Penang Sangam High School
P.O. Box 44, Rakiraki
Year 13 Agriculture Lesson Notes Week 20

Strand	**AS 13.4 Livestock Production**
Sub-Strand	**AS 13.4.1.1: Crabs**
Content Learning Outcome	**Explore and outline the classification, species and the major groupings of Crabs in Fiji.**

Lesson 1: **Classification, Species and Crab Major Identification Grouping**

Classification
Livestock: Crabs
Phylum: Arthropoda
Class: Malascostraca
Order: Decapoda

Species common to Fiji
1. *Scylla serata*
2. John garth ia lagos toma yellow crop
3. Yellow Fiddler Crab (Beqa Island, Fiji)
4. Coconut crab (*Birgus latro*) (Cikobia Island, Fiji)

Mud crab species	Common habitat
Scylla serrate	Associated with mangrove forests with full salinity oceanic water for the greater part of the year. Can tolerate reduced salinity
S. tranquebarica	Associated with mangrove forests and coastlines with reduced salinity seawater for part of year
S. paramamosain	Associated with various habitats including shallow coral rubble; shallow sub tidal flats and estuarine ponds; mangrove forests
S. olivacea	Associated with mangrove forests and coastlines with reduced salinity seawater during the wet season

Different markets defer in their demand for crabs, some according to species, and others according to the growth stages, production stages or sex (male/female) of the crabs.

Lesson 2: **Site Selection**

Inter moult periods - when the exoskeleton becomes much harder through mineral and protein deposition.

Marine detritus - organic material suspended in water and piled up on seabed floor, which is referred to as marine snow.

Mud crab diet in the wild consists mainly of marine detritus, mollusks, crustaceans and fish, the importance of which to their diet appears to vary with location.

As feeding rates are temperature dependent, lower feeding rates can be expected in the cooler months and may in part explain longer inter moult periods observed during winter months in the more temperate extent of mud crab distribution, where nutrient reserves may become limiting.

Site Selection - based on land availability, cost, existing infrastructure and proximity or logistical connections to grow-out areas

1. **Hatchery**
   - unpolluted source of marine seawater and freshwater
   - ability to discharge treated hatchery waste water
   - land suitable for construction of hatchery buildings
   - access to reasonable transport arrangements for staff and products

The more oceanic the source of marine water, the better, as this reflects the offshore water conditions under which mud crab eggs hatch naturally.

2. **Grow-Out Pen** - similar to that of prawn

3. **Mangrove pens**
   - construction to be in areas already known (either currently or historically) for their good production of mud crabs from a wild fishery
   - areas with relatively low tidal ranges are preferred

If there is an extreme tidal range, pen construction should be higher to contain crabs on high tides and stronger to withstand higher current.

Low- to medium- density mangroves is preferred because denser stands of mangrove will be more difficult to construct pens in.

Lesson 3: **Nursery Design Options**

Megalopae - the final larval stage found in decapod crustaceans

Crablets - baby crabs

Hapa nets - a cage like, rectangular or square net impoundment placed in a pond for holding fish for various purposes. They are made of fine mesh netting material.

Zooplankton - small floating or weakly swimming organisms that drift with water currents

Environmental Parameters for Nursery Culture

- wide range of temperatures and salinities.
- temperature of 30˚C optimum and salinities of 10 – 25 ppt.

Nursery Design Options

1. **Tanks**

- surface area of tanks is most important.
- rectangular, with a flat base constructed from concrete or fiberglass
- sloping floor to a sump (simplifying drainage)
- provision made for the supply of fresh, saltwater and aeration

Issue

- tanks exposed to the elements
- overheating of tank water esp. in hotter months, which can lead to high mortalities of crablets
- changes in salinity from heavy rain could stress crablets and lead to increased mortality rates

Solution

- nursery tank systems to be covered with an overhead roof to filter out direct sunlight and also prevent rain entering the tanks
- various materials can be placed or suspended in nursery tanks providing three-dimensional shelter, which increases the surface area available for settled crabs
- materials that can be used include bunches of netting, leaf fronds, straw, PVC off-cuts or artificial sea grass

2. Net cages (hapa nets)

- square or rectangular net cages (or Hapa nets) typically of 1–2 mm mesh opening, are set in earthen ponds
- the base of the net buried into the bottom of the pond
- ponds should be used or designed so that a water depth of 80–120 cm of water can be maintained to support moderate water temperature fluctuations and steady plankton populations
- zooplankton populations to be established in ponds to provide feed for megalopae once they are stocked

3. **Earthen ponds**

- ponds may be stocked with Gracilaria, netting, straw or other shelters to provide habitat for crablets
- for net cage nursery culture of megalopae, mixed zooplankton population developed within the pond is the primary food source for the megalopae
- nursery ponds should be surrounded, typically around their banks, by a short fence (height 20–40 cm) constructed of relatively fine mesh (1–2 cm) netting or similar to ensure crablets
cannot move away from the ponds should water conditions in them deteriorate for any reason.
- the fence is made more effective if the top of the net is covered with plastic sheeting, which crablets cannot climb over

Feed

- advanced Artemia (5 days old) at 20–25/ml and formulated shrimp larval feeds
- formulated prawn starter diets (as few crab-specific diets have been developed)
- diets of trash fish
- molluscs can be used to feed crablets
- on-grown Artemia, up to adult size, can also be fed throughout the megalops and early crablet stages
- diets of 45–55% crude protein and 9–15% lipid support optimal growth in crablets

Harvest of Crablets

- harvested from nursery systems after a 3–4-week period and moved to grow-out systems having grown to over 1 cm and to weights up to 0.3 g, at the C3–C4 stage
- in net cages, lift nets with feed on them can be used to attract and harvest crablets
- for the final harvest from a net cage, one end of the cage can be lifted and crablets scooped from the other
- to minimize risk of death in transit, any soft-shell, recently moulted crablets should not be transported until their shell has hardened

Transportation of Crablets

- crablets older than C2 can be transported with or without water
- cooling crablets before transport is recommended to prevent both moulting and lower oxygen consumption during transport
- crablets can also be transported in water using the same method as used for post-larval shrimp or juvenile fish
- out of water, crablets can be transported in containers on moist sand or damp cloth, in containers that are lined and covered to minimize evaporation and resulting desiccation, while ventilated to ensure they can respire adequately
- it is recommended that transport of crablets out of water should not exceed 30 hours

Lesson 4: **Grow-Out Operations**

Preparation for stocking

- ponds should be dried out for several weeks and any repairs undertaken
  - this assists in ensuring any unwanted species are removed from the pond that may be competitors for feed fed to crabs or predate on crablets

- turning over the soil in the bottom of the pond or tilling can assist in preparing the pond for the next crop
  - this helps in the breakdown of organic residues and release of nutrients

- tilling can be combined with the addition of lime to pond floors
  - liming can be used to improve the pH of pond sediments, accelerate decomposition of organic matter and improve fertilizer response

Grow-out Operations

Ponds

1. **Stocking for monoculture**

- mud crabs are stocked at low densities (0.5–1.5 crabs/m2) with survival rates as high as 67%

Semi-intensive operation of ponds are more profitable than extensive systems and that stocking size, as well as feed used have a significant effect on the final bodyweight of mud crabs.

Survival rates of mud crabs in ponds vary considerably, no doubt reflecting husbandry practices, water quality parameters and the quality of stock, with reports ranging to highs of over 70%.

2. **Stocking for monosex monoculture**

Male crabs attain a higher final weight than female crabs

As crabs can usually be sexually differentiated by the time they are at the C4–C6 stage by examination of the shape of their abdominal segments, ponds can be stocked for monosex culture from advanced crablets.

Advantages

- can simplify post-harvest processing
- may minimize aggressive behavior between crabs associated with sexual maturity
- that survival of monosex mud crabs was significantly higher than among mixed sex crabs

3. **Stocking for polyculture**

Mud crabs can be polycultured successfully with species including

- milkfish
- grass shrimp
- *Litopenaeus vannamei*
- tiger shrimp (*Penaeus monodon*)
- Gracilaria spp.

Stocking operations

To assess the quality of a batch of crablets, one should examine the following criteria:

1. Visual health – pick a sub-sample of crablets and examine for
   - fouling
   - unusual coloration
   - damage to legs or claws

2. Size variation – while crablets in any batch may be at different
   - moult stages
   - size

3. Variation should be minimal - extreme variation in size indicates batches may have been combined. Too large a variation in size increases the likelihood of losses to cannibalism.

4. Activity – if crablets have been transported to farm at temperatures less than optimal, they may be sluggish. After equilibrating to ambient temperature, they should be actively walking or swimming.

Grow-out Operations

1. On arrival, crablets (or representative samples of each batch) should be counted to ensure the order has been fulfilled. Crablets can be transported to a grow-out facility with or without water.
If packed in water, they may be cooled to 22–24˚C to prevent moulting on the way to the farm and lower oxygen consumption.

2. At the farm, crablets should be put in basins (or similar containers) with a small amount of water from the pond for which they are intended to acclimatize. Once acclimatized to the temperature of the water and its salinity, they can be released into the pond. For larger ponds, distributing them from several different points around the pond to assist in distributing them evenly around the pond is recommended.

Lesson 5: **Management Practices**

Monitoring Process

It would be useful if farmers can keep basic records for each mud crab pen including:

- date crabs stocked
- number of crablets stocked
- average size of crablets stocked
- supplementary feeds provided per day, including details of the type of feed used
- the weight provided per feed
- an estimate of feed used per day by comparing the percentage of feed left on feeding trays at the end of a feeding period
- average size of crabs (every fortnight)
- any signs of disease
- number and mass of crabs harvested

Uses of these records

• farming mortality rate
• number of crabs harvested/number of crablets stocked
• growth rate

FCR = the ratio of gain in wet body weight of the crab to the weight of feed provided.

Pond Operations

The oxygen concentration of brackish water or saltwater in ponds should be kept above 3 ppm or preferably at 5 ppm.

As mud crabs are currently farmed at densities that can be considered semi intensive, maintaining reasonable levels of oxygen is usually not an issue.

However, it is worth having access to paddle wheels or aerators for ponds to counter events that can occur suddenly, lowering oxygen levels, such as algal crashes within the water column.

Feeds

Mud crabs raised on a variety of diets including low-value/trash fish , slaughter wastes, fish wastes, horse mussels, brown mussels, brackish water snails, shrimp heads, golden snails (Pomacea canaliculata), telescope snails (Telescopium telescopium), small bivalves (Potamorcorbula spp.), animal hides, entrails, kitchen leftovers and formulated shrimp feeds.

It has been shown that S. serrata gain weight faster and moult more frequently on diets containing higher protein (up to 55% of diet) and lipid (up to 15% of diet) levels. The same study demonstrated formulated feeds can produce feed conversion rations (FCR) of 1.2 to 2.1:1 for juvenile crabs.

Related work also demonstrated that by increasing the protein content of mud crab feeds from 25 to 45% there was also a progressive increase in the protein content of crabs.

Lesson 6: **Diseases**

Disease in crabs can cause a major loss in the business if not taken care off. Most of the diseases can be prevented or at least controlled by strict and proper management practices.

Diseases	Symptoms	Prevention
1. Virus		*Strict control of sourcing b rood stock and crablets *Avoid brood stock from areas known to have problems with parasites or disease
Mud crab reovirus (MCRV)	- high mortalities - very pathogenic	
Mud crab muscle necrosis virus	- white muscle - muscle necrosis	
2. Bacteria		
Red sternum syndrome	- red legs and joints - discolored haemolymph	
Chitinoclastic bacteria	- damage of shells of mud crab brood stock over a 3-month period	
3. Parasitic barnacles		
Sacculina granifera	- makes mud crabs unfit for human consumption	
Octolasmis spp.	- infested crab gills - stalked barnacles can have debilitating effect - impacts on respiratory gas exchange	
4. Parasitic		
"Milky disease" "Bitter crab disease" (BCD) "Pink crab disease" (PCD) "Yellow water disease" hematodinium	- white muscle and milky liquid in mud crab - the parasite is in the haemolymph and tissues	

Lesson 7: **Harvesting**

Harvesting done after 3-8 months or once the crab reaches 400 g to 500 g size.

The size at harvest will depend on both the species being cultured and the needs of the markets that any particular farm is servicing.

Male crabs of S. serrata grow to 700 to 800 grams at the maximum .The export size of the crab is 500g and above for males and 250g and above for females.

Mud crab fattening - is most suitable method for small-scale aquaculture because:

- turnover is fast, hence, the period between investment and returns is short
- fattened crabs can be stocked at higher densities (15 crabs/sq m) compared to grow-out systems (1 crab/sq m) as no moulting occurs so losses due to cannibalism are reduced
- short production time reduces the risk of losing crabs to disease so a higher survival rate for fattening (>90%) compared to grow-out systems (40%)

Most markets will take a variety of sizes but offer premium prices for particular types of mud crab.

Premium prices can be obtained in most Asian mud crab markets for females carrying internal eggs, and for very large males with large claws.

As premium prices can be obtained for female "egg-crabs", females may be monitored and are only harvested when mature ovaries (red-orange) can be viewed through the carapace

Harvest techniques

Grading at harvest should be undertaken quickly and unsuitable mud crabs returned to the pond to complete grow-out. Once some of the crabs in a pond are identified as large enough to harvest, harvesting of crabs can commence.

1. Crab pots of various designs can be used to harvest crabs. These are baited with food attractive to crabs. It is found that the largest crabs in a pond tend to enter traps first. As this is the case, ponds can be partially or selectively harvested on a regular basis, progressively removing the larger crabs from the pond. To complete the harvest, either trapping is continued until no more crabs are trapped, or the pond is drain harvested, with crabs collected from the pond's drain or the lowest part of the pond.

2. Harvesting is done with different kinds of trap like the bamboo cage, lift net, scissors net, fish corrals and gill nets.

Lesson 8: Post-harvest Management

Once harvested, mud crabs must be examined, cleaned and stored for transportation to a processing facility, unless this is situated on-farm.

On harvest, tie claws of mud crabs with string or vine to ensure they cannot damage one another or people involved in further processing, distributing and selling the product.

To ensure mud crabs intended for the live crab market are not "empty", "water" or "thin", crabs should be tested and if found to be "empty", crabs should either be returned to the aquaculture facility or sent to a specific crab fattening facility.

If crabs are to be transported to temporary storage facility or processing shed, once taken from the water they are typically stored in a fish crate or container and covered with dampened material (e.g. hessian sack) to reduce desiccation and protect against flies.

Some preliminary sorting (by size, sex or missing limbs) may be done depending on arrangements with the facility that will be doing final processing and packaging.

If mud crabs are to be held for some time before going to processing facility, containers holding the crabs should be kept in the shade and kept moist to avoid dehydration and heat stress. A spray system can be used to keep crabs moist, temperatures moderate and humidity high.

Significant Stressors of Mud Crabs

- ✓ movement (handling, grading and transportation)
- ✓ exposure to breeze (resulting in enhanced dehydration)
- ✓ temperature, either too high, too low or sudden change
- ✓ time, from harvest to processing, and from processing to market
- ✓ respiratory metabolic stress, as they cannot obtain sufficient oxygen
- ✓ starvation
- ✓ accumulation of ammonia

The most useful biochemical indicators of stress in mud crabs have been identified as glucose and lactic acid within their haemolymph, and ammonia excretion (rather than ammonia in the haemolymph) when examined together.

How to Minimize Stress in Mud Crab Supply Chains

- ❖ maintain crabs in a drought-free environment.
- ❖ hold and transport crabs at constant temperature within the preferred range of 25–30˚C
- ❖ maintain crabs under a spray system to retain moisture and temperature
- ❖ dip crabs in aerated water for 2 hours per day enabling them to excrete ammonia (3 hours following extended emersion)
- ❖ utilize a recovery tank to hold mud crabs under optimal conditions for a period of time to regain condition prior to continuing along the supply chain
- ❖ cover or wrap mud crabs in damp-hessian-lined container to reduce moisture loss
- ❖ avoid draughts and maintain temperature
- ❖ handle gently

Receiving Mud Crabs into a Processing Facility

Processing area should be clean, tidy and organized ready to commence processing without delay.

Once containers of crabs have been moved into the processing area, doors should be closed to maintain temperature and exclude flies or vermin.

As crabs are then processed, details of the receipt will be transferred to the grading, sorting or processing form, to ensure the traceability of product through the facility.

Processing

Before grading commences, the cool-room or processing shed needs to be properly organized, with appropriate items organized, which include crates (for different grades and rejects), packing tables, rubbish bins, weighing scales, pallets and forms.

The facility should be setup according to the documented quality control system.

On arrival in a processing facility, crabs are usually rinsed to clean them prior to assessment by processing staff.

The Grades

Grades A, B, Top-quality, vigorous crabs with both claws intact and strong leg and antennae movement are the premium grade of hard-shell crabs for the live market.

Often, this grade is further sorted by sex and size (e.g. small, medium and large). These grades would then be packed into separate boxes, if the market demands them to assist in marketing and also important if different prices are given to the different grades.

In addition, larger female grades may be further assessed to see if they are carrying ripe ovaries and can be classified as "egg crabs", another premium product.

The status of a female crab's ovaries can be seen by holding it up to a strong light, the eggs being visible through the carapace.

One claw- While a top-quality crab, from a health perspective, a one-clawed crab is not seen as a premium product in some markets, and will usually receive a lower price. As such, it is usually separately graded and packed.

Slow - A mud crab is deemed to be "slow" if its legs do not move when it is handled, or its legs brushed and will not walk if placed on a surface. Included in the same grade are crabs that show "bubbles" from around the mouthparts. Such crabs are likely to die in transit.

Handling

Handling mud crabs is a critical stage in the supply chain. All employees involved need to be adequately trained in basic hygiene and food handling with regards to their personal responsibilities (e.g. washing, protective clothing, diseases).

Procedures must be developed to minimize the risk of mud crabs being contaminated. These include ensuring that the product is:

- ✓ handled on surfaces that are clean and sanitized
- ✓ protected from contamination
- ✓ not exposed to disease (from staff)
- ✓ only handled by staff following rigorous and effective washing
- ✓ detailed, site-specific procedures documented and regularly checked by supervisory staff

Packing

For local, domestic markets, mud crabs can be packed in plastic crates or containers of various descriptions. However, for export markets involving airfreight, wax-lined cardboard boxes, with ventilation holes at each end of the box are commonly used.

Crabs should be packed so that claws are not facing the outer edge of the box, with head and claws tilted towards the top of the box. This minimizes the risk of mud crabs becoming partially untied during transit

and pushing their claws through box walls, potentially damaging freight handlers.

Each box should be clearly identified as to the grade of crab, the packer's number (to ensure the accountability of the packer), receiver's number (for traceability), date and total net weight of mud crabs packed. Prior to shipment, boxes should be stacked neatly on pallets or similar.

Transportation

The best processing of mud crabs can be ruined by poor procedures and practices during the transportation process to market. The more steps there are in the transportation process, the more difficult it is to manage.

Lesson 9: Uses of Crabs and their By – Products

Uses of Crabs

- food
- tourist attraction

Uses of Crab By-Products

- crab meal for livestock/ shrimp
- shells for decorations
- fish bait
- horseshoe crab blood can detect and trap bacterial toxins
- blood is harvested for a test to ensure medical products are not contaminated