pens (4 households), a combination of tethering and pens (3 households), etc. The majority of these households claim that they choose the kind of pig production mode depending on convenience. Some of them follow the community regulation of grounding pig in pen or fence. If a pig disturbs any other villagers' property, the pig owner has to be fined 300 Baht. Surprisingly, many of them are concerned about the hygienic security, and that is why they keep pigs in pens. In addition, they also claim that financial constraint plays a big part on their decision of choosing a pig production mode.

A majority of these representative highlanders kill pigs by themselves in the backyard (44 households). Only one household goes to local butcher and one household kills pigs inside the pen.

Major feeds that these people feed the pigs are banana trunk and rice chaff (43 households). Some of them use food scrap (23 households) and carcasses left over (3 households) as pig feed. These can be considered as a risk for infection with Trichinellosis in pigs since they have a chance to consume infected animal parts.

In considering the pig raisers' knowledge about Trichinellosis, a majority of them (49 households) do not know anything about this disease. However, twenty-eight households know that keeping pigs in pens is hygienically safe for the pigs. For those who do not keep pigs in pens, most of them (27 households) tend to

change the behavior by putting pigs in pens after they know that pens can lead to hygienic security in the pigs. However, only 15 households decide not to change the behavior mainly because of the financial constraint.

In considering the health practices, most of the pig raisers (32 households) never check the health situation of their pigs, but the rest of them have checked the health situation of their pigs. They tend to check the health situation of their pigs by themselves (7 households). Furthermore, when their pigs get sick most of them (18 households) usually treat them themselves. Some of them (12 households) do nothing. Some of them (10 households) ask for someone such as the public health volunteers which are their neighbors to help. A few (5 households) use herbal remedies and only one person (1 household) sells the sick pig. Surprisingly, thirty-eight households apply deworming drugs for their pigs with almost two applications annually. Though, deworming drugs cannot effectively kill parasites located in muscles, the high tendency of applying deworming drugs amongst this population shows a good sign that they are aware of the parasitic diseases in pigs. For those who do not apply the deworming drug, they claim that it is not important to use it (4 households). Some of them claim that their pigs are already healthy (2 households), while one household thought that their pigs are too old, no need to use the deworming drug anymore. In addition, only two households do not even know that they should apply deworming drug for their pigs.

#### **4.1.3 Food Chain-relevant Trichinellosis Risk Factors**

Most of food-preparing persons (40 persons) in these representative households are female. Most of them are Red Lahu (45 persons) and

most of them have already been granted Thai citizenship (52 persons). Thirty-five had never attended school. This probably is the reason why most of them (39 households) do not know that consuming raw or undercooked meat is harmful for their health.

In these two villages, in each year, villagers usually kill native pigs on the Lahu New Year festival (or Kin Wor) (41 households), wedding ceremonies (28 households), funerals (27 households), merit making (24 households), sacrifices (17 households), and New Rice Alms' ceremony (15 households). Additionally, the pork is almost always shared with the neighbors and even with visitors or strangers.

Nonetheless, the villagers also eat outside of the house. Most of them (31 households) go to their neighbor's house. From the interview, we found that they usually have alcoholic drinks with raw or undercooked meat. Twenty-six of them go to a restaurant and a few of them go to other villages, churches and markets. Twenty-nine households go to eat outside occasionally, especially when there is a special occasion. Only a couple households go to eat outside everyday and only 5 households never go to eat outside at all.

Fortunately, most of the villagers in these representative households (69.44%) do not like consuming raw or undercooked meat, and most of those who do not like it (72.73%) said it is "nasty". Around 45.46% of them claim that it is harmful for health. Only a few of them said that their parents do not allow eating raw or undercooked meat (3.03%) and some (3.03%) claimed that the materials for preparing raw or undercooked meat are more expensive.

However, for those who like to consume raw or undercooked meat, around 90% of them claimed that it is “delicious”. Some of them (31.71%) believe that it is a tradition to eat it. Surprisingly, many of them (31.71%) believe that consuming raw or undercooked meat can give them strength. Around 12% of them love to eat it with alcohol and a few of them think it is “cool” (2.44%) and they feel used to consuming raw or undercooked (2.44%).

After the enumerators educated the danger of consuming raw or undercooked meat to these people, only around 60% of them said they would stop eating raw or undercooked meat. All of them said they are scared of the danger. Surprisingly, around 21% of them insisted on continuing to eat it as usual and the rest claimed to eat it only on special occasions (14.89%). A few of them claimed that they will eat less (2.13%) and some are still unsure (2.13%).

For those who insist on continuing to eat raw or undercooked meat, around 62% of them said that it is because of their own preference. A few of them said it is because nothing bad ever happened to them (12.5%). Some of them claimed that they eat the deworming drug after consuming raw or undercooked meat (12.5%). A few of them said it is because of the tradition (6.25%) and some claimed that they have to eat it with their husband (6.25%).

From the questionnaire, we found out that there are nine different kinds of animals that the villagers eat, including, white pig, native pig, chicken, wild boar, water monitor, wild cat, snake, dog and rat. These animals can be infected by *Trichinella* if they consume infectious cysts in meat. Humans become infected when they eat raw or undercooked infected meat. The study found that the villagers do not eat raw or undercooked chicken, water monitor, wild cat, snake, dog and rat while

they consume the rest as raw or undercooked. Most of the time they consume white pig (annually around 260 days on average as for cooked and around 86 days for raw or undercooked) that they can buy from other villagers (71.70%), from neighbor (28.30%) and with their own reproduction (3.77%). The villagers often consume native pig (annually around 73 days on average as for cooked and around 33 days as for raw or undercooked) that they can buy from other villagers (9.26%), from neighbors (50%) and from their own production (61.11%). Since the villagers' houses are located nearby a forest, they often hunt wild boar for consumption (25.93%). However, some of them buy it from other villages (14.81%), from neighbors (24.07%) and from their own production (3.70%). Annually, they consume wild boar around 12 days on average as for cooked and only around 2 days as for raw or undercooked.

#### **4.1.4 Environment-relevant Trichinellosis Risk Factors**

After slaughtering pigs or other animals, most of the representative households (26 households) use the carcasses left over as pet feed. Some of them (7 households) just sweep them down to the floor. Only a few of them put carcasses in the trash can or bury them. Thirty-eight households bury animals that died of sickness. Unfortunately, a few of these households eat animals that died of sickness within the family, share to neighbors, or sell it out to other neighbors. For the naturally dead animal, forty-one households usually bury it.

Amongst these households, a couple of them clean pig areas twice a day, ten households do it once a day, four households do it every other days,



four households do it every other two days, five households do it once a week, seven households rarely clean, and nine households never clean pig areas.

In considering the pig waste disposal, a couple of these families dispose of it twice a day, eight households dispose of it once a day, seven households dispose of it every other day, a couple of households dispose of it every other two days, seven households dispose of it once a week, a few households rarely dispose of it and fourteen households never dispose of it at all.

In considering disposal of the feed left over, twenty-two households dispose of it every time after feeding. Seven households dispose of it sometimes and thirteen households never dispose of it.

In considering the cleanliness of surroundings, sixteen households clean surroundings every day, fourteen households do it every other day, fourteen households do it once a week and ten households rarely do it. Twenty-three households tend to use wet garbage as animal feed. Twelve households throw this trash in the forest nearby. Ten households sweep it down to the floor. Twelve households dispose it by burning. Eight households put it in a trash can, while only a couple households bury it. For solid waste, twenty-eight households dispose it by burning. Thirteen households put it in community trash can. Eight households throw it in forest. Seven households sell it out. A couple of households bury it and only one household reuses it. However, a couple households just sweep the trash down to the floor. Most households have seen around 1-5 rats a day. Most of these households do not recognize the danger of rats. In addition, twenty-five households use rat control. Furthermore, ten households have seen wildlife around the villages.

#### 4.1.5 Economic-relevant Trichinellosis Risk Factors

##### a) Financial Status

As for a primary source of income, these representative households earn money from crop production (50 households), working as laborer (5 households), merchandise (3 households) and animal farming (2 households). As for a secondary source of income, they earn money from working as a laborer (29 households), animal farming (21 households), crop production (2 households) and selling merchandise (1 households). On average, a family earns 58,537.96 Baht annually. Forty households do save some money for different purposes, including, investment in agriculture (30 households), buying products (22 households), preparing for children's education (12 households), preparing for contingency purposes (7 households), preparing for vacation (1 household). Some of them also provide loans for others (3 households). Thirty-one households use the savings money for pig production investment, including buying deworming drugs (20 households), buying more pigs (15 households), buying pig feed (5 households) and also for improving pig hygiene (4 households).

Forty-two of these representative households have fallen into debt. Twenty-one households borrow money from their neighbors. Nineteen households borrow money from village funds. Eleven households are able to access money from the Bank for Agriculture and Agricultural Co-operatives (BAAC). Eight households access sources of funding through informal leasing. A few of them use private leasing or go to Government Saving Bank (GSB) to access sources of funding.

Since most of these people are Thai citizens, they can access the universal coverage for health care service (50 households). A few of them can access the health care service for free through other alternative choices such as the free medical service for elderly, public health volunteer, low income people and as a community leader. A couple of them have private insurance or registered in the social security service. Usually, when these people are sick, they will go to a district hospital (40 households), Tambol health promoting hospital (36 households), nearby clinic (23 households), Maharat hospital (7 households) which is a provincial hospital, Prasat neurological hospital (6 households) which is another provincial hospital, or Fang hospital (5 households) which is district hospital in another district. However, some of them decide to buy medicine by themselves at the pharmacy store (34 households). Some of them use a traditional health care (13 households) or spiritual treatment (9 households).

In considering the convenience products that these people possess, these households have motorbike (48 households) that facilitates convenient travel from house to the cropping farm or to the town. Only a few of them own a truck (5 households). They also have television (45 households) with satellite dish (43 households) and radio (21 households). Many of them have a cell phone (19 households) and only a couple them have laptops, etc.

#### b) Access to Information

Amongst these people, the most important source of information and news is television (47 households). Those who do not have television may watch it with their neighbors who have it. Word of mouth from

neighbors is also seen as a channel to pass along information or news to other neighbors (38 households). Besides, some people receive news from the public announcement (38 households). Additionally, they also access information and news by listening to the radio (47 households), and through reading newspapers (5 households). A few of them use internet and read local journals or magazines. Furthermore, they also receive services from persons and institutions, including, headman (on average around 29 days visited in a year), teacher (on average around 13 days visited in a year), public health officers (on average around 3 days visited in a year), animal health volunteer (on average around 1 day visited in a year), public health volunteer (on average around 28 days visited in a year), animal health volunteer (on average around 2 days visited in a year), police (on average once in every other year), heifer officer (on average once in four years), tree bank officer (only once), sub district officer (on average once in four years) and district officer (only once). From the interview, we found out that, on average, most of these people are not satisfied with the services from these institutions. This may be because there are a lot of them do not receive some services from these people or institutions.

#### c) Cost Structures and Revenue Stream of Highlanders' Pig production modes

The cost structure of pig rearing is composed of fixed cost from pig house and variable cost from feed cost, water supply and pig housing maintenance, and other miscellaneous variable cost. Different kinds of pig production modes have different cost structures and yield different revenue stream to the family as illustrated Appendix G. These costs are calculated until a farmer can sell a pig out.

As overall, the cost of pig rearing per capita is 926.41 Baht. A pig can be sold for approximately 2,900 Baht. The profit per capita is approximately 2,300 Baht. However, if we consider the opportunity costs including the cost of time spent for raising pigs and the cost saved from not buying pigs, the profit per capita will be approximately 2,200 Baht.

From the study, there are two kinds of pig production modes that yield a loss to households. They include pens (3 households) and fences underneath the house (2 households). The combination of raising pigs in pens and tethering yield the highest profit per capita (4,193.24 Baht) while the combination of raising pigs in outdoor-located fences, pens and free range yield the lowest profit per capita (423.13) to the household

#### **4.2 Bayesian Belief Network Model of Trichinellosis Risk**

The conceptual transdisciplinary framework of Trichinellosis risk is developed (see Appendix B) by experts based on the existing knowledge and the experience from the field study to explain interconnection of the risk factors. It is also applied to solve decision problems associated with management of the relevant institutions attempting to reduce the risk. The decision problems include (1) institution's decision to support money for pig pen construction to pig growers and (2) institution's decision to encourage people to stop consuming raw or undercooked meat.

#### 4.2.1 Institution's Decision to Support Money for Pig Pen Construction

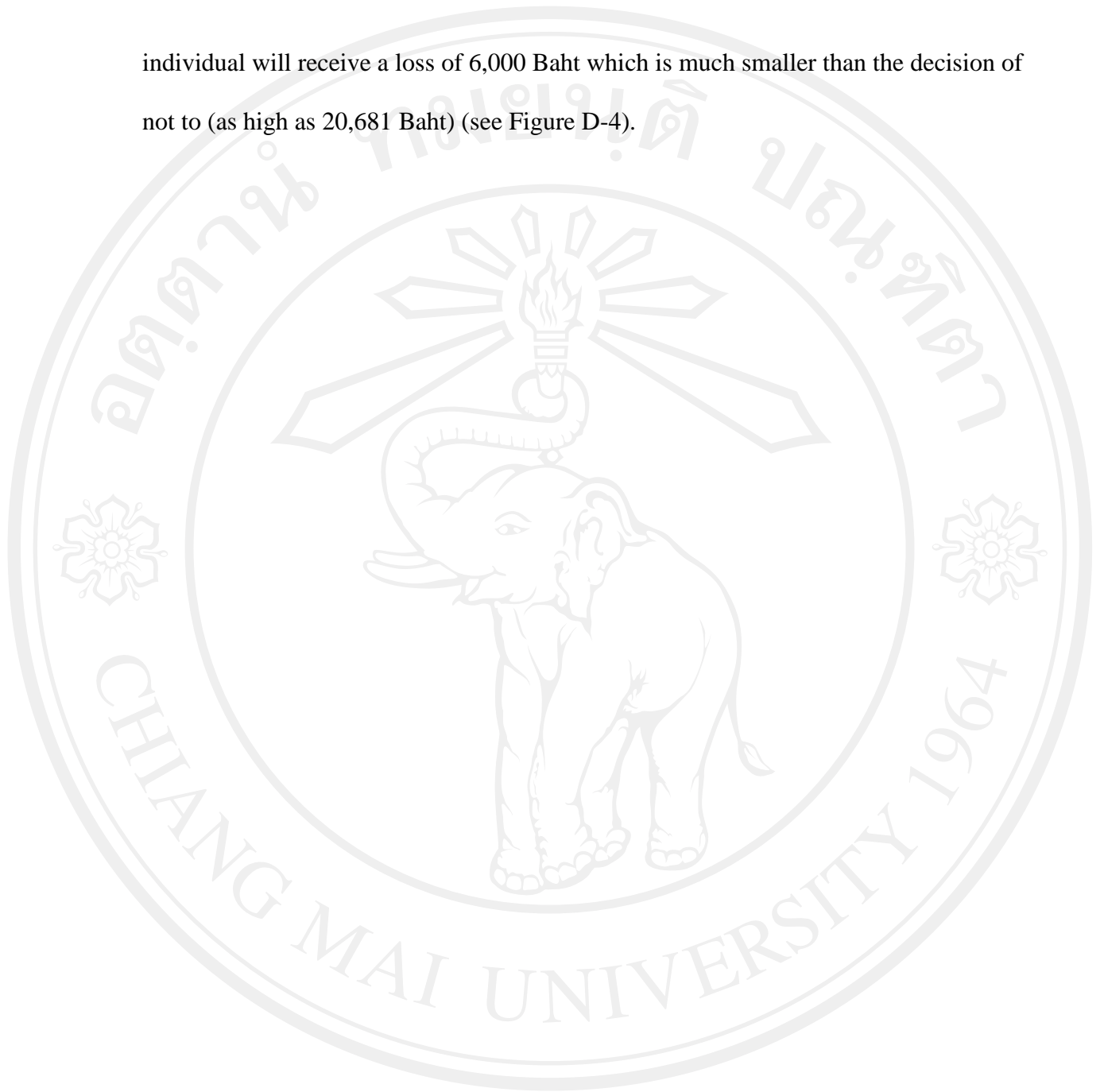
After we incorporate the data into Model 2 (see Figure C-3), the outcome node illustrates the probability that pigs are at high risk to be infected by *Trichinella* is 31.48%, at medium risk is 37.04% and at low risk is 31.48%. For the attitudes toward changing the practices of the pig growers, without being educated, the probability that they will not change the practice is 50.27% and the probability that they will change is 49.73%. This means that they are reluctant whether to change the practice or not. With these circumstances, if the institution decides to launch a program to support money for pig pen construction to pig growers in attempting to reduce the risk that pigs will be infected by *Trichinella*, a household will receive a negative outcome of 3,912.20 Baht per household (in case that the household also agree to change the practice). However, if the institution decides not to launch the program, a household will receive a negative outcome of 5,747.80 Baht per household. Though, without taking possible benefits from the reduction in the risk that pigs will be infected by *Trichinella* from keeping pigs in pens into consideration and under the assumption that the institution has unlimited resources to construct the pen, we can say that a household will be better off if an institution supports a budget to construct pig pens. Moreover, if we assume that a household receives news from someone that the village has a high prevalence of *Trichinella* infection in pigs, the model shows that there will be a slight increase in the willingness to change the practice to keep pigs in pens and the decision from the institution to support pen construction costs for pig growers still outperformed the decision of not to support (see Figure C-4). This showed that the information that their pigs are at high risk to

be infected with *Trichinella* has an effect on the decision of pig growers to switch to keep pigs in pens.

#### **4.2.2 Institution's Decision to Encourage People to Stop Consuming Raw or Undercooked Meat**

After we incorporate the data into Model 1 (see Figure D-3), the outcome node illustrated the probability that people are at high risk to be infected with Trichinellosis is 16.50%, at medium risk 19.65% and at low risk 63.85%. For the attitudes toward changing the behaviors, without being educated about the danger of consuming raw or undercooked meat, the probability that they will not change the habits is 38.60% and the probability that they will change is 61.40%. This means that they tend to change the habits by themselves easily. With these circumstances, if the institution decides to launch a program to encourage people to stop consuming raw or undercooked meat in order to reduce the risk that people will be Trichinellosis, an individual will receive a negative outcome of 3,912.20 Baht. However, if the institution decides not to launch the program, an individual will receive a negative outcome of 5,747.80 Baht. Since we already include the cost of visiting the village into the model, in this case, we can say that an institution should go to the field and encourage people to stop consuming raw or undercooked meat because it yielded less loss than not to. Moreover, if an institution has heard news that a village is at high risk that people will be infected with Trichinellosis, this information can be updated the model and the decision making process. In this case, if the institution launches a program to encourage people to stop consuming raw or undercooked meat, an

individual will receive a loss of 6,000 Baht which is much smaller than the decision of not to (as high as 20,681 Baht) (see Figure D-4).



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