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Rice cultivation and quality in Australia

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Résumé. *L'Australie produit chaque année près de 1,1 million de tonnes de riz. La variété Amaroo à grain demi-long fournit près de 60 % de la récolte, le reste étant représenté par huit autres variétés couvrant une gamme différente de types de qualité commerciale. En 1995, le riz Amaroo a rendu 9,47 t/ha sur toutes les superficies et Illabong, un riz du type Arborio, 10,6 t/ha. A ces rendements élevés, a certainement contribué une série articulée d'instructions concernant la culture du riz, dite «Rice check», puisqu'en 1994 le rendement moyen des producteurs qui avaient réalisé les sept points prévus dans cette liste de contrôle a été de 10,2 t/ha, pour toutes les variétés. En 1995/96, la recherche sur le riz a bénéficié de subventions pour un montant de 1,8 million de dollars australiens, dont 1 million environ provenait d'une taxe à la production imposée aux riziculteurs.*

Abstract. Australia produces about 1.1 million tonnes of rice each year. The medium grain variety Amaroo comprises about 60% of the crop. However, eight other varieties that cover a range of market quality types make up the remainder. In 1995, Amaroo yielded 9.47 t/ha over all areas and Illabong, an Arborio type rice, yielded 10.6 t/ha. A coordinated set of growing instructions "Rice check", has contributed to these high yields with growers who achieved all seven key checks averaging 10.2 t/ha in 1994 over all varieties. In 1995/96, rice research grants of $Australian 1.8 were made to researchers, about $Australian 1 million of this contributed by rice growers through a levy on production.

In Australia, rice is grown commercially within the irrigation areas associated with the Murrumbidgee and Murray river systems in South Western New South Wales. In the recent past, small amounts of rice have been grown in Queensland, Western Australia and the Northern Territory, but these areas do not currently produce commercial rice crops. One grower produces rice in Northern Victoria and is attempting to convince others to follow his example.

The NSW rice crop is grown exclusively under flood irrigation and farming operations are entirely mechanised. Planting is carried out in September and October by combine or sod/seeder into dry seed beds or by aerial sowing of pre-germinated seed into shallow water. Water is maintained on the crop for approximately four months. Before harvest, the water is drained from the bays and the soil allowed to dry prior to mechanical header harvesting. In NSW, the rice crop is free from disease and is troubled by few insects although weeds, mainly barnyard grass, can be a problem. Yields are high by world standards and some farmers regularly achieve over 13 tonnes per hectare.

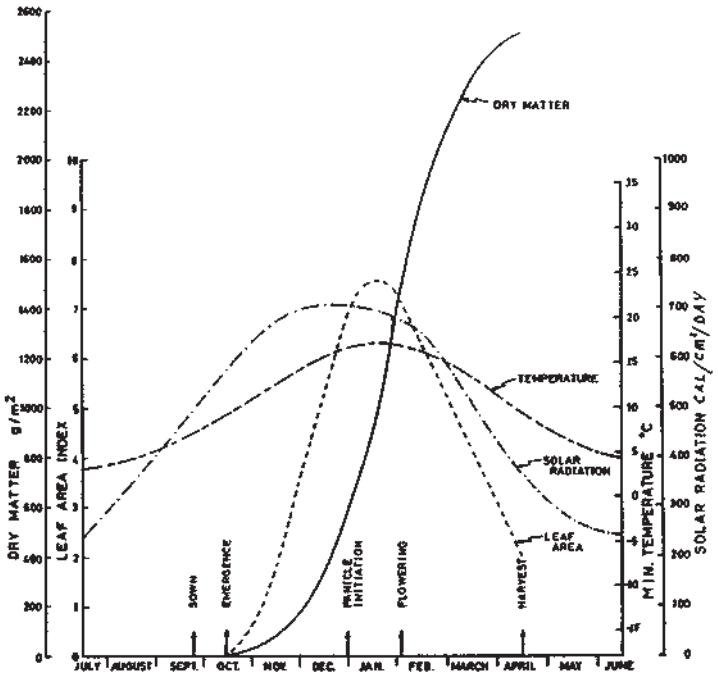
The relation of climate to rice growth in Southern New South Wales has been discussed by Boerema (1973) and is illustrated in Figure 1.

Temperatures at both ends of the rice growing season are low. Seedling emergence is slow but further vegetative development takes place during a period of increasing temperature and radiation. Panicle differentiation and growth occurs during the period of highest temperature and radiation. Grain set and ripening occupy a period of falling temperature.

There were many attempts to grow rice in Australia early this century; however, a commercial industry was not established until 1924. Following two years of successful trials using the Californian varieties Caloro, Colusa and Wataribune. Yields were initially very low but by 1929-30 had more than doubled to 4.1 t/ha from 8093 ha of crop.

Major improvements in yield and adaptation were made by simple reselection of the Californian variety Caloro. Midseason and later strains were released in the early 1930s and an early-maturing grain was released in 1956 for the southern cooler areas.

Figure 1. The growth of rice in relation to minimum temperature and global solar radiation in the Murrumbidgea irrigation area



Caloro, with its early, midseason, and late-maturing strains, was very well adapted to southern New South Wales and was virtually the only variety grown for almost 30 years. It was, however, sometimes severely damaged by low temperatures during reproductive development. The grain was also subject to suncracking and, particularly in late maturing crops, contained chalky spots which detracted from its appearance.

Another Californian japonica, Calrose, was introduced in 1952 and showed immediate promise. It was earlier maturing, more cold tolerant, and much less prone to suncracking and chalkiness than Caloro 2. After extensive testing, Calrose was released to industry in 1956. At first, yields were lower than for Caloro 2 and farmers were reluctant to change varieties. A single cycle of selection in the variety produced a strain of Calrose which consistently outyielded Caloro 2. It was introduced through the pure seed program and began to replace the original seed in 1964-65. By 1972, it had completely replaced Caloro 2 and remained the most widely grown variety until the early 1980s (McDonald, 1994).

The original rice varieties grown in Australia were of the short grain or pearl type. They were introduced from California, where rice growing was in its first decade, but were all of Japanese origin. Short grain varieties, mostly selections of Caloro, were the only types grown until 1956 when a medium grain variety was released. Until the 1950s, the Australian domestic market was the major outlet for NSW rice. The variety Caloro is very soft cooking and its grains have a tendency to cling together when boiled. This type of rice suited the mainly British-based cuisine that dominated Australian cooking at this time. Rice was used extensively in puddings and other desserts. Some rice was used in breakfast foods but most by-products of milling were used as animal feeds. Exports of rice during this time were mainly to the United Kingdom where Australian Caloro was prized by canners of rice pudding (Blakeney, 1992).

The release of the Californian bred Calrose in 1956 was the beginning of quality diversification for the NSW industry. Calrose remained a major variety until release of M7, a dwarf medium grain type. It was the forerunner of Amaroo, Bogan and Echuca, the current medium grain varieties. All these varieties are described as being of the Calrose class and great care was taken during their selection to standardise the appearance and cooking qualities. Medium grain varieties are the major type of rice grown in the NSW rice industry. They all have apparent amylose contents of about 20% and a gelatinisation temperature of 68°C. The determination of the amylose content of rice starch is a difficult analytical problem. For research studies, we have used semi-micro differential potentiometric iodine titration but this method is too slow for routine use. Within the rice breeding program, we use iodine colorimetric methods but these give a less precise result. A new method based on the binding of amylopectin to concanavalin A is being tested this season. Aside from amylose content, the size of the amylose and amylopectin molecules and the way they interact with each other and with lipids influence apparent cooked grain texture.

Attempts were made to grow American long grain varieties in the early 1960s; however yields were very low. In 1967, the first locally bred long grain, Kulu, was released. Kulu had reasonable yield for the time but was soft cooking and had poor whole grain milling yields. At this time the Australian domestic table rice market was becoming more diverse with consumer demand for parboiled and long grain rice. In 1972, Inga was released to replace Kulu and in 1980 Inga was replaced by Pelde. These long grains, now referred to as Inga class, have soft texture when cooked. Their starches contain about 22% amylose; they have gelatinisation temperatures of 71-72°C and mill to produce slender, translucent grains. This

type of rice has become popular on the domestic market where it is usually served as boiled rice to accompany a savoury meal. It is also exported to Asia where its soft texture has earned it premium prices. A higher yielding variety of this type, Langi, was released in 1995.

Short grain varieties were phased out of production in the late 1970s, leaving the industry producing two major types of rice. Rice was however being imported into Australia and these imports were usually of quality types not produced by the local industry. The breeding program, after consultation with marketers, evolved standards for a number of specialty rice types that will either fill niches in the domestic market or be particularly suited to certain export markets. The first of the new types, a firm cooking long grain with an amylose content of 28%, was released in 1988 as Doongara. This rice is useful as firm table rice, has superior quality when parboiled and is well suited to wet pack processing. A second specialty type with big, bold, partially opaque grains has been grown since 1989 for export. Rices of this type are grown in Italy and Spain and are usually called Arborio type. A superior variety of this type, named Harra, was released in 1991 and replaced with a variety with superior appearance and yield, Illabong in 1993.

A third specialty type was released in 1991. The new variety, Goolarah, is a fragrant type similar to the Thai jasmine rices. The fragrance is of the 'pop-corn type' and is associated with a particular taste. This variety had excellent appearance but poor yield and a high yielding variety of this type Kyeema was released in 1995.

The plant breeding programme has released new varieties at the rate of about 1 per year since 1989 and currently has aims of high yields, cold tolerance and seedling vigor as well as seven defined quality niches. Australian exports over 80% of its production and recent varietal research has emphasised the quality needs of the Japanese market. The variety Millin released in 1995 has provided an initial step towards meeting this markets requirements.

In the past decade area, production and yield have all significantly increased (Fig 2, 3, 4).

Figure 2. Trend in NSW rice area

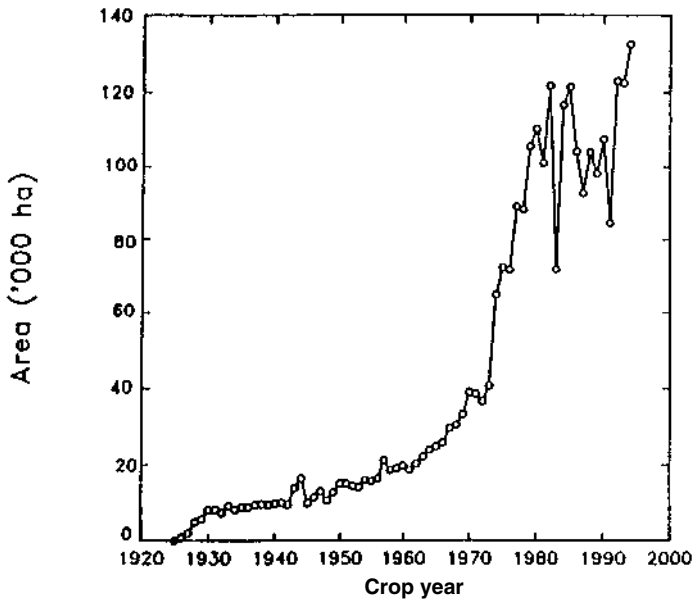


Figure 3. Trend in NSW rice production

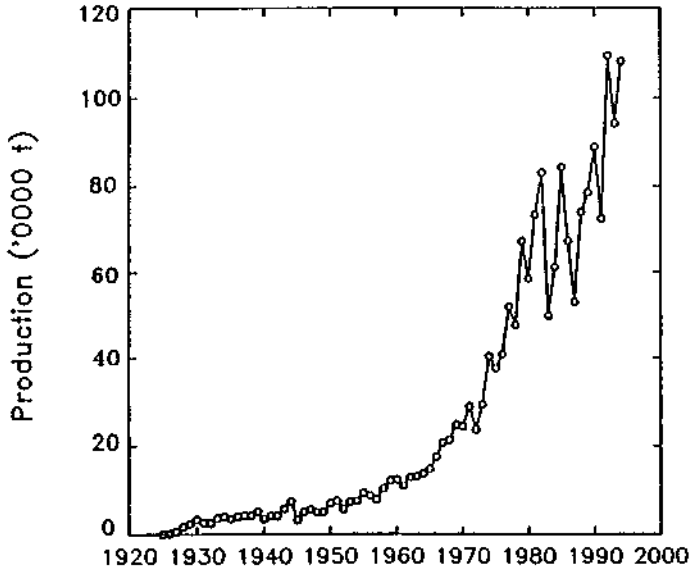
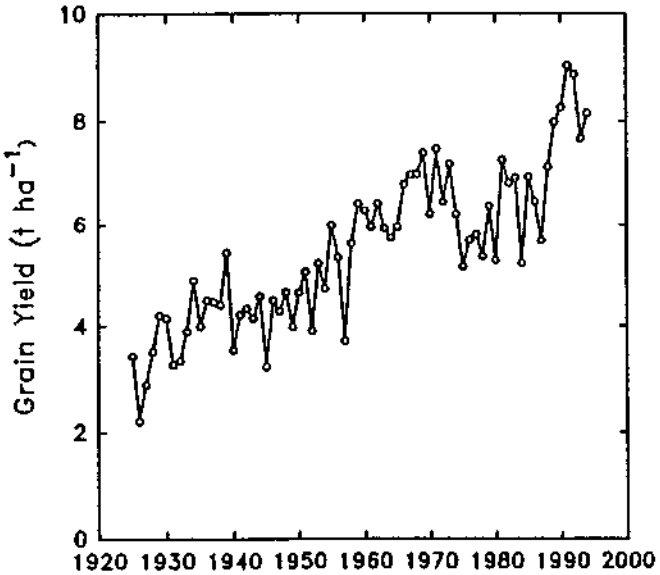


Figure 4. Trend in NSW rice yield



Average yields are high, Amaroo average yield in 1995 was 9.47 tonnes/ha, Illabong, an Arborio type rice, was the highest with an average of 10.60 tonnes/ha.

I – Farmer adoption of research

Co-operation between research and extension staff and with producers has been a feature of the New South Wales rice industry. This has ensured rapid exchange of information producing, on the one hand, highly relevant research and, on the other, keen expectations of useful new technology.

Beginning in 1985, a simple decision support system called 'Ricecheck' was developed and has become very widely used by farmers with spectacular effects on the adoption of technology and on yields (Lacy, 1994). Ricecheck assumes that all factors which might affect yield are important. Eight key factors or checks have been identified from surveys of highly productive crops (Table 1). The objective nature of checks is maximised by specifying measurements or ranges to be achieved. Farmers using the system are required to take measurements on their crop, compare their data with the Ricecheck standards, and

take appropriate action to compensate inadequacies or correct deficiencies. The NIR-based tissue-testing service supports 1 of the key checks by quantifying the N status of crops at panicle initiation as the basis for decisions about topdressing (Batten and Blakeney, 1991).

A useful measure of the effectiveness of technology transfer is the level of yield achieved by farmers. While the average performance of rice farmers is below the best research station performance, there is no such gap with the best growers.

II – Research funding

The rice industry has always placed high value on research and extension services. Rapid expansion of the industry in the 1970s produced pressures for much greater research effort and led to substantial financial support for research and extension projects. Currently, growers are levied on production to provide total research and development funds of almost $11.8 million in 1994-95. Allocation of funds to research areas is indicated in Table 2 (McDonald, 1994).

Table 1. Key checks underlying Ricecheck recommendation

No.	Key check
1	Develop good field layout with landformed, even grade between well-constructed banks of height > 40 cm (measured at lowest point)
2	Use recommended sowing dates
3	Obtain good or economic weed control
4	Establish seedling population 150-300 plants/m2
5	Achieve optimum crop growth level at panicle initiation 500-1100 shoots/m2 and NIR tissue N 1.2-2.2% depending on variety
6	Topdress N based on shoot counts and NIR tissue analysis using rice NIR tissue test
7	Achieve early pollen microspore water depth 20-25 cm on high side of each bay for Amaroo, Bogan, Jarrah, Illabong, Langi and Doongara; and 25 cm for Pelde, Kyeema and Goolarah
8	Harvest as soon as possible after physiological maturity when grain first reaches 22% moisture

Table 2. Allocation of research and development funds by the Rice Industry Research and Development Committee

Research area	Per cent of funds
Varietal improvement	49
Crop establishment	3
Agronomy-crop physiology	3
Crop nutrition	8
Crop protection	9
Sustainable farming systems	7
Technology transfer, human resource development	7
Harvesting, storage, handling, transport	5
Milling and processing	Funded separately by Ricegrowers Co-operative Ltd
On product R&D	5
Administration	2
Uncommitted funds	2
Total	**100**

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