100 bits is where calculations start to get interesting," says Gershenfeld, who agrees that, without some very clever new development, the best an NMR-based quantum computer will ever do is tickle the lower end of that range. To get even that far, he says, an NMR-based system will have to be cooled to near absolute zero or use new algorithms. Says NIST's Monroe, "This NMR scheme is pretty slick stuff, but in the long run they're going to have to find a particularly special molecule or state that allows them to extend it to large numbers."

Still, what can be done now can be done with easily available and affordable equipment—"off-the-shelf coffee cups, off-the-shelf liquids, off-the-shelf magnets, etc.," says Lloyd—and it will open the way to testing new algorithms proposed for quantum computation and studying the properties of bizarre multiple-spin quantum states that until now have been untouchable. And if researchers can figure out how to extend the technology to larger bit numbers, says Gershenfeld, the future is unlimited. While traditional computer scientists struggle to squeeze more and more devices on a chip (see p. 303), NMR-based quantum-mechanical computing holds the promise of letting nature do all the work. "We're just computing more powerfully by being smarter about what nature allows us to do."

–Gary Taubes

ARCHAEOLOGY

Yangtze Seen as Earliest Rice Site

NARA, JAPAN—The cultivation of rice—a potent symbol of civilization for many Asian nations—may have occurred first along the middle Yangtze River in central China, according to preliminary findings by a team of Japanese and Chinese archaeologists. If confirmed, the findings, described at an international meeting* held here last month, would move back the date—and narrow the location—of the earliest domestication of this important crop.

Evidence for very early rice cultivation in the region may mesh with another find described at the meeting: a walled city several hundred kilometers upstream that could be the oldest such settlement yet found in China. Although both finds need much more work before the claims can be accepted, some archaeologists speculate that the two discoveries taken together suggest that the Yangtze region, rather than the more politically powerful Yellow River area to the north, could be the site of the oldest civilization in China.

This new view of rice cultivation was described by Syuichi Toyama, an environmental archaeologist at Japan's Kogakukan University. Toyama surveyed both published and recent unpublished radiocarbon data on 125 samples of rice grains, husks, plant remains, and impressions of rice grains in pottery from more than 100 sites along the 5400-kilometer length of the Yangtze. He reported that the oldest samples, with a median age of 11,500 years, are clustered along the middle Yangtze in Hubei and Hunan provinces. Samples from sites both upstream and downstream are typically younger, dating from 4000 to 10,000 years ago. That pattern, says Toyama, suggests that rice cultivation originated in the middle Yangtze and spread from there.

The work "is very important, and the fact that the dates are coming from a series of sites is persuasive," says Ofer Bar-Yosef, an archaeologist at Harvard University's Peabody Museum. Bruce Smith, an archaeologist at the Smithsonian Institution in Washington, D.C., who has written on the origins of agriculture, says that evidence has been mounting for the last decade that the Yangtze was probably the site of the earliest rice cultivation. But until very recently, the oldest evidence of Yangtze rice cultivation went back only 8000 years. The new findings are also likely to further refute earlier theories that rice was first cultivated in an arc extending from northern Laos, across northern Thailand and Burma and southwestern China, to the Assam region of India.

Grain of truth? This upper Yangtze site could be earliest Chinese settlement.

Toyama's dates would also make rice cultivation along the Yangtze older than the millet cultivation of northern China, which dates back 7800 years. It could also predate the earliest known agricultural site in west Asia—the domestication of barley 10,000 years ago. Bar-Yosef says that determining where and when rice cultivation began could help to explain the environmental, climatic, and perhaps social conditions that fostered its emergence. "The questions that are left open concerning the agricultural revolution 10,000 years ago in China are: What caused it? What led to this change?" he says.

The second component of the Yangtze findings—claims that early rice cultivation in the region nurtured an ancient, lost civilization—stand on more tenuous evidence. "It needs more work," says Fekri Hassan, an archaeologist at University College, London, who heard the presentations in Nara. A team excavating a site called Longmagucheng, along the upper reaches of the Yangtze about 35 km southwest of Chengdu in Sichuan Province, believes it may have identified the ruins of a fortified town with an earthen wall. Near the center of the enclosed area, which measures 1100 by 600 meters, is a three-tiered earthen platform that the researchers believe served some religious or governmental ceremonial function.

Unpublished radiocarbon dating of soil taken from the walls and the earthen platform place the site at between 4500 and 5000 years ago, says Yoshinori Yasuda, a geographer who heads the Japanese side of the team. Although that is younger than ancient civilizations in the Middle East, it would be older than anything yet found in China. Indications of urban settlements suggest that it was more advanced, and thus probably older, than a civilization believed to have existed along the Yellow River in northern China, says Yasuda.

The dig is being carried out by the Kyoto-based International Research Center for Japanese Studies, Sichuan Union University, and the archaeological department of Chengdu City. It is funded entirely by Japan's Kyocera Corp., a high-tech ceramics-maker, to promote cross-cultural understanding.

While intrigued, other archaeologists want to see more evidence. Harvard's Bar-Yosef says that a city of that size should also show evidence of houses, storage facilities, and refuse pits. "We're just at the very start," says Chaolong Xu, a Chinese archaeologist trained at Kyoto University who is a member of the Longmagucheng team. Xu foresees more than a decade of excavations at this and nearby sites in the valley to determine the region's role in human history.

–Dennis Normile

* International Symposium on Agriculture and Civilizations, Nara, Japan, 13–14 December 1996.