

# TARS LEADING CONVERSATIONS October 2020

# **MEETING REPORT**

# Shrimp Aquaculture: Managing AHPND, EHP and WFS

Watch the Webinar at TARS 2020 Shrimp Aquaculture - AHPND, EHP & WFS

**Organisers:** 





# Managing AHPND, EHP and WFS

Industry leaders debate on the different challenges faced by farmers in Vietnam, India, Indonesia and Thailand at the virtual TARS Leading Conversations.



These five shrimp were originally from one batch of post larvae and were subjected to different pathogens.

A: White spot syndrome virusinfected shrimp;

B: Shrimp that was experimentally affected with white faeces disease;

C: A typical EMS affected shrimp; D: Shrimp infected with EHP with some abnormality in the hepatopancreas and the midgut; E: Specific pathogen free shrimp.

Figure 1. Transmission route for Enterocytozoon hepatopenaei (EHP)

Credit: ShrimpVet Lab, Vietnam



**Figure 2.** Size comparison of specific pathogen free (SPF) shrimp and four *Enterocytozoon hepatopenaei* or EHP-infected shrimp after two weeks of infection.

F or the most part of 2020, Covid-19 took centre stage. The immediate and medium-term problems revolved around disruptions in the production chain affecting global shrimp supply and demand. Shrimp aquaculture's longterm problem is still the ongoing threat of disease and decreasing survival rates, which result in lower productivity and increasing costs of production.

During this pandemic, prices have fallen but with higher cost of production and lower survival rates impacted by disease problems. In general, management of the diseases, acute hepatopancreatic necrosis disease (AHPND) or early mortality syndrome (EMS), *Enterocytozoon hepatopenaei* (EHP) and white faeces syndrome (WFS) continues to be difficult for many farms while there have been success in some.

In this virtual conversation held on October 21, the focus was on the three major diseases; AHPND, EHP and WFS. Industry leaders: **Dr Loc Tran**, Founder and Director of ShrimpVet Laboratory, Vietnam; **Haris Muhtadi**, Chairman of Indonesia's Feedmill Association and Associate Director at PT CJ Feed and Livestock Indonesia; **Ravikumar Bangarusamy**, General Manager – Technical, Growel Feeds, India and **Soraphat Panakorn**, Commercial Development Manager, Aquaculture-Asia Pacific, Novozymes Biologicals, Thailand, were tasked to elucidate the current situation and debate on the different challenges faced by shrimp farmers in Vietnam, Indonesia, India and Thailand, respectively. They also contributed with suggestions on some of the best practices in managing these three diseases.

#### AHPND, EHP and WFS

Loc summarised the current knowledge on the three diseases:

- EHP is a major problem now in Asia causing severe slow growth in farmed shrimp and economic losses.
- AHPND which began in 2009, had quickly spread to several countries across Asia and it is still a major concern for shrimp farming across the world.
- WFS has become a growing problem, causing significant damage, during the culture period in several shrimp farming countries, including Southeast Asia and India. There are two types of WFS, one is recoverable caused by *Vibrio* or other bacteria, and the other with WFS in combination with EHP. Since the hepatopancreas will be permanently damaged, shrimp will suffer from many infections without being able to recover or resume growth.
- Alongside, these three diseases, white spot syndrome virus (WSSV) is still a major disease in Asia as well as globally.

EHP microsporidia form spores within the hepatopancreas cells, and absorb nutrients. "In laboratory co-habitation studies, we could induce EHP transmission via faeces of infected shrimp. Here we placed the infected shrimp inside a net suspended in a tank, with healthy shrimp in the tank.

After 24 hours, the healthy shrimp became infected and once infected, the shrimp will stop growing by about 70%," said Loc. For example, the average daily growth (ADG) of vannamei shrimp is about 0.3 - 0.35g/day; it may be reduced to 0.1g/day with an EHP infection.

A survey of post larvae, grow-out shrimp in ponds as well as broodstock feed (including bloodworm, oyster and squid) and broodstock faeces found that both EMS and EHP pathogens originated from the feed. Pathogens in live feed were transferred to the broodstock and then infected eggs, nauplii, post larvae and finally transferred to grow-out shrimp.

"A growing infection rate in both post larvae and juveniles was observed, indicating that pathogens can accumulate in the system which includes hatchery and shrimp ponds."

Additional Loc added that the systemic infection of Vibrio (such as Vibrio harveyi causing muscle necrosis) seems to increase (see box on page 39).

#### **Controversy on pathogens of WFS**

Typically, WFS affects shrimp at 30+ days of culture (DOC) and has been closely associated with eutrophication, algal bloom/crash and bad feeding management. "There is a lot of controversy about the causes of WFS," said Loc when presenting what his team has discovered so far.

"We worked hard on a bacterial etiology theory and isolated different types of bacteria from the gut of WFSinfected shrimp. We enriched and cultured the bacteria, and then soaked the bacteria in shrimp feed before feeding the feed to experimental shrimp. WFS was observed at a certain level and it was clear that bacteria at high density, is the direct cause of WFS.

Interestingly, we also found that shrimp affected with EHP will likely also have white faeces. So, what is the real cause of white faeces?"

"Subsequently, in an EHP infection study in a very clean environment where shrimp was fed with feed containing antibiotics to intentionally kill the bacteria, white faeces was not seen much.

However, pre-infection of EHP may result in white faeces in a later Vibrio challenge because the EHP infection causes damage to the hepatopancreas, allowing for any secondary bacterial infection. This is the reason why there are shrimp with WFS in EHP-infected ponds."

Loc underlined that typically, if samples were collected from shrimp grow-out ponds and tested for EHP, it is very likely that there is a 60% chance of a positive result.

#### The above is the general scenario with diseases in many shrimp farms. However, what is the situation in India, Thailand and Indonesia, going back to 2014 when AHPND first came onto the scene in most of Asia?

**RB:** Both WFS and EHP are widespread across India with outbreaks increasing at 10-15% yearly, since 2014. This year, 60% of farms are affected by WFS and I can divide this up as 40% of farms with infections at DOC 50-60 and 20% after DOC 20-30. In the latter, EHP was transmitted to WFS infected post larvae. EHP could be transmitted through untested post larvae. Poor sampling of post larvae and transport methods could affect accuracy of results.

Feed conversion ratio (FCR) as well as production costs, are increasing while survival rates are declining. When I

compare shrimp productivity per billion of post larvae, both productivity and the percentage of the crop success rates are declining year by year. Since 2016, we see that irrespective of the stocking density, there is a drop in survival rate.

**SP:** Thailand has seen less outbreaks of AHPND and it does not create huge damage to production as before. However, cases of WFS and EHP are increasing and they come together. We not only see an increase in the number of WFS cases, but they are detected earlier; detections used to be at DOC 60-70, but now it is as early as DOC 35.

We also found that most WFS-infected shrimp were previously infected with EHP. The infections may have come together with the post larvae or shrimp infected after stocking in EHP infected-ponds in the last crop. EHP or WFS infections will be higher and occur earlier in ponds which have not been cleaned properly. The estimated increase of these diseases is 5-10% each year.

**HM:** Since 2014, we are noticing that WFS and EHP are affecting more farms in Indonesia. Farmers find WFS difficult to handle as compared to WSSV. WFS does not kill all of the shrimp. Farmers keep feeding them with no significant increase in ADG, resulting in increases in FCR and the shrimp sizes are not as good as expected. Unlike Thailand and Vietnam, AHPND is a new disease, reported in Indonesia in 2019. There is no official data but AHPND is now becoming a very serious problem and it is increasing from area to area.



Loc Tran

#### Among these three diseases which one comes first? If shrimp is infected with one, how predisposed are they with the rest?

LT: We are not dealing with a single pathogen, but multiple pathogens and we see a lot of co-infections. The effect is lowering the animal's immunity and making them more susceptible to other diseases. For example, I thought WSSV was linked to temperature, but I found that more cases were caused by fluctuations in bacteria in ponds or algal crash. We also found that shrimp pre-exposed to Vibrio are more likely to suffer from EHP later and vice versa. We must think about disease management in terms of a big picture, not as a single pathogen.

**RB**: Vibrio and EHP are pathogens associated with WFS. If a disease is caused by Vibrio, then it is treatable. An EHP infection has three levels: stage 1, stage 2 and stage 3. EHP stage 1 is reversible but stages 2 and 3 are difficult to treat even with good management practices, functional feeds and probiotics. **HM:** Yes, I agree. It is almost impossible to find only one disease in our shrimp ponds.

Farmers strongly believe that some diseases and Vibrio like those causing AHPND come from the post larvae. From our experience, the same batch of SPF post larvae from a hatchery cannot guarantee the ponds' success during harvest; some may succeed while others fail. Most farmers know how to identify algal crash and bacteria that will trigger all kinds of diseases.

**SP:** A cocktail of the diseases happens everywhere, including Thailand. In most cases, EHP comes with the post larvae. EHP-infected shrimp are more vulnerable to other diseases (EMS, AHPND, WSSV) or adverse conditions such as heavy rain or plankton crash.

In Thai farms, WFS has been increasing especially during the rainy season, and my investigations show that it has doubled from the previous year's heavy rain or monsoon season. EHP has been increasing in recent years too.

However, suppose shrimp is infected with AHPND, chances for an EHP infection may be less because the shrimp dies first before the EHP symptoms show up. If shrimp is weak from WSSV, it will die before it can show the symptoms of WFS, AHPND or EHP. Today, our first step is to ensure that post larvae are EHP-free to prevent infectious diseases.

"In Thai farms, WFS has been increasing especially during the rainy season. EHP has been increasing in recent years too."



Soraphat Panakorn

## *In India, are WFS-infected shrimp predisposed to RMS?*

**RB:** Most ponds have a combination of both WFS and running mortality syndrome (RMS). However, the difference is that RMS starts when the shrimp reaches more than 25g.

After 20-30 days, it is difficult to continue the culture even up to 10g because survivals are low and the farmer will experience losses. RMS is related to poor pond bottom and water conditions, pond carrying capacity etc.

#### In Indonesia, is IMNV still very prevalent?

**HM:** Shrimp can be infected with WFS and infectious myonecrosis virus (IMNV) but farmers are more concerned with WFS because the mortality is faster and worse than IMNV. Now, farmers are struggling to control WFS and AHPND compared to IMNV, the disease that used to be a huge issue for Indonesia in the past.

# Among these three diseases, which is of most concern for Thai farmers?

**SP:** Farmers worry more on EHP as he needs a microscope to look for spores in the hepatopancreas. But for WFS, over 1-3 weeks, he can see the white faeces floating on the water surface.

#### All three diseases have lowered survival rates, increased forced harvests and culling of ponds as well. What are the real survival rates in your country (discounting the bonus post larvae given by hatcheries) and changes in cost of production?

**HM:** Today, the average survival rate is only 50%, from 70% in the past. Even one or two diseases affect survival.

Production costs have increased from around IDR46,000/ kg (USD3.26/kg) to more than IDR55,000/kg (USD3.90/ kg) for size 45-50/kg. This is because WFS requires constant feeding and increases FCR to 1.8 from 1.4, while EHP causes low growth rates.

**RB:** Based on data collected from more than 800 ponds across India, most incidences of WFS were observed at DOC 50-60, while some were at DOC 20-30. When the shrimp sizes reach 30, 40 and 60/kg, the survival rate declines. Mortalities are slow and unnoticed, the survival rate at harvest is low as well. This causes farmers to harvest the shrimp when they see the onset of WFS and loose-shell (Table 1).

**SP:** For many years, our survival rates have been 80% and above, even when we discount the bonus post larvae. Now, some can reach 70-80% while others can only get 30%; on average, it is about 50-55%.

Both production costs and FCR are increasing as well. This year, we get smaller-sized shrimp that are sold with a lower price and farmers are suffering from production costs that exceed the selling price.

#### Prior to 2014, India is known for large size shrimp. Do you think that today, farmers target smaller shrimp and lower prices because survival rates drop so much after DOC 90?

**RB:** At 10-15g shrimp, I would say that the risk is very low. They do not have problems with survival. When it goes up to the 30-40/kg sizes, there is a drop of 20-30% in survival rates.

The cost of production in a normal pond for size 100/kg is USD2.27, while the pond with WFS has a slightly higher production cost.

### At 30% survival rate, what would be the cost of production in Thailand?

**SP:** The number of farms with 30% survival rate is small but you can see that if production cost is THB100/kg, they can sell only 30% of the harvest. For sure, they lose three times of the production cost!

But it will also depend on the time of harvest. When shrimp sizes are only 200/kg which is the smallest size the market can accept, they can lose 3 the times cost of production. If they continue to grow shrimp and growth is good, they can reduce losses or even cover the production cost or even have some profit margins. " ... Most incidences of WFS were observed at DOC 50-60, while some were at DOC 20-30. When the shrimp sizes reach 30, 40 and 60/ kg, the survival rate declines."



**Ravikumar Bangarusamy** 

#### With increases in cost of production, are farmers hesitant to go back into farming or are they just skipping cycles to reduce losses?

**RB:** No, farmers are slowly implementing better management practices and the use of probiotics. Over the past three years, with Loc Tran, we are developing and fine-tuning the SOP. In our R&D farm, we also follow the regular application of probiotics at 2 to 3-day intervals and we found 20-30/kg size shrimp with no WFS, but with RMS.

The trick is to keep the Vibrio load under control throughout the culture period.

**SP:** Yes, some farmers skip cycles but many just reduce the stocking density. Ten years ago, it was regular practice to manage the harsh condition at the end of each year and the monsoon season by fallowing, reducing stocking density or number of the ponds stocked. But over the past 3-4 years, with new technology and confidence in feed and post larvae quality, many continue farming.

This year, Thai farmers have decided to return to the past practices and even let some ponds or farms fallow because prices are not very encouraging. They prefer to wait and see. With this Covid-19 pandemic, they are also uncertain of the future.

**HM:** There is no choice but to go ahead. But farmers have become more realistic, stocking 100-125 PL/m<sup>2</sup> instead of the usual, 150-200 PL/m<sup>2</sup>. Another change is feeding. Prior to EHP and WFS, farmers push feeding with using automatic feeders or manually to get the maximum ADG. Today, it is lowering the amount of feed to control water quality. They focus on water treatment in reservoirs instead of treating pond water directly.

#### There have been reports of farmers managing by living with all these diseases. What mitigation procedures have worked for them?

**RB:** During pond preparation, we need to address the problem of EHP. Water treatment must change according to farm location. Probiotics application starts at 10-14 days prior to stocking. We have to continue throughout the crop. For example, over the DOC 100, we use water probiotic after fermentation up to DOC 50, i.e. 2X water probiotics: 1X soil probiotics. When feed input is high after DOC 50, it is 2X soil: 1X water probiotics. This is at regular intervals of 3 days. For each application, we only use 100-200g of probiotic after fermentation.

My recommendation is to use anaerobic fermentation and night application for soil probiotic. For water probiotic, the protocol is to use aerobic fermentation and application at 9–10 am.

Here in India, farmers do the first screening with PCR for viruses, but my advice is to do a *Vibrio* test first. Stress test should follow. We have been practising these in the past 2 years and do not have any problem with WFS and EHP in almost six crops in our R&D and customers' ponds.

**SP:** First, the diseases must be identified before they can be treated. In Thailand, we can roughly assume that there is a chance of the eight root trigger factors of WFS: from *Vibrio*, hydrogen sulphide, plankton crash, EHP, antibiotics (if used more than 10 days), some groups of bacteria and gregarine.

These may come as a combination of 2-4 factors and to manage or reduce WFS, identify and fix these factors one by one. With AHPND, when shrimp are molting and are in the sludge area, *Vibrio* will enter the empty stomach, colonise and destroy the hepatopancreas (Figure 3).

Farmers use these methods for shrimp health: select post larvae, nurse shrimp before stocking, lower saline water to avoid AHPND, use good probiotics and frequently monitor the water for bacteria count. Additionally, they remove sludge, use polyethylene (PE) lining and improve dissolved oxygen to ensure a clean pond bottom.

In cases of severe EHP infection, it would be better to harvest when prices are good. When shrimp size is small, farmers mix some easy-to-digest protein like fermented fish into the feed and add trace minerals, vitamins, sugar, salt and probiotics into the soluble feed to improve shrimp health. This makes the shrimp ready for a good size harvest.

"Farmers realise that most incidences are mostly triggered by the blooms, abundance of Vibrio and other bacteria caused by overabundance of organic material,"



Haris Muhtadi

**HM:** Indonesian farmers realise that disease is a combination of the animal and the environment. All hatcheries in Indonesia are using the PCR test as a mandatory test before releasing the fry to the farmer. Farmers realise that most incidences are mostly triggered by the blooms, abundance of *Vibrio* and other bacteria caused by overabundance of organic material. The management practice is to reduce the organic matter loads by chlorination, more water exchange to reduce plankton blooms and more siphoning. In the past, farmers siphon pond bottom after 35 or 40 days, but now they start from 20 days. We are also starting nursery culture (although this is still not popular), to have stronger post larvae after 20-25 days. Stocking density is lower and

during blind feeding, farmers have cut back to only 60-70% of the ration.

**LT:** We can detect EHP in various samples, including broodstock feed, broodstock faeces, nauplii and post larvae. I recommend choosing large-size post larvae for sampling as there are difficulties in detection limits of methods when we sample small post larvae. They should request the laboratory to conduct real-time diagnostic or nested PCR.

### If a shrimp is infected with EHP at below size 100/kg, what is the average growth rate?

**SP:** The ADG would be 0.2g-0.1g. Normal ADG would be about 0.25g up to 0.3g/per day.

#### *If polychaetes fed to the broodstock carry EHP and AHPND pathogens, why do hatcheries still use them?*

LT: Since we do not have a complete artificial diet for broodstock, we still have to rely on locally sourced fresh feed. But often farms discharge water into estuaries, and will contaminate the food chain which includes bloodworms etc. To reduce disease risks in oyster, we can remove the viscera and the feed contents inside, wash well, chop and refrigerate at least overnight. Freezing will kill EHP spores.

One way to reduce the density of pathogens, including bacteria and potential EHP in live polychaetes, is to keep them in flow-through water for at least 12 hours. EHPpositive polychaetes cannot be fed to shrimp but they may be frozen overnight. This can quite successfully control EHP and has been the practice in our hatchery over the last few years. It is laborious but is worth the while.

### Do functional feeds work and if they do, why are they not used often?

**RB:** Functional feeds offer a solution and combining them with stringent feed management practices and the use of probiotics will produce excellent results. The amino acids and protein content are slightly higher than regular feeds.

The farmer should look at the unit cost instead of the cost of the functional feed/kg only. For 10g shrimp, we recommend the feeding rate for 100,000 shrimp at 24-25kg for regular feed and only 18kg for our functional feed. This means that the unit cost for functional feed is much lower.

**HM:** Functional feeds are about 15-20% more expensive than regular feeds in Indonesia, but over a crop cycle, the farmer can apportion into half functional feed and half regular feed. The increase in feed cost is insignificant when using a mix of functional feed and regular feed. More feed millers in Indonesia are introducing functional feeds targeted at various diseases.

### *Is there an association between WFS and soybean meal rich feeds?*

**HM:** I do not believe so. However, phytase or any kind of antinutritional factor in soybean is meal, is suspected to affect the ability of the shrimp's hepatopancreas to digest feed that contains a lot of soybean meal.

**SP:** We found that the most important factor is not soybean meal, but it is the nutrient profile of the feed. Suppose that the nutrition profile is good enough with soybean meal added into the feed, the shrimp can grow significantly. Until now, it has not been proven to be true.

LT: We have worked with different formulations and high inclusion of soybean meal in the lab, but we have not seen any indication that it is associated with WFS. Whether we can formulate the diet well or not, it will affect the shrimp's performance in terms of growth rate. When we start seeing WFS caused by bacteria, our protocol is to produce fermented soybean and use it as a treatment for gut bacterial disease. Using a lot of soybean will make it difficult for the shrimp to digest the feed, so that is why I see more feed mills using fermented soybean meal in their feed instead.

#### Are there any remedial actions against AHPND?

LT: What farmers can do every day is to check the shrimp very carefully, such as during siphoning. If you detect any shrimp mortality, throw a cast net and collect at least 100 shrimp and put them into a bucket with some water where you check the digestive tract, including the hepatopancreas, stomach and midgut, for any abnormalities.

If you find any shrimp with an empty gut and atrophied hepatopancreas, do a simple dissection and crush the hepatopancreas to see if the content within the hepatopancreas turns white. If yes, this is a strong indication that the shrimp might be suffering from AHPND. Next is to follow all appropriate procedures to stop mortality, including reduced feeding, water exchange and application of some prophylaxis.

**SP:** The normal practice in Thailand for identifying infected shrimp is to drop an empty check tray at the edge of the sludge area in the middle of the pond and check it frequently for weak and infected shrimp on the tray.

#### Specific to Vietnam, what are the successful farmers doing right which you can share with the other countries

**LT:** Today in Vietnam, we understand that the disease pressure is very high. We can no longer continue with traditional farming methods. Many farmers are more consolidated and have invested in farm engineering, better farm design, water treatment system and ponds which allow them to have multiple phases.

First, they split farming into nursery and grow-out. They then divide the cycle into four phases, when they see problems. The nursery stage is 25-30 days starting with PL10 and harvesting 1g shrimp. In the nursery, the stocking density could be as high as 2,500-3,000 PL/m<sup>2</sup>. Next, they farm at 300-500 PL/m<sup>2</sup> for another 30 days. In phase 3, stocking is at 150-200 shrimp/m<sup>2</sup>.



Figure 3. The addition of probiotic should help to prevent attachment of pathogenic bacteria.

After completing phase 2, the shrimp is already about 8-10g and after another 30-35 days, the shrimp will reach around 25-30g. They will start partial harvests and continue to 30-40g, 50g or larger or they may transfer the shrimp to a very large pond, an earthen pond and farm shrimp at 50-70 shrimp/m<sup>2</sup> and allow the animal to reach 40g to more than 50g. By doing so, they can significantly reduce the risk of disease, nitrite toxicity (which sets in after 30 days) and vibriosis. We can reduce the damage from EHP and increase growth by transferring shrimp to a larger environment and reducing density.

In earthen pond culture, we follow Ravikumar's protocol. We reduce stocking density from 100PL/m<sup>2</sup> down to 40-50 PL/m<sup>2</sup>. Farmers prepare the ponds properly and some send sludge samples to our lab to test for EHP. If the pond is contaminated, they either line the pond or have a crop holiday. Probiotics are applied regularly.

These are practices by some successful farmers but we still have to spread the success stories to more farmers. It is still a long way to go, but we are seeing a lot of successful farmers in Vietnam nowadays. In conclusion, there are several takeaway messages from this conversation.

- There is no one major disease problem. It is always a combination of diseases that causes the mortality such as AHPND, WFS and EHP. EHP remains the most challenging at the moment. EHP could occur without co-infections with WFS and if shrimp are infected with WFS, there is high probability of EHP infections too.
- Multiple phases and adapting suitable stocking densities are mitigation strategies. Reduce stocking densities during stressful weather conditions.
- Detect diseases early with continuous sampling and monitoring. Do not wait for mortality or slow growth to set in.
- Functional feeds are not a silver bullet. It can only work in a holistic manner with good pond management practices.
- Evidently, the presence of WFS is linked to pond environment; disease management must be in terms of a big picture, not just for individual pathogens.

The video on the complete conversation is available at www.tarsaquaculture.com

Normal Ponds			WFS Ponds								
Shrimp size/kg at harvest	100	80	60	40	30	Shrimp size/kg at harvest	100	80	60	40	30
Average Survival Rate (%)						Average Survival Rate (%)					
Andhra Pradesh	93	90	82	75	66	Andhra Pradesh	91	82	69	59	54
Rest of India	90	87	78	73	65	Rest of India	82	78	63	54	46
Average	92	89	80	74	66	Average	87	80	66	57	50
Feed Conversion Ratio						Feed Conversion Ratio					
Andhra Pradesh	1.00	1.13	1.26	1.41	1.60	Andhra Pradesh	1.15	1.28	1.50	1.80	2.05
Rest of India	1.00	1.19	1.31	1.52	1.67	Rest of India	1.16	1.32	1.56	1.90	2.19
Average	1.00	1.16	1.29	1.47	1.64	Average	1.16	1.30	1.53	1.85	2.12
Cost of Production (USD)						Cost of Production (USD)					
Andhra Pradesh	2.27	2.49	2.72	3.17	3.68	Andhra Pradesh	2.63	2.97	3.44	4.04	4.51
Rest of India	3.04	3.25	3.47	3.81	4.22	Rest of India	3.43	3.58	3.95	4.25	4.74
Average	2.66	2.87	3.10	3.49	3.95	Average	3.03	3.28	3.70	4.15	4.63
Average DOC in Normal Ponds	65	74	88	116	143	Average DOC in WFS Ponds	74	86	105	133	160

**Table 1**.Summary of crop analysis conducted by the Growel Feeds team. Stocking density ranged from 30 to 43PL/m²Copyright Growel Feeds Pvt Ltd, India.

#### Results from the three poll questions at the TARS Leading Conversations

Poll 1: Which is the biggest threat to your business?			Po fu pr wi
AHPND	36%		0%
WFS	31%		1-
EHP	33%		5-

Poll 2: Would farmers use<br/>functional feeds? If so, how much<br/>premium price would they be<br/>willing to pay?0%9%1-5%48%5-10%43%

Poll 3: Due to diseases, how much has your costs of production increased?

0-10%	10%
10-20%	33%
>20%	57%