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Australian Native Rice

— *A new sustainable wild food enterprise* —

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Australian Native Rice: A new sustainable wild food enterprise

By P.A.S Wurm, L.C. Campbell, G.D. Batten and S.M. Bellairs

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Researcher Contact Details

Penny Wurm
School of Environmental & Life Sciences
Charles Darwin University
Darwin. NT. 0909

Phone: 08 8946 6355
Fax: 08 89 46 6847
Email: penny.wurm@cdu.edu.au

In submitting this report, the researcher has agreed to RIRDC publishing this material in its edited form.

RIRDC Contact Details

Rural Industries Research and Development Corporation
Level 2, 15 National Circuit
BARTON ACT 2600

PO Box 4776
KINGSTON ACT 2604

Phone: 02 6271 4100
Fax: 02 6271 4199
Email: rirdc@rirdc.gov.au.
Web: http://www.rirdc.gov.au

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Foreword

Australian native rices (*Oryza rufipogon* and *O. meridionalis*) are an abundant and widespread resource in floodplains across monsoonal Australia. *O. meriodnalis* has been observed to produce between 26- 265 kg ha^{-1} in native plant communities (Wurm 1998). Native Australian rice has been harvested and consumed by Indigenous people for thousands of years. Wild rice may have the potential to support new small scale, wild harvest enterprises as well as contributing to breeding programs for cultivated rice, *O. sativa*.

This project investigated the milling and processing, mineral nutritional and putative cooking qualities of rice grain samples from wild populations of two native rices. The success of this project sets the scene for a future study that would, in close collaboration with Indigenous project partners, include assessment of the environmental, cultural and economic feasability of an industry based around wild rice.

The project developed a successful de-husking process for both wild rice species which are significantly more difficult to process than domesticated rice. A preliminary nutrient analysis alongside domesticated rice showed the wild rices had higher concentrations of N, P, Na, Ca, Mg and Zn, while commercial brown rice was higher in K and Mn.

These native rices are also an internationally significant genetic resource, having remained largely isolated from cultivated rice. If further studies confirm that northern Australian wild rices have appropriate quality attributes, this information will be useful for breeding cultivated rice in the longer term. This information may also be useful to those considering commercial cultivation of wild species.

This project was funded from RIRDC core funds which are provided by the Australian Government.

This report is an addition to RIRDC's diverse range of over 2000 research publications and it forms part of our New Plant Products R&D program, which aims to facilitate the development of new industries based on plants or plant products that have commercial potential for Australia.

Most of RIRDC's publications are available for viewing, free downloading or purchasing online at www.rirdc.gov.au. Purchases can also be made by phoning 1300 634 313.

Craig Burns
Managing Director
Rural Industries Research and Development Corporation

Acknowledgments

In the Northern Territory, native rice seeds were collected with permission of NT Parks and Wildlife Service (permit No: 26840) within Fogg Dam Conservation Reserve and Beatrice Hill Research Farm, Adelaide River floodplain and Wildman River Conservation Reserve, Mary River floodplain.

Our thanks to Parks staff at Fogg Dam and Wildman River and to the manager at Beatrice Hill for supporting the ongoing study of native rices in these catchments. Thanks also to Robert Townsend for his e airboat pilot expertise.

Ms Lyn Lowe (Charles Darwin University) patiently and skilfully assisted with the de-husking of seed used in some of the analyses.

In NSW, Dr Chris Blanchard (Charles Sturt University) and Ms Denise Pleming (NSW Department of Primary Industries) are thanked for access to equipment that made de-husking feasible.

Mr Phil Williams, SunRice Pty Ltd, provided unpublished data on commercial rice mineral concentrations.

The barley pearler was generously loaned by Dr Tony Blakeney and to whom we extend thanks for many useful conversations.

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What the report is about

This report presents information about the grain quality of two widespread and abundant native rices, *Oryza meridionalis* and *O. rufipogon* in northern Australia, in order to investigate their suitability for a bush-tucker, novelty or other wild rice enterprise.

Who the report is targeted at

The report is targeted at scientists, agricultural advisors, policy makers and small bush tucker enterprise developers. The results will be useful for rice breeders in Australia and elsewhere who are interested in improving grain qualities of commercial *O. sativa* and those interested in the potential for cultivation of wild species.

Background

Wild rices were an important food for Indigenous people for thousands of years and could potentially underpin small “bush tucker” or “novelty food” enterprises for tourism or native food industries.

Australian native rices also comprise a globally significant genetic resource, having remained isolated from cultivated rices. The grain quality of wild rice species is of interest to rice breeders, and those interested in cultivating wild species.

Aims/objectives

The project aimed to investigate the processing, mineral nutritional and cooking qualities of grain accessions of two Australian native rice species and compare these to commercial rice samples.

Methods used

Samples of wild rice grain were collected from conservation reserves on two catchments, from a number of populations of two Australian native rice species *Oryza rufipogon* and *O. meridionalis*.

Standard techniques were used to determine husking and milling success, grain mineral content, nitrogen, micronutrients and starch paste viscosity.

Results/key findings

Despite the long awn, husking and milling were feasible (at the small scale of this study).

These two Australian native rice species had comparable nutritional properties to commercial rice and, for some minerals, were more nutritious.

Mineral analysis showed concentrations of Fe, Zn, Ca, Mg, P, S and N higher in the native species that in commercial samples. However, K, Mn and Na were lower than in *O. sativa*. Thus nutrient concentrations in native rice seeds are not a barrier to their use as a food.

Mineral concentrations also differed significantly ($p < 0.05$) between the two wild species, with N, P, K, Mg and Cu all being significantly higher in *O. meridionalis* than in *O. rufipogon*.

In particular, one measure of cooking quality, peak starch viscosity, was significantly lower in wild rices than most commercial rices. Nevertheless, the measurements in wild rice samples were similar to some existing commercial rice samples. This reflects the amount of amylose and amylopectin in the grain starch, and indicates cooking quality will not be a barrier enterprise development.

Implications for relevant stakeholders

The cooking and nutritional properties of Australian native rices are suitable for bush tucker, novelty, native food or other wild rice enterprises. Wild rice grains also have a potentially appealing colour.

The results also indicate that the nutritional properties of grain need not limit the inclusion of *O. meridionalis* or *O. rufipogon* in breeding programs for cultivated rice.

Recommendations

The grain properties of these native rices indicate they are suitable for inclusion in food products, although some further testing will be required prior to human consumption.

Preliminary consultation with Indigenous enterprise facilitators, undertaken during this study, indicate interest in pursuing a feasibility study for subsequent enterprise development. This would involve further agronomic, ecological and business analysis.

The links between the concentrations of mineral nutrients and factors such as soils and environment, and plant parameters such as yield, harvest index and grain size and seed retention need to be evaluated for their impact on any subsequent product quality.

It is recommended that resources and partnerships be sought to further explore enterprise options.

Introduction

Native rices are important components of our ecological biodiversity and cultural heritage. They are "an understudied, strategically important genetic resource" (D Vaughan, pers. comm. 2008) and may provide an opportunity for a new food industry. Native bush foods have the potential for commercial development through the sustainable harvesting of native foods to underpin small enterprises in rural and remote communities in the Northern Territory (Gorman & Whitehead 2005, Whitehead et al. 2006). This project specifically investigated the use of native rice grain as a "bush tucker" or gourmet products that may be developed for the tourism industry. We focused on the two most abundant species viz. *Oryza rufipogon* and *O. meridionalis*. This project aimed to determine the processing, nutritional and cooking qualities of grain samples from populations of these two native rices and compare them to commercially available rice.

Native rices (*O. rufipogon* and *O. meridionalis*) are an abundant and widespread resource in floodplains across monsoonal Australia. Native Australian rice has been harvested and consumed by Indigenous people for thousands of years. Native rice may have the potential to underpin a wild rice enterprise as a "bush tucker", "novelty" or gourmet product (either as grains or flour) for the tourism and niche gourmet markets. Indigenous floodplain communities have limited economic opportunities and a wild rice enterprise would provide economic, cultural and social benefits. Traditional methods exist for managing floodplains, harvesting and preparing rice for consumption.

These native rices are an internationally significant genetic resource, having remained largely isolated from cultivated rice (*O. sativa*) and have the potential to contribute to a world wide need for wild cultivars and agricultural development in the Asia-Pacific region. If grains of northern Australian native rices are found to have appropriate quality attributes, this information may be useful for breeding of cultivated rice in other parts of Australia or Asia in the longer term.

This project was a pilot study, which foreshadows partnerships among Indigenous enterprise partners and collaborators with expertise in wetland plant ecology, agronomy and grain science, cookery and small enterprise development.

As these grain qualities were found to be favourable, funding will be sought to implement a full project. In collaboration with Indigenous project partners, this would include assessment of the cultural considerations of offering native rice as a product for tourism, an evaluation of the ecological feasibility of and impact of native rice harvesting and an assessment of the effort, cost and barriers associated with collection and processing.

With this in mind, the project investigated the processing, mineral nutritional and cooking qualities of replicate grain accessions of two Australian native rice species and compared these to commercial rice samples.

Objectives

This project assessed the grain qualities of native populations of Australian native rices and compared these to commercial rice samples, with a view to developing a larger project to investigate the development of a native rice “bush tucker”enterprise.

Although more difficult to process due to its large awns and small grain size than cultivated rice, modern processing methods should overcome these difficulties.

Specifically the project aimed to:

- Determine the grain nutritional quality in terms of
    - protein content (nitrogen)
    - macro and micro mineral nutrient composition.
- Determine starch viscosity as a de facto measure of cooking quality.
- Compare the preliminary assessment of the grain quality of the two native rices and commercial rice samples.
- Maintain discussions with Indigenous custodians with a view to developing research partnerships.

Methodology

Grain collection

Grain samples were collected within the Fogg Dam Conservation Reserve and Beatrice Hill Research Farm in the Adelaide River catchment, and Wildman Conservation Reserve in the Mary River catchment in the Northern Territory. Collecting was done in April 2008, at the end of the wet season, when sufficient grain was held in the inflorescence.

Grain was collected by passing through stands of rice in an airboat while suspending collection containers at the level of the inflorescences. Samples were then labelled and placed in loosely tied clean plastic bags. Because of the high numbers of invertebrates collected along with the seed, plastic bags of grain were left outdoors and open for 24 to 48 hours to allow the insects to evacuate the bags. Seeds were then separated from remaining detritus and transferred to paper bags and stored at room temperature at constant humidity in the laboratory in Darwin before dispatch to Sydney for analysis.

In order to compare the qualities of these native rices with commercial rice, samples of commercially available rice were included in some analyses.

Grain processing and analysis

This study was completed in two stages, reflecting the pattern of funding received for the project. Specifically, funding was received to cover the field collection, some grain processing and analysis of pooled seed samples (i.e. pooled across sites and samples for each of the two wild species studied).

The analyses of pooled samples indicated that grain nitrogen, nutrients and pasting qualities were similar to cultivated rice. Top up funds were obtained to undertake a study of the variability of these attributes among samples for each species, stratified according to sample or site for each species, where there was sufficient grain for any particular analysis.

For this reason, the methods and results for grain quality analyses are reported for **pooled samples** and **stratified samples** in the following sections of the report.

Grain processing

The native rices were difficult to process due to their large awns and small grain size compared to cultivated rice, but successful de-husking processes for both species were developed, at least to prepare research scale quantities of de-husked grain.

Pooled samples

A research-scale rice de-husker fitted with standard rollers (Model THU35B, Satake Australia Pty Ltd, NSW) was used. Grains were then cleaned over a small seed grading vibrating screen (Kimseed grain cleaner, Kimseed Engineering, WA). White rice was produced by milling brown grains using a hand-held barley pearler (Kett,Toyomenka Pty. Ltd., Sydney). Rice flour from brown and white rice was obtained by grinding grain to pass a 0.5 mm screen (Newport Scientific, Warriewood, NSW) fitted with a stainless steel impeller.

Grains obtained using this methods were used in an initial analysis aimed at comparing overall qualities of pooled samples of *O. meridionalis* and *O. rufipogon* with commercially available grains, and to compare brown and white samples or the native rices.

Stratified samples

Seeds were placed between two boards covered in finely ribbed rubber. The boards were moved briskly against each other by hand, while applying moderate pressure. De-husked seeds were set aside after each of 3 to 4 passes of the boards, until the majority of seed had been obtained from a sample. The most difficult to de-husk seeds were discarded.

Grains obtained using this method were used in subsequent analyses aimed at determining within-species and between-site variability in grain qualities.

Grain analysis

Grains were analysed for nutritional value by measuring nitrogen and mineral content (total nitrogen, chloride, boron, calcium, copper, iron, magnesium, manganese, phosphorus, potassium, sodium, sulphur, and zinc) and starch pasting qualities, which is useful in determining rice eating and cooking quality (Bao 1999; Zhou et al. 2002).

Pooled samples

Mineral concentrations of de-husked grain, husks and awns were measured by inductively coupled plasma analysis after nitric acid digestion (Zarcinas et al. 1987). Nitrogen was measured by the Dumas combustion method using a Leco(R) analyser.

Starch paste viscosity profiles were determined using Rapid Visco(R) analyzer (RVA) (Newport Scientific, Warriewood, NSW), at the University of Sydney's Plant Breeding Institute at Narrabri, NSW. This method involved exposing rice flour to a standard, temperature-programmed heat-hold-cool-hold protocol, during which the viscosity of the paste was measured. The viscosity profiles during a 12 minute heating–cooling cycle were recorded for ground samples (4 g) of brown rice flour with 25 mL water

Stratified samples

Methods used were the same as those used for the pooled samples. Total nitrogen was measured by the Kjeldahl digestion (with concentrated sulphuric acid decomposition with selenium catalyst, and indophenol blue colorimetric determination).

Starch paste viscosity was analysed using Rapid Visco(R) analyzer (RVA) rice method (Newport Scientific, Warriewood, NSW) at AgriFood Technology Pty Ltd Laboratories, Werribee, Vic.

Design and data analysis

For pooled samples a simple inspection of means and standard error was undertaken.

For stratified samples, where there were sufficient quantities of seeds for replicate samples, the variability of grain quality attributes between native species, within a sample or between sites was evaluated using ANOVA (Statsoft Corp, 2008), using a significance level of $p<0.05$.

Prior to ANOVA, data were inspected for violations of the assumptions of ANOVA.

Results

Grain processing

A preliminary trial was undertaken whereby awns and husks were removed manually for both species. Individual seed weights were 10.42 ± 1.86 mg/seed for one population of *O. meridionalis*, 11.42 ± 1.29 and 11.05 ±1.17 mg/seed for two populations of *O. rufipogon*.

Milled brown rice percentages were 57% for *O. meridionalis* and 48% for *O. rufipogon*.

Seeds of both species collected from Beatrice Hill, Mary River and Fogg Dam in April 2008 were also de-husked manually. Seed weights of O. *meridionalis* varied between sites from 14.6 to 24.5 mg/seed before de-husking and from 9.1 to 13.5 mg/seed as brown rice. The mean milling percentage of these samples was 56.9 ± 3.9%. Seed weights of *O. rufipogon* were between 14.6 to 15.7 mg/seed prior to de-husking and between 8.6 and 10.5 mg/seed after de-husking resulting in a milling percentage of 65.1 ± 4.1%.

A single sample of brown rice was placed in a barley pearler, using standard barley settings, to generate white rice. This resulted in about 70% turnout of white rice.

Milling percentages were not obtained from the larger samples when de-husked mechanically.

Visual inspection of de-husked, brown grain indicated that grain colour was very variable. The majority of brown rice grain was reddish-brown to dark brown. However, there was a significant percentage of much lighter coloured grain including some with greenish tinges. This may well reflect the maturity of the grain at harvest.

When brown rice was further milled in the barley pearler, the resultant white rice was similar in colour to commercial white rice. This result was unexpected due to the higher protein concentration in the wild rice than in cultivated rice. More samples are required to confirm this comparison.

Grain nutrients

Pooled samples

No difference in N was detected between native species, for pooled samples. The mean nitrogen content of grains from both native species was 1.70 ± 0.16%, equivalent to 10.6 ±1.0% protein, which is several percent higher than that for commercial rice (Table 1).

The minerals Zn, Ca, Mn and P are also higher in the native rices than in commercial Australian rice (Table 1).

On the other hand, commercial *O. sativa* had higher concentrations of Mg, Na, K and Cu in the grain than either of the wild rice species. There were no differences between native and cultivated species for Fe, B or S.

Table 1. Data for pooled samples for grain mineral (mg kg-1) and protein (%) content for pooled samples of *O. meridionalis, O. rufipogon* and *O. sativa*.

Data for native rices are for pooled samples collected at Fogg Dam and Beatrice Hill.

Species	Fe	Mn	B	Cu	Zn	Ca	Mg	Na	K	P	S	Protein
O. meridionalis	17	18	1	1	31	122	1616	9	2463	3663	1210	10
O. rufipogon	14	24	1	2	29	147	1143	11	2150	2850	1018	10
#*O. sativa*	11	38	0.9	2.7	17	91	1090	26	2850	2770	1000	7

Data for *O. sativa*, from a large number of pooled samples, supplied by P. Williams, SunRice Pty Ltd, NSW.

Stratified samples

Further analysis of grain nutrient qualities of the two native species revealed significant differences in some minerals, when replicate samples were analysed. Specifically, *O. meridionalis* has significantly higher total nitrogen, potassium, magnesium and copper than *O. rufipogon* (Table 2).

ANOVA of replicate subsamples for four collections of *O. rufipogon* seeds within the Fogg Dam area, indicated that some mineral parameters varied significantly among *O. rufipogon* samples. Specifically, ANOVA indicated P (0.12-0.25%), K (0.10-0.19%), Mn (0.050-0.096%) and Cu (2.6-3.3 mg/kg) varied significantly among collections of *O. rufipogon* from within the Fogg Dam area.

Table 2: Mineral content of native rice grains. Mineral levels that are significantly different between the two native species are indicated by * (p <0.05).

Species	*N (%)	Nitrite (mg/kg)	S (%)	*P (%)	*K (%)	Ca (%)	*Mg (%)	Cl (%)	Na (%)	*Cu (mg/kg)	Zn (mg/kg)	Mn (mg/kg)	Fe (mg/kg)	B (mg/kg)
O. meridionalis (n = 6)	1.9 ± 0.1	<50	0.10 ± 0	0.33 ± 0.05	0.23 ± 0.03	0.02 ± 0	0.13 ± 0.02	<0.050	<0.005	4.8 ± 0.6	28 ± 1	20 ± 1	19 ± 3	2.5 ± 0.2
O. rufipogon (n = 5)	1.6 ± 0	<50	0.09 ± 0	0.20 ± 0.02	0.15 ± 0.01	0.02 ± 0	0.08 ± 0.01	<0.050	<0.005	2.8 ± 0.1	24 ± 1	19 ± 1	10 ± 1	2.4 ± 0.1
#*O. sativa*			1	0.28	0.29	0.01	0.11		0.003	2.7	17	38	11	0.9

# Indicates unpublished data for *O. sativa* , for a large number of pooled samples, supplied by P Williams, SunRice Pty Ltd

Starch paste analysis

Pooled samples

Starch paste analysis indicated RVA properties for the two native rice species were not significantly different ($p<0.05$), but with *O. sativa* having a significantly higher peak viscosity than the two native species (Table 3).

Table 3: Rapid visco analysis of samples of *O. meridionalis* and *O. rufipogon*, collected from the Mary and Adelaide River catchments.

Viscosity parameters are reported in Rapid Visco Amylograph Units (RVU). Values with the same letter are not significantly different ($p<0.05$).

Species	Rapid visco analysis (RVU)
O. meridionalis	198.4 ± 13.0 a (n = 8)
O. rufipogon	206.0 ± 56 a (n = 5)
O. sativa	384.7 ± 20.0 b (n = 8)

Peak viscosity for *O. rufipogon* was more variable (greater standard error) than for *O. meridionalis* or *O. sativa*. RVA values ranged from 130-221 RVU for *O. meridionalis*, and 159 - 301 for *O. rufipogon* and between 221-469 for *O. sativa* samples (Appendix 2).

Implications

The cooking and nutritional properties of Australian native rices are suitable for bush tucker, novelty, native food or other wild rice enterprises. Wild rice grains also have a potentially appealing colour.

The key findings of this study are: (i) wild rice cooking quality (based on RVA values) is comparable to commercial rices sold in Australian supermarkets (ii) initial screening suggests that the cooking quality of both wild species is similar (iii) that the mineral concentrations in the grain of the wild rices are similar to or greater than in domesticated rices (iv) protein concentration is 3% higher in the wild species than in Australian commercial rice (v) the colour (whiteness) of the white rice of the wild species is comparable to that of commercial rices and (vi) the variable colour of brown wild rice may itself be a desirable quality.

The results also indicate that the nutritional properties of grain need not limit the inclusion of *O. meridionalis* or *O. rufipogon* in breeding programs for cultivated rice.

The fertility of the floodplain soils on which these wild rices grew was not assessed. However, floodplain soil pH is generally low, potentially saline, and fertility is highly variable. Extractable phosphorus ranged from 5 to 34 ppm, extractable potassium from 40 to 1015 ppm and total nitrogen from 0.14 to 0.86 % in the top 30 cm of soil (White 1981). In this study it was particularly notable that zinc, magnesium and phosphorus were present in higher concentrations in native rice grains than commercial rice grown in southern NSW. Thus it is possible that these rices may have mechanisms for comparatively greater efficiency of nutrient uptake for some nutrients. Equally well, it is hypothesised that lower sodium in the wild rices indicates an exclusion mechanism. Further investigations are warranted especially for potential rice breeding programs.

The technical information about wild rice grain resulting from this project will be useful to Indigenous and other organisations, and could underpin new enterprises or a larger rice industry.

There is also considerable interest in Australain native rices by local and overseas scientists and agriculturalists (Henry et al. 2008) and further studies are urgently required. In the words of the international rice expert, Dr Duncan Vaughan "*Australian native rices are an understudied, strategically important, genetic resource".*

Consultation for potential enterprise development

During the course of this project we received expressions of support for future projects and interest in results from NT Government (Regional & Indigenous Economic Development unit), North Australia Land and Sea Mangers Alliance (NAILSMA), Tropical Rivers and Coastal Knowledge consortium (TRaCK), an individual Indigenous family and the Northern Land Council (NLC).

The time may be ripe for further work. The NT Government and Northern Land Council are currently working together to implement joint management plans for National Parks, and to explore the potential for Indigenous custodians to benefit from National Park Management through livelihoods and wild harvest enterprise development. We understand from conversations with the NLC that Indigenous ranger groups, for example, are actively seeking small scale projects to supplement other activities such as weed and feral animal management.

However, a number of factors need to be present at a site in order for a native rice enterprise development, or research into enterprise development, to proceed. These include: (a) abundant populations of native rices, (b) Indigenous custodians interested in establishing enterprises, (b) equipment to collect wild rices samples at least at a research scale (e.g. airboat), (d) other infrastructure to support field trials (e.g. grading equipment; sheds in which to experiment with processing) (e) an existant local market for any product developed (e.g. a tourist presence) and (f) established partnerships to underpin research and enterprise development (e.g. between Indigenous custodians and agencies such as NLC, CDU and others).

Discussions with staff at the Northern Land Council indicate there is at least one potential site where these factors come together. We are happy to provide further details informally but prefer not to name potential future research partners before formally commencing consultations with people on the ground. Exploring this potential will comprise the next phase of this project and preliminary discussions with Indigenous custodians will underpin any further request for funding.

Recommendations

This study has demonstrated that Australian native rices meet requirements for nutritional and cooking quality. As such, the project has prepared the ground for further studies which are needed to deal with a range of issues.

- Although husking and milling proved feasible using small, research-scale equipment, it will be necessary to investigate methods for larger scale processing.
- A subsequent step is to evaluate the starch branching, which would provide further evidence as to the cooking properties and potential markets for these products. Expertise to undertake these analyses is resident in the Faculty of Agriculture, Food and Natural Resources at the University of Sydney.
- Although this small pilot project indicates that the nutritional and cooking qualities of wild rice are suitable for human consumption, it is recommended the routine toxicity testing be undertaken to eliminate this as an issue.
- While a number of samples were used in this study, the possible variability in grain qualities across habitats and years is not known. For example, while cooking quality is largely genetically determined, there can be a significant environmental interaction (Bao et al. 2006). Thus the spatial and temporal reliability of grain quality needs to be determined.
- For enterprise development to be considered, further research is also required on the ecological impacts and cultural considerations for a wild rice bush tucker enterprise, based on ecologically sustainable harvesting.
- If a larger scale, commercial industry is to be considered in the future, much greater understanding of environmental impacts, markets, agronomy and grain quality would be required. Dr Lindsay Campbell is currently trying to recruit a suitable person to undertake preliminary economic studies for a wild rice industry. This study may be able to identify impediments to development of an industry, or whether a large scale industry is desirable.)
- Research partners need to be identified from interested Indigenous representative groups, the Northern Territory Government and, if possible, potential commercial users of the rice, in order to frame subsequent funding applications.

The satisfactory nutritional quality of the species of wild rice studied paves the way to seek funding to develop the necessary protocols to establish a native rice enterprise.

This would include the following:

- Confirmation of the research findings of this preliminary study by assessing samples collected from a diverse geographic area.
- Assessment of the links between the concentrations of mineral nutrients and factors such as soil and environment with plant parameters such as yield, harvest index and grain size.
- Evaluation of the more southerly distributed *O. australiensis*, as to its mineral nutrient, protein and cooking quality so that the relative merits of each of the three main Australian native rices are known.
- Formulation of a benefit sharing agreement among traditional custodians and others

- Formulation of a research agreement among traditional custodians and others
- Consideration of potential products and cultural considerations with Indigenous custodians
- Formulation of benefit sharing agreement among Indigenous custodians and others
- Implementation of nursery and field experiments to determine the timing of maximum yield for the each species
- Investigation of the logistics in the field of wild harvest
- Development of preparation and cooking methods for native rice products
- Assessment of the ecological feasibility and protocols for sustainable wild rice collection

The results of this study will be made available to other researchers via the RIRDC website.

Appendices

Appendix 1: Raw data for mineral and nutrient analysis for native rices collected from the Mary River and Adelaide River (Fogg Dam and Beatrice Hill) and commercially available rice samples.

All samples were brown grain.

Species	Year	Site	Sample	Replicate	Total N %	Nitrate mg/kg	S %	P %	K %	Ca %	Mg %	Na %	Cl %	Cu mg/kg	Zn mg/kg	Mn mg/kg	Fe mg/kg	B mg/kg
O. meridionalis	2008	Fogg Dam	1	A	1.9	<50	0.12	0.31	0.22	0.02	0.11	<0.005	<0.05	5	28	19	14	2.5
O. meridionalis	2008	Fogg Dam	2	A	1.8	<50	0.11	0.41	0.27	0.021	0.15	<0.005	<0.05	5.9	30	16	14	1.9
O. meridionalis	2008	Fogg Dam	2	B	1.8	<50	0.11	0.39	0.26	0.019	0.14	<0.005	<0.05	7.1	29	16	22	2.1
O. meridionalis	2008	Beatrice Hill	3	A	2.2	<50	0.1	0.39	0.27	0.028	0.17	<0.005	<0.05	4.2	30	22	25	2.8
O. meridionalis	2008	Beatrice Hill	4	A	1.9	<50	0.10	0.28	0.19	0.015	0.11	<0.005	<0.05	5.5	30	25	19	2.3
O. meridionalis	2008	Beatrice Hill	5	A	2	<50	0.09	0.18	0.14	0.015	0.07	<0.005	0.058	3.3	22	17	12	2.3
O. rufipogon	2008	Fogg Dam	7	A	1.4	<50	0.11	0.17	0.14	0.022	0.07	<0.005	<0.05	3.3	26	22	12	2.6
O. rufipogon	2008	Fogg Dam	7	B	1.3	<50	0.09	0.13	0.11	0.016	0.05	<0.005	<0.05	2.6	21	17	8.3	2.7
O. rufipogon	2008	Fogg Dam	7	C	1.6	<50	0.08	0.12	0.1	0.016	0.05	<0.005	<0.05	2.6	18	16	6.2	2.2
O. rufipogon	2008	Fogg Dam	8	A	1.5	<50	0.10	0.21	0.16	0.021	0.08	<0.005	<0.05	3.1	26	22	8.7	3.2
O. rufipogon	2008	Fogg Dam	8	B	1.4	<50	0.10	0.23	0.18	0.025	0.10	<0.005	<0.05	3.1	28	25	14	2.9
O. rufipogon	2008	Fogg Dam	8	C	1.4	<50	0.10	0.23	0.18	0.024	0.09	<0.005	<0.05	3	28	25	12	2.7
O. rufipogon	2008	Fogg Dam	9	A	1.4	<50	0.09	0.15	0.13	0.021	0.06	<0.005	<0.05	2.8	23	21	11	2.1
O. rufipogon	2008	Fogg Dam	9	B	1.4	<50	0.09	0.14	0.12	0.02	0.06	<0.005	<0.05	2.7	23	21	9.5	2.8
O. rufipogon	2008	Fogg Dam	9	C	1.5	<50	0.1	0.16	0.15	0.025	0.07	<0.005	<0.05	3	26	24	17	2.9
O. rufipogon	2008	Mary River	10	A	1.5	<50	0.08	0.13	0.11	0.015	0.05	<0.005	<0.05	2.1	23	16	9.2	1.7
O. rufipogon	2008	Mary River	10	B	1.6	<50	0.07	0.12	0.11	0.016	0.05	<0.005	0.053	2.1	22	16	10	2
O. meridionalis	2007	Mary River	11	A	2.1	<50	0.08	0.29	0.19	0.013	0.1	<0.005	<0.05	<1.0	20	13	7.4	1.7
O. rufipogon	2007	Fogg Dam	12	A	1.8	<50	0.09	0.22	0.16	0.015	0.08	<0.005	<0.05	2.9	26	18	7	2.1
O. rufipogon	2007	Fogg Dam	12	B	1.6	<50	0.10	0.23	0.18	0.018	0.08	<0.005	<0.05	2.9	30	20	11	2.8
O. rufipogon	2007	Fogg Dam	12	C	1.5	<50	0.10	0.25	0.19	0.019	0.10	<0.005	<0.05	3	30	22	8.9	2.5

Appendix 2: Raw data for rapid visco analysis of Australian native rices collected from Fogg Dam and Beatrice Hill on the Adelaide River floodplains and a site on the Mary River floodplains, and commercially available cultivated rices.

Note: 12 cP = 1 RVU

Species	Polish	Site	Sample ID	Year	Peak Viscosity (Peak 1) (cP)	Peak Viscosity (Peak 1) (RVU)	Trough 1 (cP)	Breakdown (BD) (cP)	Final viscosity (cP)	Setback (SB) (cP)	Peak time (min)	Pasting temp (oC)
O. meridionalis	brown	Beatrice Hill	GPS #12	2008	1790	149	1717	73	4560	2843	5.85	56.8
O. meridionalis	brown	Beatrice Hill	GPS #10	2008	1563	130	1496	67	4120	2624	6.98	86.3
O. meridionalis	brown	Fogg Dam	GPS #14	2008	2251	188	1980	271	5299	3319	5.72	82.3
O. meridionalis	brown	Fogg Dam	GPS #15	2008	2333	194	1977	356	5206	3229	5.65	82.3
O. meridionalis	brown	Mary River	MR005- 060707	2007	1607	134	1580	27	4238	2658	6.72	68.6
O. rufipogon	brown	Fogg Dam	GPS #20	2008	2026	169	1818	208	4534	2716	5.25	54.8
O. rufipogon	brown	Fogg Dam	GPS #21	2008	3056	255	1864	1192	5330	3466	5.18	78.3
O. rufipogon	brown	Fogg Dam	GPS #19	2008	2241	187	1603	638	4831	3228	5.12	79
O. rufipogon	brown	Fogg Dam	FD-210407	2007	2365	197	2055	310	5754	3699	5.58	85.5
O. sativa	brown	Commercial	SunRice Calrose	2008	3686	307	1705	1981	3106	1401	5.38	72.5
O. sativa	white	Commercial	SunRice Premium	2008	4068	339	2445	1623	4473	2028	5.32	82.2
O. sativa	brown	Commercial	Riviana Natural	2008	3119	260	1835	1284	4071	2236	5.38	68.6
O. sativa	brown	Commercial	Sun Rice Wholegrain	2008	3711	309	1912	1799	3487	1575	5.52	71.1
O. sativa	white	Commercial	Riviana Arborio	2008	5366	447	2322	3044	3971	1649	5.38	59.4
O. sativa	brown	Commercial	New Eastland Thai Red	2008	3050	254	2317	733	4921	2604	5.38	84.0
O. sativa	brown	Commercial	Sakuva Red Rice	2008	3395	283	3019	376	6507	3488	5.85	54.9
O. sativa	white	Commercial	SunRice White	2008	2657	221	2350	307	5035	2685	5.65	80.7

Appendix 2: (cont.)

Species	Polish	Site	Sample ID	Year	Peak Viscosity (Peak 1) (cP)	Peak Viscosity (Peak 1) (RVU)	Trough 1 (cP)	Breakdown (BD) (cP)	Final viscosity (cP)	Setback (SB) (cP)	Peak time (min)	Pasting temp (oC)
O. meridionalis	Brown	Beatrice Hill	Dam Wall 1	2008	2508	209	-	-	-	-	-	-
O. meridionalis	Brown	Beatrice Hill	Dam Wall 2	2008	2226	186	-	-	-	-	-	-
O. meridionalis	Brown	MaryRiver	GPS #18	2008	2434	203	-	-	-	-	-	-
O. meridionalis	Brown	MaryRiver	MR	2007	2647	221	-	-	-	-	-	-
O. rufipogon	Brown	Beatrice Hill	GPS #11	2008	2448	204	-	-	-	-	-	-
O. rufipogon	Brown	Fogg Dam	FD 210407	2007	3610	301	-	-	-	-	-	-
O. rufipogon	Brown	MaryRiver	MR	2007	1903	159	-	-	-	-	-	-
O. sativa	Brown	Commercial	SunRice Calrose Medium Grain, Australia		3936	328	-	-	-	-	-	-
O. sativa	White	Commercial	Sun Rice Basmati, India		3516	293	-	-	-	-	-	-
O. sativa	White	Commercial	Amaroo, Australian		4104	342	-	-	-	-	-	-
O. sativa	White	Commercial	Thai long grain, Thailand		4164	347	-	-	-	-	-	-
O. sativa	White	Commercial	SunRice Doongara Clever Rice		4740	395	-	-	-	-	-	-
O. sativa	White	Commercial	Jasmine Thai Rice, Thailand		4980	415	-	-	-	-	-	-
O. sativa	White	Commercial	Arborio, Spain		5064	422	-	-	-	-	-	-
O. sativa	White	Commercial	SunRice Japanese Sushi, Australia		5412	451	-	-	-	-	-	-
O. sativa	White	Commercial	SunRice Premium Long-grain, Australia		5628	469	-	-	-	-	-	-

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Australian Native Rice

— A new sustainable wild food enterprise —

by P.A.S Wurm, L.C. Campbell, G.D. Batten and S.M. Bellairs

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Wild rice was an important food for Indigenous people for thousands of years and could potentially underpin small "bush tucker" or "novelty food" enterprises for tourism or native food industries.

Australian native rice species also comprise a globally significant genetic resource, having remained isolated from cultivated rices. The grain quality of wild rice species is of interest to rice breeders, and those interested in cultivating wild species.

The project aimed to investigate the processing, nutritional and cooking qualities of grain accessions of two Australian native rice species and compare these to commercial rice samples.

The report is targeted at scientists, agricultural advisors, policy makers and small bush tucker enterprise developers.

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Cover photo: Australian native rice *Oryza meridionalis* on the Mary River floodplain courtesy Sean Bellairs

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Contact RIRDC:
Level 2
15 National Circuit
Barton ACT 2600

PO Box 4776
Kingston ACT 2604

Ph: 02 6271 4100
Fax: 02 6271 4199
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