

How Rice Farming Shaped Culture in Southern China

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Abstract

We present a detailed theory linking southern China's history of rice farming to its modern-day culture. We explain how rice was farmed traditionally, what makes it different from other major staple crops, and why these differences could shape culture. Next we review empirical evidence that people who have grown up in the rice areas of China have different relationship styles and thought styles from people in the wheat areas. We also discuss why the rice theory is not environmental determinism—rice does not automatically lead to collectivism. Finally, we ask whether modernization is signaling the death of rice culture or whether cultures rooted in historical subsistence style can persist even after less than 2% of the population actually farms for a living.

Keywords: culture, rice theory, agriculture, farming, China, India

Rice Farming and Culture

The Yangtze River cuts from West to East across the middle of China (Figure 1A). Around the Yangtze and to the south, people have been farming rice for over a thousand years. To the north of the Yangtze River, people have been farming wheat and millet for thousands of years. This chapter argues that these two farming systems shaped cultures in northern and southern China.

This chapter is about China, but China is not the only country with a traditional rice/wheat split. India also has a rice/wheat split (Figure 1B). Many other cultures have farmed rice traditionally—Japan, Vietnam, Thailand, Indonesia, parts of Italy, West Africa, and South America to name just a few. Rice is a major staple crop in many parts of the world, and more than half of the top 10 most densely populated cities in the world are in rice areas (Malone & Van Riper, 2007). If rice shapes culture, it has probably influenced cultures in these other areas of the world.

This chapter is not about culture in the past. It's about culture now—how people think now, how often they get divorced, for example. But if we are trying to understand modern cultures, why should we look to farming? Farming is remote from most people's lives. But for thousands of years, farming was not remote. Farming was how the vast majority of people in China spent their time, day in, day out. Farming meant the difference between feasting and starving. A system so central to so many people's lives had plenty of time to shape the culture. This chapter explains what made rice so different from wheat and why that could shape culture.

1. How Rice is Farmed

If we want to understand how rice farming affected culture, we need to know how people farmed it. For reasons we will make clear later, we will talk mostly about paddy rice farming in China, Korea, and Japan. By “paddy rice,” we mean rice that people farmed (1) in

standing water (2) in plots that they built up with soil to hold in water and (3) that they actively drained or filled with water.

Below, we explain two of the most important differences between rice farming and wheat farming. That ignores lots of crops. There are plenty of other important crops in the world—potatoes, sugar cane, and cotton are a few. There are also plenty of other subsistence styles—hunting and gathering, slash and burn farming, and fishing.

We contrast rice with wheat because these have been two important cereal crops in China. They provided much of the calories for the majority of the population in many areas. In China, we use wheat, corn, and soybeans statistics to represent dryland crops that are grown more or less similarly (and at the very least, very differently from paddy rice). In other areas of the world, crops like millet, barley, sorghum, and potatoes are more common dryland crops (but keep in mind that a single crop can be grown different ways).

Although we use wheat to represent farming in northern China, millet was widespread in northern China before wheat (Fuller, Harvey, & Qin, 2007). Around 500 BC, Confucius was probably more familiar with millet than wheat or rice. In the *Analects*, Confucius mentions broomcorn millet (roughly 500 BC; Elvin, 1982, p. 16). Thus, we say “wheat” for simplicity, but this also includes crops like millet and corn.

Irrigation Networks

The feature that separates rice most clearly from wheat is that it grows best in standing water (Khush, 1997). This is not true of wheat. There are varieties of dryland rice that grow without needing to be flooded (Bray, 1986, p. 11). However, farmers can attain the highest yields with flooded rice, so the rice plant incentivizes people to irrigate their fields (Khush, 1997).

How much of an incentive are we talking about? Farmers planting dryland rice produce about 1.2 tons per hectare; irrigated rice yields 5 tons per hectare (Khush, 1997; also:

Bray, 1986, p. 15). Thus, in nations where calories and thereby population size were huge factors in state power (Scott, 2014), nations could increase their size and power by irrigating rice rather than growing dryland rice. Paddy rice was a path to success.

We focus on rice that humans actively irrigated, but not everyone needs to irrigate rice. Paddy rice came from parts of the world that naturally flood with seasonal rainfall or waterway flooding (Tsuruta, n.d.). Parts of China could grow rice without human irrigation if they wanted to.

However, even in areas that flood naturally, there are still incentives to putting in human irrigation. For one, irrigation can precisely control the level of water. Natural flooding is irregular. Too much water slows rice growth; too little water lets weeds take over (IRRI, 2007). Human irrigation also allows farmers to control the timing of flooding and draining.

Controlling water also makes it easier to complete the tasks rice requires. For example, if fields are wet when farmers need to harvest, it takes longer to complete the harvest (Hayami, 1978, p. 27). Thus, even in areas that flood naturally, active irrigation can still improve rice yields.

Labor Requirements

The second important characteristic of paddy rice is that it requires more work. On average, rice requires about twice the number of man-hours to grow as wheat (Buck, 1935, p. 302; Fei, 1945, p. 214).¹ This is because rice requires tasks that wheat usually does not.

One important rice task is transplanting. Many farmers grow rice seedlings in small plots away from the main fields and then transplant them to the main field after they've

¹ A savvy reader could argue that it doesn't make sense to split irrigation and labor. After all, a lot of the extra labor of rice comes from the irrigation. If irrigation is the key variable, why not just talk about irrigated versus non-irrigated agriculture? Irrigation took a lot of work, but labor could also be an important element of crops that don't have to be irrigated. By leaving room for two separate mechanisms, we can distinguish between these two variables in future research.

grown. Growing them first in small plots helps farmers more precisely control the water levels for the young seedlings (Fei, 1983, p. 74). Transplanting also frees up the main fields to grow other crops. Transplanting has these benefits, but it adds to the labor burden of rice (Elvin, 2006, p. 209).

Another task is making the field flat. Flatness is particularly important for rice because it grows in standing water. If a field is uneven, part of the field will have too much water, which slows the growth of the rice. The other part of the field will have too little water, which allows more weeds to grow and compete with the rice. Level fields yield more rice (IRRI, 2007).

Another method anthropologists have used to compare rice and wheat labor requirements is to observe farmers in traditional villages. For example, anthropologist Fei Xiaotong embedded in a village in Yunnan and found that rice required about twice as much labor as wheat and barley (Fei, 1945, p. 214). Similarly, American John Buck led a survey team that visited farms in 22 Chinese provinces in the 1930s. They found that rice farmers were spending an average of 50 days per year per crop acre, compared to 25 days for wheat (Buck, 1935). This was true not just of rice farmers in China. For example, anthropologists have found similar differences between rice and millet farmers in West Africa (Richards, 1987).

If the labor difference between rice and wheat really is so large, do we need precise social scientists to discover it? In fact, the farmers themselves were well aware of the difference. For example, a Chinese farming guidebook in the 1600s told readers, "If one is short of labor power, it is best to grow wheat" (quoted in Elvin, 1982, p. 30). Fei found that farmers in his village planted corn when they were short of labor (Fei, 1945). This also demonstrates the crops like corn require less labor even when grown on land that can also grow rice.

Why Would Anyone Farm Rice?

Rice sounds like a pretty awful crop. It requires twice as much work as wheat? And I have to build an irrigation network to support it? What kind of fool would say yes to that deal?

The answer is simple. All that work pays off. Paddy rice produces more tons per hectare than the other major staple crops (Fuller & Qin, 2009, p. 88). For example, Chinese rice farmers in the 1930s were yielding 223 kilograms per *mou* (666.5 square meters; Buck, 1935). Wheat farmers were yielding about 71 kilograms. Historically, paddy rice yielded three to five times more than wheat (Perkins, 1969, p. 19, 267). The rice plant rewards hard work.

This extraordinary productivity per acre has implications for the problem of reverse causality. Suppose that all of China had the right environment for rice, but only some areas chose to grow rice. That would mean it's people who already like to work together who chose to grow rice, not rice that made people work together.

The productivity of rice provides one piece of evidence that reverse causality is not a problem. Because rice is so productive, people have a strong incentive to grow it. We can see this incentive in the data, which shows that most of the places in China that *can* grow rice *do* grow rice. Environmental suitability for rice (according the United Nations Food and Agriculture Organization) strongly predicts where farmers actually grow rice in China $\beta = 0.85, p < .001$. Environmental suitability for rice also consistently predicts cultural differences within China (Talhelm et al., 2014, Table 2).

Other Differences

We focus here on irrigation and coordination as the characteristics that most clearly distinguish rice farming from wheat farming. However, we are under no illusion that these are the *only* things that make rice different from other crops. Rice is an entire system. An entire book could be written explaining the system of rice farming and how it is different from other

crops. Our writing elsewhere describes other potential factors, such as population density (Talhelm, 2015).

2. Why That Matters for Culture

Irrigation and Coordination

The way people farmed rice was different from the way people farmed wheat, but what does that have to do with culture? Our argument is that these two features of rice—irrigation and labor—set out problems that humans could solve by adapting their behavior and social structure. Below we explain the behaviors that humans set up in order to farm rice.

Coordinating Tasks. First, irrigation usually requires farmers to coordinate. In fields where many plots are connected to a single irrigation network, farmers have to coordinate when to fill and drain their fields (Bray, 1986, p. 119; Fei, 1946, p. 172). This infrastructure creates an environment wherein rice farmers are more socially enmeshed. In this environment, one person's behavior influences other people's outcomes. In this environment, it's hard to be a rogue rice farmer.

Compare that to a standard wheat village. Many wheat farmers rely on rainfall, and that makes social relationships simpler. It rains on wheat farmers' fields equally whether they coordinate or not. Wheat farmers' relative independence gives them more social flexibility. The costs of offending another villager or being a bit eccentric are lower because wheat farmers rely on their neighbors less than rice farmers. This fits with the finding that irrigation farmers in India show more social conformity than dryland farmers (Chapter X). This could also help explain why northern China is known for being *zhishuang* (直爽), direct and forthright (even at the cost of hurting people's feelings).

Collective infrastructure building. Second, irrigation often requires collective action. Many irrigation networks are large projects. It was probably out of the scope of a single family to set up an entire irrigation network. In India, temples coordinated efforts to

build irrigation networks (Stargardt, 1983, from Bray, 1986, p. 65). That means the task of setting up the irrigation system would fall across many families.

Irrigation commons problems. Third, irrigation creates commons problems. Over time, dirt will build up in irrigation channels and clog the system. Irrigation walls will fall apart over time and need to be repaired.

With big irrigation networks, these maintenance costs are large burdens, and they're spread out over multiple families. This is a classic commons problem. Any one family will benefit from that maintenance work, but no single family will want to do that work on its own.

To solve this problem, rice villages had systems for coordinating when they filled and drained their fields and for maintaining the irrigation infrastructure. For example, Fei (1983) documented how rice farmers in a southern Chinese village coordinated tasks, such as pedaling wooden machines to fill or drain their fields (Figures 2-3). Farmers set up rotating task assignments with punishments for farmers who failed to show up for their tasks.

The economist Masahiko Aoki (2001) took this argument further. He argued that rice villages set up strong systems of social isolation to punish free-riders.² He describes a custom wherein Japanese rice farmers would refuse to help free-riding farmers or invite them to local festivals, called the "80% separation" system (p. 49; *Mura-Hachi-Bu*, 村八部).

Another element is preventing flooding. People use irrigation networks to add water to fields, but some systems also functioned to keep too much water from coming in. If the walls fail, and the rice is flooded with too much water, it will grow more slowly or not at all (IRRI, 2007).

² We are not arguing that only rice villages punish free-riders. Surely wheat farmers, herders, and Wall Street bankers punish egregious free-riders. Instead, the argument here is that paddy rice had *more* shared tasks and thereby more chances to punish free-riders. And because rice requires so much labor, it's harder to put food on the table for an outcast rice farmer than for an outcast wheat farmer.

For example, some farms near Shanghai sat below the water level (Elvin, 2006). This was not an individual problem. The walls holding the water back stretched across multiple plots. Even if one family built their wall securely, that work would be wasted if their neighbor's wall collapsed. A Chinese text described how this forced different farmers to work together:

[If] the wall of the polder [low-lying field] for one family's holding has collapsed, then the wall in sound condition in the rest of the polder is useless. Under these circumstances, the poor and rich will give each other mutual support (quoted in Elvin, 2006, p. 118).

Water sharing. Finally, because paddy rice is a thirsty plant, farmers have to decide how to divide water resources. That is particularly true in places where rainfall is unreliable from year to year. When water is low, farmers need to coordinate their water usage or risk nasty confrontations. Or even worse, if farmers refuse to coordinate and draw out all the water early in the season, there may not be enough water in *anyone's* field to get a crop that year.

Rice villages have found different ways of coordinating water use. Perhaps the most detailed picture we have is of the *subak* system in Bali (Suarja & Thijssen, 2003). *Subaks* are a bit like local water committees, deciding how to divide water, when to plant, and when to do maintenance. Farmers in *subaks* meet to discuss these decisions and then vote to make decisions. In years where rainfall is low, the assemblies can decide to grow crops other than rice—crops that use less water.

Again compare this to wheat farming (at least wheat that isn't irrigated). If farmers in a village are all relying on the rain to water our wheat, they don't need to decide how to

distribute that rain. Rain falls on all plots equally. Rain even falls on the plots of farmers that everyone else in the village hates.

Cooperative Labor Exchanges

The high labor demands of rice are important for culture because rice farmers set up cooperative labor exchanges to deal with the labor demands. For example, several farmers in a village would all work together to plant one farmer's rice plot now in exchange for working on their plots later. In the village Fei Xiaotong studied, farmers enlisted relatives and acquaintances in nearby villages (Fei, 1945, p. 65). Under Japanese tradition, only the first son inherited the rice field (Honda, 1996). That meant farmers often had non-farmer siblings in nearby cities who could come back and help during the planting and harvesting season.

This is a feature of rice farming in many cultures. Anthropologists have found similar labor exchanges in West Africa (Richards, 1987), Korea (Reed, 1977), India, Malaysia, and Indonesia (Bray, 1986). The anthropological evidence suggests that many rice cultures hit upon the idea of using labor exchanges to meet the high labor demands.

Were rice cultures the only cultures that shared labor? The way we've talked about rice so far could make it sound like rice farmers are the only people who share labor. That is obviously wrong. Thomas's Midwest American wheat farmer ancestors shared labor to build barns; shifting farmers³ help each other clear fields (Suehara, 2006); fishermen in Indonesia work together to kill large whales (Henrich et al., 2005). Rice farmers aren't the only people who share labor.

However, it is precisely by seeing how rice exchanges were different from other labor exchanges that we can see what made rice different. For example, among shifting farmers in

³ The most well-known form of shifting farming is slash-and-burn agriculture. Shifting farmers clear a plot of wild land, farm it, and then move to a new field.

the Congo, labor sharing was more like a festival (Suehara, 2006). Families came together to clear a plot of land. After the land was cleared, the host would provide everyone banana beer.

There are a few key differences between shifting farmer exchanges and rice exchanges. First, the Congolese farmers would repay the favor on the same day in beer. In contrast, anthropologists in China and Japan reported that farmers strictly returned labor with labor (Fei, 1945; Suehara, 2006). In fact, if a farmer received labor but then fell ill and couldn't return the labor, he would reciprocate by paying for laborers to work the field (Fei, 1945).

Second, rice labor exchanges were less of a social nicety and more of an economic necessity. If rice farmers were exchanging labor out of fun or social spirit, they might exchange labor during the less-busy time periods, such as during tilling or weeding. Instead, rice farmers exchanged labor at peak labor times—transplanting and harvesting. In contrast, Suehara reports that Congolese exchanges were designed more to make work fun and exciting—work that was “otherwise lonely and tedious” (Suehara, 2006, p. 61).

Rice labor exchanges may have made rice communities more interdependent, with relationships more focused on reciprocation. For example, recent studies have found that Chinese and Japanese participants are more likely than Americans to feel indebted to others after accepting a favor (Hitokoto, 2016; Oishi & Komiya, 2016) and less likely to ask for emotional support (Taylor, Welch, Kim, & Sherman, 2007).⁴ This might also explain our anecdotal observation that people in China and Japan are more hesitant to ask for favors—they're concerned about accumulating “debt.”

Why Rice Cultures Aren't About Loving Everyone

⁴ This point confuses many people. Shouldn't people in interdependent cultures be *more* likely to rely on each other? Describing rice cultures as collectivistic and cooperative easily leads people to have these intuitions. But tight, interdependent ties mean that relationships are bound up with duties. That also means the costs of accidentally damaging those relationships is higher.

After the rice theory findings in China were published (Talhelm et al., 2014), several media articles described southern China as more “cooperative.” We have used the word “cooperation” to describe rice farming, so the description is fair. But a reader whose parents grew up in southern China commented on one of the articles saying, that doesn’t sound like my parents! We agree.

The problem with words like “cooperative” is that they make it sound like people are generally more pro-social. It sounds like, “They are warm. They help people. They like everyone.” In reality, collectivism in East Asian rice areas is more about reciprocal obligations and tight relationships with trusted ties. It’s less about being warm and fuzzy, and more about navigating an interconnected web of relationships.

This isn’t just a misunderstanding of non-specialists. For example, one study used a self-report collectivism scale to measure collectivism across China (Van de Vliert, Yang, Wang, & Ren, 2013). This scale had participants rate broad, warm-sounding statements such as “What is good for my organization is also good for me” (Van de Vliert et al., 2013, p. 594). On this scale, southern China scored **less** collectivistic than northern China (Van de Vliert et al., 2013).

Researchers have found this same pattern when they compare East and West. A meta-analysis found that China, Hong Kong, and Taiwan scored significantly **lower** than the US on self-report scales of collectivism (Oyserman, Coon, & Kemmelmeier, 2002). All of this suggests that the intuition of the reader whose parents were from southern China was correct. People in rice areas are not more likely to endorse vague, socially positive statements.

So if collectivism in rice areas is not about warm feelings toward other people or groups, what is it? Here we describe three findings that speak to three specific social styles.

Friend/Stranger Distinction. In China, we tested participants on their friend/stranger distinction. In this task, participants imagine going into business with a friend or stranger;

then they discover the friend or stranger was honest or dishonest; and they can choose to punish or reward the friend and stranger (Wang, Leung, See, & Gao, 2011). Even though the behavior of the friend and the stranger are identical, previous studies have found that participants in Singapore reward the friend much more than they reward the stranger (Wang et al., 2011). Americans also reward the friend more than they reward the stranger, but the difference is much smaller.

In China, we found that people from the rice region drew a larger distinction between friends and strangers than people from the wheat region (Talhelm et al., 2014). Rewarding a friend more than a stranger for identical behavior could be described positively as loyalty or negatively as nepotism. In either case, the friend/stranger task doesn't measure people's behavior toward "other people" in general. It more precisely assesses non-self-report differences in how people treat a stranger and a friend.

This mirrors findings from a rare natural experiment with rice farmers in Sri Lanka (Aoyagi, Sawada, & Shoji, 2014). As a part of a development project, the Japan Bank for International Cooperation helped fund irrigation infrastructure in southern Sri Lanka. In the interests of fairness, the government used a lottery to randomly assign farmers to new irrigation networks—a windfall for researchers. Researchers found that being hooked into the same irrigation network increased people's trust toward other people in the same irrigation network. And as farmers spent more years in the same irrigation network, trust increased. Importantly, trust increased more to people in the same irrigation networks as opposed to people in other nearby irrigation networks or people in general.

Importance of the Self. Another variable was the relative importance of the self. We had participants from all over China draw a diagram of their social network, with circles to represent the self and friends. A previous study found that Americans, Brits, and Germans draw the self circle bigger than they draw friends, whereas participants in Japan draw the self

and friends roughly the same size (Kitayama, Park, Sevincer, Karasawa, & Uskul, 2009). In China, participants from the wheat area drew the self larger than their friends; in the rice area, participants drew the self roughly the same size as friends (Talhelm et al., 2014).

Relational Mobility. We also tested whether rice areas in China have lower relational mobility. In cultures with high relational mobility, it is easy to meet new people, form new relationships, and leave unsatisfying relationships (Schug, Yuki, & Maddux, 2010). In cultures with low relational mobility, there are not as many opportunities to meet new people, and it is less acceptable to exit relationships. Unlike self-report scales, the relational mobility scale asks people not to rate themselves, but rate their social environment—their school, their neighborhood, their community.

Previous studies have found that US has higher relational mobility than Japan (Schug et al., 2010; Yuki, Thomson, Kito, Yamada, & Schug, 2016). In India, we have found preliminary evidence that people from the wheat areas report higher relational mobility than people in rice areas. This relationship style may fit with the strict labor coordination in rice villages. When you have to work with your neighbor and your cousin to put food on the table, relationships are more entrenched and harder to exit. Note that none of the three differences we describe here involves warm feelings toward other people in general or feeling that “what is good for my organization is also good for me,” like the self-report collectivism scale mentioned earlier.

3. How It Got That Way: The Historical Development of Rice

One day Thomas (the first author of this chapter) stumbled upon a rice village in southern China. It was summer—very hot and humid. It was also time to transplant rice seedlings, and the villagers were putting the seedlings into the flooded rice paddies in a group of 11 (Figure 4). Standing there on the edge of the rice paddy, it’s easy to think, “Wow, we’re witnessing traditional rice farming.”

Yet rice farming was not “born” into the world like this. Consider rice farming in the Shanghai region during the Tang Dynasty (618-906 AD). Rice farmers were burning their fields instead of plowing them, and they even hunted and fished for a large portion of their calories (Elvin, 2006, p. 168). Even in the 1100s, farmers in Guangdong Province were still farming without transplanting (Bray, 1986, p. 44).

There are ways to farm rice that are much easier than intensive farming. So why did China eventually develop intensive rice farming? Why not keep using easier methods? To understand the development of rice farming, it’s important to understand the tradeoffs. Intensive rice paddies produce some of the most calories per hectare of any grain crop. But that productivity comes at a high labor cost. That means farmers can maximize different resources:

1. Maximize calorie output per unit of labor.
2. Maximize calorie output per unit of land.

If the goal is to maximize calories per unit of labor input, then intensive rice paddies are not a smart choice. Instead, dryland rice, potatoes, or slash and burn agriculture are better choices.

The decision comes down to which resource is plentiful and which is scarce. With a small population and lots of plentiful land, it makes sense to plant large plots with low-intensity labor input. Yet in a densely populated area where land per person is scarce, it makes more sense to put more labor into a small plot and achieve incredibly high outputs per acre.

There is historical evidence suggesting that farming in China developed from low labor per hectare to high labor per hectare. For example, historical records show that Chinese landowners sued each other over smaller and smaller pieces of land over time (Elvin, 2006, p. 182). This is a likely narrative: As China’s population grew, labor became more plentiful, and free land became scarce. This made intensive paddy rice more attractive.

This historical development hits home the point that not all rice is equal. Low-intensity dryland rice is very different from high-intensity paddy rice. The intensive rice paddy farming of places like China and Japan probably depended on the pre-conditions of stable government and population density.

These historical antecedents could also explain why other parts of Asia still use rainfed rather than manmade irrigation systems. For example, much rice in Southeast Asia (such as in Thailand) is rainfed rather than irrigated (IRRI, 2009). These areas may have lacked the consistent population pressure or societal infrastructure and stability needed to push toward more intensive manmade irrigation systems.

Thus, rice output alone may not be the correct predictor of rice culture. Historical rice intensity and the methods of farming may be the more precise predictors of rice culture. Future research comparing intensive rice regions with rainfed and dryland rice regions can answer this question.

4. Why Rice Is Not Ecological Determinism

The rice theory is not the first theory to link culture to subsistence style. Researchers have connected the environment to culture in anthropology (Hallowell, 1949; Harris, 1977), history (Fischer, 1989), economics (Alesina, Giuliano, & Nunn, 2013), and psychology (Barry, Child, & Bacon, 1959; Berry, 1967; Nisbett & Cohen, 1996; Uskul, Kitayama, & Nisbett, 2008). Because subsistence theory has a rich history, we can draw on their experience of criticisms of subsistence theories to help refine the rice theory.

Perhaps the most common criticism of subsistence theories is the charge of “ecological determinism.” Ecological determinism reduces culture to the following formula:

If a region has X environment, it has Y culture.

In other words, the environment completely determines the culture.

Another reason ecological determinism offends some researchers is that it seems to rob humans of free will. One stream of anthropology focuses on the symbolic meaning of cultural practices. That stream emphasizes how arbitrary certain cultural practices are. Why does Culture X feast around circular tables instead of square tables? Why does China use chopsticks and France use forks? One reason is that humans have the agency to invest arbitrary objects with meaning. But deterministic theories seem to take that agency away.

Perhaps the stronger criticism is that cultures are not that simple. Regions with similar environments do not inevitably produce the same cultures. Regions with vastly different environments can produce similar cultures (for examples, see: Cohen, 2001). If a good researcher knows everything about the environment of a tribe, it would be foolhardy for that researcher to predict with 100% confidence what that culture will be like.

In this section, we build upon these criticisms with two larger points. First, ecology is surely not the only variable that influences culture. Subsistence theory cannot come close to explaining all of culture. Clearly there are historical oddities, powerful individuals, contact with other cultures, and many other factors that influence culture.

Second, the environment for rice does not always lead to rice culture. The environment for rice does not always lead to the intensive paddy rice farming of China. The story is more complex. Below we explain why.

Why labor exchanges are not inevitable. The rice theory is not so simple as to say that rice causes collectivism. Instead, the model requires another step. Rice presents a problem: it requires lots of labor and grows best in standing water.⁵ This problem calls out of a solution—there are rewards (calories) to be given to people that can solve this problem.

⁵ And some rice regions haven't even faced this problem in the first place! Areas with low population density and plentiful land can get enough calories out of the rice without creating systems to grow it intensively.

As an analogy, the natural world presents humans with the problem of rain and cold weather. That problem calls out for a solution—the rewards are warmth, safety, and health. Even though the problem is the same, humans solve it in different ways. People have lived in caves, carried tents, built cabins, and erected modern apartment buildings. A single problem does not always lead to identical solutions.

Rice presents a problem. Cooperative labor exchanges and irrigation coordination are one way to solve that problem. But this is not the only way. Rice farmers have come up with different solutions for the labor problem.

Let's focus on labor exchanges. Labor exchanges are not the only solution to rice's labor problem. In modern times, farmers use diesel water pumps, tractors, and sometimes even planes to reduce the number of man-hours needed to farm rice (Bray, 1986). In coastal Georgia and South Carolina, landowners forced slaves to plant rice (Smith, 1991). Coastal Georgia and southern China had the right natural environment to grow rice, but China ended up with labor exchanges, and Georgia ended up with slavery. Labor exchanges are not inevitable. Heartwarming teamwork is not the only solution to rice's labor problem.

Even if we look at cultures that have settled upon labor exchanges, we will still find differences. People in different areas choose different types of people to exchange labor with. For example, in one village in Malaysia, farmers would exchange labor in groups of 10 or 12 families (Bray, 1986, p. 120). In Sierra Leone, a researcher observed families, friends, divorcees, and even groups of children exchange labor on rice plots (Richards, 1987). In China, farmers would sometimes hire laborers depending on the circumstances (Fei, 1945). These different systems could lead to differences in the cultures.

Not all rice is irrigated. Another complication to the rice theory is that rice doesn't have to be irrigated. If we predict which areas of the world will have rice culture by measuring how much rice they grow, we are glossing over different types of farming

(although sometimes rice output is the only statistic available). Rice grows best in standing water, but it does not need standing water.

The biggest exception is dryland rice. These are varieties of rice that grow on dry land, no irrigation needed. Dryland rice has the advantage that it requires less labor, but it produces far fewer calories per acre (Khush, 1997; also: Bray, 1986, p. 15). Farmers usually grow dryland rice on hilly areas that are hard to irrigate or in land that is simply too dry for paddy rice. Farmers could also decide to plant wet rice one year and dryland rice the next year if they are short of labor.

Nor is it true to say wheat is *never* irrigated. Some wheat and millet is irrigated. Now, wheat irrigation is not the same as rice irrigation, particularly because wheat and millet are not grown in standing water. But in very dry areas, farmers do irrigate wheat and millet. For example, an unusual amount of wheat farmland in India is irrigated (Sayre, 2002).

Even among rice grown in standing water, irrigation methods are not always the same. Wet rice can be roughly split into human irrigated and rainfed rice. In areas blessed with the right amount of rainfall or flooding at the right time of year, farmers can rely on nature's flooding and save themselves much of the work required in human irrigation. Much of the rice grown in Southeast Asia is rainfed (IRRI, 2009). Thus, rice culture in non-human-irrigated rice areas of Southeast Asia may be different from rice culture in China.

Human agency. Here's the kindergarten version of the rice theory:

Environment for rice = interdependent culture

Here's the university version:

The environment for rice = the ability to grow rice + higher likelihood that the people living there will use one of many different types of strategies that unlock rice's potential to produce higher calorie output per acre than other major grain crops.

This formula is longer, but by adding in these elements, we return human agency to culture. This also forces the theory to accommodate the variability of human culture. It forces the theory to recognize that one type of environment does not mean one type of culture.

At the same time, we should not be so naïve as to say that ecological theories brook no human agency. The very foundation of ecological theories is that humans are capable of recognizing payoffs in their environment and strategizing their behavior to fit their environment (even if their decisions do not always lead to the best outcomes). If humans *weren't* doing this, are we not robbing humans of their agency, of their intelligence?

5. The Future of Rice Farming

Changes in Rice Farming

Technology is making it easier to farm rice without cooperation. In 1909, it took a team of rice farmers in Japan 14 full days of work to irrigate a single hectare (Bray, 1986, p. 55). Today, a single person can water several hectares by turning on a diesel water pump. What rice means for culture depends on how people farm it.

Technology is also changing *where* we farm rice. In traditional China, rice was grown in wet, warm areas. Yet it was really the “wet” part that determined most of where rice was grown. As one demonstration, we ran a regression to test whether precipitation or average temperature is a better predictor of how much farmland different provinces in China devoted to rice paddies in 1986 ($N = 28$). In that regression, temperature was not significant ($\beta = .18, p = .22$), but precipitation was ($\beta = .77, p < .001$).

Modern technology is now bringing rice to those dry areas. Underground wells, diesel pumps, and other irrigation technology have given farmers in drier places access to water. We analyzed changes in Chinese agricultural data from 1986 to 2011 to see how much rice farming has changed. China's core rice areas did not increase over this period. By far the biggest increase in rice farming happened in the three cold and dry northeastern provinces (Liaoning, Jilin, and Heilongjiang). In fact, nowadays many people in China say the tastiest rice comes from the northeast.

Does rice farming still bring collectivism when that farming arrives with modern irrigation technology? We don't know, but our initial data suggests it has not (Talhelm et al., 2014). For example, divorce rates in China's northeast are far and away the highest among Han China (Talhelm et al., 2014, p. 605, controlling for GDP per capita). Perhaps modern technology has allowed northeastern farmers to farm rice without needing to build out the same cultural infrastructure to support it. Or perhaps there simply hasn't been enough time for these changes to influence this aspect culture.⁶

Will Rice Culture Disappear with Modernization?

But in the face of modernization, how long will rice culture last? In the US, farming technology has vastly shrunk the percentage of the labor force that farms from about 50% in 1870 to less than 2% (Bureau of Labor Statistics, 2015; Daly, 1981). China has experienced the shift away from farming more recently. This trend could easily lead to the conclusion that rice culture is on its deathbed.

⁶ There is one more intriguing possibility. The study in Sri Lanka found that being hooked into a rice irrigation network increased trust toward other farmers in the same network (Aoyagi et al., 2014). That finding suggests that effects of farming style can happen within a few years. If the same is true in northeastern China, perhaps the recent changes have influenced local farmers but have not had enough time to permeate the culture as a whole, including people who have never farmed.

In our tests of over a thousand students around China, we found differences between people from the rice and wheat areas despite the fact that they had never farmed for a living. This suggests that culture has inertia. But just how long will it last?

There is evidence that cultural differences rooted in subsistence style can persist long past the point that people put down their plows. Nisbett and Cohen (1996) argued that the US south's settlement by Scots Irish herders brought with it a culture of toughness based on the need to protect valuable and easily stealable property—cattle. (Fischer [1989] gives a deeper historical account of settlement waves in the US.) Yet roughly 200 years after that settlement happened, they found evidence that the south has higher rates of violence and more forgiving attitudes toward people who have committed honor violence. This case gives one speculative answer: subsistence cultures can persist at least 200 years.

Japan provides another intriguing test case. Japan was historically a rice culture. In 1950, 57% of the nation's farmland was devoted to paddies (Japanese Statistics and Information Department, 2009). Yet Japan has been modern and wealthy for decades. In terms of GDP per capita, Japan caught up with Western Europe in the 1970s and surpassed it in the 1980s (Maddison, 2003). To this day, Japan has a higher GDP per capita than Western Europe. If wealth and modernization stamps out rice culture, Japan is probably our best test case to see it.

Yet nearly 50 years of wealth have not made Japanese people “Western.” Of course, many things have changed. Birth rates have dropped, high-rise apartment buildings have sprung up, and millions of people have found white-collar office jobs (World Bank, n.d.). There is some evidence that individualism has increased in Japan, although the evidence is mixed (Hamamura, 2012; Yamawaki, 2012). And in international studies of individualism, Japan still scores far lower than similarly wealthy countries (for analysis, see: Talhelm, 2015,

which draws upon data from Gelfand, Bhawuk, Nishii, & Bechtold, 2004; Hofstede, 2001; Suh, Diener, Oishi, & Triandis, 1998).

How are rice cultures passed down in the modern age? One way to think about it is to think of urban neighborhoods in Japan as modified rice villages. Urban neighborhoods are rice villages in the sense that they still have strong neighborhood associations with lots of obligatory activities, such as cleaning parks and common areas, fire and disaster prevention, and festivals (Schoppa, 2012). Although less than 2% of Japanese population today are rice farmers ([The Nikkei, 2015](#)), many non-rice farming Japanese live in neighborhoods that have a similar function to traditional rice villages.

The cases of the American south and Japan give us two points of evidence that cultural differences rooted in historical subsistence style can persist even in the face of modernization. Yet these are just two suggestive datapoints. Ultimately only time will tell.

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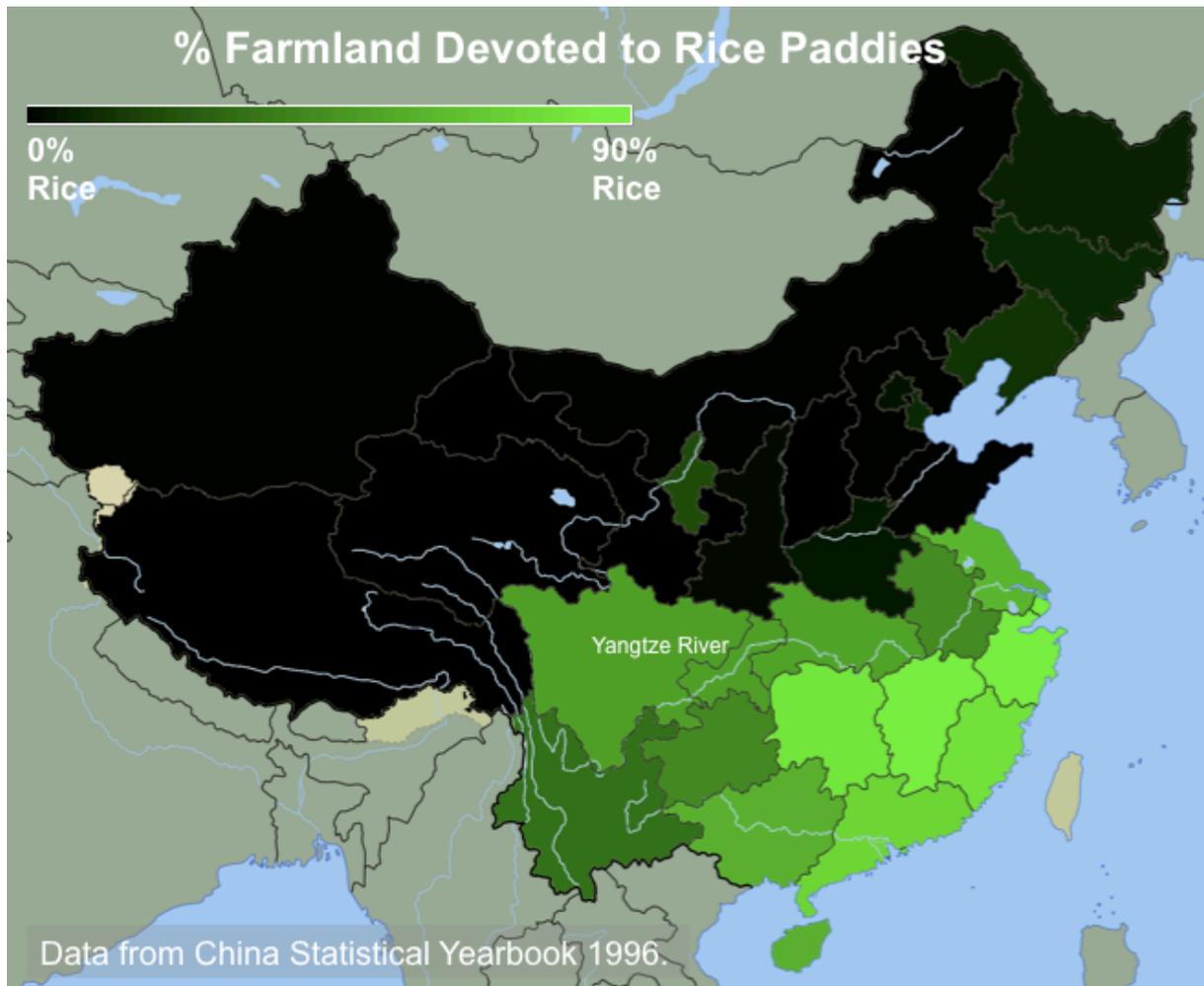


Figure 1A. Percentage of farmland devoted to rice paddies per province in China. Statistics are from the 1996 Statistical Yearbook. Southern China has a history of farming rice, and its culture has tighter, more enmeshed relationships compared to the relatively loose culture of China's wheat-growing north.

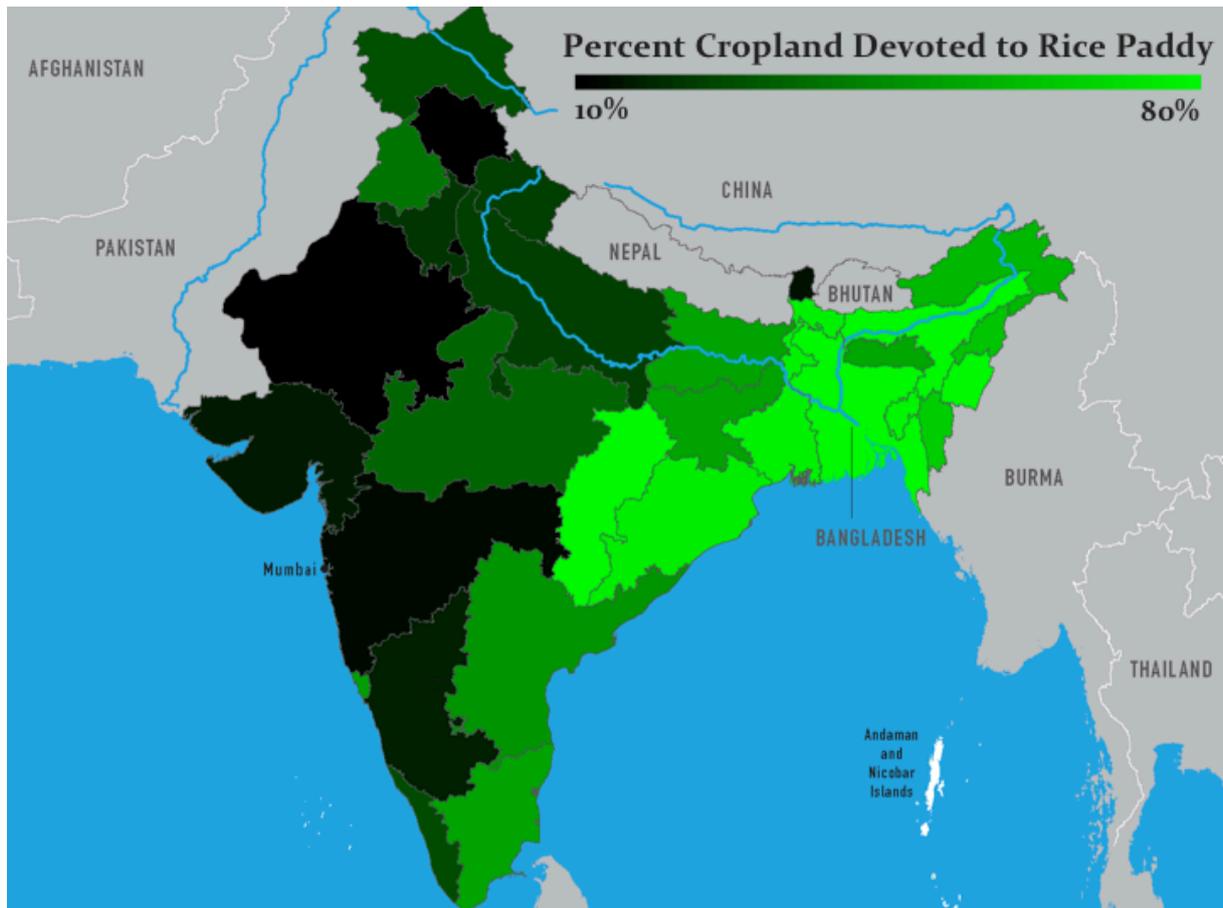


Figure 1B. Percentage of food cropland devoted to rice paddies per state in India. Statistics are from 1995 government statistics. India provides an interesting test case in contrast to China because India's rice production is not correlated with average temperature.

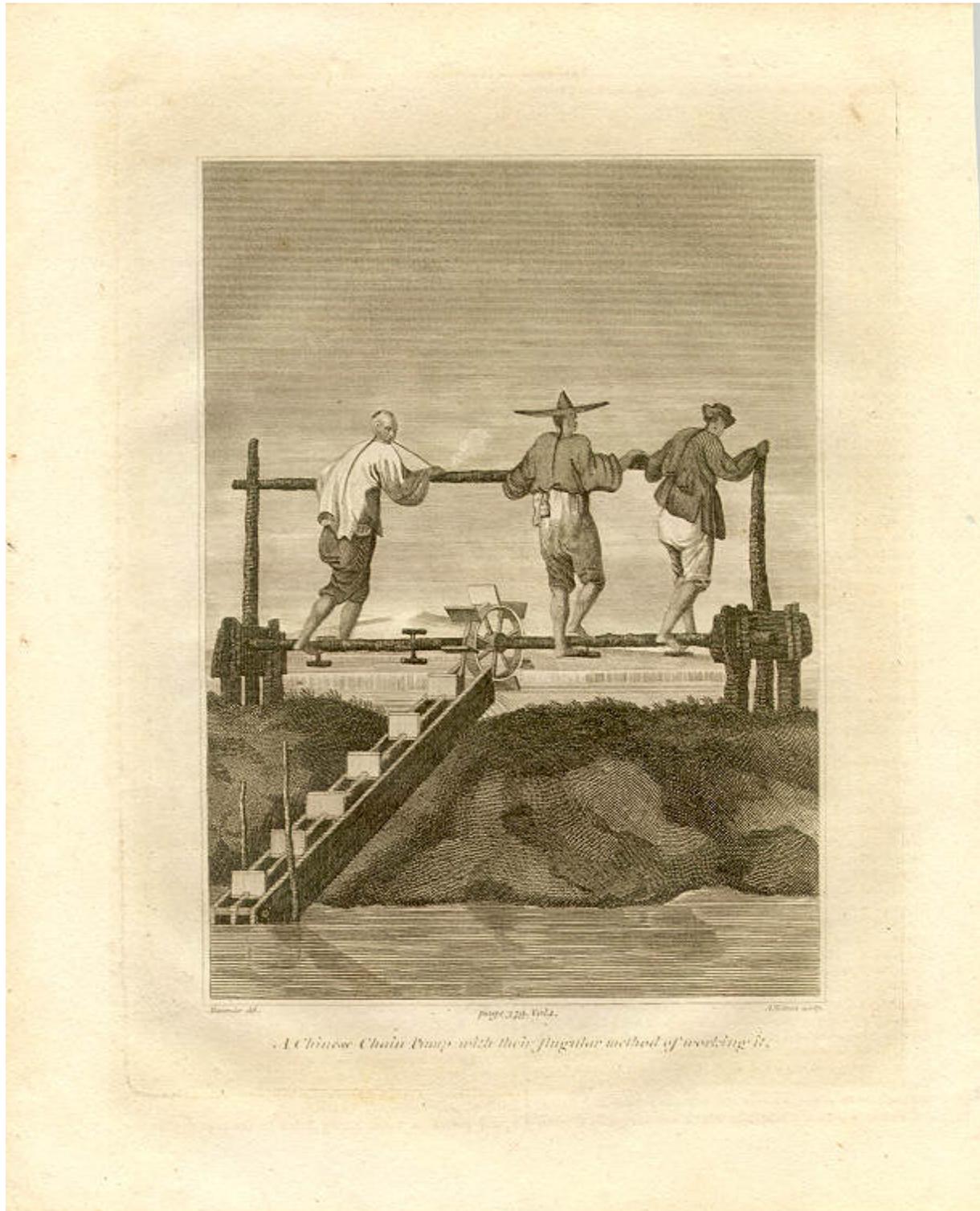


Figure 2. A dragon's backbone tool for irrigation, commonly used in China. It is also known as a square-pallet chain pump. Pumps like these helped farmers reap more rice, but they also increased the labor requirements.



Figure 3. A dragon’s backbone pump in Sichuan, China 1943. Photo by Joseph Needham.



Figure 4. Rice farmers transplanting rice seedlings in Guangdong Province. Photo courtesy of Thomas Talhelm.