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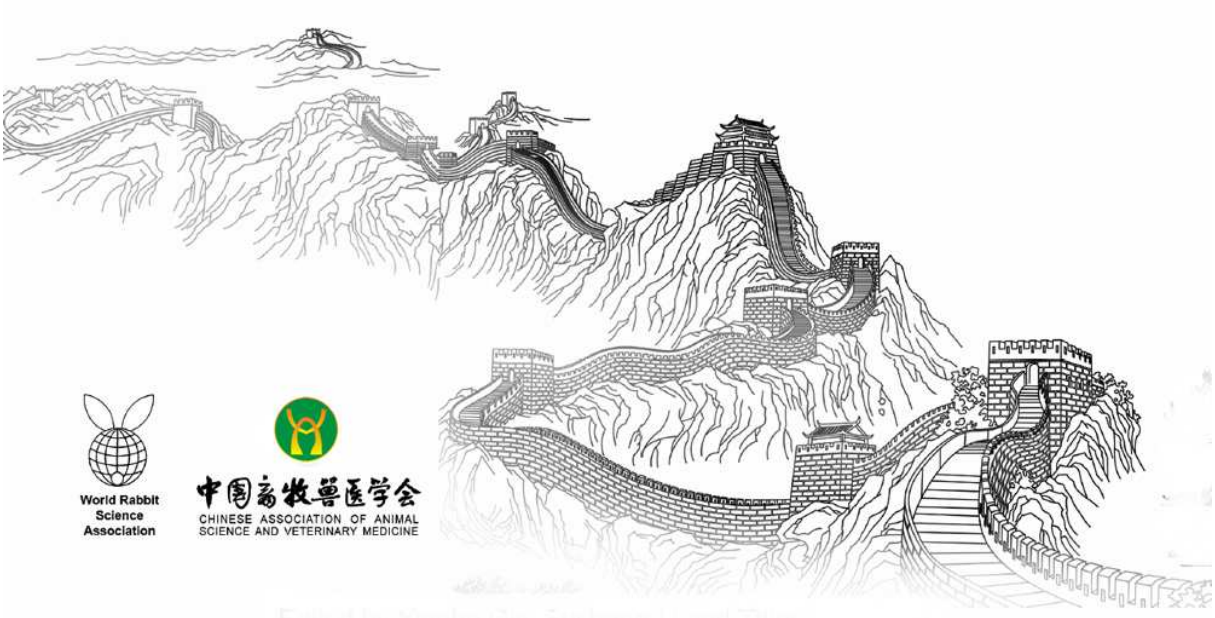

RABBIT PRODUCTION AND RESEARCH IN ASIA : PERSPECTIVES AND PROBLEMS

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ABSTRACT

Increasing population and global warming are among many challenges in attempt to secure food supply for world needs, including for people in Asia, in which short of meat, poverty and unemployment often occur in this region. Slow production of and limited land availability for ruminant animals, high feed cost and disease threats, including bird flu, in poultry production caused a significant raise of rabbit farming in Asia, and particularly in many areas in Asean countries. A drastic increase of rabbit farming and number of farmers occurred in Asia especially in China. Most of farms operations are small in scale and fed primarily on forage and by product feeds. Such operations have a high risk on production and marketing, yet at present, they have been developing fast and are practiced in most areas in China, Vietnam and Indonesia. A shift from family consumption to income-oriented farming occurs almost everywhere.. Benefit/Cost ratio varies from 1.1 – -3.4, depending on the system and scale of farming, which varies from 5 – -500 does. Some companies in China produce thousand tons of rabbit meat, but micro- and small-scale operation (< 50 does) with self forage-providing is very common. At larger scale operation (> 50 does) a combination of forages and commercial feed is practiced. Processing into meat products increases economic value from 46 to 120 %. Cooperation among farmers are formed to strengthen production and supply to ensure a more sustainable operation. Model of cooperation among farmers-farmers or company/ industry farmers are explored to gain more efficiency and effectivity of production. Problems are usually associated with the type or scale of farming. Problems of large scale farming are mostly related increasing production efficiency and opening more market, while at micro- and small-scale farming, most problems are usually technical, initial investment, unavailability of good breeds, cheap feeds and effective low cost management. Researches follow the problems. In China, which has more advanced farming and technologies, directing his research to support commercial rabbit industry. On the other hands, other Asian countries including India and Asean countries are still thriving with LEISA (low external input sustainable agriculture), a characteristics of micro- and small-scale village production. Micro- or large-scale operation, both are concerned in creating the best cooperation among company-farmers. This paper discusses the rabbit production, farming, problems and research in Asian countries, particularly those occur in China, India and some Asean countries such as Vietnam, Indonesia, Malaysia, Thailand and Cambodia.

Keywords : Rabbit production, Research, Problems, Asia

INTRODUCTION

World population and food demand

At the rate of yearly changes from 1.09 % in 2020 to 0.57 % in 2050, the world population is predicted to reach 9,725 billion people (UN, 2015; Worldometer, 2016). Alexandratos and Bruinsma (2012) predicted almost 600 million lower than that of data from the UN. The difference could be due to the prediction of growth rate. Nonetheless, the world population will increase over about 2.5 billlions in the next 35 years. A huge number of people to be fed, to be provided with energy, clean water and shelter. FAO (2012) predicted there should be an increase of 70 % of food, 50 % of energy and 50 % of clean water. The increase is assumed that annual grain production should increase to attain 3 billion

tonnes from 2.1 billion tonnes and meat production, with bigger percentage, from 200 million tonnes today to 470 million tonnes in 2050. The increase for meat production could be caused by the increase of meat demand as the consequences of higher income of people.

Among these numbers (Table 1), most of them live in the developing countries (7,671 from 9,150 billion), where, in some areas within, usually the food availability and people welfare are already and will still be problems. FAO (2012) assumed that in developing countries, the production may have to come mainly from intensification (80 %), that is from increase of yield and cropping, rather than from expansion of land (20%), which could be from deforestation. On the other hand, it was also reported that the major cereal crop has been steadily declining from 1960 to 2000. In addition, climate change and the increase use of some cereals for biofuel production, which account almost 10 % of the global production in 2007-08 (FAO, 2012) has to be well considered. Many of the developing regions of the world are facing a double burden of a growing population and malnutrition (Weingartner, 2005, in Kol and Lukefahr, 2008). A great effort of change in technology to flip the situation from the declining production to substantial increase of production is quite a challenge for the future.

Table 1. Predicted world population by the UN (2015)

Country	2015	2020	2030	2040	2050	Source
World	7349.5	7758.2	8500.8	9157.2	9725.1	[1] and [2]
	7302		8309		9150	
Yearly change, %		1,09	0.87	0.71	0.57/*0.48*	[2, 3]
Developed countries	1396		1437		1439	[3]
Developing countries	5879		6839		7671	[3]
East Asia						
China	1,376.0	1,402.8	1,415.5	1397.7	1348.0	1
Japan	126.6	125.0	120.1	113.8	107.4	1
South Asia						
India	1311.1	1388.9	1537.7	1633.7	1705.3	1
Nepal	28.5	30.2	33.1	35.0	36.2	1
Pakistan	188.9	208.4	244.9	279.0	309.6	1
Bangladesh	161.0	170.5	186.5	197.1	202.2	1
Srilanka	20.7	21.2	21.5	21.4	20.7	1
South East Asia (Asean)						
Lao	6.80	7.40	8.49	9.42	10.17	1
Cambodia	15.5	16.8	19.0	20.9	22.5	1
Vietnam	93.4	98.2	105.2	109.9	112.8	1
Thailand	68.0	68.6	68.3	66.2	62.5	1
Malaysia	30.3	32.4	36.1	38.9	40.7	1
Philippine	100.7	108.4	123.6	137.0	148.3	1
Singapore	5.60	6.00	6.42	6.65	6.68	1
Brunei	0.42	0.45	0.49	0.53	0.54	1
Indonesia	257.6	271.9	295.5	312.4	322.2	1
Papua New Guinea	7.62	8.41	10.06	11.70	13.24	1
Timor Leste	1.18	1.31	1.58	1.86	2.16	1
Total East, South and South East Asia	3,799.9	3,966.9	4,234.0	4,393.2	4,471.2	

[1]Dept. Economic and Social Affairs. Population Division. World Population Prospect. UN (2015)
[2]Worldometer (2016). [3](Alexandratos and Bruinsma (2012)

Predicted population in the East, South and South East Asian countries (Table 1), in which almost half (51.7 % in 2015 and 46.0 % in 2050) of world population live in this region. Except Japan and

Singapore, most of other countries are still in developing stages, and indeed, some areas within the countries are falling in the category of poor areas. According to World Bank (2016) the Gross National Income per capita in 2011-2015 in Bangladesh, Cambodia, Lao, Papua New Guinea were US$ 3330, 3080, 5060, and 2790, respectively. Celagrid and ILRI (2007) in Kol and Lukefar (2008) reported that Cambodia the average monthly income of urban households was US$ 723 while in rural households was only US$ 210 and the gross national product (GNP) is about US$ 300 per person per year, similar to that of Vietnam and Laos (Taucher, 2000 in Kol and Lukefahr, 2008). This data indicated that lots of improvement are essential to increase welfare of people as well as preparing food for the certain countries in Asia.

In terms of meat demand The FAO paper (Alexandratos and Brunsma, 2012) (Table 2) showed that at 2005/2007 meat consumption in developed countries is 80 kg/capita, while in the developing countries is 27.9 per capita, although this average figure is certainly influenced by intercountry differences. This data is somewhat higher, compared to the data reported by Kol and Lukefahr (2008) in Table 4. It is very probable that the data of meat consumption by Alexandratos and Bruinsma (2012) in the developing country includes the data from China, which by the 2015 has already consumed more than 70 kg meat/capita/year (Qin, pers. comm).

Table 2. Growth in Population vs. Growth in Meat Consumption (hypothetical projection of per capita and total demand

	population		**Changes % per annum**
	2005/2007	**2050**	**2005/2007-2050**
Developed countries	1351	1439	0.14
Developing countries	5218	7671	0.88
World	6569	9111	0.75
	Meat (kg/capita) + 1kg for each group		
Developed countries	80.0	81.0	
Developing countries	27.9	28.9	
World (derived)	38.7	37.2	
	Meat total demand (000 tonnes)		**% per annum**
Developed countries	108145	116598	0.17
Developing countries	145824	222076	0.96
World	253969	338674	0.66

Alexandratos and Bruinsma (2012)

Change of meat demand for South Asia from 3.5 (2010) to 4 kg/capita (2020) is very small; on the other hand, for South East Asia, from 12.7 (2010) to 25.7 kg/capita is rather optimistic (Table 3). While in the developed countries, the changes do not seem to be significant (from 70 kg to 80 kg/capita/year), as it is already levelling off. However, for year 2050, as assumed by FAO (2012), the meat production has to increase from 200 million tonnes to 470 million tonnes (2.35 fold). If this is the case, then to meet the demand a very substantially large increase for meat production is needed.

Table 3 : Projected per capita demand for livestock products in Asia (kg/year) (Rosegrant *et al.*, 1995)

Livestock products	South Asia		Southeast Asia		East Asia (including Japan)	
	2010	**2020**	**2010**	**2020**	**2010**	**2020**
Beef	1.4	1.5	4.5	6.0	2.3	3.1
Pork	0.4	0.4	8.6	10.5	30.6	38.2
Sheep meat	1.1	1.2	0.5	0.7	1.0	1.2
Poultry meat	0.6	0.7	6.9	8.5	5.2	6.5
Total	**3.5**	**4.0**	**12.7**	**25.7**	**39.1**	**49.0**

It is well known that ruminant animal is slow in growth and in reproduction and need a large area to provide forages. Attempts have been made to produce fodder from a small land through multi-deck system. Results were varied among authors. Melisa (2014) reported a 2,.3- 2.5 kg fresh forage per kg corn harvested at 8 days-old, while Sneath and Mc Intosh (2003) reported a value of about 6-10 kg/kg corn. At 10-12 days harvest, Suryono (2015, pers. com) in Medan, North Sumatera claimed to produce 7 kg fresh fodder/kg corn. However, to be used for cattle production commercially it still needs considerable improvements as the dry matter of fodder output is less than the corn input. Hence, it may still need a long period of time for meat production from ruminant animals.

Poultry is the biggest producer of meat at present. The feed for poultry comes from cereal grains, mainly maize, soybean meal and wheat bran. In developing countries, rice bran is often used. The feed cost is the biggest constraint in poultry production. Besides, a tight biosecurity should be applied to ensure the safety of the bird production .If most of cereal grain is shifted for human consumption, then the poultry production has to look for alternative feed, which is not simple. China has started to reduce the use of cereal for poultry and swine, hence the rabbit production has more opportunity to develop (Wu, 2012). In such situation, rabbit, with its high production potential, seems to fit in as another source of meat for human consumption.

Advantage of rabbit production.

The potential of rabbits as a fast meat producing-animal has been reported everywhere. Being small, herbivorous and practicing caecotrophy, prolific and fast growing, short generation interval and high genetic diversity, able to utilize forages and high fibrous materials, able to extract plant protein efficiently (eg. Cheeke, 1986 ; Lai and Cay, 2008; Lukefahr, 2008) make the rabbit fits for small- as well as large-scale operation for meat production. Furthermore, being low in saturated fat, salt and cholesterol level and high protein content, rabbit meat is considered as high quality healthy meat (Lukefahr, 1989). In addition, rabbit produce high quality manure (Sajimin and Raharjo, 2004), which create synergistic interactions between livestock and crops, by improving the sustainability of the farming system and improving soil fertility (Kol and Lukefahr, 2008). Being small, also causes low labor costs and investment, two factors that become constraints to small farmers

The bottom line for meat production is to convert plant proteins of little or no use to people as food into high-value animal protein. In efficient production systems, rabbits can turn 20 percent of the proteins they eat into edible meat. Comparable figures for other species are 22 to 23 percent for broiler chickens, 16 to 18 percent for pigs and 8 to 12 percent for beef. A similar calculation for the energy cost of these proteins is even more unfavourable to ruminants. When cattle or sheep are raised for meat production, most of the energy consumed by the herd or flock is used to maintain breeding females which have a low prolificacy: a maximum of 0.8 to 1.4 young per year against 40 for female rabbits. (Lebas, 1997). The rabbits grow and reproduce rapidly, litter size of 6 -9, daily weight gain of 32 g/h/d and give production of meat from 40 – -120 kg/year and the Benefit/Cost (B/C) ratios ranges from 1.42 to 3.55 (Raharjo, 2015). Even with the theoretical lower energy cost when cattle are raised for both milk and beef, rabbit meat is still more economical in terms of feed energy than beef. Rabbit meat production is therefore an attractive proposition (Lebas etal, 1997).

Furthermore, the traditional maize-soybean and other grain fed to these domestic poultry put them in direct competition with humans for food. For countries with no cereal production, poultry production is costly and expensive, hence rabbit production is especially interesting., The development and problems of rabbit production, however, are very much influenced by the types and scales of farming, which may differ between countries where the rabbits are farmed. Objective of this paper is to discuss the rabbit production and research in Asia, its perspective and problems. Data or information and discussion, however is limited by the data gathered by the authors, related mainly to the rabbit situation in China, India, Vietnam, Cambodia, Thailand, Malaysia and Indonesia. Unless otherwise mentioned specifically, discussion in this paper is related mainly to the above seven countries.

RABBIT PRODUCTION IN ASIA AND THE WORLD.

Slow production of and limited land availability for ruminant animals, high feed cost and diseases threats in poultry production and high investment for these animals, caused a significant raise of rabbit farming in many countries in the world, especially in the areas with high population and limited land availability. Numbers of rabbit slaughtered in the world, in 2013 was 1.178 billions heads producing about 1.7816 million tonnes of meat (FAO Statistics, 2015). Figure 2 showed that the biggest share come from Asia (52 %), followed by Europe (29 %), Americas (13 %) and Africa (6 %).

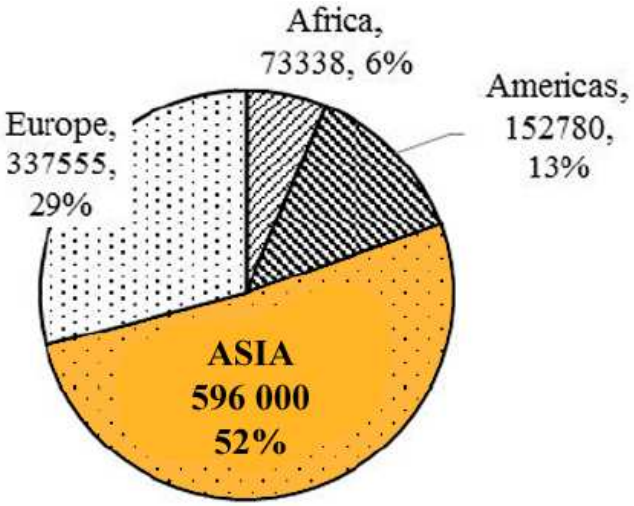

Figure 2. Numbers of slaughter rabbits and the regions share in year 2013.

Numbers of slaughtered rabbit is consistently increasing since 1961 to 2012 (Table 4). This may also indicate that the acceptance of rabbit meat is increasing. The number of slaughtered rabbit did slightly decrease in 2013, about 0.27 %, as in most regions, except Africa, the numbers were decreased. Before the year 2000, the share of slaughtered rabbits were dominated by the Europe regions (90 to 42 %). Share from Africa, Americas and Asia were small, only 10.2% in 1961 and steadily increased to 57.67 % in year 2000. Thereafter the share of Asian countries was bigger than of other regions. In Asia, the largest production come from China, which accounted 40 – -42 % share of the world production. The number of slaughtered and meat production was slightly decrease in 2013, about 2.4 % for slaughtered animal and 0.48% for meat (FAO Statistics, 2015).. The decrease occurred in Asia (excluding China in numbers of slaughtered animals), Europe and America.

Rabbit farming in developing countries in Asia is usually started and aimed to improve nutritional consumption of the poor family in the villages. Being small, easily fed with local forages, such as grass, hay, vegetable waste, by-product feeds, easy to raise and can utilize ‘easy to find’ local materials, such as bamboo and wood for their hutches, rabbits farming is truly fit to raise in the villages, where all those ‘materials’ are available (eg. Farrel and Raharjo, 1984; Mikled et al., 2008; Binh, 2012).

Utilizing rabbit for family meat consumption meets the LEISA (Low External Input for Sustainable Agriculture) program; a program usually promoted for micro- or small-scale agriculture activity and supported by governments. Royal Project Foundation and Heifer Project International in 2002 in Thailand (Mikled et al., 2008), UPGK (Family Nutrition Improvement Project) in 1982 in Indonesia (Sitorus et al., 1982). Gradually farming rabbits has become an exercise to earn cash income. Rabbits are sold as pets, source of meat or laboratory animals (NZW breed in particular); and in vegetable production area, rabbit manure can be sold as a superior organic fertilizer, to other organic or inorganic fertilizer (Sajimin and Raharjo, 2004; Juarini etal, 2008).

Table 4. Numbers of rabbit slaughtered and share (to the world) in different region

Year	World	Africa	Americas	Asia	Europe	China	Africa	Americas	Asia	Europe	China
	Numbers of slaughtered rabbits						Share of the region to the world slaughtered rabbit				
1961	271336	10083	7767	9630	243856	7000	3.72%	2.86%	3.55%	89.87%	2.58%
1965	280891	11559	7786	14530	247016	12000	4.12%	2.77%	5.17%	87.94%	4.27%
1970	333175	12084	8193	23835	289063	22000	3.63%	2.46%	7.15%	86.76%	6.60%
1975	444813	13980	11176	33390	386267	30000	3.14%	2.51%	7.51%	86.84%	6.74%
1980	496627	21744	14137	43514	417232	40000	4.38%	2.85%	8.76%	84.01%	8.05%
1985	524350	47012	13802	40325	423211	37400	8.97%	2.63%	7.69%	80.71%	7.13%
1990	630239	55164	110200	65675	399200	64000	8.75%	17.49%	10.42%	63.34%	10.15%
1995	758017	60025	124474	196810	376708	193928	7.92%	16.42%	25.96%	49.70%	25.58%
2000	883731	64294	142164	303187	374086	258782	7.28%	16.09%	34.31%	42.33%	29.28%
2005	1029850	69422	182040	453425	324963	378404	6.74%	17.68%	44.03%	31.55%	36.74%
2010	1130003	71790	152738	571882	333593	464525	6.35%	13.52%	50.61%	29.52%	41.11%
2011	1159673	73338	152780	596000	337555	474704	6.32%	13.17%	51.39%	29.11%	40.93%
2012	1174763	73910	158707	599322	342824	478000	6.29%	13.51%	51.02%	29.18%	40.69%
2013	1171578	74770	158713	596340	341755	475000	6.38%	13.55%	50.90%	29.17%	40.54%

FAO Statistics (2015)

The outbreak of Avian Influenza (AI) in 2002 in Asia (FAO, 2006) and especially in Asean countries (Raharjo, 2008, Mikled, 2008, Binh, 2008) triggered the rapid development of rabbit farming in this region. In spite of high feed cost for poultry industry, backyard farming of poultry is threatened with many existing diseases, and was particularly true with the outbreak of bird flu, causing a great loss of many death to people and birds and of about USD 463 million as economic lost in Indonesia (Raharjo, 2008). Such situation has promoted the rabbits to restructure backyard livestock system, generating choices of work activity. Many of small-scale poultry farmers in the rural areas in Indonesia switched their farming to rabbit raising. The Government of capital city of Jakarta (Indonesia) prohibits the bird farming in the area. It causes some Livestock Services, in an attempt to support small farmers in Jakarta chose to raise rabbits (BPTP, 2014, pers comm.).

The progress and development of rabbit production in the above mentioned Asian countries are country- dependent. China is the most rapid in developing rabbit production, and at present has become the largest producer of rabbit meat in the world (Gao, 2013). From 2001 to 2010, Chinese rabbit meat production increased from 406 thousand tons to 690 thousand tons, the growth rate reaches 70%, while pork production increased only by 25%, beef by 28% and poultry by 37% (Wu et al., 2013). Such high numbers accounts more than 42 % of the total world rabbit meat production (Yan et al., 2012). Although most of production come from small-scale farming, rabbit industries grow in many provinces (Qin, et al, 2012). In countries like Vietnam (Binh and Son, 2013) and Indonesia (Raharjo, 2008) rabbit production increase at a slower rate. Other countries such as Lao, Cambodia, Thailand are probably in the starting stage to the development of rabbit utilization as an economic commodity even though raising rabbits as household pet has been known for quite sometimes. Malaysia, on the other hand, the scale of farming is averagely small, less than 300 does per farm (Alimon, 2013), yet the operation is fully commercial. There is one big rabbit farm in Malaysia, East Asia Rabbit Ranch, which currently has over 30,000 rabbits (Alimon, 2013).

Interesting to note that sometimes in the 90s the rabbit production and consumption in South East Asian countries had already exist in the significant number (Table 5) (Lebas etal, 1997). Export occurred from China, while imports were surprisingly took place in Japan, Singapore and Sri Lanka. The estimated production and consumption data for Asean countries were interestingly high. For example, the production from Indonesia 50 thousand tonnes, while according to production data by Livestock and Animal Health Statistics (DGLSAH, 2014), the carcass production was only 485 tonnes and the population was 1053 thousand heads. In Malaysia, with the total population of about 406

thousand (Alimon etal, 2013) would hardly reach such number of production. Nevertheless, in the years 80s, in Indonesia, farming rabbit was boosted by the Excellency President of Indonesia, for village family nutrition, so the production could be very high. Similar situation took place in Malaysia, where in 1988, Malaysian small holder farmers and entrepreneurs were encouraged by His Agriculture Minister to go into rabbit farming for both export and local consumption. Rabbit farming in Thailand was also started from the Royal Project Foundation chaired by His Highness Prince Bhisataj Rajani (Mikled et al., 2008).

Table 5. Production and Consumption of rabbit meat in Some Asian countries (Lebas et al., 1996)

Major rabbit-producing countries in some Asian countries in 1990						
Country	Estimated prod. *carcass weight*) (000 tonnes)	Annual carcass production (000 tonnes)	Consumption of rabbit meat (kg/cap/year)	rabbit meat importing and exporting countries		
				Exports	Imports	Balance
China	120	> 100	0.07	40.0	0	+ 40.0
Japan			0.03	0	3.0	- 3.0
Indonesia	50	20-99	0.27			
Thailand	18	5-19	0.31			
Viet Nam	18	5-19	0.27			
Philippines	18	5-19	0.29			
Malaysia		5-19	0.50			
Srilanka		**5-19**		**0**	**1.0**	**- 1.0**
Bangladesh		**1-5**				
Nepal		**1-5**				
Singapore				**0**	**1.0**	**- 1.0**
Source	**Lebas and Colin (1992); Colin and Lebas (1994)**	**Lebas, 1997**	**Lebas and Colin, 1992: Colin and Lebas, 1994.**	**Colin and Lebas, 1994**		

Most countries in the regions of Asia run their rabbit farming in a micro- and small-scale operation (Table 6). Even China, the world largest rabbit-producing countries depends its production on the small scale farming, which accounts more than 90 % rabbit production in the country (see also Table 8). The industrial-type farmings are mostly run in China. Identified big industry in China are Kangda Food Co in Qingdao, which produces more than 40 million tonne s of meat in 2010 (Yan YK et al., 2012) and Hage Co in Sichuan with more than 10 million tonnes production per year (Hage, 2010, pers. Comm.).

In order to increase effectiveness and efficiency in farming operation, small farmers with the common interest, are usually forming group of farmers. At a more progressive state, these groups of farmers join in a cooperative or make a cooperation with the company. When only small numbers of farmers exist in the area, usually they are working individually, or even in an area with huge number of farmers, but lack of trust among them, hence farmers are usually prefer to work individually. In both cases, the farming is difficult to develop. Except in China, most probably the majority of rabbit farmers work individually, although they do join the rabbit group or association. This group functions to discuss matters related to rabbit farming or as a social gathering. This situation needs to be improved or otherwise the progress and development is difficult to grow.

The success of raising rabbit to generate income for farmers attracts other farmers to follow and gradually rabbit farming, even though micro- in scale, start to grow in the area. For many reasons, but mostly (at least in the case of Indonesian situation), rabbit raising is aimed to get quick cash income and avoid high mortality of weanlings, the rabbit farmers sell the young rabbit as pet (Sutisna, 2004, pers comm.). Consequently, the availability of meat is limited. However, at present, more and more rabbit farmers have turned their interest into production of meat rabbit, as considered more and more

demand for meat rabbits. Other than for pet and meat, rabbit has also been used to produce quality wool and fur in China (Lai and Cai, 2008; Gu, 2012).

Table 6. Summary of rabbit production in some Asian countries

Country	Production		Scale	System	Main purpose of farming	Feeding	Reference
	Meat,000 tonnes	000 heads					
China	660.000		Small-to industrial-	Farmers+coop + industry	Meat, fur, wool , fancy	Pellet*, forages	1,2,3,4
India			Micro- to small-		Meat	Pellet, forages	5
Cambodia			Micro- to small-	Individual - group	Pet, meat	Pellet, forages, by-products,	6
Vietnam	24.7	7,655.6	Micro- to medium	Individual, coop, farmer group, and	Pet, meat, Fur	Pellet, forages, by-products	7,8,9,10
Thailand		6.8	Micro- to small-	Individual, farmer group, coop	Pet, meat	Pellet, forages, by-products	11, 12
Malaysia		441.4	Small- to medium-	individual	Pet, meat	Pellet, forages,	13
Indonesia	0.5	1,053.7	Micro- to medium-	Individual, farmer group, coop	Pet, meat, fur, lab use	Pellet, forages, by-products	14,15

1 Yan et al (2004) 2 Qin (2012), 3 Gu (2012), 4 Yan et al (2012), 5 Muralidharareddy (2013), 6 Mikled e tal (2008), 7 Binh and Ky Son (2013), 8 Nguyen VT (2013), 9 Nguyen TDH et al (2013), 10 Nguyen QL and Dinh VH(2008), 11 Mikled et al (2008), 12 Nakkitset et al (2008), 13 Alimon et al (2013), 14 Raharjo (2008), 15 Sumanto et al (2013).

Micro- and small-scale rabbit farmings depend mostly on forage availability, which are usually, available in the backyard or the surrounding area. Sometimes, farmers give additional by-product or waste product feeds, such as rice bran, waste of bean curd industry, vegetable waste, etc. (eg. Sastodihardjo et al., 1988; Nakittset et al., 2008). For medium- or industrialscale, feeds are fed in the form of pelleted premixed diet, which contains all necessary nutrients to support optimal growth for the rabbits. Applying the pattern of evolution for crop livestock system (Chantalakana and Skunmun, 2002) as cited by Kol and Lukefahr (2008) onto the evolution or stage of development of rabbit production in some countries in Asia, it is very obvious that except China, which has already attained the stage 4 (specialization- fully industrialized, equipped with laboratory analysis)), most countries in Asian and particularly in South East Asia are still in the stage 1 (pre intensification = similar to the micro- and small-scale operation) and 2 (Intensification = medium-scale farming) and very few commercial farming are in the stage 3 (income diversification).

Rabbit Production in China

Actually, since the 1990s-2010s rabbit production in Asian countries has experienced fast development, especially after the outbreak of the bird flu (*e.g*. Raharjo, 2008; Binh, 2013). Meat production increased almost 2 folds, from 428.891 tons in 2000 to 829.603 tons in 2011, accounted 90% of the world total increase (Gao, 2013), although mostly the production come from China, which in year 2008 had produced about 588,000 tons and only about 8.538 tonnes were exported (Qin, 2012). In 2013, however, China had already produced 503.660 million slaughtered rabbit with 785 thousand tonnes (Table 7). This data is slightly higher than that reported by FAO Statistic (2015), 543.1 vs 475.0 millions head. Nonetheless, in both data, the numbers of slaughtered rabbits in China grew tremendously from only 73.1 millions in year 1990 to 503.66 million in 2013 (CAHVY, 2015), a 688

% increase in 23 years or % per year. A further increase of 3.63 % is estimated to be reached in the next 3 years ahead, to produce a total rabbit meat of 874 thousand tonnes.

Table 7. Numbers of rabbit slaughtered and meat production in China 1990-2016.

	Slaughtered, 10000 head	Annual growth	Stock10000 heads	Annual growth	Rabbit meat, 10000 tont	Annual growth
1990	7314.9	NA	NA	NA	9.6	-6.80%
1995	15019.9	-11.25%	NA	NA	26.8	17.03%
2000	25878.2	17.08%	17781.7	12.62%	37.0	19.26%
2005	37840.4	11.34%	21764.1	7.66%	51.1	9.38%
2010	46452.5	7.33%	21500.7	-3.24%	69.0	8.49%
2012	48776.7	2.75%	22158.2	2.13%	76.1	4.10%
2013	50366.0	3.26%	22345.3	0.84%	78.5	3.15%
2014*	51679.1	2.61%	22736.1	1.75%	82.9	5.61%
2015*	52912.0	2.39%	22763.0	0.12%	85.0	2.52%
2016*	54391.0	2.80%	22862.	0.44%	87.4	2.79%

Data Source : China Animal Husbandry and Veterinary Yearbook

* The data after 2014 is estimated by Industrial Economic Analysis Group of China Rabbit Research System

Cooperation between farmers, small or large scale, together with the participation of Government could be a very ideal type of entrepreneurship in the future, as it involves many human resources, more adoption of technology-research results, optimizing land utilization, secure market, especially for micro- and small scale farmers who less ability to market their products, and very possibly more production of healthy organic agricultural products.

The high number of rabbit production in China, are concentrated in 3 main areas, *i.e.* East China (Anhei, Shandong, Jiangsu, Fujian, Zhejiang); North China (Hebei, Henan, Shanxi) and the Southwest of China (Sichuan, Chongqing), which accounted almost 92 % of the total rabbit production in China (Lai and Cai, 2008). The data of slaughtered rabbits in the main 10 provinces of China in 2007 and 2013 are shown in Table 9. Sichuan, a major consumer producer of rabbit meat in China slaughtered almost 175 million rabbits/year in 2007 and increased to 504 million in 2013.

Table 9. Number of slaughtered rabbits in 10 major provinces in China in 2007 and 2013: million heads.

Rank	2007		2013	
	Province	Slaughtered number	Province	Slaughtered number
1	Sichuan	174.984	Sichuan	503.665
2	Shandong	83.390	Shandong	199.094
3	Henan	39.922	Chongqing	62.442
4	Hebei	30.259	Henan	44.818
5	Jiangsu	28.499	Jiangsu	41.401
6	Chongqing	19.929	Hebei	40.417
7	Fujian	15.284	Fujian	33.066
8	Zhejiang	7.588	Jilin	18.831
9	Shanxi	4.887	Hunan	7.936
10	Hunan	4.648	Guangxi	6.718

Data Source: China Animal Husbandry and Veterinary Yearbook (2008 and 2014)

Various rabbit breeds are raised in China. For meat rabbit the main imported species are the New Zealand White, Californian, Checkered Giant, Japanese White, Chinchilla, Belgian Hare, Lop-ear rabbit. The meat-type rabbit hybrid, such as Zika from Germany and Hyla from France are available.

The local or local cross are Harbin Big White, Saibei, Elco, Taihangsan, Anyang gray, Yufeng Yellow and Fujian Yellow (Qin, 2012).

Beside rabbit meat, China produces a substantial amount of rabbit wool and rabbit fur. Lai and Cai (2008) reported that China has become the country who obtains the highest yield of rabbit wool (2-5 tons per year) and mostly are exported (> 90 %). Highest wool production and revenue from selling rabbit were obtained in year 2000, in which the production was 4990 tonnes and the revenue was $ 6.12 million. Export price is more attractive as it always higher than the domestic price. China claims to have good breed of wool rabbit, which was selected from Chinese Angora and produces 4,729 g/year for the female rabbit and 2,982 g/year for the male rabbit (Gu, 2012). The wool-type breeds available in China include German Angora, China Angora, Anhui long hair, and French Angora. New long hair rabbit breeds developed in China includes Zhenhai Giant, Jiangsu Coarse Hair, Zhejiang Coarse Hair, Yimeng Giant Long Hair and Taishan Coarse Long Hair rabbit (Qin 2012).

China farms a substantial numbers of fur-producing rabbit, the Rex. Rex fur from China is good in quality, as a result of a long selective breeding. The skin area is wide and, through a well tanning technology, is pliable and the hair/fur is soft. Currently China produces around 1 billion animal skin annually and 110 million ares from the Rex rabbit. In 2004, production from Rex rabbit was 5 million, and about 400 million from meat rabbit skin (Lai and Cai, 2008). Data in 2004, showed that China sold 140,000 Rex skin for RMB 12.49 millions (=C¥ 89/skin = US$ 14.2) and 4.62 million meat rabbit skins worth C¥115.5 million (=C¥ 25/skin=US$ 4.0). Furthermore, although most of the Rex breeds used for production were initially imported (German Rex, France Rex and American Rex), Gu (2012) showed results from selection and crossbreeding of Rex to produce own strain of Rex, including Venus and Jirong Rex rabbits. Further, Lai and Cai (2008) informed that the need of Rex fur market in America and Japan is around 10 million and is still increasing gradually. China, however, could supply only 800~900 thousand per year, hence the gap of demand to supply is still wide.

Most of rabbit farms in China, especially the medium- and large- scale operation have been using the commercial pellet feed, which is formulated according to the nutrient requirement for the rabbits. For small scale farms, however, they also used some forages available aroud the area to reduce the feed cost.

The high China rabbit production is substantially supported by the small-scale operation. To develop effective organization of these large numbers of farmers, especially to manage the market, supply and demand, as well as to effectively transfer the technology, the industries and farmers set up the cooperative (Qin, 2012). It is the success of their management of cooperation that boost the high rabbit production. China rabbit industries adopt 3 types of cooperation, adjustable according to the need of farmers, composition and management in the areas. Qin (2012) reported this types of cooperation (coop – this term will be used for 'cooperative') are as follow (i) "*classic rabbit farmers cooperative*" - a basic coop, in which farmers make a coop based on common interest is financed by members according to their ability. This type of coop applying a strict constitution and regulations and membership requirements, and employing professional management team and members enjoy the profit sharing scheme based annual production results; (ii) "*combined processing company+farmers*", in which the company sponsors the cooperation though providing funds for production components, i.e. rabbit buildings, cages, breeding stock, feed, and drugs at low price, and also technical assitance for production and disease control.
Farmers contribute labor and submit some security payments. Farmers received their income, from selling slaughtered rabbit, after deduction from the operation cost; (iii) the third and commonly adopted type is "processing company+farmers' cooperatives'. The cooperative acts similar to the processing company in the second type coop, provides breeding stock, feed and vaccination services to all coop farmers and set up a standard sale for product selling and prices, yet farmers have the option to sell their rabbits especially if market is good. This company+coop type is formed to accommodate a large and often scattered farmer members, in which the cooperative become a liaison for the company and farmers, as the company has limited control over farmers. To ensure the consistent production, the company provides standard operational procedure of farming. In addition, the company normally

enjoys the support from local government in the form of financial, policy and scientific research funds (Qin, 2010). In China, the Government supports the development of group/farmer cooperative in the form of 'State Law of Farmers Professional Cooperatives (Qin, 2010, cited from Zhu et al, 2009).

Food safety and disease control are another areas of concerned. Food safety related to control of the meat products. Industries such as Kangda Food C°. builds a laboratory for testing of possible toxic residues or microbe contamination in the products. Disease control, such as VHD, pasteurellosis, brocho-septicemia and enteric diseases have been claimed well controlled (Yan HP, 2004).

Rabbit Production in Vietnam

Vietnam is a country with third biggest population (93.4 million in 2015) in South East Asia after Indonesia and the Philippines (UN, 2012). It is a country with huge export of rice, about 7.72 million tons in 2012 and its livestock production (pigs, cattle, chickens, ducks, goat and rabbit) contributed 27 % of total food supply in the country, including the rabbit meat (Dinh and Ky Son, 2013). Vietnam, is a significant rabbit producing country in Asia. In 2012, Vietnam rabbit population were 7.655 million, increased from 1.985 millions in 2000. The meat production was about 24.7 thousand tonnes in 2012 (Table 10). In the period of 2000- 2012, the growth increase of rabbit population and rabbit meat production were 32.1 % and 36.1 % per year, respectively, whose increase was higher than meat production from other livestock in the country (Binh and Ky Son, 2013). However, consumption of rabbit meat is still relatively small, about 270 g/capita/year, compared with other livestock or poultry meat.

Table 10: Livestock population and percentages change from 2000 to 2012 in Vietnam

meat (000 tonnes)	2000 *1000 heads*	2005 *1000 heads*	2010 *1000 Heads*	2011 *1000 Heads*	2012 *1000 Heads*	Growth rate %/ years 2000-2012
Total meat	1,997	2,835	4,017	4,169	4,271	
Pig	20,194.00	26,435.00	27,373.00	27,055.98	26,493.92	2.60
pork,	*1,513*	*2,288*	*3,027*	*3,098*	*3,160*	*9.1*
Cattle	4,127.9	5,540.7	5,916.0	5,436.56	5,194.178	2.15
Poultry	316,400,0	321,890.0	321,497.0	322,568.90	308,460,0	-0.21
poultry meat	*322.6*	*321.9*	*615.9*	*696,0*	*789,4*	*12.1*
Buffaloes	2,897,0	2,922,0	2,913,0	2,712,025	2,627,813	-0.75
	86,56	*85,87*	*87.8*	*87,79*	*88,47*	*0.18*
Goat, Sheep	552.5	1,070.0	1,178.0	1,267.8	1,343.6	20.3
mutton	*6.5*	*12.6*	*15.8*	*17.2*	*18.9*	*1.59*
Rabbit*	1,985,0	3,450,0	5,360,0	6,379.66	7,655.50	32.1
rabbit meat,	*5.7*	*9.9*	*15.4*	*19.4*	*24,70*	*36.1*

Source: Vietnam Agriculture Department-MARD (2000, 2005, 2010, 2011 and 2012) cited by Binh and Son (2013)

Most rabbit farming in Vietnam are in micro-scale extensive systems raised by households in the rural areas for own meat consumption. Following the outbreak of bird flu in year 2003, green ear and foot–mouth disease (FMD), rabbit farming received more attention from the Government and farmers, and the aim of farming is shifted to improving income of rural farmers (Binh and Ky Son, 2013). Substantial numbers of research were carried out to improve reproduction (Mai et al., 2008), nutrition (e.g. Nguyen VT. 2008), management and disease control (Nguyen QT, 2008). Current price of rabbit meat has also increased, VND 45,000/kg live weight for meat and 80,000 VND/kg of live weight for breeding stock while cost of 1 kg live weigh of beef or pig is about 23.000 VND or 22.000 VND, respectively (Binh and Ky Son, 2013), The high price of meat gives higher income for the raisers and promotes rabbit production in Vietnam.

Distribution of rabbit population in Vietnam is presented in Table 11 (Binh and KySon, 2013). Rabbit population are highest (53.1 % of the total) in the North of Vietnam, where the area is also widest in the country (166.6 km2). The rate of population increase is high in the centre to the north areas (48 – -113 %), also in the red river delta (91.6 %).

Table 11. Land area and distribution of rabbit population in different areas of Vietnam

Locations	Land area* km^2	Rabbit population** in 2010		Rabbit population ** in 2012		Increase rate,
		1000 heads	%	1000 heads	%	%
North of Vietnam	166,6	2,265,141	42.3	4,060,457	53,1	79.3
Midland and northern mountainous	102,9	826,000	15.4	1,226,000	16,0	48.4
Central of northland	51,2	352,141	6.6	752,141	9,9	113.6
Red river delta	12,5	1087,000	20.3	2,082,316	27.2	91.6
Centre of Vietnam	98,7	983,002	18.3	1,183,002	15.4	20.3
South-central coastal	44,2	630,000	11.7	730,000	9,5	15.9
Central high land	54,5	353,002	6.6	453,002	5,9	28.3
South of Vietnam	65,8	2,112,131	39.4	2,412,131	31,5	14.2
Southeast	23,5	1090,131	20.3	1,190,131	15,5	9.2
Mekong river delta	42,3	1,022,000	19.1	1,222,000	16.0	19.6
Total	331,1	5,360,274	100.0	7,655,590	100.0	42.8

Vietnam National Statistic Department (2012), Vietnam Agriculture Department-MARD (2010; 2011; 2012), cited by Binh and Ky Son, (2013)

Most farmers in Vietnams are maximizing the utilization of local materials, sucha as bamboo and woods for housing and cages which are abundantly available locally around the areas, with or without combination with wire mesh. Forages and/or by-product feeds are mostly fed the rabbit, although some farmers have already used the animal with pellet diet to improve production. In term of breeds raised, most rabbit found in Vietnam are local breeds (Re, Black and Grey Rabbit) and some imported breeds from Hungary and France (New Zealand White, California, Panon and Hyplus rabbits). They were reported to growing well in the Vietnam environment (Binh and Ky Son, 2013). Related to their production, diseases is among the inhibiting factors. The major diseases reported among rabbit in Vietnam are scabies, coccidiosis, diarrhoea, pneumonia and haemorrhages; Diarrhoea and Pneumonia. The important are haemorrhages. Viral Hemorrhagic Disease, was detected in 1997 and is considered the most dangerous viral infectious diseases causing high mortality, that were controlled by vaccination through using vaccine made in Vietnam from 1998. Other are usually treated effectively with drugs and 90-95% of all infected animals were recovered (Nguyen QT, 2008)

Other than for meat and pet production, rabbit in Vietnam is also utilized to produce manure. Its manure is mainly used for organic fertilizer and also to grow earth worm that is used as source of protein for chicken farms. Le Thi et al., (2000) in Nguyen DB and Nguyen KS (2013) reported that 1 kg of earth worm can be produced from 18 kg fresh rabbit manure in about 4 hmonths. This production is much better than those from buffalo and cattle manure, which needs 87 and 108 kg fresh, respectively, to produce the same amount of earth worm.

At the earlier stage, rabbit meat is not customary in the Vietnamese dishes, and therefore the rabbit products are sold to the restaurants and the demand is low. However, since the economic in Vietnam is somewhat liberalised and the income of people is increasing, the demand for meat is also increasing. The outbreak of bird flu in 2004 also triggered the demand for breeding stock and rabbit meat in many different areas of Vietnam. These two situations triggered the promotion and development of rabbit production and the market for rabbit products rabbits was more open and easy to find in the cities (Binh and Ky Son, 2013). Further, some small processing units for rabbit meat were built, and as the consequence, the demand was increasing and could not meet the demand. As a result, the prices of

rabbit meat in increasing rapidly. The needs to have good quality breeding socks is then becoming a priority. Further stage is to expand the breeding centers, currently in North Vietnam to other areas, eg Central and South of Vietnam. This expansion is the initiative pursued by Goat and Rabbit Research Center in North Vietnam for the future of rabbit development.

Rabbit Production in Indonesia

Being a very populated country, almost 257 millions in 2015 (UN, 2015) and consists of more 16,500 islands, Indonesia has to work hard to feed the people while also to transport them throughout the country. Table 12 shows the rabbit population in major provinces in Indonesia from 2010-2014. Main meat consumption in Indonesia is chicken meat, mutton, beef, meat from ducks, then pork (DGLSAH, 2004). Very few comes from the rabbit, as the production also very low, and concentrated in some areas. In 1984-1990, rabbit production in Indonesia was phenomenal, due to the support by the President of the Republic in the attempt to improve meat consumption by the villagers. Rabbit raising was very popular in the rural areas, especially in Java (Sastrodihardjo et al., 1988). Further, as the time went by, most farmers tried to switch from own consumption to income orientation, but the market was not available. Rabbit farming declined. However, following the outbreak of the bird flu (Raharjo, 2008b), rabbit became a 'prima donna' for small farmers (Raharjo, 2008a). Rabbit raising can be found in almost every province in Indonesia, although mostly the size is micro and small, depend primarily on forage feeding and sold as 'play' pet rabbit and, yet, gave a significant income to the farmers.

Table 12. Rabbit population and rabbit meat production in Indonesia

	Provinces	2010	2011	2012	2013	2014	%/year
1	North Sumatera	35.759	21.063	20.577	144.429	15.596	-14.1
2	West Sumatera	39.903	n.a	22.910	22.548	23.224	-10.4
3	Lampung	274484		35394	34230	36662	8.3
4	West Java	107681	171880	282553	318436	223179	26.8
5	Central Java	330574	350844	376730	292059	293276	-5.5
6	DI Yogyakarta			30681	31935	34741	6.6
7	East Java		162719	226718	326776	327430	33.7
8	Bali	3934	5709	5907	6915	7155	20.5
9	West Nusa Tenggara	2865	2763	2956	7415	3052	1.6
10	East Kalimantan			10468	11301	11414	4.5
11	North Sulawesi	839	1084	1842	2304	2760	57.2
12	Central Sulawesi				3300	3629	10.0
13	South Sulawesi				5215	5350	2.6
14	Papua	32068	33046	43306	40458	44284	9.5
	Indonesia Total	**833666**	**760106**	**1074847**	**1137041**	**1053684**	12.9
	Indonesia, rabbit meat (tonnes)	**112**	**192**	**301**	**592**	**485**	83.3

Dir.Gen. Livestock Production and Animal Health (2014)

The rabbit population are concentrated in Java (Table 12). The total population in 2014 was only about 1 million does, much less of those in Vietnam. North Sumatera, Central Java and East Java are fast developing provinces for rabbit farming. However, due to eruption of the local volcano close to the central rabbit farming, the development decreased drastically, especially in North Sumatera, where the volcano is erupting for more than 2 years. However, at present, more and more farmers raise rabbit in a commercial type, as the rabbit farming is very profitable (Table 13). Benefit/Cost ratio for meat rabbit, in an intensive system, using fully commercial pellet feed, 1.42, meaning the profit is about 42 %. If the feeding is mixed, 50 % commercial pellet + forages ad libitum, the B/C ratio increased to

1.74. The most profitable is selling the products as fancy and laboratory rabbits. However, their market are very limited or not always available.

Table 13. Economic analysis of raising 100 does and 20 bucks with or without forage feeding per 2 months.

Type of rabbit	Feed	Litter size	TCP/FC*	Price (Rp000)	Profit (Rp000)/ 2 mo	B/C ratio
Meat-type	Premixed, 100 %	6	100/80	24/kg carcass	3,374	1.42
	Premixed, 50 % + forages	6	100/70	1.5/ft fur	4,600	1.74
Meat + Fur	Premixed, 100 %	5	100/80	24/kg carcass	6,834	1.79
	Premixed, 50 % + forages	5	100/70	20/ft fur	8,640	2.40
Fancy	Premixed, 100 %	5	100/80	15/weanling	2,575	2.19
	Premix 50 % + forages			20/3 mo-old	2,962	1.88
	Premixed, 100 %	5	100/70		3,395	2.94
	Premixed, 50 % + forages				4,135	3.55
Laboratory	Premixed, 100 %	6	100/70	35/kg live	21,520	3.10

* TCP = Total Cost Production, FC = feed cost; UD$ 1.00 = Rp. 5,500.00

Individual micro- and small-scale farming could be sustaining for a long time, depending on the availability of market or the ability of farmers to market the products. However, many reports indicated that small scale farmers are usually lacking in marketing ability, lack of technology, lack of cooperative interest and easily influenced by situational changes. Moreover, small- and micro scale operation is difficult or slow to progress. Individually, farmers could not produce high numbers or supply, if they do, they may have difficulty to market the products. Besides, purchasing materials in a small numbers usually is more costly. A joint-cooperation or making a farmer group is necessary to increase the supply so the market can be opened wider. Type of cooperation exist in Indonesia is similar to first type of cooperation showed in China, 'farmers to farmers cooperation'. Expetedly a cooperation of the second, third or even 4 type can be realised soon.

Rabbit Production in Malaysia

Rabbit farming is a relatively new sector in the livestock industry in Malaysia and they can be classified as those that supply rabbit meat, and those that supply live rabbits for breeding and for pets. It was started with the encouragement from the Minister of Agriculture in 1988. Although the farm size are mostly small and grow slowly, but at a steady phase for both pet and meat rabbit industries. As far as small holder farmers are concerned keeping rabbits can be lucrative and profitable and provides added income to the farmer. Those farms, who are seriously starting for commercial purpose usually has 500 – 1000 does in farm. There is a big farm with 30,000 rabbits, an East Asia Rabbit Ranch in Semenyih, Selangor. This farm combines the farming and eco-tourism. Data from Ministry of Agriculture Malaysia as cited by (Alimon et al., 2013) showed that there is 216 registered rabbit farms with the total number of 430,617 heads (Table 14). Although no data report of production and consumption of rabbit meat, Lebas etal (1997) reported that Malaysia produced rabbit in the range of 5000- 9000 tonnes in the 1990s. Backyard small-scale farming from few up to 500 rabbits are not registered as a farming enterprise and office of livestock services considers it as the family activities for own meat or extra income, hence is difficult to get the data from them.

Meat-type rabbits raised are commonly the New Zealand White and Californian White or their cross, while for pet-rabbits, almost all attractive, cute rabbits breeds are available and imported from Europe and USA. The pet rabbit association in Malaysia is often run the rabbit contest with the Jurors come from abroad (Aisyarurrida-MARBA, 2015, pers. comm).

Table 14: The number of registered farm and average number of rabbits in various states in Malaysia

No	State	Number of farms	Average number of rabbits	Total
1	Johor	4	80	320
2	Kedah	103	1717	176,851
3	Kelantan	16	139	2,224
4	Pahang	3	22	66
5	Pulau Pinang	12	1432	17,184
6	Perak	49	3190	192,020
7	Selangor	10	3920	39,200
8	Terengganu	18	664	11,952
10	Sarawak	1	1600	1600
	Total Malaysia	216		430,617

Dept. of Veterinary Services, Ministry of Agriculture and Agro-based Industries (2013)

Although small in scale most farms including pet rabbits in Malaysia use commercial pellet feed, usually with a crude protein content of 18-20%. Pet rabbits are fed rabbit pellets and supplemented with leafy vegetables or grass hay. To reduce feed cost, some feed formulators include palm kernel meal, up to 20-30 % (Carrio etal, 2011), which are available abundantly in Malaysia. Problems in production is associated with diseases. Most common rabbit diseases found in Malaysia are snuffles, scabies, ringworm, fly strike, myxomatosis, VHD and diarrhoea.

The system of marketing rabbits in Malaysia is farms → middle man → consumers, or a direct farm → consumer. Farms sell their rabbits live or carcass to retailers. The retailers may select the rabbits at farm, and for rabbit meat, they have to make sure the slaughtering follow the halal procedure. Retailers then sell the carcass or meat to food processors (satay sellers, restaurants or other consumers). Rabbit meat or dressed carcass are sold at RM 30-35/kg, while price for pet rabbits is usually higher, ranging from RM 20, the weanlings, to few hundred ringgit depending on the breed. High quality bucks worth up to RM2000, and usually are imported from other countries. Interesting to note that some of the farms listed in Table 14, are edu-parks incorporated within a farm. Food processors, outlets and restaurants usually ask farms that can provide continuous supply for their outlets (Alimon et al., 2013).

Rabbit Production in India

Rabbit as a meat-producing animal is newly introduced in India. Some farmers have set up rabbit farms in Andhra Pradesh, Kerala, Goa, Karnataka, Himachal Pradesh, Hyderabad, Vijayawada, Jammu and Kashmir and hilly areas of Uttar Pradesh, Haryana and Tamil Nadu (Muralidhararedy et al., 2013). Low investment, small in size (less land to use) and high productivity are among the attractive factors to start rabbit farming. High protein, low cholesterol and low saturated fat content make the rabbit meat is acceptable to the people in India. In addition, farming is actively promoted by educated young people in Hyderabad, Kurnol and some parts of Andra Pradesh. Some activities on feeding roughages for rabbit and mortality pattern of some breeds of rabbits in the East Himalayan region were studied (Das and Bardoloi, 2008; Das and Bujabura, 2012 – cited by Murallydhararedy et al, 2013)

Rabbit Production in Thailand

Initially, rabbit is treated more as the fancy animal than for the meat production livestock. Lots of strains of pet rabbits, such as American Fuzzy Lop or Angora Lop, California rabbit, Dutch, English Angora, English Lop, English Spot, Flemish Giant, French Angora, Giant Angora, Holland Lop, Jerry Woody, Lion Head, Mini Lop, Mini Rex, Netherland Dwarf, Polish, Rex, Satin Angora, Teddy Bear, Thai rabbit (Native Breed) and Woody Toy are raised by hobbyists and rabbit fanciers. On the other, only small number of Thai people consume rabbit meat (Jamikorn, 2013).

Following the serious strike of bird flu in SEA countries, including Thailand, which caused the shortage of poultry meat to rural families, have made the increase of rabbit farming. At least 20 Royal Project Development and Extension Centers (RPDEC) and 89 farmers were involved in the rabbit raising scheme in the upland areas of Thailand for commercial market and home consumption, with the total rabbit population were 6797 heads (Table 15). The RPDEC project is chaired by His Serene Highness Prince Bhisataj Rajani. The project was run for some years through the Livestock Development and Extension Section, Royal Project Foundation with the objective is meat production through the feeding of vegetable waste. At present, rabbit meat is not only sold in the European restaurants, but also in the Thai market and increasing every year as demand is increasing in the big cities (Mikled et al., 2008).

Table 15. Numbers of farm, farmers and rabbit population involved in the RPDEC project

Name of centre	Number of rabbits in the Centres	Number of rabbits in the Farms	Total	No. of farmers
Kae Noi	29	44	73	3
Khun Pae	74	361	435	1
Teen Tok	63	70	133	7
Thung Roeug	32	43	75	3
Pung Ka	35	0	35	-
Pang Da	94	111	205	3
Phra Bat Huai Tom	0	501	501	15
Mae Lord	215	208	423	5
Mae Hae	808	0	808	0
Wat Chan	530	160	690	7
Huay Siew	52	356	408	10
Inthanon	171	4	175	1
Pa Mieng	89	1290	1379	24
Nong Khiew	21	30	51	2
Mae Sariang	16	0	16	0
Mae Tha Nuea	0	566	566	2
Huay Nam Khun	0	107	107	2
Nong Hoi	200	490	690	3
Thung Rao	10	17	27	1
Total	**2,439**	**4,358**	**6,797**	**89**

Mikled etal (2008)

Marketing of rabbit meat and smoked rabbit meat in Thailand from 2006 – 2008 showed significant increase on weight meat sold and income received (Table 16). Marketed rabbit meat increased 75 %, while the smoked meat increased 177 % from 2006-2007 to 2007-2008, respectively. This data indicated that rabbit meat gained more acceptance as the supply increasing.

Table 16. Situation of marketing rabbit meat in Thailand from 2006-2008.

	2006-2007		2007-2008		2006-2007		2007-2008	
	Rabbit meat		Rabbit meat		Smoked rabbit meat		Smoked rabbit meat	
	Weight (kg)	Income (Bht)	Weight (kg)	Income (Bht)	Weight (kg)	Income (Bht)	Weight (kg)	Income (Bht)
Total	1,935.30	261,238.50	3,396.2	458,136.00	131.18	32,795	364	89,978

Rabbit Production in Cambodia

Rabbit farming in Cambodia is similar to the starting stage of rabbit farming in those other Asean countries. Started as hobby, sold as pet rabbits and start to grow as more serious farming after the bird flu outbreak, micro- or small- in scale as the household activity, depends almost entirely on forage feeding and maximizing use of manure are also the type of rabbit farming in Cambodia (Pok and Lukefahr, 2008). Studies on the use of available forages for rabbits, such as Water Spinach (*Ipomea aquatica*), Sweet Potato vines (*Ipomea batatas* L), Mulberry (*Morus alba*), Cassava foliage (*Manihot esculenta* Crantz), Leucaena (*Leucaena leucocephala*), Gliricidia (*Gliricidia sepium*), Stylo *(Stylosanthes guianensis*) were reported. Pok et al. (2006) showed that feeding water spinach as the sole diet to the crossbred of Local x New Zealand rabbit produce 14-20 g bodyweight gain, and when are fed at the amount of 50 % to replace guinea grass, the growth and lactation performance improved about 25 % (Pok and Lukefahr, 2008).

RABBIT RESEARCH IN MAJOR COUNTRIES OF ASIA

Research in rabbit production usually follows the type of rabbit production in the area. In the medium and large or industrial scale, research is usually aimed at the most productive breed under the best or most efficient nutritional feed use, most effective management including disease control and treatment, and management of housing and cooperation with farmers. Research in marketing and product processing are also carried out. In the above mentioned countries this is the type of research conducted in China, although Wu etal (2012), humbly said that compared to the European or North American countries rabbit research in China are considered as still in the early stage. In the micro- and small-scale production, most researches are directed more towards the low cost efficient feed available in the area and disease control. Other areas that need attention, for the tropical countries in particular- as most rabbit suffer from heat and humid stress, is housing management, treatment against enteric diseases and also farmer group management to combine micro- and small-farming system and the industrial system.

Table 17. Summary of collected rabbit research carried out in some Asian countries

Area of research	China	India	Cambodia	Thailand	Vietnam	Malaysia	Indonesia
Breeding	x				x		x
Reproduction	x				x		x
Nutrition	x	x	x	x	x	x	x
Housing management	x						
Disease management	x				x		
Product Processing	x				x		x
Socio economic, marketing	x	x		x	x		x
Cooperative system	x			x	x		x

The above Table 17 does not reflect the intensity or number of research conducted in each area. For example, in the area of nutrition, research have been carried out in every country, but number of nutrition research in each country will be different. Table 21-24 showed example some of the researches carried out in different countries in Asia.

In an attempt to provide sufficient food a huge number of population, while the arable land is limited, Chinese Government is very serious on grain saving program, hence animals that consume grains or agricultural products for human have to search other alternative products. In such situation, rabbit has the opportunity to develop. In the last several decades, rabbit production have been growing very fast, from only 2.58 % share in 1961 to 40.54 % share in 2013 (FAO Statistic, 2015). This fast growing is certainly supported by intensive research. Therefore, it is not surprising that rabbit research in China

covers all aspects necessary for the production of meat-, fur- and wool-type rabbits (Table 18). Nevertheless, some problems in production and research also exist in many aspects. This problems will be discussed in the section on general discussion.

Table 18. Example of some topics in research on rabbit production in China

Area of research	Topics	Results	Author
Breeding and Reproduction	production traits, Functional gene, wool density and fineness measuring, Coat colour formation mechanism in Rex rabbit, Gene Polymorphisms, hair follicle genes	-The genes correlated with growth traits contain *SH2B1 etc.* -Identification and differentiation of transcriptome profiles in Chinchilla and White Rex rabbit skin -Exon 3 contained two SNPs and exon 4 had one Indel. SNPs on exon 3 were associated with immune traits. -the protein ratio of meat in black rabbit, the total amino acid in black rabbit meat -hair follicle development in Rex rabbit was mainly in E20-E25. -There were a total of 1342 different expression genes associated with wool density of Rex rabbit embryo of 24 day.	Xie et al., 2014 Lai et al., 2012, 2013, 2014, 2015.Jia et al., 2014 Liu Hanzhong et al. 2015 Chen Yunying et al. 2015 Yang Ruifei et al. 2015 Zhang Kai et al. Wan et al., 2014.Sun, 2013 Sun et al., 2014.Li, 2014 Ma, et al., 2011
Nutrition	The nutrition standards of meat and Rex Rabbits Evaluation of nutritive value on new feeds	-Optimal level of dietary Se for growth and anti oxidative parameter -Dietary linoleic acid addition had little effects on growth performance -Dietary electrolyte balance doesn't affect growth performance -The levels of added α-linolenic acid in diets can significantly affect average daily intake in growing meat rabbits. -Dietary fiber per starch ratios and age significantly alter the composition of caecal microbiota in growing rabbits.	Fuchang Li and Lei Liu (2011, 2012, 2013, 2013, 2013,2015)
Housing management	The water conditioner system in open rabbit house;Cooling with refrigerating air conditioner; Cooling with wet pad–fan in rabbit house in hot & humid region; The production supervising system in large scale rabbit farm The litter boxes of female rabbit	-water conditioner cooling system can alleviate the heat stress of does in pregnant or lactating stage -wet-pad cooling can effectively improve thermal environment, survival rate and profit level in the enterprise had been greatly improved. -biomimetic litter nests can achieve higher litter body weight and lower weaned mortality. The biomimetic litter boxes could meet the breeding environmental requirements in cold region.	Ti Boyu etc., 2011. Jia Jing etc., 2014. Liu Peng etc., 2015. Ye Yun etc., 2015. Ren Keliang etc., 2014. Liu Bo etc., 2015

Diseases	Coccidia, infection rate; Coccidiosis vaccine; RHDV VLPs, epitope; RHDV vaccine; Bordetella bronchiseptica, vaccine Atomic Model of Rabbit Hemorrhagic Disease Virus Translation Initiation of Rabbit Hemorrhagic Disease Virus (RHDV) RHDV B-cell epitopes	- Precocious lines of 3 species of coccidia. 3 epitopes of RHDV VLPs. -An inactivated vaccine(BAC-VP60 strain) was acquired, 2 immune protective proteins were screened.A pseudo-atomic model of RHDV -VPg interacts with eukaryotic initiation factor 4E (eIF4E) in vivo and in vitro and that eIF4E silencing inhibits RHDV translation, -it identified for the first time two	Chen dongjin et al (2015), Cui yujuan et al (2015), Song yanhua et al (2015). Wang Fang et al. (2015), Liu Yan et al. (2015), Xue Wang (2013), Zhu J (2015). Wang B (2013). Yanhua Song (2016) Kong D (2016) Guo H (2016). Gao J (2013) Yuan D (2013)
	New vaccine of Rabbit hemorrhagic disease virus	epitopes that act as HBGA binding sites on the RHDVa P domain -3 monoclonal antibodies and 4 MAbs were identified. -Expression of optimized capsid protein was increased in Sf9 cell -Protective immune responses in rabbits induced by a suicidal DNA vaccine of the VP60 gene of rabbit hemorrhagic disease virus. - the RHDV-VLPs display system	Cheng Y (2013). Qiu L (2013) Chen M(2014)
Product Processing	Cleaner production for rabbit skin dressing; Ecological tanning; biotechnology for rabbit skin process; Rabbit hair processing and comprehensive utilization	-Water-saving 68%-76% in wet process; Free formaldehyde and Ts=74℃; -Degreasing rate is above 75% and shorten soaking time - characteristics and characterization of rabbit hair fiber cortex structure - new type of hair carding machine - dissolved & reuse of abandoned hair - new type of rabbit hair carding machine of the volume and twist hair net -Research on moisture adsorption property and thermal insulation property of rabbit hair -Characterization of rabbit hair powder	Zhang Zongcai etc., 2011; Li Yao etc., 2012; Li Yao, Wu F. etc., 2011 Liu Han, Li B. etc., 2014 Wu Fanhua etc., 2013; Li Min etc., 2013.Zhangyi etc. 2015. Yang wei-zheng etc. 2015. Zhangyi etc. 2010, Lijuan etc. 2013 Zhangyi etc. 2012 Wang X.Q etc. 2010 LI Huiqin etc. 2010
Socio economic, marketing	Rabbit industry development and challenges, Industry upgrading, Domestic consumption, Global market and trade	-Local rabbit industry development faces huge challenges. -Large scale producers emerge as the percentage of small scale producers falls. -Rabbit product consumption among urban residents is still very limited, with great market potential. -Price plunge on global market causes export decline and import fluctuation.	Guo, Li and Ren, et al. (2015) Jie, Liu and Tang, et al. (2015) Wang and Wu (2015) Li, Wu and Jiang (2015)
Cooperative system	Business model , major types of Cooperatives, roles and functions, trend of Cooperatives	-There are three major types of Cooperatives: classical cooperative, combined cooperatives and "processing company + farmers' cooperatives". -Cooperatives is the key for small farmers to adapt to big market -"Company + farmers" is one of the main business mode in agriculture industrialization. "Company plus cooperative plus farmers" is one of its extension.	Yinghe Qin (2012) Wang G. (2014) Chen Z.P.(1998) Ci L.L. (2008) Guo H.D., Huang Z.H(2001)

Most of research topics in Vietnam were in the nutrition area (Table 19). This is related to the micro- and small-scale farming, which are mostly carried out by low-income farmers, in the village areas. Yet, rabbit farming is suitable for such operation, especially to maximizing the use of forages, vegetable waste and by-product feeds, by converting the plant protein into high quality meat.

In terms of breeds, Vietnam is actively develop high productivity breeds, including the crossing of improved breed with their local breeds. Panon, Hyplus, GP New Zealand White and GP Californian reproduced (LS > 7.3) and grew (> 50 g/h/d) well and reached 2.7-3 kg at 3 mo old (Binh and Ky Son, 2013). Another area that need attention is the disease control which caused high mortality (30 %) from birth to slaughter.

Table 19. Example of some topics in research on rabbit production in Vietnam

Area of research	Topics	Results	Author
Breeding and Reproduction	- Performance of some breeds of rabbits in Vietnam - Performance of NZW and Hyplus - Preservation technology of semen from various rabbit breeds	- Performance is breed dependent. Bodyweight at slaughter 1.3–3.1 kg, Litter/doe/year 6 – 8, LS 6.1 – 8.4 heads, crossbred BW gain 8-18 g/h/d - Hy plus was superior growth, LS at weaning, but lower conception rate - Panon, Grey and Black breed has higher sperm concentration (> 280 mill/cc), - motility and live sperm was better in 15 ºC preserved,, dilution is better at 1:5.	Binh and Ky Son, 2013 Truong etal (2008) Mi Ti etal (2008) Van Thu and Ba Mui (2008
Nutrition	- Productivity of some forages - Feeding banana, sweet potato leaves(SP), cassava roots (CR), mixed forages, guinea grass (GG) and water spinach (WS), SP and their combination, waste of cabbage - Use of paddy rice, rice, rice hull to SP vines Feeding strategy of forages for rabbits - NDF and crude protein (CP) requirements	- Tricanthera, banana and elephant grass has high biomass (> 80 tonnes/year/ha), - Mixed forages and SP leaves gave better performance than CR, and banana - Best performance was by feeding combined WSSPGG, BWG was 27 g/h/d - cabbage waste to replace paragrass diet increased body gain 16.8 to 21.4 g/ek/h - Supplementation of rice to sPV diet, increased BW gain, reduced FCR and has significant economic impat. - Different forage needs different appropriate feeding system to maximize nutrient intake - NDF levels at 36 and 39 % and CP at 21 % gave the best daily BW gain	- Thi Mui etal. (2001) - LY Thi and Binh (2000) - Kim Dong and Van (2008) - Duong Huyen etal (2013) - Thu (2013) - Vin Chau and Thu (2013) - Truong and Kim Dong (2013)

Housing management	- Raising in the cages or shelter - Design of rabbit coop for small scale farms	-Performance of does and weanlings were better under shelter, but higher mortality -Type, size and materials for cages should comply with the comfort of rabbit. Use of	- Thu Ha and Binh (2000). - Quang Lich and Vuong Hung (2008)
Diseases	- Reproduction and resistance to diseases of newly imported breeds	First breeding of imported NZW was 159 days at 3.5 kg BW, conception rate > 70 %, Coccidiosis occurred during lactation 23 %, after weaning 23 %, and the death rate 14.3 %	- Quang Tuyen (2008)
	Earth worms production from different manure.	Manure from rabbit and goat is superior in producing earth worms	Quang Suc etal., 2000,
Socio economic, marketing	Meat price from different animals	Meat price from rabbit is higher than beef and pork, but lower than that from goat, sheep and chicken	Binh and Ky Son, 2013.

Situation of rabbit production in Indonesia is similar to those in Vietnam. Micro-, small- and medium-scale operation, maximizing the use of forages and by-product feeds, initially for pets and gradually develop to commercial rabbit meat orientation. Search for good quality breed and attempting to produce adaptive breed to the humid tropics environment is part of research activity in Indonesia. Selection and cross breeding on fur-producing rabbit Rex and Satin, has been evaluated for more than 10 years. A new breed, called Reza which has soft uniform yet shiny fur rabbit, as a result of Rex x Satin rabbit has been produced since year 2000. However, the fur industry in Indonesia is not yet developed. Micro- and small- scale farmers often faced with high mortality of rabbit, caused by heavy diarrhea and bloat, particularly at rainy season. Unfortunately, research on rabbit diseases in Indonesia is minimal, if any. Example of some rabbit research carried out in Indonesia is presented in Table 20.

Table 20. Example of some topics in research on rabbit production in Indonesia

Area of research	Topics	Results	Author
Breeding and Reproduction	- Performance of Hycole and Hyla rabbit in Indonesia - Use of hormones in reproduction - Productivity of Flemish Giant x Reza - The use of Cytochrome B for meat authentication - Creating shiny fine hair rabbit from Rex and Satin	- High performance of Hycole and Hyla, but mortality is high (> 30 %) - Use of hormones increased reproductivity , but not mortality during weaning. - Crossing FG x Reza at 3rd generation slightly improved production. - primers from cyt b gene using multiplex PCR can be useful for fast, easy and reliable control of food safety and violation of labeling requirements - A new breed, produced from Rex and Satin, with shiny soft velvet like fur, called Reza	- Brahmantiyo etal (2015) - Dewantoro etal (2015) - Brahmantiyo etal (2013) - Nuraini etal (2013) - Raharjo and Prasetyo (20017b)
Nutrition	- Palatability of tropical forages in Indonesia - Coco peat, source of fiber and the use of enzyme - the use of Curcuma and effect on enteritis - dietary protein for fur-producing animals	- legumes were preferred over grasses and agricultural by-products, - Gliricidia is unpalatable, - Leucaena is very palatable and give BWG 18-20 g/d, Erythrina, was well accepted, - Coco peat at < 4 %, rice straw can be used as fiber source, enzymes, increased nutrient digestibility - Turmeric (Curcuma sp) reduce the case of	Raharjo etal (1985, 1987) Raharjo etal (2013) Haryati etal (2013) Haryati etal (2014) Raharjo etal (2014) Susanna etal (2013)

	- use of bangun-bangun leaves (Coleus) to increase milk production in rabbits	enteritis, but was not consistent - Crude protein 18 % and DE 2550 kkal/ kg was sufficient for growth of Rex - Coleus leaves, improved performance of doe and kits during lactation	
Product Processing	- Electric stimulation on characteristic of carcass	- Physical characteristics of meat was best after 10 h aging	Suradi etal (2013)
Socio economic, marketing	- Financial analysis of rabbit breeding at different scales operation	- at df 12%, IRR was 35.5-61.9 % indicated rabbit business is bankable at interest > 12 %	Sumanto etal (2013) Sumanto (2013)
Cooperative system	- model of rabbit bioindustry based on farmers group	- Integration of rabbit industry, horticulture and fish pond in a group cooperation is considered	Raharjo (2015)
Others	- rabbit research in Indonesia	- Various aspects of research in Indonesia were presented	Nasrullah etal (2014)

Table 21. Example of some research topics in other countries in Asia (India, Malaysia, Thailand, Cambodia).

Area of research	Topics	Results	Author
Nutrition	- Feeding lettuce, water spinach and ruzzi grass to NZW and crossbred rabbits (Thailand) - Increasing level of water soinach for rabbit Cambodia)	- Daily gain of rabbit fed Ruzzi grass is less than those fed lettuce, water spinach, mimosa nigra; NZW has higher gain than the crossbred - Fresh water spinach support growth from 14 to 20 g daily gain and DM conversion 3.83-5.18	Nakkitset eta (2008)Pok etal (2006)
Post harvest and product processing	- Factors affecting carcass traits of broiler rabbits (India) - Carcass trait, organoleptic and consumption (India)	-Slaughter weight, age, sex and breed has significant effect on carcass -High quality protein and low cholesterol caused high acceptance	Das and Bardoloi (2008) Das and Bujarbarua (2005)
Socio economic, marketing	- Survey on rabbit meat acceptance (Malaysia)	Only 58 % of the respondent have tasted rabbit meat and 15 % eat regularly	Nursuhana etal (2012)

Problems in rabbit production and its outlook.

In the past 3 decades, rabbit production in Asia has been developing fast, from 8.76 % of its world share in 1980 to 50,.90 % in 2013 (FAO Statistics). This may also indicate that the acceptance of rabbit meat is getting higher, although the majority it occurs in China and Vietnam. Some other countries like Thailand, Malaysia and Indonesia are still having this 'reluctant psychological effect' to consuming the rabbit meat. Most of rabbit farms in Asia, including in China are operating in micro- and small- scale. Few in Malaysia, Indonesia and Vietnam are operating in medium scale. Many medium- and large-scale operation are operating in China. In the purpose to support self-sufficient family meat consumption, in the area where forage availability is high, micro and small scale farming has many advantages as the farmers can operate the farms at least cost system. However, without cooperation, this small and-medium-scale will be difficult to expand or developed. In reality, in most countries but probably at different intensity, small scale farmers still work individually, and this is

partly, but probably the strongest reason why the progress and development of micro and small scale rabbit production is slow or even fail, especially when the government support is also lack. Micro and small scale farming has constraints and problems such as limited capital, difficult to adapt to technology, less access to source of feed, lack of management, hardly practicing breeding management, low quality and productivity and low risk resistance (Gao, 2013). Nevertheless, even though the rabbit farming is growing towards industrialization, small or big, the cooperation of farmers in the form of simple or modern management will exist, especially where large numbers of micro- or small-scale farmers exist. The cooperation will likely to change along with the development of rabbit farming industry (Qin, 2012). From the production perspective, even when the production and research have made progress in small or big farms, including those in China, there are still problems and challenges and can be grouped into:

(i) large groups of small farms are difficult to be organized effectively, lack of decision ability hence often caused production and market fluctuation and consequently less competitive in marketing. Type of cooperative no 4 (Qin, 2012) seems the most promising. However, in the other countries, where company or industry does not exist, yet, probably cooperative type 1 (farmers to farmers), provided with tight control, is more suitable. The active role of government is required.

(ii) lack of high yield breeds due to insufficient research fund and long period breeding time in area of breeding, hence most quality breeds are imported. This is a classical problem, especially, again when the scale of farms is micro/small, no group cooperatives or association. Government support is needed.

(iii) high labor cost, especially in the case of China, where farming is very commercialized, as a consequence of fast economic development in China, and this situation cause a burden to the industry. In this cases, the small scale has the advantage for not employing paid labor.

(iv) modern techniques such as artificial insemination and auto-feeding are still not popular. Sometimes artificial insemination conception rate is not high. In addition, even though the technique is profitable, but expensive or costly, farmers are reluctant to do.

(v) environment control on rabbit house and storage facilities are not developed for most medium and small scale farms. Simple environment control usually causes diseases and poor storage condition causes feeds or feedstuffs moist and mouldy.

(vi) the medication of rabbits in the field, such as anti-coccidial drugs is not standard, which causes drug resistance in parasite populations; farmers prioritizing disease treatment rather than the diseases prevention.

In the research perspectives, the main problems for both small- to large scale operation include:

- i) lack of suitable breeds that has productivity, yet adaptable to the environment in the area. A particular case in hot and humid countries, such as in South East Asia, the productivity is rather low, hence the effort to create suitable breeds and to improve breed performance for meat rabbit are almost imperative. Problem is that research in breeding is costly and take long period of time. Such research, even in China with many rabbit industries, needs the government support. For China, who also produces wool from Angora rabbit, research for fine and better wool quality breed is needed, especially when the preferred German Angora breed is decreasing even in Germany. Fine hair fibber is more and more useful in textile industry and more interesting to consumers.

- ii) in countries where the of commercial pellet is considered expensive, more and more use of cheap source of feed are being sought. Choice is on high productivity and high nutritional value of forages and/ or by-product feeds, which are usually cheaper than conventional feeds. The use of additives, probiotic, and prebiotics to enhance low quality feeds into better one is other area for research.

- iii) for disease control, the molecular mechanisms of pathology and immunology for many pathogens in rabbits, such as coccidia, rabbit haemorrhagic disease virus, which are mostly carried out in China, are not clear. No inbred lines of rabbits are available for scientific research. The immunogenicity of *Bordetella* is low in combined inactivated vaccine against Bordetellosis and Pasteurellosis. It's in serious need of striking up a rapid and accurate diagnostic method of the disease caused by mycotoxins, especially also in the humid areas. Nutritional-diseases interaction in rabbits, to ensure digestive health need future research.

- iv) for processing of rabbit products, new tanning agents should be developed to produce well tanning property of skin and fur, pliable, soft, yet has quality strength that meet the industry requirement.. Moreover, cleaner technology must be adopted to decrease effluent that may pollute the environment and saving water resource;

- v) for environment control, the standard models of new built rabbit farm, for micro or small as well as for medium and large scale, need to be studied for different climate zone in different areas.

- vi) for management and economic researches, there are two major problems; one is how to improve scientific management for medium and small scale farms, including scientific decision on production and marketing, effective and normative management, etc. The other is how to improve monitoring and early-warning on rabbit framing so as to provide full information to farmers and reduce or increase production in relation to market fluctuation. Of course, there are also some other research issues in economic area, such as how to tap market potentials and improve marketing of rabbit products and how to reduce the shocks or risks from world market

CONCLUSION

Rabbit farming is a lucrative business provided that production is consistent and market can be determined. Number of farms and farmers growing from time to time in many countries in Asia. Consequently the rabbit production in Asia countries has been progressing been progressing and developing fast at different degree depending on the situation and condition of each country. More and more medium and large scale framing are developed, but large number of micro and small scale farms will still exist and playing important roles in the family income, especially in the poor rural areas. To improve production and increase effectivity of farming, cooperation of small farmers has to be formed. The status, degree and management of organization of farmers groups (or cooperative) will play a critical role in future development of rabbit industry. Availability of quality feeds, for backyard or for industry has to be secured especially in the situation where land for agriculture becomes less and less available.

Although the potential of rabbit is high to contribute a significant numbers of meat production to the growing world population, some problems do exists. . Surely all these problems are points of discussion in each country to improve rabbit production in Asia and at a global objective is to contribute to provide more meat to the growing population in the world. A comprehensive strategy is needed for each country to develop the production and farming suitable and appropriate to the situation and condition in their area.

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Rabbit Production and Research in Asia : Perspectives and Problems.

Raharjo, YC, Bahar, S and Qin, YH,

Challenges in world food supply :

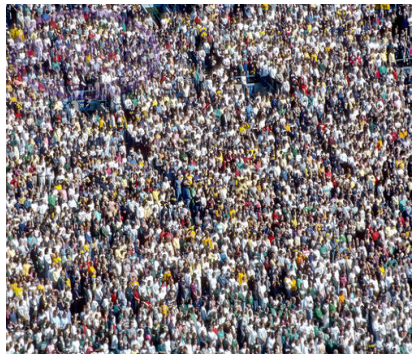
1. Increasing population

- 2011 → 7 billions
- 2050 → 9.2 – 9.7 billions (Worldometer, 2016)

Table 1. World population 2015-2050

	2015	2020	2030	2040	2050
World	*7302*		*8309*		*9150*
Developed	*1396*		*1437*		*1439*
Developing	*5879*		*6839*		*7671*
China	1376	1403	1416	1398	1348
India	1311	1389	1538	1634	1705
Pakistan	189	208	245	279	310
Bangladesh	161	170	186	197	202
Indonesia	258	272	295	312	322
Philippine	101	108	124	137	148
Vietnam	93	98	105	110	113

FAO (2012), UN (2015)



challenge in world food supply ...

- will occur mainly in developing countries
- especially in the village areas
  - smaller land for household to work on
    (land for production eventually smaller)

→ need to increase food supply 50 %, clean water 40 %, energy to 39 % *(FAO, 2012)*

2. Global warming

* decrease or uncertain crop production
* reduce potential of livestock production
* natural disasters → floods, landslides

3. Local Crisis

* quality of manpower (skill, workdrive, commitment)

d. Impact of Crisis:

- **Famine/short of nutrition > 3 billion people**
- **Decrease Income**
- **Unemployment**
- **Incompetent**
- **Poverty**

Table 2. World population and predicted meat consumption

	Population	
	2005/2007	2050
Developed	1351	1439
Developing	5218	7671
World	6569	9150
	Estimated meat consumption	
Developed		81.0
Developing		28.9
World		37.2
Further needs	< 200 mill tons	> 450 mill tons

FA0, 2012

Table 3. Projected per capita demand of meat consumption in Asia (kg/year)

Livestock species	South Asia		South East Asia		East Asia (include Japan)	
	2010	2020	2010	2020	2010	2020
Beef	1.4	1.5	4.5	6.0	2.3	3.1
Pork	0.4	0.4	8.6	10.5	30.6	38.2
Mutton	1.1	1.2	0.5	0.7	1.0	1.2
Poultry meat	0.6	0.7	6.9	8.5	5.2	6.5
Total	3.5	4.0	12.7	25.7	39.1	49.0

Rosegrant etal (1995) in Kol and Lukefahr (2008)

Comparison among animals in meat production

- slow in growth and reproduction
- need large area for forage production *(a luxury for arid , dry developing countries)*
- Less efficient in converting plant proteins to meat than small animals like rabbit
- Large ruminant 400-500 kg meat/fem./year,
- Small ruminant 75 – 100 kg LW/ewe/year
- multi-deck (verticullture system) produce high yields in small area, but costly and results between researches are inconsistent

Comparison among ..

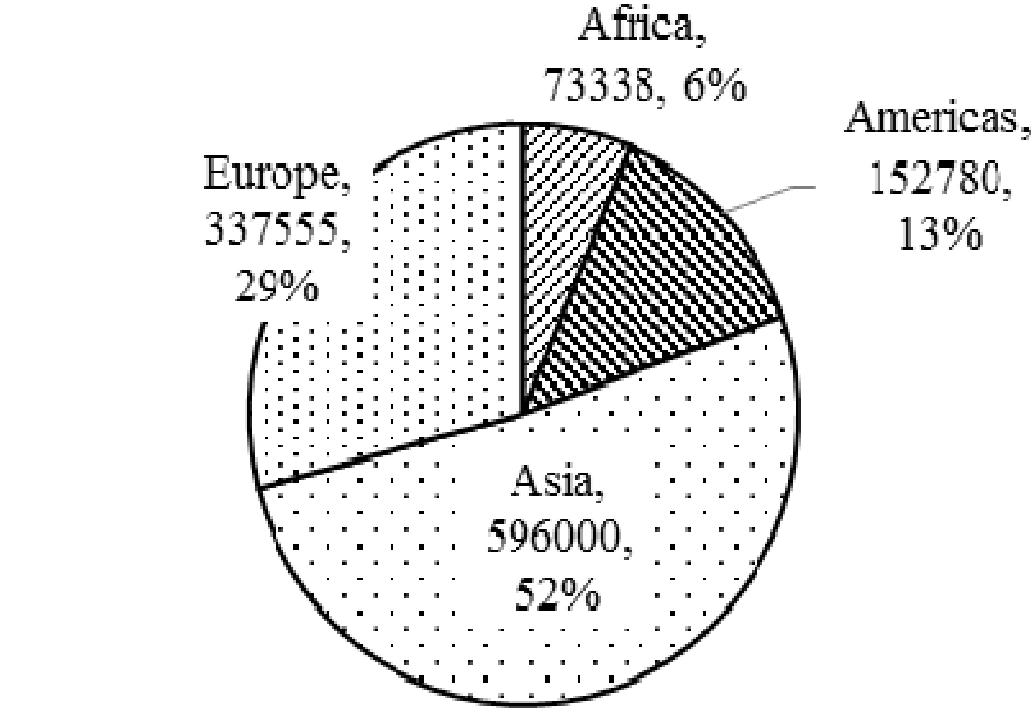


- Highly productive, fast growing
- small investment
- small size, easy to market, easy to handle
- expensive feed, competitive to human food
- diseases, bird flu, ND, etc.


- Highly productive, fast growing
- small investment
- expensive feed, competitive to human food
- forbidden in some countries
- diseases, hog cholera

- Highly productive, short reproductive interval
- forage feeding, effective converting plant protein to meat
- 40 – 120 kg/doe/year
- Not popular meat, difficult to market
- High mortality, diseaase problems

RABBIT PRODUCTION IN ASIA AND THE WORLD



Data source: FAO statistics

Figure 1. Numbers of slaughter rabbits and the regions share in year 2013

Table 4. Numbers of rabbit slaughtered and share (to the world) in different region *(FAO Statistics , 2015).*

Year	World	Africa	Americas	Asia	Europe	China	Africa	Americas	Asia	Europe	China
	Numbers of slaughtered rabbits						Share of the region to the world slaughtered rabbit				
1961	271336	10083	7767	9630	243856	7000	3.72%	2.86%	3.55%	89.87%	2.58%
1970	333175	12084	8193	23835	289063	22000	3.63%	2.46%	7.15%	86.76%	6.60%
1980	496627	21744	14137	43514	417232	40000	4.38%	2.85%	8.76%	84.01%	8.05%
1990	630239	55164	110200	65675	399200	64000	8.75%	17.49%	10.42%	63.34%	10.15%
2000	883731	64294	142164	303187	374086	258782	7.28%	16.09%	34.31%	42.33%	29.28%
2010	1130003	71790	152738	571882	333593	464525	6.35%	13.52%	50.61%	29.52%	41.11%
2011	1159673	73338	152780	596000	337555	474704	6.32%	13.17%	51.39%	29.11%	40.93%
2012	1174763	73910	158707	599322	342824	478000	6.29%	13.51%	51.02%	29.18%	40.69%
2013	1171578	74770	158713	596340	341755	475000	6.38%	13.55%	50.90%	29.17%	40.54%

- Increase production of slaughtered rabbits in all regions, total was from : 271 mill (1961) – 1,171 (2013)

  → increase acceptance to rabbit meat ?
- production from Europe is shifted to Asia , especially China

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Rabbit production in Asia :

- Initially is aimed at family meat consumption in the rural areas, or source of manure for vegetable production
- Micro-, small-scale operation, depending almost entirely on forage feeding
- Developing fast in SEA countries after the outbreak of bird flu (Avian Influenze) in around 2000s
- At present → developing to commercial orientation, pet n meat
  → industrial → China

Tabel 5. Production and Consumption of rabbit meat in Some Asian countries (Lebas etal., 1996)

Country	Estimated prod. *carcass weight*) (000 tonnes)	Annual carcass production (000 tonnes)	Consumption of rabbit meat (kg/cap/yr)	rabbit meat importing and exporting countries		
				Exports	Import	Balance
China	120	> 100	0.07	40.0	0	+ 40.0
Japan			0.03	0	3.0	- 3.0
Indonesia	50	20-99	0.27			
Thailand	18	5-19	0.31			
Viet Nam	18	5-19	0.27			
Philippines	18	5-19	0.29			
Malaysia		5-19	0.50			
Srilanka		5-19		0	1.0	- 1.0
Bangladesh		1-5				
Nepal		1-5				
Singapore	.			0	1.0	- 1.0
Source	1	2	3	4		

1, 2, 3 and 4 in Lebas etal., (1997)

Table 6. Summary of rabbit production in some Asian countries. *From various sources*

Country	Production		Scale	System	Main purpose of farming	Feeding	Ref
	Meat, 000 tons	000 heads					
China	660.000		Small-to industrial-	Farmers+coop + industry	Meat, fur, wool , pet	Pellet*, forages	1,2,3,4
India			Micro- to small-		Meat	Pellet, forages	5
Cambodia			Micro- to small-	Individual - group	Pet, meat	Pellet, forages, by-products,	6
Vietnam	24.7	7,655.6	Micro- to medium	Individual, coop, farmer group,	Pet, meat, Fur	Pellet, forages, by-products	7,8,9,10
Thailand		6.8	Micro- to small-	Individual, farmer group, coop	Pet, meat	Pellet, forages, by-products	11, 12
Malaysia		441.4	Small- to medium-	individual	Pet, meat	Pellet, forages,	13
Indonesia	0.5	1,053.7	Micro- to medium-	Individual, farmer group, coop	Pet, meat, fur, lab use	Pellet, forages, by-products	14,15

- Success of micro- and small-scale → attract other farmers to follow
- Micro and small-scale depend primarily on forage feeding + some by- or waste products

Rabbit production in China

Table 7. Numbers of rabbit slaughtered and meat production in China 1990-2016.

	Slaughtered, 10000 head	Annual growth	Stock10000 heads	Annual growth	Rabbit meat, 10000 t	Annual growth
1995	15019.9	-11.25%	NA	NA	26.8	17.03%
2000	25878.2	17.08%	17781.7	12.62%	37.0	19.26%
2005	37840.4	11.34%	21764.1	7.66%	51.1	9.38%
2010	46452.5	7.33%	21500.7	-3.24%	69.0	8.49%
2012	48776.7	2.75%	22158.2	2.13%	76.1	4.10%
2013	50366.0	3.26%	22345.3	0.84%	78.5	3.15%
2014	51679.1	2.61%	22736.1	1.75%	82.9	5.61%
2015*	52912.0	2.39%	22763.0	0.12%	85.0	2.52%
2016*	54391.0	2.80%	22862.	0.44%	87.4	2.79%

China Animal Husbandry and Veterinary Yearbook (2015). estimated data.*

**** The development in 20 years are almost 4 folds, from 268 to 874 thousands tonnes***

TABLE 8. SCALES OF PRODUCTION OF RABBIT FARMS IN SHANDONG IN 2002 (QIN, 2012)

Number of rabbits raised	Number of meat rabbit farms	Percentage	Number of Angora rabbit farms	Percent age
50 - 99	9,960	80.98	29,117	90.88
100 - 299	1,522	12.37	2,285	7.13
300 - 499	479	3.89	484	1.51
500 - 999	242	1.97	106	0.33
1,000 - 2,999	66	0.54	41	0.13
3,000 - 4,999	15	0.12	7	0.02
5,000 - 9,999	12	0.10		
10,000 - 49,999	4	0.03		
Total	12,300	100	32,040	100

- Mostly are small- and medium-scale, only few are big farms → based on cooperation with small farmers.
- Mostly use the comercial pellet feed.
- in 2002, number of farmed rabbit Angora is bigger thean meat rabbit → high production of Angora wool

Type of rabbit produced in China :

1. **Meat rabbit : (see table 8)**
- **production (2013) = 785.000 tonnes**
- **breed : NZW, Californian, Japanese white, Zika, Hyla, Harbin big white, Fujian yellow, etc... (*Qin, 2012*)**

2. **Wool producing rabbit *(Lai and Cai, 2008)***
- **production (2002) : 2-5 tonnes = Usd 6.12 mill.**
- ***breed : German Angora, China Angora, Anhui Long Hair, French Angora, Jiangsu Coarse hair, Zhejiang coarse hair,etc..***

3. **Fur-producing rabbit : *(Lai and Cai, 2008)***
- **Rex – production (2004) 5 million pelts**
- **Meat rabbit – production 400 million pelts**
- **Sells of fur in 2004 = 140,000 pelts for C¥ 12.49 mill (usd$14.2/pelt)**
- ***breed : German, French, American, Venus and Jirong Rex, etc***

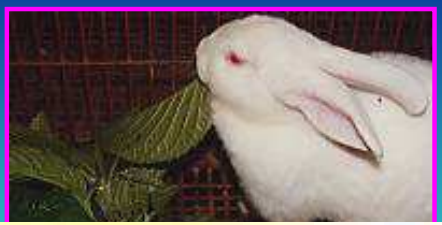
4. **Fancy rabbit – various breed**

Rabbit production in Vietnam

- A country with third biggest population in SEA – 93 mill in 2013
- A country with huge export of rice
- High production of meat – 27 % of the total food supply
- Mainly from pork, beef, chicken meat, duck meat, mutton and rabbit meat.
- A significant rabbit producing country in Asia, after China
- Rabbit population in 2012 → 24.7 thous. tons *(Binh and Ky Son, 2013)*

	2000	2005	2010	2011	2012	Growth rate
	(000 heads)					%
Pig	20,194	26,435	27,373	27,055	26,493	2.60
Cattle	4,127	5,540	5,916	5,436	5,194	2.15
Dairy cattle				142,702	166,989	1.42
Poultry	316,400	321,890	321,497	322,568	308,460	-0.21
Buffaloes	2,897	2,922	2,913	2,712	2,627	-0.75
Goat, Sheep	552.5	1,070	1,178	1,267	1,343	20.3
Rabbit*	1,985	3,450	5,360	6,379	7,655	32.1

- Rabbit production increasing rapidly after the outbreak of bird flu in 1998-2003, triggered the demand for breeding stock and meat
- Rabbit price increases almost double from 45.000 to 80.000 VND/kg LW, while beef or pork is only 22.000 -23.000VND/kg LW
- Increasing numbers of small processing units → increase the deman d for meat
- Most farmers → maximizing use of forages/by product feeds including rice
- Breeds are local (Re-, Black and Grey rabbits), and imported (NZW, Californian, Panon, Hyplus)
- Extensive use of manure, including worm production
- Hemmorhagies, dirrhea, pneumonia, scabies are main diseases



Rabbit production in Indonesia

- A very populated country with 257 million people throughout the archipelago.
- Main meat consumption are from chicken, cattle, sheep/goat, ducks, very rare from rabbits
- 1982 – rabbit production was started for improving rural family nutrition
- 2003, after the bird flu, demand for rabbits was high both for breeding stock and also products including pet
- Farming is spread rapidly in the countries, main ones in 14 from 33 provinces

- Population is still low, about 1 million does in 2014
- Most ly micro to small scale (5 – 500 does),
- Depends on forages/by product feeds
- A very profitable farming, with BC ratio 1.42 – 3.55, especially when involving feeding forages and sold as breeding stock
- At present, mostly for pet, although meat demand is increasing
- Most breeds are imported breeds
- High mortality due to diarrhea occured during wet season.

High interest is increasing to form an integrated rabbit farming based on cooperative among farmers and investor

Rabbit production in Malaysia, Thailand, Cambodia and India

- Production in these countries are similar
- Mostly are for pet production, sold as pet, although some farms already starting to produce meat, eg in Malaysia and India
- Micro to small scale operation, depending mainly on forages, except in Malaysia, where the scale at some farmers are more than 400 does and using commercial pellets for their feeds, The farm numbers, however very few
- Rabbit production in Malaysia was encouraged by the Minister of Agriculture for rural farming.
- Malaysian Rabbit Breeders Association is active and coordinating rabbit meat production beside frequent contest for fancy rabbit

- Total number of rabbit farms registered are 216 farms with total of 430 thousands does in Malaysia
- In Thailand, the rabbit production was encouraged by the Prince Bhisataj Rajani who chair a program Royal Project Development and Extension Centers, in which rabbit is involved. Projects were started involving 89 farmers joined in 20 royal projects
- The meat rabbit is increasing in demand, not only in the hotels and restaurants for foreigners, but also for local market in the big cities in Thailand.
- Recorded population is about 6797 does in the 20 projects in Thailand

- Rabbit farming in Cambodia is still relatively low, and use mainly for pet production purpose.
- However, intensive research was carried out through Cell Agrid, on the utilization of forages including the use of water spinach, guinea grass, leucaena etc.

- Rabbit production in India is also in the starting stage (Murali, 2013).,
- Meat are sold to the hotels and restaurants, but gaining more popularity in the local people because of its healthy nutritious meat.
- Farmings are spread in Hyderabad, Kurnol, Andra Pradesh, Tamil Nadu, ttar Pradesh and East Himalayan regions
- Feeding roughages and mortality pattern were studied in rabbit in East of Himalaya.

Rabbit Research in Major Countries in Asia :

Summary of rabbit research carried out in some Asian countries.

Area of research	China	India	Cambodia	Thailand	Vietnam	Malaysia	Indonesia
Breeding	x				x		x
Reproduction	x				x		x
Nutrition	x	x	x	x	x	x	x
Housing management	x						
Disease management	x				x		
Product Processing	x				x		x
Socio economic, marketing	x	x		x	x		x
Cooperative system	x			x	x		x

RESEARCH PRIORITIES IN RABBIT PRODUCTION :

1. **Breeding**
   To create lines for high productivity rabbits suitable for specific areas, both conventional and molecular
2. **Nutrition**
   Imrovement of growth and reproduction and reduction of mortality through the use of appropriate feed/forages/by-product and additives and the health digestive system, especially at small and medium scale farming
3. **Reproduction**
   Improvement of reproductivity of the does and bucks at various altitude areas
4. **Management**
   Improvement of management in housing system at small and medium scale operation
5. **Cooperative**
   to from an effective system of cooperation between company, farmers, coop and government
6. **Disease Control and Treatment**
   To find ways to control the attack or outbreak of diseases thru management, vaccine or drug production in an eco-friendly ways.
7. **Processing of meat, fur and fertilizers and strategy of marketing**
   Improvement of quality product of meat, fur and fertilizers and their marketing.

→ To formulate a model of rabbit agribusiness, small and medium scale, based on group farmers to empower rural economy, yet friendly to the ecology.

Problems in rabbit production and their outlook

- **In the past 3 decades – rabbit production in Asia is growing fast, from 40.3 millons 1985 to 596.3 millions (slaughtered) in 2013 → may also increase acceptance to rabbit meat, especially in China and Vietnam**
- **Not so, for Indonesia, Malaysia and Thailand...- 'bunny syndrome' still occur for many people**
- **Micro- and small scale farming dominating the production → efficient, flexible, cheap and helping many rural farmers, but it is slow to progress and develop, difficult to adapt to technology, working individually, depends on middle man for selling products, hardly practicing breeding management → yet for the future this type will still exist and important for rabbit production**
- **Problems of organizing the large group of small farmers; lack of decision ability, less competitive..**

...Problems in rabbit production ...

- **Lack oh high quality breeds in many countries**
- **Insufficient research funds and long period for breeding**
- **High labor cost (China), particularly with the industrial system as result of economic development**
- **Needs of improvement on technology such as AI, auto-feeding, which somestimes are not effective**
- **Environment and housing control are not developed for micro and small sale operation**
- **Disease treatment apparently is most preferred than disease prevention, especially in the micro- medium scale**
- **Findings suitable feeds appropriate for rabbits including nutrient requirements are still priorities**
- **Etc..etc..**

CONCLUSION

- Rabbit farming is a lucrative business provided the production is consistent and market can be determined
- Number of farms and rabbit meat production increase from time to time in Asia countries, although at different 'speed' between countries.
- More and more medium and large scale of farming are developed, but micro and small scale are still important parts
- Cooperation among farmers, company and cooperatives including role of governments should be sought
- The potential of rabbit is high to contribute the meat for the growing world population, yet improvements in each countries needed to be solved –
- A comprehensive strategy, with the help of rabbit association, is needed to support this development going.

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Thank you
For your attention

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