

Week 12. Harvesting and grading/sorting of fish

Methods of harvesting naturally depend on the culture system, the species cultured and the form in which the product is to be marketed. Properly designed fish ponds have special provisions for draining and easy harvesting, whereas in pens and similar enclosures suitable nets and other fishing devices have to be used.

In open-water stocking and ranching, fishing equipment used in capture fisheries is the common choice. Harvesting is usually the most labour-intensive operation in an aquaculture farm, apart from its construction, so there have been attempts to introduce as much mechanization as possible in order to reduce labour.

Harvesting from drainable ponds is relatively easy, if there is a harvesting sump or similar device. In a nursery or fry-rearing pond it is almost essential to have a harvesting sump to avoid injury to fry or fingerlings during harvest.

Drainage is performed at a rate suited to the size of the outlet and the drainage channels, and the fish are concentrated in the harvesting sump. From the harvesting sump, the fish can be collected by loading equipment, if necessary with the help of a net. In case the harvesting sump is considered too small for the quantity of fish, it may be necessary to combine seining and draining to harvest the fish in good condition.

Some of the fish may be seined and the rest caught in the sump. When live fish are marketed, it is useful to spray fresh water or aerate the water in the sump, to avoid weakening or mortality of the fish.

Harvesting cage and raceway farms

It is comparatively easy to harvest stocks from intensive culture systems, particularly tank and raceway farms. They can easily be drained partially or completely as required and the animals removed by dip nets or suitable mesh.

Harvesting from cage farms can be a little more complex, depending on the location and size of the cages. Except in the case of small cages, it will not be practical or advisable to lift them for removing the stock. In many cases it may be possible to tow the cages to the shore is not feasible, boats may have to be used.

When the farm has central or peripheral walkways, it is easier to raise the cages and remove the animals. But even then, some producers prefer to use seines to gather the fish and, in large farms, pumps may be used to transfer the fish to the loading area. In salmonid cage farms in Norway, feeding is stopped for a period of about a week before harvesting. This is done to empty the alimentary canal, so as to prevent quick deterioration and also to 'firm up' the flesh. During harvest the fish are removed very carefully to avoid bruising the skin and meat.

Special care is taken to avoid undue stress to the fish during harvest, as meat quality is known to be affected by stress. Generally, the fish are transported by live-hauling boats or in plastic tanks installed in boats or trucks.

Grading fish into groups of similar individual sizes is a common management practice in fish farming.

2. You may need to grade:

- when harvesting juvenile fish, before stocking them in fattening ponds;
- when separating faster- from slower-growing stock, for example male and female tilapias;
- during the early life of predatory fish when the range of sizes becomes too large;
- when selecting predatory fish for a suitable size to use for controlling fry populations;
- when selecting fish of a suitable size for polyculture;
- when harvesting a pond where fish of various ages and sizes are present;
- during partial harvesting, to select the fish which have reached market size.

3. Grading has **several advantages**:

- reducing fish losses through cannibalism;
- improving supplementary feeding efficiency through adequate food ration;
- increasing the accuracy of stock estimates for monitoring (see Section 16.0);
- reducing the proportion of small fish at harvest of fattening ponds;
- increasing production, for example by increasing the proportion of faster growing males in tilapia ponds.

4. **Fish sorting** usually involves separating a mixed group of fish into different species, males and females, immature and mature fish, diseased and clean fish, etc. This is often done at the same time as grading and usually needs more skilled people.

5. **The sorting of fish into groups of the same species** occurs only when different species of fish are farmed together. At harvest, either for stocking as juveniles or for marketing as food fish, the fish are first sorted by species before being graded, if necessary, by size.

Note: fish may also be **sorted according to sex**, for example when stocking fattening ponds for monosex culture of tilapia males or when stocking breeding ponds with a specific ratio of males to females.

6. It is always best **to grade and to sort live fish** some time after harvest to give them a chance to overcome their stressful experience. First hold the live fish in a good storage place for a few days before handling them again. If the **fish are not to be sold alive**, they can be sorted and graded either during or immediately after harvest.

7. If smaller batches are involved, you may be able to sort and grade immediately, preferably during cool conditions. Fish should be handled as little as possible and taken rapidly to their recovery areas.

Grading or sorting your fish

8. **Sorting fish by species** is best done on a sorting table (see Section 12.1). For resistant fish such as warm water fish in general, this method can also be used **to grade fish by size**. But there are also several other simple ways to grade fish by size which you will learn later (see Sections 12.2 to 12.7). Select the most appropriate grading method according to the accompanying chart.

Simple methods for grading fish by size

Type of grader	Size of fish			Fish to be kept		Section
	Very small	Small	Large	Alive	Not alive	
Sorting table	—	●	●	● ¹	●	121
Calibrated container	●	●	—	●	—	122
Net	—	●	—	●	—	123
Harvesting structure	—	●	●	●	●	124
Grading trough/basin	—	●	●	●	●	125
Floating grading box	—	●	●	●	●	126
Mechanical grader	—	●	●	●	●	127

¹ Only for fish resistant to out-of-water handling, such as most warmwater species

12.1 How to sort and grade on a sorting table

Building a simple sorting table

1. You can easily build a simple, portable sorting table yourself or with the help of a local carpenter. You will require the following supplies:

- one piece of 10 to 15 mm plywood sheet, if possible "marine" quality, 130 x 90 cm;
- 15-mm wooden boards, 10 cm wide:

2	pieces	140	cm	long	(A)
2	pieces	87	cm	long	(B)
3	pieces	60	cm	long	(C)
2	pieces	30	cm	long	(D)
2 pieces	20 cm long (E)				

- strong wooden pieces, at least 2 x 4 cm:

4	pieces	105	cm	long	(F)
2	pieces	130	cm	long	(G)
4 pieces 110 cm long (H)					

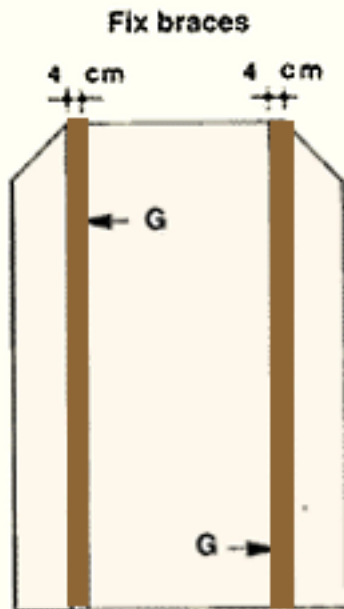
- bolts and nuts: two pieces 8 cm long, 8 mm diameter;
- nails and screws for assembling the table;
- white or grey paint, preferably for swimming pools (thick and plastified), and brush. If this type is not available, use any good quality paint or varnish to seal the surface of the plywood, and attach a well-fitted renewable sheet of polythene to the table top during use.

2. When you have these materials proceed as follows.

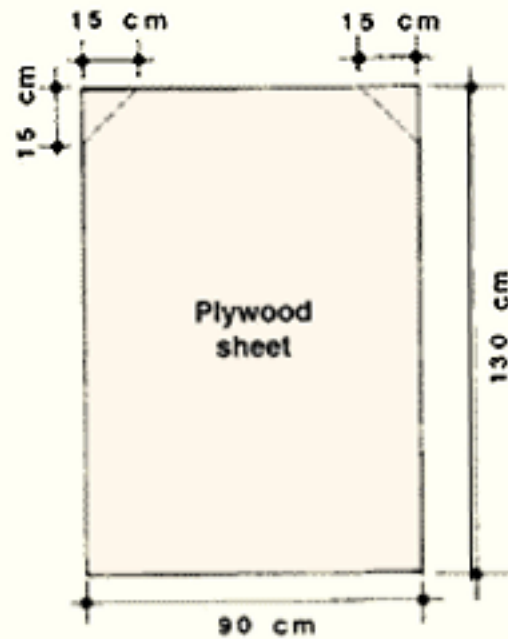
(a) **Build the table top:**

- cut two angles from the plywood sheet as shown;
- fix two braces G to the plywood sheet;
- turn the sheet around and fix boards A and B around it;
- carefully paint the table top and its sides with at least two coats, to produce a very smooth surface.

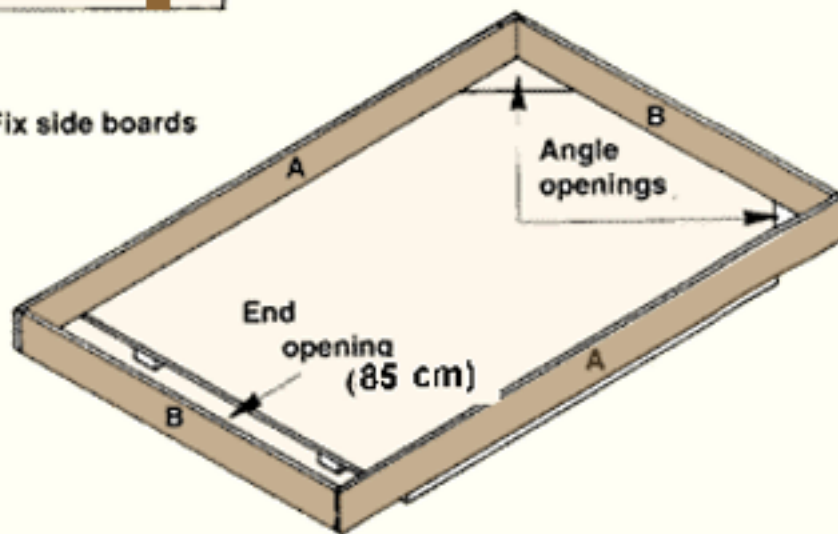
Build the table top



cut angles from plywood



Fix side boards

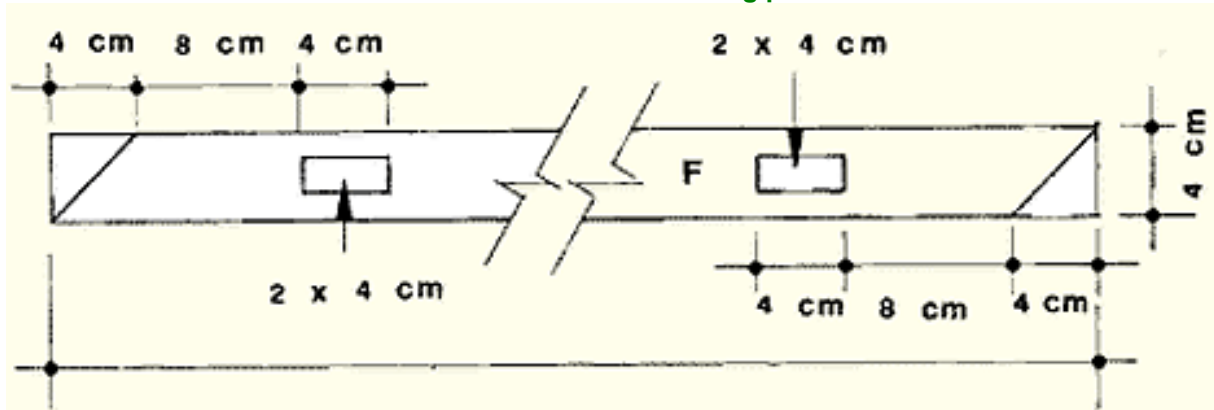


Note: the side boards enclose two angle openings at the upper end of the plywood sheet and an 85 cm-wide opening at the lower end.

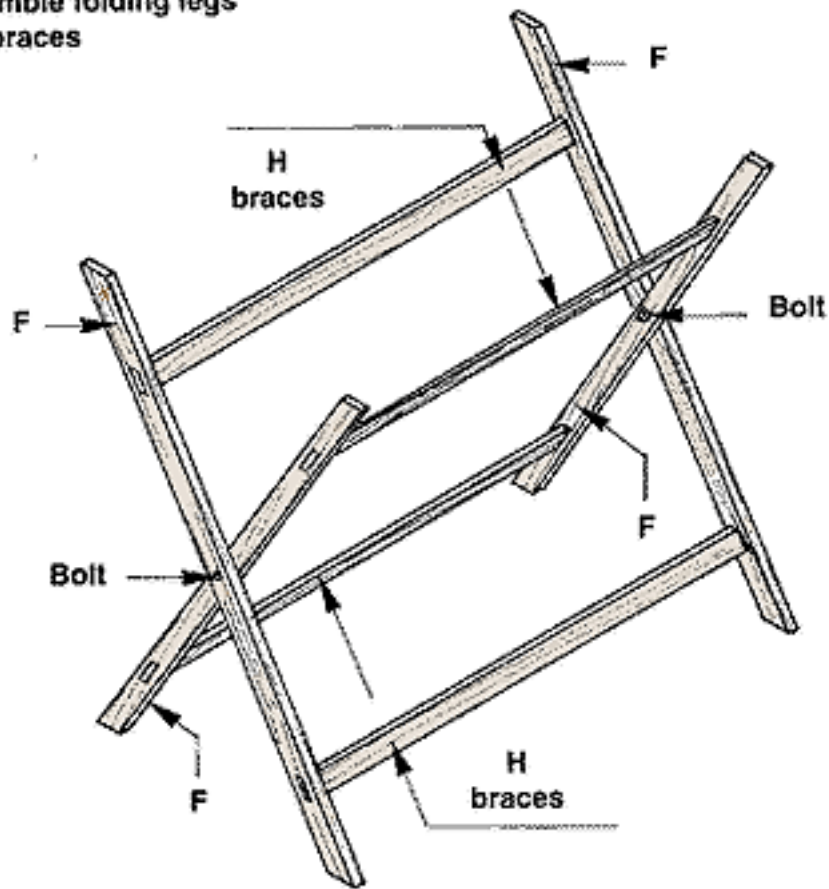
(b) Build the folding legs to support the table top:

- cut out holes as shown from the four F pieces;
- cut the extremities of each F piece at 45° as shown;
- drill an 8 mm hole at each centre and assemble the F pieces, two by two, with bolt and nut;
- assemble the two pairs of folding legs with four braces H, two at the bottom and two at the top of each folding leg;
- paint the support to provide protection.

Trim ends and cut holes in leg pieces



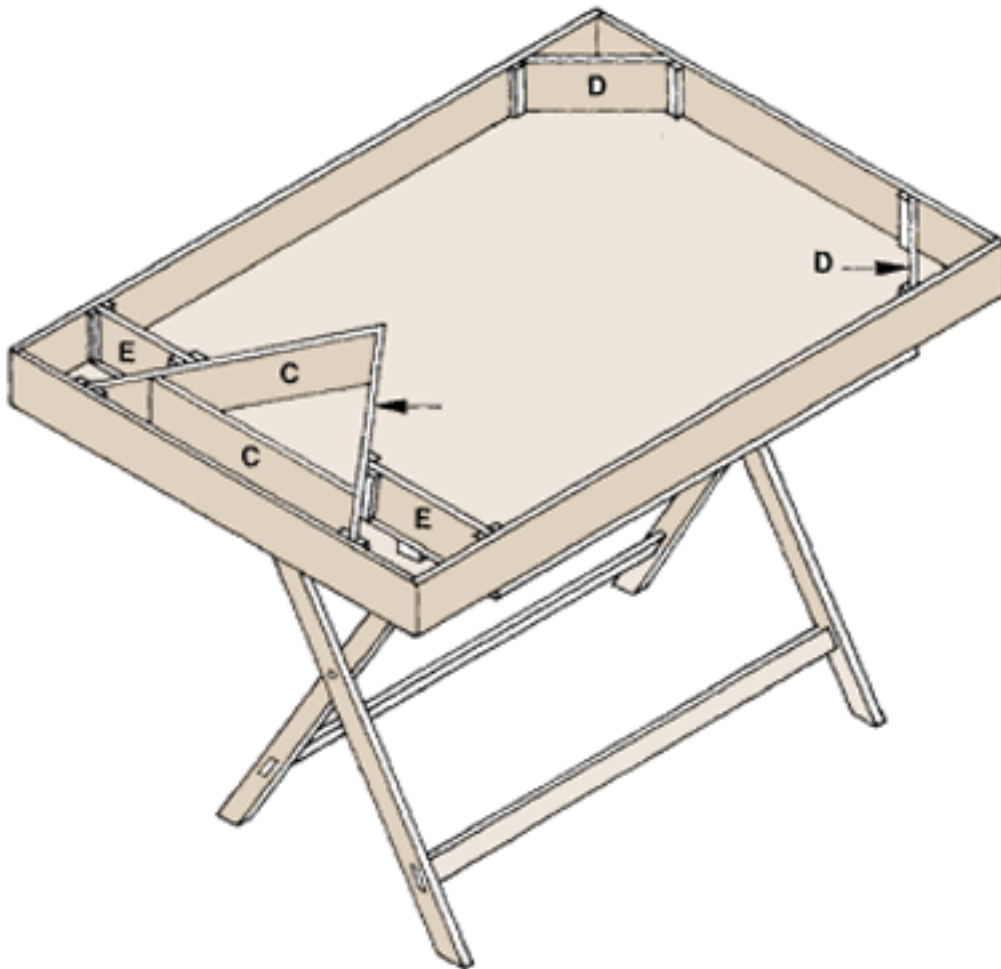
Assemble folding legs and braces



(c) Place removable boards to regulate sorting:

- cut corners of D pieces at a 45° angle;
- assemble C pieces into a triangle;
- place this triangle on the top of the table, along the narrow side opposite to the cut corners;
- cut one corner of each E piece as needed to fit tightly against the triangle and fix blocks to keep these boards from moving sideways;
- paint these boards for protection.

Place removable sorting boards



Note: if necessary, adjust the measurements of the table openings and their blocking boards to accommodate your particular kind of fish.

3. Open the folding legs and place the table top on them, within the underside braces. Your table is now ready to be used for sorting or grading fish into four categories (sizes and/or species).

4. If you have only three categories, remove the triangle and its two lateral boards to open the table end.

Note: this illustration shows all removable boards in the closed position; they can be removed one by one to provide openings for sorting and grading fish from any or all corners or from the full-length lower end opening; place a container with clean, fresh water below each opening to collect the fish.

Using the sorting table

5. When using the sorting table, you should try to keep the fish in good condition. Proceed as follows.

(a) **Set up the sorting table** close to the harvesting site, if possible in the shade.

(b) Before starting, wet its surface well with clean water.

(e) Under each opening of the table, place a container with clean, fresh water, such as buckets, plastic basins or half metal drums which can be used to transport the fish (see Section 14.1).

(d) Use good handling nets with no rough or torn edges.

(e) Bring only small batches of fish to the table at a time. Put them in suitable temporary holding containers, with a regular change of clean water. This also helps to rinse them clean of mud, algae and plants.

(f) Transfer the fish gently on to the top of the sorting table.

(g) Have three or four qualified persons working around the table. The fish should be handled as little as possible and sorted quickly.

(h) **Start sorting:**

- first the large fish, if any, placing them directly in a dip net and into water;
- then the fish which are in the smallest number, sliding them towards one of the corner openings into a container and water;
- then the remaining group(s).

(i) After having sorted or graded this batch of fish, **rinse the table well**, with plenty of clean water.

(j) Place another batch of clean fish on the table and continue sorting or grading.

(k) Move the sorted fish as soon as possible to their recovery or destination areas.

6. At the end of the working day, clean the table well, dry it and store it in a protected place.

Note: the surface of the sorting table should always be perfectly smooth to avoid bruising the skin of fish. Regularly check your table surface and, if necessary, smooth it well with sandpaper and repaint it.

12.2 How to grade fish with a calibrated container

1. This method is particularly useful for smaller fish, which are more sensitive and more difficult to handle than larger fish. The basic idea is to place a group of fish in a container held in water, from which the smaller ones can drop through or swim away through holes of a specific size made in the bottom and in the walls of the container. If possible, the container should be held in flowing water.

2. You may use one of the following:

- **specialty woven baskets**, each of them for fish of a certain size (see chart below);
- **plastic basins** with holes of a uniform size drilled in the bottom and the lower 10 cm of the sides, for example from 0.3 to 10 mm in diameter;

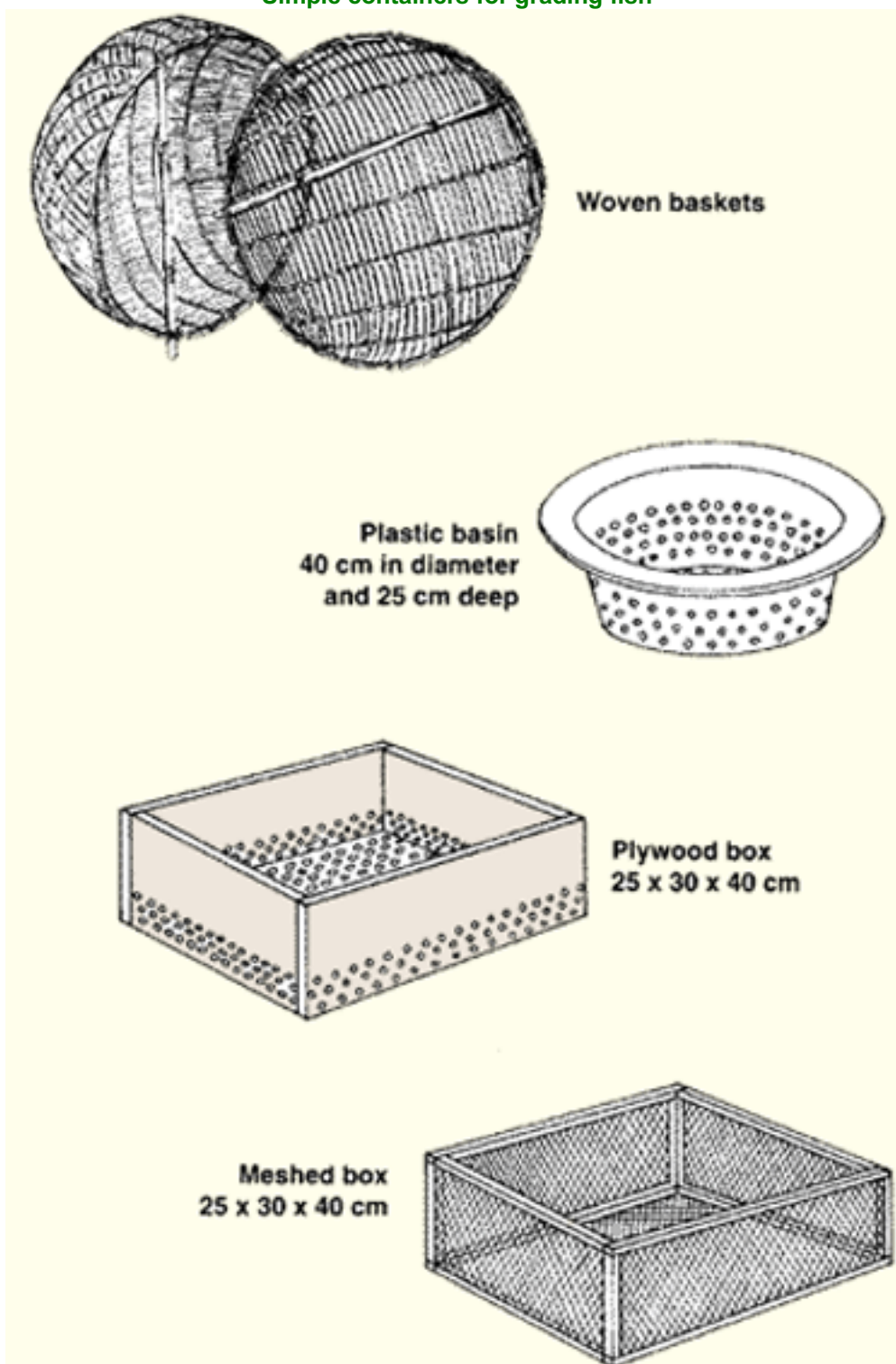
- **wooden boxes** with holes drilled as above;
- **meshed boxes** made from a wooden frame and material with a specific mesh size such as netting, plastic or metal mesh (see Section 12.7).

Grading Nile tilapias with woven floating baskets¹

<i>Opening size between vertical bars (mm)</i>	<i>Weight of escaping fish</i>	
	<i>Range (g)</i>	<i>Mean (g)</i>
9	1.8-2.8	2.0
12	6.6-8.8	7.1
15	13-15	14.3
19	22-32	29.8
26-28	Above 100	—

¹ Personal communication from J. Moehl, Zimbabwe

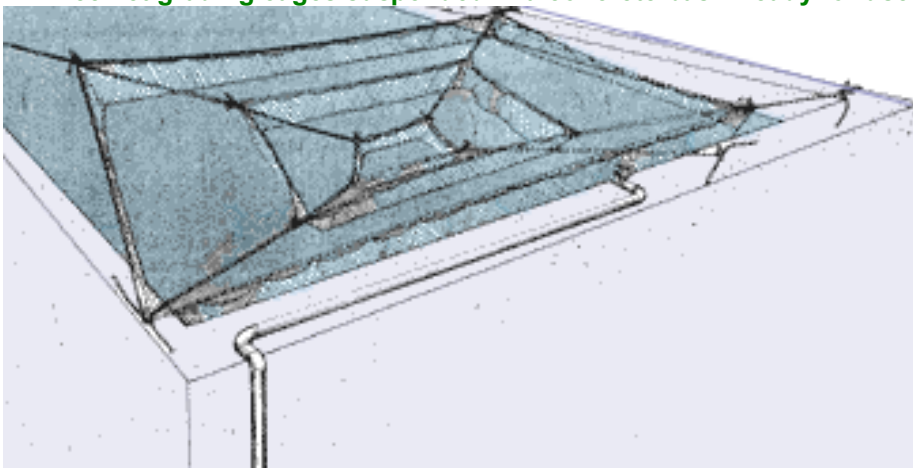
Simple containers for grading fish



3. For grading a stock of fish of widely mixed sizes, it may be better to use a **series of large meshed boxes or net cages with different mesh sizes which fit into one another**. Put the fish stock in the inside cage and let the smaller ones swim through the largest mesh towards the outside cages, as far as they can go according to their size. Select the series of mesh size well, on the basis of the general shape of the fish to be graded ([see Section 12.3](#)).

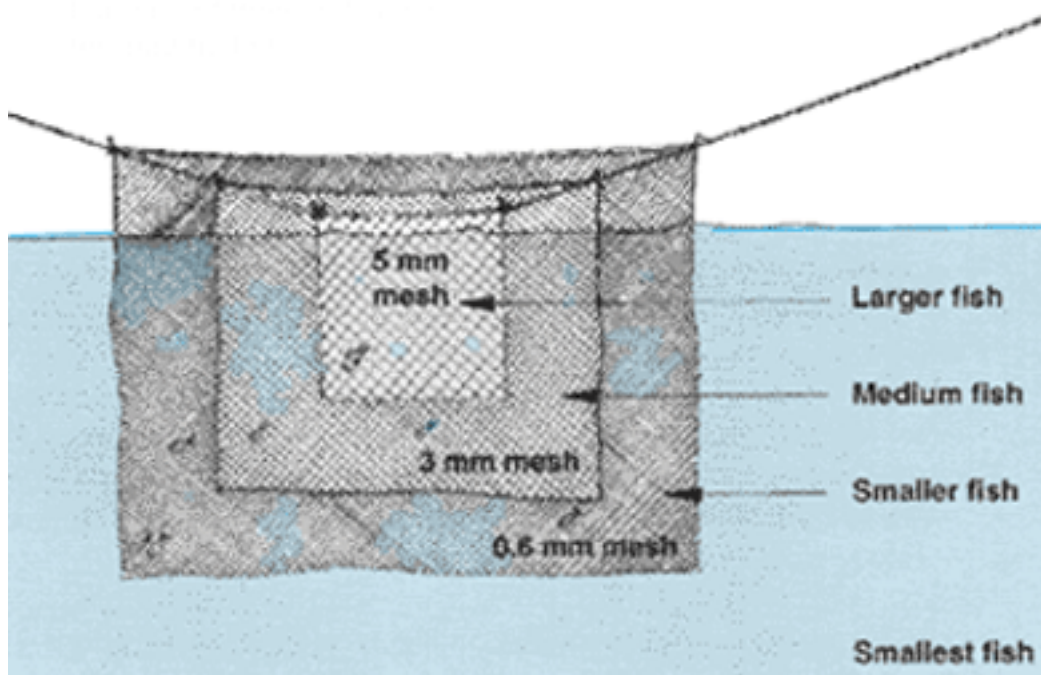
4. If the fish will not all swim through by themselves, raise and gently shake the grading container to move the fish through the meshes or holes.

Three net grading cages suspended in a concrete basin ready for use



Note: the largest fish are kept in the inner net cage while progressively smaller fish are kept in the two outer cages; the smallest fish escape into the concrete basin.

Diagram of three net cages for grading fish



Note: you can also build three light wooden boxes covered with mesh or screen for this kind of fish grader

12.3 How to grade fish with nets

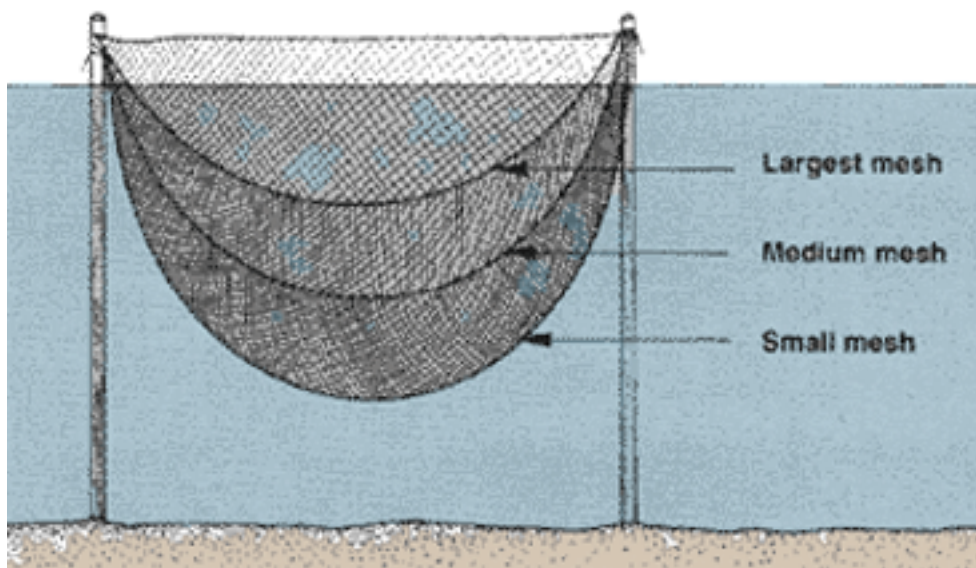
1. Another simple way to grade live fish is to use a series of nets with specific mesh sizes. Such a method is particularly useful to grade large quantities of fry and fingerlings before stocking.

You may use one of the following:

- a series of dip nets (see [Section 8.4](#)) can be made into a portable grading system to be used with juvenile fish stored and concentrated in small tanks or basins; or
- a series of square or rectangular grading nets, made from seine netting and rope (see [Section 8.2](#)) can be stretched over each other within a storage pond. Place the net with the largest mesh size on top and the one with the smallest mesh size on the bottom of the net series.



A series of grading nets hung from poles



2. In both cases **select the mesh size** of the netting material carefully, according to the general shape of the fish to be graded (see the accompanying chart). If necessary, make your own tests to determine which are the most appropriate mesh sizes for your particular case.

Note: always start by grading out the largest fish. If fish get caught in grading meshes, remove them quickly to a safe storage area.

Average size of smallest fish retained by various net meshes¹

<i>Nile tilapia</i>			<i>Tilapias</i>		<i>Common carp</i>	
TL (mm)	LW (g)	Mesh size (bar mm)	LW (g)	Mesh size (bar mm)	LW (g)	Mesh size (bar mm)
10	0.01-0.05	0.5	5	10	5	10
15	0.06-0.1	1.5	10	15	10	15
20	0.2-0.4	2.0	20	20	20	20
25	0.5-1.0	3.0	40	25	40	25
45	1.5-2.0	4.5	80	30	100	30
55	2.5-3.5	5.5	120	35	170	35
			160	40	240	40

¹ Fish sizes as total length (TL) or live weight (LW)

12.4 How to grade fish in harvesting structures

1. There are simple ways for grading mixed-size fish stocks, either with a **harvesting box** or in a **harvesting basin** (see Section 11.3).

(a) Design your harvesting structure so that it can be used for grading fish into two or three size groups, as shown below.

(b) Make a series of grading panels to fit into this harvesting structure. You may use wooden or metal frames covered with meshed material such as netting, plastic or metal mesh or set with vertical steel, wooden or plastic rods, for example 4 to 6 mm in diameter.

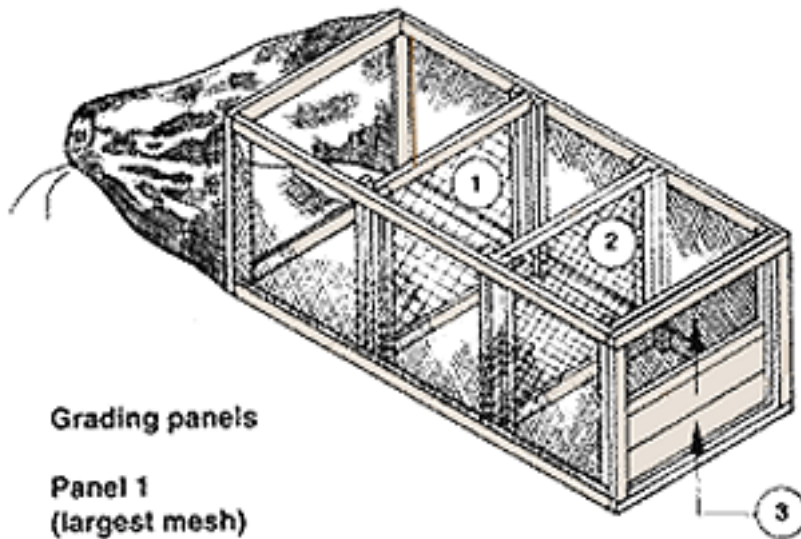
(c) Select the spacing or mesh size of each panel according to your particular needs (see Section 12.3).

2. A **mobile harvesting box** should have two sets of grooves along its length to accommodate grading panels. Add another set of grooves at the end of the box using either a fixed end screening or a final grading panel. For better handling, use a solid section for the lower half of this end panel to help keep your fish in water at all times.

3. A **permanent harvesting basin** should have two (or more) sets of grooves along its length to accommodate grading panels.

4. Move the fish from the pond **in small batches** to give them the opportunity to swim (generally upstream, see next section) through the grading panels as far along as possible without excessive crowding. **Remove each size group** of fish with dip nets as soon as possible. Note the **necessary data** for proper monitoring (see Section 16.0). Dispatch each group to its next destination, for example storage pond, fattening pond or delivery to market. Grade another batch of fish.

Grading fish in a harvesting box



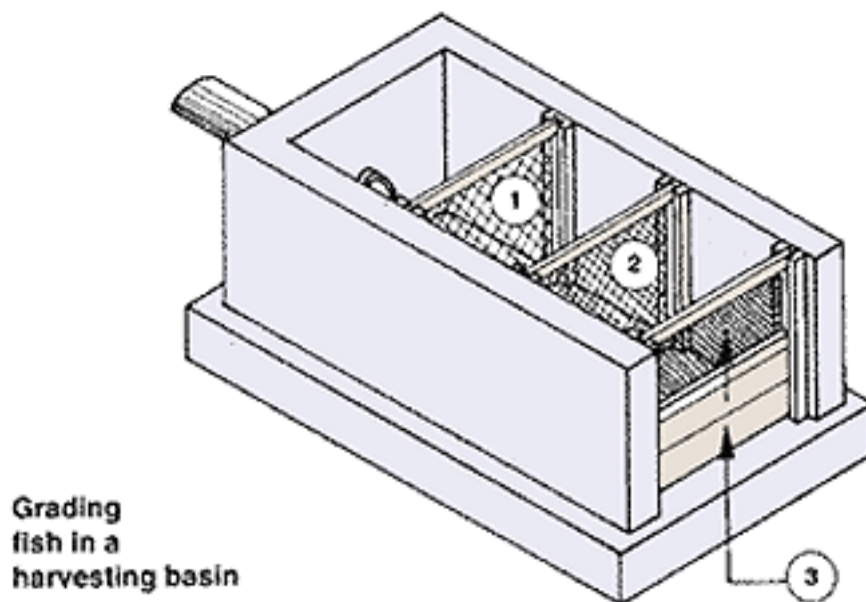
Grading panels

Panel 1
(largest mesh)

Panel 2
(medium mesh)

Panel 3
(small mesh
and boards)

Note: approximate
dimensions are
70 cm (high)
x 75 cm (wide)
x 150 to 200 cm
(long).



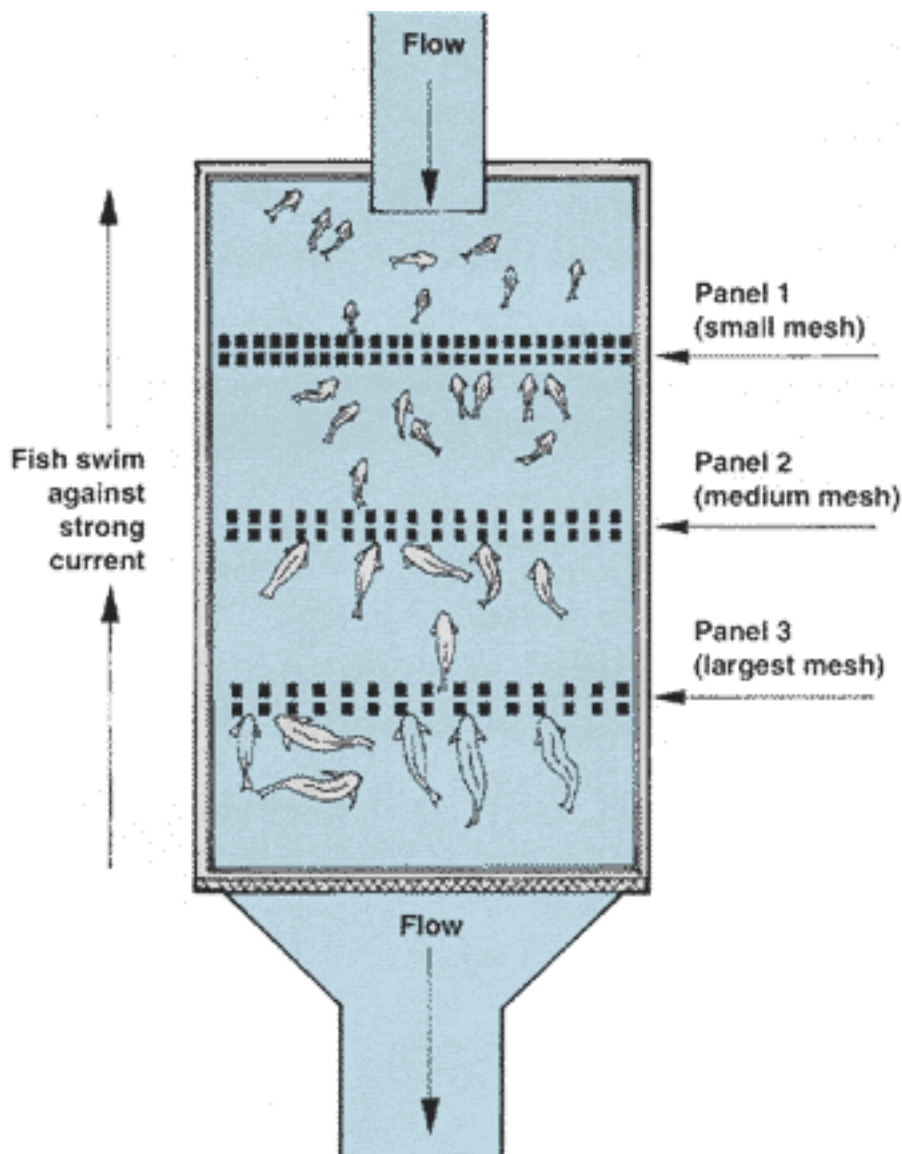
Grading
fish in a
harvesting basin

12.5 How to grade in troughs, basins or tanks

1. Several fish species such as common carp, tilapias and trout **react to a strong water current** by swimming against it. You may take advantage of this tendency to grade your fish. This method is particularly useful for fry and fingerlings. To apply this method, you require:

- a good water flow;
- a well-designed grading structure; and

- a series of grading panels.



(a) The **water flow should be sufficient to create a good current** within the grading structure. You may use water from a nearby feeding canal or pond, fed by pump, pipe or siphon. The flow should be adjustable ([see Section 11.3](#)).

(b) **A well-designed grading structure** can be:

- **a wood or fibreglass trough**, which can be transported around the farm and set up next to the pond to be harvested; or
- **a basin or tank** built from bricks or concrete blocks at a central location in the fish farm.

(c) **A series of grading panels** (see Section 12.4) should fit into two or more sets of grooves set along the sides of the grading structure.

2. For grading proceed as follows.

(a) Set the required grading panels in the grading structure, with the **largest openings towards the downstream end**.

(b) Start the water flowing through the structure.

(c) Put the batch of fish to be graded **in the downstream end** of the structure.

(d) **Regulate the flow**, so that the fish move towards the inflow. The smallest ones should be able to swim against the current and reach the upstream end of the structure.

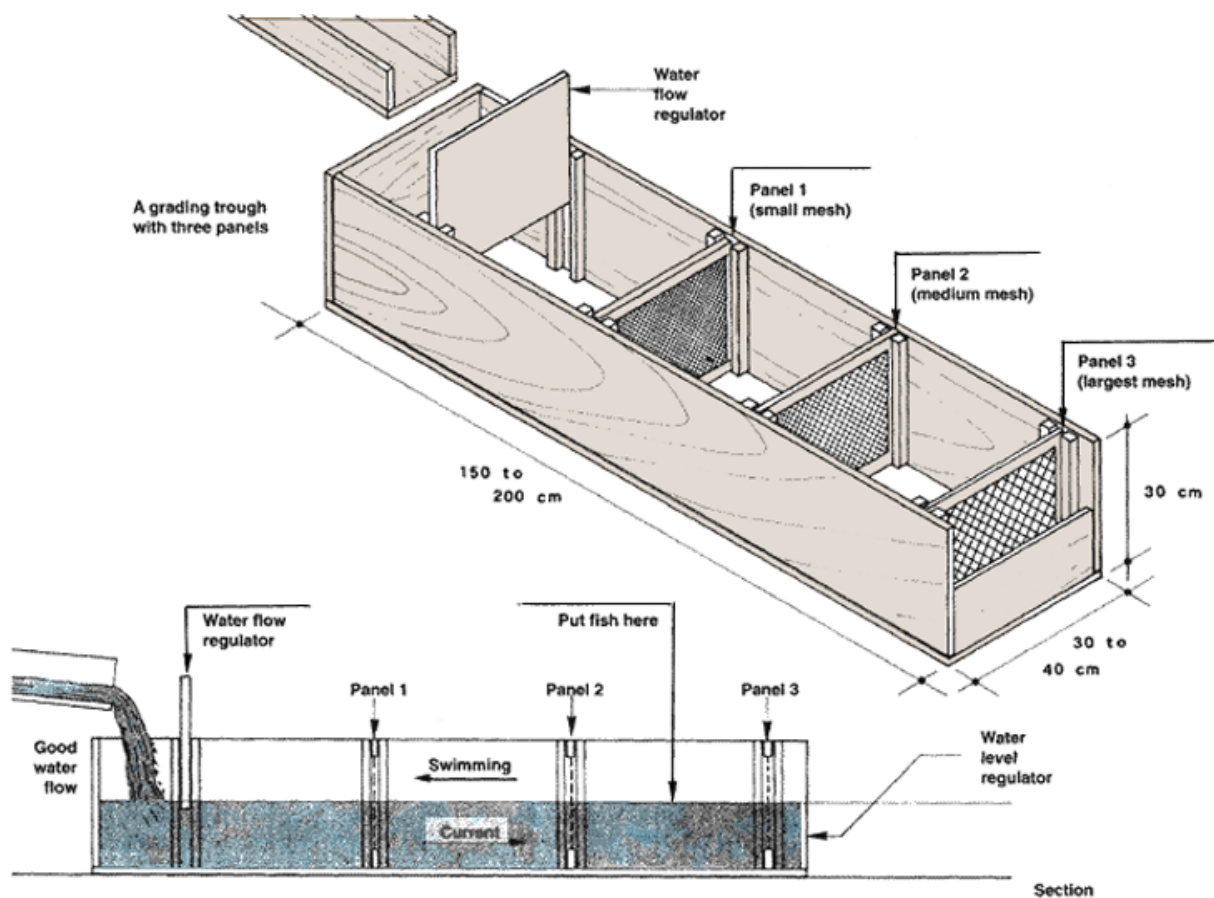
(e) **Remove each size group of fish** separately:

- the largest ones from the downstream section;
- the medium ones from the middle section(s), if any; and
- the smallest ones from the upstream section.

(f) Grade the next batch.

(g) If necessary repeat this grading process with another series of grading panels.

Note: your fish should be in good health to be strong enough to swim against the current. Usually, it is best to grade them a few days after harvest from the pond.



12.6 Floating grading cages

1. This method is particularly useful for grading **fish from partial harvests**, to separate those which have reached **market size** from the **smaller ones**, which are returned to the pond.

2. A simple **floating grading cage** can be built with the following materials (as shown):

- **synthetic netting**, made for example from 23 tex x 18 twine and mounted on 6 mm ropes with **a hanging coefficient of 50 percent** (see Section 8.1); select mesh size to retain the smallest size of fish required for marketing (see Section 12.4);
- a **strong frame** made from 6 x 8 cm pieces of wood, assembled with bolts and nuts (140 mm and 12 mm in diameter) and **hooks** attached every 30 to 40 cm to fix the net to the frame;
- **floats** made from plastic barrels (30 to 60 l) and fixed to the wooden frame with nylon rope.

3. Do not build a floating cage too large. Size it according to the depth of the ponds where it will be used and the quantities of fish to be graded. You will need **at least one cubic metre of cage volume per 80 kg of fish**. Allow at least 30 cm between the base of the net and the pond bottom.

Example

You plan to grade at the most 500 kg of fish for market in a cage floating in a pond 1.50 m deep. Build your cage with the following dimensions:

- total volume required: $500 \text{ kg} \div 80 \text{ kg/m}^3 = 6.250 \text{ m}^3$;
- depth of cage: $1.50 \text{ m} - 0.30 \text{ m} = 1.20 \text{ m}$;
- area of cage: $6.250 \text{ m}^3 \div 1.20 \text{ m} = 5.21 \text{ m}^2$;
- typical dimensions: 2.1 x 2.5 or 2.3 x 2.3 m.

4. To use the grading cage, simply put the harvested batches of fish within the cage. **Wait for a few hours**, giving the fish time to rest. Check closely on their condition, in particular if they have to be marketed live. Then **drive the small fish from the cage** by splashing the water and progressively lifting up the cage bag to crop the market fish out. Be careful to keep the cage meshes open to allow the small fish to escape.

Building a simple floating grading cage

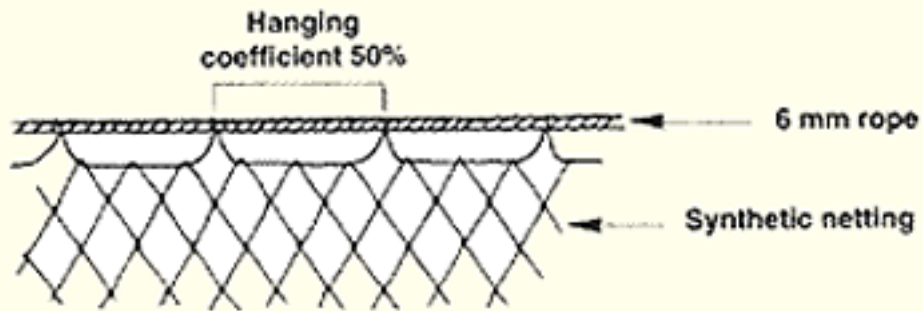
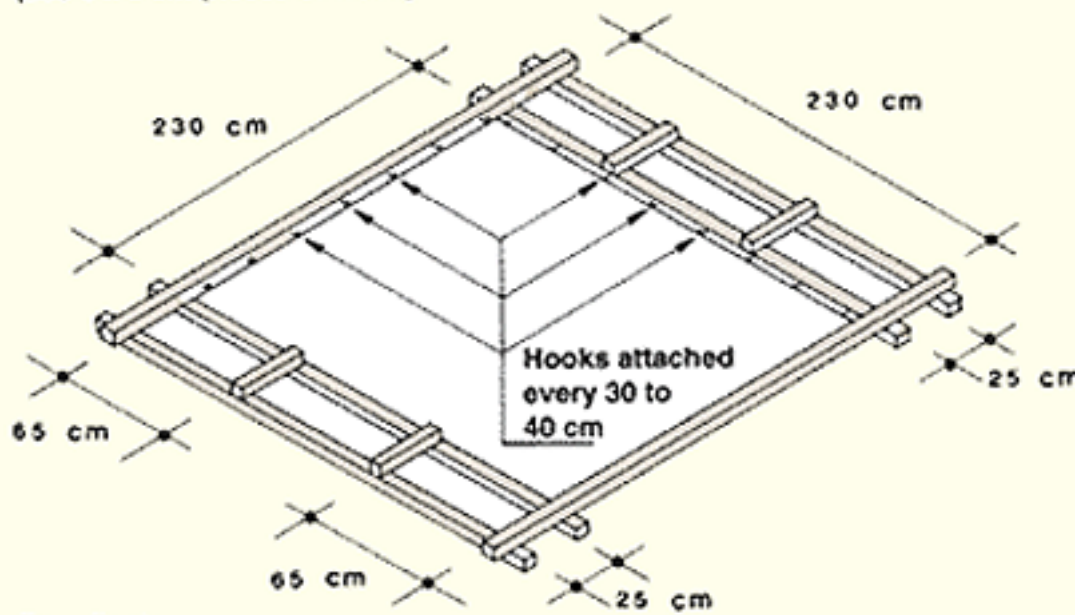
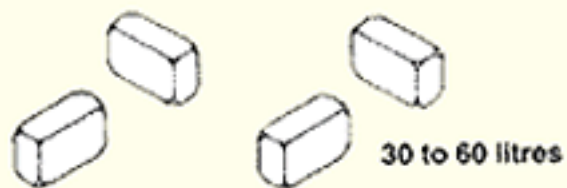


Diagram of the frame
(use 6 x 8 cm-pieces of wood)

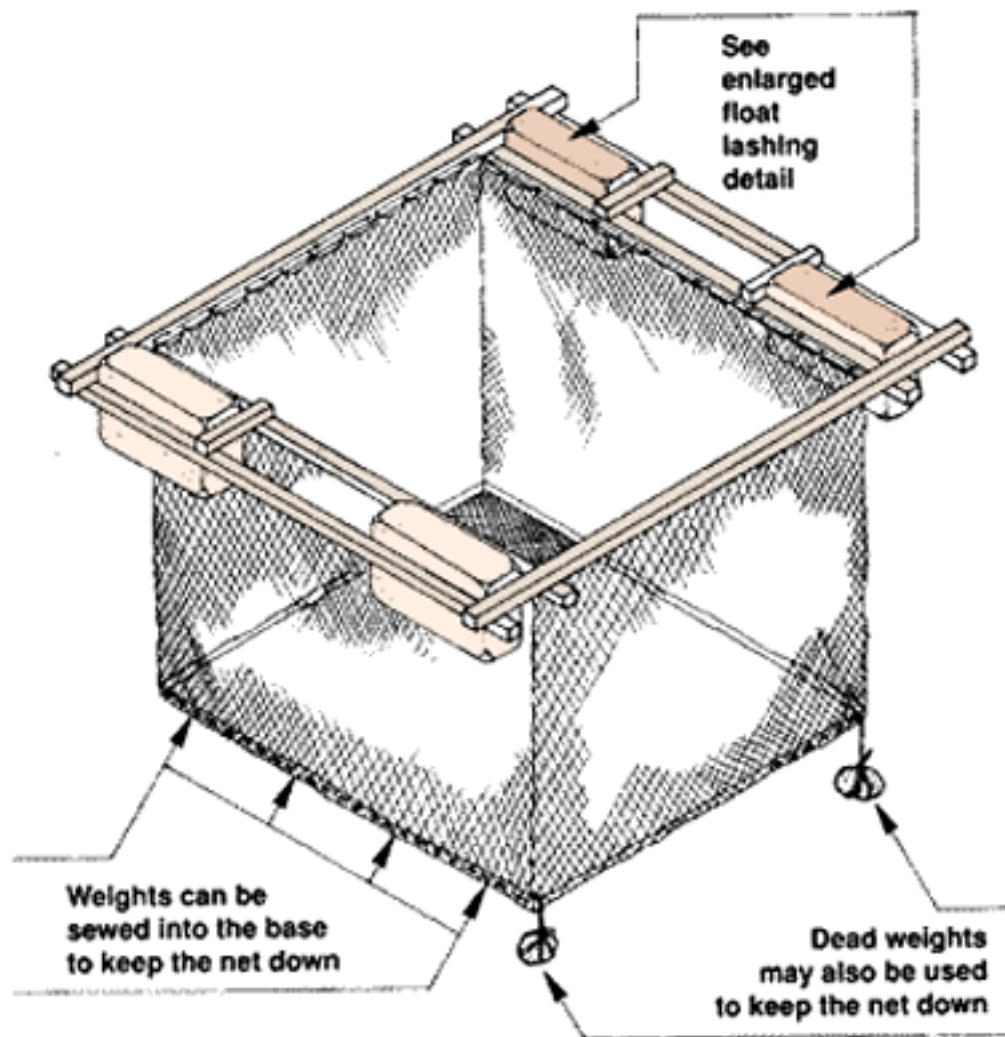


Four floats



Plastic containers
or other floating material

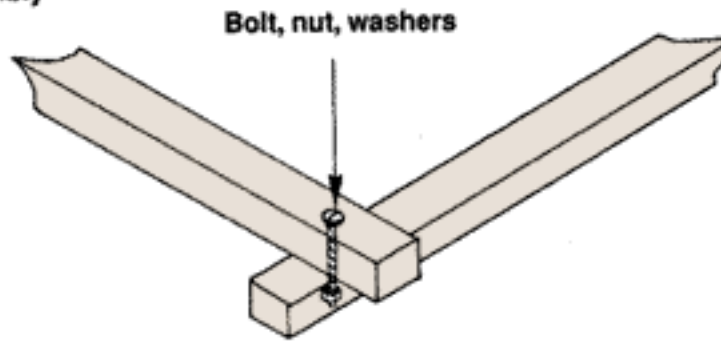
Diagram of completed floating grading cage with floats and netting in place



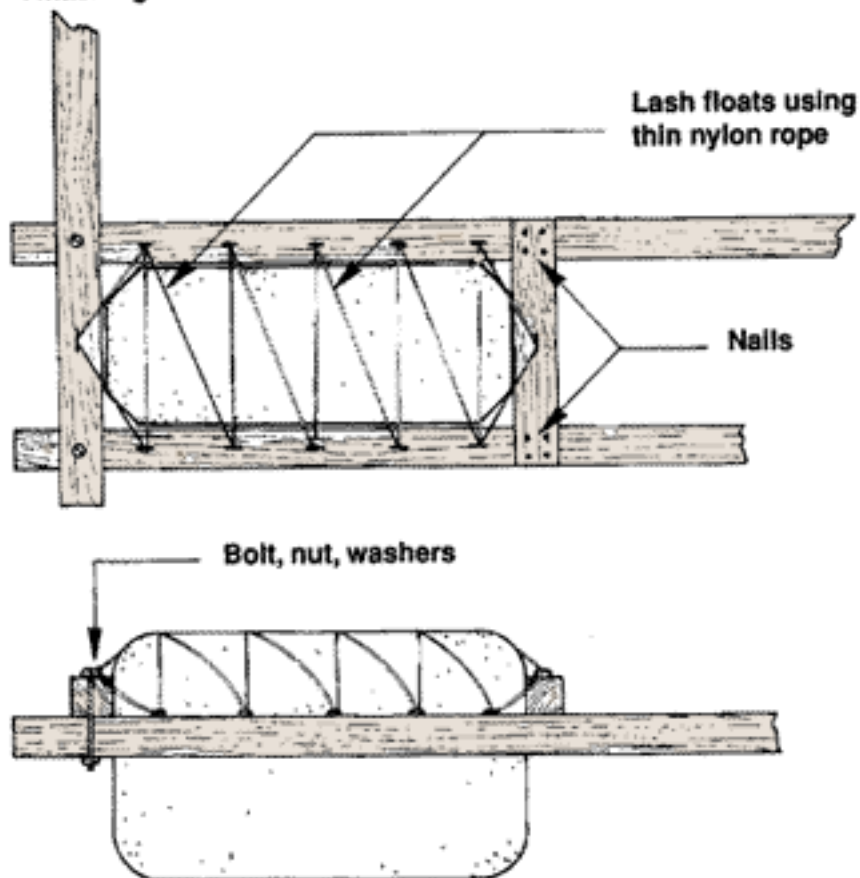
Note: the top of the frame should float about 30 cm above the water level; allow at least 30 cm between the base of the net and the bottom of the pond.

Construction details

Frame assembly



Attaching floats

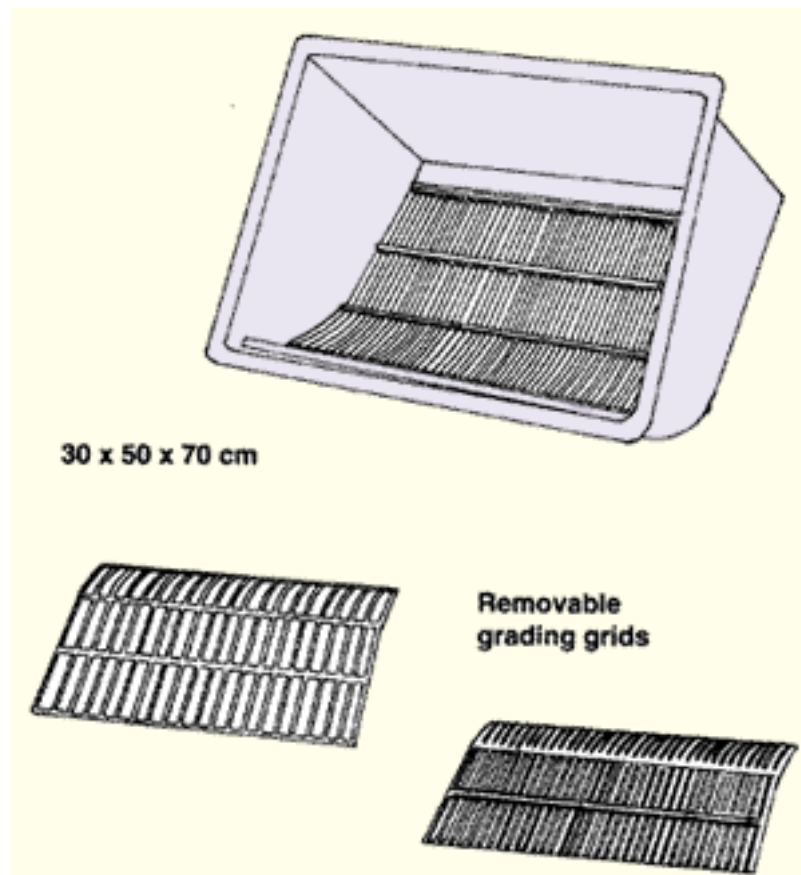


12.7 Box and mechanical graders

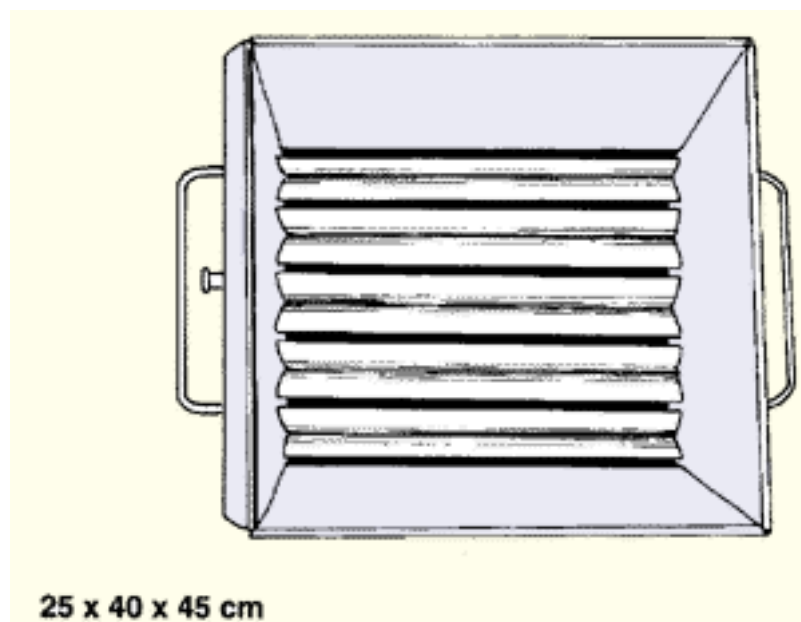
1. You can buy more sophisticated graders of various designs from specialist suppliers. You can also make simpler versions yourself. These graders normally consist of a wood, metal or fibreglass box, with one or more components with grading bars or slots set in its base. Small grading boxes are used directly inside the pond or harvesting basin. Larger boxes are usually transported around the farm and are set up on the pond bank.

2. There are three main types:

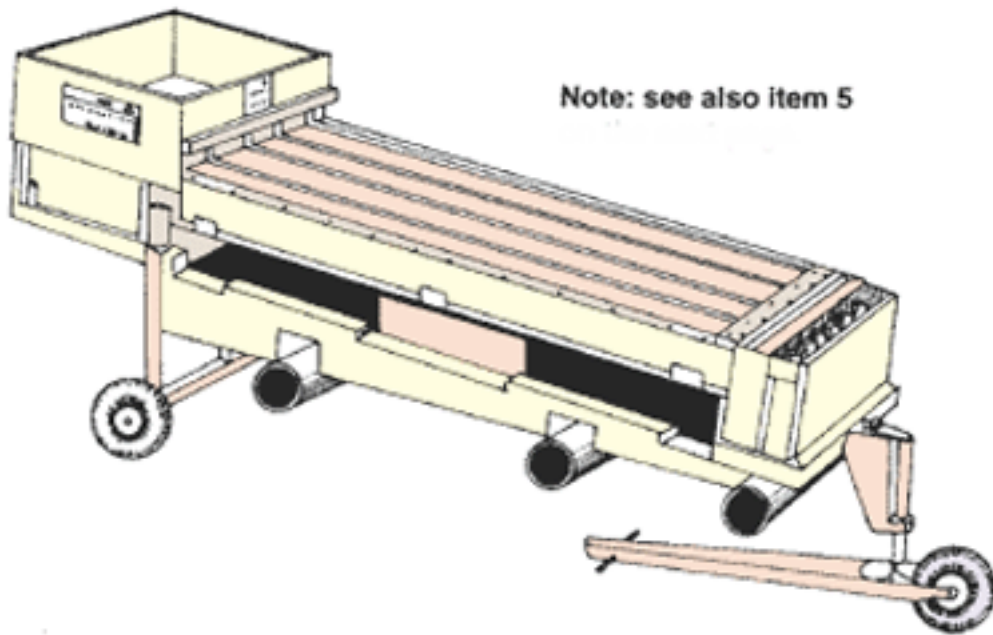
- **fixed-width graders:** usually with replaceable bases of a set grading size (these are the simplest, and you can make or buy them);



- **adjustable graders:** the grading bars can be adjusted to change the grader spacing;



- **variable-width graders:** the graders' spacing increases from the upper to the lower end.



Making a simple grader

3. You can make a **simple fixed-width grader** as follows.

(a) Make a metal, wood or fibreglass box with typical dimensions:

- 60 x 40 x 40 cm deep, for one person, for fry and fingerlings;
- 100 x 80 x 50 cm deep, for two people, for fingerlings to market size;
- alternatively, size the box according to the grader bases available.

(b) Finish the inside of the box as smoothly as possible.

(c) Fit simple handles and, at the base of the box, add the inner ledge on which the grader screen is placed.

(d) Make several grading screens, using netting, or preferably metal, plastic or fibreglass rod, set under a wood, metal or plastic frame, sized so that it will fit neatly inside the box on the inner ledge.

(f) If necessary use simple wooden pegs or- rubber bands as simple clips to hold the grader screen in place.

Using the grader

4. The grader is used by placing it in the water, in the area where the smaller fish are to go, and netting batches of fish into it. The box is lifted up and down, to let the smaller fish drop through, leaving the larger sizes, which are then tipped out into a receiving cage or transport box, for example.

5. Fully **mechanical graders** are usually transported to the side of the pond and are frequently trailer-mounted. They are usually variable-width graders, with a sloping

upper trough in which the fish are placed (or pumped), which is separated from two or more lower receiving boxes by the grader screen. These receiving boxes are usually connected by pipe, through which the fish return by gravity to their final locations. A continuous flow of water and fish enters the upper end of the trough where the screen width is narrow. Smallest size fish drop through in the first receiving box. The fish move progressively down the trough until the widening screen allows them to drop through into their appropriate size group.

