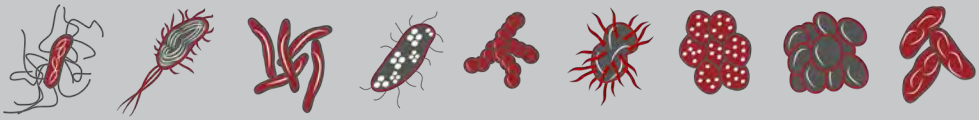
Antimicrobial Resistance in Food-Animal Production

THAILAND OVERVIEW



ReAct
Action on Antibiotic Resistance

Antimicrobial Resistance in Food-Animal Production

THAILAND OVERVIEW

ReAct
Action on Antibiotic Resistance

Published By
ReAct Asia Pacific
Christian Medical College, Vellore,
Tamil Nadu, India
Website: www.reactgroup.org
Email: satyasagar@gmail.com
Year of Publication: 2018

Follow us, like us

Sign up for the ReAct Newsletter at www.reactgroup.org

@reactgroup /reactgroup

ReAct - Action on Antibiotic Resistance

Table of Contents

GLOSSARY 1

INTRODUCTION 5

SECTION A
Food-Animal Production

Livestock Population 7
Food-Animal Production 7
Intensive Production 8
Fisheries 8
Shrimps 9

SECTION B 17
The Emergence of Antimicrobial Resistance

Antimicrobial Consumption 19
Antibiotic Use in Animals 21
AMR in Food-Animals 23
Poultry 24
Shrimps 26
Fisheries 27
Waste Water 27
Pesticides 28

SECTION C 31
Responding to Antimicrobial Resistance

Livestock 33
Fisheries 34
Antibiotic Production, Distribution and Dispensing 35
Food Safety 37
Export-Related Rules 38
Poultry 39
Monitoring & Surveillance 41

SECTION D 43
What Can Be Done

Box 1: Antibiotic Use in Shrimp Farms 14
Box 2 Farm-to-Table Tracking 40
Box 3: Raised Without Antibiotic Certification 46

TOOLBOX

The ReAct Toolbox is a web-based knowledge repository for antibiotic resistance that collects:

- Scientifically accurate information
- Practical advice
- Links to useful resources
- Examples from the field

Access the Toolbox:

www.reactgroup.org/toolbox

Glossary

AGP	Antimicrobial growth promoters
AMR	Antimicrobial resistance
ACFS	National Bureau of Agricultural Commodity and Food
API	Active Pharmaceutical Ingredients
CAC	Codex Alimentarius Commission
DLD	Department of Livestock Development
ENR	Enrofloxacin
FDA	Food and Drug Administration
FSSR	Food Safety and Standards Regulations
FAO	Food and Agriculture Organization of the United Nations
GMS	Greater Mekong Sub-region
HPAI	Highly Pathogenic Avian Influenza
MDR	Multidrug resistant
MRSA	Methicillin-resistant Staphylococcus Aureus
NAP	National Action Plan
NTA	Non-therapeutic Antimicrobial
OIE	World Organisation for Animal Health
OTC	Oxytetracycline
SPS	Sanitary and Phytosanitary
TFFA	Thai Frozen Foods Association
UHC	Universal Health Care
WHA	World Health Assembly
WHO	World Health Organization

Introduction

In 2016, Thailand consisted of 77 provinces, covered 513,000 km and had an estimated population of 66 million.[1] For an upper middle-income country Thailand has very impressive health indicators and is among the few countries in the South-East Asia region that boasts of a Universal Health Care (UHC) system covering 98% of the population.

All this has been thanks to substantial state investments in literacy, access to safe drinking water and sanitation, improvements in nutrition and a strong primary healthcare network, in particular rural health infrastructure. Over the years Thailand has also benefited from adoption of a community health approach, with over a million trained health volunteers playing an important role in raising public awareness on health issues.[2]

Currently antimicrobial resistance (AMR) has been a growing problem in Thailand and places a high burden on the country's health and the economy in Thailand. For example, between 2000 and 2014, the prevalence of imipenem resistant *P. aeruginosa* and *Acinetobacter spp.* increased from 10% to 22% and from 14% to 65%, respectively.[3]

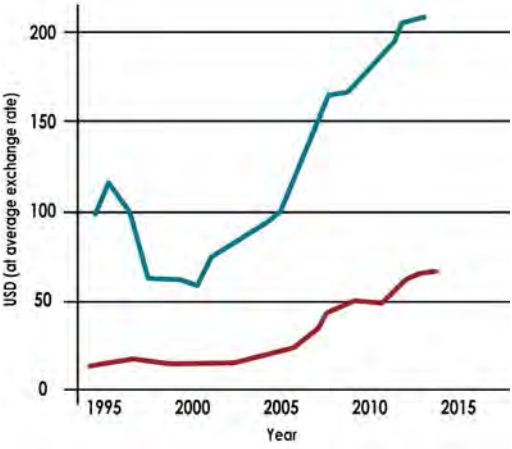
The burden of AMR in Thailand has been estimated in 2010 to result in 3.24 million days of hospitalization and 38,481 deaths per annum, and to cost 0.6% of national GDP.[4]

AMR is also emerging as an important concern in the food-animal farming sector. Like other countries in the region, Thailand too has developed intensive farming systems, leading to the rising consumption of fertilisers, antibiotics, and pesticides, of which many farmers have limited technical knowledge. The lack of effective regulations, appropriate policies, and poor implementation of standards for antibiotic use, together with low levels of biosecurity, hygiene, and sanitation, have accelerated the emergence and dissemination of antibiotic resistance.[5]

Apart from human health, AMR also poses a threat to animal health and food production. Antibiotic resistance in livestock is expected to increase infectious disease outbreaks, slow down

productivity and disrupt international trade.[6] Projections have estimated that global livestock production would decline steadily and, in a 'high AMR-impact scenario', production in low-income countries would decline the most, with a possible 11% loss by 2050.

Per capita total expenditure on health[i]



Responding quickly to the AMR problem in 2016, the Thai cabinet endorsed the first five year National Strategic Plan on Antimicrobial Resistance in Thailand from 2017 to 2021.[7] The plan sets targets for a 50% reduction in AMR morbidity; 20% and 30% reductions in antimicrobial use in human and animal health respectively, and a 20% increase in public knowledge about AMR, including awareness of appropriate use of antimicrobials.

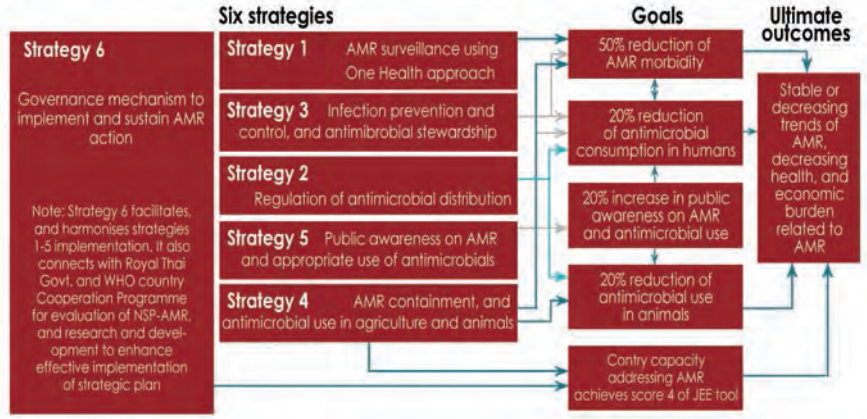
The National Strategic Plan has come up with strategies in particular to tackle the problem of antibiotic use in the food-animal sector. These include strengthening surveillance of AMR in livestock and crop production, better regulation of distribution of antimicrobials used in food-animal farming, reduction of use of antimicrobial and introduction of stewardship programs in veterinary hospitals and clinics.

Thailand's National Strategic Plan on AMR 2017-2021

Vision: Reduction of mortality, morbidity and economic impacts from AMR.

Mission: Establish policies and national multi-sectoral mechanisms which support effective and sustained AMR management system.

Six strategies for tackling AMR[ii]



---

1 Official statistics registration systems [Internet]. Bangkok: Ministry of Interior; 2016. Available from: http://stat.dopa.go.th/stat/statnew/upstat_age_disp.php. Thai (accessed on 10 February 2018)..
2 Thailand's health ambitions pay off. Bulletin of the World Health Organization. http://www.who.int/bulletin/volumes/92/7/14-030714/en/ (accessed on 9 February 2017).
3 Sumpradit N, Wongkongkathep S, Poonpolsup S, et al. New chapter in tackling antimicrobial resistance in Thailand. The BMJ. 2017;358:j3415. doi:10.1136/bmj.j2423.
4 World Health Organization, SEARO. http://www.searo.who.int/thailand/areas/antimicrobial-resistance/en/ (accessed on 17 February 2018).
5 Antimicrobial policy interventions in food animal production in South East Asia Flavie Goutard; BMJ 2017;358:j3544 http://dx.doi.org/10.1136/bmj.j3544 (accessed on 2 February 2018).
6 World Bank Group. Drug resistant infections: a threat to our economic future. The World Bank 2016. http://pubdocs.worldbank.org/ en/689381474641399486/1701381-AMR-LabReport-Web.pdf (accessed on 12 February 2018). Viroj Tangcharoensathien et al. Antimicrobial resistance: from global agenda to national strategic plan, Thailand.
7 http://www.who.int/bulletin/volumes/95/8/16-179648/en/ (accessed on 18 February 2018).

Image Sources

i Country statistics and global health estimates by WHO and UN partners. (http:/www.who.int/gho/en/).
ii Sumpradit N, Wongkongkathep S, Poonpolsup S, et al. New chapter in tackling antimicrobial resistance in Thailand. The BMJ. 2017;358:j3415..

SECTION A

Food-Animal Production

Thailand is one of the world largest food producing and exporting countries. In 2014 the agricultural sector accounted for 10.25 % of Thailand's GDP or around US$20 billion. Of this, after crop production, fisheries held the largest share at 17%, followed by livestock at 11%.[8]

Livestock Population

The major livestock species produced in Thailand are chicken, swine, dairy cattle and beef cattle, with goat and sheep only a very minor composition of national stocks.[9,10]

Commercialized swine and chicken population have showed the fastest growth, rising between 2002 and 2012 from 6.70 to 10.98 million heads for swine and 228.76 to 384.18 million numbers for chicken. This rapid growth has been in response to escalating domestic demand and growing global consumption of broiler meat and products.[11]

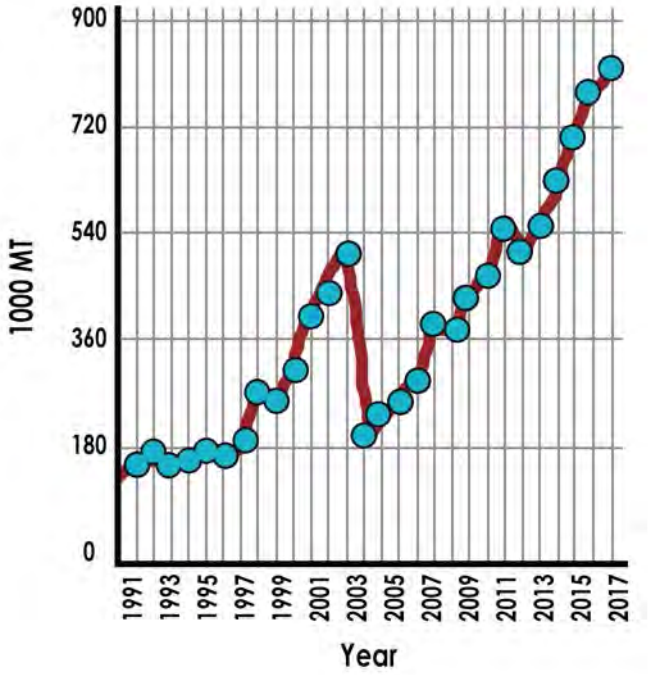
Livestock population (million heads) in Thailand[iii]

Year	Beef Cattle	Dairy Cattle	Buffalo	Goat	Sheep	Swine	Chicken	Duck
2002	5.55	0.36	1.62	0.18	0.04	6.70	228.76	25.03
2003	5.92	0.38	1.63	0.21	0.04	7.82	252.72	23.80
2004	6.67	0.41	1.49	0.25	0.05	6.29	179.74	15.65
2005	7.80	0.48	1.62	0.34	0.05	8.17	254.20	21.54
2006	8.04	0.41	1.25	0.32	0.05	7.15	184.33	20.84
2007	8.85	0.49	1.58	0.44	0.05	9.30	283.13	24.95
2008	9.11	0.47	1.36	0.37	0.04	7.74	235.60	22.72
2009	8.60	0.48	1.39	0.38	0.04	8.54	281.67	27.57
2010	6.43	0.53	1.19	0.38	0.04	8.35	266.03	29.23
2011	6.58	0.56	1.23	0.43	0.05	9.68	316.53	32.18
2012	6.33	0.58	1.24	0.49	0.04	10.98	384.18	36.69
% change 2008-12	30.52	22.96	8.82	31.48	14.55	41.86	63.06	61.49

Food-Animal Production

Milk, pork and poultry meat exhibited the highest production and consumption growth rate compared to other products for Thailand. Broiler chicken products are one of Thailand's main export commodities while other non-ruminant species and ruminant are produced for domestic consumption and small scale trading. Indigenous livestock, such as beef cattle, buffaloes, native chicken, goats and pigs, are mainly kept in low input production systems.[12]

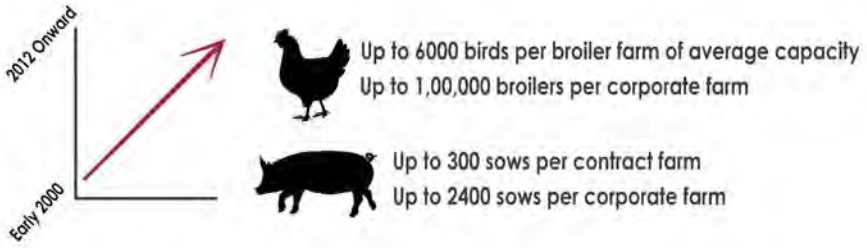
Thailand broiler meat (poultry) exports by year[iv]



Intensive Farming

Over the last three decades Thailand has witnessed a structural change from extensive to intensive farming system, especially in dairy cattle, swine, broiler, layer and duck production. The introduction of intensified modern livestock operations, dominated by contract farming system/companies and characterized by larger herds per farm, has resulted in a decline in the number of traditional, back-yard growers.

Rise in intense farming : Broilers and Sows[13]



The shift to large-scale operations is driven by economies of scale in both production and marketing as well as input procurements and risk management.

Poultry

Over the past four decades, Thailand's poultry sector has transformed itself from backyard farming into a leading poultry exporter. Today, the poultry sector occupies more than half of Thailand's total meat and feed production, ranking number four in Asia's poultry meat production, with a total of almost 1.8 million tons in 2015.[14]

Thailand's largest poultry export markets are the EU and Japan. Approximately 70% of the total poultry production in Thailand, 1.2 million tons was consumed domestically in 2015, whereas 30% was exported.[15]

For much of the past two decades, Thailand's broiler production relied heavily on contract farms where the exporter would provide farmers with day-old chicks and feed, medicines and some other supplies and then buy-back the raised chicken at a guaranteed price. Early in 2000, the European Union (EU) detected nitrofurans (a banned group of antibiotics) and dioxin in some broiler imports from Thailand. This finding, in addition to new animal welfare standards in the EU, brought about a set of export restrictions that led many firms to shift to vertically integrated production in order to ensure quality standards.[16]

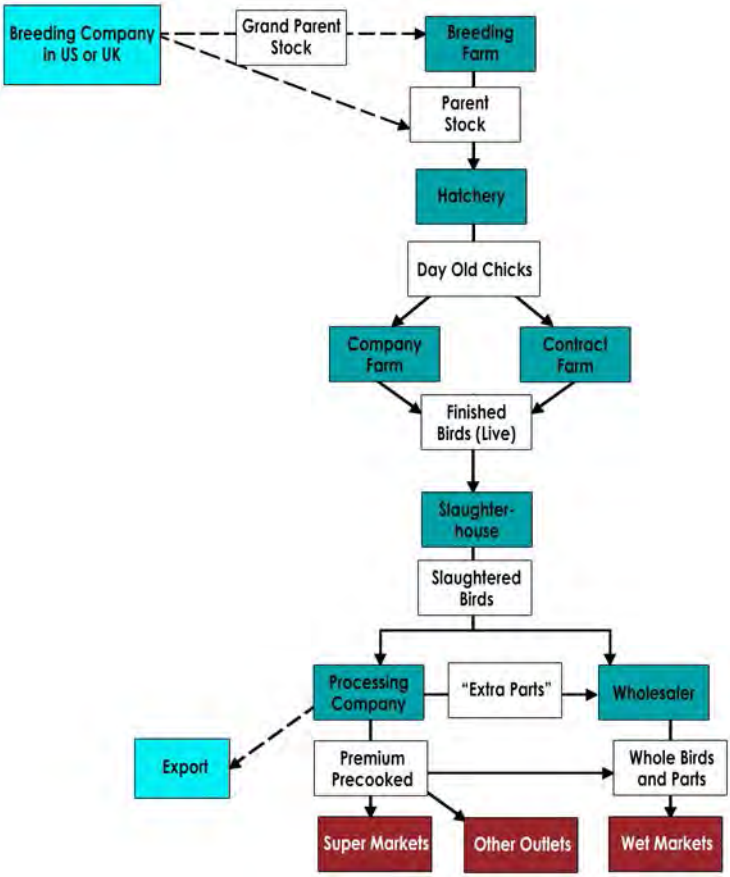
Apart from the need to meet standards set by EU export controls, Thailand's poultry sector has also transformed towards higher biosecurity following the outbreak of the Highly Pathogenic Avian Influenza (HPAI) H5N1 virus in 2004 that devastated the industry.

Today much of the Thai broiler industry is rapidly industrializing and moving towards more vertical integration. It is now commonplace for medium- to large-scale companies to own feed mills. Many large

integrated farms even include (cooked and semi-cooked) food-processing plants as part of their integration.

The integrated commercial farms currently cover 80-90% of national production. Traditional poultry farms are spread across the country and account for 10% of national production with most of their produce being consumed locally.[17]

Vertically Integrated Supply Chain[v]



Legend: Dotted lines represent market transitions while solid lines show internal resource movements.

Fisheries

Thanks to its long coast-line, Thailand ranks among the world's top ten countries that engage in deep-sea fishing, with a fish catch of 3.1 million metric tons in 2013.[18] Its ubiquitous network of streams, swamps, canals, and basins also provide a constant source of freshwater fish.

Thailand is among world's leading seafood exporters, with half its production comprising crustaceans, mostly shrimp traded internationally. [19]

In 2013 Thailand exported approximately US$ 7 billion worth of fish and seafood.[20] Top export destinations were the U.S. (22.8%), Japan (20.4%), Australia (5.4%), Canada (4.4%) and the UK (3.9%).

Shrimps

Thailand is one of the world's largest exporters of shrimp, canned tuna, squid, and cuttlefish. Shrimp products and canned tuna, respectively, contribute 36% and 27% of the total value of Thailand's fish exports.[21]

Thailand's shrimp industry is the third largest in the world, accounting for one-fifth of all production globally.[22] Thailand is the largest exporter of shrimp globally, primarily to the US (46%), Japan (20%) and the European Union (EU) (16%).

Aquaculture now dominates shrimp production, and around 90% of shrimp produced is farmed, mostly by family-owned enterprises or small businesses with small

land holdings of less than two hectares. Many Thai shrimp farmers use intensive farming methods that require inputs including industrially prepared feed, chemicals, antibiotics, aeration devices and are stocked by hatchery produced post-larvae.

Almost all Thai shrimp are raised in giant, man-made rectangular shrimp farming ponds and pens that are filled with coastal sea water, directed and controlled by dikes. The shrimp are fed shrimp feed that is produced on an industrial scale.

Most of Thailand's shrimp is cultivated in over 25000 farms, which are then processed by 122 independent shrimp processing plants.[23]

The two most commonly farmed species are Pacific White shrimp (also known as Whiteleg shrimp or L. Vannamei) and Giant Tiger shrimp (P. Monodon). Global production of Pacific White shrimp, the most commonly farmed species, has grown from just 11 000 tonnes in 1981 to approximately 2.8 million tonnes in 2011 and is valued at US$ 12.2 billion. Although Pacific White shrimp are not native to Asia, their increased prevalence is a result of their perceived resistance to disease.[24]

Box 1: Antibiotic Use in Shrimp Farms

One study, conducted in 2000, shows that a large proportion of shrimp farmers along the Thai coast used antibiotics in their farms.[25] At least sixty-nine of the seventy-six farms included in the study were intensively managed.

Of the seventy-six farmers interviewed, 74% used antibiotics in shrimp pond management. minimum of thirteen different known antibiotics were used by the farmers and additionally about ten were documented but not identified. Among the most commonly used antibiotics were norfloxacin, oxytetracycline, enrofloxacin and different sulphonamides. The wide-spread use of fluoroquinolones among the farmers in this study, e.g. norfloxacin and ciprofloxacin, is a particular cause for concern, especially considering their importance for treatment of a broad range of human pathogens.

Prophylactic use of antibiotics turned out to be very common. Of the farmers who used antibiotics, 86% used them in preventive management, as well as to treat disease when symptoms had arisen. Farmers either used higher doses or what they considered to be more potent antibiotics for treatment rather than for prevention. Of the farmers who used antibiotics in farm management, 14% distributed them daily to the shrimps.

Many of the farmers participating in the study did not have sufficient information on efficient use of antibiotics. For example, 27% of all farmers who used antibiotics used them to prevent or treat viral diseases such as white spot disease. Many of the farmers in this study were aware of the risks with disinfectants and/or pesticides, and about half of them used gloves or facial masks while handling these chemicals. However, none of the farmers mentioned risks from handling antibiotics, and many of them used their bare hands to mix the antibiotics with the feed.

The study concluded that more restrictive use of antibiotics could have positive effects for the individual farmer and, simultaneously, decrease impacts on regional human medicine and adjacent coastal ecosystems. It is likely that dissemination of information could contribute to a decreased use of antibiotics, without decreasing the level of shrimp production.

8 Thailand's agricultural exports strongly placed. Oxford Business Group. https://oxfordbusinessgroup.com/overview/world%E2%80%99s-kitchen-despite-some-short-term-hurdles-thailand-continues-rank-among-world%E2%80%99s-leading (accessed on 12 February 2018).
9 For the purpose of this paper chicken are also included in the livestock category.
10 K. Sommart, S. Nakavisut, S. Subepang , and T. Phonbumrung. THAILAND COUNTRY REPORT—Food-feed estimation: Data, methodologies and gaps. Department of Animal Science, Faculty of Agriculture, Khon Kaen University, Khon Kaen, Thailand; Department of Livestock Development, Ministry of Agriculture and Cooperative, Bangkok, Thailand http://breeding.dld.go.th/small/sansak_papers/FoodFeedEstimationDataMethodologiesAndGaps.pdf (accessed on 8 February 2018).
11 ibid.
12 ibid.
13 ibid.
14 The poultry sector in Thailand. Netherlands Embassy in Thailand. 2016. https://www.rvo.nl/sites/default/files/2016/12/FACTSHEET-POULTRY-SECTOR-IN-THAILAND.PDF (accessed on 3 March 2018).
15 ibid.
16 Supply Chain Auditing for Poultry Production in Thailand. S. Heft-Neal et al. 2008, http://www.fao.org/3/a-bp271e.pdf (accessed on 9 March 2018).
17 ibid.
18 http://factsanddetails.com/southeast-asia/Thailand/sub5_8h/entry-3322.html#chapter-6 (accessed on 28 January 2018).
19 Global supply chains: insights into the Thai seafood sector. Errighi et al; ILO DWT for East and South-East Asia and the Pacific. ILO, 2016. (apmigration.ilo.org/resources/global-supply-chains-insights-into...seafood.../file1, accessed on 1 March 2018).
20 http://www.seafish.org/media/publications/thailandethicsprofile_201509.pdf (accessed on 27 February 2018).
ibid.
21 https://www.youtube.com/watch?v=3ozx43pWgZ0.
22 http://www.seafish.org/media/publications/thailandethicsprofile_201509.pdf (accessed on 27 February 2018).
23 CSR report.
Holmström, Katrin & Gräslund, Sara & Wahlström, Ann & Poungshompoo, Somlak & Bengtsson, Bengt-Er-
24 ik & Kautsky, Nils. (2003). Antibiotic use in shrimp farming and implications for environmental impacts
25 and human health. International Journal of Food Science & Technology. 38. 255 - 266. 10.1046/j.1365-2621.2003.00671.x.

Image Sources

iii THAILAND COUNTRY REPORT Food-feed estimation: Data, methodologies and gaps K. Sommart et al; Department of Livestock Development, Ministry of Agriculture and Cooperative, Bangkok, Thailand. http://breeding.dld.go.th/small/sansak_papers/FoodFeedEstimationDataMethodologiesAndGaps.pdf (accessed on 8 February 2018).
iv https://www.indexmundi.com/agriculture/?country=th&commodity=broiler-meat&graph=exports (accessed on 21 August 2018).
v Supply Chain Auditing for Poultry Production in Thailand. S. Heft-Neal et al. 2008, http://www.fao.org/3/a-bp271e.pdf (accessed on 9 March 2018).

SECTION B

The Emergence of Antimicrobial Resistance

Antimicrobial Consumption

Overall, 5371 antibiotics were registered in the Thai Food and Drug Administration's database for 2016.[26] Of these two thirds are for humans and the remainder for animals, some as medicated premix.

Antimicrobials account for 15-20% of the total human drug costs in Thailand, and 50% of antimicrobial consumption is antibiotics; the other 50% are antiviral, antifungal, and other drugs.

US$315m was spent on antibiotics in 2009, which is higher than on medicines for cardiovascular diseases (US$260m) and cancer (US$225m). Penicillins, cephalosporins and carbapenems are the top three antibiotics consumed.

Antimicrobial consumption[vi]

- More than 5200 antimicrobial products are registered with the Thai Food and Drug Administration.
- Antimicrobials account for 15-20% of the total human drug costs, and 50% of antimicrobial consumtion is antibiotic; the other 50% are antiviral, antifungal, and other drugs.
- $315m was spent on antibiotics in 2009, which is higher than on medicines for cardiovascular diseases ($260m) and caner ($225m).
- Penicillins, cephalosporins and carbapenems are the top three antibiotics consumed.

One study identified about 24,000 distributors, retailers and wholesalers who were fully licensed for pharmaceutical sales in 2017.[27] As a result of proliferation of such drug sale outlets, most antibiotics easily available in both the human and animal health sectors, leading to frequent inappropriate use.

The 1987 Drug Act regulates pharmacists working in pharmacies, on aspects such as working hours and the dispensing of special-control drugs. Historically, there have been no legal requirements for the keeping of records on the types and quantities of antibiotics dispensed within the retail sector.

Most antibiotics are classified as "dangerous drugs" that can only be dispensed by licensed pharmacists in pharmacies, but can be obtained, legally, without a prescription, with the quality of dispensing largely reliant on the competences of the doctors, pharmacists and veterinarians involved. Only a few antibiotics, e.g. betalactamase inhibitors, carbapenems and fosfomycin, are classified as special-control drugs because of the high prevalence of resistance to them. Such drugs cannot be obtained, legally, without a prescription and are reserved for hospital use.[28]

A research study that carried out interviews with key informants representing the country's health providers, every private and public clinic and hospital had a pharmacy section in which antibiotics were dispensed to inpatients and outpatients according to the prescriptions of doctors.[29] Although most of these prescriptions were not required by law, the routine issuing of prescriptions, even for drugs that were not, legally, prescription-only, had become the tradition of most health facilities. Antibiotics were also dispensed directly to consumers and pet owners by licensed pharmacists in wholesalers or drugstores.

Antibiotic Use in Animals

The use of antibiotics for animals has been regulated by the Thai Department of Livestock Development since 2003, but compliance among farmers has been found to be varying.

One example of some farmers bypassing regulations is outlined in a recent study that shows how they are able to directly access active pharmaceutical ingredients (API) in order to mix it with the feed given to their livestock.[30]

In Thailand, all drugs must be registered with the Food and Drug Administration before production or importation. There is, however, no corresponding requirement for the registration of API. Drug distributors and retailers can only sell API legally to manufacturers. However, a lack of monitoring and tracking of the API ingredients and inadequate inspections at the drug distributors and retailers mean that this legal restriction is generally ignored.

Thailand imports active pharmaceutical ingredients (API), for local manufacturing into finished products.[31] API are imported either by manufacturers or by licensed importers who then sell the ingredients to manufacturers. It also imports medicated premix for the manufacture of medicated feed by feed mills.

The antibiotics produced by the manufacturers are sold to distributors, retail outlets and/or wholesalers. The imported finished products are distributed, by importers licensed to distribute or by distributors, to drugstores, farms, feed mills, health facilities, veterinary facilities and/or wholesalers. The import and manufacture of human medicines is very similar to those of veterinary medicines, both coming under the Thai Food and Drug Administration regulations.

One study pointed out that interviews with regulators, retailers and wholesalers indicated illegal distribution of both finished products and certain API.[32] The 1987 Drug Act stipulates that all API must be used by manufacturers to produce finished products. However, a few informants reported how drug inspectors had confiscated API that was being used directly on livestock in farms.

The interviewees from the farming industry reported how the high cost of buying medicated feed had persuaded some farmers to mix active pharmaceutical ingredients into their animal feed. The farmers who produced their own medicated feed did not have quality control and, in the interviewees' opinion, the feed they produced was unlikely to have an even distribution of API. Although the 2015 Animal Feed Quality Control Act prohibited such direct use of API in animal feed, inadequate inspection allowed farmers to purchase such ingredients from drugstores or wholesalers.

Informants representing animal feed companies also reported how feed mills mostly purchased medicated

feed, either for treatment or for prophylaxis during periods of increased vulnerability, for example, when livestock were transferred to new environments.

The large number of licensed individuals involved in the antibiotic supply chains can be categorized according to the type of license granted to them under the 1987 Drug Act or 2015 Animal Feed Quality Control Act. According to the licenses issued in 2016–2017, these chains involved 793 drug importers, 187 drug manufacturers, 323 animal feed importers, 299 animal feed mills, 27,165 feed stores and about 24,000 other individuals who were distributors, wholesalers or retail pharmacies.

AMR in food-animals[33]

In livestock and animal products, antibiotic resistant bacteria are a widespread phenomenon throughout the Greater Mekong Subregion (GMS), of which Thailand is a part. Common human enteric pathogens such as *Salmonella*, *E. coli* and *Campylobacter* are found in both live animal samples and meats for purchase, and these strains exhibit extensive antibiotic resistance, often to multiple drugs.

Antibiotic resistance results from the use of antibiotics as growth promoters in animal feeds and inappropriate use of antibiotics for treatment of livestock in systems of any scale. In addition, a review of studies on antibiotic resistance in the GMS highlighted the contribution of livestock intensification to the transmission of resistant strains through the food chain.

In 2002/2003 a study was conducted in Sangkhla Buri, Kanchanaburi province, in which Thailand found enteric

bacterial pathogens in 97% of raw food samples of chicken, pork and fish from a local market. The two most common bacteria identified in this study were *Salmonella* (84%) and *Arcobacter butzleri* (74%), followed by *Campylobacter* (51%), *Plesiomonas* (27%) and *Aeromonas* (5%).[34]

In 2003 another study from Khon Kaen province, Thailand, found the rates of antibiotic specific resistance of Salmonella in pork, chicken, and human patients to be closely related, suggesting a transfer of resistant bacteria through the food chain to the consumer.[35]

Finally, a study conducted on meats from the open markets and supermarkets in Bangkok in 2007 found *Listeria monocytogenes* in 15.4% of all samples. Of these isolates, 95.5% were resistant to cefotaxime, ceftazidime and ceftriaxone.[36]

Poultry

Even though Thailand is a major exporter of chicken meat, for several reasons, there are few published quantitative data on antibiotic use in Thai livestock production.[37]

In a survey or rural poultry farms in 2016, a group of Thai researchers attempted to estimate the total amount of antibiotics used annually for prophylaxis in production of chicken.[38] Using both quantitative and qualitative methods, they extrapolated the data collected from eight farms in a single province. None of the farms reportedly used antibiotics as growth promoters and had a median capacity of 15,000 chickens.

The regimen used by several of the farms, based on recommendations from the company supplying the

broiler stock, included amoxicillin, colistin, doxycycline, oxytetracycline and tilmicosin.[39] According to WHO, amoxicillin is a critically important antimicrobial, colistin is one of the highest priority critically important antimicrobials and doxycycline and oxytetacycline are highly important antimicrobials.[40]

The mean total weight of antibiotics used per chicken was 303 mg, allocated daily for 31 days and typically mixed with drinking water and distributed via a pipe system. The last 10 days on the farm no antibiotics was given to the chicken, representing an attempt to eliminate antibiotics from the chicken meat reaching consumers.

This translates into around 101 mg of antibiotics per kilogram of chicken meat produced. In meat production (not exclusively chicken) within 30 European countries in 2015, antibiotic use per so-called population correction unit, i.e., per kg of biomass produced, varied from 2.9 mg in Norway to 434.2 mg in Cyprus.[41]

Using this data, the researchers estimated that each year, over eight cycles, a farm with a capacity of 14,000 chickens could raise 112,000 chickens and use 34 kg of antibiotics. If 62% of the 1.4 billion meat chickens raised in Thailand in 2016 had been raised without the use of any antibiotics and 38% had been given only the antibiotic prophylaxis the total amount of antibiotics used on those 1.4 billion chickens would have been about 161 tonnes.

The researchers have made the novel recommendation of developing global standards to measure 'antibiotic footprint' of meat products, for display of all antibiotics used in the production process, through labels on food products. This they say will allow consumers to choose meat that was produced with minimal use of antibiotics.

Shrimps

It is well known that antibiotics are commonly used in shrimp farming to prevent or treat disease outbreaks, but there is little published documentation on details of usage patterns. One study, conducted in 2000, shows that a large proportion of shrimp farmers along the Thai coast used antibiotics in their farms.[42] Of the seventy-six farmers interviewed, 74% used antibiotics in shrimp pond management. Most farmers used these antibiotics prophylactically, some on a daily basis, and at least thirteen different antibiotics were used. Many farmers were not well informed about efficient and safe application practices. A more restrictive use of antibiotics could have positive effects for the individual farmer and, simultaneously, decrease impacts on regional human medicine and adjacent coastal ecosystems. It is likely that dissemination of information could contribute to a decreased use of antibiotics, without decreasing the level of shrimp production.

In Thailand, erythromycin and tetracyclines were detected in aquaculture water with oxytetracycline concentrations up to 180 ng/L.[43] In integrated aquaculture farms excreta from chickens, that may have been given antibiotics, is used as feed. This can lead to the transfer of residues to fish used for human consumption.[44]

Fisheries

One study investigated the use, environmental fate and ecological risks of antibiotics applied in tilapia cage farming in the Tha Chin and Mun rivers in Thailand.[45] Information on antibiotic use was collected through interviewing 29 farmers, and the concentrations of the most commonly used antibiotics, oxytetracycline (OTC) and enrofloxacin (ENR), were monitored in river water and sediment samples. The study also assessed the toxicity of OTC and ENR on tropical freshwater invertebrates and performed a risk assessment for aquatic ecosystems. All interviewed tilapia farmers reported to routinely use antibiotics.

Peak water concentrations for OTC and ENR were 49 and 1.6 µg/L, respectively. Antibiotics were most frequently detected in sediments with concentrations up to 6908 µg/kg dry weight for OTC, and 2339 µg/kg dry weight. for ENR. The results of the study indicated insignificant short-term risks for primary producers and invertebrates, but suggest that the studied aquaculture farms constitute an important source of antibiotic pollution.

Waste Water

One study, carried out in 2011 and 2012, collected water samples from five wastewater treatment plants (WWTPs), six canals, and in mainstream Chao Phraya River of Bangkok.[46] Hazard quotients estimated for acetylsalicylic acid, ciprofloxacin, diclofenac and mefenamic acid in most of the canals and that of ciprofloxacin in the river, were greater than or close to 1, suggesting potential ecological and health risks. The study reported levels of ciprofloxacin

up to 200 ng/L in waste water treatment plants and receiving waters.

In another study up to 3 µg/L of oxytetracycline and up to 1.6 µg/L of enrofloxacin were detected in a conventional treatment plant effluent.[47]

Pesticides

Studies on the composition of soil microorganisms revealed that the widespread use of the herbicide glyphosate promoted the relative abundance of gram-negative bacteria, such as *Burkholderia spp*., which have been linked to the regional emergence of human melioidosis.[48]

26 Sumpradit N, Wongkongkathep S, Poonpolsup S, et al. New chapter in tackling antimicrobial resistance in Thailand. The BMJ. 2017;358:j3415. doi:10.1136/bmj.j2423.
27 Sommanustweechai A, Chanvatik S, Sermsinsiri V, et al. Antibiotic distribution channels in Thailand: results of key-informant interviews, reviews of drug regulations and database searches. Bulletin of the World Health Organization. 2018;96(2):101–109.
28 ibid.
29 ibid.
30 ibid.
31 ibid.
32 ibid.
33 Padungtod P, Kaneene JB, Hanson R, Morita Y, Boonmar S. Antimicrobial resistance in Campylobacter isolated from food animals and humans in northern Thailand. FEMS Immunol Med Microbiol. 2006;47(2):217–25.
34 Bodhidatta L, Srijan A, Serichantalergs O, Bangtrakulnonth A, Wongstitwilairung B, McDaniel P, et al. Bacterial pathogens isolated from raw meat and poultry compared with pathogens isolated from children in the same area of rural Thailand. Southeast Asian J Trop Med Public Health. 2013;44(2):259–72.
35 Angkititrakul S, Chomvarin C, Chaita T, Kanistanon K, Waethewutajarn S.
Epidemiology of antimicrobial resistance in Salmonella isolated from pork, chicken meat and humans in Thailand. Southeast Asian J Trop Med Public Health. 2005 Nov;36(6):1510-5.
36 Indrawattana N, Nibaddhasobon T, Sookrung N, Chongsa-nguan M, Tungtrongchitr A, Makino S, et al. Prevalence of Listeria monocytogenes in Raw Meats Marketed in Bangkok and Characterization of the Isolates by Phenotypic and Molecular Methods. J Health Popul Nutr. 2011;29(1):26–38.
37 Nhung NT, Cuong NV, Thwaites G, Carrique-Mas J. Antimicrobial usage and antimicrobial resistance in animal production in Southeast Asia: a review. Antibiotics (Basel). 2016 Nov 2;5(4):37.http://dx.doi.org/10.3390/antibiotics5040037 pmid: 27827853.
38 Antibiotic use in poultry: a survey of eight farms in Thailand. Direk Limmathurotsakul et al. Bulletin of the World Health Organization 2018;96:94-100.
39 ibid.
40 Critically important antimicrobials for human medicine – 5th revision. Geneva: World Health Organization; 2017. Available from: http://apps.who.int/iris/bitstream/10665/255027/1/9789241512220-eng.pdf (accessed on 1 March 2018).
41 Sales of veterinary antimicrobial agents in 30 European countries in 2015. Trends from 2010 to 2015. Seventh ESVAC report. London: European Medicines Agency; 2017. Available from: http://www.ema.europa.eu/docs/en_GB/document_library/Report/2017/10/WC500236750.pdf (accessed on 1 March 2018).
42 Antibiotic use in shrimp farming and implications for environmental impacts and human health (PDF Download Available). Available from: https://www.researchgate.net/publication/227620359_Antibiotic_use_in_shrimp_farming_and_implications_for_environmental_impacts_and_human_health [accessed Feb 27 2018].
43 Shimizu A, Takada H, Koike T. Ubiquitous occurrence of sulfonamides in tropical Asian waters. Sci Total Environ. 2013;452-453:108-15. doi:10.1016/j. scitotenv.2013.02.027 13.
44 Koeypudsa W, Yakupitiyage A, Tangtrongpiros J. The fate of chlortetracycline residues in a simulated chicken-fish integrated farming systems. Aquacult Res. 2005;36:570-7doi:10.1111/j.1365–2109.2005.01255.x
45 Rico A et al. Use, fate and ecological risks of antibiotics applied in tilapia cage farming in Thailand. Environ Pollut. 2014 Aug;191:8-16. doi: 10.1016/j.envpol.2014.04.002. Epub 2014 May 5.
46 Tewari S, Jindal R, Kho YL, Eo S, Choi K. Major pharmaceutical residues in wastewater treatment plants and receiving waters in Bangkok, Thailand, and associated ecological risks. Chemosphere 2013;91:697–704. doi:10.1016/j. chemosphere.2012.12.042.
47 Rico A, Oliveira R, McDonough S. Use, fate and ecological risks of antibiotics applied in tilapia cage, the bmj | BMJ 358:Suppl1 45 Antimicrobial Resistance in South East Asia farming in Thailand. Environ Pollut 2014;191:8-16. doi:10.1016/j.envpol.2014.04.002.
48 Intensified food production and correlated risks to human health in the Greater Mekong Subregion: a systematic review. Richter et al. Environmental Health (2015) 14:43.

Image Sources

vi Sumpradit N, Wongkongkathep S, Poonpolsup S, et al. New chapter in tackling antimicrobial resistance in Thailand. The BMJ. 2017;358:j3415. doi:10.1136/bmj.j2423.
vii Thai Feed Mill Association.

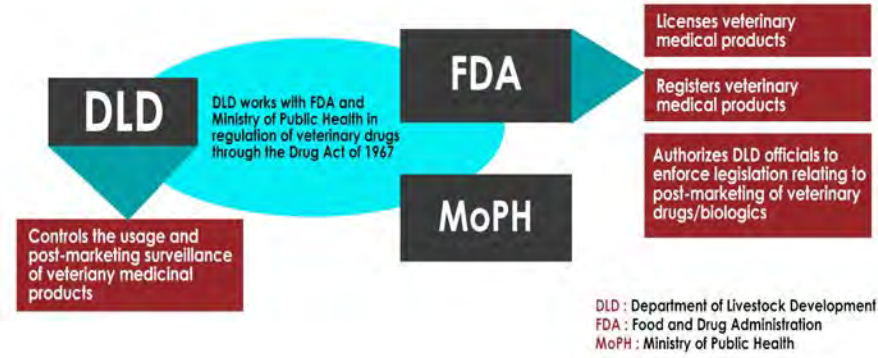
SECTION C

Responding to Antimicrobial Resistance

Livestock

The Department of Livestock Development (DLD), Ministry of Agriculture and Cooperatives, is the major organization that plays a very important role in regulations and control of all matters regarding livestock and livestock products.[49]

DLD, FDA and MoPH : Working Together[50]



Since 2005 the FDA has prohibited registration of antibiotics for use as growth promoters and also rejected any application of new antimicrobials used in humans (e.g. carbapenems) for use in animals.[51] Antimicrobials have also been reclassified and their distribution controlled under the Act.

The DLD, on its part in 2009 put out a list of drugs and chemicals that are not allowed to be used in food animals. Under the Feed Quality Control Act 2015 DLD banned all antibiotics used for growth promoters in food animals.[52] DLD also issues importation standards of livestock and livestock products, which among other things addresses environmental and animal welfare concerns.

The National Bureau of Agricultural Commodity and Food Standards (ACFS) is another governmental agency under the Ministry of Agriculture and Cooperatives that is involved in standards and policies of the country. ACFSs issued a Code of Practice for Control of Use of Veterinary Drugs describing good practices for the use of veterinary drugs for food producing animals to avoid excess of maximum residue limits of veterinary drugs in animals, animal produce and animal products for human consumption.[53] Recently, ACF has drafted guidelines for judicious use of antimicrobials in broiler farms.

Fisheries

The Thai Department of Fisheries (DOF), in the Ministry of Agriculture and Cooperatives, is the principal government agency responsible for the development and management of fisheries and aquaculture in Thailand.

The Thai Frozen Foods Association (TFFA) plays an important role in shrimp exports. To gain access to international markets, all producers and exporters need to be registered with TFFA, which now represents the interests of over 300 processors and traders.

Given increasing pressures from high-income importers, export processors have taken steps to improve the labour conditions and environmental threats in their supply chains. This has in turn encouraged their direct and indirect suppliers to improve compliance to the relevant standards. Processing export facilities are highly concentrated and regulated, as they need to register with the Thai Department of Fisheries (DOF) and must be

members of the Thai Frozen Food Association (TFFA), complying with Hazard Analysis and Critical Control Points (HACCP) standards to export. However, there is a lack of proper regulation and enforcement in processing of shrimp products for the domestic market, due to the absence of pressure from overseas buyers.

Antibiotic Production, Distribution and Dispensing

Two Acts regulate the use of antibiotics and medicated feed through inspection, licensing and marketing:[54]

- the 1967 Drug Act; and
- the 2015 Animal Feed Quality Control Act.

The 1967 Drug Act, enforced by the Food and Drug Administration of the Thai Ministry of Public Health, regulates finished products used in human and veterinary medicine and active pharmaceutical ingredients.

The 1967 Drug Act divides antibiotics into a large group of "dangerous drugs not requiring prescriptions" and a much smaller group of "special-control drugs requiring prescriptions".

Unfortunately, this categorization meant that most antibiotics could be dispensed, by licensed pharmacists in retail pharmacies, without a prescription. However, the Thai FDA is currently in the process of upgrading regulation needed to plug this loophole and restrict the quantity of antibiotics that could be distributed to any individual or to control the excessive use of antibiotics in livestock.

The 2015 Animal Feed Quality Control Act is enforced by the Department of Livestock Development of the Thai Ministry of Agriculture and Cooperatives. This Act prohibited direct use of active pharmaceutical ingredient in animal feeds. However, a recent study indicates that many Thai farmers were, illegally, adding active pharmaceutical ingredients to animal feeds, probably as a cost-saving measure.[55]

Following a series of public consultations, the Thai Food and Drug Administration is currently working on a reclassification of antibiotics in which a larger proportion of the drugs will be categorized as special-control/ prescription-only, in line with the recommendations made by the World Health Organization in its 20th Model List of Essential Medicines.[27]

Food Safety

Thai Agricultural Standards Related to AMR

- General Standards (39 items):

• Code of practice for control of the use of veterinary drugs, safety requirements for agricultural commodity and food.
• Manual of diagnostic tests for animals.

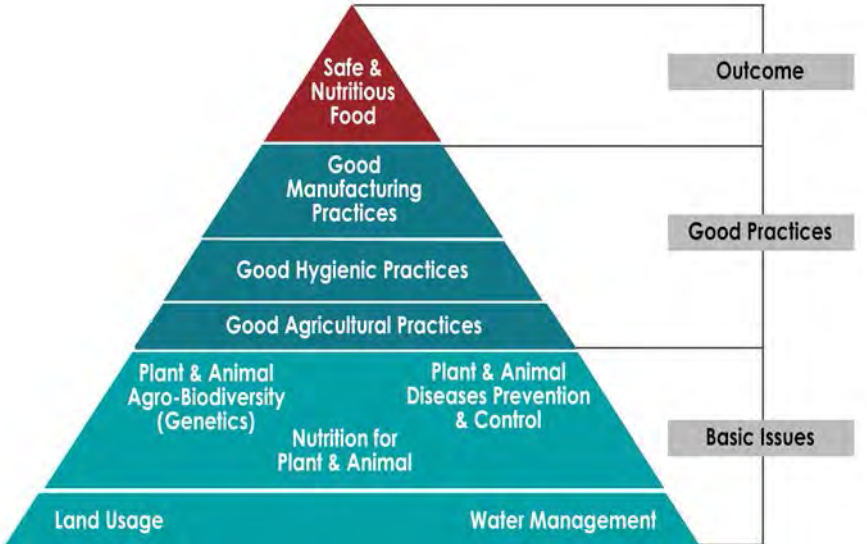
- Production Standards (1144 items):

• Good Agricultural Practices for livestock farming, aquaculture and crop production, Good Manufacturing Practices for milk collection centers.
• Guidelines for health and welfare management for animals, farm veterinarian,, disease treatment, sanitation etc.

- Commodity Standards (1102 items):

• Meat, beef, shrimp, egg, milk, honey etc.

Thailand's Food Chain Approach[viii]



Export-Related Rules

Agreement on the Application of Sanitary and Phytosanitary

Thailand is one of the signatories to the World Trade Organization's Agreement on Application of Sanitary and Phytosanitary Measures (the "SPS Agreement"), which entered into force on 1 January 1995. It concerns the application of food safety and animal and plant health regulations.

The Agreement on the Application of Sanitary and Phytosanitary Measures sets out the basic rules for food safety and animal and plant health standards.

The SPS Agreement[ix]

It allows countries to set their own health standards. But it also says regulations must be based on science. They must be applied only to the extent necessary to protect human, animal or plant life or health. And they should not arbitrarily or unjustifiably discriminate between countries where identical or similar conditions prevail.

Member countries are encouraged to use various international standards, guidelines and recommendations where they exist. However, members may use measures which result in higher standards if there is scientific justification. They can also set higher standards based on appropriate assessment of risks so long as the approach is consistent, not arbitrary.

Poultry

In March 2002, EU had found that Thai chicken contain residues of nitrofuran and has tightened its rules on Thai chicken exports. They announced a ban on the use of antibiotics in frozen-chicken products imported from Thailand.[56] Thai exporters were subjected to 100% inspection due to the danger of chemical residues present in the products. Since most large-scale farms rely heavily on export, this effective tracking scheme forces them to comply with the export standard to improve their production standards, including those concerning chemical residues. This is to avoid heavy punishment if they fail to comply.

Box 2: Farm-to-Table Tracking

Concerns about the health and safety of consumers have led to the imposition of minimum standards for aquaculture products by importers such as the USA and European Union (EU). Thailand is one of the largest exporters of aquaculture and fisheries products, and has responded to these food safety concerns over the entire chain of production.[57]

The Thai Department of Fisheries (DOF) is the competent authority for inspection and certification of all fish and fishery products. The strategy of the DOF in order to improve food safety related to shrimp production is the "Farm-to-Table" approach. As part of this, controls have been placed on the use of prohibited substances in farms, feed production, fishery imports, and processing and finished product levels.

Processing plants, for example, are required to implement Good Manufacturing Practices (GMP) and Hazard Analysis and Critical Control Points (HACCP), a systematic preventive approach to food safety from biological, chemical, and physical hazards in production processes. DOF has also developed fundamental guidelines—Good Aquaculture Practices (GAP)—for hygienic shrimp production.

The Code of Conduct (CoC) programme for the marine shrimp industry, which began in 1998, emphasizes traceability from retailers or consumers to the farm through a coding system for product recall purposes.[58] DOF introduced Movement Documents (MD) as a paper-based tool to accomplish traceability of the control and monitoring programme on the use of drugs and other chemical agents. Feed manufacturers are also required to implement GMP and HACCP system in their production so that this can be traced back to the feed ingredient supplies.

There have been however problems encountered in the implementation of this traceability system. The following are some of the shortcomings identified:

- Lack of resources: It is not an easy task to change the habits of farmers where record keeping used to be outside their interest and can add more cost to maintain records for their products.
- Lack of awareness: Lack of knowledge about the benefits and advantages of having a traceability system.

Monitoring & Surveillance

According to the Thailand National Strategic Plan 2017-2021, the monitoring and evaluation (M&E) will include a few key actions such as, establishing baseline indicators for 2016 and strengthening the infrastructure and the functioning of M&E systems which contribute to monitoring progresses of each goal against each of its five targets.

Evidence on AMR and magnitudes of antimicrobial use in human and animal will be regularly shared with prescribers in human and agriculture sectors, in order to change course of actions, general public and decision-makers.

---

49 Perspectives on Antimicrobial Resistance in Livestock and Livestock Products in ASEAN Countries Amornthep Archawakulathep et al. Thai J Vet Med. 2014.44(1):5–13.
50 ibid.
51 Policy of Antimicrobial use (AMU) in Livestock in Thailand, Julaporn Srinha Division of Animal Feed and Veterinary Products Control (AFVC) Department of Livestock Development (DLD) Ministry of Agriculture and Cooperatives (MOAC). http://www.favamember.org/wp-content/uploads/2017/05/Policy-of-AMU-in-livestock-in-Thailand.pdf (accessed on 12 June 2018).
52 ibid.
53 ACFS, 2009. http://www.acfs.go.th/eng/general_standard.php?pageid=2 (accessed on 2 March 2018).
54 Sommanustweechai A, Chanvatik S, Sermsinsiri V, et al. Antibiotic distribution channels in Thailand: results of key-informant interviews, reviews of drug regulations and database searches. Bulletin of the World Health Organization. 2018;96(2):101–109.
55 Viroj Tangcharoensathien et al. Antibiotic distribution channels in Thailand: results of key-informant interviews, reviews of drug regulations and database searches. Bull. World Health Organ. 2018;96:101–109.
56 http://www.fao.org/WAIRDOCS/LEAD/x6170e/x6170e3c.htm (accessed on 1 March 2018).
57 Traceability of aquaculture products in relation to feed and feed ingredients. Laddawan Krongpong | 8 March 2017 . https://enaca.org/?id=906 (accessed on 2 March 2018).
58 Codex Alimentarius Commission: procedural manual. http://apps.who.int/iris/handle/10665/43217 (accessed on 1 March 2018).

Image Sources

viii Key elements of Thailand's achievement in food and nutrition security, Kraisid Tontisirin, Senior Advisor , Institute of Nutrition , Mahidol U. Thailand. 2017. http://www.inmu.mahidol.ac.th/4decades_INMU/pdf/Kraisid.pdf (accessed on 28 August 2018).
ix Thailand and the WTO, World Trade Organization. https://www.wto.org/english/thewto_e/countries_e/thailand_e.htm (accessed on 28 August 2018).

SECTION D

What Can Be Done

What is to be done?

- A system for recording antibiotic dispensing at retail pharmacies should be established and then carefully audited by pharmacists.

- The continued professional education of retail pharmacists should be promoted, as a means of reducing the inappropriate use of antibiotics, and other drugs.

- The sales of large quantities of antibiotics to individuals need to be restricted by differentiating wholesalers from the retailers in the licensing system. This includes prohibiting wholesalers from selling large quantities of antibiotics to farmers, or others who are not licensed retail outlets, and carefully restricting the sale by retailers of large quantities of such drugs to individuals.

- The ongoing policy to reclassify more antibiotics as special-control/prescription-only drugs in Thailand should be rapidly implemented.

- A national system for tracking the active pharmaceutical ingredients should be established immediately, to prevent the direct use of such ingredients on farms.

Box 3: Raised Without Antibiotics Certification

In early 2017, the Betagro Group in Thailand, a large supplier of chicken to consumers in Asia and Europe, became the first company to flaunt a 'Raised without Antibiotics' certification, issued by global public health organization NSF International.

According to NSF International, the certification protocol, which provides independent verification of on-package claims, can be granted to a wide variety of animal products, including meat, poultry, seafood, dairy, eggs, leather and certain supplement ingredients. Betagro is Thailand's second biggest producer of poultry meat after the Charoen Pokphand (CP) group.

NSF defines 'Raised without Antibiotics' as follows: "from birth/hatching and during suckling period, animals and animal products represented as certified shall be raised without the use of antibiotic treatments. When medically necessary as determined by an authorized veterinary surgeon, any animals treated with antibiotics, or exposed to antibiotics through maternal exposure via suckling, at any time may no longer be represented as "Raised without Antibiotics" in any form."

A 2016 survey conducted for NSF International found that 59% of the consumers prefer products from animals raised without antibiotics.[59] But, without an independent, transparent protocol and certification process, consumers have not been able to verify claims made by marketers—until now.

Under the programme, animals cannot be certified if they have received antibiotics. NFS International does not consider ionophore chemical coccidiostats, as contributors to antimicrobial resistance, and permits their use, under the direction of veterinary surgeon, to prevent infections, depending on labelling regulations in the region of product sale.[60] However, to comply with United States Department of Agriculture (USDA) rules, the claim "Raised without Antibiotics" is permitted on the label intended for US markets only if chemical coccidiostats were excluded from the production practice.

According to NFS International the certification programme also encourages preventive measures such as vaccination, alternative treatments, litter management techniques and appropriate stocking density to maintain the health and welfare of the animals. If sick animals require antibiotics for treatment, they can receive veterinary care but must be removed from the Raised Without Antibiotics programme.

---

59 http://www.nsf.org/consumer-resources/cooking-cleaning-food-safety/raised-without-antibiotics (accessed on 1 March 2018).

60 NSF Protocol P463 NSF Raised without Antibiotics Certification Program http://www.nsf.org/gated_pdf/cvv_rwa_standard.pdf (accessed on 1 March 2018).

Ever since they were discovered over eight decades ago, antimicrobials, especially antibiotics, have saved countless lives from infectious diseases and transformed modern medical procedures, including surgery, organ transplantation and cancer treatment. However, over the years, the slow but steady spread of antimicrobial resistance — whereby the bacteria turn antimicrobial drugs ineffective — threatens to undo these important gains.

While a significant role in the spread of such resistance has been due to growing use of antimicrobials in the human health sector, there is now recognition that widespread use of these miracle drugs in food-animal production is also a major factor.

This booklet gives a brief introduction to the problems, solutions and challenges involved with the use of antimicrobials in food-animal production. It is meant for policy makers, health professionals and concerned civil society groups interested in initiating action on this important issue.