Storage techniques boost food security over the long haul

RIU

Validated RNRRS Output.

Improved techniques for long-term storage are opening up new opportunities in developing countries. Large-scale storage is essential for grain marketing chains and food security systems, yet over time, quality deterioration often leads to nutritional and financial losses. Now maize stackburn, resulting from the build-up of heat in the interior of bag stacks, can be avoided by using passive ventilation. For milled rice in hot humid climates, quality is ensured over several years by sealing bag stacks into plastic envelopes flushed with phosphine or carbon dioxide. This long-term rice storage technique is used in Indonesia, the Philippines and Vietnam, to safeguard these nations' emergency rice reserves.

Project Ref: **CPH24:**
Topic: **5. Rural Development Boosters: Improved Marketing, Processing & Storage**
Lead Organisation: **Natural Resources Institute (NRI), UK**
Source: **Crop Post Harvest Programme**

Document Contents:

Research into Use
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Geographical regions included:

Ghana, Indonesia, Philippines, Vietnam, Zimbabwe,

Target Audiences for this content:

Crop farmers, Processors,

Description

CPH24

A. Description of the research output(s)

1. Working title of output or cluster of outputs.
In addition, you are free to suggest a shorter more imaginative working title/acronym of 20 words or less.

Preserving grain quality in long-term storage

2. Name of relevant RNRRS Programme(s) commissioning supporting research and also indicate other funding sources, if applicable.

Crop Post-harvest Programme

3. Provide relevant R numbers (and/or programme development/dissemination reference numbers covering supporting research) along with the institutional partners (with individual contact persons (if appropriate)) involved in the project activities. As with the question above, this is primarily to allow for the legacy of the RNRRS to be acknowledged during the RIUP activities.

R5104 (1993 – 1996) Investigations on stackburn in sub-saharan Africa (Ghana, Zimbabwe)

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*4. Describe the RNRRS output or cluster of outputs being proposed and when was it produced? **(max. 400 words)**. This requires a clear and concise description of the output(s) and the problem the output(s) aimed to address. Please incorporate and highlight (in bold) key words that would/could be used to select your output when held in a database.*

Large-scale storage is an essential component in both grain marketing chains and food security systems. Grain and other durable commodities may be stored for relatively long periods and subsequent quality deterioration is a common problem leading to nutritional and financial losses.

Two research outputs (one of which is an RNRRS output) offer opportunities for better retention of the quality of grain kept in long-term storage, favouring better food security, increasing the options for strategic storage and improving opportunities for grain to be marketed at the most favourable times. In the 1990s, improved methods of **long-term storage** of **maize** were developed to prevent **stackburn**. This is characterised by brown discolouration due to the build-up of heat in the interior of bag stacks and can affect local or imported maize grain, especially when kept in polypropylene sacks. The improved method of storage involves the use of passive ventilation and additionally, for grain stacks maintained out of doors, a moisture absorbent layer between grain and tarpaulins. For **milled rice**, quality decline can be rapid in hot humid climates but if bags stacks are sealed into plastic envelopes flushed with **phosphine** or **carbon dioxide** then quality can be maintained for several years, the same technique may also have applications for **small-scale storage** of **high value commodities** such as spices, coffee etc. Although initially more expensive than conventional storage methods, sealed stack storage

becomes cost effective when used for relatively long periods.

5. What is the type of output(s) being described here?

Product	Technology	Service	Process or Methodology	Policy	Other Please specify
	X				

6. What is the main commodity (ies) upon which the output(s) focussed? Could this output be applied to other commodities, if so, please comment

The main commodities are maize grain and milled rice. Stackburn is specific to maize grain and so approaches to avoid stackburn are specific to this crop. Stackburn is known from countries in all regions of sub-Saharan Africa (Zimbabwe, Mozambique, Malawi, Zambia, Tanzania and Ghana). To avert general quality deterioration, rather than just stackburn, sealed stack storage can be used, although well developed for rice, this is applicable to a wide variety of grain in large-scale storage (units of at least 100 tonnes more likely 300 tonnes) but could be scaled down for high value commodities such as spices, coffee etc.

7. What production system(s) does the output(s) focus upon? Please tick one or more of the following options. Leave blank if not applicable

Semi-Arid	High potential	Hillsides	Forest-Agriculture	Peri-urban	Land water	Tropical moist forest	Cross-cutting

8. What farming system(s) does the output(s) focus upon?
Please tick one or more of the following options (see Annex B for definitions).
Leave blank if not applicable

Smallholder rainfed humid	Irrigated	Wetland rice based	Smallholder rainfed highland	Smallholder rainfed dry/cold	Dualistic	Coastal artisanal fishing

*9. How could value be added to the output or additional constraints faced by poor people addressed by clustering this output with research outputs from other sources (RNRRS and non RNRRS)? (**max. 300 words**). Please specify what other outputs your output(s) could be clustered.*

Value is added to the RNRRS output on how to avoid maize stackburn by offering it along side another output that promotes better quality preservation in long-term storage. The technology is sealed stack storage developed and promoted initially by the Australian Centre of International Agricultural Research (ACIAR) in Indonesia and subsequently in the 1980s with DFID technical assistance. The method involves completely sealing bags stacks into a plastic envelope and either replacing the air in the envelope with carbon dioxide or introducing phosphine gas into the enclosure.

Validation

B. Validation of the research output(s)

***10. How** were the output(s) validated and **who** validated them?*
Please provide brief description of method(s) used and consider application, replication, adaptation and/or adoption in the context of any partner organisation and user groups involved. In addressing the "who" component detail which group(s) did the validation e.g. end users, intermediary organisation, government department, aid organisation, private company etc... This section should also be used to detail, if applicable, to which social group, gender, income category the validation was applied and any increases in productivity observed during validation (max. 500 words).

The technologies in question were all developed and validated in association with the staff responsible for the operation of large-scale storage systems and with academic institutions.

Stackburn avoidance – Technology to prevent stackburn was validated in experimental trials undertaken by researchers in Zimbabwe, using outdoor stacks covered with tarpaulins that are typical of the operation of the Grain Marketing Board (GMB). This involved building bag stacks using a honeycombed stacking pattern to give good ventilation. In addition, a layer of hessian, sawdust or groundnut shell was placed between the tarpaulins and bags to absorb any condensation. In 1993, ventilated stacks and control stacks were prepared. Over 15 months it was shown that all ventilated stacks had moisture content stability while control stacks exhibited fluctuating moisture content. Other issues were explored such as the acceptability of stackburnt maize as animal food. It was determined that the stackburnt maize is nutritionally inferior but before use as animal feed determination of appropriate blending regimes for livestock and poultry rations would be required.

Subsequently, key staff in Zimbabwe were trained in the use of the technique with the intention that they would introduce it into depots in the north-eastern region of the country. The result of the programme was the successful introduction throughout the depots of GMB in north-eastern Zimbabwe as a routine stacking method during 1995/96.

Sealed stack storage – the storage of milled rice in sealed stacks was first investigated with the National Logistics Agency (BULOG) and the National Food Authority (NFA) in the Philippines, in projects supported by ACIAR. In initial trials of the technique, bags stacks of rice of 300 tonnes capacity were kept in sealed stacks for up to three years, during which time quality deterioration was negligible compared with controls. Owing to the very successful performance of this technique, operational programmes for the storage of rice in sealed stacks were then implemented. Further refinement and development of appropriate management systems were undertaken in Indonesia with the support of DFID. The method is now well documented with a training manual (ACIAR) and a training video (DFID).

*11. **Where and when** have the output(s) been validated? Please indicate the places(s) and country(ies), any particular social group targeted and also indicate in which production system and farming system, using the options provided in questions 7 and 8 respectively, above **(max 300 words)**.*

Stackburn avoidance – 1990 – 1996 Zimbabwe and Ghana, this technology is applied in large scale central storage systems and not in farming situations.

Sealed stack storage – 1980 -1990 Indonesia and Philippines, late 1990s Vietnam, this technology is applied in large scale central storage systems and not in farming situations.

Current Situation

C. Current situation

*12. **How and by whom** are the outputs currently being used? Please give a brief description **(max. 250 words**).*

Stackburn avoidance– currently GMB is Zimbabwe is carrying little or no stock due to serious food shortages so the technique is not applicable despite having been adopted for some years. In Ghana, where there were also project activities, the Ghana Food Distribution Corporation closed some years ago so that the potential user is no longer operational. It is expected that the technique is probably not in current use. It has not been possible to contact GMB staff in Zimbabwe to verify this.

Sealed stack storage - The role of BULOG in Indonesian rice marketing has declined since the 1980/90s with the effect that storage periods are now much shorter so the need for sealed stack storage, to retain the quality of the rice maintained in long-term storage, is much reduced. However, the method using carbon dioxide remains to be used as and when large stocks indicate the need for long-term storage. The NFA in the Philippines uses sealed stack (with phosphine) for its long-term rice storage. Sealed stacks (with carbon dioxide) is used in Vietnam for preservation of the nation's emergency food reserves of rice. They have made a number of minor innovations and try to maintain grain temperature steady for fear of excessive condensation during their winter.

*13. **Where** are the outputs currently being used? As with Question 11 please indicate place(s) and countries where the outputs are being used **(max. 250 words).***

Stackburn avoidance - probably no current use.

Sealed stack storage - In Indonesia in the stores of the National Logistics Agency, in Java, Sumatra and Kalimantan sealed stacks storage remains an option although not in current use. In the Philippines in NFA stores and in Vietnam in Hanoi the method is currently in operation.

*14. What is the scale of current use? Indicating how quickly use was established and whether usage is still spreading **(max 250 words).***

Stackburn avoidance – probably no current use.

Sealed stack storage - In Indonesia, sealed stacks with carbon dioxide have been very successful so that by 1989

over 200,000 tonnes were being stored using this technique and in subsequent years the amounts varied according to the need for long-term storage. The quantities kept using this method subsequently rise and fall according to the need for long-term storage. In Philippines, NFA in 1999 had about 30,000 tonnes of milled rice in sealed stacks under phosphine and were planning to use the same technology for the storage of bagged maize grain. No details are available on the extent of usage in Vietnam.

15. In your experience what programmes, platforms, policy, institutional structures exist that have assisted with the promotion and/or adoption of the output(s) proposed here and in terms of capacity strengthening what do you see as the key facts of success? ***(max 350 words).***

The promotion and adoption of research outputs has been mainly by large-scale storage institutions who have taken up the outputs of their own collaborative research with external research agencies. In Zimbabwe, stackburn avoidance technology was researched with and adopted by the GMB. In SE Asia, sealed stack technology followed the same pattern with BULOG in Indonesia and NFA in the Philippines.

In sub-saharan Africa the para-statal institutions that would previously have been involved in the adoption and promotion of these types of outputs have largely been dismantled with a few exceptions, such as GMB in Zimbabwe, National Cereals and Produce Board Kenya, and national food security reserves of Ethiopia, Sudan and Zambia. Large-scale grain storage is now largely the preserve of private grain traders who would take on these technologies for purely commercial ends. In this case, platforms that support grain market development would be the ideal partners for continued promotion of stackburn avoidance technology.

In South and SE Asian countries, large state supported grain research institutions and grain handling parastatals are still in operation such as in India the Indian Grain Management and Research Institute (IGMRI) and the Food Corporation of India (FCI), in Pakistan the Agricultural Storage and Services Corporation (PASSCO) and in Bangladesh (Ministry of Food and Disaster Management) and these would be interested in large scale applications of sealed stack technology. In SE Asia, Cambodia may soon produce sufficient rice to be interested in long-term storage under sealed storage and in other parts of the region such as Vietnam organisations like the Post Harvest Technology Institute (Ho Chi Minh) and National Institute of Plant Protection (Hanoi) could be interested in the medium-scale application of sealed stacks for the strategic storage of high value commodities particularly as the country through its National Food Reserve Department (Hanoi) already has some experience with this system for rice storage. For medium-scale application of sealed stack storage, organisations with links to farmers group producing relatively high value commodities are likely to be good starting points.

Environmental Impact

H. Environmental impact

24. What are the direct and indirect environmental benefits related to the output(s) and their outcome(s)? ***(max 300 words)***

This could include direct benefits from the application of the technology or policy action with local governments or

multinational agencies to create environmentally sound policies or programmes. Any supporting and appropriate evidence can be provided in the form of an annex.

Stackburn – no direct or indirect environmental benefits

Sealed stack storage – sealed stack storage can replace the application of synthetic insecticide (typically organophosphorous compounds) in stores. This is a benefit for storage workers who would be exposed to them, for consumers whose food is potentially contaminated with them and the general environment which may be polluted through inappropriate disposal and/or leakage.

25. Are there any adverse environmental impacts related to the output(s) and their outcome(s)? ***(max 100 words)***

Stackburn avoidance - no direct or indirect adverse environmental effects

Sealed stack storage - no direct or indirect adverse environmental effects

26. Do the outputs increase the capacity of poor people to cope with the effects of climate change, reduce the risks of natural disasters and increase their resilience? ***(max 100 words)***

Stackburn avoidance and Sealed stack storage – both methods of storage offer better overall quality at outturn of grain kept in long-term storage and there is evidence that the nutritional quality of stackburnt maize is reduced. Where the techniques are to be used in the preservation of food security reserves then they can contribute to better food quality for vulnerable people.