

## Rice: Important Grain to Human Nutrition and Caloric Intake

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### Abstract

As in island Southeast Asia where the expansion of wet rice agriculture was relatively late, the higher labour costs and capital investments of rice production were apparently overridden by the allure of auspicious rice. Let us consider something of this long history, incomplete as it is, to see what kinds of changes might be at issue.

**Keywords:** Village-based farmers; Residential spaces; Irrigation facilities; Granitic hills; Southeast Asia; Rain-fed millets

### Introduction

In South Asia, as elsewhere, the early Holocene saw newly-modified plants and animals cultigens and domesticates added to existing practices of wild plant collecting and hunting. On the peninsula, farming started only around 5,000 years ago. Here, in the Southern Neolithic, groups of village-based farmers grew dry-farmed millets, both introduced and locally domesticated. Hardy millets such as *Brachiaria*, *Setaria verticillata*, and *Echinochloa* were cultivated alongside pulses such as mung bean and horse gram. The later Neolithic saw significant innovation in crop regimes, with reports of both domesticated finger millet and Sorghum bi-color imported African crops in South Indian Neolithic sites of the second millennium BCE. Pearl millet, another African cultigen, occurs in archaeological contexts from several locations of North Karnataka, including Hallur, around the end of the Southern Neolithic and beginning of the Iron Age, as do *Paspalum scrobiculatum* and *P. miliaceum* [1]. While the agro-pastoralists of the Southern Neolithic must have harvested runoff, years of fieldwork have thus far failed to yield evidence of formal irrigation facilities. Many Neolithic hilltop and hillside settlements on the rocky granitic hills of the region were terraced; possibly productive as well as residential spaces [2]. Natural depressions on the granitic hills were no doubt of importance as water traps; many of these were enlarged and formalized in the following Iron Age.

### Discussion

Small quantities of rice, wheat, barley, and flax what we have called boutique production have been documented from Southern Neolithic sites, crops whose relatively high water requirements suggest supplemental watering. Southern Neolithic people also made extensive use of herded animals, including sheep and goats, but most especially cattle. Interest and investment in cattle is attested not just by faunal evidence but also by rock art and ashmounds. Ashmounds are large hills made by accumulations of fired and vitrified cattle dung. These rock-hard mounds have been suggested to be related to ritual and community use and are clearly associated with aggregations of cattle [3]. Whatever role ashmounds played in Neolithic life, they do suggest that dung was not, for the most part, being used for fertilization. Neolithic cattle were exploited for secondary products, from traction to manure and milk. Fuller has associated certain ceramic forms with dairying, while DNA evidence suggests a significant antiquity for the development of lactose tolerance among South Asian populations. The ongoing significance of dairy products in South Indian diets is thus of interest and clearly constitutes a long-standing form of consumption. Right from the beginnings of agriculture, then, southern Indian farmers were actively experimenting with plants and animals and were in contact with similarly innovative farmers elsewhere [4]. This era may be

seen as establishing the basic South Indian repertoire of rainfed millets and pulses, sown in synchrony with the southwest monsoon. While Neolithic farmers were clearly experimenting with exotic and water-loving crops such as wheat, barley, and rice, these were not grown on any scale and, to date, their social associations are not known. That is, we do not know if these very limited-production grains were also limited socially, an important question for future research. It will also be important to begin study of Neolithic diets and health status [5]. As patterns of mobility and consumption changed, and as aggregated villages became more common, we would expect some changes. The South Indian Iron Age saw many continuities with the Southern Neolithic, including a continued focus of settlement atop hills, but in this period of settlement aggregation and increasing social differentiation we also see the beginnings of more formalized strategies for water harvesting and storage. Most well-known for its megaliths, Iron Age southern India contained more and larger settlements than preceding periods, with some habitations that might legitimately be called towns. Here again we might expect shifts in hygiene and disease environments as people increasingly lived in larger groups; with its increase in social and political differentiation, too, the Iron Age would seem to be a time when dietary and health-related differentiations would also begin to be evident [6]. Although Iron Age agriculture is known from only a few locations, including our own work from Kadabakele, thus far early Iron Age farming resembles that of the later Neolithic. Wild animals and plants such as *Ziziphus* and *Dioscoria* continued to be important and the primary form of farming was summer cropping of millets and pulses alongside small-scale boutique production of water-loving crops. We have recovered banana starch grains as well as occasional grains of wheat, barley, and rice from Iron Age deposits at Kadabakele. The latter were supported by a new technology, the reservoir. Iron Age reservoirs often occur within megalithic complexes but are also found in and near settlements, atop the high outcrops where people grazed their livestock, gathered fuel and other products, and made their homes. We suspect, but cannot yet confirm, that Iron Age farmers used manure as a field amendment, enriching soils that supported more intensive forms of agriculture. As noted, it is starting in the Iron Age that we see emergent forms of social

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differentiation and ranking, with difference in wealth developing. From this point onward, power relations as manifest in forms of consumption increasingly made a difference in how people engaged the earth. Just as today, choices about what to consume and how to live have implications for both social and natural worlds [7]. It was perhaps in the Late Iron Age or subsequent Early Historic period that the basic rupture between patterns of food consumption within South Indian society first emerged – the distinction between irrigated rice-based cuisines and dry-farmed millet-based diets. Although we still have much to learn about Iron Age food practices and how they may have been socially differentiated, changed forms of production and consumption did lead to measurable environmental effects. Remote sensing and geo-archaeological analysis has shown that Iron Age residents of the granitic hills of southern India significantly modified slopes and soils, with large-scale soil erosion off the hills inhabited by Neolithic and Iron Age residents. Hillside erosion did, however, represent an opportunity for later farmers and the newly-deepened colluvial soils of the valleys near the Tungabhadra River would by the fourteenth century support an intensive regime of irrigated agriculture that has continued more or less unbroken until today. Today's farmers thus plow an Iron Age legacy each season. The Early Historic period was a time of remarkable change in peninsular India, including the development and expansion of regional polities and formalized relations of social inequality as well as the intensification of specialized craft production and long distance trade [8]. Ritual landscapes, too, were transformed by the introduction of North Indian religious traditions and their amalgamation with pre-existing local practices. Around the same time, the introduction and expansion of rice agriculture and its integration with existing strategies of dry farming, herding, and foraging led to the emergence of complex new agricultural regimes and transformed regional landscapes. The Early Historic marks the beginnings of urban life in South India, an as-yet poorly understood transition associated with expanded inequality, possibly including the beginnings of the significant dietary differentiation already well-developed by the following Early Middle period [9]. While Shaw has argued that the large runoff-fed reservoirs held behind earthen dams around the central Indian Buddhist centre of Sanchi date to the Early Historic, and inscriptions from other parts of South India describe large reservoirs from the first few centuries CE, in our study area large reservoirs were first built only around CE 1200. However, a decisive shift in the location of settlements from hilltops in earlier periods to the base of hills in the Early Historic does suggest a shift in farming practices. At Kadabakele, an Early Historic town sprawling across the flood plain of the Tungabhadra River was established at the base of the hill that had supported earlier homes, a pattern replicated at nearby Maski and Tekkalakota. These settlement shifts may be associated with a new focus on farming the seasonally-inundated silt-rich alluvium, a scarce and precious resource in the interior, but the major landform in productive coastal deltaic regions. Excavations at Kadabakele show flood deposits in Early Historic levels hundreds of meters away from the current river bed, suggesting that the settlement was occasionally overcome by the river. Despite its risks, the seasonal flooding of the Tungabhadra provided a rich flush of water and silt that would have been ideal for farming, even water-loving crops like rice, coconuts, bananas, and sugarcane. Early textual sources from southern India include a corpus of texts referred to as the Tamil Sangam literature [10]. Like all early texts, they were written down later than first composed and their date of the first few centuries CE is only approximate. Associated with the rice producing regions of the far south, these poems contain references to the management of flooded rivers. In the Jivaga Chinthamani the poet writes, When there is plentiful rain the peasants are happy. The hail the rain with shouts of

joy, and beating of drums. When there are breaches in the banks of the river, the people are informed by beat of the drum, and they rush to the spot and work together to repair the breach. The wives of the peasants encourage their husbands to work untiringly in the fields by serving liquor to them. Sangam literature also describes irrigated rice farming, including transplantation. We do not yet know if bordered, flooded paddy fields were made and used in the semi-arid interior regions during the Early Historic, but this does seem to be the period when rice farming moved from a limited, boutique form of production to become the foundation for emergent rice-based elite cuisines and ritual practices, an agrarian and culinary assemblage whose exacting labor and water demands ensured that practices of dry-farming would continue to be critical in areas where water supplies were insufficient. Although rice has been present in South Asia since the third millennium BCE, a more critical consideration is when, how, and why rice came to be grown on a large scale across many parts of the subcontinent. The development of India's 'rice bowls' grew out of a long history of decision-making and value-creating on the part of prehistoric peoples. In more well-watered regions such as the deltas of the Kaveri and Krishna-Godavari, the transition from millets to rice was probably earlier. The semi-arid interior, however, poses significant challenges to rice farming and here dry-farming of millets continued to be important even as tremendous effort was expended to facilitate rice cultivation.

## Conclusion

In our study area, the new colluvial soils formed by hilltop erosion became a key agricultural resource after the Iron Age and into the Middle periods, a time when some familiar contours of South Indian landscapes emerge-temple-based sectarian religions, urbanization, literary traditions, and differentiated economies with irrigated fields, dry fields, and abundant grazing lands.

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## Conflict of Interest

None

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