Rice Growing Manual for the Northeast USA

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We are thankful for this opportunity.

During the past three years, we met many people through this project. It was truly a privilege for us. We appreciate their kindness, friendship, and interest in rice growing; and, we thank all who have helped us in many ways.

We hope that in the future this booklet becomes only one of the many manuals for rice growing in the northeast.

Preface

The last 3 year's experiments with growing rice in the northeast tells us that rice is very productive and therefore there is a real potential for rice to become a commercial crop in the future. Although we would like to see rice growing in the northeast, the important issue is:

"How it is Grown".

After starting to write this manual, we became concerned with growing rice sustainably in the northeast without regard to the complexities that surround the rice paddy agroecosystem within a watershed. The following is a short explanation of the many issues that are related to growing rice and their potential impact on the surrounding landscape.

Because rice is new to this area and this type of aquatic agriculture is quite different than the dryland agriculture that we are familiar with, we want to emphasize the unique character of the multifunctionality of rice paddy systems.

A rice paddy is a shallowly flooded, irrigated field that functions as a human-made wetland. Therefore, it provides similar benefits to natural wetlands including the following:

- Watershed: groundwater recharge, climate moderation, flood and erosion control, landslide prevention.

- Wetland Biodiversity: support important wetland biodiversity (e.g. reptiles, amphibians, fish, crustaceans, insects, molluscs, and birds).

- Community Use: municipal water supply, fire engine, education (i.e. school field studies), and recreation (i.e. greenways).

By integrating conservation and agriculture, the multifunctionality of rice paddy systems can optimize biodiversity, stability and productivity within an agroecosystem and is therefore a very interesting and important issue to consider for the future.

Note 1: The biodiversity of the paddy agroecosystem depends not only on the paddy fields themselves, but also on the surrounding natural/semi-natural habitats, such as, water channels, irrigation ponds, levees, farmlands, forests, rivers, lakes, etc.

Note 2: It is not recommended to convert natural wetlands to human-made wetlands.

Note 3: There is a need to be extremely careful about non-native invasive species, chemical use, and crop management that disturbs these human-made wetlands.

To get more information on this subject, the following two sources are very useful:

The Ramsar Convention on Wetlands, Resolution X.31, "Enhancing biodiversity in rice paddies as wetland systems", http://ramsar.org/res/key_res_x_index_e.htm Click on Resolution X.31. (Note: other parts of this site, www.ramsar.org, are very informative)

Rice is life: Scientific Perspectives for the 21st Century: Proceedings of the World Rice Research Conference, held in Tokyo and Tsukuba, Japan on November 4-7, 2004, by K Toriyama, K L Heong, B Hardy, World Rice Research Conference, International Rice Research Institute, published by the International Rice Research Institute, 2005. You can download it free from: http://books.google.com/books/irri?id=EpNk3lsX1cgC&pg=PA163&dq=rice+is+life

Pay particular attention to: "Section 11: Enhancing the multifunctionality of rice systems."

Also, we recommend to get a copy of both our 2008 Northeast SARE Farmer Grant proposal and our final 2008 Northeast SARE Farmer Grant Report before the season starts:

1) For hard copies of our 2008 NESARE Farmer Grant proposal, our final report or the first edition manual, contact the NESARE office at 802-656-0471 or email nesare@uvm.edu.

2) For electronic copies of the above, contact Carol Delaney, NESARE Farmer Grant Specialist, carol.delaney@uvm.edu or 802-656-0697.

3) For shorter summaries of the above, go to www.sare.org/reporting/report_viewer.asp and search for FNE08-624.

How to use this manual.

This manual covers how we are growing rice in the northeast USA. It is not a comprehensive manual on all aspects of growing rice. We intended it to be used along with the following book, without which you may have difficulty understanding the basics of growing rice.

A Farmer's Primer on Growing Rice by Benito S. Vergara. 1992, The International Rice Research Institute (IRRI)

Order by: sending an e-mail to irripub@CGIAR.ORG with book information, number of books and shipping address. They will send you an invoice. Mail them a check in US$ and they will

ship the books.

In this manual we explain not only what we know, but also what we don't know yet, or what we need to know. We set it up as follows:

- The left side of the page explains how we are growing rice.
- The right side of the page has comments that include: references, further reading, comments, and considerations.

1. Several Things to Consider Before You Sow Seed

A. Site Selection

Before you start, there are 3 factors to consider:

1. Soil type: A rice paddy needs to hold water well. Ideally, your soil needs to include about 50% clay content.
   Also, soil underlain with an impervious hardpan or claypan helps to hold water.

2. Irrigation water and warmup pond.
   Rice could grow in either a wet (paddy) or a dry (field) setting. However, in the northeast, during May and June, water works as a heat-holding medium and creates a much milder environment for rice growing.
   A pond could hold irrigation water to use in July and August, when demand for water is the greatest.

3. Climate (heat) – ideally a full day of sunshine
   First, we are talking about the rice growing season, which is May through September.

University of California/Davis: www.plantsciences.ucdavis.edu/uccerice/main.htm. This site has useful, general information.

The International Rice Research Institute web site: start with "Frequently Asked Questions" http://www.irri.org/about/faq/asp

The details need to be investigated.

Working with water gives us an extended growing season and the ability to avoid the last frost and colder days.

The details need to be investigated.

We have a plan to make a record of the weather during the 2009 season.

1. Several Things to Consider Before You Sow Seed

Location of Akaogi Farm

We think that Akaogi Farm is located in the coldest rice-growing climate (roughly speaking) in the northeast. Our farm is located in southeastern Vermont at lat. 43° 02' N, and long. 72° 32' W. It is approximately 5 miles west of the Connecticut River and 900 feet above sea level. Even though we are in southeastern Vermont, because of our altitude, we are colder than other locations that we monitor: Burlington, Vermont and Ithaca, New York.

B. Choice of Variety

To start an experiment, we recommend a Hokkaido bred, cold tolerant, early maturing variety. We supply "Hayayuki" for that. You can find out more about Hayayuki at the National Small Grain Collection web site.

In the last 3 years we have tried a total of 40 or more varieties for preliminary evaluations to see whether they develop mature seeds in our climate (cold tolerance and early maturity). So far, we have identified 25 varieties, which were bred mainly in Hokkaido, Japan.

Hayayuki means "early snow" in Japanese.

Seed sources: Both of the following are "active germplasm collections" (or genebanks) and are in the public domain. They have over 19,000 accessions of rice from 110 countries.

You can request seed free of charge for your experiment.

The National Small Grain Collection: http://www.ars.usda.gov/main/docs.htm?docid=2884

The Dale Bumpers National Rice Research Center in Arkansas http://ars.usda.gov/Main/docs.htm?docid=8318

1. Several Things to Consider Before You Sow Seed

Importing Rice Seed

The USDA has restrictions on rice importation.

The importation of rice (*Oryza spp*.) is prohibited from all sources except from Mexico, which requires a written permit.

If you want to import seed, you have to go through the quarantine process. Although it is time-consuming and difficult, following this procedure is important because it helps prevent the spread of unwanted disease, pests, weed seeds, and soil.

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Here are two examples that demonstrate the importance of following protocols:

1. The states of the Mississippi River Delta have extra restrictions placed on the importation of rice from the rest of the USA, to prevent a particular disease from entering the area.

2. We personally know of a research institution that had to destroy their whole plant collection in the greenhouse because of the existence of a prohibited pest. Even under careful control, these things could happen.

This is important for “All the Growers” interested in growing rice in the northeast, especially since we do not have these problems here now. We do not want to see one person’s mistake jeopardize rice growing in the northeast.

1. Several Things to Consider Before You Sow Seed

C. Construction of Paddy System

A rice paddy system consists of: a warmup pond or reservoir, a paddy, and a method to connect the two.

→ Preferably this is done the fall before.

To construct our paddy system, we did as follows:

1. Remove the sod → make a pile aside for compost.

→ Sod pile – after 1-2 years use as soil compost.

2. Remove topsoil → make a separate pile.

3. Level the subsoil (with minimum disturbance)

4. Return the topsoil and spread. Make the surface as level as possible.

If you are not ready to build a paddy, you can grow rice in a 5-gallon container:

a. Put the container in a sunny, protected place.
b. Add soil to the 5-gallon container to within 2 inches of the rim.
c. Transplant the seedling into the soil.
d. Add water up to 1/2 of the height of plant at first. When the plant gets bigger fill to the top of bucket.
e. Add water when needed to ensure standing water at all times.

We (ourselves, the engineer from the NRCS, and the contractor) did not have any experience constructing a rice paddy system prior to this.

For larger scale rice paddy systems (1 acre or larger), you may need to use a special machine to make the surface level.

→ U.C./Davis website.

2. Seasonal Activities (Growing Season: May - September)

First you need to decide whether you direct sow seed or raise seedlings.

At this moment, we raise seedlings and transplant later.

A. Raising Seedlings

To raise seedlings we use a 14' x 48' unheated greenhouse in which we set up 4' x 8', 1 foot high frames that can be covered with 4' x 8' panels of foam insulation.

1. Soaking seed, 50°F for 7-10 days. Change water every other day.

   How to select well-ripened seeds prior to the soaking process.

   Easy method

   - Put seeds in the water and discard any seed that float to the surface.

   Better method

   - Do the same as above except use "salt water."

   Salt : water = 1.3 lbs : 1 gallon
   Rice seed (volume) : water = 1 : 2
   (As soon as finish, quickly rinse off the salt, then proceed to soaking process.)

2. Sowing seed:
   We use 128-size plug trays and regular potting soil (smaller size plug trays also work).
   2-3 seeds /cell
   Start mid April

3. Greenhouse temperature control

   - Low Temperatures

   When expected nighttime temperatures go below:

These websites are the Japanese version of the extension service in Hokkaido. They have an excellent growing manual for their cold climate.
http://www.agri.pref.hokkaido.jp/kit
http://www.agri.pref.hokkaido.jp/kme
http://www.agri.pref.hokkaido.jp/rumoi

These sites are, unfortunately, in Japanese only. But, if you or a friend can read Japanese, it is by far the best resource regarding rice growing in a cold climate.

Length of soaking time may vary by temperature and variety.

Generally, Hokkaido bred varieties take longer.

The depth of dormancy is also related to the climate during the ripening phase.

Purpose of soaking is to break dormancy and for uniform germination of seed.

Direct sowing seed eliminates quite an amount of time and work; but, in the northeast, many places do not have long enough of a growing season. More experiments are needed regarding this.

2. Seasonal Activities (Growing Season: May - September)

40°F → close the sides
32°F or lower → cover with row covers or insulation board
You should do these 1-3 hours before sunset.

- High Temperatures

Don't exceed 80-90°F – High temperatures and humidity cause disease (wilting) and tall, thin seedlings

After 2 weeks we fill the 4' x 8' frames (lined with a plastic sheet) with water up to the top of the plug trays. This creates a warmer environment during night and saves the labor of watering.

Hardening: 4th week - try to transition seedlings to conditions similar to the outside environment.

B. Preparation of Paddy

Fertilizer N : 60-75 lbs/acre
we use dry chicken manure

Puddling: Roto till with water and soil to improve the paddy's ability to hold water.

Also, it is suggested to mix water and soil around the edges of the paddy (on the inside of the levees) and spread this mud mixture on the paddy-side wall of the levees.

C. Transplanting – mid May

Ideally a calm, warm (50°F for high), sunny day.

Spacing: 12" x 8", 2-3 plants /hill

Depth: 1/2" deep (top of plug is 1/2" below soil surface

Most of our work is done by hand except tilling, threshing, and dehulling.

For larger scale growers (but smaller than large-scale, commercial rice growing areas like California or Arkansas) there are a series of machines available from Japan and possibly other countries for all stages of production from start to end, including transplanters.

Further investigation needed.

After two weeks, if older leaves start to turn yellowish, then side dress with fish emulsion or compost tea, etc., as necessary.

Fertilizer amount varies with your soil condition.

Make sure the surface is as level as possible

These two are more important to do if your soil does not have the desired amount of clay.

Try this spacing the first year; there are many variations.

If the seedlings are planted too shallow, then they may fall over.
If the seedlings are planted too deep, then they develop tillers slowly.

2. Seasonal Activities (Growing Season: May - September)

D. Water Management

From May to late July, as the plant are establishing, the water temperature is higher than the air temperature.

Background

Relation between air temperature and water depth May-July

Air Temperature + Water Depth ←→ Water Temperature

		Water Depth	
		Deep	Shallow (1”)
Air temperature	High	Water temperature rises slowly Nighttime low water temperature stays high High-low difference is small	Water temperature rises quickly; may be very high Nighttime low water temperature is low High-low difference is large
	Low	Water temperature rises slowly Nighttime low water temperature is high High-low difference is small	Water temperature rises slowly Nighttime low water temperature is low Daytime high water temperature is low

Water acts as a heat holding material; it creates a much warmer environment for rice growing.

The details need to be investigated.

2. Seasonal Activities (Growing Season: May - September)

E. Growth Phases

1. Vegetative Phases: Mid May – Late June

- During this phase cold days or frost are common.
- Careful water management is the key to smooth growth.
- Maintaining 1-2”depth of water in the paddies to warm up is better
- Especially, when you expect a last frost, a temperature lower than 40°F, or a windy day, fill rice paddy with water up to a depth of 3/4 the height of the plant to protect the plant.

2. Reproductive Phase (Panicle formation → flowering): Late June – Early August

- Because rice is a tropical plant, during this phase it is especially sensitive to low temperatures of 50°F or lower. If temperatures of 50°F or lower continue for a period of 2-3 days then the damage to the rice production could be severe

- From the end of June on gradually increase the depth of the water. If possible, by the middle of July the depth should be from 4” to up to 8”, to protect against a possible drop of temperature (50°F or lower).

- During this time period the water

To maximize the water temperature, add irrigation water early in the morning (the coldest temperature of the day) quickly, within a short period of time.

During the day do not move the water in order to maximize the water temperature.

You need to increase the water depth gradually, over a period of 1-2 weeks, in order to obtain a water temperature of 70-90°F at a depth of 4-8”.

It is difficult to warm up a quantity of water to 70-90°F in a short period of time.

2. Seasonal Activities (Growing Season: May - September)

3. Ripening Phase (flowering to harvest): Early August – Mid to Late September

- Because the rice plants are established, this phase uses lots of water. Keep the paddies flooded at all times.

- 2-3 weeks prior to harvest day, stop adding water to prepare for the harvest.

- Harvest: start early September - end late September

  During this period, light frost may cause little damage, if any.

  Harvest
  When about 90% of the panicles change color from green to brown, the rice is ready to start harvesting. You have a window of about 1 week or more - depends on the weather.
  We cut the rice stems using a hand scythe and make bundles from a handful of stems. Then, we hang them to dry in a drying greenhouse for 2-4 weeks.

  For grain storage the recommended moisture content is 15%.

If you use a combine, you may need to dry the rice further after harvest to reach the 15% level.

2. Seasonal Activities (Growing Season: May - September)

F. Weed Control

Up to now (3 years) we haven't had a serious weed problem. Our paddies were newly converted from a field (dryland) to a paddy. But, we are expecting that this will become an important issue in the future.

We will rogue weeds early in the season (early June to late June); and then once more (end of June to the beginning of July) to hand pick the weeds we missed the first time.

G. Insects, diseases - so far we do not have much!

H. Wildlife pests and others

- Canada geese munch on the plants early in the season
- Later when grain is ripening we observed rats, sparrow eating the grain. These could be serious.
- Others have reported deer

→

We are interested to try a rotary weeder if it is available.

Levees, we cut the weeds 3 times a year because they shade the rice plants and invite voles that could make a hole through which you could loose water.

Interesting subject for future investigations – growing rice with duckling, fish, etc., as weed control.

The Power of Duck – Integrated Rice and Duck Farmiing by Takao Furuno, 2001, Tagari Puclications; www.tagari.com

Rice Today, The International Rice Research Institute, Vol.7, No. 1, pg. 30, The Unsung Heroes of the Rice Field by Yolanda Chen.

Its subtitle says: "Simply by growing rice, farmers cultivate a complex - and free - pest control system without doing a single extra thing."

She is talking about tropical, irrigated rice fields, but we think that the principle is the same for the northeast.

Dr. Chen worked as an entomologist in IRRI's Crop and Environmental Sciences Division, 2004-07. She now teaches at the University of Vermont.

2. Seasonal Activities (Growing Season: May-September)

trouble, but we do not know the details.

I. The Integration of Conservation and Agriculture

In 2008 we started to contact many experts related to this subject.

In the 2009 season we plan to start to investigate and document the wildlife that inhabit our rice paddy and to identify aspects of watershed managment, especially those associated with our paddy system, as base information to establish a sustainable rice growing system.

In the case of coffee production www.audubooncoffeeclub.com/pages.php?pageid=39
This is one of the approaches of the integration of conservation and agriculture. Coffee trees planted with shade trees conserve habitats for migrating birds at the same time as producing coffee.

J. Processing Equipment

- Threshing – separating the grain from the stem. After threshing done, you have rough rice.
  We use a foot powered threshing machine.

- Dehulling – processing from rough rice to brown rice by removing the hull. After dehulling you have brown rice.
  We are now in the process of importing a dehuller from Japan.

- Milling – processing from brown rice to white rice by removing the bran. After milling you have white rice.

Foot powered thresher: it seems that this is still being manufactured in Japan. It is a very simple, but very useful machine. The following websites are in Japanese, but the pictures will give you an idea of what this machine looks like
www.welcome-ogihara.com/summer5.html

www.yoshitokunouki.com/dakkoku.html

www.hokuetsu.jp/10_f_1.html

http://www.ennou.com/s-dakkoku.html

2. Seasonal Activities (Growing Season: May-September)

We do not have one of these yet.

J. Processing Equipment

- Milling (cont.)

There is a table top type milling machine that polishes the brown rice with different adjustable settings, available from Japan. We are working to collect more information.

There are various degrees of milling. One example is Haigamai, which is a semi-milled rice that stills has some of the bran and germ attached. This rice holds some of the nutritious value of brown rice while taking a shorter time to cook.

Sources of Equipment in the USA

Grainman Grain Machinery, Mfg., Corp. – www.grainman.com.

Satake USA – www.satakeusa.com

Seedburo – www.seedburo.com

Yamamoto FC2K dehuller – http://www.calibrationplus.com/yamamoto/

Calibration Plus – www.calibrationplus.com

Importing Equipment from Japan

It is rather complicated and expensive. We suggest that people who are interested in importing equipment from Japan get together and pool their order to save time and money.

3. Additional Information

A. Seed Saving.

Rice is naturally a self-pollinating plant.

It is self-fertilizing.

We are not sure about safe distances between 2 different varieties, but so far we have not had a problem even with spacing as close as 1' apart.

B. Cooking

There are many different types of rice available. So, there are many different methods of cooking.

There are many books available on this subject. For a start, we recommend the following book. It will answer most of your questions and will explain the ethnic cultures of major rice eating people, especially the central position that rice plays in their everyday meals.

Seductions of Rice by Jeffrey Alford & Naomi Duguid, 1998, published by Artisan. www.artisanbooks.com