CONTROLLING WATER LOSSES FROM AQUACULTURE PONDS

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Fish and shellfish farming are viewed as two of the most viable opportunities for diversification and profitability in Texas agriculture. Crawfish production acreage exceeds 18,000 acres in the state while channel catfish, sportfish fingerlings, saltwater shrimp, baitfish and red drum acreage is expanding rapidly.

Most of this production is in ponds, which are generally built by constructing levees around a portion or all of the water that is to be impounded. Some of these ponds are filled by run-off but the majority are filled with water pumped from wells (groundwater). Some precipitation falls into the ponds but most of the water comes from wells.

The water budget for the average aquaculture ponds is P + WR = (S+E) ± ©V, where P = Precipitation; WR = Water required from wells; S = Seepage; E = Evaporation and ©V = Change in storage.

Water requirements vary with location. With normal seepage rates, for instance, the amount of water required to maintain water levels varies from more than 100 inches in far West Texas to less than 20 inches in Southeast Texas.

Groundwater for filling and maintaining ponds is a major demand on many aquifers. To maintain the water level in 100 acres of fish culture ponds in Central Texas from March to November may require 500 acre feet or 420 gpm. The cost of pumping water varies with the total dynamic head and the cost of fuel or electricity. A cost of $20 per acre foot is typical. There fore, this 100-acre fish farm might spend $10,000 just to maintain the water level in ponds.

Draining of fish culture water into streams in the area is a potential source of water pollution. However, because the water high in organic and inorganic nutrients it can be used to fertilize pastures or other crops. Reusing this water in the same or other ponds reduces the pollution potential and eliminates the cost of refilling the ponds.

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SEEPAGE

Seepage is the major cause of water loss from most fish culture ponds in the state. It usually exceeds the evaporation rate, except in ponds in the High Plains region. The principle causes of seepage are as follows:

1. Ponds built in areas where soil contains high amounts of sand or gravel.
2. Shallow soil with underlying fractured bedrock.
3. Soils with a high gypsum content in which voids develop as gypsum dissolves.
4. Improper construction methods including failure to compact clays in the bottom of the pond, failure to place a clay core in the levees, no anti-seep collars around drain pipes and improperly designed drains.

If ponds are constructed on permeable soils, seepage rates will be very high. Reports of more than 1 inch of seepage loss per day are common. Even in the best situation some water will be lost through seepage. The typical rate is from 0.01 to 0.2 inch per day. Data collected at Auburn University indicate that because the viscosity of water decreases with increasing temperature, seepage rates for ponds may be up to 25 percent higher in summer than in winter.

A seepage rate of 0.2 inch per day from a 1-acre pond does not seem significant but this rate will result in a water loss of 6 inches per month or 6 acre-feet in a year. If better site selection and proper construction techniques would reduce this to even 0.1 inch per day, more than 3 acre-feet of water would be saved in a year. Obviously seepage control should be of the highest priority during pond construction.

To protect against seepage, select a site for the ponds where soils have a high clay content and follow good construction techniques. Here are some seepage reduction techniques which may be used during initial construction or when renovating old ponds:

* Select the pond site based on soils engineering data for the subsoils. One source of

data is the SCS soil survey report. Subsoils should be classified as clay loam to clay texture with a liquid limit of 30 or more, plasticity index of 15 or greater, and more than 30 percent passing a No. 200 mesh sieve. Sandy clays, clay loams, sandy clay loams and clays all fit these specifications.

* Compact the embankment in layers 6 to 8 inches thick.

* Compact soils on the pond bottom and sides at optimum moisture content. This can be done with heavy machinery during initial construction or it can be accomplished using sheep or goats to cut up and trample the bottom and levees when renovating.

* Install clay blankets over the pond bottom and sides. This clay should be carefully chosen, as some clays contain heavy metals which can be toxic to fish.

* Incorporate bentonite into the pond bottom when a suitable clay is unavailable. Bentonite is a clay product which swells when wet and fills the minute holes in the soil.

* Incorporate organic matter such as manure into the pond bottom to reduce seepage. This is basically the same technique used for centuries in making adobe bricks in the Southwest.

* Place a pond liner over the pond bottom when clay soil is unavailable. These flexible membrane liners can be of rubber, polyethylene, vinyl plastic or woven fabric. They are very expensive, but may pay for themselves in reduced pumping costs.

The last 4 techniques are expensive; however, the need for them usually can be avoided with proper site selection and good construction techniques.

EVAPORATION

Pond evaporation is usually estimated as Class A pan evaporation times 0.81. Record evaporation rates reported for various spots in Texas are in Table 1.

Obviously pond evaporation varies widely across the state, with higher rates occurring in the more arid western region. Actually net evaporation (pond evaporation minus precipitation) is more important in determining water requirements. In Texas this may be more than 80 inches per year.

Additional evaporation loss can occur when ponds are aerated. To guard against evaporation losses, management of aeration is important. Aeration is usually used in fish ponds to prevent low concentrations of dissolved oxygen. Boyd reports that in Alabama, aeration of ponds using 1-horsepower per acre increased the evaporation rate by 8 percent per day. Nighttime aeration did not increase evaporation from pond surfaces. Because low dissolved oxygen concentrations usually occur during darkness, aerators should be operated only at night to conserve water. Daytime aeration may be necessary in certain situations to prevent fish loss, but these occasions are rare.

Aquatic weed often grow in shallow water around the edges of ponds or float on the pond surface. These weeds interfere with pond management and also transpire large amounts of water. This loss of water varied from 0.85 to 2.5 times normal evaporation, with an average of 1.46, in tests done in Alabama. The same situation occurs with trees such as willow on mesquite growing near the pond. Reports from Texas Tech University indicate that an average 30-foot-canopy willow will transpire more than 400 gallons per day, which is taken up by the roots extending into the pond. Obviously aquatic weed control is a major factor in curtailing the loss of water from fish ponds.

STORAGE

One of the most obvious ways to reduce water usage, and therefore pumping costs, is by reducing water lost from an overflowing drain pipe. This can be accomplished by maintaining the water level several inches below the drain pipe. If the water level is kept a few inches below the drain, all rain falling into the pond can be stored. In Southeast Texas, rainfall during the spring and summer usually exceeds the evaporation loss during the summer months. If all rainfall is stored, pumping costs can be greatly reduced.

Fish farming is often practiced in watershed ponds that are filled primarily by run-off rather than groundwater. Water levels normally decline during the summer months and increase during the winter and spring. If these ponds have adequate storage volumes and adequate watershed areas, enough water can be stored to maintain sufficient water depth for fish production. Where possible, watershed ponds should be considered for fish production in order to conserve water.

There are some disadvantages to watershed ponds for fish production. Large acreages are necessary and the ponds cannot be constructed side by side, which increases construction costs. Pond shape is regulated by the topography of the area and this may make harvest difficult. Finally, the supply of water will vary from year to year depending on rainfall. In those areas where rainfall is low and evaporation is high, as in West Texas, watershed

ponds are impractical for fish production, but in other areas of the state they should be considered.

WATER REUSE

If ponds are properly constructed and all obstructions are removed from the bottom, fish can be harvested with out draining. This prevents the loss of nutrients and also reduces the requirements for pumping additional water. Because filling ponds that have been drained will require from 4 to 6 acre-feet of water per acre of surface, harvesting without draining will mean a major saving in water cost. Studies conducted to date indicate that acceptable water quality can be maintained in ponds that are not drained each year. Repairs of levees and other renovation work will normally mandate draining every 4 or 5 years, but major savings will accrue if annual draining can be avoided.

When ponds must be drained for harvesting it is usually possible to pump the water to an adjacent pond to save the water. In some instances water can be drained by gravity from one pond to another. If pumping must be done, the relatively low head lift from one pond to another would result in considerable savings as compared to the cost of pumping from a deep well.

Water conservation should be primary consideration in locating and constructing fish farms in Texas. Proper attention to details will result in major savings.

TABLE 1

PAN EVAPORATION RATES FOR THESE TEXAS LOCALITIES

	Pan evaporation in./yr.	Lake surface evaporation in./yr.	Net evaporation over rainfall in./yr.
Amarillo	121	98	86.4
El Paso	135	110	100
Orange	69	56	0

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