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BACK TO THE FUTURE! THOUGHTS ON RATOON RICE IN SOUTHEAST AND EAST ASIA

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In China *Oryza sativa* has been grown as an annual for perhaps 10-12 000 generations although ratooning certainly survived until about 3 500 years ago. By contrast, in Southeast Asia, including marginal areas populated mainly by ethnic minority peoples such as India's northeastern territories and parts of Bangladesh, the cultivation of perennial strains extended into the twentieth century. The degree to which this practice survives to the present is not known. Despite being grown as an annual, many strains of rice retain a perennial habit to some degree though yields are commonly very much lower from ratoon crops than from initial plantings. In Japan, a ratoon yield of about 15 percent of the first harvest has been reported. No systematically-gathered data on ratoon-crop yields have been found, though Hill (2010) has drawn together historical accounts of the practice. He reported observing it in Johor, Peninsular Malaysia in the 1960s and in northern Laos in the 2010s.

The need for Asian rice-growers to move from highly labour-intensive methods to less labour-intensive methods arises from a general rise in the cost of labour. In the 1960s the opportunity cost of rice-growing in China and much of Southeast Asia was probably close to zero. In most of the region it is now much above that level, a situation reflected in substantial short-term circular migration by rice-growers and in some cases by production at an economic loss, as was already reported in parts of Peninsular Malaysia in the 1960s.

Because tillage, nursery-preparation and planting, and, especially, transplanting, may require half to two-thirds of labour input per crop, any system of production that can reduce such inputs, without an excessive yield penalty is very desirable for the cost of labour will inevitably continue to rise.

Keywords: ratooning rice, Southeast Asia, East Asia, agricultural development

INTRODUCTION

In Asia rice ratooning has a long history, one which is generally little known among rice scientists or farmers. For Southeast Asia, Hill (2010) has examined that history in some detail, pointing out that much of the documentary record has been misinterpreted by later commentators. This paper extends the analysis to China and Japan though for linguistic reasons this author does not have access to works in Japanese or in Chinese. Drawing on the resources in his on-line bibliography on the history of Southeast Asian agriculture (Hill, 2007), an outline of the historical record for the region is given. This is followed by a consideration of some important areas for the future study of ratooning and assessment of the feasibility of promoting ratooning in the region.

Over the last half century the region has seen a remarkable structural transformation of agriculture in general and rice production in particular. Generally there has been a long-continued process of commercialization of production, though in some areas this has had limited effects, largely because of structural limitations in production, such as very small size of farms and, especially limited alternative activities. Fifty years ago it seems likely that in much of the region, Japan and Southeast Asian plantation areas accepted the opportunity cost of rural farm labour was close to zero. That situation has largely changed with urban employment as a rapidly-emerging economic alternative. This has been and continues to be linked with permanent rural-urban migration but also with widespread temporary circular migration. For example, a study some years ago showed that the population of Bangkok in the dry season was about nine percent higher than in the wet season. This was the result of farmers flocking to the towns for temporary employment, partly in manufacturing but especially in construction, as the Thai case suggests (Hill, 2002).

Urbanization and the overall growth in real incomes together with demographic changes have also had the effect of reducing per person demand for rice, though total demand has continued to rise partly for demographic reasons. This situation is unlikely to last. The population fertility rates of Japan and Thailand, as well of major urban concentrations such as Hong Kong and Singapore, are now well below replacement level which is about 2.2 children per woman of child-bearing age. China's population growth rate is forecast to fall to zero around 2026 and the total population will fall substantially thereafter unless its government abandons its 'one-child' policy and adopts a more pro-natalist stance. Even if it does that there is likely to be a substantial increase in the cost of labour for around two decades until the new generation reaches the labour force.

Globally, the consumption of rice per person has levelled out the late 1980s (Rejesus *et al.* 2012) though demand in Africa continues to rise. Estimates of very large increases in demand are probably not well-founded. Fageria (2007), for example, estimated a requirement of 60 percent more rice by 2025, just over a decade away. The reality is that since the 2007-8 season, global rice stocks have tended to rise, reaching close to an estimated 35 percent of annual global consumption by 2013-14 (FAO Rice Monitor, July 2013). This will give something of a breathing space to develop alternatives to the region's current highly labour-intensive methods.

At the same time, an emerging consideration in the production of rice is urban expansion, in many areas onto prime rice-growing land. Politically, governments continue to be faced with a need to ensure a continued supply of rice to urban markets at reasonable prices. Every government in the region is aware of the need to hold rice prices at a reasonable level for urban workers. Given that farm labour costs are inevitably rising and that labour mobility is increasing, there is a need to control the costs of rice production. One method of doing this is to ratoon, for this approach substantially reduces the labour cost of traditional methods involving nursery preparation and transplanting, probably by around 50 to 60 percent per crop (Flinn and Mercado, 1988). One competing strategy, of course, is to abandon transplanting and to substitute for it broadcast sowing. However, this has the considerable disadvantage that satisfactory weed control in the early stages of growth requires enhanced applications of herbicides, the long-term effects of which are not fully-known. This may emerge as an issue with ratooning as well, especially if a main crop is followed by two ratoons, as seems to have been practice in some areas in the past.

RATOONING - THE HISTORICAL RECORD

Ratooning clearly has a long history. In China, so far considered to be the home of the longest-running sequence of rice cultivation, it seems likely that ratooning was abandoned as a general practice in early historical times, perhaps 3 000 years ago or even more. If this is so, then the practice of growing *Oryza sativa* as an annual may have led to genetic drift away from good yields from ratoons. Certainly, the limited data for ratoon yields from present-day varieties show a wide range. An analysis of such literature as is available to me gives claimed ratoon yields ranging from around 8.7 tonnes/ha (Xu *et al.* 1988; Prashar, 1970) to about 0.3 tonnes/ha or even less. Chauhan *et al.* (1988) give comprehensive data. Parenthetically, it should be noted here that almost without exception writers on the subject of yields fail to give data on the size of the plots employed in making their yield estimates. Many are probably serious over-estimates, seemingly being based upon small-scale trials.

The origins of rice cultivation have been the subject of much debate, some of it perhaps underlain by nationalistic considerations. Oka and Morishima (1997) review several hypothesized routes to the evolution of Oryza *sativa*, pointing out that many common wild rice varieties tend to differentiate into *indica* and *japonica* types. Watanabe (1997) briefly examines the origin and differentiation of cultivated rice in Asia. As a crop, rice may go back 6-8 000 years in China though whether it was fully-domesticated at that time is a matter of some doubt (Sweeney and McCouch, 2007; Liu Zhiyi, 2000). Similar ages have been claimed for India. Rice-growing in Japan dates back to the late Jomon period, around 3 000 BP at the earliest (Matsuo *et al.* 1997). This is somewhat later than the earliest rice in mainland Southeast Asia where the crop dates back four or five millennia, possibly more. Even in equatorial Southeast Asia, the crop may date back as much as six millennia, as recent data from the Niah Cave, Sarawak, suggest (Hunt and Rushworth, 2005). Their finding at this low latitude, just south of four degrees north latitude, may imply an early existence of non-photoperiodic varieties or at least of varieties responsive to very small differences in day-length. What can be asserted with some degree of confidence is that *O. sativa* probably differentiated into two subspecies, the more northerly and temperate *japonica* and the more equatorial *indica*, as a result of at least two independent series of steps leading to domestication (Tao Sang and Song Ge, 2007).

Arguably, many of the early varieties of rice in the region had a significant ability to ratoon though wherever it may have been grown it seems likely that it would not have been grown beyond a second ratoon at the most, for by that stage the competition from weeds would probably have rendered yields so low as to be not worth harvesting. A search of the modern literature failed to find a single case of anything beyond a first ratoon, though as I have argued elsewhere, it seems likely that a second ratoon was probably taken in Indochina and in other parts of Southeast Asia in earlier historical times (Hill, 2010). Documentary and field research has shown that the practice of ratooning survived into modern times in the Malay Peninsula, in Laos, and reportedly, in one-crop areas in Japan (T.S. Stanley, personal communication, 10 Dec. 2007).

Earlier, ratooning seems to have been fairly widespread. While not quite a ‘free good’, ratoon rice avoids the need to till the soil, to prepare nurseries and to transplant seedlings to the extent that this practice may reduce labour demand by about half. Certainly it may increase the labour demand for weeding but not to a level comparable to the demands of soil preparation, nursery preparation and transplanting. For China, Ho Ping-ti has assembled firm evidence for what was probably perennial cultivation, likely more or less contemporaneous with annual cultivation, dating from the Shang dynasty (*ca* 1 600 BC to *ca* 1 046 BC), though Ho refers to it as a wild rice (Ho, 1957, 1969). Cultivation of some kind, or at least weeding and replanting are probably indicated because weed invasion inevitably overtakes any abandoned rice-field. Fuller, Harvey and Qin (2007) have pointed to the cultivation of what they rather paradoxically refer to as 'wild' rice, as early as the 5 000 BC.

The documentary record for Southeast Asia is rather more extensive though bedevilled by major gaps, for example for Indonesia. Clercq (1871) is just one of a host of papers in Dutch on agricultural practices in colonial times in Indonesia to be silent on the matter of rice ratooning. It is unlikely to have been altogether absent. For Japan the evidence for ratooning at any period linguistically accessible to this author is exiguous. The four-volume compilation by Matsuo and his colleagues seemingly makes no mention of the practice though it is difficult to be certain because that work lacks an index. Papers in that collection make no mention of the practice (Matsuo *et al.* 1997).

The early literature has been beset by problems of interpretation, as Hill, (2010) has noted. In particular, in archaeological contexts, is the formidable difficulty of distinguishing the remains of annually-grown rice varieties from their perennial cousins. What is clear is that much of the work of historians of the region dealing with the documentary evidence has been bedevilled by a lack of knowledge of field practice by present-day cultivators. It is simply beyond belief that the rice-growers of thirteenth-century Cambodia had the means to complete three or four full cropping cycles in a year for even today, two are not common, depending as they do upon an adequate supply of irrigation water. The notion of three 'crops' in a year is also to be found in Chapman's account of Cochin China in the late eighteenth century but again the probability must be that this refers to three harvests rather than to three full crop cycles (see Lamb, 1961). If this account be a little equivocal, that of Father Pierre Poivre for Siam, published in 1770, very likely refers to ratooning though an alternative explanation is that the rice was a shattering variety.

'It is astonishing, however, to observe, these lands, frequently neither laboured nor sown for years together, produce extraordinary crops of rice. The grain, reaped negligently, sows of itself, and reproduces [sic.] annually another harvest, by the help of the river Menam....' (Poivre, 1770).

Another early account is that of Ma Huan for Java in the early fifteenth century. He noted that rice ripened twice in a year and that the kernels were small. The latter observation is probably a clincher for it is now known that the grains of perennial varieties tend to be smaller, on average, than those of more annual varieties. Other examples are quoted by Hill (2012). In seventeenth century Siam, now Thailand, Nicholas Gervaise reported in 1688, 'One sort that grows without anyone sowing it...' Perennial though it must have been, however, it could not have survived colonization by adventitious vegetation but for human intervention. A century or so later the Abbé Raynal spoke of rice that 'bore plentiful crops spontaneously' – surely again a reference to a perennial variety. More equivocal is an account of Assam by Neufville dating from the early nineteenth century. He spoke of the lowlands producing two crops annually, possibly referring to a main crop and a ratoon (Neufville, 1828).

Rather later is a report for the Philippines by Alfred Marche who travelled in that region in 1879 to 1881. Like the others already mentioned, he reported up to three harvests in a year in Laguna Province, with parts of Tarlac and Pampanga, the location of dry-season harvesting described 40 years later by Apostol.

Even more recent are several accounts of a small area in what is now Arunachal Pradesh by the German, later British, ethnographer Christoph von Fürer-Haimendorf (1946, 1955, 1962). He described two types of rice-fields at an elevation of about 1 500 metres – those kept permanently wet and those that allowed to dry out soon after harvest. On the former class of land the soil was not tilled, the rice being perennial though where there were gaps in the plant cover these were made good by the planting of seedlings early in the growing season. Von Fürer-Haimendorf's 1962 paper speaks as if this form of cultivation still existed but whether it still survives and whether there are holdings of the ratooned rice varieties in any repository are not known.

This author has seen ratooning in the field for consumption as food only once. In the early 1960s he visited the Orang Kanaq, a small group of aboriginal people whose ancestors were settled in Johor from the Indonesian province of Riau. They no longer grow the crop (Mahani Musa, 2011). On a much later visit to a rural area east of the northern Lao town of Vientiane some ten years ago, ratooning was again seen but then it was unlikely that the crop was being harvested, for the area was being grazed by cattle, a practice widespread in most of SE Asia before double-cropping became common.

RATOONING – THE PRESENT SITUATION

The modern literature on the ratooning of rice is quite scattered. A good deal relates to India rather than to East and Southeast Asia though much of that is relevant because it deals with general agronomic matters of wide applicability. A useful starting point is the IRRI collection of essays *Rice ratooning* (IRRI, 1988), though the appearance of that monograph, the reportage has increased steadily. Basically, a ratoon crop has the major advantages over a transplanted crop of requiring only about half of the labour input of the main crop and perhaps 60 percent less water (Oad *et al.* 2002; Oad *et al.* 2002). There is, however, a very wide range of genetic potential for ratooning with some cultivars giving very small yields, or none, and others giving yields that are greater than the main-crop yield of the same cultivar. (see, for example, Krishnamurthy, 1988).

Incidentally it may be noted in this context that seasonality may play a part here. Many research reports fail to mention the obvious point that in theory a proper comparison of main-crop (transplanted) and ratoon yields requires that the crops be compared over the same time-period, a condition not readily met given the much shorter growing period of the ratoon. Replication over several seasons may reduce errors of estimation arising from this source.

While there is some lack of knowledge among present-day rice scientists that ratooning has been of some significance in the more-distant past, there is a small body of publications on the subject, mainly by Indian workers, dating from the 1970s. (see *Rice ratooning*, 1988, for examples, especially papers by Krishnamurthy and by Mahadevappa, for overviews). There is a small literature by Chinese workers, mainly in Chinese. For Japan there seems to be very little literature, at least in English or any other western language. Ichii and Kuwada's paper of 1981 and some of their references are exceptions. The major four-volume work edited by Matsuo *et al.* (1997), a translation from Japanese into English, seemingly makes no mention of the practice though it is difficult to be certain for the work is not indexed. The standard international work on the subject, the IRRI *Rice ratooning*, 1985, is now rather dated but brings together a good deal of what rice scientists were investigating at that point.

Although there is a considerable body of modern literature on ratooning, some of its value is reduced by deficiencies in research methodology and reportage. An early paper by Prashar (1970) for example, compared the ratoon and main crop yields of two modern HYV's, IR 5 and IR 8, reporting remarkably high yields ranging from 6 tonnes per hectare to almost nine, with IR 8 outperforming the earlier cultivar. As with many later studies, it may be suspected that the yield data are derived from very small scale cutting trials.

The study by Ichii and Kuwada (1981) gave yields for ratoons harvested at varying intervals with the highest yields at 10 and 20 days after heading but fail to give the areal unit to which they refer. Many papers also fail to give details of the plot size to which their data refer. This is a considerable weakness for it has long been known that reported yields from square-metre scale experiments often far outweigh those from plantings at larger scales. Xu *et al.* (1988) for instance state that their results 'were obtained from small areas' but fail to indicate how small. Their results therefore suffer from the common defect of such studies as giving unrealistically high yields. They give main crop yields ranging from 5.6 to 9.8 tonnes/ha and ratoon yields from 3.1 to 8.7 tonnes/ha, in one case, for IR 24, with a ratoon yield of 8.7 tonnes/ha/day with a main crop of 8.4 tonnes/ha.

More comprehensive data, covering 124 experimental plantings, many in India, are those of Chauhan *et al.* (1988). Outstanding were ratoon performances by the variety Intan, reported from Karnataka, India, at 2.3 to 7.7 tonnes/ha, the variety Milbuen 5 from the Philippines, at 5.6 tonnes/ha, and IR 8 at 8.2 and 8.7 tonnes/ha, all above the main crop yields. By contrast, moderate ratoon yields were reportedly obtained from IR 42 and IR 97523-71-3-2, ranging from 33 to 49 percent of the main crop yields with ten cultivars giving a ratoon yield of less than 10 percent of the main crop yields. One early comparison of IR 5 and IR 8 is that of Prashar (1970) for Ethiopia. He claimed that IR 8 outyielded IR 5 for both the main and ratoon crops though his yield data, ranging from 6.3 to 8.7 tonnes/ha, like many others, may be suspect.

Another relevant paper is that of Chauhan *et al.* (1988). These workers screened 24 modern genotypes and found that of the 24 examined, only ten showed any regeneration at all, with RP 1664-4461 showing a very modest ratoon yield of 1.7 tonnes/ha and IET 7613 a yield of only 0.8 tonnes/ha. This result raises the suspicion that ratooning ability may have been bred out of some of the modern cultivars. If this notion is sustained, important considerations are raised as a strategy for future research is developed. Of particular concern is the fact that IRRI has screened for their ratooning ability only a tiny proportion of its vast holdings of cultivars.

On the other hand, work in Karnataka, India, with six modern cultivars, including IR 28, showed excellent yields from both the main crop and the ratoon (Krishnamurthy, 1988). Main crop yields reportedly ranged between 8.7 and 11.8 tonnes/ha for the main crop. In percentage terms the ratoon yield ranged between 67 and 90 percent of the main-crop outturn where the main crop had been direct-seeded, compared with a range of ratoon yields between 59 and 78 percent of main crop yields where the main crop had been transplanted. A later study of lowland genotypes, by Santos *et al.* (2003), involved five early maturing modern varieties and four medium-term types. For the former the average ratoon yield was 59 percent of the main crop outturn but for the latter types the average was a disappointing 39 percent.

Flinn and Mercado (1988) have a most useful overview of the economic aspects of ratooning, concluding that the technique offers major advantages by reducing both labour and water requirements by about half compared with the main transplanted crop. Another advantage is the reduced length of the crop year, opening the possibility of a further crop, other than rice in the same crop year, and the freeing up of labour and other resources for alternative uses. This is a particular advantage where temporary circular migration and the earnings from urban employment have become important. But these authors also point to economic disadvantages. Included are uneven maturing of the ratoon crop, uneven grain quality and generally low and uncertain yields, matters of no great concern where production is for subsistence perhaps, but important where the crop is marketed.

The question of whether or not technical innovations are gender-neutral is one of considerable importance. It is widely-known in Peninsular Malaysia and Indonesia, for example, that beginning in the 1960s, the harvesting of rice panicle by panicle over the course of several weeks by women using the traditional small harvesting knife was replaced by men wielding sickles. Given that in the major rice-growing states of northern Peninsular Malaysia and in nearby Peninsular Thailand, gangs of women were employed as harvesters, this was a severe loss of income in some villages of that region. One further consequence was that quality immediately fell as immature panicles were cut together with the mature ones. In turn that necessitated much closer attention to field levels since uneven ripening in part reflected variations in soil moisture across the fields (Baker, 1940; Colani, 1940; Fukuda, 1986). In the Minangkabau areas of Peninsular Malaysia, where little rice-growing still survives, the introduction of machine tillage in the 1960s had a reverse effect. There tillage by women, who mostly owned the land, was gradually replaced by men driving hand tractors.

A further clear advantage of ratooning may be added. For regions frequently vulnerable to damage from tropical cyclones, notably the Philippines north of Mindanao, the southern provinces of China within about 100 km of the sea, and the central and northern provinces of Viet Nam, ratooning potentially reduces the length of the growing season compared to double-cropping thus avoiding the effects of late-season cyclones. In this context it is worth noting that studies of climate change are forecasting an increase in the number and intensity of tropical cyclones, probably also to be accompanied by more, and more intense rain.

Since 1988, understanding of some of the 'mechanics' of ratooning has increased. For example, a Texas study by Turner and Jund (1993) showed that good levels of total non-structural carbohydrate (TNC) in the main crop were essential to satisfactory yield from the ratoon. They also suggest that cultivars may differ widely in their ability to accumulate TNC prior to heading. Both findings have been confirmed for an Asian context by Cheng and Li (1994) who also noted that only one of the five *indica* hybrids they examined showed good ratooning ability.

One area of research that has attracted some attention is that of the optimal height for cutting the culms of the main crop to ensure a good yield from the ratoon. This is because the ratoon yield depends upon the total carbohydrate content in the stem base (Oad *et al.* 2002a,b). A Texas study by Jones (1993) suggested that ratoon yields for the two American varieties used, 'Lebonnet' and 'Lemont', could be optimized by lowering the cutting height of the main crop to 20 - 30 cm. Other authors, with South American or Asian experience, suggest that the optimal level may be somewhat lower at 10 - 20 cm (see Santos *et al.* 2003, and for example, Bahar and De Datta, 1977; Calendacion *et al.* 1992). Ahmed and Das's work (1988) rather contradicts that finding for they noted that ratoon yields remained about the same for heights from 15 - 45 cm but declined drastically below the lower level. An earlier study, by Prashar (1970), showed quite a contrary pattern. He found that the ratoon yield was significantly higher where the main crop was cut at ground level rather than at four, eight and 12 cm, though the maturity period was shorter with higher cutting. Clearly, as with many other characteristics, there is considerable variability but it seems likely that cutting the main crop stems at a low level, can, other things being equal, be compensated by a delay in harvesting. That, of course, raises issues of reliable water supply and in climatically marginal areas, sufficient warmth to continue growth.

One issue that has received rather limited consideration is that of the quality of the ratoon crop, not a major consideration where the crop is for self-consumption by the cultivator and his family but an important issue for the commercial and semi-commercial producer because lower quality means lower income. No reportage on the physiology of ratooning that may lead to uneven ripening has been found.

Part of the problem is asynchronous ripening of the ratoon (Calendacion *et al.* 1992). This is certainly so where, as is general in commercial production, harvesting is done in a few hours rather than over weeks. That was once general practice in many parts of insular Southeast Asia. At lower latitudes in Southeast Asia, panicle-by-panicle harvesting using a small knife was general until the 1960s though it has now been largely replaced by the sickle and a single harvest. Practised only in single-crop areas, that method meant that harvesting could be spread over as much as two months so that variable ripeness was much less an issue. Presumably, were that method to be applied to the ratoon crop, the problem of uneven ripening might be mitigated, but only at the cost of a considerable increase of labour input, one so large as to make that approach unattractive to commercial producers.

CONCLUSION

Just how widespread ratooning may currently be is difficult to establish. For the Philippines, for example, it has been claimed that more and more farmers gain extra income from ratooning, especially in Bulacan and Nueva Ecija provinces (Lacanlale, 2004). One newspaper report indicates that in Leyte 5 000 ha of potential ratoon-crop land has been identified (*Sun Star* 17 July 2013). But for most of the region, good data are lacking. In Malaysia, for example, where rice-growing is heavily subsidized by government, the problem of the rising cost of agricultural labour has been met from two sources. One is the growing practice of broadcast sowing, requiring the enhanced application of selective herbicides, and the other is by the importation of low-paid field labour from outside the country. In this context, a study of the costs and benefits of this approach compared with ratooning is desirable. This might include consideration of the social costs of such migrant labour.

For farmers a key question is whether to ratoon or not. On this issue the size of the main-crop harvest is not a good indicator, for the key question is the level of TNC – total non-structural carbohydrates – in the stems of the main crop. A high level means that, other things being equal, it is safe to proceed with ratooning (Boyd, 2000). This test offers reinforcement to the rather subjective method of observing the speed at which stubble was regrowing after the main-crop harvest. By lowering the main-crop cutting height to about 20 cm d with the usual 45 cm, it has been found that the ratoon yield is enhanced quite substantially, to the extent of 1.1 to 3.3 tonnes/ha as reported by Boyd for Texas. So far as is known, no such test is available in Asia.

One novel approach is that of Calendacion (1992) and his colleagues. They deliberately flattened the standing straw after the main crop harvest thereby locking it prone upon the soil surface, an action they term 'lock-lodging'. This was done manually. At a mean of about 1.5 tonnes/ha, yields from plots thus treated were significantly higher than from conventional ratooning at about 1.1 tonnes/ha, though otherwise the treatments were the same. This procedure requires more labour than conventional ratooning. Perhaps a similar effect might be achieved by the application of a heavy roller, perhaps a toothed type, to improve aeration on heavy clay soils especially.

Clearly, one thing that must be avoided at all costs is the kind of rice development debacle represented by attempt to develop a million hectares of rice land from forest in Kalimantan

(Boehm and Siegert, 2001; Rieley, 2001). This project, launched in 1995, aimed at the development of what is mainly peat land, from the outset, a very problematic undertaking. It ultimately directly affected some 1.5 million hectares, while burning in 1997 is estimated to have covered 15 million km^2 in smoke for a period of several weeks and to have added 0.5 parts per million CO_2 to the global atmosphere (Rieley, 2001).

Ratooning must be a viable alternative to that approach. The Philippines government is promoting it as a means of attaining national self-sufficiency in rice (*Sun Star* newspaper, 17 July 2013), though to this observer, the estimate of only 45 days to obtain a ratoon crop seems highly optimistic. The approach is also being promoted in Pakistan (Hafeez ur Rehman *et al.* 2013).

But beyond ratooning is the development of truly perennial systems of cropping similar to that described for the Apa Tani by von Fürer-Haimendorf long ago. In this endeavour Sacks and his colleagues have been active (Sacks *et al.* 2003a,b) though warning that it is likely to take five to ten years to breed suitable perennial rice varieties for upland areas. Perhaps there are high-production ratooning varieties currently hidden among the very extensive holdings at the IRRI, for that institution has never made a systematic search for them. Given the very large holdings of materials at IRRI that is a significant challenge. A simple start would be to find out if the perennial rice among the Apa Tani still survives and whether there are other communities that use similar cultivars.

In the Association of Southeast Asian Nations (ASEAN) region, which accounts for 22 percent of global consumption, the consumption of rice is driven largely by population growth (Wailes and Chavez, 2012). That has fallen sharply and is now only around 1.1 percent annually. This can probably be met from improved yields, particularly as consumption per person declines, though only slowly at present (Zhang 2007; Wailes and Chavez, 2012). Japan has long seen falling demand for rice though its home production has been artificially sustained by large subsidies. China's demand is also likely to fall. Globally, rice stocks are steadily rising and actual prices show a slight downwards trend, in real terms perhaps more than slight, given rates of inflation in the region. Throughout the region the cheaper grades of rice are already being used as animal feed or in the production of beer. But whatever scientists may think and do, the reality is that the region's increasingly urban people will continue to demand cheap rice, even as the per person consumption falls, possibly at an accelerating rate in future. Ratooning offers a potential to obtain increased production at relatively low cost. That is a bargain to be promoted, but on firm scientific bases.

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