INTENSIVE SHRIMP CULTURE IN INDOOR TANKS USING HETEROTROPHIC METHODS

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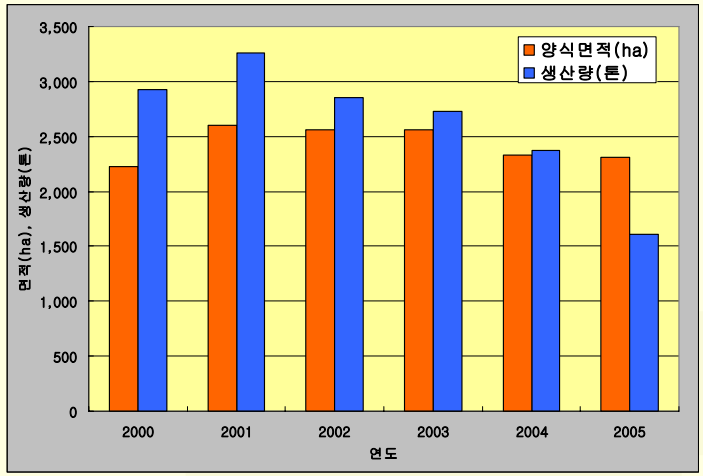
SHRIMP FARMING IN KOREA

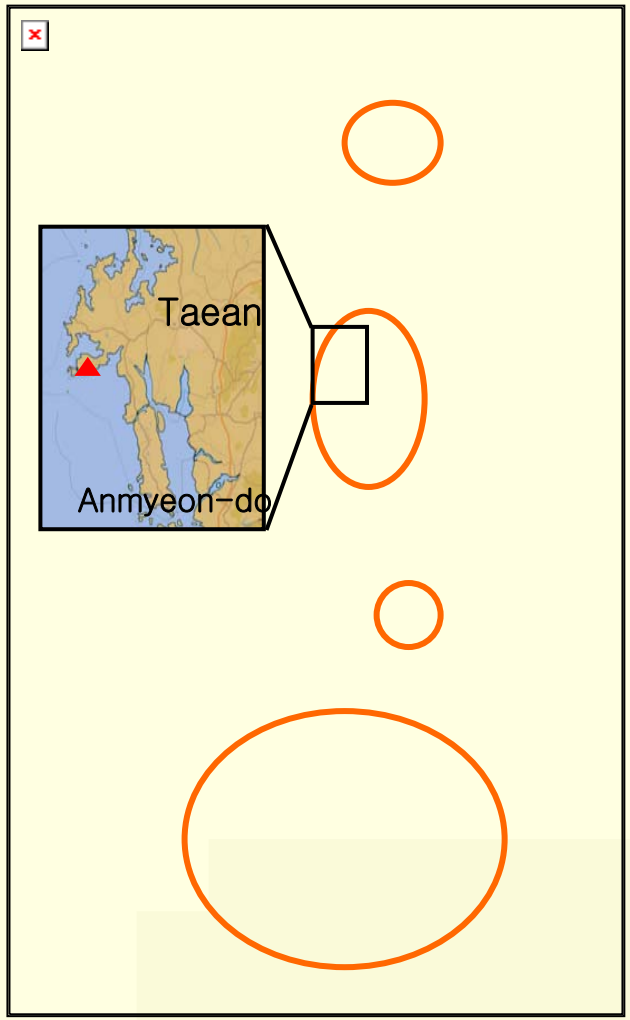
- Shrimp farming in Korea was developed in 1980s.
- Farmed shrimp production rapidly increased since the 1990s
  - 3,256 MT from about 2,600 ha of 437 farms in 2001
- However, due to more frequently occurring outbreaks of shrimp diseases, the farmed shrimp production decreased to 2,332 mt in 2004.
- Unit production (MT/ha)
  - 1.25(2001), 1.11(2003), 1.07(2003), 1.02(2004)



- Two native species, *Fenneropenaeus chinensis* and *Marsupenaeus japonicus* were cultured before the mid-1990s
- *M. japonicus* has not been cultured since the first outbreak of WSSV in 1993.
- White shrimp was introduced as an alternative of *F. chinensis* which was suffered from viral diseases
- In 2003, SPF (specific pathogen free) broodstocks of Pacific white shrimp, *Litopenaeus vannamei* were introduced from Hawaii to the West Sea Mariculture Research Center

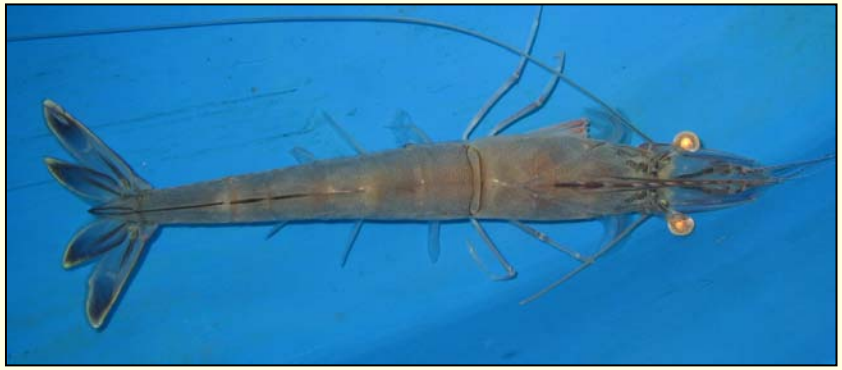
MAJOR CULTURED AREAS IN KOERA

- About 95% of shrimp farms located in the west coast of Korea.
- More than 70% of farmed shrimp produced from Jeollanam-do



SPECIES OF FARMED SHRIMP IN KOREA

Marsupenaeus japonicus
(Kuruma shrimp)



Fenneropenaeus chinensis
(fleshy shrimp)

Litopenaeus vannamei
(Pacific white shrimp)

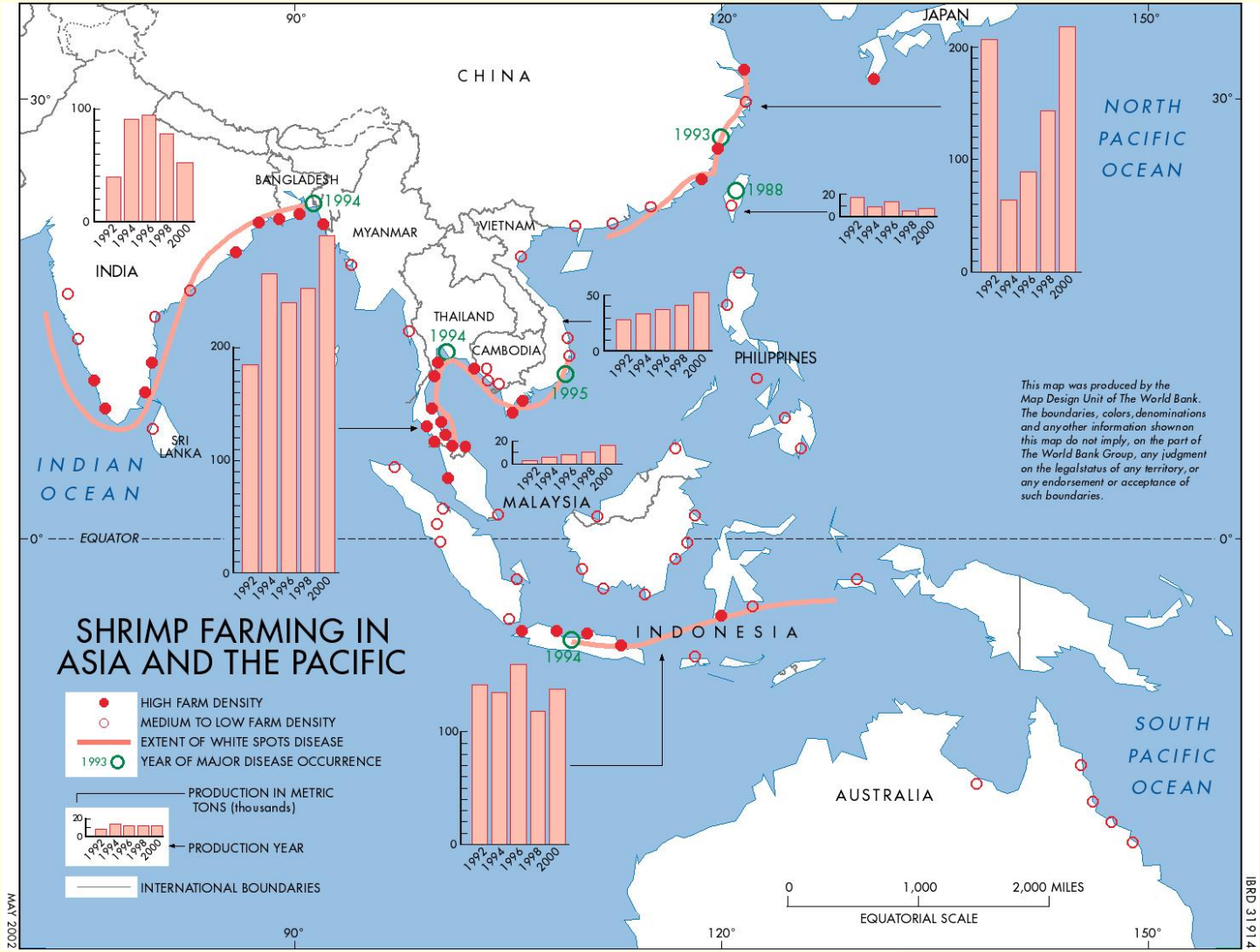
PROBLEMS OF SHRIMP FARMING IN KOREA

- Culture of white shrimp has been increased during last three years and the farmed production occupied about 28% of total farmed shrimp production in 2006.
- About 10,000 SPF broodstocks imported from Hawaii for larval production in 2007 (> 70% of total shrimp culture)
- Although the white shrimp is known to have higher resistance to diseases than the fleshy shrimp, postlarvae (presumptive HHS) produced from SPF broodstock might be easily exposed to viruses in outdoor ponds and many farmers can experience heavy crop-losses due to viral outbreaks.
- Thus there is a need for the development of new production practices that are sustainable and biosecured

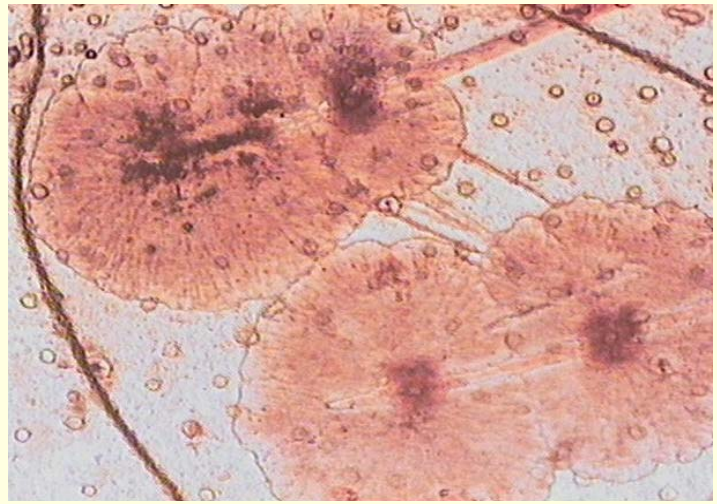
MAJOR VIRAL DISEASES OF FARMED SHRIMP

- HPV (Hepatopancreatic Parvo-like Virus) from *F. chinensis* in 1991
- BMN (Baculoviral Midgut Gland Necrosis) from *M. japonicus* in 1991
- WSSV (White Spot Syndrome Virus) from *M. japonicus* in 1993
- IHHNV (Infectious Hematopoeitic and Hypodermal Virus) from *L. vannamei ?*
- TSV (Taura Syndrome Virus) from *L. vannamei ?*

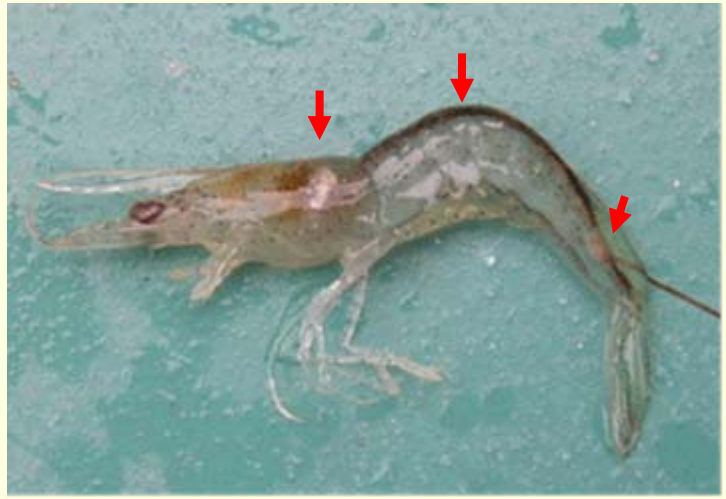
Map showing shrimp culture areas in the Asia-Pacific and the extension of WSSV



Clinical signs of WSSV



Clinical signs of other viruses

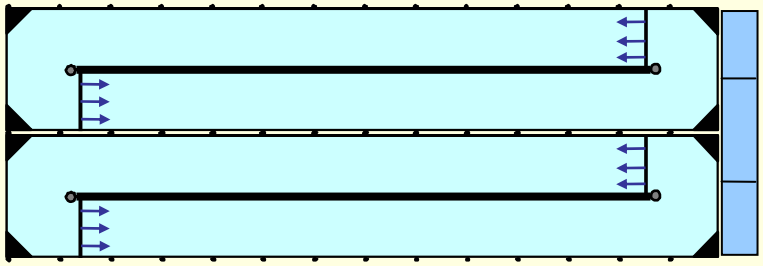


ALTERNATIVE TECHNOLOGIES FOR SHRIMP CULTURE

- Indoor shrimp culture may be an alternative technology which can keep high biosecurity and minimize the risk of viral infection from environment.
- There are three kinds of indoor culture methods for shrimp production.
  - RAS (recirculating aquaculture system) which consists of grow-out tanks for shrimp and separate biofiltering facilities, like as traditional finfish RAS culture.
  - Flow through tank culture system which is applied to shrimp production in commercial scale in China.
  - No water exchange system using heterotrophic management of water

RAS (Recirculating Aquaculture System).

- Consisting of grow-out tanks and separate biofiltering tank
  - MegaFlow system in Israel
  - HBOI (Harbor Branch Oceanography Institute)
  - OI (Oceanic Insitute) in Hawaii
- Water exchange 0.5%/day
- High cost for construction and operation
- Production 2-4kg/m^2 (2 crops/y)



Flow through tank culture system, China

- Commercialized in nothern China
- Concrete tanks in greenhouse (500-1,000MT)
- Using probiotics
- Underground water or heating by coal or sunlight
- High cost for heating : water exchange 5%/d
- Production 4 kg/m^2 , 2 crops/year

NO WATER EXCHANGE SYSTEM BY HETEROTROPHS

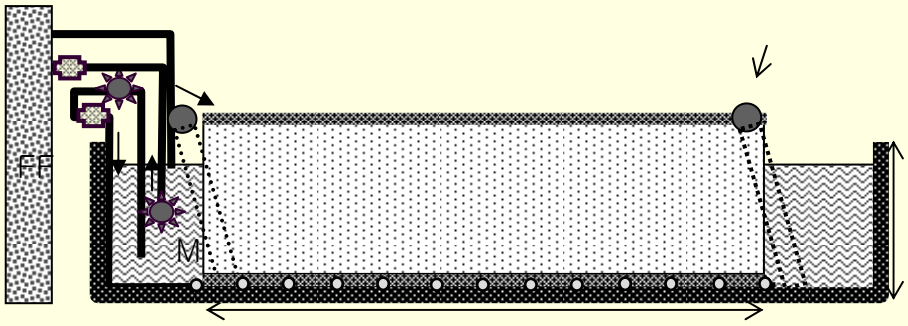
- This system consists of grow-out tanks or raceways equipped with air blower and solid removal facilities such as foam fractionator.
- In this system, entire nitrogen cycle (removal of toxic nitrogen compounds) takes place in grow-out tanks where bacterial flocs are intensively developed.
- Current technology advancement suggests that yields higher than 8 kg/m^3 are feasible in commercial scale production systems using this method.

No water exchange system, WMC, U.S.A.

- Operating system in commercial scale (282m^2)
- Bead filter for removing sludge
- Oxygen generator, air blower, AquaMats
- Maintaining heavy bacterial flocs (hetertrophic bacteria)
- Production 6-8kg/m^2 (2.5crops/y)

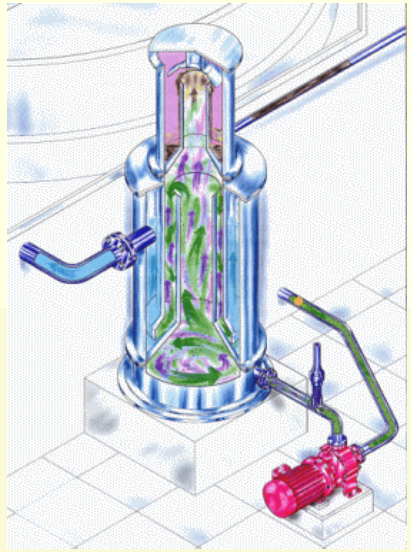
No water exchange system by heterotrophic management, WSMRC

- Raceway or circular tanks (18-30MT)
- Limited water exchange < 0.5%/day
- Equipments
  - Air blower with water injector system, foam fractionator, air lifts, oxygen generator
- Maintain rich bacterial (heterotrophic) flocs by high C/N ratio
  - Add molasses as carbon source



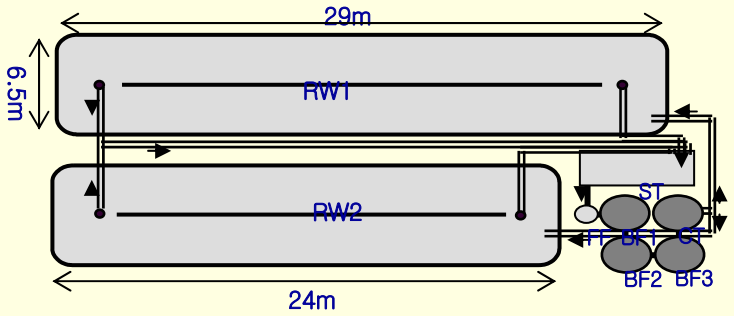
- Nursery culture
  - Stock 2,500-5,000 PL/m^2 (PL5-PL10)
  - Harvest 2.5-4kg/m^2 (BW 0.5-1g)
  - Survival > 90%

- Grow-out culture
  - Stock 500 juvenile/m^2
  - Survival 80-90% (BW 18-21g)
  - Harvest 4-5kg/m^2
  - FCR < 1.5



IMPLEMENTATION OF NO WATER EXCHANGE SYSTEM

- Goseong in the east coast
- RAS for culture of *F. chinensis* in 2003
- Heterotrophic method for *L. vannamei* since 2004
- Size of growout tanks : 190, 160, 300m^2
- Production about 4 kg/m^2
- Price of shrimp 25-45 US$/kg



Comparing different culture systems for shrimp production

	Outdoor pond (Autotrophic)	RAS	Heterotrophic system
Cost of construction and facilities	Low	High	Medium-high
Operation cost (esp. energy)	Low	High	High
Stability of seawater	Low	Medium-high	High
Biosecurity from pathogens (viruses)	Low	High	High
Technology for managing culture water	Low-medium	Medium	High
FCR	High >1.5	Medium > 1.5	Low < 1.2
Grwoth rate	Low	Medium	High
Crops per year	1	2-2.5	2-2.5
Productivity(kg/m^2/crop)	0.3-0.5	2-4	4-8

Problems to be solved…

- High cost for construction and facilities
  - Use circular PE tanks in hatcheries
- High operation cost
  - Energy : well insulated greenhouse, underground water, discharge water of power plants
  - Oxygen : efficient design for air providing system
- Lack of knowledge and experience
  - Training farmers through implementation research project
- Lack of infra-structure of SPF seeds and feeds of good quality

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