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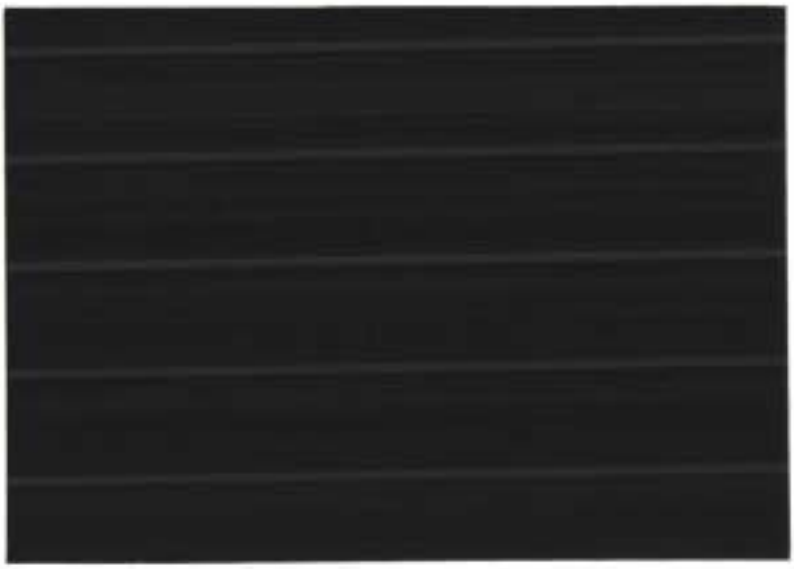

Natural Resources Institute

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Investigations into the causes and prevention of heating and discoloration ('Stackburn') in bag stored maize

Report No. 3: Technical note on a coordination visit to Ghana

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ACKNOWLEDGEMENT

We are very grateful to our colleagues in the University of Legon and Ghana Food Distribution Corporation (GFDC), for the friendly reception we received and for the fruitful discussions. The field visits to storage sites with field staff were particularly valuable in assisting us to better understand the stackburn issue in Ghana.

BACKGROUND

1. The visit to Ghana was a contribution to the collaborative ODA/EC DGXII research project into the causes and management of stackburn in maize (grain heating and discolouration). The purpose of the visit was to to enable the Zimbabwe sub-contractor to ensure that the Ghana and Zimbabwe research programmes are properly coordinated.

2. Peter Tyler, NRI Post-Harvest Grains Specialist (on behalf of the Co-ordinator) drew up the programme (Annexe I) for Noah Kutukwa, Research Manager, Zimbabwe Grain Marketing Board (GMB) on behalf of the Contractor, and accompanied him.

3. The objectives for Noah Kutukwa were:

* to meet contractors and sub-contractors in Ghana (University of Legon, and Ghana Food Distribution Corporation (GFDC));

* to visit warehouse facilities and become familiar with maize handling and storage practices in Ghana;

* to discuss the research programme planned for Ghana, noting particularly questionnaire design and opportunities for harmonisation of experimental techniques between the two countries;

* to draft proposals for investigations at Grain Marketing Board depots aimed at understanding the causes of stackburn, and developing satisfactory management practices for bagged maize susceptible to stackburn; and

* on return to Harare, to liaise with Dr Desiree Cole, (University of Zimbabwe contractor) and, subject to GMB management agreement, initiate a programme of work in Zimbabwe.

4. On behalf of the project Coordinator, opportunity was also taken to discuss research programmes. This report comprises a diary account of all the meetings and discussions held in Ghana.

DIARY NOTES OF MEETINGS AND DISCUSSIONS

26th October

5. Introductory meetings were held at the University of Legon (Department of Botany) with Dr Odamtten (Project Leader for Ghana), Prof. Clerk (Mycologist) and, in the Department of Zoology, with Dr Allotey (Entomologist).

6. It was confirmed that the budget allocation for Ghana due under the project for 1993/4 had been received and was committed. The modified questionnaire to be used to collect data on the incidence of stackburn in selected GFDC warehouses was reviewed. Proposals for students to monitor a stack trial in four to six locations and to undertake the mycological examination of maize samples were explained. The importance of agreeing a stacking plan for the cubic stacks of 500 minibags of 50kg was discussed.

7. Proposals for student work on the infestation aspects of maize and the contribution that this may make to stackburn were discussed with Dr Allotey. He is suggesting that the role of insects in the spread of moulds should be studied. An association of psocids with polypropylene bags in Ghana has been noticed.

8. At GFDC, the introductory meeting with Mr Edwards, Deputy General Manager, Food Security, Storage and Infestation, was devoted to explaining and comparing the policies and operations of both GFDC and GMB, and the incidence of stackburn (heating in relatively dry, stored maize).

9. Whereas the GMB handles only cereals, oilseeds and pulses, GFDC manages a much wider range of commodities including maize, paddy, root crops (cassava), imported rice and other foods. Cold stores are maintained for meat and fish. GFDC also operates several general supermarkets and owns maize-processing and storage sites for bulk grain, situated in key maize production areas. These provide a cleaning and drying facility for maize harvested at moisture levels too high for safe storage. Warehouse capacity for bagged maize is mostly rented from the Cocoa Marketing Board. Unfortunately these stores are not ideally suited to the storage of maize: they lack adequate ventilation and many floors are uneven. This sometimes results in poor results from fumigations. The standard stack size for bagged maize is 300t built to a width of 8m and a height of approximately 16 layers. The GFDC stacks are much smaller compared with the outdoor stacks adopted by GMB, which can hold up to 5000t each. Since stackburn obviously occurs within warehouses and in the smaller-size stacks adopted by GFDC, it appears that the solution to the stackburn problem for GMB in Zimbabwe does not lie in reducing the size of stacks or providing storage sheds.

10. The problem of stackburn had been identified by GFDC on three occasions, involving some 3000t out of a total of about 20,000t. GMB, operating on a much larger scale, has experienced damage affecting at least eight 5000t stacks. Both organisations can relate the start of the problem to the introduction of woven polypropylene (wpp) sacks. Mr Edwards said that, although GFDC was very supportive of the proposal to conduct observations on bagstacks of maize on four trial sites, they were unable

to commit funds to buying maize that would be held for nine months. NRI was asked to assist with a loan to fund the purchase.

27th October

11. Visits were made to a series of GFDC storage sites, accompanied by Mr Mantey, Grain Quality and Pest Control Supervisor. At Kineshie processing and silo site, Eric Quaye, Technician, described the maize intake, drying and storage facility and the processing procedure. Associated warehouses were visited and the Manager, Peter Hover, explained the storage and details of the GFDC fumigation technique using phosphine. He expressed a view, at variance with that generally held, that grain kept fresher in wpp sacks than in jute sacks. A sample of stackburned maize delivered to Accra from Sunyani was taken for comparison with stackburned maize in Zimbabwe.

12. GFDC-rented warehouses in Tema were inspected. Examination of one of three stacks of yellow maize (each about 250t), imported from the USA some 16 months earlier, clearly revealed discolouration in the centre of a partially-discharged stack. Dry-grain heating appeared to be the explanation, but there was also patchy mould and insect damage. Samples were collected and subsequently shown to Mr Edwards, and were left for Dr Odamtten to examine.

13. The port area in Tema was visited and unloading of a consignment of wheat using the ship's derricks and clam grabs was observed. Grain was discharged into dockside hoppers and then into dump trucks for delivery to the local flour mill. Intake and storage of imported bagged Thai rice was seen in a dockside warehouse. The cocoa export facilities of the Cocoa Marketing Board (CMB) were also visited. The final grading procedure for cocoa about to be exported was seen. The cocoa grading technique and pest control operations were explained by Mr Pi-Bansa, Head of Quality Control, and Mr Abottey, Manager, CMB Tema.

14. An important visit was made to Poly Sacks (GH) Ltd, manufacturers of the wpp sacks used by GFDC and others. Mr Annat, Factory Manager, explained the manufacturing processes starting with polypropylene pellets through thread manufacture to weaving, stitching and finally printing. He also explained that the warp and weft can be adjusted to provide a more open weave if that is desired. The present standard bag, supplied to GFDC for maize, is specified as 8x8 strands/square inch (25.4mm). Each strand is 3mm wide (untwisted) so the total open space is 1.4mm per 25.4mm. The space can be increased by reducing the strands per square inch to 7x7 or 6x6. Mr Mantey (GFDC) indicated that GFDC would be keen to try alternative weave bags. Both Mr Annat and Mr Anil

Mohinani, Managing Director, Poly Sacks, were unaware of the problem of stackburn in maize and could offer no immediate explanation. They mentioned that the Cocoa Marketing Board had experienced problems when cocoa waste had been stored in wpp sacks: apparently it had moulded and caked. CMB had reverted to the use of jute bags.

28th October

15. At the GFDC Brong Ahafo Regional Office, the Regional Manager, Mr Awoade, explained how the first occurrence of stackburn was discovered in maize in polypropylene bags in a rented cocoa warehouse at Abuakwa. Three stacks in an unventilated store heated internally. A copy of the report on the incident was provided.

16. The silo site at Sunyani was visited, where maize brought in by local producers was being dried. Also, a store rented from Ghana National Trading Corporation (GNTC), a parastatal, was seen at Sunyani. This was the location of a second incident of stackburn.

29th October

17. At the GFDC Kumasi Regional Office, Peter Twumasi, Senior Storage and Infestation Control Officer, explained how he had investigated the Sunyani case of stackburn. Fresh maize dried to 13% moisture was placed in a mixture of jute sacks and wpp bags, and built into one stack 14 bags high in the (GNTC) warehouse. The store is in good structural condition, but lacks ventilation. Maize heating was noticed and, as the stack was broken down, individual bags were examined for temperature, moisture and discolouration. A significant temperature difference was detected between maize stored in jute sacks and that stored in wpp bags as they were removed from the centre of the stacks. Temperatures were higher in individual wpp bags (35-40°C) and browning was more noticeable than in adjacent jute bags (30-33°C). The lower three layers of bags and those on the outside of the stack were unaffected. No signs of infestation were reported. It was concluded that the heating had been intercepted before the full stackburn cycle was completed. (A copy of this report was not immediately available, but it has been requested.)

18. The wholesale maize market at Kumasi was visited and a discussion held with a market trader. Maize is received in the market by the truck-load from local trader/transporters who collect directly from producers. Grain dealers from areas where there is a deficit then come to buy from the wholesalers. There are no processing or covered storage facilities because these are not required for the current pattern of trade, which depends upon rapid turn-over of stocks. A more subtle

distinction of maize varieties and qualities is made by the private trade than the broad grading classification applied by GFDC. A strong preference was expressed for storage of maize in jute sacks rather than wpp bags.

19. On return to Accra, a final round-up meeting was held with the Acting Managing Director, GFDC, Mr Amankwa. He made the very useful suggestion that the association between variety of maize and susceptibility to stackburn should be examined.

30th October

20. A summary of the meetings held, and the observations made, on the stackburn problem in Ghana was prepared. This was discussed with Dr Odamtten at a final round-up meeting. He accepted our conclusion that there was a strong likelihood that grain respiration may contribute to the stackburn incidents in Ghana. He agreed to consider including in the proposed research programme a component to investigate the physiological aspects of maize storage. This will be done in consultation with GFDC, and the wpp bag manufacturers will be invited to submit alternative types of bag for evaluation. The research plan will be finalised and circulated very shortly for comment. Also, Dr Odamtten will visit the Tema warehouse to investigate the stackburned maize in store there.

OBSERVATIONS

21. The main observations are as follows:

* Stackburn was not recognised in maize in Ghana until after the introduction of wpp bags as a replacement for jute sacks.

* Stackburn occurred in dried maize: mould damage and caking were not significant.

* Stackburn was not directly associated with any significant insect infestation, although it is conceded that the efficacy of fumigations is at times reduced due to gas leaking through old fumigation sheets and porosity of the concrete floors in some stores.

* Discoloration was confined to bags within the central core of stacks: the outer layers were not affected.

* Several warehouses used by GFDC lack adequate ventilation, having been designed for cocoa storage. (Cocoa requires the maintenance of a high temperature to prevent moisture uptake.) Maize keeps better under well-ventilated conditions.

* Detailed examination (by Peter Twumasi of GFDC) of bags during the breakdown of one stack in Sunyani comprising maize in a mixture of both polypropylene and jute bags, revealed higher temperatures and greater discolouration of maize in polypropylene bags than in jute sacks. Even adjacent bags exhibited this clear difference.

* We discovered a new instance of stackburn during a visit to a warehouse at Tema. It had arisen within a stack of imported USA yellow maize which had been in store for 16 months. Maize from the interior of the stack was found to be discoloured in the characteristic way whilst that on the outside remained a normal colour.

* There is declared resistance to storing cocoa in polypropylene bags by the Cocoa Marketing Board, and private grain traders will not adopt wpp on the grounds that maize spoils.

* There is scope for adjusting the weave of the polypropylene bags, with the objective of obtaining a more open bag, in order to increase porosity to moisture, heat and gases.

* However, no stackburn has been reported from rice in wpp bags, or sugar and similar products handled by GFDC, which are not capable of respiring.

* Variation between varieties of individual crops was suggested as a reason for the unpredictability of stackburn (by the General Manager, GFDC).

* Stacks in Ghana are much smaller than those built in Zimbabwe (5000t). Thus, if stackburn is encountered in Ghana in small stacks, then reducing the overall size of Zimbabwean stacks is unlikely to offer a solution to the problem.

CONCLUSIONS

22. Based on the circumstantial evidence available, we are of the opinion the cause of maize heating and consequential stackburn in Ghana may be associated with the adoption of wpp bags and that grain respiration may be a contributory factor.

23. The proposed research programme in Ghana should include a component to examine this possibility, and determine whether grain respiration may be a factor.

24. In planning the research, careful consideration should be given to the physiological state of the selected grain. Such factors as variety, age, condition and amount of processing may well influence the physiological activity/dormancy of the grain. Freshly-

harvested grain may be more likely to heat then relatively dormant grain.

25. As appropriate, the project coordinators should encourage exchange of information between the respective wpp bag manufacturers. (Noah Kutukwa is chairing a Standards Committee in Zimbabwe that is drawing up Official Standards for Grain Bags based upon a South African Standard.) Alteration of the weave chosen for the respective grain bags may well contribute to reducing the problem. Consideration should be given to including candidate bag types with different weaves in the experimental stacks.

26. This visit, which focused closely on the serious technical problem of stackburn, provided an excellent opportunity for the first-hand exchange of practical experiences. It served to stimulate new ideas which will significantly change the approach to solving the problem.

ANNEXE I PROGRAMME FOR THE VISIT

Monday 25th Noah Kutukwa arrives Accra 21.00 from Harare, Ghana Airways. Met by Peter Tyler NRI. Accommodation Sunrise Hotel.

Tuesday 26th 09.00 University of Ghana, Legon. Discussions Dr Odamtten, Head of Botany Dept and Project Coordinator; Prof G C Clerk, Senior Mycologist, overseeing the mycological work; and Dr Joseph Allotey, Entomologist and Deputy Project Coordinator, re the Ghana research programme.

14.30 Ghana Food Distribution Corporation (GFDC), Head Office, discussions with Deputy General Manager, Mr Jimmy Edwards, GFDC structure and policy and the stackburn problem.

16.00 Visit Post Harvest Development Unit, Ministry of Agriculture. Mr Robin Boxall, NRI Manager, Larger Grain Borer Research Project.

Wednesday 27th 09.00 GFDC. Mr Manteh, Grain Quality and Pest Control Supervisor visit to GFDC storage warehouses Accra and Tema. Also food imports and handling and Ghana Cocoa Marketing Board, Quality Control Division, Tema Port.

15.00 Industrial Area. Meeting with wpp bag manufacturer/GFDC.

Thursday 28th Visit to maize storage sites, Kumasi and Sunyani, including location of stackburn incidents. Discussions with Mr Sammy Ewoade, GFDC Area Manger. GFDC vehicle pick up at Sunrise Hotel 07.00. Overnight Kumasi.

Friday 29th Visits to silo sites to see procurement, drying and processing in Kumasi. Visit to Asawasi wholesale grain trader's market. Nobewan village; inspection of producer storage of maize and cocoa processing/drying. Return to Accra.

14.30. Round-up discussion GFDC, Acting General Manager.

16.00 Discussion with Mr Kwaku Nicol, Head of Post-Harvest Development Unit, Ministry of Agriculture.

19.00 Dinner with Mr Jimmy Edwards, GFDC.

Saturday 30th Preparation of report. Final discussion with Dr Odamtten.

Sunday 31st Depart Accra 20.30 for Harare.