Postharvest Food Losses in Developing Countries: A Bibliography

NATIONAL ACADEMY OF SCIENCES

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Compiled by
Robert F. Morris
for the Steering Committee on
Postharvest Food Losses in Developing Countries
Board on Science and Technology
for International Development
Commission on International Relations

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This bibliography has been prepared by Robert F. Morris for the Steering Committee on Postharvest Food Losses in Developing Countries, Board on Science and Technology for International Development, Commission on International Relations, National Research Council, for the Office of Agriculture, Bureau for Development Support, Agency for International Development, Washington, D.C., under Contract No. AID/csd-2584, Task Order No. 23.

Contents

Acknowledgments

This bibliography could not have been compiled without the patient and skillful assistance of Maryalice Risdon, Board on Science and Technology for International Development, National Academy of Sciences, whose help in tracking down elusive reports from obscure publications has enhanced the value and coverage of this work.

Estelle Miller and her staff of the Manuscript Processing Unit of the Academy greatly facilitated the accumulation of the thousands of references contained in this volume. The author index was made possible through the courtesy of Richard Ulmer, who wrote the program necessary to alphabetize the first lines of the citations.

Citations were gathered from many sources, beginning with the bibliographies listed in Section 14b. Especially helpful were Adams (1977), Haines (1974), Hogblom (1974), Mphuru (1976), and Stiles (1977).

The single most important source of references was the Library of the Tropical Products Institute, London. The kindness and courtesy of TPI Director P. Spensley and his staff, especially D. G. Coursey, J. G. Disney, Peter Tyler, and P. F. Prevett, and the technical staff of the TPI Library is particularly acknowledged.

A. A. C. Huysmans, Coordinator, Action Programme for Prevention of Food Losses at the Food and

Agriculture Organization in Rome, helped in obtaining references from the FAO Library, and the following FAO personnel added references from their personal files: W. Philip Appleyard, James Bunnell, H. A. B. Parpia, and H. Shuyler.

A special note of thanks to W. Dale Anderson and Wilson Smith of the Agricultural Research Service, Beltsville, Maryland; to J. C. Miche and Jacques Deuse of the Institut de Recherches Agronomiques Tropicales, Montpellier, France; to Celine Alvey, National Academy of Sciences Library, especially for assistance with the many interlibrary loan requests; to M. Gehringer, Library of Congress, Washington, D.C.; to W. Olson, National Agricultural Library, U.S. Department of Agriculture, Beltsville, Maryland, and his staff; to R. Martin, National Fisheries Institute, and V. Sidwell, National Marine Fisheries Service, Washington, D.C.; and to S. Sternlieb of the United States General Accounting Office, Washington, D.C.

Introduction

In many areas of the world, losses of foodstuffs from harvest to the point of consumption are enormous. Yet such losses are at least partially avoidable both technically and economically. By reducing these postharvest losses within developing countries, food availability could be substantially increased. Recognizing this opportunity, the United Nations General Assembly resolved in 1975 to reduce world food losses 50 percent by 1985.

The United States Agency for International Development (AID) also recognized postharvest food losses as an important problem and in 1977 requested the National Academy of Sciences to undertake a comprehensive study of the subject in developing countries, with particular emphasis on losses of major food crops. This bibliography was commissioned as part of that study and is published as a companion volume.*

As outlined in the table of contents, the bibliography includes: reported estimates of food losses; discussions of loss factors and vectors; papers describing methodologies for food loss assessment; specific food loss reduction procedures; aspects of training for loss reduction; other information sources; and references dealing with the economics of food conservation.

The compilation of the bibliography followed the boundaries established for the Academy's food loss study. The bibliography focuses on the following commodities and food groups: grains (particularly maize, rice, and wheat); pulses and legumes; fruits and vegetables; roots and tubers; and fish. Other animal foods (such as red meats and poultry) and dairy products have been excluded. Articles

*Postharvest Food Losses in Developing Countries, National Research Council, 1978.

are cited that deal with losses during various steps in the postharvest system--in the harvesting process itself and in storage and transportation, for example--while certain other loss aspects are not addressed. Those omitted include: production losses or low yields occurring from germination failure; field losses from weeds, insects, and other animals; and field losses resulting from virus and other diseases. To omit such preharvest losses from this bibliography is not to underrate their importance, for they are often considerable. It is, rather, to differentiate the crop-protection area, which is relatively well documented, from the postharvest area, which is not.

Similarly, the bibliography excludes the loss of nutritional value after harvest--a loss that particularly affects fruits and vegetables. Such reductions in nutrients often occur as a result of microbial attack, processing, cooking, dehusking of grains, and insect destruction of grain embryos, and though they are not included in this study, they are significant and deserve greater attention.

The approximately 2,100 entries in the bibliography represent the documentation that it was possible to identify with the resources available. It represents in large measure those documents and references brought to the attention of the study by an extensive network of experts. It does not claim to be either definitive or comprehensive, nor does inclusion of a particular reference imply that its scientific merit has been substantiated. In some cases, annotations from other bibliographies were used to help give the user greater information. Other annotations were provided by the compiler.

The table of contents is largely self-explanatory and is the key to identifying placement of documents. Author and country indexes provide additional ways to locate papers. Because it is an alphabetical computer listing of the first line of each citation, the author index may also include a few words of the title.

At the end of each reference is an alphanumeric code used to catalog the various citations during compilation. For example, the book written by Lindblad and Druben has been assigned the alphanumeric code "12 a L8":

Lindblad, C. L. and Druben, L. 1976. Small farm grain storage. Action/Peace Corps Program and Training Journal, Manual Series No. 2. VITA Publications, Manual Series No. 35E.

Washington, D.C.: Peace Corps and Volunteers in Technical Assistance (VITA). 150 pp. plus appendices. 12a L8

The number 12 denotes Section 12 of the bibliography (Specific Food Loss Reduction Procedures). The small letter "a" refers to the subdivision within this section (i.e., Storage Structures). Because a copy of the manual was obtained by the compiler, the code also carries the designation "L8." The capital letter "L" refers to the first initial of the author's last name, and the "8" denotes that it was the eighth paper obtained in which the author's name began with the letter "L." Articles for which no copies were actually obtained do not carry the author/paper number code.

The many aspects of postharvest food losses make it difficult to categorize references, particularly when a reference contains information about several commodities and vectors of loss. Since it was impossible to secure copies of all references cited, many were simply classified according to the information contained in the title.

Commodities are listed under common usage headings. For example, if a reference describes two similar commodities such as cassava and potatoes, the report will be cited under Roots and Tubers, General. Commodities such as carrots and onions are listed under vegetables rather than the section on roots and tubers (which in this bibliography refers to the "starchy" roots and tubers). Likewise, tomatoes--while botanically a fruit--are cited under the vegetable category.

Papers dealing with two distinct commodities such as vegetables and grain are listed in Section 1: General Food Losses and Control. Similarly, references dealing with two grains, such as rice and wheat, are listed in Section 3: General Grain Losses and Control.

Because information regarding losses of rice, maize, and wheat is abundant, these three grains are cited in separate sections. They are further subdivided according to the cause of the loss (i.e., insects, birds, microorganisms, rodents, and other causes). Further, since some papers deal largely with storage structures or control measures appropriate for one of these three cereals, such references are included in other subdivisions under the specific commodity.

Much generalized literature is also available on food loss reduction techniques. For this reason, Section 12 includes references relating to storage structures, fumigation, chemical additives and insecticides, packaging, biological control, and irradiation. Since irradiation is generally impractical in developing countries for food preservation, insect disinfestation, or sprout inhibition, no attempt was made to seek references in this area, and only those which were available have been included.

Section 13 lists references relating to training for food loss reduction. These references are isolated under a separate heading in order to emphasize the paucity of literature in the field.

Section 14 provides a listing of additional reference sources, as well as other bibliographies relevant to postharvest losses. A final section includes references on economic aspects of food losses. The limited number of citations reflects the dearth of information available on the subject.

In many cases, obtaining reprints of articles cited in this bibliography may be difficult for research workers in developing countries. The Information and Documentation Service of the Food and Agriculture Organization of the United Nations (FAO) may in future be able to make reprints of valuable postharvest literature more widely available. The National Agricultural Library of the U.S. Department of Agriculture (Beltsville, Maryland) is planning to use computer tapes generated from this bibliography as a special subset of the AGRICOLA automated retrieval system. Questions concerning access to the bibliography through this method should be directed to:

Charles N. Beebe, Head
Automated Retrieval Service
National Agricultural Library
Beltsville, Maryland 20705

The papers collected in the course of preparing the bibliography (i.e., those references bearing the alphanumeric code) have been sent to Kansas State University, the principal AID contractor concerned with food loss reduction in developing countries. Questions regarding the availability of microfiche copies of the documents cited in this work should be addressed to:

Postharvest Documentation Service
Kansas State University Library
Manhattan, Kansas 66506

The postharvest area does not lend itself to easy categorization. Its multidisciplinary nature makes it difficult to cross-reference with other fields of specialization such as storage entomology, food packaging, and food technology. There is a pressing need for authors, librarians, and information system specialists both to recognize postharvest food losses as an area of specialized interest and to work toward more accurate coding of present and future literature. Through proper indexing and cross-referencing, the task of researchers can be simplified, particularly through the use of automated retrieval systems.

Organizing the literature in this field is an essential step toward filling knowledge gaps and more accurately refining loss estimates and reduction measures. Through better information, policy decisions regarding loss prevention programs can be taken with greater confidence. Through skillful application of technologies designed to reduce postharvest food losses worldwide, the scientific and technical communities can more effectively ameliorate world hunger.

1
General Food Losses and Control

a. Insects

Agricultural Research Council, Pest Infestation Laboratory. 1969. Pest infestation research 1969: the report of the Pest Infestation Laboratory. London: Her Majesty's Stationery Office. 1a

Reviewed in Tropical Stored Products Information, 1970, 20:p 39. Includes insects infesting farm stores; insecticide resistance - particularly to development in *Tribolium castaneum* of resistance to lindane and malathion in several countries.

Aitken, A.D. 1963. A key to the larvae of some species of Phycitinae (Lepidoptera, Pyralidae) associated with stored products, and of some related species. Bulletin of Entomological Research 54 (2): 175-188. 1a

Aitken, A.D., Ed. 1975. Insect Travellers. Vol. 1 Coleoptera. (Ministry of Agriculture, Fisheries and Food, Technical Bulletins - No. 31). London: Her Majesty's Stationery Office. 191 p. 1a

Reviewer (C.P. Haines) in Tropical Stored Products Information, 1976 (31), page 55-56 says that the great majority of tropical storage species are listed and that it is the most complete catalogue of storage pests with full annotation that he has seen.

Work in Congo showed that after one year's storage the loss of weight resulting from insect attack was: for sorghum 50 percent; for beans 20 percent; and for groundnuts 15 percent.

Barnes, J.M. 1969. Pesticide residues as hazards. PANS 15 (1):2-8.1a

Review article with some reference to residues in stored products.

Benson, J.F. 1973. The biology of Lepidoptera infesting stored products, with special reference to population dynamics. Biological Reviews of the Cambridge Philosophical Society 48: 1-26.1a

Buhl, C., Weidner, H. and Zogg, H., Eds. 1975. Krankheiten und Schadlings and Getreide und Mais. Ein Bestimmungsbuch. (Diseases and pests of grain (wheat, barley, rye, oats) and maize. A determination book). Stuttgart: Verlag Eugen Ulmer. 431 p. 1a

Calderon, M. 1974. The possible role of aeration in the control of stored product insects in warm climates. In: Proceedings of the first internatinal working conference on stored-product entomology, Savannah, Georgia, 7-11 October, 1974, pp. 77-84. Savannah, Georgia: Organizing committee of the conference. (Available from Dr. Robert Davis, Stored-product Insects Research and Development Laboratory, USDA-ARS, P.O. Box 22909, Savannah, Georgia. Price: $7.50). 1a C100

Calderon, M. 1962. The Bruchidae of Israel. Rivista di Parassitologia 23(3):207-216. 1a C100

Calderon, M. and Donahaye, E. 1964. Records on the occurrence and hosts of stored product insects in Israel. Rivista di Parassitologia 25 (1): 55-68.1a

Campbell, A. and Sinha, R.N. 1975. An energy budget for the granary weevil (Sitophilus granarius). In: Proceedings of the 1st international conference on stored product entomology, 7-11 October 1974, Savannah, Georgia, pp. 542-548. Savannah, Georgia: Organizing Committee of the Conference. 1a

Chaddick, P.R. and Filce Leek, F. 1972. Further specimens of stored products insects found in ancient Egyptian Tombs. Journal of Stored Products Research 8 (1): 83-86.1a

Champ, B.R. 1966. Insects and mites associated with stored products in Queensland. 4. Acarina and Pseudoscorpiones. Queensland Journal of Agricultural and Animal Sciences 23:197-210.1a

Champ, B.R. 1974. World survey of pesticide resistance. In: CSIRO Division Entomology Annual Report 1973-74, 36. (Abstract only). Canberra, Australia: Commonwealth Scientific and Industrial Research Organisation. 1a

This survey was sponsored by the Food and Agriculture Organization of the United Nations and conducted in conjunction with the Pest Infestation Control Laboratory of the United Kingdom. Sixty-four countries were visited to collect strains of the major grain pests and seek information on their local importance, and samples were obtained from a further 44 countries. Examination of the resultant 1,400 strains for susceptibility to malathion, lindane, methyl bromide and phosphine was completed. The emergence of resistance to fumigants is of particular concern because the world has been dependent on fumigation both as a routine disinfectation treatment and as an alternative for combatting insecticide-resistant strains. Although fumigant resistance does not yet appear to be a practical problem, the widespread occurrence of strains surviving treatment with doses that would normally be expected to kill susceptible strains, and the ease with which the resistance of the strains can be increased by laboratory selection, probably indicate that a serious situation may develop. (Condensed from Tropical Storage Abstracts.)

Chittenden, F.H. 1911. Papers on insects affecting stored products. The lesser grain borer. The larger grain borer. Bulletin. U.S. Bureau of Entomology. 96 (3): 29-52. 1a

Cockbill, G.F. 1953. Investigations on the control of insect pests of stored grains and pulses. Rhodesia Agricultural Journal 50:294-323. 1a

From insecticide trials the loss in gross weight of beans over a 5 month storage was 11 percent, for maize 4.9 percent, and for sorghum 2.1 percent.

Cornes, M.A. 1964. A revised listing of the insects associated with stored products in Nigeria. In: Nigerian Stored Products Research Institute, Annual report, pp. 96-119. Lagos: Nigerian Stored Products Research Institute. C44 1a

Lists 197 species of insects infesting stored products in Nigeria. Describes the insects associated with 41 different commodities from

bagaruwa seed to yams. Also presents the insect species alphabetically.

Cotterell, G.S. and Howe, R.W. 1952. Insect infestation of stored food products in Nigeria. Report of a Survey 1948-50. Colonial Research 12.1a

Cotton, R.T. 1950. Insect damage to stored grain and its prevention. Pest control 18 (10):8. 1a

Council on Environmental Quality. 1972. Integrated Pest Management. Washington, D.C.: U.S. Government Printing Office.C46. 1a

Discusses more dependable integrated pest control with minimum adverse environmental effects with possibilities of economic advantages and greater effectiveness. Involves maximum reliance on natural pest population controls plus a combination of techniques designed to contribute to suppression including cultural methods, pest-specific diseases, resistant crop varieties, sterile insects, attractants, augmentation of parasites or predators, or chemical pesticides as needed. 74 references.

Coyne, F.P. 1970. Weevils cost Kenya £1,000,000. Kenya Farmer (170):7-8. 1a

Part 1 covers diseases and pests on living plants in the field. Part 2 covers diseases and pests in stored grain. The first section gives identification keys based on pest symptoms in the grain. The second section provides keys for the identification of insects, both adults and larvae, and covers some primitive species, e.g., Lepinotus, Liposcelis, as well as the more common Coleoptera and Lepidoptera. There is a table for the recognition of mites (e.g., Acarus, Tyrophagus, Glycyphagus, Cheyletus, etc.) A key for the identification of rodents covers Rattus norvegicus, R. rattus, Mus musculus domesticus and M. musculus musculus. - Tropical Storage Abstracts.

Davey, P.M. 1965. Insect pests of stored products in the tropics and the commodities and conditions in which they occur. Tropical Stored Products Information 10:377-386.1a

Lists 59 insects of stored products with tables describing species, distribution, food, maximum-minimum-and optimum temperature and relative humidity plus days from egg to adult (under optimum conditions) and adult longevity. 58 references.

Davies, J.C. 1960. Coleoptera associated with stored products in Uganda. The East African Agricultural Journal 25(3):199-201. D7 1a

Decker, G.C. 1955. Wanted - An evaluation of insect losses. Journal of Economic Entomology. 48:226-227. 1a

de Luca, Y. 1969. Au sujet des caracteristiques d'un lot de graines depreciees par les Bruchides (Col.). Annales de la Societe d'Horticulture et d'Histoire Naturelle de l'Herault 109 (2):92-101. D18 1a

de Monte, A. 1958. The enemies of stored grains: Insects: damages caused; and the principal injurious species. FAO Grain Storage News 2(1) Jan 1960. 1a

The author reviews the subject of losses in stored products and states that it is not easy to convert into meaningful figures the economic, hygienic and nutritional losses. He classifies losses into direct and indirect losses and subdivides them into smaller categories.

Dobson, R.M. 1954. The species of Carpophilus Stephens (Col., Nitidulidae) associated with stored products. Bulletin of Entomological Research 45 (2):389-402. 1a

Domenichini, G. ed. 1972. La defesa antiparassitaria nelle industrie alimentari e la protezione degli alimenti.: Proc. of 1st symposium, 18-20 October 1972. Piacenza, Italy: Camera di Commercio Industria Artigianato e Agricultura. 459 p. 1a

Donahaye, E., Navarro, S. and Calderon, M. 1966. Observations on the life cycle of Caryedon gonagra (f) on its natural hosts in Israel, Acacia spirocarpa and A. tortilis. Tropical Science 8(2):85-89. 1a D100

Dyte, C.E. 1970. Insecticide resistance in stored-produce insects with special reference to Tribolium castaneum. Tropical Stored Products Information 20:13-18. 1a

Dyte, C.E. 1974. Problems arising from insecticide resistance in storage pests. (Paper presented at the EPPO Conference on storage pests and diseases. Paris, 11-14 June 1974). EPPO Bulletin 4 (3):275-89. 1a

A survey of the occurrence of insecticide or fumigant resistant strains of stored-product insects is given. Studies on the geographic distribution of insecticide resistance show that in some cases resistance is localized, and in other it is almost universal. Tribolium castaneum is known to be resistant to lindane in 71 countries, and lindane-resistant strains of Oryzaephilus surinamensis, Rhyzopertha dominica, Sitophilus oryzae and Sitophilus zeamais occur in over 30 countries. Malathion-resistant T. castaneum strains are known from 70 countries, and T. confusum and R. dominica resistant to malathion are known from 25 countries. Resistance to fumigants appears to be uncommon but field strains resistant to methyl bromide, phosphine or ethylene dibromide have been reported. Cross-resistance has been studied in a few strains, but malathion resistance may involve resistance to other organo-phosphorus compounds in at least 6 species. Although resistance to pyrethroids and juvenile hormone analogues is known, these compounds show promise for future use against storage pests. Tropical Storage Abstracts.

European and Mediterranean Plant Protection Organization. 1968. International Conference on the protection of stored products, November 27-30, 1967, Lisbon-Oeiras. Paris: European and Mediterranean Plant Protection Organization. 1a

Food and Agriculture Organization of the United Nations. 1977. Pest resistance to pesticides and crop loss assessment - 1. Report of the 1st Session of the FAO Panel of Experts Held in Washington, D.C. 16-19 August 1976. Rome: FAO. 1a

Freeman, J.A. 1952. Damage and loss to stored products from attack by insects and mites. Transactions 9th International Congress of Entomology (Amsterdam 1951) 1:823-828. 1a

Freeman, J.A. 1969. The importance of the control of insects in home-grown grain. Chemistry and Industry 4 October 1969:1401-1404. 1a

Freeman, J.A. 1974. Infestation of stored food in temperate countries with special reference to Great Britain. Outlook on Agriculture 8(1):34-41. 1a

Frings, H. and Frings, M. 19761. Sound production and reception by stored product insect pests: A review of present knowledge. Journal of Stored Products Research 7(3):153-162. 1a

Gerberg, E.J. and Golheim, S.L. 1957. Weight loss in stored corn and beans caused by the insect feeding. Journal of Economic Entomology 50:391-393. 1a

Attempt is made to correlate the number of insects per bean and the percent loss of weight. The average weight loss caused by one bean weevil in 60 days was 3.5 percent.

Giles, P.H. 1969. Observations in Kenya on the flight activity of stored product insects, particularly *Sitophilus zeamais* Motsch. Journal of Stored Products Research 4 (4):317-329. 1a

Giles, P.H. 1965. A record of stored product insects associated with Northern Nigerian foodstuffs. Samaru Miscellaneous Paper 8. Samaru, Zaria, Nigeria: Institute for Agricultural Research, Ahmadu Bello University. 1a

Gillenwater, H.B. and McDonald, L.L. 1975. Repellency of nineteen candidate compounds to adult *Tribolium confusum*. Journal of the Georgia Entomological Society 10(2):151-155. 1a

Graham, J.F. 1964. Stored products work in Kenya. Tropical Stored Products Information (8):287-288. 1a

Brief survey of the history and work of the Pest Infestation of Stored Products Committee.

Great Britain. Ministry of Agriculture, Fisheries and Food. 1968. Insect Pests in Food Stores. Adv. Leafl. No. 483. London: Her Majesty's Stationery Office. 1a

Green, A.A. 1968. The prevention of insect damage to grain in farm stores. Ceres 1 (4):13-17. 1a

Green, A.A. 1967. Cutting the cost of insect damage. Farm and Country 222(4158):341-343. 1a

Haines, C.P. 1974. Insects and arachnids from stored products: a report on specimens received by the tropical stored products centre 1972-1973. London: Tropical Products Institute. 1a

Halliday, D. 1966. Field studies of fumigation of produce from northern Nigeria with phosphine. N.S.P.R.I. Technical Report No. 4. Lagos: Federal Ministry of Information. 27 p. 1a

Halstead, D.G.H. 1967. A new genus and species of Lathridiini (Coleopteria: Lathridiidae) from farm stores in Kenya. Proceedings of the Royal Entomological Society of London (B) 36(11-12):177-180. 1a

Harein, P.K. 1976. Losses resulting from stored grain insects. Paper presented at the National Food Loss Conference, 12-15 September 1976, Boise, Idaho. 1a H12

The importance of a multidisciplinary approach to loss reduction from insect damage to stored produce is stressed. Emphasis is placed on pest prevention rather than pest control. Insect losses appear to be the most important cause of loss and a 10 percent average loss of grain and cereal products in the U.S. is cited. About 100 insects are responsible for all the damage to stored products and 20 of these are considered major pests. The types of damage by insects and the health risks are discussed. Biological controls such as sterile-male techniques and insect pathogens are discussed, as well as chemical repellents, new packaging and additional insecticides. 5 references.

Harris, W.V. 1950. Report of the entomologist. In: Annual Report of the Department of Agriculture, Uganda, 1947-1948, pp. 1-5. 1a

Harris, W.V. 1935. Report of the entomologist. In: Annual Report of the Department of Agriculture, Tanganiyika, 1937, pp. 1-8. 1a

Hawthorne, R.M. 1970. Estimated damage and crop loss caused by insect/mite pests, 1969. Report of the United States California Department of Agriculture No. E82-12; 12 pp. 1a

Herford, G.V.B. 1961. Losses resulting from the infestation of stored products by insects. Proceedings of the Nutrition Society 20(1):11-15. 1a H23

Herford, G.V.B. 1961. Food lost in store by insect attack. SPAN 4(1):40-42. 1a H25

Hill, D.S. 1975. Agricultural insect pests of the tropics and their control. London: Cambridge University Press. 1a

Hinton, H.E. 1945. A monograph of the beetles associated with stored products. Volume 1. London: British Museum Natural History. 1a

Hinton, H.E. and Corbet, A.S. 1972. Common insect pests of stored food products. British Museum of Natural History Economic Series No. 15. London: British Museum. 1a

Howe, R.W. 1973. Loss of viability of seed in storage attributable to infestations of insects and mites. Seed Science and Technology 1(3):563-586. 1a H35

Abundant insects may generate sufficient heat to kill seeds and encourage fungal growth. Some insects eat the embryo while insects that live inside stored seeds seldom damage embryo, but cause failure of germination or weak seedlings. Some insects introduce fungi into seed while others cannot develop unless fungi are present. Insects may also bind seeds together making sowing difficult. Recommends drying and storage of seed in dry, cool, facilities where insects can be excluded as opposed to use of toxic chemicals, 101 references.

Howe, R.W. 1965. Losses caused by insects and mites in stored foods and feedingstuffs. Nutrition Abstracts & Reviews 35(2):285-303. 1a H36

Howe begins with some historical remarks then describes the importance of weight loss due to insects and the methods for estimating weight loss. Descriptions of typical foodstuffs, minimum temperature and humidity for increase in epidemic numbers, optimum temperature range and likely increase per lunar month are given for 37 species of stored product insects. Quality damage is described as holes in seeds, reduced germination, contamination by insects and fragments and excreta, chemical changes in flavor or nutritive value, heating of produce, and possible introduction of public health risks such as pathogens, bacteria, rickettsiae, plague bacilli, nematodes and tapeworms. In highly industrialized countries losses should be small but the high aesthetic standards result in large monetary losses. In less industrialized tropical countries weight loss and quality deterioration are serious especially when produce is stored on a small scale. 124 references.

Howe, R.W. 1965. A summary of estimates of optimal and minimal conditions for population increase of some stored products insects. Journal of Stored Products Research 1(2):177-184. H38 1a

A table is presented giving the minimum temperature and humidity at which 43 species of beetle, 9

species of moth and one mite can multiply sufficiently to become pests, and the range of temperature most favorable for each. An estimate of the maximum rate of increase for each species is also given. 53 references.

Howe, R.W. 1952. Entomological problems of food storage in northern Nigeria. Bulletin of Entomological Research 43(1):111-144. 1a H34

Paper discusses sacked groundnut storage in open pyramids and covered warehouses. Large and violent temperature and humidity fluctuations in open storage were less favorable to insect multiplication than warehouse storage. Lists the pests associated with groundnuts which result in overall loss due to insect attack of 4.5 percent. Losses are greater in warehouses than in pyramids, in outer sacks than inner ones and especially in the presence of Trogoderma. 8 references.

Howe, R.W. 1951. Miscellaneous experiments with grain weevils. Entomolgists Monthly Magazine 88:252-255. 1a

Effect of insect damage on germination is described. It was observed that heavily infested samples reached a maximum of 78 percent germination while sound kernel reached as high as 90 percent.

Howe, R.W. and Freeman, J.A. 1957. Insect infestation of West African produce imported into Britain. In: Scientific Council for Africa South of the Sahara. Meeting of Specialists on Stored Food Products, Salisbury, Rhodesia, 1957, pp. 59-60. London: Scientific Council for Africa South of the Sahara. 1a H33

Howe, R.W. and Legkovitch, L.P. 1957. The distribution of the storage species of Cryptolestes (Col., Cucujidae). Bulletin of Entomological Research 48:795-809. 1a

Howe, R.W. and Currie J.E. 1964. Some laboratory observations on the rates of development, mortality and oviposition of several species of Bruchidae breeding in stored pulses. Bulletin of Entomological Research 55(3):437-477. 1a

Hughes, A.M. 1961. The mites of stored food. MAFF Technical Bulletin. No. 9. London: Ministry of Agriculture, Fisheries and Food. 1a

Hurlock, E.T. 1967. Some observations on the amount of damage caused by Oryzaephilus surinamensis. Journal of Stored Products Research 3:75-78. 1a

Hurlock, E.T. 1965. Some observations on the loss in weight caused by Sitophilus granarius (L.) (Coleoptera, Curculionidae) to wheat under constant experimental conditions. Journal of Stored Products Research 1:193-195. 1a H44

The incidence and extent of infestation on food grains stored by the cultivators in Gujarat in 1966. 1970. Pesticides Annual 4(12):55-58. 1a I2

Jay, E.G.; Arbogast, R.T.; and Pearman, G.C. Jr. 1971. Relative humidity: its importance in the control of stored-product insects with modified atmospheric gas concentrations. Journal of Stored Products Research 6:325-329. 1a J9

Jay, E.G. and Pearman, G.C. Jr. 1971. Susceptibility of two species of Tribolium (Coleoptera: Tenebrionidae) to alterations of atmospheric gas concentrations. Journal of Stored Products Research 7:181-186. 1a J11

Kennard, C.P. 1960. British Guiana--Review of work in economic entomology. Report of the 7th Commonwealth Entomological Conference, 6-15 July 1960, London, pp 214-215. London: Commonwealth Institute of Entomology. 1a

Khare, B.P. 1972. Insect pests of stored grain and their control in Uttar Pradesh. Pantnagar (U.P.), India: G.B. Pant University of Agriculture and Technology. 153 p. 1a K7

Project reported studied insect fauna and relative potential population under different climatic conditions, and assessed the importance of varying construction design and material for storage structures. Loss in weight was described as being directly related to storage method, design and local climatic conditions. Protein content decreased due to insect feeding while fat acidity increased. Bread made from infested grain was unpalatable. Aluminum silicate and cow dung ash were found to be highly effective against S. oryzae while Cannabis sativa acted as a good repellent and Acerus calamus was toxic to insects. Average maximum weight loss of wheat due to insects after 1 year of storage was 4.3 percent, 3.98 percent to paddy after six months storage, and 10.63 percent to maize after 9 months. 99 references.

Kiritani, K. 1964. Insect infestation of stored rice in Japan. In: Proceedings of the 12th International Congress of Entomology, London, pp. 630-632. London: International Congress of Entomology. 1a K8

Koura, A. and el Halfaway, M.A. 1972. Weight loss in stored grains caused by insect infestation in Egypt. Bulletin de la Societe Entomologique de Egypt 56:413-417. 1a K13

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May, R.M. 1977. Food lost to pests. Nature 267:669-670. 1a M16

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Parkin, E.A. 1965. The onset of insecticide resistance among field populations of stored-product insects. Journal of Stored Products Research 1:3-8. 1a P6

Parkin, E.A. 1959. Insects and stored food: world losses and control measures surveyed. Food Manufacture 34:164-168. 1a P2

A general article discussing groups of stored products infested with general statements regarding estimates of losses, extent of infestations, control measures, insecticide resistance, importance of hygiene, and choice of treatment. 6 references.

Parkin, E.A. 1959. Insects and stored food. I. World losses. World Crops 11:405-407. 1a P3

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Stored product entomology has built up a background of experience and knowledge which, if more widely applied could effect immediate and extensive saving of foodstuffs. In hot climates the value of these savings would be greatly in excess of the cost of control measures. More work is needed on chronic toxicity of insecticides and levels of contamination of foodstuffs. Work is needed on the summation of losses that will permit comparison under differing conditions. Various control methods (mechanical, sealed storage, nonradiant heat, radiant energy, fumigation and contact insecticides) are briefly discussed. 144 references.

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Pierrard, G. 1962. Les insectes associes aux denrees entreposees au Burundi et au Rwanda. _Bulletin d'Information de l' INEAC_ 11 (4-6):389-393. 1a

Pieterse, A.H. and Schulten, G.G.M. 1974. Investigation on insecticide resistance in _Tribolium castaneum_ (Herbst), _T. confusum_ Duv. and _Sitophilus zeamais_ Motsch. in small maize cribs in Malawi. _Tropical Agriculture_ 51(1):63-67. 1a

Ten strains of _Tribolium castaneum_, six strains of _T. confusum_ and thirteen strains of _Sitophilus zeamais_ from Malawi were tested for susceptibility to lindane and malathion. The strains were collected from maize cribs in different parts of the country with the exception of two strains of _S. zeamais_ which were collected from imported packages of seed maize. Resistance to lindane was found in six strains of _T. castaneum_ while three of these strains were also partly resistant to malathion. It was concluded that resistance genes in _T. casteneum_ remain easily integrated in the genome of unselected populations. The strains of _T. confusum_ and _S. zeamais_ were susceptible with the exception of the strains of _S. zeamais_ from imported seed maize which proved to be highly resistant to lindane. A critical situation has not yet been reached in Malawi. However, it seems likely that alternative pest control methods for the protection of stored produce at small farm level are required in the near future. _Tropical Storage Abstracts_, 1974(1)p10-11.

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A suction trap was run continuously in a Nigerian store containing cowpeas in order to capture flying adults of Callosobruchus maculatus. Of the 211 adults caught, 149 were females and 135 of theses were of the active form. Adults were removed from 8 kg of cowpeas sampled on four occasions from the store, and in these only one-third of the adults were active females. The numbers of adults caught by the traps were recorded hourly and from these records using probability paper, two peaks of flight activity were detected, a small one with a mean at 07.20 hr - 260 min. and the main one at 17.50 hr 8± 110 min. The beetles flew throughout the day and night with no inhibition by low light intensity. Temperature appears to be the most important factor and peak flight activity occurred at highest temperatures and low relative humidity. The first small peak activity in the morning was ascribed to the rise in temperature above the low ambient night temperatures which are probably lower than the threshold for the species. Tropical Storage Abstracts, 1974(3), p. 44.

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Due to insect losses, a fumigation warehouse for imported and exported food is recommended. Aid imports and groundnut exports were of principal concern.

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Reviews Indian data regarding weight loss, percentage infestation and their relationship of foodgrains during storage. Presents 57 estimates of weight loss, 28 estimates of percentage of infestation, and 13 examples of the relation between degree of infestation and weight loss. Presents annual averages of storage losses by insects of 8 commodities and gives one table of loss values from other countries. 80 references.

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Viljoen, J.H. (assisted by) de Beer, P.R.; du Toit, D.M.; Potgieter, H.V.; and van Tonder, H.J. 1973. Control of insect pests in stored products in South Africa. Technical Communication No. 105. Pretoria: Republic of South Africa, Department of Agricultural and Technical Services. (Paper presented at the Entomological Symposium, Pretoria, 27 September - 1 October 1971.) 1a

A review is given of the history of stored grain insect problems in South Africa as mirrored by the Annual Reports of the Maize Control Board. The economic aspects of insect control in stored products are discussed, followed by a synopsis of the more important pests found in S. Africa. A review is given of research carried out in the past, followed by a detailed description of the present mode of operation regarding the testing of contact insecticides as protectants of bulk stored grain, grain in bag stacks and testing of fumigants. Aspects which should be investigated in the present research on irradiation as a means of insect control are discussed. (Authors' summary). - Tropical Storage Abstracts 1973(2)p. 36. 1a

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This list was compiled during 1971-72, in the course of an investigation into grain storage practices in Ethiopia, sponsored by the Freedom from Hunger Campaign, England. It comprises insects collected by the authors during the period, and a review of storage records published by previous authors. The insects were collected over a very wide area from a variety of storage. structures ranging from the small farmer's baskets to large dock warehouses. The mites were only collected in Harar Province. Among the insects listed, the following Orders are represented: Coleoptera, Dictyoptera, Hemiptera, Hymenoptera, Lepidoptera, Thyusanura and among mites, Astigmata, Mesostigmata and Prostigmata. There are brief notes on the commodities with which the various arthropods are associated, and some comments on the distribution and frequency of the various species. Tropical Storage Abstracts

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Samples of Tribolium castaneum and other storage insects were collected from ships and stores in Mombasa port, which is designated as a quarantine area, and where, therefore, stores are regularly treated, mainly with malathion as a fabric spray. T. castaneum samples were compared with known susceptible strains, using malathion, lindane, fenitrothion and pirimiphos methyl. A high degree of malathion specific resistance was found in the Mombasa strains, and there was some degree of cross-tolerance. Fenitrothion showed promise as an alternative to malathion, but it is noted that continued use of any single spray protectant is likely to end in development of resistance. Tropical Storage Abstracts.

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c. Rodents

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Fall, M. 1977. Agricultural development and the ecology of rodent control. Paper presented at the UNITAR/State of California Conference on Alternative Strategies for Desert Development and Management, Sacramento, California, 31 May-10 June, 1977. 1c F3

Fall, M.W. and Sanchez, F.F. 1975. Pest research profile: the Rodent Research Center. PANS 21(2):206-209. 1c F4

First Scientific Symposium of Rodents and Their Control in Egypt, Assiut University, 12-17 February, 1972. List of papers presented. 1c F7

Food and Agriculture Organization of the U.N. Plant Production Division. 1968. Control of rats and other rodents. FAO regional conference for the establishment of an agricultural research programme on an ecological basis in Africa /Sudanian zone/ Rome, Italy, 11-15 November, 1968. 1c

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Describes studies on the biology of Bandicota bengalensis, the lesser bandicoot rat, with special reference to grain stores in India. Points out that badly maintained buildings, lack of hygiene, and poor handling of bagged grain leading to spillage, combined with the rodent's inherent fertility, have resulted in a build-up of large populations in many Indian cities. Some estimates of the grain losses caused by these rodents are given. Points out that poisoning and trapping will not necessarily reduce the effective breeding population. Suggests that the most useful means of managing urban rodent populations is environmental manipulation, i.e. elimination of rodent access to food, repair of structural defects, removal and disposal of accumulated trash, blockage of passages, hygienic disposal of garbage and sewage. Such cheap, labour intensive and culturally adapted methods are most appropriate in the existing situation. Tropical Storage Abstracts, 1976 (3), p. 34-35.

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Gratz, N.G., and Arata, A.A. 1975. Problems associated with the control of rodents in tropical Africa. Bulletin of the World Health Organization 52:697-706. 1c G22

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A reference manual for control methods of rats and mice in Great Britain. The general control principles may be applicable to other areas or personnel training programs.

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Hall, D.W. 1961. Protecting the harvest in under-equipped countries. Lecture given at International Technical Congress of Agricultural Machinery, Paris, 1961. 1c H7

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Sponsored by the Johns Hopkins University Center for Medical Research and Training and the U.S. Agency for International Development. Contains the following papers:

1. Patnaik, I.C. Rodents in problems of health and food in India.
2. Tiwari, K.K., and Biswas, B. Taxonomy and distribution of common Indian rodents.
3. Malhotra, S.P. Hindu rituals and beliefs towards animal life.
4. Davis, D.E. Appraisal of rat populations.
5. Deoras, P.J. The significance of probable change of rat population in Bombay.
6. Seal, S.C., and Banerji, R.N. Changing patterns of rodent populations in Calcutta and Howrah.
7. Spillet, J.J. Population studies of the lesser bandicoot rat in Calcutta.
8. Calhoun, J.B. Community structures among small mammals.
9. Ghosh, P.K.; Gaur, B.S.; and Taneja, G.C. Adrenal responses to varying available floor space in the Indian desert gerbil.
10. Barnett, S.A. The feeding of rodents.
11. Majumder, S.K.; Krisnakumari, M.K.; and Urs, Y.L. Some observations on food preferences and intake of rats under different ecological conditions.
12. Parrack, D.W. Food consumption in three common Indian rodents (By title only).
13. Batra, H.N. Results of rat control measures in intensive agricultural districts program.
14. Chitre, G.D., and Deoras, P.J. Observations on the feeding propensity and behavior of rats. (By title only).
15. Prakash, I. A review of the studies on the food of Indian gerbils.
16. Southwick, C.H. Reproduction, growth and mortality of murid rodent populations.
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6 Supp. Proposal for fund to reduce losses
7 Smaller Farmers' Development
COAG/77/Inf. 1 List of documents
3 List of Participants
Statement by Mr. Edouard Saouma, Director-General of the FAO of the UN, to the 4th Session of the Committee on Agriculture, Rome 20 April, 1977. 1e F25

Food and Agriculture Organization of the U.N. 1977. An analysis of an FAO survey of post-harvest food losses in developing countries. Rome: FAO. 1e F9

Food and Agriculture Organization of the U.N. 1975. Reducing post-harvest food losses in developing countries. Rome: FAO. 15 p. + annexes (AGPP:MISC/21). Annex I - FAO Programme of work and budget, 1976/77; Annex II - Principal FAO activities on reduction of post-harvest food losses in developing countries 1968-1975; Annex III - FAO units potentially involved in needed coordination for reduction of post-harvest losses of all foods in developing countries; Annex IV - Some institutes endeavouring to reduce post-harvest food losses in developing countries; Annex V - Text of the letter from the Director-General to all senior agricultural advisers FAO country representatives (17 October, 1975). 1e F21

Food and Agriculture Organization of the U.N./Industry Cooperative Program Mission to Dahomey. 1972. Report to the government of Dahomey by the ICP mission to Dahomey (7-17 April 1972). Vols. I & II (English and French). Rome: FAO 116 p. 1e

Due to losses, among other reasons, improved and increased storage facilities, especially for maize, were recommended.

Food and Agriculture Organization of the U.N. 1971. Report on a project formulation mission on farm grain storage in Africa. Project TF/AFR/45(DEN). Reprot FAO/DEN/TF 51. Rome: FAO. 61 p. 1e

Losses reported to the mission and their major causes are noted for several commodities stored at different levels in 9 countries.

Food and Agriculture Organization of the U.N. 1970. Food losses: the tragedy and some solutions. Rome: FAO. 1e F14

Food and Agriculture Organization of the U.N. 1969. Food losses. Rome: FAO. FAO-07651-69-PI. 1e

Food and Agriculture Organization of the U.N. 1969. Storage problems in developing countries: The role of storage in world food supplies. World food problems No. 9. Rome: FAO. 1e

Estimate of losses in USA and India are given. Discusses the shortcomings of the estimates so far reported. Noted that at farm level a farmer will constantly be withdrawing supplies for his own consumption and consideration should be taken into account when one is estimating losses.

Food and Agriculture Organization of the U.N. Plant Production and Protection Division. 1969. Study of the control of storage pests at farmer and merchant level. In: Report of the conference on the establishment of an agricultural research programme on an ecological basis in Africa - Sudanian zone - Rome, 11-15 November, 1968, p. 65-67. FAO: Rome. (RU:AER/68/Report). 1e

Food and Agriculture Organization of the U.N. 1968. International action for prevention of losses of protein Foods. FAO/WHO/UNICEF 1968. FAO/WHO/UNICEF Protein Advisory Group meeting, Rome, Italy, 9-13 September, 1968. FAO-05415-68-WM. 1e

Food and Agriculture Organization of the U.N. Nutrition Division. 1966. Storage methods and facilities. FAO, 1966. FAO conference on cereal and bread technology for the Near East Region - Cairo, UAR, 5-10 February, 1966. 1e

Food and Agricultural Organization of the U.N. 1965. Avoiding losses of foodgrains after harvesting. World Crops 17(4):59-64. 1e

Food and Agriculture Organization of the U.N. 1962. Report of the CCTA/FAO symposium on storage of food crops in Africa, Freetown, Sierra Leone, 20-24 February 1962. Meeting report no. PL/1962/7. (English and French). Rome: FAO. 37 p. (mimeo)

Traditional storage practices for 12 commodities and losses due to insects, mositure and rodents and those associated with the nature of the storage facilities were discussion subjects with respect to food and seed. Recommendations regarding loss evaluation, improved storage techniques, use of chemicals, control of rodents and the need for a storage manual are included.

Food and Agriculture Organization of the U.N. 1946. Destruction of food in storage by insects, rodents and fungi. Rep. Nu/Wa WP3. 1e

Food and Agriculture Organization of the U.N. 1946. Destruction of food in storage by insects, mites, rodents and mould fungi, report of an expert committee. Washington, D.C. 1e

Forsyth, J. 1962. Major food storage problems. In: Agriculture and land use in Ghana, ed. by Wills, B.J. Chapter 21, pp. 394-401. London: Oxford University Press. 1e F37

France, Secretariat d'Etat Aux Affaires Etrangeres. 1974. Manuel de conservation des produits agricoles tropicaux et en partculier des cereales. (Techniques rurales en Afrique). (France: Secretariat of State for Foreign Affairs, Manual of Storage of tropical agricultural products, particularly cereals. (Rural techniques in Africa). Antony, Haute de Seine, France: Centre d'Etudes et d'Experimentation du Machinisme Agricole Tropicale. 1e

Consists of three principal parts. The first deals with the general problem and discusses factors affecting the spoilage of stored produce such as microorganisms and moisture, insect pests and rodents. Methods of conservation discussed include drying, ventilation, pest control. The second deals in greater detail with drying and storage, at both traditional and commercial levels. The third concerns equipment and management at main storage centres, and gives some estimates of the economics of storage. Appendices give details of moisture relations, principal pests, ventilation factors, and some principal suppliers of equipment. Finally, eight crops including maize, rice and grain legumes are discussed in detail. Tropical Storage Abstracts, 1975(4) p.51.

Freeman, J.A. 1962. Infestation of stored products in Iran: Report of a survey carried out in November 1957 and January 1958. London: Ministry of Agriculture, Fisheries and Food. Infestation Control Laboratory. 84 p. 1e

Frohlich, G. and others. 1970. Pests and diseases of tropical crops and their control. tr. by Liebscher, H. and Koehler, F.; ed. by Liebscher, H. Oxford: Pergamon. 1e

Includes a survey "Pests of stored food and their control" pp. 314-325.

Gallop, R.A. 1976. Turning food into waste. Paper presented at the National Food Loss Conference, 12-15 September, 1976, Boise, Idaho. 1e G1

German Foundation for Developing Countries. 1970. Storage and marketing of agricultural produce under tropical conditions: proceedings of the seminar from 22 to 27 February, 1970 at Colombo, Ceylon. Berlin: German Foundation for Developing Countries. 1e

Ghana: losses in stored beans and maize. 1966. Grain Storage Newsletter and Abstracts. 8(3):71. 1e G5

Gorham, J.R. 1975. Filth in foods; implications for health. Journal of Milk and Food Technology. 38(7):409-418. 1e G18

Gramet, Ph. n.d. Reflexions sur l'estimation des pertes occasionnees par les rongeurs dans les cereales stockees et perspectives d'avenir. Jouy-en-Josas, INRA, Laboratoire des Petits Vertebres, 1974. Unpublished paper. 1e G21

Hadler, S. 1976. Developing country foodgrain projections for 1985. Washington, D.C.:

International Bank for Reconstruction and Development. 1e H2

Hall, C.W. 1976. Improving food availability to consumers. Background information for the National Academy of Sciences' World Food and Nutrition Study, study team 6. Pullman, Washington: Washington State University, College of Engineering. 1e H4

Hall, D.W. 1970. Handling and storage of food grains in tropical and subtropical areas. Rome: Food and Agriculture Organization of the U.N. 1e H6

Hall, D.W. 1969. Food storage in the developing countries. Tropical Science 11(4):298-318. 1e

Hall, D.W. 1968. Prevention of waste of agricultural produce during handling, storage and transportation. Tropical Stored Products Information 15:15-23. 1e

Hall, D.W. 1966. Agricultural engineering--some essential considerations on the storage of food grains/cereals, legumes and oilseeds in tropical Africa. Informal working bulletin No. 24. Rome: Food and Agriculture Organization of the U.N. 1e

Hall, D.W. 1963. Stored products organizations in some overseas countries. Tropical Stored Products Information 6:191-196. 1e

Hall, D.W. 1955. Problems of food storage in tropical territories. Annals of Applied Biology 42:85-97. 1e H8

Hall, G.E. 1974. Damage during handling of shelled corn and soybeans. Transactions of the ASAE 17(2):335-338. 1e

Hamilton, A.G. 1975. Review of post-harvest technologies: Botswana. Ottawa, Ontario, Canada: Canadian University Service Overseas. 1e

Reports on a survey conducted in four villages in an area of approximately 500 Km². Comprises 6 chapters: 1. Description of Botswana; 2. Botswana agriculture; 3. Storage: 4. Marketing and distribution; 5. Utilization of sorghum; 6. Rural food preference and storage survey. Each chapter has summary and own references.

Recommendations are made on future projects concerning: sorghum milling; consumer surveys;

controls on imports; intermediate storage facilities; use of malathion; self help; recruitment of women for extension work. Chapter 3 reviews the position of storage in the food supply system, and crop storage work conducted in Botswana over the past 40 years, including early efforts to construct concrete silos during 1939-1945, to the Grain Storage Project introduced in 1968. Attention is given to harvesting and threshing techniques, and detailed descriptions are given of traditional and modern farm storage methods in Botswana. It notes the replacement of traditional bulk storage methods by bags and other convenient forms of storage. Local methods of protecting stored grains are examined, including the use of insecticides (malathion) and fumigants (phosphine). A review of methods of determining grain loss is given, with examples of visual aids used in promoting improved storage. Tropical Storage Abstracts, 1976(1):7-8.

Harper, J.M. 1977. Plate waste. Paper presented at 11th Annual Industry Seminar, American School Food Service Association, Vail, Colorado, January 25, 1977. H15 1e

Harris, V.T. and Eschmeyer, P.H., eds. 1976. Sport fishery and wildlife research 1974-75. Washington, D.C.: U.S. Fish and Wildlife Service. H18a 1e

Contains information regarding rat control by sustained baiting, and information about the efficacy of bird frightening agents, pp. 7-14.

Harris, W.V. 1941. Native methods of food storage in Tanganyika. East African Agricultural Journal (6): 135-138. 1e

Herford, G.V.B. 1957. Pest infestation laboratory, D.S.I.R. In: Scientific Council for Africa South of the Sahara. Meeting of specialists on stored food products, Salisbury, Rhodesia, 1957, pp. 143-148. H24 1e

Hindmarsh, P.S. 1972. Food storage work in Zambia. Farming in Zambia 7 (3): 22-25. 1e

Summarises the factors causing deterioration in harvested crops in Zambia. Notes that the climatic conditions are suitable for rapid development of the insects causing damage. Discusses the effects of insect damage - loss of nutritive value of food grains, loss of quality and loss in weight. A brief description of rodent damage is given and there are notes on mould damage and production of mycotoxins, in particular aflatoxin. An account is given of the surveys and research carried out by the Food Conservation and Storage unit on the biology and control of Sitophilus spp and Sitotroga cerealella. A chart indicates the incidence and movements of grain pests throughout the farming year. Tropical Storage Abstracts, 1973 (3)p. 44-45.

Hindmarsh, P.S. 1976. Reduction of post-harvest losses to durable produce in Zambia. Tropical Stored Products Information 31:13-15. H28 1e

Holman, Leo E. and Snitzler, James R. 1961. Transporting, handling, and storing seeds. In: U.S. Dept. of Agriculture, Yearbook of agriculture 1961, pp. 339-347. Washington, D.C.: U.S. Government Printing Office. H30 1e

Howe, R.W. 1975. Some obvious and not so obvious sources of post-harvest loss. In: Proceedings 8th British insecticide and fungicide conference, 17-20 November, 1975, Brighton, England. Vol. 3, pp. 975-980. H37 1e

Hoyle, B.S. 1967. The seaports of East Africa. Nairobi: East African Publishing House. 1e

Reviewed in Tropical Stored Products Information, 1971 (22), p. 51. A reference book for those interested in the problems of storing, transporting and disinfesting East African exports.

Hughes, H. D. and Henson, E.R. 1972. Crop production. 3rd rev. ed. New York: Macmillan. 1e

Hughes, H. 1969. Problems of food processing industries in developing countries. International Bank for Reconstruction and Development/International Development Association, Report No. EC-169. H42 1e

Hulse, J.H. 1975. Research on post-harvest technology (Agenda Item 11). Presented to the Consultative Group on International Agricultural Research, Technical Advisory Committee, 9th meeting, Rome, 3-7 February, 1975. H43 1e

Hyde, M.B., et al. 1973. Airtight grain storage. Agr. Serv. Bulletin No. 17. AGS:ASB/17. Rome: Food and Agriculture Organization of the U.N. 71 p. 1e

Idusogie, E.O.; Olayide, S.O.; Olatunbosun, D. 1977. Resume of implications of agricultural wastes on Nigerian nutrition and economy. In: Sub-regional *consultation on increasing food availability through waste reduction and improving the marketing system in West Africa with special reference to food grains, fruits and vegetables, held in Monrovia, Liberia, 25-29 October, 1976*. Addis Ababa, Ethiopia: U.N. Economic Commission for Africa. 1e

IFPRI. 1977. *Recent and prospective developments in food consumption: some policy issues*. Research Report No. 2. Washington, D.C.: International Food Policy Research Institute. 1e

Imrie, F. 1975. Single-cell protein from agricultural wastes. *New Scientist* 66(950):458-460. I1 1e

India. Famine Enquiry Commission. 1945. *Famine enquiry: Final report.* Madras: Government Press. pp. 158-164. 1e

Noted that the normal losses to crops in India from diseases, pests, vermin, etc. may be placed at 10 percent of the total produce.

Instituto Interamericano de Ciencias Agricolas. 1977. *Seminar on the reduction of post-harvest food losses in the Caribbean and Central America, held 8-11 August, 1977, in Santo Domingo, Dominican Republic*. Santo Domingo: IICA.

Vol. I: Case analysis by countries; Vol. II: Presenticiones de organismos internacionales; Vol. III: Case studies in the Dominican Republic; Vol. IV: Basic documents for work in committees; Vol. V: Participants, program, conclusions and recommendations; Vol. VI: Documents presented in English and selected documents translated from Spanish. 1e Iba

International Development Research Centre. 1975. Research and development requirements on post-harvest systems. Background paper issued in connection with Commonwealth Ministerial meeting on food production and development, London, 4-12 March, 1975. 1e

International Group for Agricultural Development in Latin America and the Caribbean (IGAD/LAC). 1977. *Post harvest systems in Central America: IGAD/LAC program identification*. Washington, D.C.: IGAD/LAC. 1e I100

Institut de Recherches Agronomiques Tropicales. 1971. Research on stored products protection in the tropical areas. FAO conference on the establishment of cooperative agricultural research programmes between countries with similar ecological conditions, Guinean zone, Africa - Ibadan, Nigeria, 23-28 August, 1971. Rome: Food and Agriculture Organization of the U.N. 1971. 6 p, 2 tab. FAO-15381-71-WM. 1e

Israel, Ministry of Agriculture, Agricultural Research Organization, Institute for Technology and Storage of Agricultural Products, Division of Stored Products, YAFO. 1975. Progress report for the year 1974/1975. Bet Dagan, Israel: Division of Scientific Publications. I13 1e

Jameson, J.D., ed. 1970. Agriculture in Uganda. Rev. ed. London: Oxford University Press, for Ministry of Agriculture and Forestry, Uganda. 1e

Javor, L. and Kartevok, R. 1969. Pests of stored products. Budapest: Mezogazdasagi Kiado. 158 p. 1e

Kamel, A.H. 1974. Storage pests. In: Proc. 1st FAO/SIDA Semin. Improv. Prod. Field Fd Crops Pl. Sci. from Afric. and Near E., Cairo, Egypt. 1-20 September, 1973, pp. 585-593. 1e

Begins with a brief description of main storage facilities in Egypt, comprising: 'Shounas' - areas of land, enclosed by walls or fences and usually uncovered; underground storage - sand ditches and pits; room-type stores usually of unbaked bricks; mud and chaff built bins of 1-15 tons capacity; terminal elevators. Emphasizes need for a grain storage programme. Brief notes are given on insects attacking stored cereals, leguminous seeds and flour and milled products. Sources of infestation are discussed, and recommended control measures include store hygiene, residual insecticide sprays on store fabric, dusting of stacks, and fumigation of infested stacks using carbon disulphide, hydrogen cyanide, methyl bromide or phosphine. There are also notes on rodent pests - seven species are named, and recommendations for control include proofing, inspection, baiting, fumigation and store hygiene. Recommendations are also made for control of bird pests - mainly sparrows. Tropical Storage Abstracts.

Kipps, M.S. 1970. Production of field crops. 6th ed. rev. New York: McGraw-Hill. 1e

Kitchen, R. 1972. Agriculture's growth hit by poor transport facilities. African Development September, 1972. p. Z. 17. 1e

Krishnamurthy, K. and Girish, G.K. 1972. Basic technological requirement of transport and storage. Post harvest technology of cereals and pulses, proceedings of a seminar, New Delhi, 21-23 December, 1972. ed. by Pingale, S.V. et al. pp. 139-142. Indian National Science Academy/Indian Council of Scientific and Industrial Research/Food Corporation of India. K17 1e

Larter, L.N.H., and Martyne, E.B. 1943. A preliminary list of plant diseases in Jamaica. Mycological Papers, No. 8. Richmond, Surrey: Commonwealth Mycological Institute. 1e

League for International Food Education/Institute of Food Technologists, Nutrition-Food Technology Study for Latin America. May, 1977. Final Report. Unpublished report. Grant No. AID/ta-G-1238. 1e L4

League for International Food Education. 1976. Small scale intensive food production. Report of a workshop on improving the nutrition of the most economically disadvantaged families, Santa Barbara, California, 24-27 October, 1976.Washington, D.C.: L.I.F.E. L5. 1e

Levac, C. 1974. Rapport au gouvernement du Tchad sur le stockage des grains. Proj. CHD/72/001 FAO No. AT3260. Rome: Food and Agriculture Organization of the U.N. 34 p.

A study of storage practices and estimations of losses due to insects, rodents and moisture. Improved storage practices are recommended emphasizing central storage for domestic and World Food Programme (WFP) commodities and at rice mills. 1e

Lever, B.G. 1970. Agricultural extension in Botswana. Reading: University of Reading, Dept. of Agricultural Economics. (Development study No. 7, Feb. 1970). Abstract of section on crop storage pests, Tropical Stored Products Information, 1970 (20), page 41. 1e

The majority of farmers failed to appreciate the need for either insecticides or storage hygiene.

Lever, R.J.A.W. 1971. Losses in rice and coconuts due to insect pests. World Crops 23(2):66-67. 1e

Lindblad, C.; Newman, M.; and Vinita, R. 1975. Considerations in rural development - one perspective; grain storage in Dahomey. ACTION - Peace Corps program and training journal 3(4):19-24. 1e

Paper prepared for the West African seminar on grain storage in Cotonou, Dahomey, 13-23 December, 1975. Discusses the problems which arise implementing projects such as grain storage. Part One deals with the assessment of the problem, and takes into account traditional storage methods, market price realities, social customs and traditions, personnel, transportation, material availability and other factors. In Part 2 the choice of the improved method to be popularized is considered, and in Part 3 methods of financing the project. Part 4 is concerned with extension and stimulation of interest in improved storage methods and finally the question of integration into the local infrastructure is emphasized. Tropical Storage Abstracts, 1976 (1):10. 1e

Ling, L. 1961. Man loses a fifth of the crops he grows. Atlantis (Special FAO-FFH issue):1-68. 1e

Locke, M.T. 1975. Safer storage for the produce of this land of ours. An account of Crop Storage Section's exhibit at the 1975 Nairobi Show. Kenya Ent. Newsl. (2):12-14. 1e

Points out that small-holder stores, made to traditional designs, are usually basically sound provided they are well made and maintained. Examples are given of modifications recommended by the staff of the laboratories to reduce termite attack on the store structure and contents, and to prevent rodent damage. Illustrations show various local designs fitted with ratguards made from different materials. Tropical Storage Abstracts 1976(3):37. 1e

Main, C.E. 1977. Crop destruction--the raison d'etre of plant pathology. In: Plant disease, vol. 1, pp. 55-78. New York: Academic Press. 1e M100

Majumder, S.K. 1970. Protecting food from deterioration during storage, handling and distribution in technologically less developed countries of the world. Proceedings of the 3rd International Congress of Food Science and Technology, Washington, D.C. pp. 518-531. 1e

The first section discusses food protection in relation to food technology. It points out that in less developed countries traditional storage methods offer very little protection from insect and other damage, and the small size of individual land holdings does not encourage adoption of modern techniques of harvesting; and tropical and semi-tropical climates provide most favourable conditions for fungal damage and insect infestation. This situation is aggravated by increasing use of convenience foods in flexible packages which are permeable to infestation. The second section is devoted to food composition and specificity of infestation. Examples given include Sitophilus on endosperm, Ephestia on germ, Rhizopertha and Tribolium on broken or powdered grain, and Callosobruchus on low fat whole legume beans. The conditions which favour different fungi and bacteria are discussed. Biodeterioration, the way in which it is manifested, and methods of detecting and evaluating it are examined. The third section deals with prevention of biodeterioration. Sophisticated techniques such as ideal warehouses, controlled atmosphere, specialized silos, grain irradiation, and microwave application are at present beyond the reach of many developing countries. Preharvest prophylaxis with malathion, captan, and Bacillus thuringiensis inhibits field infestation by preventing oviposition, excluding fungi, and acting as lepidoptericide respectively. Tricalcium phosphate sprayed on a crop prior to harvest remains effective during post-harvest operations. Post-harvest practices include improvement of traditional storage structures to exclude rodents and non-mammalian pests, and to provide hermetic and water-vapour proof containers. On a larger scale, modern bins, and inert-gas atmospheres are considered. Other methods discussed include fumigation, parboiling, protectant admixtures such as tricalcium phosphate, and abrasive or absorptive inert dusts. Tropical Storage Abstracts, 1973 (1):10-11.

Majumder, S.K. 1972. What constitutes loss? Post harvest technology of cereals and pulses, proceedings of a seminar, New Delhi, 21-23 December, 1972. ed. by Pingale, S.V. et al., pp. 207-209. M7 1e

Indian National Science Academy/Indian Council of Agricultural Research/Council of Scientific and Industrial Research/Food Corporation of India.

Malawi: Ministry of Agriculture and Natural Resources. 1973. A guide to the safe storage of cereals, oilseeds, and pulses. Lilongwe, Malawi: Ministry of Agriculture and Natural Resources. 1e

A guide intended for use by the farmers, storekeepers and traders of Malawi. There are 24 sections, the first five dealing with storage in general, moisture relations, and insects as storage pests. Descriptions are given of the main insect pests. Other sections deal with insecticides and their application, and there are notes on the protection of specified commodities. Improvements to the traditional crib or 'nkhokwe' are described and illustrated. The final sections deal with fumigation, airtight storage, rodent control and the storage of dried fish. Tropical Storage Abstracts.

Mallamaire, A. 1958. Notes sur les pertes causees aux denrees stockees en Afrique occidentale devant leur conservation. In: Scientific Council for Africa south of the Sahara. Meeting of specialists on stored food products. Salisbury, Rhodesia, 1957, p. 103. London: Scientific Council for Africa South of the Sahara. 1e

Marchione, T.J. 1977. Food and nutrition in self-reliant national development: the impact on child nutrition of Jamaican government policy. Medical Anthropology 1(1):57-79. 1e M10

Matthews, R.H. and Garrison, Y.J. 1975. Food yields summarized by different stages of preparation. (Agriculture Handbook No. 102, Rev. ed.) Washington, D.C.: U.S.Department of Agriculture, Agricultural Research Service. M15 1e

McElheny, V.K. 1976. Technology: protection of grains from plague in developing lands. The New York Times, Wednesday, 27 October, 1976. M2 1e

McFarlane, J.A. 1969. A study of storage losses and allied problems in Ethiopia. Slough, England: Tropical Stored Products Institute. 1e

MacKay, P.J. 1967. Theory of moisture in stored produce. Tropical Stored Products Information 13:9-14. 1e

Discusses the importance of moisture content/relative humidity equilibrium and illustrates this in the case of several tropical products by means of a graph.

McLoughlin, P.F.M., ed. 1970. African food production systems: cases and theory. Baltimore: The Johns Hopkins Press. M6 1e

Metuge, K.G.I.; Hellyer, B.; and Gould, J. 1977. Bloc-Notes du Monde Rural. No. 12. February, 1977. Yaounde, Cameroun:FEMEC, Commission pour le Developpement., B.P. 790, 30p. M22 1e

Special issue dealing with grain storage in the Cameroon. Begins by explaining the reason for the issue. Continues with notes on traditional storage & drying methods in the Cameroon. Discusses the reasons for drying grain. Lists the enemies to traditional grain storage, including birds, animals, moulds, excessive smoking, overdosing with insecticides and fire hazards, then discusses insects, rodents & grain storage. Compares the advantages of different storage methods found in the Cameroon - rafter storage in houses, traditional grass granaries, jute sacks, plastic sacks, steel drums, wood boxes, cribs, mud block silos, silos of metal or cement. Finally outlines the selection criteria for storage facilities. Tropical Storage Abstracts, 1, 1977, p. 8. FEMEC: Federation des eglises et missions evangeliques du Cameroun (Federation of Evangelical Churches and Missions in Cameroon).

Miller, R.J. 1976. Food losses: summary and social impact. Paper presented at the National Food Loss Conference, 12-15 September 1976, Boise, Idaho. M25 1e

Moran, M. Transfer of post harvest technologies to small farmers. Paper presented at the seminar on the reduction of postharvest food losses in the Caribbean and Central America, 8-11 August, 1977, Santo Domingo, Dominican Republic. M30 1e

Morley, G.E. 1973. Informal technical report on grain marketing and storage, Somalia: central grain storage. Rept. AGS:SOM/507. Rome: Food and Agriculture Organization of the U.N. 15 p.

Losses particularly due to insects and moisture in maize and sorghum are discussed. 1e

Morris, R.F. 1978. Roots, tubers, fruits, and vegetables in the developing economies: a review of AID postharvest loss reduction efforts. A report prepared for the Agency for International Development, Washington, D.C., 25 September, 1978.

Project #931-1155.11. Contract #AID/ta-C-147-614. Unpublished paper. 1e M39

Morris, R.F. 1978. Methods of reducing postharvest losses of roots, tubers, fruits, and vegetables in developing country economies. A report prepared for the Agency for International Development, Washington, D.C., 11 July 1978. Project #931-1155.11. Contract #AID/ta-C-147-614. Unpublished paper. 1e M38

Morris, R.F. 1978. Fruit, vegetables, roots, and tubers in the developing economies: an estimation of losses. A report prepared for the Agency for International Development, Washington, D.C., 25 May 1978. Project #931-1155.11. Contract #AID/ta-C-147-614. Unpublished paper. 1e M37

Morris, R.F. 1978. Roots, tubers, fruits, and vegetables in the developing economies: an estimation of value. A report prepared for the Agency for International Development, Washington, D.C., 24 March 1978. Project #931-1155.11. Contract #AID/ta-C-147-614. Unpublished paper. 1e M36

Mphuru, A.N. 1971. A review of storage problems in Tanzania. Paper presented at the 2nd Conference on Land Use in Tanzania, 28-30 June, 1971. 1e

Munro, J.W. 1966. Pests of stored products. London: Hutchinson. 1e

National Academy of Engineering. 1970. The food-people balance: proceedings of the symposium sponsored by the National Academy of Engineering at the 6th annual meeting. Washington, D.C.: National Academy of Engineering. N1 1e

National Food Loss Conference. Food losses--identification and prevention. Boise, Idaho, 12-15 September, 1976. Sponsored by the College of Agriculture, University of Idaho; Agricultural Research Service (USDA); and the Cooperative State Research Service (USDA). N4 1e

National Nutrition Advisory Committee (India). 1968. Report of the study group on food losses and their prevention of the National Nutrition Advisory Committee. Part I: Food grains. P9 1e

National Research Council, Agricultural Board, Committee on Plant and Animal Pests, Subcommittee on Vertebrate Pests. 1970. Vertebrate pests: problems and control (principles of plant and animal pest control, Vol. 5). Washington. D.C.: National Academy of Sciences. N5 1e

National Research Council, Commission on International Relations, Board on Science and Technology for International Development. 1978. Postharvest food losses in developing countries. Staff summary report of an international working group meeting, 31 October - 3 November, 1977, Washington, D.C. Washington, D.C.: Natinal Academy of Sciences. 1e

National Restaurant Association. n.d. Pest control. Chicago: National Restaurant Assocation. N7 1e

New York State College of Agriculture and Life Sciences. 1975. Food science research needs for improving the utilization, processing, and nutritive value of food products. (A grant report to the Science and Technology Policy Office, National Science Foundation.) Ithaca, N.Y.: State College of Agriculture and Life Sciences, Cornell University. N12 1e

Ngatia, C.M. and Warui, C.M. 1976. Pest control in Mombasa - island and port - a function of the storage and infestation control survey - Mombasa Unit. Kenya Ent. Newsletter. (3):16-23. 1e

Describes the work of the Unit, which is designed to preserve Mombasa port as an insect pest-free quarantine area. Regular inspections are made of ships and port warehouses, and of import and export cargoes, and recommendations made regarding insecticidal treatments. In addition, regular inspections are made of godowns (warehouses) outside the port area, and storekeepers are advised of any infestation detected. The authors point out that difficulties arise, and in pursuit of their duties staff are more likely to make enemies than friends. Tropical Storage Abstracts.

Nigerian Stored Products Research Institute. 1967. Annual report, 1966. Lagos: Nigerian Stored Products Research Institute. 1e

Nyanteng, V.K. 1972. The storage of foodstuffs in Ghana. Technical Publication Series, No. 18. Legon: University of Ghana, Institute of Statistical, Social and Economic Research. N15 1e

Reports on a survey carried out during 1970 and 1971, by interviewing farmers, agricultural officers and assistants and using two questionnaires, one designed for each group. In the introduction the problems arising from storage of foodstuffs in hot, humid countries are discussed generally, and it is noted that butyl silos have been found to have, in practice, a useful life of only six to twelve months. The second chapter deals with the role of storage and farmers' storage policies and covers the role of storage in distribution, prices and production of foodstuffs. In the third chapter, the storage of cereals, and methods and structures in current usage are discussed. The fourth chapter deals with storage of other food crops, and includes yams, cassava, cocoyam, plantain, groundnuts and vegetables. There is a final summary and recommendations. The appendix gives details of the questionnaires, and a discussion on storage losses. The plates mainly illustrate storage containers and structures throughout the country. Tropical Storage Abstracts.

OECD Planning Group on Science and Technology for Developing Countries. 1977. Report of the steering group on pest control under the conditions of small farmer food crop production in developing countries. Paris: Organization for Economic Cooperation and Development, Development Centre. 1e 0100

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If the world population of 4 billion were fed on a U.S. type diet produced by modern agriculture, known petroleum reserves would be exhausted in about 13 years. 15 percent of U.S. energy is spent on its food system which amounts to .023 barrels of oil per day per person. This is twice the total daily per capita fossil fuel use for all developing nations. Postharvest losses are about 20 percent and range from 9 percent in the U.S. to 40-50 percent in some developing nations, especially in

the tropics. Examples of bioenvironmental control are given with reference to their greater importance on a world basis than the use of pesticides. Energy used to produce, formulate, package, and apply pesticides is significant, whereas bioenvironmental control requires little or no fossil fuel. Energy inputs for postharvest pest control are described as tremendous and calculated by one example as being 5 times greater than for production itself.

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Discusses the increasing emphasis being placed on the need to help rural people of developing countries to produce enough food for their own subsistence. One of the main causes of food shortage is agricultural waste in general and post harvest losses in particular. There are five critical stages at which losses occur; at harvest; during processing; in storage; during distribution; and through the marketing systems. Each stage is examined briefly and a few examples are given. Tropical Storage Abstracts.

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Discusses various estimates of losses in stored foodstuffs, especially at farm level. Insects are the most important agents responsible for postharvest losses, principally Lepidoptera and Coleoptera. Principal pests in the Lepidoptera are given as *Sitotroga cerealella*, *Ephestia* (*Cadra*) *cautella*, *Plodia interpunctella* and *Ephestia* (*Anagasta*) *kuehniella*. The various factors influencing the amount of damage caused by insects are examined, in relation to control. These include pre-harvest and pre-storage infestation, drying and handling, choice of variety and proximity of growing area to storage premises. Discusses extension programmes in relation to the use of insecticides. The difficulties resulting from insecticide resistance are noted. The insecticides most commonly used to protect stored grain are lindane, malathion and pyrethrins. In a recent global survey of resistance, it was found that resistance to lindane occurred in all pest insects - *Sitophilus oryzae*, *S. zeamais*, *S. granarius*, *Rhyzopertha dominica*, *Tribolium castaneum*, *T. confusum*, *Oryzaephilus surinamensis* and *O. mercator*., and malathion resistance was almost equally widespread. There is also evidence of resistance to fumigants (methyl bromide and phosphine) in practical conditions. Losses caused by microorganisms, birds and rodents are mentioned, and the need for general improvement in post harvest techniques, combined with adequate training, is stressed. Tropical Storage Abstracts, 1976 (2): 26-7.

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Losses of stored produce are primarily due to insects and mites, microorganisms, and rodents. Damage and losses in quantity and quality are briefly described. Suggestions for storage loss assessments are given with reference to (a) social structure of the village, especially the pattern of use and disposal of the grain by farmers; (b) the occurrence of different grain varieties and the quantities produced; (c) the pests concerned and methods of storage. Losses can only be prevented when produce is properly stored. Highest acceptable moisture contents for safe storage are given for 10 products. The most important storage pests are described and the factors involved in the infestation of maize are listed. A brief description of microorganisms and the resulting losses associated with molds, bacteria and yeasts are given. The species of rodents and the types of damage caused by them are described. Storage methods for unshelled and shelled produce are

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Climate plays an important if not crucial role in determining whether cosmopolitan pests of stored foodstuffs will become established in a food-storing region of the world. Using a recognized climatic classification of regions where major cereal and food crops are produced, the characteristic patterns of infestation of storage insects and mites predominant in these regions are examined. Heterogeneity of species distribution and variation in insect density corresponding to diversity of climatic conditions within a region, such as in Kenya in East Africa and Uttar Pradesh in India are emphasized. The climatic conditions during harvest of various wheat producing regions are analysed and considered an important factor in setting the pattern of postharvest deterioration of stored grain. Laboratory data on physical limits of Sitophilus, Rhizopertha, Sitotroga, Cryptolestes and other major storage pests were correlated to climatic data of selected regions to postulate certain basic patterns of distribution and infestation of major storage insect pests. How the basic relationships between climate variables and infestation records can be used to predict potential insect outbreaks is illustrated by a deductive multivariate analysis of 3 years' insect

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Discusses the estimated magnitude of post harvest losses in food and their causes. Suggests that pest attack by insects, rodents and birds is most important in grains, while micro-organisms cause the most damage to horticultural produce. Points out that there is a considerable body of technology available to reduce post harvest losses, and at the farmer level many simple, low cost techniques have been developed. Some of these are discussed. The need for care in using chemical treatments is emphasized. Other important needs are for agricultural extension workers to be made aware of such techniques, for supplies of low cost structural materials and pesticides to be made available, and for more efficient marketing systems to dispose of local food surpluses. Tropical Storage Abstracts, 1976 (2) p. 28.

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Papers submitted:
Bropleh, Nah-Doe P. Opening remarks.
Adedeji, Adebayo. Increased food supply for self-sustained reliance in Africa.
Anthonio, Q.B.O. Strategies for improving the marketing system and minimising food wastes in West Africa.
Wahby, O. Views and observations on food waste and its reduction, with special reference to fruits for processing.
Beyele, F.T. Problems of transit in West Africa and waste reduction.
Beyele, F.T. Cooperation, trade in West Africa - and waste reduction.
Taylor, R.W. Contribution of The Gambia.
Adeyokunnu, T.O. Food waste in Nigeria.
Reusse, E. Strategies for improving the marketing system and minimising food wastes in West Africa.
Osuntogun, Adeniyi. Food waste in West Africa.
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Storage pest control by physical means is the oldest method known and is still one of the most important. This survey deals with the following topics: current agronomic practices as related to storage; physical exclusion of pests; addition of chemically inert solids; modification of the storage atmosphere; modification of moisture and temperature; physical impact such as turning and use of the Entoleter; radiation such as sound, visible light, UV, IR, radiofrequency and ionizing radiation; host-plant resistance; integration and interactions of physical control methods with other methods; and the future prospects for physical control. Tropical Storage Abstracts. 1975 (3), p. 45-6.

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Recently the Paddy Marketing Board has been called upon to keep paddy in storage for periods of many months, and has repeatedly found it necessary to write off losses caused by drying out and deterioration during storage. A survey was conducted with a view to estimating these losses and formulating a procedure to minimise loss of weight of paddy in stores, and to carry out a laboratory analysis of samples to help determine the major causes of these losses and their effect on outturns and quality of milled rice. The report examines the results and recommends courses of action. Principal recommendations include more careful inspection at time of procurement, evaluation of suitability of storage premises, planned stacking, regular and careful inspection, regular checking of physical stocks, accurate keeping of tallies, planned movement of stock to ensure first in -- first out, and provision for pest control including fumigation. Tropical Storage Abstracts, 1975 (5), p. 72-73.

Williams, C.E. 1973. Storage practises in Badeku village (a case study). Tropical Stored Products Information 25:43. W16 1e

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Zambia. 1969. The Grain Marketing Act. (Applied Laws, Cap. A.L. 10). The Grain Marketing (Acceptance Standards) Regulations 1969. Statutory Instrument 296 of 1969. Supplement to the Republic of Zambia Gazette of 6 June 1969. 1e

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Sorghum storage observations indicated that new improved varieties deteriorate more rapidly in store than indigenous varieties. In trials on storage of dried cassava, the most important molds recorded were Aspergillus glaucus, Penicillium spp and Rhizopus nigricans.
Farm trials included the storage of cob maize in traditional bins. The attempt to control primary insect species in stored cob maize was unsuccessful, the main problem being control of Sitotroga cerealella. Storage of shelled maize in traditional bins was more satisfactory, when combined with the use of malathion at 12 pm a.i. Storage of shelled maize in improved brick bins, combined with the use of pirimiphos methyl, malathion, lindane dust, and bromophos dust, all maintained visible damage levels at less than 5 percent up to 12 months after harvest.
Trials were also carried out in depot storage, on shelled maize in jute sacks. Tropical Storage Abstracts (abridged).

Zambia - National Agricultural Marketing Board. 1970. The National Agricultural Marketing (Acceptance standards) Regulations. Lusaka: Government Printer, 1970. 15 p. (Statutory instruments - no. 207 of 1970). 1e

Acceptance standards for maize, shelled and unshelled groundnuts, seed cotton, beans and sorghum. Brief review in <u>Tropical Stored Products Information</u>, 1971 (22), p. 55.

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Adams, J.M. 1976. A guide to the objective and reliable estimation of food losses in small scale farmer storage. Tropical Stored Products Information 32:5-12. 2 A4

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Association of Official Analytical Chemists. 1955. Offical Methods of Analysis. 10th Ed. Washington, D.C.: Association of Official Analytical Chemists. 2

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A measured sample is boiled for 10-15 minutes in 10 percent NaOH. After cooling, water is added and the liquid is drained through gauze. Remains of larvae, cocoons, pupa etc. are then counted.

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A biological technique for assessing the susceptibility of varieties of maize to post-harvest infestation by _Sitophilus zeamais_ Motsch. has been developed. The effects of the age and population density of the parent insects upon the results obtained were investigated, and the possible effects of insect selection due to breeding upon particular maize varieties were looked at. Twenty-five Malawi, two Colombian and three Indonesian maize varieties were tested for susceptibility, and the results obtained were summarized using an 'Index of Susceptibility' which took into account both the F_1 progeny developing during the tests and a measure of the average development period of these progeny. It was concluded that the hardness of the kernels, as estimated by the proportion of floury endosperm was related to susceptibility, and that the hardness was closely coorelated with amylose content. It was concluded that susceptibility was determinated in these varieties by factors operating after oviposition. Abridged from Tropical Storage Abstracts, 1975 (1) p. 5. 2

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Twenty-five varieties of Malawi maize were assessed for their susceptibilities to post-harvest infestation by Sitophilus zeamais Motsch. The varieties were found to have a wide range of susceptibilities to infestation. The moisture content of each variety at equilibrium with 70 percent R.H. was measured, an estimate of the amount of starchy endosperm in each variety was made, and the mean weight of kernels of each variety was estimated. No correlation was found between the equilibrium moisture contents and the susceptibilities of the varieties, but there were good correlations between the amount of starchy endosperm of the varieties and their susceptibilities, and between the mean kernel weight of each variety and their susceptibilities. (Author's abstract) Tropical Storage Abstracts, 1973 (2) p 23. 2

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Test methods are described for detecting resistance to malathion or lindane in *Sitophilus oryzae*, *S. zeamais*, *S. granarius*, *Rhyzopertha dominica*, *Tribolium castaneum*, *T. confusum*, *Oryzaephilus surinamensis* and *O. mercator*. The methods are similar in principle and basic detail to the FAO method prescribed for *T. castaneum*, and depend on exposure of adult insects to insecticide-impregnated papers. Responses are judged after 5 to 6 or 24 hours, according to the speed of action of the insecticides. Base line data are established with known susceptible strains. It is then possible to select discriminating concentrations which can be used to screen samples of beetles for resistance. Survival in such tests is a danger signal calling for more extensive testing to define the degree of resistance present.

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As part of continuing studies, investigations were carried out on the assessment of quality loss in wheat damaged by _T. granarium_. Samples of different compositions having 5, 10, 20, 50, 80 and 100 percent damaged kernels were prepared. These samples were analysed for quality factors: moisture, protein, gluten, alcoholic acidity, free fat acidity, crude fat, sedimentation value, reducing and non-reducing sugars, ash and viability. It was concluded that the amount of protein, gluten, crude fat, sedimentation value, reducing and non-reducing sugars and ash decreased with the increase in damaged kernels in the samples, while alcoholic acidity and ffa increased. Germination decreased from 95 percent in the 100 percent sound kernels to 0 in the case of 100 percent germ eaten kernels. There was 16.36 percent weight loss in wheat. _Tropical Storage Abstracts_, 1976 (1) p. 7. 2

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Harris, K.L. 1941. General principles for the study of insect and rodent filth in cereals. Food and Drug Administration Mimeograph 12-18-41. Washington, D.C.: U.S. Food and Drug Administration. 2

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3
General Grain Losses

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The most important cereals grown in this region are sorghum, millet and maize. Rice and wheat are grown to a limited extent. Losses due to storage pests are estimated to be between 4 and 10 percent. Drying normally occurs in the field but this is difficult with millet and early maize, which are harvested during the rains in June-October. Insect attack, principally by *Sitotroga cerealella* and

Sitophilus oryzae occurs in the field prior to harvest, during drying, and from infested residues in the granaries. The methods of storage described comprise granaries or "rumbus" constructed of dried earth or woven plant materials; modern silos of cement block or dried earth plastered with cement; underground pits - usually for long term storage; various containers in the farmers' houses, such as sacks, earthenware pots and calabashes. The rumbu is the commonest structure used. It is not suitable for fumigation but does permit admixture of insecticidal dusts. Pest control measures suggested include prompt harvesting, thorough drying and storage of threshed grain, selection of resistant varieties and airtight storage. In nonairtight storage, application of 0.5 percent lindane at 10 ppm is recommended. In view of residue problems alternative insecticides are needed. Condensed from _Tropical Storage Abstracts_.

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Caswell, G.H. 1975. Grain storage problems in Nigeria. Samaru Agricultural Newsletter 17(1):2-3 (Author's address: Senior Entomologist, P.M.B. 1044, Zaria, Nigeria). 3

Points out the problems resulting from the significant increase in the urban population, which is no longer able to grow sufficient food to feed itself. Considers present farming and food storage methods and puts forward the suggestion that while these should be retained (but improved) in rural areas, a new approach is required to the feeding of large urban areas. The author advocates large mechanised farms where results of research can be applied. In Nigeria, it is suggested that maize should be grown in the drier savannah areas, e.g., Samaru. Points out that dry conditions inhibit the multiplication of pests such as Sitophilus, and similar factors apply to sorghum and millet, so bulk storage is advocated, and the author comments on the number of bulk storage silos throughout the country which are unused. An exception is made for cowpea, which is very susceptible to insect attack even in dry areas, and which might best be stored in silos. (Condensed from) Tropical Storage Abstracts. 3

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Notes tests on small structures designed to hold 500-1000 kg. of food-grains. A circular flexible bin formed from high molecular weight, high density polyethylene (600-1000 gauge) having a base and an airtight cap was developed to replace the more expensive masonry, cement or metal structures (in collaboration with other organizations). It was made rodent and insect proof by covering with a hessian polyethylene laminate treated with high viscosity rat repellent and insecticidal emulsion. Fumigation was carried out using ethylene dibromide based minifume tablets. Tropical Storage Abstracts. 3

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Christensen, C.M. and Kaufmann, H.H. 1977. Good grain storage. Extension folder 226. St. Paul, Minnesota: University of Minnesota, Agricultural Extension Service. 3 C100

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Cotton, R.T. 1948. Storage losses of grain - The world picture. Transactions of the American Association of Cereal Chemists 6(2):100-107.

He estimates that on a world basis the losses due to insects, fungi and rodents are of the order of 10 percent. He lists the results from the FAO survey which cover 27 countries. The total loss in estimated about 25,750,000 metric tons, without considering farm losses. Taking farm losses into account the total loss would be about 65,000,000 tons which is enough to supply caloric value for more than 360,000,000 people. 3

Cotton, R.T. and Wilbur, P.A. 1974. Insects. In: Storage of cereal grains and their products, Ed. by Christensen, C.M. St. Paul, Minnesota: American Association of Cereal Chemists. 3

Coyne, F.P. 1945. Principles of cereal storage. Delhi, India: Dept. of Food. 45 pp.

Estimates that India loses 1 million tons of grain annually due to pests.

Crombi, A.C. 1943. The effect of crowding upon the natality of grain infesting insects. Proceedings of the Zoological Society of London. A, 113:77-98. 3

Culpin, C., ed. 1966. Farm grain drying and storage. 3rd ed. London: Her Majesty's Stationery Office. 172 p. (Ministry of Agriculture, Fisheries and Food Bulletin no. 149). Contains 55 references, 1942-1965. 3

Davey, P.M. and Elcoate, S. 1965. Moisture content/relative humidity equilibria of tropical stored produce. (Part 1. Cereals.) Tropical Stored Products Information 11:439-67. 3 D3

De Beer, A.G. 1972. Drying and storing agricultural produce on the farm. Farming in South Africa 48(5):29-68. 3

Deuse, J. and Pattinson, I. 1970. Senegal - Institute of food technology - Problems of grain storage in Senegal, proposed solutions and measures undertaken. UNDP/SF Project SEN/5, Institute of food technology. Rapport interne No. 71. Rome: Food and Agriculture Organization of the U.N., 1970. 33 p., 1 annex, 8 ref. FAO-14001-70-WS. Restr. 3

Dexter, S.T., Chaves, A.M.; and Edje, O.T. 1969. Drying on anaerobically preserving small lots of grain for seed or food. Agronomy Journal 61(6):913-919. 3

Dichter, D. 1976. The stealthy thief. Ceres 9(4):51-55. 3 D27

Duval, C.T. 1971. Store your grain: grain storage - a message to all the people of Botswana. Gaborone: Agricultural Information Service. 4p illus. 3

An extension pamphlet on the advantages of storing grain.

Esmay, M.L. 1973. Drying, storing and handling food grains in developing countries. In: Agricultural mechanization in developing countries, ed. by Esmay, M.L. and Hall, C.W. pp. 135-175. Japan: Shin-Norinsha Co., Ltd. 3E6

The chapter on drying and storing (Chapt. 6 by Merle L. Esmay) covers the following: objectives; terminology; food grain losses; second generation problems; factors influencing storage and transportation; distribution and utilization of food grains; farmers' organizations; storage principles; drying principles; mechanical drying systems; a proposed flat bed batch dryer for paddy rice; storages requirements; grain storage; storage design; storage summary; storage program recommendation; transportation; and guide lines. Each chapter has a summary and a list of selected references. Tropical Storage Abstracts.

Esmay, M.L. 1971. A second generation problem of the green revolution: food grain storage. Agricultural Mechanization in South East Asia, spring: 64-66. Originally published in Asia Foundation Program Quarterly 57 (1970:5-9. 3 E8

Fifield, C.C. 1959. Milling, baking, and chemical properties of Marquis and Kanred wheat grown in Colorado and stored 25 to 33 years. Cereal Science Today 4(6):179-183. 3 F6

Fiscus, D.E., Foster, G.H.; and Kaufmann, H.H. 1971. Physical damage of grain caused by various handling techniques. Transactions of the ASAE 14:480-485, 491. 3

Food and Agricultural Organization of the U.N. Agricultural Services Division. 1970. The introduction of high yielding varieties with special reference to procurement, drying and storage. Sixth session of the IRC working party on agricultural engineering aspects of rice production, storage and processing - Teheran, Iran, 5-9 December, 1970. Rome: Food and Agriculture Organization of the U.N., 1970. 5 p., 9 ref. FAO-13197-70-WM. 3.

Food and Agriculture Organization of the U.N. Nutrition Division. 1966. Principles of grain storage. FAO conference on cereal and bread technology for the Near East Region- Cairo, UAR, 5-10 February, 1966. Rome: Food and Agriculture Organization of the U.N., 1966, 11 p., 1 tab., abstr. FAO-60509-66-WM. 3

Food and Agriculture Organization of the U.N. Nutrition Division. 1965. Drying and dehydration - Drying of staple food crops. First FAO food technology seminar for the African region - Accra, Ghana, 13-20 December 1965. Rome: Food and Agriculture

Organization of the U.N., 1965, 5. FAO 60493-65-WS. 3

Forrest, R.S.; Petersen, T.A.; Hogue, J.J.; and Steckle, J. 1975. The post-harvest food grain industry in semi-arid Africa. Ottawa: International Development Research Centre. 83 p. 3 F35.

This report deals with a description and analysis of the post-harvest food grains industry in semi-arid Africa, utilising the systems concept. It arises out of the work of a three-man mission, which spent five weeks in the spring of 1974 in a number of African countries interviewing key people and agencies associated with the industry. The mission members were engaged by the IDRC of Ottawa, Canada at the request of the Consultative Group on International Agricultural Research.

Foster, G.H. 1968. Grain damage from high-speed drying. Paper presented at the symposium on grain damage held under the auspices of the ASAE, Iowa State University, Ames, Iowa, 17-18 April, 1968. 3

High-speed and high-temperature drying may damage grain by increasing brittleness of the grain; stress cracks or endosperm fissures.

Foster, G.H. and Holman, L.E. 1973. Grain breakage cause by commercial handling methods. Marketing Research Report No. 968. Washington, D.C.: U.S. Department of Agriculture.

Reports investigations designed to determine the extent and cause of physical damage to grain by equipment used in handling grain. Drop weight was the most significant test variable in the free-fall and spouting tests. In the grain-thrower tests, the belt speed was the most significant.

Foster, G.H. and Peart, R.M. 1976. Solar grain drying. Agriculture Information Bulletin No. 401. Washington, D.C.: U.S. Department of Agriculture. 13 p. 3 F37a

Freeman, J.A. 1969. The control of insects in stores of home grown grain. Chemistry and Industry 40:1401-1404. 3

Freeman, J.A. 1959. Infestation of grain and feeding stuffs. In: N.A.A.S. Quarterly Review 45: 11-19. (August, 1959).

Enumerates principles by which the infestation of grain stored on farms can be prevented. Lists 11 Items, from 1948-1957.

Garland, P. 1971. Grain drying. Farmer's Newsletter - Large Area 78 (April):4-6. 3

Geddes, W.F. 1958. The chemistry, microbiology and physics of grain storage. Food Technology 12(11):7-14. 3

Giles, P.H. 1964. The storage of cereals by farmers in Northern Nigeria. Tropical Agriculture (Trinidad) 41(3):197-212. 3

From the result of survey work it is estimated that about 4 percent of the total sorghum and millet crop is lost to stored product insects every year.

Gilman, G.A. and Martin, P. 1971. A brief survey of grain storage and handling methods used in Lesotho (April 28th - May 4th). Report, University of Botswana, Lesotho and Swaziland. 7p + appendices Typewritten. 3

Girish, G.K. 1970. Respiration of grain under storage conditions. Bulletin of Grain Technology 8(1 and 2):22-29. 3

Girish, G.K. and Krishnamurthy, K. 1973. Losses in foodgrains in storage. In: Post Harvest Technology of Cereals and Pulses. Proceedings of a seminar, New Delhi, 21-23 December, 1972, ed. by S.V. Pingale, et al., pp. 199-205. New Delhi: Indian National Science Academy/Indian council of Agricultural Research/Council of Scientific and Industrial Research/Food Corporation of India. 3 G13

Girish, G.K.; Tripathi, B.; Tomer, R.P.S.; and Krishnamurthy, K. 1974. Studies on the assessment of losses. IV. Conventional grain storage practices and losses in rural areas in Uttar Pradesh. Bulletin of Grain Technology 12(3):199-210. 3 G14

Girish, G.K.; Goyal, R.K.; Tomer, R.P.S.; Srivastava, P.K.; and Krishnamurthy, K. 1972. Studies on preservation of foodgrains in rural storage structures. Part I: Studies on the preservation and losses of foodgrains in underground pits "Khatties" in Uttar Pradesh (India). Bulletin of Grain Technology 10(1): 11-21. 3 G10

Gormely, P.; Keck, M.; and Ackels, A.A. 1968. Review of grain storage, handling, processing and distribution problems and proposals in the Republic of Korea. Food grain drying, storage handling and transportation report no. 6. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute. 96 p. 3 G18a

Grain dryer for the small man. 1972. The People. Dacca, Bangladesh, Nov. 13. 3 G19

Grain dryers, last but not least. 1975. World Farming 17(7):20-29. 3 G20

Grain Storage in Botswana: An analysis of the first three years of extension operations of the Botswana government FFHC Grain Storage Scheme, September, 1969 - August, 1972. 3

Great Britain. Ministry of Agriculture, Fisheries and Food. 1971 Preservation of grain quality during drying and storage. Rev. ed. (Short-term leaflet - no. 24) London: Ministry of Agriculture, Fisheries and Food. 7p. 3

Great Britain. Ministry of Agriculture and Fisheries. 1954. Farm grain drying and storage. Bulletin No. 149. London: Her Majesty's Stationery Office. Chapter XIII, Control of Pests, pp. 117-121. G25 3.

Greer, E.N.; Jones, C.R.; and Moran, T. 1954. The quality of flour stored for periods up to 27 years. Cereal Chemistry 31(6):439-450. 3 G27a

Greiffenstein, A.C. and Pfost, H.B. 1974. Moisture absorption of bulk stored grain under tropical conditions. Grain storage, processing and marketing research report no. 6. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute. 76 p. 3 G28a

Guilfoy, R.F. and Mongelli, R.C. 1969. Relationships between grain transit losses and boxcar defects. ARS 52-25. Washington, D.C.: U.S. Department of Agriculture, Agricultural Research Service. 3

Haddad, A. 1968. Grain storage in Libya. In National Training centre on agricultural marketing, Tripoli, Libya, 30 September - 26 October, 1967. Lecture No. 9, Tripoli, Libya, 1968. Rome: Food and Agriculture Organization of the U.N., 1968, p. 64-66. FAO-07544-68-XB. 3

Hafiz, A. and Hussein, S., 1961. Good seed storage reduces losses and increases production. Agriculture Pakistan 12(3):368-385. 3

The author points out that losses due to insects are about 5.6 percent; that due to rats 6-10 percent and due to moulds 1.2 percent.

Hall, C.W. 1957. Drying farm crops. Westport, Connecticut: The AVI Publishing Corp, Inc. 336 p. H5 3

Hall, C.W. 1956. Preventing crop losses by drying. Agricultural Engineering 37:414-415. 3

Hall, E.G. 1968. Mechanical shelling damage. Paper presented at the symposium on grain damage held under the auspices of the ASAE, Iowa State University, Ames, Iowa, 17-18 April, 1968. 3

This was an attempt to determine the characteristics of breakage that result from the shelling process. The data included particle size as related to various factors such as moisture content.

Harnessing the sun. 1976. Agricultural Research 25(6): 10-12. 3 H13

Harrington, J.F. and Douglas, J.E. 1969. Seed storage and packaging; applications for India. New Delhi:National Seeds Corporation. 3

Harris, K.L. 1958. Insect infestation of grain and contamination of cereal products. Cereal Science Today 3:12-15. 3

Harrison, L.S. 1954. India - grain storage: Report to the government. EPTA Report No. 345. Rome: Food and Agriculture Organization of the U.N. 21 p. FAO-50345-54-MR. 3

Hays, H.M. 1975. The marketing and storage of food grains in northern Nigeria. Samaru miscellaneous paper 50, 155 pp, 36 tabl, 17 fig, 40 refs. 11 append. Zaria, Nigeria: Institute for Agricultural Research, Samaru Ahmadu Bello University. 3

Reports on a detailed survey carried out during the 1970 and 1971 crop years. Studies were restricted to the two most important grain crops, guinea corn (Sorghum vulgare) and millet (Pennisetum typhoideum) (syn. typhoides) and included: the traditional marketing system; production, storage

and marketing patterns at the producer level; detailed evaluation of marketing costs in terms of the services provided: budgeting of incomes of marketing intermediaries; examination of intermarket price differentials in relation to transport and other costs; and examination of storage costs as a factor in determining price changes. Three villages and three major markets were examined in detail, and data were collected from farmers and traders. Some descriptions are given of production and marketing. Estimates indicate that approximately 20 percent of millet and sorghum are dissipated as ritual gifts, tithes, etc., the balance being stored. Village storage methods observed were in-hut storage of threshed grain in sacks, and storage of bundles of unthreshed grain in a "rumbu" or dried earth granary, constructed of dry grass and clay, resting on large stones and covered with a thatched roof. Some estimated storage costs are given for a typical rumbu of 1.1 metric ton capacity. An examination is made of transport systems and urban markets, and recommendations are made for the modernisation and expansion of marketing services. Tropical Storage Abstracts.

Hays, H.M. 1975. The storage of cereal grains in three villages of Zaria Province, Northern Nigeria. Savanna 4 (2): 119-123, 3 tabl, ref. (Author's address: Dr. H.M. Hays, Lecturer and Research Fellow, Department of Agricultural Economics and Rural Sociology, Institute for Agricultural Research, Ahmadu Bello University, PMB 1044, Zaria, Nigeria). 3

Reports on a study of storage practices of 54 farmers in three villages of Zaria Province in Kaduna State. The crops were the two most important in Nigeria, millet and sorghum. The types of storage structures are described with some comments on their adequacy and efficiency. In the light of present storage practices for millet and sorghum, it is concluded that the scope for improvement through the use of better structures is limited, and that the widespread 'rumbu' is cheap and effective. There is some scope for reducing storage losses through wider adoption and proper use of insecticides. Tropical Storage Abstracts, 1976 (3) p. 36.

Hearle, H.F. and Hall, D.W. 1963. The use of low temperature high air volume drying of tropical crops. Tropical Stored Products Information 5:168-173. 3

Hebblethwaite, P. 1955. Combine losses. Farming Mechanization 7(76):316-318. 3

Hemelrijck, M. van 1960. Ouelques indications relatives au sechage en sacs (essais du sechoir Nu-Way). (Some information on the drying of materials in sacks. (Trials in the Nu-Way drier.) Bulletin Agricole du Congo 51(6) (December, 1960). 3

Henderson, S.M. 1953. Ranch grain drying; adequate drying capacity, short hauls, lower costs among advantages. California Agriculture 7(7):9. 3

Henriksson, R., et al. Food grain storage in Tanzania. Uppsala, Sweden: Inst. for lantbrukets byggnadsteknik, Lantbrukshogskolan. 3

Holmes, E.S. Recommendations for FECOAGROH grain storage and handling facilities in Honduras. Food grain drying, storage and handling and transportation report no. 24. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute. 39 p. 3 H30a

Hulse, J.H. 1975. Research and development requirements on post-harvest systems; Commonwealth Ministerial Meeting on Food Production and Rural Development, London, 4-12 March, 1975. Ottawa: International Development Research Centre. 18 p. On cover: Commonwealth Secretariat. 3

Paper argues "that more serious attention and material support be given to improving post-harvest grain systems, and will recommend certain courses of action for consideration by the Governments of the Commonwealth Nations." Deals with post-harvest (i.e. post-production) problems as they relate to subsistence grains and refers to the whole system of operations from the place and time of harvest to the point of consumption, with special reference to Africa and Asia. Recommends that existing organisations be strengthened, that individual efforts be more effectively co-ordinated, and that mechanisms for technical guidance, co-operation and exchange of information be created. For Appendix A - see: Padua, Dante B. de (1974) Post-harvest rice technology in Indonesia, Malaysia, the Phillipines, Thailand. Appendix B (not seen).

Hummel, B.C.W.; Cuendet, L.S.; Christensen, C.M.; and Geddes, W.R. 1954. Grain storage studies. 13: Comparative changes in respiration, viability, and chemical composition of mold-free and mold-contaminated wheat upon storage. Cereal Chemistry 31:143-150. 3

Mold-free grain respired at a uniform rate whereas the inoculated seeds showed a rapid rise. Germination of seed stored 19 days was injured by moisture content of 14.9 percent, as was also mold-contaminated wheat with moisture content of 14.9 percent.

Huysmans, A.A.C. 1970. Storage of food grains: Problems and prospects. Bulletin of Grain Technology 8(3):92-97. 3

Huysman reports some of the results on estimate of losses which have been made by a committee on losses of food grains during post harvest handling. According to the committee more than 50 percent of the total loss was due to rodents. For the whole of India an average loss of nearly 2 million tons of grain per year for the period of 1962-1965 is reported.

Hyde, M.B. 1968. Successful storage of high moisture grain. Esso Farmer 20(3):11-14. 3

Hyde, M.B. 1965. Principles of wet grain conservation. Journal and Proceedings of the Institution of Agricultural Engineers (England) 21(2):75-82. 3

Hyde, M.B. 1958. Underground storage of grain and its effects on grain quality. Getreidequalitat, Trocknung und Lagerung, Berichte auf der 2. Getreidetagung vom, 21-23 Mai, 1958 in Detmold, Detmold, 1958, p. 153-165, tab., refs. 3

Hyde, M.B. and Oxley, T.A. 1960. Experiments on the airtight storage of damp grain. 1. Introduction, effect on the grain and the intergranular atmosphere. Annals of Applied Biology 48(4):687-710. 3

Hyde, M.B. and Daubney, C.G. 1960. A study of grain storage in fossae in Malta. Tropical Science 2 (3):115-129. H48 3

Hyde, M.B.; Baker, A.A.; Ross, A.C.; and Lopez, C.O., 1973. Airtight grain storage (with particular reference to hot climates and developing countries). Agricultural Services Bulletin No. 17. AGS: ASB/17. Rome: Food and Agriculture Organization of the U.N. 3

Chapter 1 deals with the scientific principles of airtight storage, and includes: respiration of grain; respiration and pest control; storage trials with dry grain; airtight storage of high moisture grain; and the creation of oxygen free conditions. The second chapter discusses small scale structures including: traditional methods - e.g. gourds, underground pits; plastic sacks; metal drums and bins; earthern and concrete structures; flexible structures with plastic and butyl liners. Some costings are given. Chapter 3 describes semi-underground bins in Cyprus and Kenya, and gives an account of their design, development, construction and performance, site planning and capital costs. The final chapter is devoted to airtight underground silos in Argentina, starting with the history of their development continuing with notes on design and construction methods, handling equipment, costs and storage procedure, and ending with a review of their limitations. Tropical Storage Abstracts.

The incidence and extent of infestation on food grains stored by cultivators in Gujarat 1966. 1970. Pesticides India 4(12): 55-58. 3

Discusses the findings of a committee appointed to assess losses of food grains during post-harvest handling and storage by farmers. Brief review in Tropical Stored Products Information, 1971 (22) p58.

India: farm storage in the Fourth Five-Year Plan. 1966. Grain Storage Newsletter and Abstracts 8(3):71. I3 3

Indian Agricultural Research Institute. Agricultural Engineering Division 1975. Solar dryer for small farmers. Pesticides, India 9(4):59. 3

Reports on a solar energy collector-cum-dryer for drying crops quickly after harvest, designed and developed by the Division in New Delhi. The main components of the system comprise a metallic roof, air duct, blower and grain bin. The roof is fabricated from corrugated sheets blackened with bituminous paint. The air duct is made from plywood board fitted 6 cm below the roof. One end of the duct is open as air inlet, the other is connected to the blower. Heat absorbed by the roof is transferred to air in the duct, and then forced through the wet grain bed in the bin by means of the blower. Some test results are given. Grain with up to 34.9 percent m.c. could be dried to 15

percent m.c. in adverse humidity and fluctuating sunshine conditions. Some notes are given on roof orientation and elevation, and the use of transparent covers (glass or polythene sheet) to increase air temperature rise. Tropical Storage Abstracts.

Indian Standards Institution. 1956. Indian standard code of practice for handling of food grain in transit. IS:611-1955. Delhi: Indian Standards Institution. 9 p. 3

Others:
For storage of food grain and its protection during storage. IS:610-1955. 15 p.
For improvement of existing structures used or intended to be used for food grain storage. IS:609-1955. 7 p.
For construction of Bukhari type rural food grain storage structure. IS:600-1955. 7 p.
For construction of Kothar type rural food grain storage structure. IS:601-1955. 6 p.
For construction of Morai type rural food grain storage structure. IS:602-1955. 7 p.

Ives, N.C. 1974. Recommendations for drying and storage of grain in Peru. Grain storage, processing and marketing report no. 48. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute. 35 p. I14 3

Jack, D.S. 1975. Evaluation and cost estimates for grain unloading, storage and distribution facilities in Egypt. Grain storage, processing and marketing report no. 50. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute. 37 p. 3

Jamaica. Ministry of Trade and Industry. Storage and Infestation Division and Ministry of Agriculture and Lands. Plant Protection Division. 1961. Prevention and control of infestation of stored grain by insect pests and rodents. Kingston: Govt. Printer, 57, p. 3

Jellema, B.M. 1973. Improvement of cereal production and marketing in the Central African Region. Ibadan, Nigeria: International Institute of Tropical Agriculture. 81p. 3

Jennings, M.W. and Dobrovsky, T.M. 1957. Report to the government of Egypt on the construction of grain storage facilities at Alexandria and Cairo. Project

EGY/AGL-AGP. EPTA report no. 761. Rome: Food and Agriculture Organization of the U.N. 36 p. 3

Temperature and humidity and pest control as means of reducing losses were evaluated with respect to the proposed facilities.

Jervis, B.W.; Hobson, G.S.; and Benson, F.A. 1974. Some microwave measurements upon grain and straw to control grain losses in combine harvesters. Transactions of the ASAE 17(6):1139-1143. 3

Johnson, I.M. 1957. Cut grain losses from your combine this season. East African Farmer and Planter 2(1):25. 3

Kahlon, A.S. 1970. Impact of changing conditions on grain marketing institutions and the structure of grain markets in the erstwhile. Punjab. Ludhiana, Punjab: Punjab Agricultural University. 3

In the appendix he lists extent of losses which have been reported by various workers.

Kamel, A.H. and Zewar, M.M. 1973. Loss in weight in stored corn and millet due to Sitophilus oryzae and Rhyzopertha dominica infestations. Agricultural Research Review (United Arab Republic) 51(1):29-31. 3

Kaminski, T.L. 1968. Need for evaluation of grain damage. Paper presented at the symposium on grain damage, held under the auspices of the ASAE, Iowa State University, Ames, Iowa, 17-18 April, 1968. 3

Khare, G.B.; Sengar, C.S.; Singh, K.N.; Agrawal, R.K.; and Singh, H.N. 1972. Losses in grain due to insect feeding, I: Wheat. Indian Journal of Agricultural Research 6(2):125-133. 3

Khare, B.P. and Mills, R.B. 1968. Development of Angoumois grain moths in kernels of wheat, sorghum and corn as affected by site of feeding. Journal of Economic Entomology 61(2):450-452. 3

Khare, R.N.; Krishnamurthy, K; and Pingale, S.V. 1966. Milling losses of food grains, Part I. Studies on losses of red gram (Cajanus cajan) during milling. Bulletin of Grain Technology 4(3):125-132. 3

King, D.L. and Riddols, A.W. 1962. Damage to wheat and pea seed in threshing at varying moisture content. Journal of Agricultural Engineering Research 7(2):90-93. 3

King, D.L. and Riddolls, A.W. 1960. Damage to Wheat Seed and Pea Seed in Threshing. Journal of Agricultural Engineering Research 5(4):387-398. 3

Kirk, L.E. 1948. Preservation of grains in storage. FAO Agricultural Studies 2:3. 3

Kirkpatrick, R.L. and Wilbur, D.A. 1965. The development and habit of the granary weevil, Sitophilus granarius within the kernel. Journal of Economic Entomology 58(5):979-985. 3

Kosak, V. 1964. Adjustment and control of the threshing mechanism prevents losses. Mechanizace Zemedelspvi (Czechoslovakia) 14(7):41-44. (Supplement). 3

Krantz, G.W. 1961. The biology and ecology of granary mites of the Pacific Northwest, I. Ecological considerations. Annals of the Entomological Society of America 54(2):169-174. 3

Kreyger, J. 1972. Drying and storing grains, seeds and pulses in temperate climates. Wageningen, Holland: Institute for Storage and Processing of Agricultural Product (IBVL). K13a 3

Kreyger, J. 1964. Considerations on possible losses of dry matter during ventilated storage of grain. Wageningen, Netherlands: Instituut voor Bewaring en Verwerking van Landbouwproduktin. 3

Extensive sampling has shown that an almost linear relationship exists between the initial M.C. and dry matter losses when stored grain is cooled but that losses are lower with continuous than with intermittent ventilation.

Krishnamurthy, K. 1975. Post harvest losses in food grains. Bulletin of Grain Technology 13(1):33-49. K15 3

La Hue, D.W. 1975. Pirimiphos methyl as a short term protectant of grain against stored-produce insects. Journal of Economic Entomology 68(2):235-236. 2 tabl, ref. (Author's address: Grain Marketing Research Centre, Agric. Res. Serv., USDA, 1515 College Avenue, Manhattan, KS 66502, USA). 3

Pirimiphos methyl, applied as a water emulsion (5, 10, and 20 ppm) to hard winter wheat and shelled yellow maize killed all exposed adult Sitophilus oryzae, Tribolium castaneum, T. confusum and Rhyzopertha dominica at 24 hours and 1 month after treatment; no F_1 progeny developed. After 3 months, a few T. castaneum and T. confusum survived exposed to grain treated with 5 ppm but no progeny developed. In addition some R. dominica survived and F_1 progeny and damage were recorded in wheat treated with 5 ppm and in maize treated with 5 and 10 ppm. Malathion, applied at a calculated dosage of 10 ppm as the chemical standard, gave complete protection to both grains for 3 months. The residues of pirimiphos methyl degraded gradually as the storage period lengthened except for the 20 ppm applied to the shelled maize. The residues of malathion degraded gradually on both grains. Tropical Storage Abstracts 1975(3):38-39.

La Hue, D.W. 1970. Laboratory evaluation of dichlorvos as a short-term protectant for wheat, shelled corn and grain sorghum against stored-grain insects. ARS 51-37 Washington, D.C.: U.S. Department of Agriculture, Agricultural Research Service. Abstracted in Tropical Stored Products Information. 1970(20):41. 3

Le Cato, G.L. 1975. Species composition influencing insect population growth and weight loss of stored rice, wheat and corn. Journal of the Kansas Entomological Society 48(2):224-231. 3

Lele, Uma J. 1971. Food grain marketing in India: private performance and public policy. Ithaca, New York: Cornell University Press. 3

Le Pelley, R. and Kockum, S. 1964. Experiments in the use of insecticides for the protection of grain in storage. Reprinted from Bulletin of Entomology 16, Part 2, June 1964, London. 3

Le Pelley, R.H. and Kockum, S. 1954. Experiments in the use of insecticides for the protection of grains in storage. Bulletin of Entomological Research 45(2):295-311. 3

Lochner, E.H.W. 1963. Safe storage of food grains in the Republic of South Africa. South African Department of Agriculture, Technical Service, Technical Communication No. 13. Pretoria: Government Printer. 3

Lockwood, L.M. 1975. Solar cabinet dryers for drying grain and other agricultural produce in Bangladesh; Preliminary report. Rep. IVS/CORR Grain Storage Project, Jalchatra, Tangail District, Bangladesh. Duplic, i +8 pp, 2 tabl, 1 fig, refs. (Author's address: Appropriate Technology Cell (Storage and Handling), Bangladesh Agricultural Research

Council, 130-C, Road 1, Dhanmandi, Dacca, Bangladesh). 3

In the introduction, the various theoretical advantages of solar dryers are discussed, and possible arguments against their introduction in Bangladesh are examined. A study was undertaken to construct and test a model solar cabinet dryer, and the report describes the model, gives details of design and cost, and examines various possible applications. It is concluded that the dryer is unlikely to be of much practical use in drying food grain, because of limited capacity and economic factors, but it may be of value in drying seed grain. The possible use of solar dryers for preserving fruit and vegetables is examined in some detail, but their acceptability for general purposes is considered to be still in question. Tropical Storage Abstracts 1975(3):39-40.

Logsdon, G. 1977. Small-scale grain raising. Emmaus, Pennsylvania: Rodale Press. 3 L100

Majumder, S.K.; Krishnamurthy, K.; and Godavari Bai, S. 1961. Pre-harvest prophylaxis for infestation control in stored food grains. Nature (London) 192(4800):375-376. 3

Mayhew, A.W.; Papworth, D.S.; and Rudge, A.J.B. 1971. Protection of grain in commercial silos. Milling 153:16-18. 6 tables. 3

McCoy, J.H. and Tolle, D.S. 1968. Implementation of grain storage operations, marketing services and price stabilization in Honduras. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute. M1 3

McCloy, J. 1955. Artificial drying in remote territories and the fuel problem. World Crops 7(3):109-113. 3

Review of problems associated with the drying of produce for market in developing areas with particular reference to the use of fuels. 69 references.

McKenzie, Bruce A. 1966. Selecting a grain drying method. Lafayette, Indiana: Purdue University, Cooperative Extension Service. M3b 3

McKenzie, B.A.; Foster, G.H.; Noyes, R.T.; and Thompson, R.A. 1967. Dryeration--better corn quality with high speed drying. Lafayette, Indiana:

Purdue University, Cooperative Extension Service. M3c 3

Majumder, S.K. and Parpia, H.A.B. 1966. Possible losses of foodgrains in India. Vijnan Karmee, Journal of the Association of Scientific Workers of India 18(4):5-11. M8 3

Majumder, S.K. and Natarajan, C.P. 1963. Some aspects of the problem of bulk storage of foodgrains in India. World Review of Pest Control 2(2):25-35. M9 3

Malawi: Department of Agriculture. 1959. African agriculture in Nyasaland (Malawi). Zomba, Malawi: Department of Agriculture. p. 75 3

It is estimated that the loss of the order of 20-30 percent occurs annually during storage of grains.

Mitchell, F.S. 1956. Grain damage during combine-harvesting. Journal and Proceedings of the Institution of British Agricultural Engineers 12(2):13-19,28. 3

Mookherjee, P.B.; Bose, B.N.; and Singh, S. 1969. Some observations on the damage potential of the almond moth, Cadra cautella in eight different stored grains. Indian Journal of Entomology (1):1-6. 3

Mookherjee found out that the question of damage as a result of continuous breeding of the pest in various grains was as follows: Rice suffered mostly with 100 percent damage after 4 months. The damage was restricted to nibbling in the germ points and no other portion of the grain were eaten up. Feeding on other seeds was not restricted to the germ but extended to other parts.

Mookherjee, P.B.; Yadav, T.D.; and Sircar, P. 1969. Studies on insect damage and germination of seeds, XIV. Germination of wheat, jowar, maize, paddy and barley seeds damaged by the developing larvae of Sitotroga cerealella Oliv. Indian Journal of Entomology 31(3):279-280. 3

Mookherjee, P.B.; Jotwani, M.G.; Sircar, P.; and Yadav, T.D. 1968. Studies on the incidence and extent of damage to insect pests in stored seeds: I. Cereal seeds. Indian Journal of Entomology 30(1):61-65. 3

Mora, M. 1978. Costa Rica country paper. Paper presented at the Seminar on Postharvest Grain

Losses, 13-17 March, 1978, Tropical Products Institute, London. 3

Morley, G.E. 1973. Grain marketing storage and price stabilization, Informal technical report. Rome: Job No. D8322. 3

Mould, H.A. 1973. Grain storage in Ghana. Tropical Stored Products Information 25:44. 3

Mould, H.A. 1971. Grain storage in the humid tropics. Cocoa Marketing Board Newsletter 48:21-4. 3

In Ghana, various storage methods of maize are currently in practice. The traditional methods are still more widely used by the farmer than the modern conventional and sophisticated methods. Traditionally, maize is stored in barns or cribs. A brief description of these methods is given. Storage of maize in silos of various sizes and constructed from various materials including hessian bags is briefly outlined. The main storage insect pests of maize and their control are given; rodent control is included. Sprouting, heating, bacteria and fungi also cause damage to stored maize. Methods of checking these spoilage factors are briefly outlined. Storage of millet, sorghum and rice, their main insect pests and the control are briefly discussed.

Mphuru, A., and Maro, M.A. 1975. Grain storage and handling in the Morogoro and Iringa regions of Tanzania. Tropical Stored Products Information 30:35-40. 3

Mphuru, A.M.; Moro, M.A.M.; and Odero-Ogmel, L.A. 1974. Traditional storage of food grains in Tanzania with particular reference to the storage of maize in Iringa and Morogoro Regions. Morogoro: University of Dar-es-Salaam, Faculty of Agriculture and Forestry. 3

Mphuru, A.N.; Maro, M.A.M.; and Odero-Ogmel, L.A. 1973. Traditional storage of food grains in Tanzania with particular reference to Iringa and Morogoro Regions. R.E. Occasional Paper 1. Morogoro: University of Dar-es-Salaam. 3

Muckle, T.B. and Stirling, H.G. 1971. Review of the drying of cereals and legumes in the Tropics. Tropical Stored Products Information 22:11-30. 3

Mushi, A.M. 1978. Country paper: Tanzania. Paper presented at the Seminar on Postharvest Grain

Losses, 13-17 March, 1978, Tropical Products Institute, London. 3

Navarro, S. 1974. Aeration of grain as a non-chemical method for the control of insects in the grain bulk. In: Proceedings of the first international working conference on stored-product entomology, Savannah, Georgia, 7-11 October, 1974, pp. 341-353. Savannah, Georgia: Organizing committee of the conference. (Available from Dr. Robert Davis, Stored-product Insects Research and Development Laboratory, U.S. Department of Agriculture-Agricultural Research Service, P.O. Box 22909, Savannah, Georgia. Price: $7.50). 3 N100

Navarro, S.; Donahaye, E.; and Calderon, M. 1969. Observations on prolonged grain storage with forced aeration in Israel. Journal of Stored Products Research 5:73-81. 3 N100

New Crop Drier. 1972. Rhodesia Agricultural Journal 69(2):47. N10 3

New Equipment for crop drying and storage. 1975. World Crops 27(5):204-214. N11 3

Niernberger, F.F. and Pfost, H.B. 1971. Observations and recommendations for improving grain storage and marketing in Bolivia. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute. N12a 3

Nyborg, E.O., McColly, H.F.; and Hinkle, P.T. 1969. Grain combine loss characteristics. Transactions of the ASAE 12(6):727-732. 3

Oosthuizen, M.J. 1962. Grain storage methods employed by certain Bantu tribes in South Africa. Paper presented at the CCTA/FAO symposium on stored food, Freetown, Sierra Leone, 20-24 February, 1962. 3 0100

Owen, E.B. 1956. The storage of seeds for maintenance of viability. Hurley, Berkshire, England: Commonwealth Bureau of Pastures and Field Crops. 3

A well documented bulletin of 10 chapters covering longevity of seed, hygroscopicity, drying, change in composition during storage, dormancy, and treatment in relation to storage.

Oxley, T.A. 1962. Loss in weight on drying. Tropical Stored Products Information 4:129-130. 3

Oxley, T.A. 1955. Grain storage in tropical climates. World Crops 7(12):473-477. 3

Oxley, T.A. 1950. Grain storage in East and Central Africa--Report of a survey October 1948-January 1949. Colonial research publication no. 5. London: Her Majesty's Stationery Office. (for losses in storage see pp. 11-12). 3

Oxley, T.A. and Wickenden, G. 1963. The effect of restricted air supply on some insects which infest grain. Annals of Applied Biology (51):313-324. 3

Parpia, H.A.B. 1969. Foodgrain losses and the nutritional gap in developing countries. FAO/WHO/UNICEF 1969. Paper presented at the sixteenth meeting of the FAO/WHO/UNICEF Protein Advisory Group, Geneva, Switzerland, 8-11 September, 1969. 3

Pedersen, J.R. 1975. Status of grain storage in developing countries. Rev. ed. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute. P20 3

Pedersen, J.R. Report on grain sanitation workshop presented by USAID/India in cooperation with Academy of Pest Control Science and Central Food Technological Research Institute, Mysore, India, 7-12 July, 1969. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute. Report No. 11. P19a 3

Pedersen, J.R. 1968. A proposal to equip metal silos in Jordan with aeration and temperature monitoring equipment. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute. P18 3

Pedersen, J.R. 1968. Report on food grain storage, marketing, handling and transportation in Jordan. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute. P19 3

Petersen, W.H. 1975. New developments--solar heat for crop drying. In: Proceedings of the 11th Grain Conditioning Conference, 15-16 January, 1975, Champaign, Illinois, pp. 47-48. Champaign, Illinois: University of Illinois. (Author's address: William H. Petersen, Extension Agricultural Engineer, South Dakota State University, Brookings, South Dakota, 57006, USA). 3

Refers to successful trials with a solar/electric crop drying installation in South Dakota in recent years. Points out the advantage of solar heating for crop drying. First, a temperature rise rather than a fixed temperature is adequate for crop drying, making it possible to use a simple inexpensive heat collector. Second, no heat storage is needed--shelled maize itself acts as a heat storage, although a secondary heat source such as electricity may increase the drying speed. Third, the probabilities of collecting solar energy, even in cloudy conditions, are excellent. A description is given of a simple installation, consisting of a bin, with a double skin painted black on the outside as heat collector, and with a simple heater, fan and ducting system as supplementary. Tropical Storage Abstracts, 1975(5):67-8.

Pfost, H.B.; Hugo, C.; and Jack, D.S. 1976. Assessment of grain storage and marketing facilities in the Dominican Republic. Grain storage processing and marketing report no. 57. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute. 3 P26

Pfost, H.B. and Niernberger, F.F. 1973. Study of grain storage and marketing in Bolivia. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute. P27 3

Philips, P.R. 1972. Grain losses in combine-harvesters: their measurement and effect on the harvesting system. Ph.D. thesis. University of Newcastle-Upon-Tyne, May, 1972. 3

Phillips, R. and Pfost, H.B. 1970. Observations and recommendations for improving grain storage and marketing in Colombia. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute. P28 3

Pingale, S.V. 1953. Effect of damage by some insects in the viability and weight of stored grain. Bulletin of the Central Food Technological Research Institute (Mysore, India) 2(6):153-154. 3

Pixton, S.W. and Warburton, S. 1971. Moisture content meters investigated: technical digest. Agriculture Merchant 51 (ii):43-48. (PICL reprint - no. 831). 3

Investigations on the use of electrical meters to determine moisture content of unusually damp grain.

Prevett, P.F. 1974. Tecnologia de graos armazenados - alguns melhoramentos recentes. (Grain storage technology - some recent developments). Bol. Inf. Soc. Bras. Cienc. e Tecnol. Alimentos No. 30:1-21 20 ref. (Port.) (Author's address: Tropical Stored Products Centre, London Road, Slough SL3 7H1, England). 3

Discusses the problem of food storage losses in general and gives an estimate for Brazil. Points out the importance of pre-storage factors. Considers the storage of produce in sacks, and building requirments such as insulation, controlled ventilation, provision for in-store fumigation, and describes the use of an impervious warehouse ceiling in East Africa. The use of a time-controlled space sprayer using dichlorvos for control of Ephestia cautella is mentioned. Plastic sheeting as cover over bagged dry produce can act as a barrier against insect attack. Sacks themselves are vulnerable to insects, and by permitting passage of moisture vapor may lead to mould growth, so that alternative sacking materials of film and woven plastics are being considered. Brief notes are given on hermetic storage, and storage of damp grain. Emphasis is placed on the need for adequate training of personnel applying modern storage. Condensed from Tropical Storage Abstracts, 1975 (3) p. 40. 3

Prevett, P.F. 1972. Nigeria - storage of rice and maize. UNDP/SF Project NIR/36, Pilot project for rural employment promotion in the western state - Internal working paper No. 159 Rome: Food and Agriculture Organization of the U.N., 1972. 48 p., 5 tab., 1 drwg, 2 maps, 4 app. with 1 tab., 19 ref. FAO-19119-72-WS Restr. 3

Ramirez, Genel, M. 1974. Almacenamiento y conservacion de granos y semillas. 2a impresion. Mexico City, Mexico: Compania Editorial Continental, S.A. 300 pp. 3

Rao, M.V.K. 1973. Mechanical methods of drying and experience. In: Post harvest technology of cereals and pulses. In: Proceedings of a seminar held in New Delhi, 21-23 December, 1972, ed. by Pingale, S.V. et al., pp. 111-114. New Delhi: Indian National Science Academy. 3

Points out that the field of mechanical drying has become highly specialised, costly and needs trained personnel. However, the problem of high moisture content needs to be tackled at farm or local

storage depot. The Food Corporation of India has introduced a mobile grain drier which uses paddy husk as fuel.

Rengifo, G. and Pfost, H.B. 1976. High temperature and high humidity grain storage. Grain storage, processing and marketing research report no. 10. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute, 46 p. R17 3

Roberts, E.H. 1972. Viability of seeds. London: Chapman and Hall. ix, 448 p. illus. 3

Equilibrium relative humidity and moisture content values for some common seeds, including rice, sorghum and wheat are given in appendices.

Ross, I.J.; Hamilton, H.E.; and White, G.M. 1975. Principles of grain storage. In: Proceedings of the 11th grain conditioning conference, 15-16 January 1975, Champaign, Illinois, pp. 9-23. Champaign, Illinois: University of Illinois. (Author's address: Professor, Agricultural Engineering Department, University of Kentucky, Lexington, Kentucky 40506, USA). 3

Summarises main factors in maintaining condition of grain in store, and selects: the moisture content of the grain; the temperature; the oxygen supply; the pH; the condition or soundness of the grain. Control of insects and rodents is briefly stated to be achieved by lowering the temperature and use of rodent proof bins respectively. Condensed from Tropical Storage Abstracts, 1975 (5) pp.68-9.

Rutherford, I. 1973. Combine harvesting losses. Power Farming 51(1): 83-91. 3

Rutherford, I. 1973. Grain losses in the harvest field...how to reduce them to the minimum. Biatas, The Tillage Farmer 27(8):204-206. 3

Saharan, G.S. 1970. Deterioration of grains by mycotoxins. Bulletin of Grain Technology 8:35-39. 3

Sarid, J.N. and Krishnamurthy, K. 1968. Protection of marketable grain. Bulletin of Grain Technology 6(1):16-20. 3

Schuler, R.T.; Rodakowski, N.N.; and Kucera, H.L. 1975. Grain harvesting losses in North Dakota. Farm Research 32(6):20-21. 3

Schwenk, R.L. 1971. Safe storage of grain in the humid tropics or producing more food grains without planting. A term paper for Professor David Thurston, Plant Pathology 655, Plant Diseases in Tropical Agricultural Development, Spring 1971. Cornell University, Ithaca, New York. 33 p. + Bibliography. S13 3

Sebestyen, E.J. 1970. Grain aeration and drying. Milling 152 (10):24-25,29-30. 3

Discusses the problems of aeration of grain when the ambient air is of high humidity.

Le sechage et la conservation sous climat tropical. 1969. (Drying and preservation in a tropical climate).Cameroon Agricole, Pastoral et Forestier 122:33-7. 3

Various products such as fish, meat, fruits, grains, and others have quite different tendencies towards putrefaction. Apart from that, in general, a higher temperature and (or) a higher moisture content of the product, increases the rate of putrefaction. This article deals mainly with the factors that affect the preservation of grains. It was found that the moisture content of a number of grains at 70 percent relative air humidity at 25°C, varied between 5 and 16 percent. It was further found that to keep grains viable for sowing, the drying temperature should not exceed 40 to 43°C. A grain stored for consumption could be dried between 50 and 55°C. Table. Graphs. Fig. T.A. v1284-1972.

Seminaire Ouest-Africain sur le role des volontaires dans le stockage des grains au niveau de la ferme et du village. Cotonou, Dahomey, 13-21 Decembre, 1974. Eschborn, Federal Republic of Germany: Office Allemand de la Cooperation Technique, 1975. 267 p. S15 3

Senegal. Institute of Food Technology, Dakar. 1970. Lectures on grain conservation, processing and storage. Agricultural Services Division UNDP/SF Project SEN/5, Institute of Food Technology, Dakar - Rapport No. 58 Dakar, Senegal, 1970. 100 p., 14 tab., 4 drwgs. 1 graph, 3 annexes. FAO-12524-70-XB Restr. 3

Shah, I.H. and Ahman, M. 1976. The design and construction of a solar energy grain dryer. In: The development of solar drying systems for cereal grains in Pakistan: relationship between solar energy drying of crops, its effect on quality of grains and associated pests. Unpublished Proposal to Pakistani Program Administrator, national Science Foundation, Washington, D.C., by Dyer, M.I., pp. 4-10. Fort Collins: Colorado State University, Natural Resource Ecology Laboratory, July 6, 1976. 3

Sikorwski, P.P. 1964. Interrelation of fungi and insects to deterioration of stored grain. Technical Bulletin No. 42. Pullman, Washington: Washington State Agricultural Experiment Station. 3

Smith, C.V. 1969. Meteorology and grain storage. Geneva: World Meteorological Organisation, xvi, 47 p. illus. (W.M.O. Technical notes - no. 101; WMO - no. 243, TP 133). 3

In English with French, Russian and Spanish summaries. 150 refs Reviewed in Tropical Stored Products Information. 1971 (21) 32. 3
Will be of value to all those concerned with the technical aspects of storage, in which climate is a significant factor.

Sojak, M. 1973. Reducing grain damage in handling corn and soybeans. Soils Crops Outlook, Soil Crop Improvement Association p. 110-112. 3

Sorenson, L.O. and Chung, D.S. 1976. Bangladesh food grain storage and stock management study. Grain storage, processing and marketing report no. 54. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute. 34 p. S28A 3

Spencer, W.P.; Pfost, D.L.; and Pedersen, J.R. 1975. Recommendations for grain storage and preservation in Senegal. Grain storage, processing and marketing report no. 54. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute. 132 p. S46 3

Sprague, E.; Carter, D.P.; Dagg, M.; Ebong, U.U.; Edache, O.A.; Golden, W.; Moomaw, J.C.; and Winkelmann, D. 1972. National accelerated cereal production survey team report to the Federal Ministry of Agriculture and Natural Resources, Lagos, Nigeria. Typewritten. 56p. 3

Srivastava, P.K.; Tripathi, B.P.; Girish, G.K.; and Krishnamurthy, K. 1973. Studies on the assessment of losses. III. Conventional grain storage practices and losses in rural areas in Western Uttar Pradesh. Bulletin of Grain Technology 11(2):129-139. S50 3

Stanley, R. 1976 Grain preservation: cutting the food losses. IDRC Reports 5 (1):16-17. (Author's address: International Development Research Centre, Box 8500, Ottawa, Canada K1G 3H9).

Describes work being carried out at the National Agronomic Research Centre (CNRA), Bambey, Senegal, with the support of the International Development Research Centre, Canada. Trials are in progress with traditional grain storage bins of different types, representing those commonly used in several West African countries. In addition to improved storage, the trials include drying and threshing, and a brief description of a drying rack is given; a note is made of a survey being undertaken involving 800 families in order to identify post-harvest problems and to determine the direction of future research. Condensed from Tropical Storage Abstracts 1976 (3) p. 41. 3

Stockage et sechage du grain a la ferme. Liaison de l'installation avec le chantiere de recolte. 1972. (Storage and drying of grain on the farm. Coordination of the drying process with the harvesting operation). B.C.M.E.A. Technico-economic studies (F) 1972, 84 p., Nb.sch., ph, et tabl. 3

Storing our grains. 1976. NEDA Development Digest 4: 7-11. (National Economic and Development Authority, Philippines). S60 3

Subrahmanyan, V. 1973. Drying of cereals and pulses - chemical methods and their implications. Post harvest technology of cereals and pulses. In: Proceedings of a Seminar held in New Delhi, 21-23 December, 1972, ed. by Pingale, S.V., p. 64-71 New Delhi: Indian National Science Council. 3

Describes treatment of paddy with dry salt to reduce moisture content and advocates its use at village level to avoid the loss of at least 4-5 percent of the kernel material between harvesting and marketing especially in humid weather.

Swarray, K.A.D. 1973. A case history on problems of grain storage in Sierra Leone. Tropical Stored Products Information 25:42-43. S65 3

Symposium on grain damage held under the auspices of the American Society of Agricultural Engineers by the Agricultural Engineering Department at Iowa State University, 17-18 April, 1968, Ames, Iowa. (Proceedings of the Symposium) Ames, Iowa: Iowa

State University Agricultural Engineering Department. S68 3

Contents include: Economic losses of damaged grain, by Uhrig, J.W.; Problems in marketing damaged grain and corn, by Barley, J.; Problems in marketing damaged grain - soybeans, by Grow, H.; Need for standards for evaluation of grain damage, by Kaminski, T.L.; Prediction of corn kernel threshing damage, by Waelti, H.; Corn damage as influenced by some variations of cylinder equipment, by Cooper, G.F.; Threshing damage to soybeans, by Young, R.E. and Buchele, W.F.; Relation of mechanical damage to drying and storage time - corn, by Saul, R.A. and Steele, J.L.; Mechanical shelling damage, by Hall, G.E.; Mechanical damage to grain during handling in commercial facilities, by Winter, D.W. and Foster, G.H.; Grain damage from high-speed drying, by Foster, G.H.; The challenge of measuring kernel damage, by Forth, M.W.; Panel discussion: How do you measure grain damage? by Hukill, W.F. (Leader).

Taylor, R.W.D. 1975. The storage of seeds. Tropical Stored Products Information 30:23-33. 3

Thomson, A.G 1954. Grain drying in tropical countries. World Crops 6 (4):144-154. 3

Reviews possible advantages to be gained for use of grain driers in humid tropical countries.

Thompson, T.L.; Villa, L.G.; and Cross, O.E. 1971. Simulated and experimental performance of temperature control systems for chilled high moisture grain storage. Transactions of the ASAE 14(3):554-449 3

Thorshaug, H. 1976. Report on work carried out in People's Republic of Benin, W. Africa, April 1974-April 1976. Final Report, FAO/African Rural Storage Centre TF/AFR/45 (DEN). Norway. T5 3

Thorshaug, H. 1975. Installations de sechage et de stockage de cereales au niveau de la ferme et du village utilises au Dahomey. (Installations for drying and storage of cereals at farm and village level in Dahomey). Bloc Notes du Monde Rural FEMEC (5):15-18. (Publ. Development Commission of FEMEC. P O Box 790, Yaounde, Cameroon). 3

Begins by discussing sun-drying. Leaving grain to dry in the field is the simplest method but exposes it to attack by insect pests. It is recommended that grain be sun-dried on a raised platform, to provide through ventilation and avoid contamination. Artifical drying has several advantages, and an account is given of a simple wood fired dryer, the 'Brooks' drier. It is easy to construct, made of readily available materials, and can reduce the moisture content of 800-100 kg. of produce from 25 to 12 percent in two to three days. Specifications for building the dryer, and annotated plans are presented, together with notes on its operation. A list of required materials and an estimate of costs are given. Shelled and unshelled maize can be dried equally quickly but if maize is to be used for seed it is suggested that an alternative method be used. Tropical Storage Abstracts, 1975 (4) p. 56.

Torre, R.G. de la 1970. Conservacion tecnica de granos alimenticios. (Technical conservation of food grains), 1973 Ed. iv + 22 pp, 1 tabl, 16 fig, 10 ph. (Span.) (Publ. Mexico/Buenos Aires, Centro Regional de Ayuda Tecnica, Aagencia para el desarrollo Internacional (AID) (Regional Centre for Technical Aid, Agency for International Development). (Distribution through AID missions in Latin-American countries). 3

Originally prepared by Ministry of Agriculture, Office for the Improvement of Agriculture, Peru, Manual No. 12. Discusses the economic concept of storage, and the factors which determine the deterioration of stored grain. Brief notes are given on the effect of relative humidity, temperature and moisture content. Insect pests are briefly described in three groups: a. insects which attack grain in the field; b. insects which only attack grain in store; c. insects which cause damage in the field and in store. Reference is made to the microorganisms and rodents. Other topics include types of storage, in-store drying, methods of stacking, equipment, procedures for inspecting grain, sources of infestation and the economics of pest control. Condensed from Tropical Storage Abstracts.

Tropical Products Institute. 1978. Report of the Seminar on Postharvest Grain Losses, March 13-17, 1978. London: Tropical Products Institute. (In preparation) 3

Tropical Stored Products Information 25. 1973. Special issue comprised of abstracts of papers presented at a seminar on grain storage in the humid tropics, held in Ibadan, Nigeria, 26-30 July, 1971. 3

Tyler, P. 1969. Survey of native grain stores in Botswana. Tropical Products Institute File 0149. London: Tropical Products Institute. 3

Reports damage losses, weight losses and germination losses of various crops in Botswana. Maximum weight losses encountered were 46 percent for sorghum, 55 percent for maize, 6 percent for millets and 23 percent for beans.

U.S. Department of Agriculture. 1966. Losses in transporting and handling grain by selected grain marketing cooperatives. U.S. Department of Agriculture Farmer Coop. Service, Marketing Research Report 775. Washington, D.C.: U.S. Department of Agriculture. 3

U.S. Department of Agriculture. Agricultural Research Service. Market Quality Research Division. 1969. Controlling insects in farm-stored grain. Leaflet no. 563. Washington, D.C.: U.S. Department of Agriculture. 3

Vandevenne, R. 1978. Note on crop loss after harvesting in the Ivory Coast. Paper presented at the Seminar on Postharvest Grain Losses, 13-17 March, 1978, Tropical Products Institute, London. 3

Van Teeling, C.G. 1975. Marketing and storage development project, Uganda. Quality control programme. AG:DP/UGA/71/513. Technical Report 1. Rome: Food and Agriculture Organization of the U.N. 50 p. F17 3

Walker, D.J. 1975. Report of the Swaziland rural grain storage project, Sept. 1972 - April 1975. Malkerns, Swaziland: Ministry of Agriculture, Malkerns Research Station. 79 p. W1 3

Watt, M.J. 1971. Grain marketing, storage and price stabilisation, Somalia. Grain storage and crop protection. Technical report 1. (ESR/SF/SOM 7). Rome: Food and Agriculture Organization of the U.N. viii, 47 p. illus. 3

Watt, M.J. 1969. Grain storage and marketing in the Somali republic. Tropical Stored Products Information 18:5-32. 3

Webb, E.R. 1969. A crop dryer and grain storage silo for the small farm. Ibadan, Nigeria: Ministry of Agriculture & Natural Resources. 3

Wendling, L.T. 1968. Assessment of food-grain storage facilities, West Pakistan 1968. Food grain drying, storage, handling and transportation report no. 7. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute. 26 p. W9 3

Whellan, J.A. 1958. Current problems in grain storage in Southern Rhodesia. In: Scientific Council for Africa South of the Sahara. Meeting of specialists on stored food products, Salisbury, Rhodesia, 1957, pp. 77-82. London: Scientific Council for Africa South of the Sahara, W1 3

Williams, S.K.T. 1973. Grain storage in the western state of Nigeria (case histories) success or failure. Tropical Stored Products Information 25:42. W17 3

Wilson, T.L. 1974. Reducing Nepal's grain losses. War on Hunger 8(3):4-5. W20 3

Winter, J.W. and Foster, G.H. 1969. Mechanical damage to grain during handling in commercial facilities. Paper presented at the symposium on grain damage held under the auspices of the American Society of Agricultural Engineers, Iowa State University, 17-18 April, 1968, Ames, Iowa. 3

The project was intended to find the levels of damage during: (a) elevating and discharging, (b) filling bins, (c) sprouting in a rail car or ship, and (d) trimming a car or ship. Free drop was the most severe treatment tested and caused the worst breakage.

4
Maize

a. Insects

Ashman, F. 1966. An assessment of the value of dilute dust insecticides for the protection of stored maize in Kenya. Journal of Applied Ecology 3(1):169-179. 4a

Bindra, O.S. and Sidhu, T.S. 1975. Effectiveness of malathion as a protectant for stored maize grain. Pesticides, India 9(9): 23-26. 3 tabl, refs. (Author's address: Punjab Agricultural University, Ludhiana, Punjab, India). 4a

Reports on tests using malathion at 20, 30 and 40 ppm on maize artificially infested with newly emerged adults of Sitophilus oryzae and Rhizopertha dominica. Four kinds of storage comprised metal bins, mud bins, Hapur "Chekkas" and gunny bags. Samples were drawn at monthly intervals. It was concluded that a dosage of 20 ppm and 40 ppm would give complete protection for 6 and 10 months respectively. Storage in metal bins gave protection over a longer period, but storage in mud bins gave better retention of seed viability. Tropical Storage Abstracts.

Coyne, F.P. 1971. Improving the protection of stored maize from insect attack on small farms in Kenya. International Pest Control 13(3):8-13. 4a

Croal, K. & Rai, B.K. 1970. Preliminary report on chemical control of paddy moth, Sitotroga cerealella (Olive.), a serious pest of paddy in storage. Thirteenth session of the IRC working party on rice production and protection - Teheran, Iran, 9-14 December 1970. FAO, 1970, 5 p., 1 tab., 5 ref. FAO-14827-70-WM. 4a

Crops Research Institute. 1967. Protecting shelled corn against pests. Kumasi, Ghana: Crops Research Institute. (Farming Guide - CC1/1) Complete ed. 8p; leaflet ed. 3p. 4a

Darling, H. S. 1947. Report of the entomologist. Annual Report, Department of Agriculture, Tanganyika 1945-1946. 4a

Darling observed that the percent damage after a 9 months of storage was 84 percent and the loss of weight was 14 percent for maize. The extent of damage rose to 98.4 percent and loss of weight to 27 percent after 15 months storage.

Davey, P.M. 1961. The acceptability and fitness of maize meal for human consumption. Tropical Science 3(4):163-173. 4a

Davies, J.C. 1960. Experiments on the crib storage of maize in Uganda. East African Agricultural and Forestry Journal 26(1):71-75.

De Lima, C.P.F. 1973. A technical report on twenty-two grain storage projects at the subsistence farmer level in Kenya. PROJ/RES/AG21. Nairobi: National Agriculture Laboratory. 182. p. (mimeo). 4a

De Lima, C.P.F. 1972. Lindane resistance in field strains of Sitophilus zeamais (Motsch.) in Kenya. Journal of Stored Products Research 8 (3):167-175. 4a

Tests showed that in general strains with high resistance factors came from localities where lindane had been in regular use in stored maize.

Dobson, R.M. 1969. A new species of Carpophilus Stephens (Col., Nitidulidae) from East Africa. Entomologists' Monthly Magazine 105 (1259-1261):99-100. 4a

Describes Carpophilus zeaphilus found on maize residues and maize cobs in Kenya and in a wheat store previously used for maize grains.

Eden, W.G. 1953. Control of rice weevil in corn with protectant dusts and sprays. Journal of Economic Entomology 46:1105-1107. 4a

In Alabama corn stored in shuck after a period of storage of 9 months showed a mean value of damaged kernels of 37.7 percent while the shelled corn showed a mean damage of 86 percent.

Eden, W.G. 1967. Insect damage to corn in three southeastern states at time of harvest and in farm storage. U.S. Department of Agriculture Marketing Research Report 792. Washington, D.C.: U.S. Department of Agriculture. 4a

During the year 1962 loss from insect damage to farm stored crop in Alabama, Georgia and Mississippi was about $10 million. After one year storage at harvest the loss was already $4 million.

Eden, W.G. 1974. A study of insect damage to corn in the southern states at time of harvest and storage. USDA-AMS-MQRD Final Rep. 4a

A summary of the research conducted in Georgia, Alabama and Mississippi is given. Using X-ray detection technique he noted that damage to ear corn increased from initial of 11.6 percent to 37.5 percent after a year of storage. He estimates a total loss of about $9,875,332 for the year 1964 in the three states.

FAO/DANIDA African Rural Storage Centre. Insect control in maize cribs. Rome: Food and Agriculture Organization of the U.N., Field Document No. 4. F29 4a

FAO/DANIDA African Rural Storage Centre. Insect control in stored maize 1975/76 season. Rome: Food and Agriculture Organization of the U.N., 7 p. F30 4a

Floyd, E.H. 1961. Effectiveness of malathion dust as protectant for farm-stored corn in Louisiana. Journal of Economic Entomology 54(5):900-904. 4a

In the control treatment it was noted that the percentage ears infested increased to 100 percent in 10 months storage while the percentage kernel damage increased to 72 percent.

Floyd, E.H.,; Oliver, A.D.; and Powell, J.D. 1959. Damage to corn in Louisiana caused by stored-grain insects. Journal of Economic Entomology 52(4):612-615. 4a

The average damage was approximately 10 percent at harvest time. This gradually increased to 17 percent in May. Attempts to separate damage

according to the pest involved showed that Sitophilus was the most destructive.

Food and Agriculture Organization of the U.N., Plant Production and Protection Division, 1969. Storage pests of corn and their control. Plant protection committee for the South East Asia and Pacific regions, Seventh session, Noumea, New Caledonia, 15-23 July, 1969. Rome: Food and Agriculture Organization of the U.N., 1969, 7 p. FAO-09900-69-WM. 4a

Giles, P.H. and Leon, O.V. 1975. Infestation problems in farm-stored maize in Nicaragua. In: Proceedings of the 1st international conference on stored product entomology 7-11 October, 1974, Savannah, Georgia, pp. 68-76. Savannah, Georgia: Organizing committee of the conference. (Authors' address: Seccion de Productos Almacenados (SEPRAL), Ministry Agric. and Livestock, Apartado 592, Managua, Nicaragua). 4a

Maize, a most important staple crop in Nicaragua, is largely produced on small farms and stored unhusked. Stored-product insects are listed according to distribution and relative occurrence. Results of trials are presented on methods of reducing these losses by early harvesting, selection of less susceptible varieties, storing ears without the husk and treating with insecticide dusts (lindane, malathion, pirimiphos-methyl, and tetrachlorvinphos) and the storage of shelled grain in plastic film bags and metal drums with or without fumigants (aluminum phosphide, carbon tetrachloride/ethylene dichloride). Tropical Storage Abstracts, 1975 (3) p37-8.

Graham, W.M. 1970. Warehouse ecology studies of bagged maize in Kenya. I. The distribution of adult Ephestia (Cadra) cautella (Walker) (Lepidoptera, Phycitidae). II. Ecological observations of an infestation by E. cautella. III. Distribution of the immature stages of E. cautella. IV. Reinfestation following fumigation with methyl bromide gas. Journal of Stored Products Research 6(2):I, 147-155; II, 157-167; III, 169-175; IV, 177-180. 4a

Graham, W.M. and Kockum, S. 1958b. Protection of bagged maize with lindane and D.D.T. Tropical Agriculture (Trinidad) 35(4):293-298. 4a

Graham, W.M. and Kockum, S. 1961. Admixture of malathion and lindane with bagged maize. _Bulletin of Entomological Research_ 52(4):727-739. 4a

Henderson, C.A.; Davis, F.M.; and Oswalt, T.G. 1972. Corn losses from insects. _Mississippi Farm Research_ 35(3):7-8. 4a

Irabagon, T.A. 1959. Rice weevil damage to stored corn. _Journal of Economic Entomology_ 52(6):1130-1136. 4a

Joffe, A. 1963. The effect of physical disturbance or "turning" of stored maize on the development of insect infestations. I. Grain elevator studies. _South African Journal of Agricultural Science_ 6(1):55-64. J14 4a

Joffe, A. 1958. Moisture migration in horizontally-stored bulk maize: the influence of grain-infesting insects under South African conditions. _South African Journal of Agricultural Science_ 1(2):175-193. J13 4a

Joffe, A. and Clarke, B. 1963. The effect of physical disturbance or "turning" of stored maize on the development of insect infestations. II. Laboratory studies with _Sitophilus oryzae_(L.) _South African Journal of Agricultural Science_ 6:65-84. J15 4a

Kockum, S. 1965. Crib storage of maize: a trial with pyrethrin and lindane formulations. _East African Agricultural and Forestry Journal_ 31(1):8-10. 4a

Kockum, S. & Graham, W.M. 1962. Prevention of insect re-infestation of bagged maize. _Tropical Agriculture_ 39(3). 4a

Kockum, S. 1958. Control of insects attacking maize on the cob in crib stores. _The East African Agricultural Journal_ 23(4):275-79. K10 4a

Koura, A.; El-Halfawy, M.; and Essa, N.H. 1969. Evaluation of certain maize varieties for infestation with _Sitophilus oryzae_ (L.), _Sitophilus granarius_ (L). and _Rhyzopertha dominica_ (F). _Agricultural Research Review_ (Cairo) 47(3):50-54. 4a

LeConte, J. 1965. The progress of infestation by _Sitophilus oryzae_ in maize silos in South Dahomey. In: _Congres de la protection des cultures tropicales: Compte rendu des travaux, 23-27 mars 1965_, pp. 69-75. Marseilles: Chambre de Commerce et d'Industrie. 4a

Le Pelley, R. and Kockum, S. 1958. The control of stored products insects in Kenya. In: Scientific council for Africa south of the Sahara. Meeting of specialists on stored food products, Salisbury, Rhodesia, 1957. pp. 107-115. London: Scientific Council for Africa South of the Sahara. L7 4a

Malawi. Ministry of Agriculture and Natural Resources. 1971. Grain storage project. Protection of maize cobs in storage. Protection of maize cobs from insect damage by the use of "Red Triangle" insecticide. (Circular no. 6/71) Limbe: Ministry of Agriculture and Natural Resources, 1971. 4 p. (Circular no. 6/71) 4a

Simple notes for farmers on insect attack on red maize cob and the use of lindane dusts to control infestation. Bilingual English/vernacular.

Moore, S.; Petty, M.B.; Luckmann, W.H.; and Byers, J.H. 1966. Losses caused by the Angoumois grain moth in dent corn. Journal of Economic Entomology 59(4):880-882. 4a

Mora, M.A. and Pedersen, J.R. 1976. Damage to stored maize infested with *Sitophilus zeamais* Motsch. Grain storage, processing and marketing research report no. 9. Manhattan, Kansas, Kansas State University, Food and Feed Grain Institute. 51 p.

Oyeniran, J.O. 1971. Microbiological examination of maize from various sources soon after harvest. Rep. Fed. Minist. Trade, Nig. stored Prod. Res. Inst. No. 9 Jan-Dec, 1971, 1973. Tech. Rep. No. 3, 27-29. (Author's address: Nigerian Stored Products Research Institute, PMB 5044, Ibadan, Nigeria). 4a

An account of studies of moisture, mold and aflatoxin contents of maize samples obtained from various sources soon after harvest is given. Discolored factors concerned with microbiological deterioration is discussed. Samples of maize on the cob had mainly field fungi. Typical storage molds occurred on all shelled maize: *Absidia corymbifera*, *Mucor pusillus*, *Rhizopus arrhizus*, *Syncephalastrum racemosum* and *Aspergillus* sp. It is recommended that maize be left on the cob until it is needed for use or is sufficiently dry to prevent mold development, unless facilities exist for immediate artificial drying. Tropical Storage Abstracts.

Quintana, R.R.; Wilbur, D.A.; and Young, W.R. 1960. Insectos del grano almacenado que infestan al maiz en el campo. Agricultura Tecnica en Mexico 10:40-43. 4a

Rossetto, C.J. 1972. Resistencia de milho a pragas da espiga, Helicoverpa zea (Boddie), Sitophilus zeamais Motschulsky and Sitotroga cerealella (Olivier). Doctorate thesis presented to the Escola Superior de Agricultura "Luiz de Queiroz" da Universidade de Sao Paulo, Brasil. ix + 111 pp, 21 tabl., 19 fig, refs. (Port., Engl. summ). (Author's address: Secao de Entomologia Fitotechica, Instituto Agronomica, Campinas, Sao Paolo, Brasil). 4a

Describes studies on the development of varieties of hybrid maize, and their resistance against field pests, and against pests which infest maize both in the field and in storage, especially Sitophilus zeamais and Sitotroga cerealella. Natural infestations were irregular in development and sorghum was found to be more suitable for rearing cultures of S. zeamais than maize. When tested as shuck corn, a flint variety was found to be more resistant to S. zeamais, but when tested as kernels, dent varieties were less damaged. Hardness of the kernel is thought to be a factor in resistance of corn in the shuck. Other factors which were found to be of importance were size of ear, shuck length, and degree of tightness beyond the tip of the ear. Some results are given of studies on the biology of S. zeamais on maize. Tropical Storage Abstracts.

Salmond, K.F. 1958. Studies on Trogoderma granarium Everts (Dermestidae-coleoptera). I. Its importance as a pest of stored maize in the Federation of Rhodesia and Nyasaland. In: Scientific Council for Africa south of the Sahara, Meeting of specialists on stored food products, Salisbury, Rhodesia. pp. 37-49. London: Scientific Council for Africa South of the Sahara. 4a

Schulten, G.G.M. 1976. Insects in stored maize ears. Abstracts on Tropical Agriculture 2(6):9-17. 73 ref. (Author's address: Department of Agricultural Research, Royal Tropical Institute, 63 Mauritskade, Amsterdam-5, The Netherlands). 4a

Review article. Points out that much of the research into storage of maize has been directed towards more sophisticated methods such as bulk and bag storage, but during recent years storage on the

small scale farm level has become more prevalent, with an associated increase in losses. The use of various insecticides is discussed. An account of the main insect pests and the sources of infestation is given. Points out that much of the infestation begins in the field and examines the factors affecting the progress of infestation -- particularly the grain and husk characteristics. Tropical Storage Abstracts.

Schulten, G.G.M. 1975. Further insecticide trials on the control of *Ephestia cautella* on stacks of bagged maize in Malawi. *International Pest Control* 15(2):18-21. (Author's address: Royal Tropical Institute, Amsterdam, The Netherlands). 4a

Field trials were conducted in Malawi to test the effectiveness of bromophos, Dowco 214, Dursban, iodofenphos and pirimiphos-methyl against *Ephestia cautella* as a pest of bagged maize. The most effective proved to be Dursban sprayed at 4 week intervals at a rate of 500 mg ai/m^2 on hessian sheets which covered the stacks followed by pirimiphos methyl and Dowco 214 at the same rate. The latter two also gave a good protection when sprayed directly on the bags. Bromophos sprayed on bags or on hessian sheets gave variable results which were in general not better than those obtained with the routine lindane, malathion sprayings. Iodofenphos does not seem to be very effective against *E. cautella*. Tropical Storage Abstracts.

Schulten, G.G.M. 1975. Losses in stored maize in Malawi (C. Africa) and work undertaken to prevent them. *EPPO Bulletin* 5(2):113-120. S11 4a

Schulten, G.G.M. The 1971-1972 survey on losses, caused by insects of maize stored in local cribs. From: Reports, Grain Storage Project Malawi, December 1969-June 1972. Limbe, Malawi: Ministry of Agriculture. 6 p. S12 4a

Singh, K.; Agrawal, N.S.; and Girish, G.K. 1974. Studies on the quantitative loss in various high yielding varieties of maize, due to *Sitophilus oryzae* (L.) (Col., curculionidae). *Labdev Journal of Science and Technology* 12-B(1):3-4. S20 4a

b. Birds

De Grazio, J.W. and Besser, J. 1974. Los pajaros silvestres se comen millones de dolares. Agricultura de las Americas 23(6):10+. D14 4b

Stone, C.P. 1972. Blackbirds vs. corn: a definition of nationwide losses. The Farm Quarterly, Fall 61:S57 4b

Stone, C.P. and Mott, D.F. 1973. Bird damage to ripening field corn in the United States, 1971. Wildlife Leaflet 505. Washington, D.C.: U.S. Dept. of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheris and Wildlife. 8 p. S58 4b

Stone, C.P.; Mott, D.F.; Besser, J.F.; and De Grazio, J.W. 1970. Bird damage to corn in the United States in 1970. The Wilson Bulletin 84(1):101-105. March 1972. S59 4b

c. Microorganisms

Aerating corn for short-term storage. 1973. Agricultural Research 22(1):3-5. A10 4c

Lopez, L.C. and Christensen, C.M. 1967. Effect of moisture content and temperature on invasion of stored corn by Aspergillus flavus. Phytopathology 57 (6):588-590. 7 refs. 1958-65. 4c

A. flavus did not invade any samples of corn stored with moisture contents below 17.5 percent, wet weight basis, but did invade those stored with moisture contents of 18.5 percent and above. A storage temperature of 35°C did not reduce, detectably, the moisture content limit for invasion by this fungus. 4c

Martinez Herrera, M.L. 1969. Efecto de algunos hongos sobre el valor nutritivo, calidad y conservacion del maiz en Guatemala. (Effect of some fungi on the nutritive value, quality and conservation of maize in Guatemala). Agronomia (Guatemala) 4(10):5-32. 4c

Moreno, M.E. and Christensen, C.M. 1971. Difference among lines and varieties of maize in susceptibility to damage by storage fungi. Phytopathology 61(12):1498-1500. 4c

Moreno, M.E. and Christensen, C.M. 1970. Efecto de la humedad y longos sobre la viabilidad de maiz almacenado. (Effect of moisture and fungi on the viability of stored maize). Revista Latino americana de Microbiologia 12:115-121. 4c

Nagel, C.M. and Semeniuk, G. 1947. Some mould-induced changes in shelled corn. Plant Physiology 22(1):20-33. 4c

Qasem, S.A. and Christensen, C.M. 1960. Influence of various factors on the deterioration of stored corn by fungi. Phytopathology 50:703-709. 4c

U.S. Department of Agriculture. Agricultural Research Service 1969. Guide lines for mold control in high-moisture corn. Farmers Bulletin No. 2238, Washington, D.C.: U.S. Department of Agriculture. 4c

d. Other Causes

Adams, J.M. and Harman, G.W. 1977. The evaluation of losses in maize stored on a selection of small farms in Zambia with particular reference to the development of methodology. London: Tropical Products Institute. 4e A8

Adesuyi, S.A. 1968. A survey of the moisture content of early maize during harvest in the Western State. In: Nigerian Stored Products Research Institute Annual Report, 1968, technical report No. 7, p. 59-61. Lagos: Nigeria: Nigerian Stored Products Research Institute.

Boshoff, W.H. 1976. FAO/African rural storage centre. In International Institute of Tropical Agriculture. Annual report, 1975, pp. 69-70. Ibadan, Nigeria: International Institute of Tropical Agriculture. 4e

Reports that considerable amounts of data have been collected on the evaluation of existing and improved methods of drying and storing maize in the humid tropics. Other data include farm storage losses, structures and methods in Africa South of the Sahara.

Brass, R.W. and Morley, S.J. 1973. Roller sheller: low damage corn shelling cylinder. Transactions of the ASAE 16(1):64-66. 4e

Byg, D.M. 1970. A guide for measuring corn harvest losses. Columbus, Ohio: Ohio State University, Agricultural Engineering Department. 4e

Byg, D.M. 1968. How to measure corn harvesting losses. Farm Machinery No. 6. Agric. Engineering Extension Services, Ohio. 4e

Byg, D.M. 1968. Machine losses in harvesting ear and shelled corn. Agricultural Engineering 49(10):607. 4e

Byg, D.M. and Hall, G.E. 1968. Corn losses and kernel damage in field shelling corn. Transactions of the ASAE 11(2):164-166. 4e

Byg, D.M. and Hall, G.E. 1967. Corn losses and kernel damage when field shelling corn. Paper presented at American Society of Agricultural Engineers Tri-state Regional Meeting, 21-22 April, 1967, Toledo, Ohio. 4e

Byg, D.M.; Gill, W.E.; and Johnson, W.H. 1964. Machine losses in harvesting ear and shelled corn. Agricultural Extension Service Bulletin MM-247. Columbus, Ohio: Ohio State University. 4e

Byg, D.M.; Gill, W.E.; Henry, J.E.; and Johnson, W.H. 1966. Machines losses in harvesting ear and shelled maize. Paper No. 66-611 presented at American Society of Agricultural Engineers annual meeting, December, 1966, Chicago, Illinois. 4e

Caswell, G.H. 1957. Grain storage problems in Southern Nigeria. In: Scientific Council for Africa South of the Sahara. Meeting of specialists on stored food products, Salisbury, Rhodesia, 1957. pp. 97-101. London: Scientific Council for Africa South of the Sahara. 4e C7

Chung, D.S. 1973. Survey of the quality of imported corn stored in East Java, Indonesia. Food grain drying, storage, handling and transportation report No. 41. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute. 32 p. 4e C24e

Chung, D.S. and Phillips, R. 1973. Report on storage of imported corn in Indonesia. Food grain drying, storage, handling and transportation report no. 40. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute. 28 p. 4e C24g

Chung, D.S.; Chung, C.J.; and Converse, H.H. 1973. Damage to corn from pneumatic conveying. ARS-NC-5. Washington, D.C.: U.S. Department of Agriculture. 4e

Church, C. 1970. Pests: good results from year-old campaign in West Province. Tropical Stored Products Information 20:21-25. 4e C26

Dahniya M.T. and Funnah, S.M. 1973. Increasing maize production in Sierra Leone. Sierra Leone Agricultural Journal 2(1):45-53. (Authors' address: Department of Agronomy, Njala University College, Private Mail Bag, Freetown, Sierra Leone). 4e

The demand for maize in Sierra Leone has been increasing steadily with the rapid development of the livestock industry. Various aspects of maize production are discussed and practical difficulties likely to be encountered by the maize farmer are outlined. In the section on harvesting and storage, it is pointed out that since harvesting takes place during a wet season, artificial drying is necessary, and the Samaru dryer is recommended. For the same reason, storage in bags is not advised, and metal silos, or old oil drums are preferred. Tropical Storage Abstracts, 1973 (5) p. 69.

Davies, W.L. 1928. The cause of deterioration of maize and maize meal. Fertilizer Feeding Stuffs and Farm Supplies Journal (London) 13:784-785. 4e

Dios, C.A. de. 1973. Kernel damage in mechanical maize harvesting (Spa). Annales de Technologie Agricole 22(3):211-216. (English Summary). 4e

Du Toit, F.P. 1973. Bulk handling and storage: commercial maize. Rhodesia Agricultural Journal 70(2):23-40 (Author's address: Senior Architect, Department of Conservation and Extension, Salisbury, Rhodesia). 4e

Discusses in detail the processes involved from harvesting to delivery at commercial storage. For mechanical harvesting, grain is normally at less than 20 percent moisture content. Differences in mechanical and manual harvesting are considered. The relationships between manual and mechanical shelling, transportation, and farm storage are discussed, and the advantages of central shelling and dispatch from the farm are suggested. Various drying techniques are examined, together with the managements of movement from farm to market. Illustrated descriptions are given of a number of farm layouts, and the merits of various types of handling equipment, e.g. augers, bucket elevators, horizontal conveyors and vibrating conveyors are compared. Some data are given relating to maize density, angle of repose, and stresses exerted in bulk stores of loose grain. No information is given regarding environmental and pest control. Tropical Storage Abstracts

Duval da Silva, P. 1971. Aspects of production storing and processing of rice in Brazil FAO 1971 - Second session of the IRC rice committee for the Americas - Pelotas, Rio Grande do Sul, Brazil, 6-11 December 1971, 18 p., 3 tab., 25 ref. FAO 19740-71-WM. 4e

FAO/DANIDA African Rural Storage Centre. Maize shelling. Field Document No. 1, 12/76/1. 7 p. 4e F26

Foster, G.H. 1975. Causes and cures of physical damage to corn. In: Corn Quality in World Markets, ed. by Hill, L.D. p. 221-229. Danville, Illinois: Interstate. 4e

Gill, N.S. 1969. Deterioration of corn (Zea mays) seed during storage. Mississippi State University. Ph.D. Dissertation. 4e

Glanze, P. 1973. Mechanized production of grain: maize in tropical and subtropical regions. Translated from the German by Liebocher, H. Edn. Leipzig, 1973. (Technical Fundamentals Series). Leipzig: Edition Leipzig, Verlag fur Kunst und Wissenschaft.

Grow, H.E. 1968. Problems in marketing damaged corn. Paper presented at the symposium on grain damage held under the auspices of the American Society of Agricultural Engineers, 17-18 April, 1968, Iowa State University, Ames, Iowa. 4e

Discusses types of damage to soybeans. Noted that insect damage is not serious but kernel damage is serious as it affects the oil content of the soya. Most of the loss in soya is mainly during combine harvesting.

Gurnah, A.M. 1973. Large scale maize production in Ghana. World Crops 25(6):308-311. (Author's address: Lecturer, Crop Production, University of Nairobi, Kenya). 4e

Notes that Ghana in the past has been a net importer of maize. Early attempts to establish large scale mechanized farms have failed. Some of the difficulties encountered are discussed, including the need for varieties suitable for two-season-cropping (major and minor crop), costs of land clearing in the forested areas, soil conservation and land preparation. Recommendations are made regarding seed selection, dressing and storage. Post harvest operations noted include the need for artificial drying and storage of the crop until a suitable selling price can be obtained. Storage is in bags and metal or butyl silos. Measures recommended to control the main storage pests, Calandra (Sitophilus) oryzae, Mussidia nigrivenella, and Tribolium castaneum, include spraying with 0.6 percent Sevin, and in-bag fumigation using one 5 ml. capsule of ethylene dibromide per bag. Fumigation of bulk grain in silos is by ethylene dibromide at 50 ml/ton. Some notes on the economics of the crop are given. Tropical Storage Abstracts, 1974 (2) p. 21.

Hall, G.E. and Johnson, W.H. 1970. Corn kernel crackage induced by mechanical shelling. Transactions of the ASAE13(1):51-55. 4e

Harris, D.G. 1973. Harvesting a record corn crop. Federal Reserve Bank of Philadelphia Business Review, October: p. 9-14. 4e

Discusses considerations involved in selecting alternative corn harvesting strategies. As harvesting is delayed field losses increase but moisture content drops.

Hesselmark, O. 1975. The relation between rainfall and maize marketing in Kenya. Nairobi: Maize and Produce Board. May 7, 1975. Mimeo. 4e H27

Johnson, W.H.; Lamp, B.J.; and Hill, G.E. 1963. Corn harvesting performance at various dates. Transactions of the ASAE 6(3):268-272. 4e

Kline, G.L. 1973. Physical damage to corn during combine harvesting and heated air drying. Ann. Tech. Agric. 22(3):217-221. 4e

Lepigre, A.L. and Pointel, J.-G. 1971. Protection of maize stored in traditional Togolese granaries. Tropical Stored Products Information 21:7-12. 4e

Miracle, M.P. 1958. Maize in tropical African agriculture. Tropical Agriculture (Trinidad) 35:1-15. Contains 53 references from 1876-1956. 4e

Mora, M.A. and Pedersen, J.R. 1975. Measurement of maize weevil and fungi damage to stored corn. Grain storage, processing and marketing research report no. 8. Manhattan, Kansas: Kansas State University. Food and Feed Grain Institute. 51 p. 4e M29

Reader, R.A. 1971. Survey of damage to maize stored under village conditions. Report no. 6. Lilongwe, Malawi: Lilongwe Land Development Project, Evaluation Section. 17 pp. 4e

The purpose of the survey was to investigate the damage to maize stored under village conditions, from insect, rodent and fungal attacks. In Malawi maize is traditionally stored in large cylindrical cribs "Nkhokwe", made from interwoven twigs, bamboo or reeds which are raised on stilts to approximately 18 inches from the ground and covered with a thatched roof. Previous data on the quantification of storage losses are extremely limited, but local opinion has suggested that damage is particularly high with actual loss estimated between 10 and 20 percent of annual production. It has also been recognized that improved varieties of maize are invariably more susceptible than 'local' varieties to damage in store. With the large scale introduction of hybrids into the Land Development Project, reaching an estimated future coverage of 85 percent of the maize acreage, the implications of storage losses are extremely serious for two diametrically opposed reasons; namely the possible reduction of existing high levels of storage losses through the introduction of insecticides and improved stores, but counterbalanced by a possible increase in the levels of storage loss through the introduction of the more susceptible hybrid and synthetic varieties. The survey was designed to allow quantification of storage losses through a complete storage cycle and to relate these losses to a number of variables, including variety and insecticide application.

Salmond, K.F. 1975. A report on investigations into grain storage problems in Nyasaland Protectorate, with special reference to maize (Zea Mays L.). Colonial Research Publications No. 21. London: Her Majesty's Stationery Office. 49 p. 4e S2

Sands, L.D. and Hall, G.E. 1971. Damage to shelled corn during transport in a screw conveyor. Transactions of the ASAE 14(3):584-585, 589. 4e

Tollier, M.T. and Guilbot, A. (1973) Changes in maize grain components under different storage conditions (German). Getreide Mehl und Brot 27(7):234-237. 4e

Waelti, H.; Buchele, W.F.; and Farrell, M. 1969. Progress report on losses associated with corn harvesting in Iowa. Journal of Agricultural Engineering Research 14(2):134-138. 4e

Warren, F.S. 1971. Harvest losses in grain corn. Forage Notes (Ottawa) 17(1):24-25. 4e

Wheatley, P.E. 1973. The maize storage problem in the less developed countries of Africa. Chemistry and Industry 22:1049-1052. 4e W12

e. Storage Structures

Chin, H.F. and Standifer, L.C. 1970. Practical method of maize storage on farms. In: Crop diversification in Malaysia. The proceedings of the conference held in Kuala Lumpur, 10-12 November, 1969, pp. 260-266. Kuala Lumpur, Malaysia: Incorporated Society of Planters. 4f

Collings, H. 1960. Hermetic sealing of a stack of maize with bituminous roofing felt. Tropical Agriculture 37 (1): 53-60. 4f

Cornes, M.A. 1963. Further investigations into the small scale storage of maize in cribs. A comparison of the rates of drying maize in three different types of cribs at Ilora in Western Nigeria. Nigerian Stored Products Research Institute Annual Report, 1963, tech. rep. No. 12, p. 101-105. Lagos, Nigeria: Nigerian Stored Products Reserach Institute. 4f

Cornes, M.A. and Riley, J. 1962. An investigation of drying rates and insect control in a maize crib with improved ventilation. West African Stored Products Research Unit, Annual report, 1962, tech. rep. No. 12, p. 72-78. Lagos, Nigeria: West African Stored Products Research Unit. 4f

Coyne, F.P. 1970. Improving farm storage of maize: general principles and their application to small farms. Nairobi: Ministry of Agriculture, Agricultural Information Centre. Reviewed in Tropical Stored Products Information, 1971 (21)p34. 4f

Cutler, J.R. et al. 1958. Maize storage in 44-gallon oil drums. In: Annual Report West African Stored Products Research Unit 1957, pp. 42-43. Lagos, Nigeria: West Africa Stored Products Research Unit. 4f

Davies, J.C. 1960. Storage of maize in a prefabricated aluminum silo in tropical conditions. The East African Agricultural Journal 25(4): 225-228. 4f

Forsyth, J. 1957. Maize storage in Ashanti. In: Scientific Council for Africa south of the Sahara. Meeting of specialists on stored food products, Salisbury, Rhodesia, 1957, pp. 71-76. London: Scientific Council for Africa South of the Sahara. F36 4f

Giles, P.H. 1967. Maize storage: the problem of today. Tropical Stored Products Information 14: 9-19. 4f

Deals with maize storage on large-scale farms; reasons for downgrading during farmer-storage, measures for avoiding downgrading or rejection by maize depots, bag storage, bulk storage, grain drying and insect control.

Kockum, S. 1953. Protection of cob maize stored in cribs. East African Agricultural Journal 19(2): 69-73. 4f

Patel, A.U. and Adesuyi, S.A. 1975. Crib storage of maize under tropical village conditions, in the Ibadan area of Nigeria. Tropical Stored Products Information 29: 33-40. illus. 8 refs, 1959-73. 4f

Shows the financial benefit to the farmer from storing grain instead of selling it at the time of harvest. Tables compare the rate of return on investments in two types of storage, crib and silo.

Pattinson, I. 1968. Report to the Government of Tanzania on crop storage problems. Rome: Food and Agriculture Organization of the U.N. 68 p. No. TA 2454 PL:TA/69. F22 4f

Riley, J.; Matheson, K.C.; Ndukwe, K.U.; Effiong, E.A.; Oho, J.B.; and Aderibigbe, O. 1959. Cribs storage of maize at Ilora. West African Stored Product Research Unit Annual Report, pp. 45-48. Lagos, Nigeria: West African Stored Products Research Unit. 4f

Sartori, M.R. and Costa, S.I. da. 1975. Armazenamento de milho em silo subterraneo revestido com polietileno. (Storage of maize in an underground pit lined with polyethylene). Boletin do Instituto de Tecnologia de Alimentos 42: 55-69. 2 tabl, 5 fig, 7 refs. (Port.). (Author's address: Instituto de Tecnologia de Alimentos, Caixa Postal 139-13100, Campinas, Sao Paolo, Brazil). 4f

Newly harvested maize with 12 percent moisture was stored in an underground pit lined with polyethylene. It was fumigated with phosphine and tightly closed. The grain remained in excellent condition during a storage period of 8 months, retaining its natural colour, brightness and odour. There were no changes in the moisture content or in the results of the standard germination tests. A small increase in free fatty acids was observed in the extracted oil. Tropical Storage Abstracts.

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Swaine, G. 1954. Undergound storage of maize in Tanganyika. East African Agricultural Journal 20 (2):122-128. 4f

Triplehorn, G.A. et al. 1966. Wire-netting cribs for the storage of maize. Biologico 32 (12): 257-266. Reviewed in Tropical Stored Products Information, 1968 (16) p26; abstracted in Rev. appl. Ent., A, 1968 56 (4) p828. 4f

Report on a campaign in Brazil to encourage small producers to erect cribs for the storage of maize.

Zambia. Food Conservation and Storage Unit, Mount Makulu Research station. A brick storage bin for the safe storage of maize. 13 p. Typewritten. 4f

f. Other Control Measures

Adesuyi, S.A. and Adeyemi, S.A.O. 1973. A comparison of malathion, iodofenphos and bromophos for the control of insect infestation on maize in cribs. In: Annual Report Nigerian Stored Products Research Institute 1970, pp. 39-46. Lagos: Nigerian Stored Products Research Institute. 4g

Three insecticides dusts of low mammalian toxicities were tried for the control of insect infestation on maize stored in cribs with a view to finding a substitute for BHC dust which is currently used.
One percent malathion at 30 ppm, 5 percent iodofenphos at 20 ppm and one percent bromophos at 20 ppm were used. Monthly samples from each treatment were analysed for moisture contents and percentage insect damage. Malathion and iodofenphos were effective for nine months and

bromophos for seven months. None of the insecticides gave complete control but each was more effective than BHC at 10 ppm when compared with the results of past trials. It is necessary to carry out a further assessment of contamination and taint in food prepared from maize treated with these insecticides, and the economy of their application before a recommendation can be made. Tropical Storage Abstracts.

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Includes chapters on harvesting, storage and marketing of maize.

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De Lima, C.P.F. 1977. An ecological study of traditional on-farm maize storage in Kenya and the effects of a control action. In: Proceedings XV International Congress of Entomology, 19-27 August, 1976, Washington, D.C., pp. 699-704. College Park, Maryland: Entomological Society of America. 4g D100

Doering, O.C., III. 1977. An energy based analysis of alternative production methods and cropping systems in the corn belt. West Lafayette, Indiana: Purdue University, Agricultural Experiment Station. 44 p. D319 4g

FAO/DANIDA African Rural Storage Centre. Crib and sun drying of maize in humid zones. Field Document No. 2. 4 p. F27. 4g

FAO/DANIDA African Rural Storage Centre. Drying/storage of maize in the husk. Field Document No. 3. 5 p. F28 4g

Griffith, D.R.; Mannering, J.V.; and Richey, C.B. 1977. Energy requirements and areas of adaptation for eight tillage-planting systems for corn. West Lafayette, Indiana: Purdue University, Agricultural Experiment Station, 1977. 8 p. G28b 4g

Hodges, T.O. and Pfost, H.B. 1968. Brief description for corn handling facility in tropical areas. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute. H28c 4g

Horsfield, B., Doster, D.H.; and Peart, R.M. 1977. Drying energy from corn cobs: a total system--1976. West Lafayette, Indiana: Purdue University, Agricultural Experiment Station. 10 p. H32a 4g

Jones, C.R. 1974. Better maize handling in Southern Nigeria. Appropriate Technology 1(2):14-15. J16 4g

Kamel, A.H. 1961. Protection of rice in storage. Cairo: General Organisation for Government Printing Offices. 4g

Lawand, T.A. 1966. A solar agricultural maize drying system. St. James, Barbados W.I.: Brace Experiment Station. Brace Research Institute, McGill University, Quebec, Canada. 4g

Low, A.R.C. 1976. Small farm improvement strategies--the implications of a computer simulation study of indigenous farming in South-east Ghana. Journal of Development Studies 12(4):334-350. L13 4g

Muller, R.E. Jr., et al. 1977. Developing an energy input-output simulator (AGNRG) for analysis of alternative cropping systems in the corn belt. West Lafayette, Indiana: Purdue University, Agricultural Experiment Station. 44 p. M33a 4g

Pinson, G.S. 1977. A wooden hand-held maize sheller. Rural Technology Guide No. 1. London: Tropical Products Institute. 8 pp. 4g

Pointel, J.G. 1969. Essai et enquete sur greniers a mais togolais. L'Agronomie Tropicale 24(8): 709-718. P39 4g

Proctor, D. et al. 1961. The safe storage of maize. Tropical Stored Products Information 3:54-63. illus. 15 refs, 1953-60. 4g

Refers especially to warehouse hygiene and insect pests. Author mentioned in editorial.

Rausher, M. 1958. Agricultural mechanization. Harvesting and storage of grain maize. Geneva: U.N. Económic Commission for Europe. 63p (AGRI/MECH/10). 4g

Sorenson, O. 1969. Observations on the corn marketing system in Guatemala. Food grain drying, storage, handling and transportation report no. 13. Manhattan, Kansas: Kansas State University. 11 p. S29 4g

Zambia. Department of Agriculture. 1971. Maize storage survey (NRDC). Ann. Rept. Res. Branch. Dept Agric. - Zambia, 1970-1971. 4g

5
Rice

a. Insects

Breese, M.H. 1964. The infestibility of paddy and rice. Tropical Stored Products Information 8: 289-99. B28 5a

The moth Sitotroga cerealella (OL.) and the beetles Rhyzopertha dominica (F.) and Sitophilus oryzae (L.) are described as the primary pests that cause most damage in the major rice producing areas. Husk defects, green and immature grains, moisture content, and availability of food for the adults are described as the factors affecting the infestibility of padddy. The infestibility of milled rice is also described. 10 references.

Breese, M.H. 1963. Studies on oviposition of Rhyzopertha dominica (F.) in rice and paddy. Bulletin of Entomological Research 53 (4): 621-637. 5a

Breese, M.H. 1960. The infestibility of stored paddy by Sitophilus sasakii (Tak.) and Rhyzopertha dominica (F.). Bulletin of Entomological Research 51 (3): 599-530. 5a

Cleare, L.D. 1962. Damage and loss caused by insects to stored rice and paddy in British Guiana. Rice Storage Investigations. Publication No. 4. Georgetown: British Guiana, Department of Agriculture. 18 p. C29 5a

Cleare has published some interesting data concerning the weight losses caused by pests to stored rice and has attempted to translate these losses into monetary losses.

Feakin, S.D. (Editor) 1976. Pest control in rice. 2nd ed. London: Centre for Overseas Pest Research. iv, 295p. 5a

Deals mainly with growing crops in the field but has a 19p section on storage pests.

Fernando, H.E. 1959. Storage loss of paddy due to Sitotroga cerealella and its control. International Rice Commission News Let. 8(1): 20-25. 5a

Seed treatment with malathion dust, and spraying storage bags with malathion.

Food and Agriculture Organization of the U.N. 1977. Strengthening of the Rice Processing Centre, Tambun (BULOG), Indonesia: Project findings and recommendations. AG:DP/INS/74/025 Termination report. Rome: FAO. 13 p. 5a

Relationships of climate on mould and insect attack are discussed. Fumigant and other insecticide usage and possible residues are also discussed. Bulk and bag storage of paddy and milled rice are considered.

Food and Agriculture Organization of the U.N. Plant Production and Protection Division. 1971. Insects infesting stored rice and corn in the Philippines and their control. Eighth session of the plant protection committee for the South East Asia and Pacific region - Djakarta, Indonesia, 4-11 October, 1971, 6 p. FAO 18101-71-WS. 5a

Food and Agriculture Organization of the U.N. Plant Production and Protection Division. 1969. Insects infesting stored rice and corn in the Philippines. Plant protection committee for the South East Asia and Pacific region/Seventh session/ - Noumea, New Caledonia, 15-23 July, 1969, 2 p. FAO 09902-69-WM. 5a

Food and Agriculture Organization of the U.N. Plant Production and Protection Division. 1969. Storage insect pests of rice and their control. Plant protection committee for the South East Asia and Pacific region/Seventh session/ - Noumea, New Caledonia, 15-23 Jul 1969, 9 p. FAO 09901-69-WM. 5a

Goarin, P. 1953. Insectes du paddy et du riz en magasin et essai de traitement des stocks a l'H.C.H. Recherche Agronomique Madagascar 2: 130-131, illus. 1953. 5a

Insects of the rice field and of rice in storage and an attempt to treat the stocks with H.C.H. Tests with storage pests.

Interafrican Phytosanitary Council. 1972. Control of insect pests of stored rice. Interafrican Phystosanitary Bulletin (Lagos) (3): 49-50. 5a

The principal pests are listed as Rhyzopertha dominica, Sitophilus oryzae, Tribolium casteneum and Carpophilus dimidiatus. Control measures begin with sanitation, followed by residual sprays on all facilities and machinery. The insecticides recommended are premium grade malathion or pyrethrin plus piperonyl butoxide at 2 gal/1000 ft^2. On concrete surfaces methoxychlor at the same rate should be used, but not inside machinery.

As a protective treatment premium grade malathion or pyrethin plus piperonyl butoxide at the rate of 5 gal water solution per 1000 bushels should be applied as the rough rice is moved into long-term storage. For control of surface infestations of moths, spraying with the above named insecticides should be carried out at regular intervals. (N.B. No note is made of the fact that malathion is ineffective against Ephestia cautella. Ed.) For established infestation the preferred treatment is fumigation. Tropical Storage Abstracts.

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Labadan, R.M. and G.B. Viado. 1959. A survey of NARIC warehouses in Luzon with reference to the control of stored grain insects. Philippine Agriculturist 42: 423-430. 5a

Manser, P.D. 1971. Report to the government of Laos on the establishment of a plant protection service. Project UNDP/FAO LAOS/68/6. AGP:TA/201. FAC No. TA3018. Rome: Food and Agriculture Organization of the U.N. 36 p. 5a

Includes a report on insect damages to rice in store and fumigation for insect control.

Mitsui, E. 1970. Infestation control of stored rice - effect of DDVP smoke generator as a grain protectant in warehouse. Thirteenth session of the IRC working party on rice production and protection - Teheran, Iran, 9-14 December, 1970. FAO 1970. 3 p. FAO-14771-70-WM. 5a

Pingale, S.V.; Kadkol, S.B.; Rao, M. N.; Swaminathan, M.; and Subrahmanyan, V. 1957. Effect of insect infestation on stored grain. II. Studies on husked, hand-pounded and milled raw rice, and parboiled milled rice. Journal of the Science of Food and Agriculture 8: 512-516. P36 5a

Husked rice is more susceptible to infestation than parboiled and raw, milled samples of rice. Appreciable increase in fat acidity and decrease in the vitamin content due to insect damage were observed. No significant differences were noted in total nitrogen and soluble nitrogen between infested and noninfested grain. 8 references.

Prevett, P.F. 1971. Storage of paddy and rice (with particular reference to pest infestation). Tropical Stored Products Information 22: 35-49. 5a

In this paper molds and insects which cause damage to stored rice and paddy are described. The storage methods of rice are discussed. Control methods are given concerning the treatment of buildings and bags containing rice and paddy. Treatment and dosages of recommended fumigants are included. 16 references.

Prevett, P.F. et al. 1960. Protection of paddy against insect pests during storage. Tropical Stored Products Information 2: 23-26. 5a

Prevett, P.F. et al. 1960. Treatment of rice stored in jute bags against insect pests. Tropical Stored Products Information 1: 4-9. 5a

Prevett, P.F. 1957. Rice infestation control research scheme, Sierra Leone. Some notes on work carried out by the scientific officer, January 1955 to July 1956. In: Scientific Council for Africa south of the Sahara. Meeting of specialists on stored food products, Salisbury, Rhodesia, 1957. pp. 67-69. London: Scientific Council for Africa south of the Sahara. P43 5a

Salmond, K.F. 1956. Insect infestation in stored rice in Nyasaland. Tropical Agriculture (Trinidad) 33(2): 34-135. 5a

Rhyzopertha dominica, Sitophilus oryzae and Sitotroga cerealella.

Shahjahan, M. 1974. Extent of damage of unhusked stored rice by Sitotroga cerealella in Bangladesh. Journal of Stored Products Research 10(1): 23-26. 5a

Singh, K.I. 1972. Insect pests of stored paddy and rice in West Malaysia. Tropical Stored Products Information 23: 29-34. 5a

Steele, B. (Ed.) 1970. Pest control in rice. London: Tropical Pesticides Research Headquarters and Information Unit. Section on storage pp. 219-236. Free to agricultural and educational establishments in countries eligible for British aid. Reviewed in Tropical Stored Products Information (20) p36. 5a

U.S. Department of Agriculture. 1971. Controlling insect pests of stored rice. Agricultural Research Service, Agriculture Handbook No 129. Washington, D.C.: U.S. Government Printing Office. 5a

Van, T.K. 1970. Infestation control of stored rice. FAO 1970. Thirteenth session of the IRC working party on rice production and protection - Teheran, Iran, 9-14 December, 1970, Rome: Food and Agriculture Organization of the U.N., 8 p. FAO 14790-70-WM. 5a

b. Microorganisms

Calderwood, D.L. and Schroeder, H.W. 1968. Aflatoxin development and grade of undried rough rice following prolonged storage in aerated bins. ARS 52-56. Washington, D.C.: U.S. Department of Agriculture, Agricultural Research Service. 5c

Christensen, C.M. 1969. Influence of moisture content, temperature and time of storage upon invasion of rough rice by storage fungi. Phytopathology 59 (2):145-148. 5c

Devi, L.R. and Menon, M.R. 1970. Effect of fungicidal pre-storage treatments on viability of paddy seeds. Agricultural Research Journal of Kerala 8(1):54-55. 3 refs. Agricultural College and Research Institute, Vellayani, Kerala, India. 5c

Padmanabham, S.Y. 1975. The relation between loss in viability and seed borne microflora in rice. Proceedings of the Indian Academy of Science 46 (3):155-169. 5c

Teunisson, D.J. 1954. Yeasts from freshly combined rough rice stored in a sealed bin. Applied Microbiology 2 (4):215-220. 5c

c. Rodents

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Israel, P. and Kalode, M.B. 1968. Rodents and damage to rice both in the field and storage. FAO 1968 - IRC Working Party on Rice Production and Protection/Twelfth session/ - Kandy, Ceylon, 9-14 September 1968, 6 p., 4 refs. FAO 05095-68-WM. 5d

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Agrawal, P.K. 1972. Loss of germination in Padma rough rice during storage. Riso 21(2):173-177. Uttar Pradesh University, Pantnagar, Nainital, India. 5e

Autrey, H.S. et al. 1955. Effect of milling conditions on breakage of rice grains. Journal of Agricultural and Food Chemistry 3(7):593-599. 5e

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Commonwealth Agricultural Bureaux. 1953-70. Effect of seed moisture content and storage conditions on viability of stored rice seeds. C.A.B. Bibl. No. 1259. Slough, England: Commonwealth Agricultural Bureaux. 5e

Craufurd, R.Q. 1961. Breakage of rice during milling. Tropical Stored Products Information 3:64-67. 5e

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Cristal, A.N. Jr. 1967. Handling losses of palay grains of IR-8-288-3 at different stages of maturity. Central Luzon State University Experiment Station Contribution No. 394. Munoz, Nueva Ecija, Philippines: Central Luzon State University. 5e

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This paper draws heavily on insights and materials derived from a study survey Post-harvest rice technology in Indonesia, Malaysia, the Philippines, Thailand: a state of the art survey. Commissioned by the IDRC. Manila: University of the Philippines at Los Banos, Department of Agricultural Engineering. 5e

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Details the result of a field survey of 591 farmers located in Camarines Sur, southern Luzon, and central Luzon during 1973-74. Post-production methods described with associated grain losses, quality effects and income effects.

Food and Agricultural Organization of the U.N. 1972. Report of the meeting of experts on the mechanization of rice production and processing. Paramaribo (Surinam), 27 September--2 October 1971.

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Contents include: Huysmans, A.A.C., Post-harvest problems; Wimberley, J.E., Storage Practices; Gariboldi, F.M., Milling problems; Temminck, W.A., The processing of extra long grain.

Food and Agriculture Organization of the U.N. 1970. Reports presented: agricultural engineering aspects of rice production, storage and processing. Engineering Division, Rice Department, Ministry of Agriculture, Thailand. FAO 1970: Sixth Session of the IRC Working Party on Agricultural Engineering Aspects of Rice Production, Storage and Processing, Teheran, Iran, 5-9 December, 1970. FAO 13187-70-WM. 5e

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Gariboldi, F. 1955. Report to the government of Ceylon on the rice processing industry. Project CEY/AGW. EPTA. FAO report no. 429. Rome: Food and Agriculture Organization of the U.N. 26 p. 5e

Includes a general survey of sources of losses in the production of rice from farming practices, including those regarding seed, through the entire postharvest system, excepting harvest itself.

Gariboldi, F. Rice milling equipment - operation and maintenance FAO Agricultural Services Bulletin No. 22. Rome: Food and Agricultural Organization of the U.N. 5e

Govindaswami, S. and Ghosh, A.K. 1968. Assessment of losses of paddy and rice during harvesting, drying, threshing, cleaning, storage and processing. IRC/AE/WP13. 5e

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Horiuchi, T.; Samy, S.S.; and Phang, C.C. 1971. Grain loss during hand harvesting in the rice cultivation in Kedah, West Malaysia. Tonan Ajia Kenkya (The South East Asian Studies) 9(2):220-226. 5e

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Langfield, E.C.B. 1957. Time of harvest in relation to grain breakage on milling in rice. Journal of the Australian Institute of Agricultural Science 23(4):340-341. 5e

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Malabuyoc, J.A.; Mamicpic, M.G.; Castillo, P.S.; Miranda, R.M.; and Callao, M.P. 1966. Grain characters: yield and milling quality of rice in relation to dates from heading. Philippine Agriculturist 49(8):696-710. 5e

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Mignard, C. 1955. Reception et usinage du riz. (The Receipt and Milling of Rice) Bulletin d'Information des Riziculteurs de France 39:15-23. July/August 1955. 5e

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Molla, M.R.I. 1972. Rice drying problem during rainy season in Bangladesh. Indian Journal of Agricultural Economics 27(2):69-71. 5e

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Nangju, D. 1969. Time of harvest for maximum grain yield and high milling and seed qualities of rice. Los Banos: University of the Philippines: College of Agriculture, Central Experiment Station. 5e

Paul, A.K. 1970. Metabolic changes in rice seeds during storage. Indian Journal of Agricultural Science 40(12):1031-1036. 5e

Pelayo, R.G. 1966. Handling losses of palay grains of peta lowland rice variety. Central Luzon State University Experiment Station Contr. No. 254. Munoz, Nueva Ecija, Philippines: Central Luzon State University. 5e

Pillai, S.M.S. 1955. Effect of lodging on yield in rice. International Rice Commission Newsletter 14:5-7. 5e

Pingale, S.V. 1970. A note on procurement, drying and storage of paddy of high yielding varieties. Sixth Session of the IRC Working Party on Agricultural Engineering Aspects of Rice Production, Storage and Processing, Teheran, Iran, 5-9 December 1970. Rome: Food and Agriculture Organization of the U.N., 1970. FAO-13198-70-WM. 5e

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Pixton, S.W. and Warburton, S. 1975. The moisture content-equilibrium relative humidity relationship of rice bran at different temperatures. Journal of Stored Products Research 11(1)1-8. (Address: Ministry of Agriculture, Fisheries and Food, Pest Infestation Control Laboratory, London Road, Slough SL3 7HL, England.) 5e

The moisture content/equilibrium relative humidity relationships at 15, 25 and 35°C, for unextracted rice brans from Burma and Tanzania, unextracted bran from a South African parboiled rice, and a pelleted extracted rice bran from India, are presented and discussed. The relationships differed in shape and position of the curves, and in the magnitude of hysteresis between adsorption and desorption. The equilibrium moisture contents at 65 percent R.H. and below, of Burmese, Tanzanian and Indian brans were in reverse order of their fibre and ash contents. These moisture contents did not decrease consistently with oil content as they did for those cereal grains and oilseeds previously investigated. The hysteresis for the parboiled bran was less, and the equilibrium moisture content was generally lower than for the other brans. For all brans tested the equilibrium moisture content at c. 70 percent R.H. fell within a range of 9-13 percent--Tropical Storage Abstracts, 1975(2)26-7.

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Rhind, D. 1962. The breakage of rice in milling: A review. Tropical Agriculture (Trinidad) 39:19-28. 5e

Roseman, A.S. and Deobald, H.J. 1958. The effect of freezing on the hydration characteristics of rice. Food Technology 12(9):464-468. 5e

Ruiz, E.L. and Castro, M.P. 1965. Harvesting losses of palay grains of macapagal (BPI-121) lowland rice variety at different levels of moisture content. Central Luzon State University Science Journal 1(2). 5e

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Two rice varieties, one short grain (Nahda) and one long grain (Arabi) were parboiled with either a soaking or a boiling treatment prior to steaming; the effect of these treatments on the rate of lipid hydrolysis during long-term storage was then investigated. Parboiling of rice reduced the development of free fatty acids (ffa) in the bran oil. Although the bran of parboiled rice can be stored as long as 10 months with only slight deterioration, the bran of untreated rice cannot be stored for more than 1 month without serious deterioration of oil and bran quality. Unparboiled bran exhibited two distinct stages of hydrolysis, an initial rapid rate for the first 7 weeks of storage and a subsequent slower rate throughout the remainder of the storage period. This latter stage was independent of variety. The long grain variety showed a lower rate of lipid hydrolysis for both parboiled and untreated samples than a short-grain one, although preboiled, or parboiled samples showed greater lipolysis of bran oil than presoaked parboiled ones. The value of the parboiling process in reducing the rate of ffa increase is partially offset by loss in resistance to oxidation, as was evident from an increase in the peroxide value for the parboiled samples. Tropical Storage Abstracts.

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Reports progress in two programmes of post harvest development, one in India and the other in Sri Lanka. In India, a one-year study of post production practices had indicated that methods and equipment used in paddy cleaning, drying, storage and processing were obsolete, and resulted in substantial losses of food grains. It was suggested that with modern technology these systems could be improved, and a pilot programme was recommended. This was to include as far as possible locally produced handling machinery, etc. and in particular reinforced concrete silos manufactured by Indian firms. With completion of the construction phase, training of personnel to operate the equipment was organized, and this included training in management. Other features included the introduction of improved milling and parboiling techniques. Bulk storage had been less readily adopted, mainly because of capital cost, and possibilities of improving existing bag storage. Generally it is concluded that India has proved the value of modern technology in post-production handling of paddy. As regards Sri Lanka, the Paddy Marketing Board/International Rice Research Institute conducted a survey, and identified eight major post production areas in which problems occurred. These were: harvesting threshing, drying, storage, parboiling, milling, procurement and marketing; systems coordination. It was estimated that losses of paddy due to these factors totalled 25-30 percent of total paddy production. The lack of trained personnel was emphasized, and recommendations were made to reduce losses, to improve rice quality and reduce costs of the P.M.B. operations. Implementation has involved training, improvement of existing storage, provision of additional storage and processing facilities. This has required collaboration by manufacturers, contractors, government units and private millers in order to establish an integrated post-production system, and some details are given. The question of communications and exchange of technical expertise between Asian nations is discussed, and suggestions for future overall systems development are made. Tropical Storage Abstracts, 1975(5)73.

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Notes that most new improved rice varieties have relatively short growing periods, and can be harvested all year round. Harvesting may therefore occur in a rainy season, and some kind of mechanical drying is essential. The basic principles of rice drying are discussed. Two kinds of artificial drying systems, one fast and one slow, are analysed. Topics include economic returns, and the drying systems. Methods include drying floors, fire heated drying platforms, convection dryers and continuous flow dryers. The small batch-type dryer is considered to have the greatest potential at farm and village level in less developed countries. An example is described that uses waste heat from the fan engine to heat the drying air. No additional heat source is required. Specifications are listed, and instructions are given for the drying unit construction, fan selection, fan assembly, power unit. Other topics include air-duct design factors, air heating tests and functional dryer design. It is pointed out that the design, though simple, must be carefully followed, and proper construction is essential if calculated air flow rates and temperature rises throughout the unit are to be attained. Tropical Storage Abstracts. 5g

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Describes a small batch-type grain dryer suitable for use by the small-scale farmer. It is inexpensive and simple enough to be locally manufactured in small machine shops in most developing countries. It consists of a rectangular bin with a perforated floor beneath which is a plenum chamber, connected by a canvas duct to an axial flow fan in a cylindrical housing, powered by an i.c. or electric motor. Two kinds of burners are available to heat the drying air, one for oil and the other for rice hulls. The bin has a capacity of 1 metric ton. Some details are given of drying air temperatures, air flow rates, fuel consumption. Engineering drawings are available on request. Tropical Storage Abstracts, 1976, (1), p. 9. 5g

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Cell (Storage and Handling), Bangladesh Agricultural Research council, 130-C, Road 1, Dhanmandi, Dacca, Bangladesh). 5g

The Government of Bangladesh has given high priority to the programme to increase food production within the country. An important feature is prevention of post harvest losses, and advance planning for storage and handling of increased yields. A brief review is given of available literature on losses in Bangladesh. There are notes on current storage practices, storage problems, and some suggestions are made for possible improvements in storage practices. The principles of grain drying are examined, and current practices in Bangladesh, their problems, and possible improvements. Mention is made of difficulties in introducing methods of small scale drying. There are notes on grain treatment for small scale storage, including phosphine fumigation, fumigant mixtures, admixture of inert and insecticidal dusts, spraying and hermetic storage. Some economic aspects of proposed changes in drying and storage are examined, and the need for more detailed and reliable field data on current practices and losses is emphasized. Tropical Storage Abstracts, 1975. (3), p. 39.

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Stout, B.A. 1966. Equipment for rice production. FAO Agric. Development Paper No. 84. Rome: Food and Agriculture Organization of the U.N. 5g

Subrahmanyan, V. 1977. Causes and prevention of post-harvest rice losses. Paper presented at the action oriented field workshop for prevention of post-harvest rice losses, FAO in cooperation with the Government of Malaysia and Food for the Hungry, Inc., 12-30 March 1977. FAO Doc. # WPPL/3. Rome: Food and Agriculture Organization of the U.N., 22 p. (Xerox copy). 5g S62

Document contains: A. Effects of high moisture, soaking and drying. B. Stabilisation of bran, production of protein and vitamin-rich rice flour. C. Planned approach for better utilisation of paddy husk. D. Spoilage of rice straw in wet season.

Toquero, Z. and Duff, B. 1976. A profile of the rice post-production industry in Camarines Sur. IRRI, Paper No. 76-02AE. Manila: International Rice Research Institute. 5g

Provides a background concerning rice post-production activities and farmer attitudes in the Bicol region.

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6
Wheat

a. Insects

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Loss of weight of wheat grains goes in accordance with the population density of the infesting insects, the highest loss occurred in the top layer of grain sacks followed by the middle and bottom layers in a small model of storage. Under the storage conditions, the fluctuation in the microhabitat temperature is very limited, while the change in the grain water content is more obvious. In *Rhizopertha dominica* (F.), *Laemophloeus testacus* (F.) and *Tribolium confusum* (Duv.) the highest insect population always occured in the top layer which has a low moisture content. These insects seem to prefer a dry atmosphere. In *Sitophilus oryzae* (L.) and *Oryzaephilus surimamensis* (L.) the

bottom layer always harboured the highest insect population. Such distribution may be related to the fact that the bottom layer is warmer with a high moisture content. Tropical Storage Abstracts.

Campbell, A. and Sinha, R.N. 1976. Damage of wheat by feeding of some stored product beetles. Journal of Economic Entomology 69(1):11-13. 6a

Daniels, N.E. 1956. Damage and reproduction by the flour beetles Tribolium confusum and T. castaneum in wheat and three moisture contents. Journal of Economic Entomology 49(2):244-247. 6a

El-Dessouki, S.A. and El-Kifl, A.H. 1976. Sitotroga cerealella infestation and its influence on certain chemical and physical properties of stored wheat in Egypt. Zeitschrift fuer angewandte Entomolgie 80(1):83-88. tabl, graph, 15 ref. (Engl. Ger. Summ.) (Authors' address: Plant Protection Department, Faculty of Agriculture, Al-Azhar University, Nasser City, Cairo, Egypt). 6a

The damage caused by Sitotroga cerealella (Oliv.) infestation in stored wheat was much greater if the wheat was stored as ears than if it were threshed and stored as grains. Throughout a storage period of 10 months from harvest time, the average level of infestation was found to be 61 percent and 23 percent in stored ears and grain respectively. S. cerealella also caused a considerable change in some important chemical and physical properties of the stored wheat. The reducing sugars and the non-reducing sugars increased by about 140 percent and 113 percent respectively compared to the undamaged wheat; starch, total protein, wet and dry gluten and ash contents, on the other hand decreased by about 13, 48, 45 and 23 percent respectively. The fermentation time in the dough from the damaged wheat was 20 minutes less than in that from undamaged grain. The moisture content was increased by about 14 percent in infested grain. Tropical Storage Abstracts, 1976(4) p. 48.

Esin, T. 1973. An experiment on the damage caused by Sitophilus granarius (L) on barley and wheat under laboratory conditions and the possibilities of protecting wheat against this pest in underground storage. Biodeterioration Research Titles 9(2):30. 6a

Golebiowska, Z. 1969. The feeding and fecundity of Sitophilus granarius (L), S. oryzae (L) and

Rhyzopertha dominica (F) in wheat grain. Journal of Stored Products Research 5(2):143-155. 6a

La Hue, D.W. 1970. Evaluation of malathion, diazinon, a silica aerogel, and a diatomaceous earth as protectants on wheat against lesser grain borer attack...in small bins. U.S. Dept of Agriculture, Marketing Research Reports, No. 860. (Abstracted in Tropical Stored Products Information 1970 (20) p41.) Washington, D.C.: U.S. Department of Agriculture. iv, 12p. 6a

Mookherjee, P.B. and Khanna, S.C. 1971. Estimate of damage to wheat by germ feeders. Entomologists' Newsletter 1(4):31. 6a E43

Navarro, S. 1977. Distribution and abundance of insects in butyl-rubber/EPDM silos containing wheat. In: Proceedings XV International Congress of Entomology, 19-27 August, 1976, Washington, D.C., pp. 680-687. College Park, Maryland: Entomological Society of America. 6a N100

Pingale, S.V.; Narayana, R.M.; and Swaminathan, M. 1954. Effect of insect infestation on stored grain. I. Studies on soft wheat. Journal of the Science of Food and Agriculture 5:51-54. 6a E56

Rao, H.A.G. and Wilbur, D.A. 1972. Loss of wheat weight from feeding of lesser grain borer. Journal of the Kansas Entomological Society 45(2):238-241. (Authors' address: Department of Entomology, Kansas State University, Manhattan, Kansas, 66502, USA).

Feeding on wheat kernels by Rhizopertha dominica larvae and adults resulted in grain shrinking during storage. Weight loss of wheat germs from 20 days of larval feeding averaged 9.5 percent. Weight losses from adult feeding were 19.4, 12.0, 9.5 and 6.5 percent per kernel during the 1st, 2nd, 3rd and 4th weeks, respectively, after adult emergence. Tropical Storage Abstracts. 6a

Schruben, L.W. 1954. Farming for profit: do insects eat your wheat profit? Kansas Farmer, Feb. 20th. 6a

Noted that 3 percent insect damage in 1,000 bushels of wheat would cost a farmer $15 in wheat destroyed. A chart is presented which translates insect damage to dollar loss per 1,000 bushels.

Singh, K.; Agrawal, N.S.; and Girish, G.K. 1972. Studies on the loss in weight caused by Sitophilus oryzae Linn. (Coleoptera, Curculionidae) to various high yielding varieties of wheat. *Bulletin of Grain Technology* 10(4):271-275. 6a S19

The average loss in weight, percentage damaged grain and consumption per grub were 1.5 to 3.7 percent, 13.2 to 22.7 percent and 9.75 mgs. to 13.5 mgs. The mean weight of each adult produced was 2.1 mgs. to 2.4 mgs.

Solomon, M.E. 1946. Tyroglyphid mites in stored products. Nature and amount of damage to wheat. *Annals of Applied Biology* 33:280-289. 6a S26

Mites cannot penetrate grains if the grain is intact, but usually less than 10 percent of the grains are so intact. Mites consumed up to 3 percent by weight of grain before drying out in laboratory experiments and were able to destroy the germ completely. Maximum rate of consumption over a 6-week period was .29 percent of grain weight/week. Mites consume germ more rapidly than grain and can reduce embryo weight by 85 percent. In infested field storages the amount of embryo material destroyed ranged from less than 1 percent of total bulk grain to about 15 percent in bags. A system of symbols was developed to represent degrees of damage to grain by mites when assessed visually, and approximate values for the equivalent weight losses are given. Dense mite infestations may cause heating.

Stojanovic, T. 1966. The effect of the initial population density of *Sitophilus granarius* and *S. oryzae* on the loss in weight in infested wheat. *Review of Applied Entomology - Series A* 58(10):3016. 6a E68

Surtees, G. 1963. Site of damage to whole wheat grains by five species of stored-products beetle. *The Entomologist's Monthly Magazine* 99:178-181. 6a S64

Venkatrao, S.; Nuggehalli, R.N.; Pingale, S.V.; Swaminathan, M.; and Subrahmanyan, V. 1960. The effect of infestation by *Tribolium castaneum* Duv. on the quality of wheat flour. *Cereal Chemistry* 37(1):97-103. 6a E73

White, G.D. 1953. Weight loss in stored wheat caused by insect feeding. *Journal of Economic Entomology* 46(4):609-610. 6a

Weight losses caused by *Sitophilus oryzae* during the developmental period in wheat is described. The mean loss in weight per infested wheat kernel

was found to be 0.67 percent after the first week of larval development; 2.36 percent after the second week; 6.52 percent after the third week, 13.59 percent after the fourth week and 20 percent upon the completion of emergence.

b. Birds

Carg, S.S.L. 1966. Losses of wheat in threshing yards due to birds and rodents. Bulletin of Grain Technology 4(2):94-96. 6b

The losses were estimated to be about 7.3 kg per yard (family) per season.

c. Microorganisms

Anderson, J.D.; Baker, J.E.; and Worthington, E.K. 1970. Ultrastructural changes of embryos in wheat infected with storage fungi. Plant Physiology 46:857-859. 6c

Davies, A.C.W. 1964. The relative susceptibility to threshing damage of six varieties of wheat. Journal of the National Institute of Agricultural Botany 10(1):122-128. 6c

Gupta, V.K.; Ram, B.; Palmer, L.T.; and Joshi, I.M. 1973. Post-harvest fungal damage to wheat due to rains. Indian Phytopathology 26(1):156-157. 6c

d. Rodents

Barnett, S.A. 1951. Damage to wheat by enclosed populations of Rattus norvegicus. Journal of Hygiene (Cambr) 49(1):22-27. 6d

Small enclosed populations of the common rat (10-26 rats) each with access to one ton of sacked wheat for 12-28 weeks caused a loss in weight of 4.4 percent of the wheat. 70.4 percent of the wheat was fouled.

e. Other Causes

Dodds, M.E. 1966. Grain losses in the field when windrowing and combining wheat. Canadian Agricultural Engineering 8(1):31-32. 6e

A bibliography of items on the relationship between grain losses in the field at harvest time and plant maturity when harvesting by the windrower-combine method. 11 items, 1925-1964.

Dohary, R.B.; Srivastava, P.K.; and Girish, G.K. 1975. Studies on the assessment of losses of wheat in Punjab. Bulletin of Grain Technology 13(3):159-161. 6e D33

Girish, G.K.; Jain, S.K.; Kumar, A.; and Agrawal, N.W. 1975. Assessment of storage losses, quality and pesticidal contamination in wheat available in the markets of western Uttar Pradesh, Punjab, and Haryana. Bulletin of Grain Technology 13(1):8-18. 6e G12

Johnson, V.A. and Beemer, H.L. Jr. 1977. Wheat in the People's Republic of China: a trip report of the American wheat studies delegation. Submitted to the Committee on Scholarly Communication with the People's Republic of China. Washington, D.C., National Academy of Sciences. 6e J15a

Chapter on "Wheat quality, storage, and processing," pp 61-71 (in press).

Krishnamurthy, K. 1972. Post harvest problems of wheat. Bulletin of Grain Technology 10(4):291-296. 6e K14

Krishnamurthy, K. 1970. Marketing and storage of foodgrains in Kenya. Bulletin of Grain Technology 8(3):121-126. 6e K16

Liscombe, E.A.R. 1962. Milling losses caused by insect infestation of wheat. Cereal Chemistry 39:372-380. 6e

Wheat infested at a level of 41 internal forms per 100 g of dirty wheat lost 1.1 percent of its weight due to insect feeding during storage period of 11 months. The entoleter-scourer aspirator used in cleaning of infested wheat prior to milling reduced the number of insect infested kernels by 40 percent. Milling a straight grade flour of 0.48 percent ash from wheat infested with 41 internal forms per 100 g of dirty wheat results in 4.5 lbs less flour per 100 lbs of wheat than was obtained from comparable noninfested wheat.

McFarlane, J.A. 1964. Wheat storage investigations in Kenya: 1962-1964. Report R 211. Slough, England: Tropical Stored Products Institute. 6e

Ramasivan, R; Singh, J.; and Krishnamurthy, K. 1966. Losses of wheat seed during storage. Bulletin of Grain Technology 4(3):117-124. 6e

Rao, B.V. 1970. Mechanical damage to wheat in a pneumatic conveying system. M.S. Thesis, Kansas State University, Manhattan, Kansas. 6e

Schlehuber, A.M. and Tucker, B.B. 1967. Culture of wheat. Agronomy, A Series of Monographs 13:179. 6e

It was observed that the yield per acre and the protein content in the grain increased steadily as the grains dry from 50 percent to 25 percent moisture in the field before harvest. Delay in harvesting caused losses.

f. Storage Structures

Current research in wheat storage. 1971. Rural Research in Commonwealth Scientific and Industrial Research Organization. Canberra (December, 1971). 6f C54

Girish, G.K.; Birewar, B.R.; Goyal, R.K.; Tomer, R.P.S.; and Krishnamurthy, K. 1974. Evaluation of some modern rural storage bins for storage of wheat. Hapur (U.P.), India: Indian Grain Storage Institute. 84 p. 6f G11

Navarro, S. and Donahaye, E. 1976. Conservation of wheat grain in butyl rubber/EPDM containers during three storage seasons. Tropical Stored Products Information 32:13-23. 6f N100

Pixton, S.W.; Warburton, S.; and Hill, S.T. 1975. Long-term storage of wheat III. Some changes in the quality of wheat observed during 16 years of storage. Journal of Stored Products Research 2:177-185.

Wheat stored at low T° (4.5±0.5°C.) and low O_2 levels is contrasted with wheat stored at ambient conditions. The viability of wheat stored at low T° remained high 96 percent while that stored at ambient T° fell to 39 percent. Free fatty acid values increased with time but the rate was higher in wheat stored under ambient conditions.

Pixton, S.W. and Hill, S.T. 1967. Long term storage of wheat II. Journal of the Science of Food and Agriculture 18(3):94-98. 6f

Pixton, S.W.; Hyde, M.B.; and Ayerst, G. 1964. Long-term storage of wheat. Journal of the Science of Food and Agriculture 15(3):152-161. 6f

Shrivastava, P.K.; Tripathi, B.P.; Girish, G.K.; and Krishnamurthy, K. 1973. Code of practice for safe storage of foodgrains (wheat) in villages. Bulletin of Grain Technology 11(3 and 4):206-210.

Successful control of grain damage was achieved in two selected villages after implementation of the code. 6f

Willson, H.R.; Singh, A.; Bindra, O.S.; Everett, T.R. 1970. Rural wheat storage in Ludhiana District, Punjab. (India). Mimeo. 40 p. 6f

This is a Ford Foundation staff document written in India and is the final report of a study of various prevailing storage methods. (Ford Foundation, 320 E. 43rd St., New York, N.Y. 10017.)

Zutzhi, M.K. 1966. Storage of wheat by farmers in Delhi. Bulletin of Grain Technology 4(3):143-145. 6f

g. Other Control Measures

Donahaye, E.; Navarro, S.; and Calderon, M. 1974. Studies on aeration with refrigerated air--III. Chilling of wheat with a modified chilling unit. Journal of Stored Products Research 10:1-8. 6g D100

Navarro, S.; Donahaye, E.; and Calderon, M. 1973. Studies on aeration with refrigerated air--I. Chilling of wheat in a concrete elevator. Journal of Stored Products Research 9:253-259. 6g N100

7
Other Grains

b. Millet

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Giles, P.H. 1962. The storage of guinea corn and millet by farmers in Northern Nigeria. Tech. Rep. Reg. Res. Sta. Samaru (20). Guinea corn (*Sorghum* spp.) and millet (*Pennisetum* spp.). 7b

Guggenheim, H., with Hamidy Hama Diallo. 1977. Grain Storage in the Fifth Region of Mali: Problems and Solutions. Report to the United States Agency for International Devellopment, Wunderman Foundation, New York.

Krishnaswamy, P. 1952. Storage and germination of millet seeds. Madras Agricultural Journal 39:485-490. 7b

Eight varieties of millet, including spp. of sorghum *Pennisetum*, *Eleusine*, *Setaria*, etc. were dried and stored in sealed bottles. Germination of 70 percent was maintained for 26 months for sorghum spp. When seed was stored in gunny sacks germination dropped to 4 to 38 percent in 1-1/2 years.

Perten, H. 1971. Niger - Study on the stability of sorghum and millet flours produced at the Sotramil mill of Zinder. UNDP/SF Project NER/9, Feasibility study for industrial processing of millet - Technical Report No. 1. Rome: Food and Agriculture Organization. 7b silos. Technical Report No. 13. In: West African Stored Products Research Unit Annual Report, pp. 73-82. Lagos, Nigeria: West African Stored Products Research Unit. 7c P44

Russell, M.P. and Rink, M.M. 1965. Some effects of sorghum varieties on the development of a rice weevil, *Sitophilus zeamais*. Annals of the Entomological Society of America 58:763. 7c

Sorenson, J.W.; McCune, W.E.; Person, N.K.; Hobgood, P.; Steward, B.R.; and Hailes, D.G. 1971. Storing, processing and handling sorghum grain. In: Consolidated report, Texas A and M University, Texas Agricultural Experiment Station, PR-2938-2949, p. 60-71. College Station, Texas: Texas A & M University. illus, 28 refs. 7c

Spears, B. 1971. Extension education in grain sorghum. In: Consolidated Report, Texas A and M University, Texas Agricultural Experiment Station, PR 2938-2949. College Station: Texas A & M University. 8 figs, 1 table. 7c

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U. S. Agency for International Development, Technical Assistance Bureau, Office of Agriculture. 1975. International agricultural research networks for sorghum and millet. Washington, D.C.: U.S. Agency for International Development. 7c U5

Venkatrao, S.; Nuggehalli, R.N.; Swaminathan, M.; Pingale, S.V.; and Subrahmanyan, V. 1958. Effect of insect infestation on stored grain: III. Studies on Kaffir corn (*Sorghum vulgare*). Journal of the Science of Food and Agriculture 9(12):837-839. 7c

Venkatrao, S.; Nuggehalli, R.N.; Swaminathan, M.; Pingale, S.V.; and Subrahmanyan, V. 1958. Effect of insect infestation on the composition of jowar (*Sorghum vulgare*). Food Science 7(3):55-56. 7c

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Waelti, H.; Turnquist, P.K.; and Matter, V.E. 1971. Harvesting techniques for reducing grain sorghum losses. Transactions of the ASAE 14(5):797-800. 7c

Waelti, H.; Turnquist, P.K.; and Matter, V.E. 1969. Harvesting techniques for reducing grain sorghum losses. Paper No. 69-633 presented at the ASAE Winter Meeting, December, 1969, Chicago, Illinois. St. Joseph, Michigan: American Society of Agricultural Engineers. 7c

Wall, W.M. and Ross, J.S. n.d. Sorghum production and utilization. Westport, Connecticut: AVI Publishing Co., 702p. 7c

Zambia Department of Agriculture. 1970. Sorghum storage survey (MN 1978). In: Annual Report Department of Agriculture, Zambia, p. 141. 7c

The survey to assess losses in rural areas showed that at harvest the damage is about 1 percent which rose to 7 percent damage in 5 months storage.

c. Miscellaneous

Institute for Agricultural Research, Samaru (NIR). 1975. The marketing and storage of foodgrains in Northern Nigeria. Samaru miscellaneous paper 50. Samaru, Zaria, Nigeria: Ahmadu Bello University.

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Karper, R.E. 1928. Longevity and viability of Kafir seed. Journal of the American Society of Agronomy 20:527. 7d

Kafir seed stored under atmospheric conditions at College Station, Texas, lost only 12 percent viability in 7 years and 23 percent in 10 years.

8
Puises

a. General

Adams, J.M. 1977. A review of the literature concerning losses in stored cereals and pulses, published since 1964. Tropical Science 19(1):1-28. 8a A5a

Ahmad, M.R. and Ahmad, M. 1969. Evaluation of losses caused by bruchids in stored pulses. Pakistan Journal of Scientific Research 21:117-122. 8a A14

Caswell, G.H. 1977. Storage and conservation of grain legumes both in rural areas and for commercial operation in urban areas. Paper presented at the FAO expert consultation on grain legume processing, held at the Central Food Technological Research Institute, Mysore, India, 14-18 November, 1977. AGS:GLP/77/15. 8a

Central Food Technological Research Institute. 1977. A brief overview of the grain legume situation (production, processing, utilization and storage). Paper presented at the FAO expert consultation on grain legume processing, held at the Central Food Technological Research Institute, Mysore, India, 14-18 November, 1977. Rome: Food and Agriculture Organization of the U.N., AGS:GLP/77/2. 8a

Davey, P.M. and Elcoate, S. 1967. Moisture content/relative humidity equilibria of tropical stored produce. (Part 3. Legumes, spices and beverages.) Tropical Stored Products Information 13:15-34. 8a D5

Davey, P.M. and Elcoate, S. 1966. Moisture content/relative humidity equilibria of tropical stored produce. (Part 2. Oilseeds.) Tropical Stored Products Information 12:495-512. 8a D4

Davies, J.C. 1973. A note on the occurrence of Zabrotes subfasciatus Boh., Coleoptera (Bruchidae) on legumes in Uganda. East African Agriculture and Forestry Journal 37(4):294-299. 8a

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de Luca, Y. 1973. Indice sanitaire des legumineuses alimentaire (Impact faunistique). (An Index of the state of health of leguminous foods). Comptes Rendus des Seances de l'academie d'agriculture de France, Seance du 6 Juin, 59(10):807-816. 8a

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El-Tantawi, M.A.; Gouhar, K.A.; Mansour, M.M.; and Guirguis, M.W. 1976. Blocking of embryonic development in the sourthern cowpea weevil Callosobruchus maculatus (F.) (Col. Bruchidae), by some juvenile hormone analogues. Zeitschrift fuer Angewandte Entomologie 81(1):37-42. 8a

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Kurien, P.P. 1977. Grain legume milling technology. Paper presented at the FAO expert consultation on grain legume processing, held at the Central Food Technological Research Institute, Mysore, India, 14-18 November, 1977. Rome: Food and Agriculture Organization of the U.N., AGS:GLP/77/11. 8a

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Parpia, H.A.B. 1972. Utilization problems in food legumes. In: Nutritional improvement of food legumes by breeding. ed. by Milner, M., London: John Wiley, for PAG/UN. 8a

Rajak, R.L. and Pandey, N.D. 1965. A life history study of the pulse beetle. Labdev 3(2):119-123. 8a

Razzaq, A.M. and Ahmad, M. 1969. Evaluation of losses caused by Bruchids in stored pulses. Pakistan Journal of Scientific & Industrial Research 21(3/4):117-122. 8a

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Entomology, London 1964, p. 642. London: International Congress of Entomology. 8a

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Yadav, T.D. and Pant, N.C. 1975. Effect of feeding by developing stages of Callosobruchus maculatus and C. chinensis on germination of pulse seeds. Seed Research 3(2):107-110. 8a

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Youngs, C.G. 1977. Some aspects of legume seed milling. Paper presented at the FAO expert consultation on grain legume processing, held at the Central Food Technological Research Institute, Mysore, India, 14-18 November, 1977, Rome: Food and Agriculture Organization of the U.N., AGS:GLP/77/22. 8a

Reports observations on the egg laying and hatching behaviour of Callosobruchus maculatus and C. chinensis on husked pulses. Concludes that retention of the husk prevents loss of moisture, maintaining suitable environment for development. Removal of the husk disturbs the moisture regulation system, allowing loss of moisture and resulting in unfavourable conditions for development. The insect will develop but only to a limited degree on processed pulses stored in high humidity conditions. Tropical Storage Abstracts. 1975 (4):58-59.

b. Beans

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Centro Internacional de Agricultura Tropical. 1976. *Zabrotes subfasciatus*. In: Annual Report, pp.A.20-A.22. Cali, Columbia: Centro Internacional de Agricultura Tropical. 8b C12b

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Mechanical damage during harvesting depends primarily upon moisture content and cylinder speed. Optimum moisture content of beans should be 17-20 percent and that of the pods 12 percent or below. 8b

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Describes laboratory trials to determine the optimum dosage of methyl bromide for the complete kill of *Bruchus rufimanus* infesting broad beans (*Vicia faba*). Tests were carried out from 1959-1972, comprising 230 fumigations of some 125,000 beans with 1-10 percent infestation. Individual samples were from 1-2 kg. It was noted that the efficiency of the fumigation increased with temperature. Survival of one or more adults occurred with a dosage of 50 mg/I for 2 1/2 hr at 32.8°C. Complete kill was obtained with 48 mg/I for 2 hr at 22.2°C. The results are not analysed statistically, for various reasons. Recommendations made in the United Arab Republic are quoted, and comprise 20-24 mg/I for 24 hr. Tropical Storage Abstracts.

Schoonhoven, A.V. 1977. Pests of stored beans and their economic importance in Latin America. In: Proceedings XV International Congress of Entomology, 19-27 August, 1976, Washington, D.C., pp. 691-698. College Park, Maryland: Entomological Society of America. 8b S100

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c. Groundnuts

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Baeta Neves, C.M.; Cancela da Fonseca, J.P.; and Pereira Amaro, J.P. 1955. Insects of groundnuts imported from Portuguese Guinea. Calculation of losses. Garcia de Orta 3:165-184 and 285-327. 8c

Blatchford, S.M. and Hall, D.W. 1963. Methods of drying groundnuts: I. Natural Methods. Tropical Science 5(2):6-33. 8c B11

Blatchford, S.M. and Hall, D.W. 1963. Methods of drying groundnuts: II. Artifical methods (literature survey). Tropical Science 5(1):82-98. 8c B11a

Booth, S.A. 1974. Cowpea storage. In: Proceedings of the Symposium, Problems of storage and handling groundnuts, other food grains and animal feeds, Organization of African Groundnut Council. Kaduna, 1973. Kaduna, Nigeria. (Appendix VII), p.51-57, 2 tabl, refs. (Author's address: Institute for Agricultural Research, Ahmadu Bello University, Samaru, PMB 1044. Zaria, Nigeria). 8c

Production of cowpeas in Nigeria has been steadily increasing, mainly in northern Nigeria, where production rose from 375,000 tons in 1957/58 to 810,000 tons in 1961/62. An account is given of the internal trade and it is noted that cowpeas consumed in principal towns might pass through the hands of four middlemen before reaching the consumer, each transaction involving the possibility of admixture with old, infested stocks. The principal storage pests are Callosobruchus maculatus and Bruchidius atrolineatus, and short notes on the progress of infestation and the damage caused are given. Storage structures briefly described comprise: earthenware pots; mud granaries or 'rumbus'; jute bags; drums; butyl rubber silos; and polythene bags with cotton liners. Of chemical methods of insect control, BHC has been found unsuitable on threshed cowpea. With certain provisos, the use of polyethylene bags with cotton liners shows promise. Tropical Storage Abstracts.

Calderon, M.; Donahaye, E.; and Navarro, S. 1967. The life cycle of the groundnut seed beetle, Caryedon serratus (01.) in Israel. The Israel Journal of Agricultural Research 17(3):145-158. 8c C100

Conway, J.A. 1975. Investigations into the origin, development and control of Caryedon serratus (OI). (Col. Bruchidae) attacking stored groundnuts in The Gambia. In: Proceedings of the 1st international working conference on stored product entomology, 7-11 October, 1974, Savannah, Georgia, USA. Savannah, Georgia: Organizing Committee of the Conference. pp. 554-566. 8c

Caryedon serratus (OI.) (Col., Bruchidae) is a pest of major significance to the groundnut industry and hence to the Gambian economy. Heavy attack takes place in two forms of storage, seed nuts in bag and trade nuts in bulk. Previous control work had been aimed at protecting nuts in store against C. serratus attack. The work described established that nuts coming into store were invariably already infested in the field and the scale and distribution of this initial infestation was determined for all areas. A sequence of primary host species supporting C. serratus throughout the year was identified and the possibilities of suppressing C. serratus population via the primary hosts in groundnut growing areas was examined. This work is continuing. The development of C. serratus populations in seed and bulk stores was studied with the areas of heaviest insect attack in large bulks of nuts being shown to be at variance with previous laboratory findings. Migration of fourth instar larvae in both bag and bulk stores was found to be a common phenomenon with nuts in the vicinity of suitable pupation surfaces suffering heavy attack. Elimination of the intake infestation by fumigation using phosphine or methyl bromide was shown to be the ideal as the need for residual insecticides is obviated. This is now the standard technique for all seed on agricultural stations and commercial farms and the entire confectionery groundnut production. Where fumigation was not possible a range of insecticides was evaluated together with alternative application techniques for bag and bulk storage. A crude admixture of malathion at 10 ppm gave very good control of C. serratus in large bulks for 16 weeks at a cost of 40 bututs per metric ton treated. Pirimiphosmethyl, lindane, phoxim, and iodofenphos were inferior to malathion at the same rate. Malathion at 20 ppm gave excellent control of C. serratus in bagged seed nuts at a cost of 6 bututs per 57 kg bag. (1 pound = 4 Dalasi = 400 bututs). Tropical Storage Abstracts 1975(3):34-35. 8c

Davey, P.M. and Swinburne, K. 1960. Infestation problems of the groundnut industry in The Gambia. Tropical Stored Products Information 2:27-30. 8c

Durden, J.C. and Cutler, J.R. 1957. The storage of groundnuts under tropical conditions. I. The effect of storage of undecorticated and decorticated groundnuts. Journal of the Science of Food and Agriculture 8:600-604. 8c

Noted that there was little difference in extent of damage between undecorticated and decorticated nuts, but there were large differences in the buildup of free fatty acids. 8c

Economic losses in Gambian groundnuts. 1970. Tropical Stored Products Information 20:1-2. 8c

In Gambia by comparing the weight of insect-damaged and sound grains it was estimated that for the year 1968 the apparent loss in weight was 2,500 tons, while the cash losses were 180,000 pounds.

Feakin, S.D. Ed. 1973. Pest control in groundnuts. PANS Manual No. 3. 3rd ed. London: Center for Overseas Pest Research, PANS Office. iii + 197 pp, 21 tabl, 90 fig, append, index. 8c

For this third edition the whole manual has been re-written and new information added. The section on storage pests now occupies 22 pages. In it are brief notes on harvesting and drying, descriptions of the main pests, Tribolium castaneum, Oryzaephilus mercator, Trogoderma granarium, Caryedon serratus, Ephestia cautella, Plodia interpunctella, Corcyra cephalonica and minor pests. There are notes on storage of shelled and unshelled nuts, warehouse hygiene and organisation, chemical control, and insecticide resistance problems. Tropical Storage Abstracts. 1974(3):35. Reviewed in Tropical Stored Product Information. 1974(28):52.

Food and Agriculture Organization: Institute of Food Technology, Senegal. 1974. La conservation et l'entreposage des arachides (The conservation and storage of groundnuts). Based on the work of Pattison, I. Rome: FAO. AGS:SF/SEN 5. Rapport Technique 10. 43 pp. 10 photos. (Fr.). 8c

Caryedon serratus attack on groundnuts and groundnut seed causes considerable losses every year in this valuable export crop, Senegal being the world's second largest exporter after Nigeria. Present control methods which include spraying of stores, insecticide treatment by layers in groundnut stacks and fumigation within a store are all unsatisfactory. Control operations should be aimed at the level of the cooperative groundnut seccos. A homogenous admixture of lindane should be applied to the seccos; tests have shown that lindane leaves residues that are well under the tolerance limits established by the legislation of importing countries. Stacks of seed groundnut can be successfully fumigated under sheets, before entering the store. For the future it is worth considering the construction of fumigable stores for groundnut seed, as total disinfestation fo small stacks is easy and will be less onerous than treatment with insecticide. Tropical Storage Abstracts. 8c

Food and Agriculture Organization. 1973. Report to the Government of Nigeria on aflatoxin in groundnuts and groundnut products: An appraisal of the situation in Nigeria. Based on the work of Crowther, P.C. Rome: FAO. UN Dev. Progm. AGP: TA/249. No. TA 3221. vi + 33 pp, 10 append, refs. 8c

A survey carried out in Nigeria in 1972/73 on the aflatoxin problem in groundnuts and groundnut products has shown that the basic need is to reduce the levels of toxin in the groundnut crop. Present extension procedures giving advice to farmers on aflatoxin control are too diffuse and it is suggested that a film be produced dealing with the problem and its control and shown throughout the growing areas by means of mobile cinema buses. In addition incentives must be introduced to recompense the farmers for carrying out these recommendations. In order to check on the efficiency of these extension and incentive processes, it is suggested that the Nigerian Stored Products Research Institute, Kano, should improve their aflatoxin testing facility. Tropical Storage Abstracts 1974(3):44. 8c

Friendship, R. 1974. A preliminary investigation of field and secco infestation of Gambian groundnuts by Caryedon serratus. London: Tropical Products Institute. iv, 14 p. illus., 8 refs. (Report no L38). 8c

Gambia Crop Protection Unit. 1968. Annual Report, 1968/69. Yundum: Agricultural Station. 15 p. 8c

Deals largely with the postharvest quality of groundnuts. Results are given of various investigations. A brief account of an investigation into food storage methods in 40 villages is given.

Ghana. Grains and Legumes Development Board. 1975. Recommended practices for the production of groundnuts. Technical bulletin No. 3. Kumasi, Ghana: Grains and Legumes Development Board. 8c

Gibbons, R.W.; Laurence, R.C.N.; Norse, D.; and Cox, R.A.J. 1975. Groundnut drying trials in Malawi. Tropical Science 17(1):15-24. 4 tabl, refs. (Authors' address: Grain Legume Research Laboratory, Agricultural Research Council, P. O. Box 215, Lilongwe, Malawi). 8c

Stripping groundnuts from the haulms at lifting and spreading the pods on mats was the most efficient method of drying groundnuts rapidly to prevent fungal contamination. Sheltering is advocated at night and if rain showers occur. Otherwise, unstripped haulms are best left inverted in the windrows until completely dry or until required labour is available. Mycological investigations showed that fungal invasion was strongly correlated with pod breakages caused by insects or harvesting implements. The main groundnut producing areas of Malawi have favourable weather conditions under which rapid and safe curing of the groundnut crops can be achieved. Tropical Storage Abstracts. 1975(4):52.

Groundnut Review. 1973. Lagos: African Groundnut Council. 8c

Covers all scientific disciplines of groundnut research.

Gupta, U.K. and Choman, J.S. 1971. Losses and nature of damage caused by seed-rot fungi in stored groundnuts in Punjab. Indian Phytopathology 23(4):603-605. 8c

Hall, D.W. 1956. Insect damage observed in stored groundnuts. East African Agriculture and Forestry Journal 22(2):11-15. 8c

Hall, D.W. 1954. The quality of groundnuts from The Gambia with special reference to insect infestation. Colonial Plant and Animal Products 4(3):227-235. 8c

Hall, D.W. 1959. Storage of produce in The Gambia. Tropical Science 1:193-199. 8c

Groundnuts is the major cash crop in Gambia accounting for about 97 percent of the export crop. Average loss was estimated about 3 percent equivalent to 90,000 pounds. The reduction in available oil accounted for a loss of 175,000 pounds.

Halliday, D. 1967. Build-up of free fatty acid in Northern Nigerian groundnuts. Tropical Science 9(4):211-237. 8c

Halliday, D.; Kazaure, L.; and Qureshi, A.H. 1967. Coverage of groundnut pyramids with plastic envelopes. In: Nigerian Stored Products Research Institute annual report, Technical Report No. 9, p 79-97. Lagos, Nigeria: Nigerian Stored Products Research Institute. 8c

Halliday, D. and Nwankwo, F.I. 1963. Moisture uptake of bagged groundnuts at Port Harcourt. In: Nigerian Stored Products Research Institute annual report 1963. Technical Report No. 9, p. 91-95. refs. 8c

Hayward, L.A.W. 1963. Infestation control in stored groundnuts in Northern Nigeria. World Crops 15(2):63-67. 8c H20

Hayward, L.A.W. 1955. Losses associated with groundnuts infested with Trogoderma granarium Everts. Journal of Science Food and Agriculture 6(6):337-340. 8c H21

Hayward, L.A. 1953-4. Losses associated with groundnuts infested by Trogoderma granarium. In: Annual report West Africa Stored Products Research Unit. 8c

Hutchison, R.S. 1967. Recherches sur le sechage des arachides stockees par les cultivateurs (Research studies on drying farmers' stock peanuts). Oleagineux 22(111):737-740. 8c

Jackson, C.R. 1967a. Development of fungi in peanuts during artificial drying. Research Report No. 19, University of Georgia, College of Agriculture Experiment Station. Athens, Georgia: University of Georgia (USA). 8c

Jackson, C.R. 1967b. Studies on control of peanut pod fungi: Part I. Effects on preplanting soil fumigants on peanut pod surface at harvest. Part II. Value of fungicidal treatment of windrowed peanuts in post-harvest reduction of pod-borne fungi and aflatoxins. Research Report No. 11, University of Georgia, College of Agriculture Experiment Station. 18 p. Athens, Georgia: University of Georgia (USA). 8c

Khalsa, J.S. 1965. Harvesting damage to peanuts. M.S. Thesis, University of North Carolina, Raleigh, North Carolina. 8c

Kirkpatrick, P.L.; Niffenegger, D.; and Yancey, D.L. 1972. Detecting stored-product moths in a peanut warehouse by using light traps and larvae traps. USDA Marketing Research Report No. 938. Washington, D.C.: U.S. Department of Agriculture. 8c

The use of ultraviolet and greenlights for attracting moths is described. The green light traps were satisfactory for this purpose.

Magar, W.Y. 1974. Problems of storage and handling of groundnuts and other food grains and animal feeds. In: Proceedings of the Symposium, Problems of storage and handling of groundnut, other food grains and animal feeds. Organization of African Groundnut Council, Kaduna, 1973. Kaduna, Nigeria: African Groundnut Council. (Appendix IV). p. 24-40, 3 tabl, refs. (Author's address: African Groundnut Council Secretariat, P.O. Box 3025, Lagos, Nigeria). 8c

One of the most pressing problems in developing countries is the production of sufficient food to meet the requirements of their rapidly increasing populations. This problem is accentuated by losses in store which may be quite high. Generally the practice is to seek increasing production rather than improving storage practices. The need for such improvement is emphasized, and factors affecting storability are outlined, with special reference to groundnuts. The importance of pre-storage quality is stressed, and there are notes on harvesting, safe moisture contents, drying, threshing and shelling. Various storage methods discussed include the pyramids of northern Nigeria, underground pits, silos and warehouses. Emphasis is placed on good store hygiene, and the maintenance of low temperatures to prevent lipolysis and retard insect development. Brief notes are given on the main insect pests and the products in which they are found. Chemical methods of insect control are discussed, and some data are given on rates of application and dosages for insecticide treatment and fumigation. Finally there are notes on fungi and rodents and their control. Tropical Storage Abstracts. 8c

McCloy, J. 1956. Some results on the artificial drying of groundnuts. In: N.I.A.E. Annual Report 1955-56, pp. 516-525. Silsoe, Bedford, England: National Institute of Agricultural Engineering. 8c M100

Myklestad, O. 1966. Drying and storing peanuts. Food Preservation Quarterly 26(2-4):21-26. 8c

Pattinson, I. and Thornton, I. 1965. The quality of unshelled groundnuts in the Gambia with special reference to insect and fungal attack. Tropical Science 7(2):67-74. 8c P14

Pearman, G.C. and Jay. E.G. 1970. The effect of relative humidity on the toxicity of carbon dioxide to Tribolium castaneum in peanuts. Journal of the Georgia Entomological Society 5(2):61-64. 8c P17

Prevett, P.F. 1970 Callosobruchus subinnotatus (Pic) (Coleoptera, Bruchidae) a potential pest of stored groundnuts. Journal of Stored Products Research 6(3):279-280. 8c

Prevett, P.F. 1964. The distribution of insects in stacks of bagged groundnuts in Northern Nigeria. Bulletin of Entomological Research 54(4):689-713. 8c

Proctor, D.L. and Ashman, F. 1972. The control of insects in exported Zambian groundnuts using phosphine and polyethylene lined sacks. Journal of Stored Products Research 8(2):127-137. (PICL reprint No. 852). 8c

Redlinger, L.M. 1976. Pirimiphos-methyl as a protectant for farmers' stock peanuts. Journal of Economic Entomology 69(3):377-379. 3 tabl, 7 refs. (Author's address: Stored Product Insects Research and Development Laboratory, Agric. Res. Serv., USDA, Savannah, GA 31403, USA). 8c

Unshelled groundnuts treated with pirimiphos-methyl at 20.9, 37.4 or 52.2 ppm to assess the effectiveness of the insecticide were held in open-top, 141.6 litre cylindrical bins for 12 months in a warehouse infested with 10 species of stored-products insects. Groundnuts treated with malathion at 52.2 ppm were used as control. Pirimiphos-methyl was equal to or more effective than the control in reducing the number of insects. In addition, groundnuts treated with pirimiphos-methyl had fewer insect damaged kernels than the control. Tribolium castaneum and Ephestia cautella were the predominant species found. Residues of pirimiphos-methyl decreased at a rate approximately 33 percent

less than malathion during the trial period. Tropical Storage Abstracts.

Rynehart, T. 1960. The control of insects infesting groundnuts after harvest in the Gambia: IV. The practical application of control measures. Tropical Science 2(3):134-139. 8c

Spickett, R.G.W.; Squires, J.A.; and Ward, J.B. 1954. Groundnuts from The Gambia. Colonial Plant and Animal Products 4(3):218-226. 8c

Zdarkova, E. and Reska, M. 1976. Weight losses of groundnuts (*Arachis hypogaea* L.) from infestation by the mites *Acarus Siro* L. and *Pyrophagus putrescentiae* (Schrank). Journal of Stored Products Research 12(2):101-104. 6 refs. 1940-1970. 8c

Describes experiment to calculate amount of food consumed by two species of mite and concluded that one individual can consume daily at least its own body weight in food.

d. Soybeans

Buchele, W.F. and Johnson, W.H. 1967. How to reduce soybean harvest losses. Iowa Certified Seed News 21(4):5-7. 8d

Byg, D.M. 1969. A guide for measuring soybean harvest losses. Columbus, Ohio: Ohio State University, Agricultural Engineering Department. 8d

Byg, D.M. 1967. Where your harvest loss occurs, ways to prevent it. Soybean Digest 77(12):67-70. 8d

Byg, D.M. and Johnson, W.H. 1970. Reducing soybean harvest losses. Ohio Report on Research and Development in Agriculture, Home Economics and Natural Resources 55(1):17-18. 8d

Carter, D.G. and Holman, L.E. 1962. Storing soybeans on the farm. College of Agriculture Circular 692. Urbana: University of Illinois. 15 p., ill., photo. 8d

Everett. 1949. Soybean harvesting losses with combine. M.S. Thesis, Iowa State College, Ames, Iowa. 8d

Holman, L.E. and Carter, D.G. 1952. Soybean storage in farm-type bins: a research report. Bulletin 553. Urbana, Illinois: University of Illinois Agricultural Experiment Station. 8d H29

Johnson, W.H. 1967. Reducing unnecessary harvesting losses. Soybean Farmer 4:June, 1967. 8d

Kapoor, K.N.; Rawat, R.R.; Luckmann, W.H.; and Purohit, M.L. 1972. Damage to soybean grain by the almond moth in Mahhya Pradesh. Journal of Economic Entomology 65(3):902-903. 8d

Lamp, B.J.; Johnson, W.H.; and Harkness, K.A. 1969. Soybean harvesting losses -- approaches to reduction. Transactions of the ASAE 4:203-207. 8d

Miller, D.L. 1970. Mechanical kernel damage and field losses of soybeans during harvesting. M.S. Thesis, Mississippi State University, Mississippi. 8d

Navarro, S.; Donahaye, E.; and Calderon, M. 1973. Studies on aeration with refrigerated air - II. Chilling of soybeans undergoing spontaneous heating. Journal of Stored Products Research 9:261-268. 8d N100

Nave, W.R. 1971. Reduction of losses and damage in soybean harvesting. Annual Report 308-077-C20 prepared for harvesting and farm processing research branch, AERA, ARS, U.S.D.A. Washington, D.C.: U.S. Department of Agriculture. 8d

Oathout, C.J. 1928. The vitality of soybean seeds. Journal of the American Society of Agronomy 20:837-855. 8d

Quick, G.R. and Buchele, W.F. 1972. Reducing combine gathering losses in soybeans. Paper no. 72-625 presented at ASAE Winter Meeting, Chicago, Illinois. St. Joseph, Michigan: American Society of Agricultural Engineers. 8d

Rodda, E.D.; Steinberg, M.P.; and Wei, L.S. 1972. Soybean damage detection and evaluation for food use. Paper no. 72-380 presented at ASAE Annual Meeting held in Arkansas. St. Joseph, Michigan: American Society of Agricultural Engineers. 8d

Wait, J.J. 1973. Reducing cutterbar losses in soybeans with low pressure air jets. M.S. Thesis, University of Illinois, Urbana, Illinois. 8d

Webber, C.R. and Fehr, W.R. 1966. Seed yield losses from lodging and combine harvesting in soybeans. Agronomy Journal 58:287-289. 8d

Whitehair, N.V.; Cleavinger, G.A.; and Enix, J.R. 1968. Soybean kernel damage. Leaflet E-694. Stillwater, Oklahoma: Oklahoma State University Ext. 8d

Young, R.E. 1968. Mechanical damage to soybeans during harvesting. M.S. Thesis, Iowa State University, Ames, Iowa. 8d

Young, E. and Buchele, W.F. 1968. Threshing damage to soybeans. Paper presented at the symposium on grain damage held under the auspices of the American Society of Agricultural Engineers, at Iowa State University, 17-18 April, 1968, Ames, Iowa. 8d

Gives a detailed account of the factors affecting bean damage in soya. Noted that damaged beans have a lower percentage germination and are highly susceptible to fungal attack. Notes that the major factors affecting damage were moisture content and pod moisture.

e. Other Pulses

Akingbohunge, A.E. 1976. A note on the relative susceptibility of unshelled cowpeas to the cowpea weevil (Callosobruchus maculatus Fabricius) (Coleoptera, Bruchidae). Tropical Grain Legume Bulletin (5)11-13. 8 refs. 8e

Notes that bruchid attack develops in the field and is then carried into store. Suggest that storing unshelled cowpeas might reduce damage. (Author's Address: Dept. of Plant Science, University of Ife, Ile-Ife, Nigeria).

Akpaetock, O.I. 1974. Drying and storage of cowpeas with ashes in airtight containers. Journal of Agricultural Engineering Research 19(3):279-287, 2 tabl, 4 fig. (Author's address: Agricultural Engineering Department, University of Ife, Ile-Ife, Nigeria). 8e

Discusses the possible use of ashes for dessicant drying of grains. The process of drying is slow, being more or less a diffusion action. Equilibrium moisture contents of a given variety of grains were found to be affected by the w/w ash-grain ratio. An appropriate drying rate mathematical model was found to describe the whole range of any set of data under given test conditions. Drying and experimental constants were found to be related to the ash-grain ration and to be dependent upon the grain variety. Mathematical formulae are proffered to establish the relationship between drying and experimental constants. Tropical Storage Abstracts.

Anthonio, Q.B.O. 1962. The economics of cowpeas storage in a concrete bin. In: West African Stored Products Research Unit Annual Report. pp 94-95. Technical Report No. 19. Lagos, Nigeria: Federal Ministry of Commerce and Industry. 8e A22

Bastos, J.A.M. 1973. Avaliacao dos prejuizos causados pelo gorgulho, Callosobruchus maculatus, em amostras de feijao de corda, Vigna sinensis, coltidas em Fortaleza, Ceara. (Evaluation of damage caused by a cowpea weevil, C. maculatus in samples of cowpeas, V. sinensis, collected in Fortaleza, Ceara, Brazil) Abstracts on Tropical Agriculture 1(1):394. 8e

Bindra, O.S. and Jokhmola, S.S. 1967. Incidence of and losses caused by some pod-infesting insects in different varieties of pigeon-pea (Cajanus cajan (L.) Millsp.). Indian Journal of Agricultural Science 37(3):177-186. 8e B8

Booker, R.H. 1967. Observations on three bruchids associated with cowpea in northern Nigeria. Journal of Stored Products Research 3:11-15. 8e

Noted that field infestation was about 2 percent. In laboratory observations one bruchid can cause a 3-5 percent weight loss in a cowpea seed. The decrease in weight loss per individual insect is lower when there are several larvae per seed.

Calderon, M. 1965. Rapport au Gouvernement du Dahomey sur la protection des grains en entrepot. Rome: Food and Agriculture Organization of the U.N.

Report of a 9-week consultancy on the problems of grain conservation in Dahomey. The factors (insects, moisture and rodents) causing deterioration are discussed, as well as problems of the different regions at the farm and commercial level. Techniques in use, research undertaken and its use, and government responsibilities are noted. Problems of maize and cowpeas (Vigna sinensis) are emphasized. Needed training, equipment and materials, research and coordination are recommended. 8e C100

Calderon, M. 1964. Probleme de conservation du nyebe (Vigna sinensis): rapport final au gouvernement de la Republique de Niger. Tel Aviv, Israel: Ministry of Agriculture, Department of Plant Protection, Stored Products Research Laboratory. 10 p. 8e C100

Caswell, G.H. 1974. The development and extension of nonchemical control techniques for stored cowpeas in Nigeria. In: Proceedings of the first international working conference on stored-product entomology, 7-11 October, 1974, Savannah, Georgia, pp. 63-67. Savannah, Georgia: Organizing committee of the conference. (Available from Dr. Robert Davis, Stored-product Insects Research and Development Laboratory, USDA-ARS, P.O. Box 22909, Savannah, Georgia. Price: $7.50). 8e C100

Caswell, G.H. 1973. The storage of cowpeas. Samaru Agricultural Newsletter 15(2):73-75. (Author's address: Senior Entomologist, Institute for Agricultural Research, Samaru, Ahmadu Bello University, PMB 1044, Zaria, Nigeria). 8e

Notes that the most important pest is Callosobruchus maculatus. Stresses the importance of store hygiene, prompt harvesting, storing in the pod, and burning of residues. Estimates that after 6 months' traditional storage 50 to 60 percent of seeds are insect damaged. Advises against the use of pesticides, especially BHC, because parasitic wasps effect some degree of control of the pest. Suggests that best control method is hermetic storage, using black polythene bags, which are described. The use of cotton liners is recommended. Notes the danger of rodent damage, which destroys the hermetic seal. There is a note on storage in 1000 lb units. The use of steel drums is described and specifications are given. Storage in larger quantities in silos is discussed, and fumigation using Phostoxin at the rate of 5 tablets per ton is recommended. Finally there is a note on the marketing of cowpea in small plastic bags. Tropical Storage Abstracts.

Caswell, G.H. 1970. The storage of cowpea in the northern states of Nigeria. Samaru Research Bulletin 120. Zaria, Nigeria: Ahmadu Bello University, Institute for Agricultural Research. 6 p. 8e C9

Caswell, G.H. 1961. The infestation of cowpeas in the western region of Nigeria. Tropical Science 3:154-158. 8e C8

Claydon, A. 1976. An investigation into the storage of winged bean roots, Psophocarpus tetragonolobus (L.)

DC. Paper presented at the 10th Waigani Seminar, Lae, Papua New Guinea. 13 p. 8e C27a

Control of cowpea weevil in storage. 1976. Tropical Grain Legume Bulletin 6:36. 8e C42

Foster, G.H. and Fiscus, D.E. 1969. Physical damage from mechanical handling of pea beans. In: 9th dry bean research conference, held at Ft. Collins, Colorado, 13-15 August, 1968, pp. 68-72. ARS-74 50. Washington, D.C.: U.S. Department of Agriculture. 8e

Friendship, R. 1975. Insect pest control and haricot beans. Ethiopian Grain Rev. 2(1):10-13. 4 pl. (Author's address: PO Box 3721, Addis Ababa, Ethopia). 8e

Points out that haricot beans are among Ethiopia's major foreign exchange earners and that to maintain their price they must be protected from damage caused by Acanthoscelides obtectus. A brief description is given of the insect's life history and of the damage it causes. Pest control measures are limited to fumigation under gas-proof sheets and the application of residual insecticides. The use of chlorinated hydrocarbons is banned by overseas importers, and premium grade malathion is recommended for spraying of bagged produce prior to fumigation. Notes for the future include further research into the insect's behaviour pattern and pre-harvest infestation, improvements in storage hygiene and more efficient inspection methods including inspection to ensure that ships loading cargoes of beans are infestation free. Tropical Storage Abstracts. 1975(3):36.

Giles, P.H. 1963. Cowpea storage by Northern Nigerian farmers. In: Proceedings of the 1st Nigerian Grain Legumes Conference, Samaru, Zaria, 1963, p. 16. 8e G6

Gutierrez, G. 1967. Conservation and storage of olive oil and prevention of its deterioration. In: International olive oil seminar - Perugia-Spoleto, Italy, 5-24 November, 1967, p. 536-563. Rome: Food and Agriculture Organization of the U.N., 10 tab., 13 graphs, 2 phot., 1 org. chart, 39 graphs. FAO/100C/F10. FAO 13258-67-WM. 8e

Halliday, D. 1967. Insect damage to foods on sale in Kano Market. In: Nigerian Stored Products Research Institute Annual Report 1966, pp. 103-107. Lagos, Nigeria: Nigerian Stored Products Research Institute. 8e

Cowpeas losses due to bruchids was 8 percent.

International Grain Legume Information Center. 1976. Control of cowpea weevil in storage. Tropical Grain Legume Bulletin 6(October):36. Ibadan, Nigeria: International Institute of Tropical Agriculture. 8e

International Institute of Tropical Agriculture. 1976. Control of cowpea weevil in storage. In: Annual report, 1975, p. 101. Ibadan: IITA, 1976. 8e

Describes an easy method for control of cowpea weevil in storage and advocates its use in rural areas.

Jotwani, M.G.; Sircar, P.; and Yavar, T.D. 1967. Studies on extent of damage and germination of seeds II. Germination of some leguminous seeds damaged by Callosobruchus maculatus. Indian Journal of Entomology 19(3):309-311. 8e

Jotwani, M.G. and Sircar, P. 1964. Studies on the extent of insect damage and germination of seeds. I. Germination of pea seeds damaged by Callosobruchus maculatus. Indian Journal of Entomology 26:130-133. 8e

He noted that average weight of seeds damaged by different number of bruchids developing within each seed is reduced by about 2.4, 4.5, 6.2, and 7.1 gm. respectively; the loss in wt. being about 12.0, 22.5, 32.0 and 35.5 percent respectively - the amount of food taken by each grub during its developmental period gets gradually reduced depending in the number of grubs developing in each seed.

Khare, R.M.; Krishnamurthy, K.; and Pingale, S.V. 1966. Milling losses of food grains. Part II. Studies on losses of peas during milling. Bulletin of Grain Technology 4(4):168-176. 8e

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12
Specific Food Loss Reduction Procedures

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Description of traditional storage pits used for sorghum and to a lesser extent maize. Report indicates that in relatively airtight pits, insect control presents no major problems. The most serious problem was found to be loss and damage due to mould attack resulting from ingress of water from the soil. Tests were carried out on three types of pit linings in pits of capacity approximately 1/2-ton, using sorghum dried to 12.5 percent m.c. or less. A matting and straw lining is described. Polythene linings presented problems owing to lack of large enough sheets of the material. The third lining consisted of a single layer of concrete, c. 2.5cm thick applied to walls and floor of the pit. The pits were opened after four months, and moisture contents and depth of mould damage were recorded. All three linings were found to be effective in reducing mould damage as compared with an unlined pit used as control. The poorest lining was that of matting and straw. Further tests were carried out on polythene linings, (condensed from) Tropical Storage Abstracts 12a

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Contains 19 technical reports including: - Cornes, M.A. and Oyeniran, J.O.: Fumigation of maize in an aluminum silo using a 1:1 carbon tetrachlo-ride:ethylene dichloride mixture. Cornes, M.A., Adeyemi, S.A.O., and Qureshi, A.H.: An assessment of the value of phosphine and ethyline dibromide for the control of pests in grain stored in polythene lined sacks. Qureshi, A.H.: Effects and persistence of dichlorous vapours liberated from Vapona pest strips on Tribolium castaneum Herbst and other stored products pests. Cornes, M.A.: New records of insects associated with stored products in Nigeria. Part 2. Qureshi, A.H.: An assessment of woven polythene bags for handling produce under Northern Nigerian conditions. 12b

Page, A.B.P. and Lubatti, O.F. 1963. Fumigation of insects. In: Annual review of entomology, ed. by R.F. Smith, pp. 239-264. Palo Alto, California: Annual Reviews Inc. 12b P

Provides an excellent review of the hazards of fumigation to the viability of seed.

Person, H.K. and Sorenson, J.W., Jr. 1970. Use of gaseous nitrogen for controlling stored-product insects in cereal grains. Cereal Chemistry 47(6):679-686. P22 12b

Perti, S.L. 1965. Control of insect infestation in foodstuffs by fumigation. Labdev: Journal of Science and Technology (Kanpur, India) 3(1):64-65. 12b P22a

Rai, L.; Sarid, J.N.; and Pingale, S.V. 1963. Fumigation of food grains in India with hydrogen phosphide. Bulletin of Grain Technology 1(1-2):3-15. R1 12b

Rowlands, D.G. 1970. The metabolic fate of dichlorvos on stored wheat grains. Journal of Stored Products Research 6(1):19-32. 12b

Schecter, M.S. and Sullivan, W.N. 1972. Gas-propelled aerosols and micronized dusts for control of insects in aircraft. 2. Pesticide formulations. Journal of Economic Entomology 65(5):1444-47. 55a 12b

Schesser, J.H. 1967. Phosphine fumigation of processed cereal products in rail cars. American Miller and Processor 95(1):8-13. 12b

Scudamore, K.A. and Heuser, S.G. 1973. Determination of carbon tetrachloride in fumigated cereal grains during storage. Pesticide Science 4 (1):1-12 + 5 tabl. + 2 Fig + ref. (Author's address: Ministry of Agriculture, Fisheries and Food, Pest Infestation Control Laboratory, London Road, Slough, Bucks, England). 12b

Alternative methods for the extraction of unchanged carbon tetrachloride residues from fumigated whole and ground wheat and maize were examined and compared. A portion of any carbon tetrachloride residue was found to be converted to chloroform by a steam distillation extraction method but not when a cold solvent extraction process was used. In addition, the effectiveness of removal of carbon tetrachloride from wheat and maize during a 3.5 h steam distillation was progressively lessened, in comparison with the cold extraction process, as the length of time that residual fumigant had been associated with grain increased. The rate of elimination of carbon tetrachloride from wheat and maize during airing at two temperatures was determined and though partially dependent on the temperature of fumigation, airing was consistently more rapid at 25°C than at 10°C. Residues in wheat disappeared more rapidly than those in maize. Grinding initially caused a sharp reduction in carbon tetrachloride content but subsequent airing rates were little faster than those of the whole grains. It is concluded that complete elimination of trace amounts of carbon tetrachloride from products of treated grain is unlikely even after milling but the toxicological significance of such residues is uncertain. (Condensed from) Tropical Storage Abstracts, 1973 (2)p33-4.

Shuey, W.C.; Youngs, V.L.; and Getzendaner, M.E. 1971. Bromide residues in flour streams milled from fumigated wheats. Cereal Chemistry 48(1):34-39. 12b

Sinclair, W.B. and Lindgren, D.L. 1958. Factors affecting the fumigation of food commodities for insect control. Journal of Economic Entomology 51(6):891-900. 12b S18b

Smith, F.F. and Boswell, A.L. 1972. Gas-propelled aerosols and micronized dusts for control of insects in aircraft. 8. Toxicity of micronized dusts to some greenhouse insects. Journal of Economic Entomology 65(5):1466-68. S22b 12b

Steiner, L.F.; Lopez-D., F.; and Woodley, J.R. 1972. Gas-propelled aerosols and micronized dusts for control of insects in aircraft. 3. Effectiveness against free flying Caribbean fruit flies. Journal of Economic Entomology 65(5):1447-1450. S50a 12b

Strong, R.G. and Lindgren, D.L. 1961. Effect of methyl bromide and hydrocyanic acid fumigation on the germination of corn seed. Journal of Economic Entomology 54(8):764-770. 12b

Strong, R.G. and Lindgren, D.L. 1960. Germination of cereal, sorghum and small legume seeds after fumigation with hydrogen phosphide. Journal of Economic Entomology 53(1):1-4. 12b

Sullivan, W.N.; Schechter, M.S.; Amyx, C.M.; and Crooks, E.E. 1972. Gas-propelled aerosols and micronized dusts for control of insects in aircraft. 1. Test protocol. Journal of Economic Entomology 65(5):1442-44. S63a 12b

Sullivan, W.H.; Schechter, M.S.; Amyx, C.M.; and Crooks, E.E. 1972. Gas-propelled aerosols and micronized dusts for control of insects in aircraft. 7. Effectiveness against pest insects of agriculture. Journal of Economic Entomology 65(5):1462-66. S63b 12b

Van der Plank, J.E. and Van Wyk, G.F. 1940. The preparation of tablets for the release of sulphur dioxide in packages of stored table grapes. In: Union of South Africa. Department of Agriculture and Forestry. Annual Report of the Low Temperature Research Laboratory, Capetown, for the year June 1938 to June 1939, pp. 43-47. Pretoria: Government Printer. V2 12b

Vardell, H.H. 1975. Methyl bromide: effect of multiple fumigation on residues in flour. Journal of Economic Entomology 68(1):69-70. V5 12b

Vardell, H.H.; Cagle, A.; and Cooper, E. 1973. Fumigation with phosphine against stored-product insects in bagged flour in plywood overpacks. Journal of Economic Entomology 66(5):1209-1210. V6 12b

Vardell, H.H.; Gillenwater, H.B.; Eason, G.; and Cagle, A. 1973. Whitefringed beetles: dichlorvos applied as a postharvest treatment to protect wheat. Journal of Economic Entomology 66(1):225-227. V7 12b

Walker, D.J. 1976. Fumigation: a method of protecting your stored grain and legumes against insect damage. Swaziland's Rural Development Newsletter, 2(4). 12b

Describes fumigation of bulk grain in gas-tight metal drums or containers. This method has no residual protective effect.

Winks, R.G. 1974. Characteristics of response of grain pests to phosphine. In: Annual Report 1973-74, Commonwealth Scientific and Industrial Research Organisation, Division of Entomology. Canberra: CSIRO (Author's address: Commonwealth Scientific and Industrial Research Organization, Division of Entomology, P.O. Box 1700, Canberra City, A.C.T. Australia 2601) 12b

Although phosphine has been used extensively as a grain fumigant its toxicity to insects has not been well understood. Laboratory investigators have reported conflicting results and the view has been expressed that phosphine is an atypical poison in that the response to it is not governed by a concentration x time relationship characteristic of many other poisons. Detailed investigation of response characteristics of Tribolium castaneum has revealed that the response is dependent on concentration. The investigation included an evaluation of time as a response factor, time as a dosage factor, the narcotic effect of phosphine and its effect on the reproductive capacity and longevity of survivors. (Condensed from) Tropical Storage Abstracts, 1975 (2) p. 30.

Winks, R.G. 1974. Fumigant resistance studies. In: Annual Report 1973-74, Commonwealth Scientific and Industrial Research Organization, Division of Entomology, pp. 38-39. Canberra: CSIRO.

The recent world-wide survey of pesticide resistance in stored grain insects indicates that low levels of resistance to methyl bromide and phosphine have arisen in field populations of some of the major grain pests. Resistance has also been detected in several laboratory strains of stored grain pests. Studies indicate that phosphine resistance may be obtained after relatively brief

selection pressure. Thus, a 10-fold increase in resistance was obtained in a laboratory strain of *Tribolium castaneum* following 6 generations of selection with phosphine. The degree of protection afforded by narcosis in a susceptible strain of *T. castaneum* was found to increase with increasing phosphine concentration. Thus, in strains exhibiting increased narcotic response, high levels of phosphine resistance may be obtained. The practical implications of this are clear. Should strains of this type occur in field populations, low, non-narcotic concentrations, with longer exposure periods, will be required to achieve control. (Condensed from) *Tropical Storage Abstracts*, 1975 (2)p31.

c. Chemical Additives plus Insecticides

Amaritsuth, W.; Amaritsuth, W.; and Knapp, F.W. 1974. Stored grain insect studies. 1. Susceptibility of the bean and rice weevil to three insecticides. 2. Resistance of mung bean and sorghum seed to laboratory infestations of bean and rice weevil. *Thai Journal of Agricultural Science* 7(1):63-70. (Authors' address: Northeast Agricultural Centre, Kohn Kaen, Thailand). 12c.

Dursban was found to be more effective than malathion in protecting mung bean (*Phaseolus aureus*) and sorghum (*Sorghum* spp.) from the bean weevil (*Acanthoscelides obtectus*) and the rice weevil (*Sitophilus oryzae*), respectively, and malathion was more effective than DDT. Seed germination was not affected by these treatments. Two varieties of mung bean, Black seed and Golden M-B, were found to be significantly more resistant to the bean weevil than was the local variety. Noticeable differences in resistance to rice weevil were found among the sorghum varieties, but only two were significantly less resistant than the common Hegari variety now being grown. *Tropical Storage Abstracts* 12c

A new method of preserving harvested crops. 1972. *Agricultural News BASF* 4, E2070, p 5-8.

Three methods have been used up to now to obtain good storage stability of wet cereals, tapioca, copra, and other crops. The crop is dried to reduce the water content to a level at which enzyme activity is minimized, respiratory intensity reduced, and microbial activity limited. Ventilation may be used to cool the air and prevent an otherwise inevitable rise in temperature. Cool air may also be introduced. However, treatment with Luprosil increases the stability of wet harvested crops without the need for drying, cooling or ventilation. Luprosil is propionic acid. It is a clear aqueous substance which prevents the development of micro-organisms such as yeast, moulds and bacteria, besides blocking the activity of enzymes which decompose carbohydrates. Among others, a 0.1-0.2 percent Luprosil concentration has been used in maize against fungi, such as *Aspergillus flavus*. 12c

Ashman, F. 1963. The chemical control of stored food insect pests in Kenya. *Agricultural and Veterinary Chemicals* 4(2):44-48. 12c

Bindra, O.S. 1971. Malathion--its role in the prevention of storage losses. *Agriculture and Agro-Industries Journal* 4(9):38-42. B7 12c

Coaker, T.H. 1959. "Insack" treatment of maize with insecticide for protection against storage pests in Uganda. *The East African Agricultural Journal* 24(4):244-50. C32 12c

Cogburn, R.R. 1972. Natural surfaces in a gulf port warehouse: influence on the toxicity of malathion and gardona to confused flour beetles. *Journal of Economic Entomology* 65(6):1706-1709. C34 12c

Eckert, J.W. 1969. Chemical treatments for control of postharvest diseases. *World Review of Pest Control* 8(3):116-138. E2 12c

English, H.; Wright, T.R.; and Smith, E. 1948. Chemicals cut storage losses; federal scientists reveal success of extensive experiments. *Better Fruit* 43(2):9-11. 12c E100

Girish, G.K.; Goyal, R.K.; and Krishnamurthy, K. 1971. Efficacy and residual toxicity of iodofenphos and malathion (5 percentdust) against stored grain pests. Part II. *Pesticides India* 5(6):18-20. 12c

Test species were adults of *Sitophilus oryzae* and *Tribolium castaneum* and larvae of *Trogoderma granarium*. 12c

Great Britain. Pest Infestation Control Laboratory. 1973. *Pest infestation control: combining the report of the Infestation Control Laboratory 1968-70 and Pest Infestation Research, 1970.* London: Her Majesty's Stationery Office. 12c

Reviewed in Tropical Stored Products Information 1974(26):3. Reviewer states "Although in the main directed towards problems arising in temperate conditions, much of the work is equally applicable to tropical and sub-tropical areas...."

Green, A.A. and Wilkin, D.R. 1969. The control of insects in bagged grain by injection of dichlorvos. Journal of Stored Products Research 5(1):11-19. 12c

LaHue, D.W. and Dicke, E.B. 1971. Phoxim as an insect protectant for stored grains. Journal of Economic Entomology 64(6):1530-1533. L1 12c

Lindgren, D.L.; Sinclair, W.B.; and Vincent, L.E. 1968. Residues in raw and processed foods resulting from post-harvest insecticide treatments. Residue Reviews 21:1-121. 12c

Majumder, S.K. and Bano, A. 1964. Toxicity of calcium phosphate to some pests of stored grain. Nature London: 202(4939):1359-1360. 12c

Majumder, S.K.; Narasimhan, K.S.; and Subrahmanyan, V. Insecticidal effects of activated charcoal and clays. Nature (London) 184(4693):1165-1166. 12c

McFarlane, J.A. 1969. The effects of synergised pyrethrins and lindane on preemergence mortality of Acanthoscelides obtectus (Say.). Journal of Stored Products Research 5(2):177-180. 12c

McFarlane, J.A. 1963. Prospects for pyrethrum with particular reference to its use in the control of pests of stored foodstuffs. Tropical Stored Products Information 6:202-212. 12c

Describes the research undertaken into the use of pyrethrins and discusses the cost factor. Concludes that the cost factor is the major factor limiting their use though this is to some extent compensated for by the safety factor.

McFarlane, J.A. and Sylvester, N.K. 1969. A practical trail of pyrethrins-in-oil surface sprays for the protection by Cadra cautella (Wlk.) in Kenya. Journal of Stored Products Research 4(4):285-293. 12c

National Research Council, Food Protection Committee, Food and Nutrition Board. 1965. Chemicals used in food processing. Washington, D.C.: National Academy of Sciences. N3 12c

National Research Council, Committee on Food Protection, Food and Nutrition Board, Division of Biology and Agriculture. 1973. The use of chemicals in food production, processing, storage, and distribution. Washington, D.C.: National Academy of Sciences. N6 12c

Ofosu, A. 1977. The role of pesticides in post-harvest protection of cereal grains with particular reference to Ghana. In: Report of the Regional Workshop on Post Harvest Losses, Accra, Ghana, 25-29 April, 1977, pp. 83-93. London: Commonwealth Secretariat. 12c. O2

Ogawa, J.M., Manji, B.T., and El Behadli, A.H. 1976. Postharvest deterioration: chemical control of postharvest diseases. In: Proceedings of the 3rd International Biodegradation Symposium, Kingston, Rhode Island, 17-23 August 1975, ed. by J.M. Sharpley and A.M. Kaplan, pp. 561-575. London: Applied Science Publishers. 12c

Ogawa, J.M.; Sandeno, J.L.; and Mathre, J.H. 1963. Comparisons in development and chemical control of decay-causing organisms on mechanical and hand-harvested stone fruits. Plant Disease Reporter 47(2):129-133. O3 12C

Page, B.G. and Thomson, W.T. 1971. The 1971 insecticide, herbicide, fungicide quick guide. Fresno, Calif.: Thomson Publications. 12c

Looseleaf. Includes pesticides suitable for use on agricultural premises. 12c

Papworth, D.S. 1961. The protection of stored cereals by malathion admixture techniques. Agricultural and Veterinary Chemicals 2:160-165. 12 references (no titles cited) 1924-1960). 12c

Parkin, E.A. 1961. The potentialities of pyrethrum in the bag storage of grain. Tropical Stored Products Information 3:77-81. 12c

Describes 5 methods of warehouse use of pyrethrum insecticides.

Parkin, E.A. 1957. A provisional assessment of malathion for stored product insect control. Tropical Stored Products Information 2:38-43. 12c

Protection of stored grain (in editorial comment). 1957. World Crops 9 (2).

Discusses paper 'The protection of stored grains with, pyrethrins and piperonyl butoxide given by W.E. Dove to International Conference of Entomologists, Montreal, August, 1956.

Rao, G.V. and Pfost, H.B. 1974. Regeneration capacity of silica gel for grain drying. Grain storage, processing and marketing research report no. 7. Manhattan, Kansas: Kansas State University, Food and Feed Grain Institute. 12c R5

Rowlands, D.G. 1967. The metabolism of contact insecticides in stored grains. Residue Reviews 17:105-177. 12c

Singh, R.H. and Benazet, J. 1975. Chemical intervention on all stages and on all scales of tropical storage practice. In: Proceedings of the 1st international working conference on stored product entomology, 7-11 October, 1974, Savannah, Georgia, pp. 554-566. Savannah, Georgia: Organizing Committee of the Conference. (Authors' address: International Institute of Tropical Agriculture, Ibadan, Nigeria). 12c

Grain protection has been in practice for centuries in the tropics. Earlier protection included use of materials such as ash and dry neem leaves, which probably acted as an abrasive and repellent respectively. In the late 1940s, the concept of synthetic chemical control transformed from mixing of BHC and DDT dust to the use of approved products such as malathion and Phostoxin. During this period research on relative efficacy of various chemicals and fumigants under tropical storage conditions was also conducted. Grains need protection at all stages from field to consumption. In the tropics field to storage infestation by stored grain pests is common. Inadequate storage methods immediately after harvest and before processing add to the problem of field to storage infestation. The process of infestation and more so of multiplication of insects continues during processing, transportation, and long term or seasonal storage before the grain is finally consumed. Yield losses during these various stages are estimated. An overall yield loss of 30 percent, as estimated by some workers, may not be an exaggerated estimate. Storage practices in the tropics vary a great deal due to factors such as climate, produce, availability of local materials, transportation, length of time to be stored. There has been a great deal of change in storage practices at government level, where large scale storage is practiced, but comparatively little change has come at the level of the tropical subsistence farmer. Tropical Storage Abstracts 1975(3):42-3.

Smith, W.L., Jr. 1962 Chemical treatments to reduce postharvest spoilage of fruits and vegetables. The Botanical Review 28(3):411-45. S23 12c

Stuckey, B.N. 1955. Increasing shelf life of cereals with phenolic antioxidants. Food Technology 9(11):585-587. 12c

U.S. Department of Agriculture. 1964. Summary of registered agricultural pesticide chemical uses. 2nd edition. Washington, D.C.: U.S. Department of Agriculture, Agricultural Research Service. 12c

U.S. Industrial Chemicals, Inc. 1950. Pyrenone prevents grain insect damage to stored wheat. New York: U.S. Industrial Chemicals Inc. 12c

Observed that wheat graded "weevily" had increased from 3.45 percent in 1948 to 4.28 percent in 1952. With light infestation, (2 percent), the total loss was about 6¢ per bushel while with heavy infestation (10 percent) the loss increased to 45¢ per bushel.

Warner, J.L. 1954. Protection of stored grain with 'Pybuthin' insecticides. World Crops 6(6):251-2. 12c

Results of trials in U.K. with insect-free grain stored in insect-free premises. "Pybuthin" is a trade name for a mixture of pyrethrins. After 16-1/2 months, the treated grain was in better condition than the untreated.

Watters, F.L. 1959. Effects of grain moisture content on residual toxicity and repellency of malathion. Journal of Economic Entomology 52(1):131-134. 12c

Weaving, A.J.S. 1975. Grain protectants for use under tribal storage conditions in Rhodesia. 1. Comparative toxicities of some insecticides on maize and sorghum. Journal of Stored Products Research 11(2):65-70. (Author's address: Ministry of Agriculture, Department of Research and Specialist Services, Salisbury, Rhodesia). 12c

Median lethal doses of five insecticides were measured for *Sitophilus zeamais* on maize and sorghum using laboratory formulated dusts.

Fenitrothion was the most toxic followed by fenthion, iodofenphos, tetrachlorvinphos and pyrethrins in ordser of decreasing toxicity. Fenitrothion on maize and sorghum (8.0 ppm) pirimiphos methyl on maize (5.0 ppm) and phenthoate on maize (4.0 ppm) showed good persistence for 12 months, other insecticides tested giving shorter periods. The optimum pyrethrins:piperonyl butoxide ratio was 1:15, smaller ratios demanding a higher deposit of pyrethrins than is normally recommended. Loss of insecticidal effect was more rapid on maize than on sorghum through responses to given doses of insecticide were less on the latter grain. Tropical Storage Abstracts, 1975(3):3. 12c

Wilkin, D.R. and Hope, J.A. 1973. Evaluation of pesticides against stored product mites. Journal of Stored Products Research 8(4):323-327. 12c

d. Packaging

Botswana. Department of Agriculture. 1969. Grain storage in bags. Gaborone: Department of Agriculture, Information Service. 12d

Botswana. Department of Agriculture. 1969. Grain storage in baskets. Gaborone: Department of Agriculture, Information Service. 12d

British Standards Institution. 1971. Guide to hazards in the transport and storage of packages. London: British Standards Institution. 12d

Part 1, Climatic hazards. 25 p. Part 2, Climate hazards (maps and diagrams) 63 p. Examples are given from a range of climatic zones.

Coveney, R.D. 1969. Sacks for the storage of food grains. Tropical Stored Products Information 17:3-22. 12d

Discusses various types of sacks - jute, cotton, paper, plastic - under various headings such as: sack construction, cost, mechanical hazards, climatic and biological hazards, sack storage.

Dallyn, H. and Everton, J.R. 1972. The influence of packaging materials on microbial growth. Proceedings of the Institute of Food Science and Technology of the United Kingdom 5(2):95-105. D1 12d

Henig, Y.S. 1975. Storage stability and quality of produce packaged in polymeric films. In: Symposium: Postharvest biology and handling of fruits and vegetables, ed. by Haard, Norman F. and Salunkhe, D.K. pp. 144-152. Westport, Conn.: The AVI Publishing Co. 12d

Majumder, S.K. 1968. Packaging and protection against insects in tropical and sub-tropical areas. In: A guide for food packaging for developing countries, p 327-345. Rome: FAO. 09619-68-WS. Restricted. 12d

Nigam, B.S.; Perti, S.L.; and Agarwal, P.N. 1969. Susceptibility of packaging materials to insects and rodents. Labdev Journal of Science and Technology (India) 7-B (2):89-98. N13 12d

Southgate, B.J. 1965. Plastic films for the bulk storage of food. Plastics Institute Transactions and Journal 233(103):11-15. S30a 12d

Wilkins, D.R. and Green, A.A. 1970. Polythene sacks for the control of insects in bagged grain. Journal of Stored Products Research 6(1):97-101. 12d

Wright, F.N. and Southgate, B.J. 1962. The potential uses of plastics for storage with particular reference to rural Africa. Tropical Science 4(2):74-81. W28 12d

Yerington, A.P. 1974. Resistance to insect infestation. Modern Packaging 47(10):46-47. 12 d Y

e. Biological Control

Assem, J. van dem and Kuenen, D.J. 1958. Host finding of Choetospila elegans Westw. (Hym. Chalcid.) a parasite of Sitophilus granarius L. (Coleopt. Curcul.). Entomologia Experimentalis et Applicata 1:174-180. 12e

Battu, G.S. and Dhaliwal, G.S. 1975. On the activity of certain spider predators against stored grain insect pests. Current Science 44(24):893-894. (Author's address: Punjab Agricultural University, Ludhiana, Punjab, India. 12e

Reports on trials of six spp. of spiders against adults and larvae of Sitophilus oryzae, Rhizopertha dominica, Tribolium castaneum and Alphitobium sp. All six spider spp. preyed actively on the host insects. Larvae and T. castaneum appeared to be the preferred host. Artemis atlanta and Selenops *aqumbensis* were equally good in preying upon *S. oryzae* and *R. dominica* respectively. *Tropical Storage Abstracts*.

Bhamburkar, M.W.; Chatterji, S.M.; Pradhan, S.; Prasad, H.; and Sethi, G.R. 1971. Feasibility of controlling stored grain pests by the sterile-male technique. In: *Symposium on the sterility principle for insect control or eradication, Athens, 1970*, pp. 365-371. Vienna: International Atomic Energy Agency. FAO 14364-71-PS. 12e

Bhatia, S.K. 1976. Resistance to insects in stored grains. *Tropical Stored Products Information* 31:21-35. 12e

Reviews current state of research into resistance to attack by maize, sorghum, rice, wheat, barley and oats. Concludes that breeding for resistance to storage pests should form an integral part of cereal breeding programmes. 98 refs. p1917-75.

Bilanski, W.K. 1966. Damage resistance of seed grains. *Transactions of the ASAE* 9(3):360-363. 12e

Clean stored grain with a beneficially destructive pathogen. 1975. *Agricultural Research* 24(3):6-7. C28 12e

Nearly 3 years ago findings of Douglas K. Hunter, ARS entomologist, and associates at Fresno, Calif., showed that the granulosis virus, a pathogen, would protect unshelled nuts against the Indian meal moth. Recently, these studies were extended by ARS entomologist William H. McGaughey at the U.S. Grain Marketing Research Center, Manhattan, Kansas, who found in preliminary experiments that a minute amount--about two parts per million--of the insect pathogen effectively control the Indian meal moth in wheat and corn. The pathogen is thought to act by inhibiting only unique aspects of the target insect's physiology. Demonstration of its potential as a biological alternative to insecticides is a significant step toward safer, more effective protection of stored grain and grain products. The moth, a serious pest, is difficult to control because of its resistance to malathion and synergized pyrethrins.

Commonwealth Agricultural Bureaux. 1976. *Biological control service*. Slough, England:CAB. 12e

Haines, C.P. 1977. The potential for use of synthetic sex pheromones for control of Ephestia *cautella* in tropical countries. In: Proceedings XV International Congress of Entomology, 19-27 August, 1976, Washington, D.C., pp. 688-690. College Park, Maryland: Entomological Society of America. 12e H100

Lovitt, A.E. and Soderstrom, E.L. 1968. Predation on Indian meal moth eggs by Liposcelis bostrychophilus. Journal of Economic Entomology 61(5):1444-1445.

Pandey, N.D. and Singh, L.N. 1974. Studies on relative resistance of some maize varieties to Rhyzopertha dominica Fabr. Bulletin of Grain Technology 12(1):29-31. 12e

Resistant Indian wheats hold promising future. 1975. Agricultural Research 24(1):10. R18 12e

Teotia, T.P.S. and Tiwari, G.C. 1971. Dharek drupes and leaves as protectants against Sitotroga cerealella, infesting wheat seeds. Bulletin of Grain Technology 9(1):7-12. 12e

von Borstel, R.C. 1968. Control of adult pests by the irradiation-of-male method. In: Symposium on the use of isotopes and radiation in entomology, Vienna, 1967, p 331-337. Vienna: International Atomic Energy Agency. FAO 04435-68-PS. 12e

Waterston, J. 1921. Report on parasitic Hymenoptera, bred from pests of stored grain. Rep. Grain Pests (War) Committee 9:8-32. 12e

Wilson, F. 1972. The use of biological methods in pest control. Tropical Science 14(2)149-158. W18 12e

Wood, D.L. and others, eds. 1970. Control of insect behaviour by natural products, edited by Wood, D.L.; Silverstenand, R.M.; and Nakajima, M. London: Academic Press, 346 p.

Chapters dealing with stored products insects include:
Burkholder, W.C. Pheromone research with stored-product coleoptera.
Nakajima, M. Fr. Studies on sex pheromones of the stored grain moths.
Yamamoto, I. and Yamamoto, R. Host attractants for the rice weevil and cheese mite. 12e

f. Irradiation

Brower, J.H. and Tilton, E.W. 1973. Weight loss of wheat infested with gamma radiated Sitophilus oryzae and Rhyzopertha dominica. Journal of Stored Products Research 9:37-41. 12f

Golumbic, C. and Davis, D.F. 1966. Radiation disinfestitation of grain and seeds. In: Proceedings, Symposium on Food Irradiation, Karlsruhe, 1966, pp. 473-488. Vienna: International Atomic Energy Agency. 12f

Laudani, H. 1967. Technology of grain irradiation. Remarks given at the dedication of the new grain irradiator at the Stored-Product Insects Research and Development Laboratory, Stored-Product Insects Research Branch, Agricultural Research Service, Savannah, Georgia, 15 May, 1967. 12f L1a

Maxie, E.C.; Sommer, N.F.; and Mitchell, F.G. 1971. Infeasibility of irradiating fresh fruit and vegetables. Horticultural Science 6:202-204. 12f

Olorunda, A.O. and Aboaba, F.O. 1977. Food preservation by ionising radiation in Nigeria present and future status. Paper presented at the FAO/IAEA/WHO International Symposium on Food Preservation by Irradiation, 21-25 November, 1977, Wageningen, Netherlands. 12f O5a

Rivera, J.R.; Gonzalez, M.A.; and Cuevaz-Ruiz, J. 1974. Sprout inhibitation in yams by gamma irradiation. Journal of Agriculture of the University of Puerto Rico 58:330-337. 12f

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Its charter, an Act of Incorporation passed by the U.S. Congress and signed by Abraham Lincoln on March 3, 1863, calls upon the Academy to serve as an official advisor to the federal government, upon request and without fee, on any question of science or technology. From 50 charter members, it has grown to more than 1,200 scientists and engineers, elected to lifetime membership for significant contributions to the advancement of science and technology.

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