Post-Harvest Losses of Foodgrains

An interim bibliography for Africa

Commonwealth Secretariat

POST-HARVEST LOSSES OF TROPICAL GRAINS WITH SPECIAL REFERENCE TO AFRICA: AN INTERIM BIBLIOGRAPHY

COMPILED BY

D.E. STILES, A.L.A.

at the request of the Food Production and Rural Development Division, Commonwealth Secretariat, London.

Commonwealth Secretariat,
London

1977

TABLE OF CONTENTS

INTRODUCTION AND OBJECTIVES

POST-HARVEST LOSSES OF TROPICAL GRAINS WITH SPECIAL REFERENCE TO AFRICA: AN INTERIM BIBLIOGRAPHY COMPILED BY D.E. STILES, A.L.A. LONDON: COMMONWEALTH SECRETARIAT, 1977.

Introduction This bibliography of post-harvest losses of tropical grains with special reference to Africa has been prepared for delegates attending the Conference on Post-harvest grain losses to be held in West Africa in April 1977.

Dorothy Parker, in her introduction to the International Bibliography of Rice Research - (Parker, 1963) says: "As anyone problems are encountered than can be anticipated at the beginning of a project ... Haste and excellence are not compatible in bibliographic work".

This is all too true of this bibliography, hence the inclusion of the word 'interim' in the sub-title - I hope that there will be an opportunity to produce a more definitive edition with improvements to the layout and arrangement (e.g. to adopt a standardised method of citation), as well as including additional material.

Objectives Recently there has been noticable interest taken in the losses, quantitative and qualitative, incurred during and after harvesting. This bibliography is intended to indicate areas in which research has taken place to control these losses (and to show up areas in which research is needed). In particular it is intended to bring this material to the notice of interested parties in Africa where much of the material, unfortunately, is not available.

Adimorah (1976) quoting Lawani (1975) states that 37.1% of the periodicals which publish papers on tropical and sub-tropical agriculture are not available in any library in Nigeria and says that very few of those which are available are held by many libraries. Adimorah complains that users in developing countries fail to avail themselves of the information available and states that his organisation's Tropical Grain Legume Bulletin is more in demand by scientists in developed countries than by those in developing countries.

He goes on to comment on the complete absence of an information network, data banks or depositories of scientific literature in most developing countries. It is with this gap in mind that this bibliography has been compiled and in order for it to be available in time for the first of the planned two conferences it has had to compiled in haste, often simply by copying or adapting references obtained from other sources.

Another bibliography on this subject has just been issued by the Tropical Products Institute (Adams, 1977). It is hoped that the two bibliographies will be complementary. Adams concentrates on the quantification of losses whilst this present bibliography includes literature on measures taken to control losses.

Coverage The bibliography concentrates on farmer storage of edibles, especially in Africa, but is not confined to these subjects - e.g. many pests are now worldwide; on-farm storage methods in other developing areas could be relevant to Africa. The edibles included are cereal and legume grains, cassava and yams. Coverage includes:- literature which quantifies losses; literature which examines the causes of the losses; literature which explores ways of preventing or reducing losses; literature which deals with treatment of damaged stocks; other storage literature.

Arrangement There are five sections:-

1. Agriculture in general - drawing attention to works which may be of value for further research into post-harvest losses.

2. Crops: post-harvest losses and their control - this is subdivided into specific crops

3. Crops: losses and their control during post-harvest operations - subdivided by specific aspects.

4. Author index

5. Subject index - this is not exhaustive and is mainly intended to draw attention to works which cover more than one subject and are therefore arranged in the main sequence under the subject which is dealt with most extensively (or, in cases of doubt, under the subject which comes first in the method of arrangement). Index references are not necessarily made to items appearing under appropriate general headings or links in chain, e.g. works on peas will be found under the general heading for legumes, 2.2. as well as under the specific heading for peas, 2.2.3. but are not necessarily indexed under the general heading or intermediate steps in the chain.

Sources Much of the material has been obtained from the following:-

Tropical Storage Abstracts; Tropical Stored Products Information; International Bibliography of Rice Research.

References in the Preface

ADAMS, J.M. (1977). A cross-referenced bibliography on post-harvest losses in cereals and pulses with particular reference to tropical and subtropical countries. London: Tropical Products Institute, 1977. (Report G110).

ADIMORAH, E.N.O. (1976). Problems of scientific information work in developing countries. Information Scientist, 1976, 10 (4), 139 - 148.

LAWANI, S.M. (1975). An assessment of the holdings of tropical agricultural periodicals in Nigerian libraries. Nigerian Libraries, 1975, 10 (1): 1 - 8.

PARKER, Dorothy (1963). Introduction IN INTERNATIONAL RICE COMMISSION. International Bibliography of Rice Research.

D.E. Stiles

1. AGRICULTURE (General)

1.01 Bibliographies

BESTERMAN, Theodore (1971)

Agriculture: a bibliography of bibliographies. Totowa, Rowman and Littlefield, 1971.
(Besterman world bibliographies)

BUSH, E.A.R. (1974)

Agriculture: a bibliographical guide London, Macdonald, 1974.
2v (xxxi, 1561p)
(Macdonald Bibliographical guides)
Entries referred to as "Bush" were located through this excellent guide.

COMMONWEALTH BUREAU OF AGRICULTURAL ECONOMICS (1971)

Aspects of agricultural policy and rural development in Africa: an annotated bibliography. 5v Intl. Publishers Serv., 1971.

MAMOUN, Izz Eldin (1974)

Bibliography of agricultural and veterinary research in the Sudan (up to 1973). Natl. Council for Res; Agricultural Res. Council '74. 178p.

1.02 Periodicals and Abstracts (including fringe subjects)

AGRICULTURAL SCIENCE HONG KONG (1968)
Hong Kong, Government Printer, for Agriculture and Fisheries Dept.
Vol. 1, no. 1, October 1968.
2 issues a year.

AGRINDEX (1975)
Rome, FAO, 1975

Biological and agricultural index; a cumulative subject index to periodicals in the fields of biology, agriculture, and related sciences. Wilson. Formerly Agricultural Index.

BOALACH, D.H. (Editor) (1967)

Current agricultural serials: a world list of serials in agriculture and related subjects (excluding forestry and fisheries) current in 1964.

Oxford, International Association of Agricultural Librarians and Documentalists, 1965-67 2v.
Vol 1 - Alphabetical list; 358p
Vol 11 - Indexes; vii, 95p

COMMONWEALTH AGRICULTURAL BUREAU

Review of applied entomology (var. vols.)

CHEMICAL Abstracts

COMMONWEALTH BUREAU OF PASTURES AND FIELD CROPS, Great Britain

List of periodicals and reports examined by the Commonwealth Bureau of Pastures and Field Crops, prepared January 1964. (In Field crop abstracts, 17, (1), Feb. 1964, pp. xiii-xxxv.

FIELD crop abstracts

GHANA JOURNAL OF AGRICULTURAL SCIENCE, Accra, Ghana Universities P., for Crops Research Institute, Kumasi (Council for Scientific and Industrial Research).
Vol 1, part 1, June 1968.
2 parts annually, June and December.

INSTITUTE OF ENTOMOLOGY AND PARASITOLOGY OF AFRICA (INEPA) NEWSLETTER.
Kumasi, Ghana, University of Science and Technology.

JOURNAL OF THE SCIENCE OF FOOD AND AGRICULTURE

NUTRITION AND FOOD SCIENCE

OUTLOOK ON AGRICULTURE

OXFORD AGRARIAN STUDIES

RURAL RESEARCH

TROPICAL abstracts. Amsterdam, Dept. of Agricultural Research, Royal Tropical Inst., 1946-1974.

Continued as ABSTRACTS on Tropical agriculture 1975 -

TROPICAL oil seeds abstracts

TROPICAL SCIENCE
London, H.M.S.O. for Tropical Products Institute

"A quarterly journal on renewable resources development"

WORLD agricultural economics and rural sociology abstracts.

WORLD crops
1949 -

1.03 Development, Extension and Research

BYRNES, F.C. (1969)

Farmers' resistance - to what? Devp't Digest, 1969, 7 (2), p 29-37.

Discusses farmers' failure to adopt innovations recommended by extension agents, etc.

EICHER, C.K. (1970)

Research on agricultural development in five English speaking West African countries. New York: Agricultural Development Council, 1970. 153 p. Reviewed in Trop. stored Prod. Inf., 1971 (22) p.52

GHANA Crops Research Institute (1970)

Annual report for the year 1967. Accra, Ghana Univerisities P., 1970.

GHANA ACADEMY OF SCIENCES. Crops Research Institute

Annual report, 1965. Accra: Ghana Universities P.,; Ashford (Kent) Headley, 1969. 123p. Contents include: Afful, B.B. and Montford, L.C.: Insect control with calcium oxylate crystals, pp. 109-110 - crystals were found in some varieties of cocoyam; Afful, B.B. and Ofosu, A.: Yam, Storage and processing; P. 26; Rawnsley, J.: Food Storage, p.5 p.5; Rawnsley, J.: The preservation of maize. p. 18 - work on storing desheathed maize cobs in traditional barns.

GREAT BRITAIN. DEPARTMENT OF EDUCATION AND SCIENCE

Scientific research in British universities and colleges 1973 - 74. Vol. II Biological sciences London: H.M.S.O., 1974

Agriculture p. 609 - 629
Agricultural economics p. 629 - 638

LYNN, C.W. (1972)

Agricultural extension services in Botswana: an evaluation study, 1971, published 1972.

33p. Typewritten

MALAWI. Shire Valley Agricultural Development Project

9th quarterly report, April-June 1975, I.D.A. Credit No. Mai. 363.

PATEL, A.U. (1973)

Changing Badeku. Ceres, 1973, 6 (1) p 60 - 61.

THORNTON, D.S. (1973) Agriculture in South East Ghana. Vol. I Summary report. Univ. Reading, Dept., Agric., Econ., Management. Dev., Stud. No. 12 xxiv + 196p p + map + 12 append. (Obtainable from: Department of Agricultural Economics and Management, Earley Gate, University of Reading, Reading, England. Price 50p)

Reports on studies carried out by the Reading/Legon Joint Research Project in Village Development, South-East Ghana. The first chapter reports on the production environment. In the second there are notes on the marketing of-cassava, groundnuts and oil palm products. Chapter 3 includes a consideration of possible improvements and puts forward recommendations on maize drying and storage. The fourth aspects of the institutions in the region, and possibilities of change, and the final chapter discusses the general nature of planning and two specific elements in it - the need for a research and development unit, and the relation between surveys and methods of regional planning. - condensed from Trop. Storage Abstracts.

1.04 General Survey Post-Harvest Losses -AFRICA

COMMONWEALTH SECRETARIAT, LONDON (1977) The reduction of losses during farmer storage of Cereal and legume grains in Commonwealth Africa by Tropical Products Inst.

2. CROPS: Post-Harvest Losses and their Control: Specific Crops

2.1 Cereals, Grains

2.1.1 Crops - Cereals -Post-Harvest Losses and their Control

2.1.1.(01)

ADAMS, J.M. (1977)

A cross-referenced bibliography on post-harvest losses in cereals and pulses with particular reference to tropical and subtropical countries. London: Tropical Products Inst., 1977. ii, 28p. (Report no.G110) ISBN: 0 85954 061 8

Contains 265 entries. The emphasis is on quantification of losses and methodology.

2.1.1.1.

Crops - Cereals - Area Studies

AUSTRALIAN FREEDOM FROM HUNGER CAMPAIGN. Grain storage project FHH Tan 11, 1967. 5p + appendices. (UN: FAO mimeographed paper, plan of operations)

BONLIEU, A., NICOU, R., and TOURTE, R. (1964)

Traitement apres recolte des produits vivriers: mil, sorgho, niebles, doliques. (Post-Harvest treatment of food crops: millet, sorghum, cowpea, hyacinth bean (Dolichos Lablab)) United Nations Conf. Appl. Sci. Technol. Benefit Less Developed Areas (Working papers, Agr.) v. 2, No. 64, 6 p. Sept. 26, 1962. (E/CONF. 39/C/64). English summary
Processing and storage in Senegal.

CANADIAN INTERNATIONAL DEVELOPMENT AGENCY, (1972) Tanzania. CIDA A. Rev., 1971-1972, 32-33. (Publ. Information Division, Canadian International Development Agency, 122 Bank Street, Ottawa, K1A 0G4).

Notes that among other projects approved for Tanzania is included a produce-storage survey and pilot project designed to develop the nucleus for a total-systems concept of grain storage, handling, transportation and processing. - Trop. storage Abstracts.

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

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 whilst 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 main 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 Trop. storage Abstracts.

FORREST, R.S., PETERSON, T.A., HOGUE, J.J. and STECKLE, J. (1975)

The post-harvest food grain industry in semi-arid Africa. The International Development Research Centre, Ottawa, Canada. Appendix B. 83p. Typewritten.

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

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.

GRAIN STORAGE IN EAST AND CENTRAL AFRICA
Colonial Office H.M.S.O., 1950

GRAIN STORAGE IN KENYA: a year's progress in protection.

World Hunger, 1970 11 (2) 4-5
Describes FFHC project in Western Province which aims to introduce better storage systems for grain on smallholdings.

GROUP FOR ASSISTANCE ON THE STORAGE OF GRAINS IN AFRICA (GASGA)
Newsletter
(2nd issue April 1975 contains useful information on bilateral technical assistance projects on grain storage in Africa. Eleven projects in 7 Commonwealth countries are listed and one multilateral project).

JELLEMA, B.M. (1973)

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

KRISHNAMURTHY, K. (1975) Post harvest losses in food grains. Bull. Grain Technol. 13 (1), p. 33-49, 69 refs. (Author's address: Department of Food, Krishi Bhavan, New Dehli, India).

Review article. Subjects discussed include: threshing and winnowing; cleaning; transportation - losses in India during transit in 1949 were estimated at 0.5 - 2.3% by rail, 0.2 to 1.25% by road and 0.5 to 1% by river. Storage losses are examined in detail and are classified as loss in weight, loss in quality and nutritive value and hygienic deterioration. Causal factors are grouped as physical, biological and engineering. Subsequent losses occur during processing such as hulling and milling of paddy. The whole concept of loss is examined, and various formulae for estimation of losses are presented. Finally the need for a positive incentive to maintain quality and prevent loss is emphasised. - Trop. storage Abstracts, 1976 (1) 9.

KRISHNAMURTHY, K. (1976)

Indian Grain Storage Institute. Trop. stored Prod. Inf., 1976 (31) p. 49-53.
Post-harvest losses in India are estimated to be about 10%. Describes the work of the Institute towards reducing these losses.

LINDBLAD, C., NEWMAN, M. and VINITA, R. (1975) Considerations in rural development - one perspective; grain storage in Dahomey. ACTION - Peace Corps Progm. and Trng. J., 3 (4), p. 19-24. (Authors' address: P and T Journal, International Operations/Action, Room M-700, Washington, D.C. 20525, USA).

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 1 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 popularised 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 emphasised. - Trop. storage Abstracts, 1976 (1) 10.

MPHURU, A., and MARO, M.A. (1975)

Grain storage and handling in the Morogoro and Iringa regions of Tanzania. Trop. stored Prod. Inf., 1975 (30) p. 35-40. Illus.
Losses of grain grown on smallholdings is high. There have been various estimates of losses. One estimates that 200,000 tons are lost annually in Tanzania during storage. 12 refs 1940-73.

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, 1974. 45p. illus. Typewritten

STANLEY, R. (1976) Grain preservation: cutting the food losses. IDRC Rep., 5, (1)p16-17, illus. (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. Trails are in progress with traditional grain storage bins of different types, representing commonly used in several West African countries. In addition to improved storage, the trails 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 Trop. storage Abstracts, 1976 (3) p. 41.

SWAZILAND GRAIN STORAGE PROJECT NEWSLETTER
(1972 -)

WALKER, D.J. (1975) Report of the Swaziland rural grain storage project. September 1972 - April 1975. v + 79 pp, 2 maps, 1 pl, 5 refs, 2 append. Publ. Grain Storage Section, Ministry of Agriculture, Malkerns Research Station, Swaziland.

Describes in detail a project, financed by the Freedom from Hunger Campaign (UK) and Christian Aid, to improve the storage of maize and other durable commodities in the Swazi Nation areas. Outlines the present storage systems and their associated problems in the predominantly subsistence orientated community. A survey conducted in 1973, 1974 and 1975 lists the varieties of maize in store, the insecticides used and the storage containers encountered. Full details of moisture contents and the extent of damage caused by insects, moulds and rodents are presented. An improved maize cob drying crib was promoted together with suitably available dilute insecticidal admixture dusts. The project attempted to improve the efficiency of fumigation practices in the small sealable metal tanks common throughout the country; efforts were made to increase the use of phosphine preparations for this purpose. A large scale training and extension programme was implemented through out the life of the project. - condensed from Trop. storage Abstracts, 1975 (4) 57.

2.1.1.2

Crops, Cereals -- LOSS FACTORS

BURRELL, N.J. (1970)

Conditions for safe grain storage. 3p. (Technical note, Home Grown Cereals Authority, No. 16, 1970)

FOOD AND AGRICULTURE ORGANISATION, AGRICULTURAL SERVICES DIVISION. (1974) Measures for reducing post harvest losses. Supporting paper for the World Food Conference Preparatory meeting, Rome, Italy, 23 September - 4 October 1974. AGS: Misc/74/5, duplic, 9 pp. Rome: UN:FAO.

Discusses post harvest grain losses which occur during drying, storage, processing, transport handling and distribution. The advantages and disadvantages of effecting improvement at farm level and low amd medium level commercial operations are compared, and examples are quoted from rice production records in India and Liberia. The areas selected for priority in improvement proposals are Asia and the Far East, and Africa South of the Sahara. Recommendations are outlined for improvements at the various post harvest stages. Finally a list is given of policy decisions which will have to be taken. - Trop. storage Abstracts, 1975 (3) p. 43-4.

FRANCE SECRETARIAT D'ETAT AUX AFFAIRES ETRANGERES, (1974)
Manuel de conservation des produits

agricoles tropicaux et en particulier 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). Cent. Etud. Exp. Mach. Agric. trop. (C.E.E.M.A.T.) 356 pp, 184 fig, 5 append. biblphy. (Fr.) (Publ. C.E.E.M.A.T., Parc de Tourvoie, 92160 Antony, Haute de Seine, France. Price £4.50).

Consists of three principal parts. The first deals with general problem and discusses factors affecting the spoilage of stored produce such as microrganisms 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.

GROUP FOR ASSISTANCE ON STORAGE OF GRAIN IN AFRICA: seminar on techniques of training, investigation and evaluation of the processes of development in the field of seed and crop storage, Paris (France) November 21-22, 1973. Trop. stored Prod. Inf., 1974 (28) p.9-15. Trans from the report in L'Agronomie Tropicale, 1974 (8).

GROUP FOR ASSISTANCE ON STORAGE OF GRAIN IN AFRICA. (1973)
Seminar on "The methodology of evaluating grain storage losses", Tropical Products Institute, London, 6-7 February, 1973. Trop. stored Prod. Inf., 1973 (24) p.13-16.
Summary of proceedings. French translation in l'Agronomie Tropicale, 1973 (5)

GROUP FOR ASSISTANCE ON STORAGE OF GRAIN IN AFRICA: seminar on training in grain storage, Dakar (Senegal) April 22-23, 1975. Trop. stored Prod. Inf., 1976 (31), p. 9-12.

A French trans. will be published in L'Agronomie Tropical during 1976.

HALL, D.W. (1970)

Handling and storage of food-grains in tropical and sub-tropical areas. Rome, F.A.O., 1970 xiv, 350p. illus. £2.40.
(UN: FAO Agricultural Development Papers - no. 90) Reviewed in Trop. stored Prod. Inf., 1971 (21)2 Headings include: Losses of stored food; Storage methods; Insect control methods; Rodent control methods.

HYDE, M.B. (1965)
Principles of wet grain conservation. J. Proc. Instn Agric. Engrs, 21 (2), p. 75-82.

KANSAS STATE UNIVERSITY (1974)

Status of grain storage in developing countries (Revised 1975) Food and Feed Grain Institute, Kansas State University, Special Report No. 3. October 1974. Typewritten 246p.

POINTEL, J.-G. (1968)

Contribution a la conservation du niebe, du voandzou, du mais, des arachides et du sorgho. Agron. trop. Nogent, 1968, 23 (9) P.982-986.
English title - Contribution to the preservation of cowpeas, Voandzeia subterranea (Bambarra groundnut), maize, groundnuts and sorghum.

PREVETT, P.F. (1974) Tecnologia de graos armazenados - alguns melhoramentos recentes. (Grain storage technology - some recent developments). Bolm Inf. Soc. Bras. Cienc. e Tecnol. Alimentos No 30, 1974, 1-21, 20 ref. (Port.)
(Author: FAO Food Storage Expert, ITAL, Campinas, Brazil: present address: Tropical Stored Products Centre, London Road, Slough SL3 7HL, England).

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 requirements such as insulation, controlled ventilation, provision for in-store fumigation, and instances use of an impervious 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 vapour 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 Trop. storage Abstracts, 1975 (3) p. 40.

SINGH, S. (1969)

Measures to prevent post-harvest losses in agricultural commodities, particularly food grains in India. 6p. In Food and Agriculture Organisation: Papers presented at the 7th session of the Plant Protection Committee for the South East Asia and Pacific Region, Noumea, New Caledonia, 15-23 July 1969. Bangkok, F.A.O., 1969.

SINHA, R.N. and MUIR W.E. (Editors) (1973)

Grain storage: part of a system. Westport, Conn., Avi Publishing Co., 1973. xiii, 481p. $ 24.00

20 papers presented at a symposium on the storage of grain, Winnipeg, 1971. A long and critical review, Trop. stored Prod. Inf., 1974 (26) p.39-42 says "The research biologists will find the book useful but it is the accountants, administrators and planners responsible for the safe storage and handling of tropical produce who should get most use from the book".

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.

SPURGEON, D. (1976) Hidden harvest. A systems approach to post-harvest technology. 36 pp. illus. ISBN 0-88936-081-2. (Publ. International Development Research Centre, Box 8500, Ottawa, Canada K1G 3H9. Price microfiche edition $ 1).

Discusses the main components of the post-harvest food grains industry, comprising: harvesting and threshing; drying and storage; processing (conservation and/or transformation of the grains, e.g. wheat into flour, flour into bread); utilization by the consumer (including home processing). The main problem is the high level of wastage that occurs during the operation of the system, and the various categories of loss, such as weight, food value, economic loss, acceptability, quality, seeds, are examined. A working example of the systems approach to the problem is the Maiduguri Mill Project in Nigeria, and this is described in some detail. Finally recommendations are made regarding development of awareness of the problems, research, training and extension. - Trop. storage Abstracts, 1976 (3)

SYMPOSIUM ON GRAIN DAMAGE, Iowa State University Agricultural Engineering Dept., April 1968. Proceedings.
160p. $ 6.00

Contents include:-
Economic losses of damaged grain, by J.W. Uhrig; Problems in marketing damaged grain and corn, by J. Barley; Problems in marketing damaged grain - soybeans, by H. Grow; Need for standards for evaluation of grain damage, by

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

TANDON, R.N., and BHATNAGAR, O.K. (1956)

Some pathological studies of Curvularia spp. causing wastage of cereal and millets in storage. Proc. Bihar Acad. Agr. Sci. 5:p.18-23, pl. Ref. 1956.

Pennisetum typhoideum. 1017

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, 20 ph. (Span.) (Publ. Mexico/ Bueonos Aires, Centro Regional de Ayuda Tecnica, Agencia para el Desarrollo Internacional (AID) (Regional Centre for Technical Aid, Agency for International Development). (Distribution through AID missions in Latin-American countries).

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 mad 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 Trop. storage Abstracts.

2.1.1.2.1.1.3.

Crops, Cereals, Loss Factors - DRYING AND STORAGE

CULPIN, C.(editor) (1966)

Farm grain drying and storage. 3rd edition London, H.M.S.O., 1966. 172 p.

(Ministry of Agriculture, Fisheries and Food Bulletin no. 149)

Bush 3982. Contains 55 references, 1942-1965.

SUBRRAHMANYAN, V. (1973)

Drying of cereals and pulses - chemical methods and their implications. Post harvest technology of cereals and pulses. Proc. Semin. held New Delhi, 21-23 December, 1972, p. 64-71 reference.

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% of the kernel material between harvesting and marketing especially in humid weather.

2.1.1.2.1.1.4

Crops, Cereals, Loss factors - DRYING, DRIERS

RAO, M.V.K. (1973)

Mechanical methods of drying and experience. Post harvest technology of cereals and pulses Proc. Semin. held New Delhi, Dec. 21-23, 1972, p.111-114.

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 dier which uses paddy hush as fuel.

SEBESTYEN, E.J. (1970)

Grain aeration and drying. Milling, 1970 152 (10)p 24-25,p29-30, 32.

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

THOMSON, A.G. (1954)

Grain drying in tropical countries.

World crops April 1954, 6 (4)p.144-154.

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

UNITED STATES: AGRICULTURAL EXTENSION SERVICE/LOUISIANA STATE UNIVERSITY (1975) Grain dryers, last but not least. Wld Fmg, 17 (7)p.20, 22-23, 29, 2 tabl, 2 Fig.

Discusses the need for grain drying and the advantages of methods of artificial drying. Lists safe storage moisture contents for maize, sorghum, oats, paddy, soyabeans, wheat. Notes are given on the design and choice of storage structures, and suitable layouts. There are some notes on the process of grain drying, and a chart indicates estimate of weight losses when drying grain or seed from one moisture content to another. - Trop. storage Abstracts, 1975 (4), p.57.

2.1.1.2.2.

Crops, Cereals, Storage Conditions STORAGE LOSSES AND THEIR CONTROL, STORAGE CONDITIONS

ABDEL-AZIZ, A-H.F. (1975)

Storage of foodgrain. A guide for extension workers. vi + 31 pp. 21 illus, 2 append, 4 refs. Rome: UN: FAO, Agric. Education Ext. Serv., Human Resources Inst. agric Reform Div., Via delle Terme di Caracalla, 00100-Rome, Italy.

Handbook divided into 3 main sections. 1. Planning extension programmes for the safe storage of foodgrain. This involves: an assessment of the problems and potential economic benefits; formulation of a package of approved practices; compatability with existing agricultural skills and social practices; availability of suitable materials; organisational

Discusses factors influencing storage conditions and outlines various methods of storage.

2.1.1.2.2.1.

Crops, Cereals, Storage Conditions - AREA STUDIES.

ADESIYU, A.A. (1974). The storage of cereals in the northern states of Nigeria. Proc. Symp. "Problem Storage Handling Groundnuts other Food Grains and Animal Feeds" org. Afr. Groundnut Coun. Kaduna 1973. Appendix VIII) 58-64. (Author's address: Cereal Entomologist, Institute for Agricultural Research, Ahmadu Bello University, PMB 1044, Samuru, Zaria, Nigeria)

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%. Drying normally occurs in the field but this is diffcult 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 method 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% lindane at 10 ppm is recommended. In view of residue problems alternative insecticides are needed. - Trop. storage Abstracts. (condensed)

BARRE, H.J. and WIMBERLEY, J.E. (1975)

Storage of food grains in South Asia. Pap. presented 1975 A. Mtg. Amer. Soc. agric. Engrs, Davis, California, June 22-25. 1975. No 75-4506, 11 pp, 1 table, 8 figs, 18 refs. (Author's address: H J Barre, Professor Emeritus of Agricultural Engineering, Ohio State University, Ohio Agricultural Research and Development Centre, Colombus, Ohio, USA).

Progress in better handling and storage methods for food grains in South Asia is being made. Most indigenous home storage methods are ineffective and costly. A simple metal bin will preserve dry grain for an indefinite period without loss and at low cost. Conversion of bag to bulk warehouse storage is finding acceptance. This highly developed method can be readily adapted for countries with hot and dry or hot and humid climates. - Trop. Storage Abstracts.

DE LIMA, C.P.F. (1973)

A technical report on twenty-two grain storage products at the subsistence farmer level in Kenya and supplementary reports 1-9. Nairobi, National Agricultural Laboratories, 1973.

DAVIES, J.G. (1967)

Some essential considerations for storage of food grains and crops in Uganda. Kampala, Ministry of Agriculture, 1967.

DICHTER, D. (1976). The stealthy thief. Ceres, FAO Rev., 9 (4), 51-53, 55, illus. (Author's address: David Dichter and Associates, Geneva, Switzerland).

Estimates that in sub-Saharan regions, losses of food grains during storage at farm or village level can amount to 25-40%. About 80% of grain produced is kept for seed or consumption, the remaining 20% is sold; if this grain could be kept in good storage conditions, farmers could benefit from higher prices during times of shortage. With Benin as an example of an area where improvments are being introduced, brief descriptions are given

Boxall (1974) in same issue p. 39-48.

GRAIN STORAGE IN METAL TANKS. Gaberones: Dept. of Agriculture, Information Service, 1969. 3p. Also issued in Setswana.

GRAIN STORAGE IN MUD CRIBS. Gaberones: Dept. of Agriculutre, Information Service, 1969. 3p. Also issued in Setswana.

HALL, D.W., HASWELL, G.A., and OXLEY, T.A. (1956)

Underground storage of grain. London: H.M.S.O., 1956. 29p. (Colonial Research studies - no. 21)

HYDE, Mary B. (1969)

Hazards of storing high-moisture grain in airtight silos in tropical countries. Trop. stored Prod. Inf., 1969, (18), p. 9-12. 9 references 1954-68.

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). Agric. Serv. Bull. No. 17. AGS: ASB/17. v + 71 pp + 37 fig + 8 tabl. + refs. (Enquiries to: The Director, Agricultural Services Division, FAO of the United Nations, Via delle Terme di Caracalla, 00100 -Rome, Italy).

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. - Trop. Storage Abstracts.

JAGADEESH, H.N., PADMINI, V. and GEORGE, J. (1976) Grain storage. bins of plywood. IPIRI J., 6 (1) p. 19-30, 7 tabl, 12 Fig, 19 refs. (Authors' address: Indian Plywood Industries Research Institute Bangalore, Mysore, India).

Claims that exterior grade plywood is a versatile engineering material, with high strength/weight ratio, and is weather-proof, waterproof, decay resistant and insect and termite-proof. Theoretical and experimental studies at the Indian Plywood Institute have shown that it is possible to make grain storage bins of any capacity in the range 0.1 - 60 tonnes or more from this material using a nail/glue technique. Structurally such bins have high strength and stiffness. Functionally, they can be made practically gas-tight to facilitate fumigation and to prevent moisture entry. The good thermal properties of plywood reduce temperature fluctuations and the associated risks of moisture migration and condensation in stored grain. Properly designed bins are not attacked by rodents. They are relatively cheap, and are recommended for the domestic and rural sectors. - Trop. storage Abstracts, 1976 (4) p.51.

MAYHEW, A.W., PAPWORTH, D.S. and RUDGE, A.J.B. (1971)

Protection of grain in commercial silos. Milling, 1971 153 16-18 + 6 tables.

PEDERSON, H., NORGAARD-PEDERSON, P.E. and GLAHN, P.E. (1971)

Storage of grain in experimental silos: functional principal and reproducibility of results in simultaneous experiments and in experiments separated in time. J. Sci. Fd. Agric., 1971 22 (9)

cereales. (Hermetic silo for storage of cereals). C. Agr. Pays Chauds, 1969, (4), p.207-214. illus.

Adopted from 'Hermetic storage of rice for Thai farmers' by R. B.L. Smith and others. Describes in detail construction of experimental prototype silo based on Wallis bin, but of small capacity suitable for the individual farm.

BOXALL, R.A. (1973)

Ferro-cement lined underground grain silos in Ethiopia. In "Ferrocement: Application in developing countries". National Academy of Sciences, Washington.

BOXALL, R.A. (1974) Improvement of traditional grain storage pits in Harar Province, Ethiopia: a preliminary investigation. Int. Pest Control, 16 (5), 4-7, 3 tabl. 6 fig, 3 ref. (Author's address: Ministry of Agriculture, Fisheries and Food, London Pest Unit, London E.1., England).

Description of traditional storage pits used for sorghum and to a lesser extent maize. Report 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 approcimately ½-ton, using sorghum dried to 12.5% 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 lining 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, - Trop. storage Abstracts (condensed)

BOXALL, R.A. (1974)

Underground storage of grain in Harar Province, Ethiopia. Trop. Stored Prod. Inf., 1974 (28) p. 39-48. illus. 7 refs 1954-74.

Gilman and Boxall (1974) in same issue p.19-38.

BOXALL, R.A. (1974b)

Improvement of traditional grain storage pits in Harar Province, Ethiopia; a preliminary investigation. Int. Pest Control, 1974 (5) 4-7. illus, 3 refs. Describes work designed to overcome the problem of mould damage in traditional pits by using matting and straw liners, polythene sheets or sacks, or a concrete lining, or a combination of these barriers. The first method is the cheapest (and least effective) but could be used for short term storage. The polythene sack method seemed promising.

CENTRAL FOOD TECHNOLOGY RESEARCH INSTITUTE (1975) Storage of food grains. A.Rep. Cent. Fd Technol. Res. Inst., Mysore, for 1973, 1975,

Notes tests on small structures designed to hold 500-1000 kg. foodgrains. 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 organisations). 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. - Trop. storage Abstracts.

GILMAN, G.A. and BOXALL, R.A. (1974)

The storage of food grains in traditional underground pits. Trop. stored Prod. Inf., 1974 (28) p.19-38. illus. 31 refs

A worldwide survey of the subject with sections on "The Mediterranean region and the Middle East", p19-22, "Africa, south of the Sahara" p22-31.

Rome, Italy.

The course was attended by 22 participants from Tanzania, Kenya, Uganda, Somalia, Zambia, Botswana, Ethiopia and Seychelles. Its objectives were to reinforce for participants a basic understanding of the factors affecting grain storage losses and instruction in techniques for their control, and to provide experience in teaching and extension of this subject. It was based on the faculty of Agriculture and Forestry of the University of Dar-es-Salaam at Morogoro. Visits were made to several stores in various areas of Tanzania. The course covered the whole range of storage types, from farmer, through trader, middle level and large-scale stores (except for silo management). Syndicate and discussion work was designed to direct participants' attention towards their own countries' storage problems. An assessment of the effectiveness of the course, both by participants and staff, was initiated. - Trop. storage Abstracts.

GRAIN STORAGE IN BAGS. Gaberones: Dept. of Agriculture, Information Service, 1969. 2p. Also issued in Setswana.

GRAIN STORAGE IN BASKETS. Gaberones: Dept. of Agriculture, Information Service, 1969. 3p. Also issued in Setswana.

HYDE, M.B. (1968)

Successful storage of high moisture grain. Esso Fmr, 1968, 20 (3), 11-14.

HYDE, M.B. & OXLEY, T.A. (1960)

Experiments on the airtight storage of damp grain. 1. Introduction, effect on the grain and the intergranular atmosphere. Ann. appl. Biol., 1960, 48 (4), 687-710.

MALAWI: MINISTRY OF AGRICULTURE AND NATURAL RESOURCES. (1973). A guide to the safe storage of cereals, oilseeds and pulses. 66 pp. illus. (Publ. Extension Aids Branch, Ministry of Agriculture and Natural Resources, P O Box 594, Lilongwe, Republic of Malawi).

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. - Trop. storage Abstracts.

OXLEY, T.A. (1955)

Grain storage in tropical climates.

World crops, Dec 1955 7 (12) p.473-477.

TROPICAL STORED PRODUCTS INFORMATION, 20, 1970.

News Review includes:-

"Farmer storage advisory leaflets" - lists of simple, short advisory leaflets on grain storage produced in a number of countries, including Botswana, Ghana, Kenya and Zambia. (These have been individually listed for this bibliography)

TROPICAL STORED PRODUCTS INFORMATION, 25, 1973.

A 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.

The 46 pages of text contain 27 papers by various authors with some illus. and refs: proceedings of seminar to be separately published.

TYLER, P.S. (1970)

Grain storage (Freedom from Hunger Campaign). Rep., A. Rep. Res. Sect., Year ending 30 September 1969. Gaborone, Dept. of Agriculture, 1970.

WOUDENBERG, G.N. van (1971)

Seeds: the storage problem. Agric. Merch., 1971 51 (10) 49, p.51.

and administrative structure. 2. Transforming scientific principles into an extension message. This includes: reasons for storage; principles of safe storage; characteristics of an effective extension message. 3. Implementing the extension programme by incorporating grain storage syllabus of field extension workers, training courses and the use of extension aids. - Trop. Storage Abstracts.

DICHTER, D. (Ed.) (1975)

West African Seminar on the volunteer role in grain storage. Cotonou, Dahomey, December 13-21, 1974. 249 pp, tabls, figs, ph, biblphies. (Engl.). (Publ. The German Agency for Technical Cooperation Ltd. (GTZ), Press and Public Relations Office, D-6236 Eschborn 1 - P O Box 5180, West Germany) (Price unknown)

Report on a seminar designed to produce a document of immediate practical utility. The main body of the report consists of selected working documents and manuals from the seminar, followed by questions and answers of a practical nature. Cassette tapes and slides strips are being made available covering the main points, including the on-the-job instructions phase. Working papers presented include:

LINDBLAD, C., NEWMAN, M. and VINTA, R. Problems related to popularising new farm-level grain storage technology.

THORSHAUG, H. Construction and utilisation of various farm and village-level grain storage facilities.

DO SUP CHUNG and PEDERSEN, J.R. Fundamentals of farm and village level grain storage.

ADESUYI, S.A. The appropriate application of insecticides to farm and village level grain storage.

KETE, L. Socio-economic aspects of grain programmes at the village level.

POINTEL, J.G. Farm and village level grain storage techniques other than silos.

NTITI, E.O. Rural grain cooperatives: their management and administration.

FAO/IITA. Worksheet for building of a drying/storage crib.

US PEACE CORPS/MINISTRY OF RURAL DEVELOPMENT AND COOPERATIVE ACTION, REPUBLIC OI DAHOMEY. Construction manual for the 4.5 ton, 2.5 ton cement-stave silo and the mud-walled grain dryer.

US PEACE CORPS/MINISTRY OF RURAL DEVELOPMENT AND COOPERATIVE ACTION. Instructions for the use of your silo and dryer.

RIGTERS, K.A. Grain storage silo developed by field staff (Norhtern Ghana). Comparative costs of improved farm and village-level grain storage structures.

Section III covers implementation of improved systems. - cond. Trop. storage Abstracts, 1975 (4)

DUVAL, C.T. (1971)

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

An extension pamphlet on the advantages of storing grain.

FOOD AND AGRICULTURE ORGANISATION (1971)

Handling and storage of food grains in tropical and subtropical areas. Edited by D.W. Hall.

London, H.M.S.O., 1971. £2-40 (Agricultural Development Papers) 350 p.

FOOD AND AGRICULTURE ORGANISATION (1975) Report on the first course of the FAO/SIDA/Tanzania Sub-Regional Training Centre on storage pest control. Swedish Funds-in-Trust, TF AFR 49 (SWE), FAO/SWE/TF 144. v + 28 pp, 8 append. Rome: UN:FAO, Via delle Terme di Caracalla 00100-

of an improved grain crib, an artificial drier, a cement stave silo and a cement block silo. The materials used, are generally locally available, and traditional building techniques can be used. A brief description is given of an improved mud block silo developed in the drier northern areas of Ghana. - condensed from Trop. storage Abstracts.

FOOD AND AGRICULTURAL ORGANIZATION (1971)

Grain marketing, storage and price stabilisation, Somalia. Grain storage and crop protection. Technical report 1, based on the work of M.J. Watt. Rome: FAO, 1971. viii, 47p. illus. (ESR/SF/SOM 7).

FOOD AND AGRICULTURE ORGANIZATION & FEDERAL GRAIN STORAGE CONSULTATIVE GROUP (1976)

Joint consultancy report on a Federal grain storage scheme for Nigeria. Lagos: Federal Ministry of Agriculture and Rural Development, 1976. 2vol.

Vol1 Main report 69p. Typewritten.

Vol2 Appendices. 192p. maps. Typewritten.

GIRISH, G.K. and KRISHNAMURTHY, K. (1973)

Losses in food grains in storage. Post harvest technology of cereals and pulses. Proc. Semin. held in New Delhi, 21-23 Dec. 1972 p. 199-205.

Examines the various forms of losses and their causes. Tabulates estimates of losses in India. Stresses the need for an agreed procedure for assessing storage losses.

THOSHANS, 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, 1975, (5), 15-18, 3 figs (Fr.) (Publ. Development Commission of FEMEC, P O Box 790, Yaounde, Cameroon).

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% 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. - Trop. storage Abstracts, 1975 (4) p.56

2.1.1.2.2.2.1.

Crops, Cereals ---- STORAGE STRUCTURES (BUILDINGS, SILOS, PITS, EQUIPMENT)

BAKER, A.A. (1974)

Trials with maize and wheat stored for long periods under hermetic conditions in the Kenya "Cyprus" bins. Trop. stored Prod. Inf., 1974 (26)p.33-37. No refs.

BONLIEU, A., NICOU, R., and TOURTE, R. (1964)

La conversation des recoltes en Senegal; essais sur le mil, le sorgho, le paddy, le niebe (Crop preservation in Senegal; trials with millet, sorghum, paddy, cowpeas.) Agron. Trop. 19(1) 7-44. Jan. 1964.

English and Spanish summaries. Storage in open metal silos compared with storage in sacks.

2069

BOON LONG, S., SMITH, R.B.L. & LOO, Y.C. (1969)

Silo etanche pour le stockage des

p. 451-457 illus.

WATT, M.J. (1969)

Grain storage and marketing in the Somali Republic. Trop. store Prod. Inf., 1969, (18), p25-32. illus., map.

Describes the system of underground pit storage used for storing maize and sorghum-even by the commercial trader-and makes suggestions for improving the method. 3 refs. 1956-67.

YADAV, T.D. and KHANNA, S.C. (1974) Pusa Kothar - an improved grain storage structure. Ent. Newsl., 4 (6), p.35-36, 1 fig. (Author's address: Division of Entomology, Indian Agricultural Research Institute, New Delhi 110012, India).

Describes how a room in a house was converted to a practically airtight and moisture proof store, by lining the walls and floor with polythene sheeting, then with bricks, to form a sandwich. A false roof was built of wooden poles and mud slabs, then covered with polythene, and finally with 5 cm thick mud plaster. Room was filled with Trogoderma infested wheat After 6 months in store, the wheat was inspected for moisture content and germination, and both were found to be unchanged. Loss in weight was negligible, whilst wheat stored in an ordinary room or 'Kothar' as control, lost 7.86% in weight. An estimate of savings is given. - Trop. storage Abstracts, 1974 (1)p13.

2.1.1.2.2.2.2.

Crops, Cereals, Storage - SACKS

COVENEY, R.D. (1969)

Sacks for the storage of food grains. Trop. stored Prod. Inf., 1969, (17)p3-22. illus., bibliog. (11 entries, 1960-67)

Dicusses various types of sack - jute, cotton, paper, plastic - under various heads such as: - sack construction, cost, mechanical hazards, climatic and biological hazards, sack storage, coatings, liners, sack closures: - and finally looks at possible future developments.

Also discussed in 'Editoral', p.1.

2.1.1.2.2.3.1.

Crops, Cereals, Loss factors, Climate ---- CLIMATE

ELDER, W.B. (1969)

CSIRO develops aeration system for farm stored grain. Power Fmg and Better Fmg Dig., 1969 78 p.10 13, illus. Describes system suitable for typical farm grain storage.

GIRISH, G.K. (1970)

Respiration of grain under storage conditions. Bull. Grain Technol., 1970 8 (1 and 2) p.22-29.

GOUGH, M.C. and WRIGHT, Susan P.D. (1976)

Selected bibliography on the movement of water and heat in cereals. Trop. stored Prod. Inf., 1976, (31) p.17-20.

70 papers from 1929-November 1974

PIXTON, S.W. and WARBURTON, S. (1971)

Moisture content meters investigated: technical digest. Agric Merch., 1971 51 (ii)p43-48. (PICL reprint - no. 831)

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

ROBERTS, E.H. (1972)

Viability of seeds. London: Chapman and Hall, 1972. £7.00. ix, 448 p. illus.

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. Proc. Grain Conditioning Conf., Ill., Champaign 1975,p9-23, 9 fig, 6 ref. (Authors address: Professor, Agricultural

Engineering Department, University of Kentucky, Lexington, Kentucky 40506, USA).

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 Trop. Storage Abstracts, 1975 (5)p.68-9.

SMITH, C.V. (1969)

Meteorology and grain storage. Geneva: World Meteorological Organisation, £1.00, xvi, 47p. illus. (W.M.O. Technical notes - no. 101; WMO - no. 243, TP 133).

In English with French, Russian and Spanish summaries. 150 refs Reviewed in Trop. stored Prod. Inf., 1971 (21) 32.
"will be of value ... to all those concerned with the technical aspects of storage, in which climate is a significant factor" - reviewer.

TAYLOR, R.W.D. (1975)

The Storage of seeds. Trop. stored Prod. Inf., 1975 (30)p. 23-33.

Concludes that the most important factor affecting seed viability during storage is moisture content and relative humidity. 85 refs. 1917-74.

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 Trans. Am. Soc. Agric. Engrs, 1971 14 (3)p. 554-559 illus, refs.

2.1.1.2.2.3.2

Crops, Cereals, Loss Factors --- PESTS AND PESTICIDES.

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, 1975 , 431 pp. (Germ.) Price unknown.

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 symptons 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. - Trop. storage Abstracts.

CHURCH, C. (1969)

Pests: good results from year-old campaign in West Province. Trop. stored Prod. Inf., 1970 (20)p 21-25. illus.

Previously printed Kenya Farmer, Dec. p18-19.

Describes a project funded by the Freedom From Hunger Campaign (UK Committee) to introduce better storage systems for grains on smallholdings in Western Kenya.

CONSERVATION OF FOOD GRAINS - SOME ACHIEVEMENTS. In: 25 years of CFTRI. Rep. Cent. Fd Technol. Res. Inst., 1973,p19-22 (Publ: Central Food Technological Research Institute, Mysore, India).

Points out the extra need for prevention of loss in storage of food grains in India, since over two thirds of production is stored and consumed in rural areas, where storage techniques are relatively unsophisticated. Notes the value of preharvest spraying with malathion to precent infestation in the field. Mentions the use of the Durofume process for protecting commercial stocks, using a mixture of ethylene dibromide and methyl bromide. An inexpensive

development has been a portable machine for impregnating jute bags with insecticidal emulsion. Other developments have been in the field of rodent control, and an inexpensive home scale fumigant labelled Minifume, used for treatment of small quantities of grain in sealed containers. A non-toxicant grain protectant in the form of activated clay has been introduced. This, when mixed with grain causes desiccation and death of insect pests. Other achievements have included the production of a grain protectant based on Bacillus thuringiensis, an economical process for the production of lindane, a cheap method of reviving used gas mask canisters, a cheap halide lamp for detecting fumigants and a paper strip detector for phosphine. - Trop. storage Abstracts, 1976 (4)p.44-5.

CONTROL OF PESTS IN STORED AGRICULTURAL PRODUCTS WITH SPECIAL REFERENCE TO GRAIN. Report of a survey in North and South America and certain Mediterranean countries in 1954 and 1955. Paris, European Productivity Agency of the O.E.E.C., 1958. 169p (Project 212).

Lists 43 items, 1918-1956. The project aims to control infestation in the countries of origin.

FEDERATION FRANCAIS DES CEREALES. (1975) Ravageurs des grains entreposees. (Pests of stored grain). (Extract from the booklet, 'Les cereales a la cooperative', (Cereals and the cooperative). Bull. anc. Elev. Ec. Meun., 1975 (268),p211-214, 12 fig. (Fr.)

A brief description is given of the main insect pests of grain, with illustrations of the insects and the damage caused. Insects involved comprise Sitophilus granarius, S. oryzae, Tribolium confusum, Oryzaephilus surinamensis, Tinea granella, Plodia interpunctella and Sitotroga cerealella. Precautions against infestation include store hygiene - use of an industrial vacuum cleaner is recommended, fabric spraying with insecticide and separation from wooden floors, if necessary by plastic sheeting. There are notes on causes of infestation, losses, and insecticides in use, with special reference to lindane, malathion and pyrethrins. Malathion is suggested as the insecticide of preference. Fumigation with methyl bromide or phosphine is mentioned only briefly and the danger is emphasised. Other control methods noted include thorough drying, and cooling by ventilation. - Trop. storage Abstracts

FREEMAN, J.A. (1959)

Infestation of grain and feeding stuffs. In N.A.A.S.q. Rev., no. 45, Aug. 1959.

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

THE INCIDENCE AND EXTENT OF INFESTATION ON FOOD GRAINS STORED BY CULTIVATORS IN GUJARAT 1966. (1970) PESTICIDES INDIA, 1970 4 (12) p 55-58.
Discusses the findings of a committee appointed to assess losses of food grains during post-harvest handling and storage by farmers. Brief review in Trop. stored Prod. Inf., 1971 (22)p58

JAMAICA. MINISTRY OF TRADE AND INDUSTRY. STORAGE AND INFESTATION DIVISION AND MINISTRY OF AGRICULTURE AND LANDS. PLANT PROTECTION DIVISION.

Prevention and control of infestation of stored grain by insect pests and rodents. Kingston: Govt. Printer, 1961. 57p.

SCHESSER, J.H. (1967)
Phosphine fumigation of processed cereal products in rail cars. Am. Miller Processor, Jan. 1967, 6 pp.

WORLD CROPS FEB 1957, 9, (2)
Protection of stored grain.
In Editorial comment

Discusses paper 'The protection of stored grains with, pyrethrins and piperonyl butoxide given by Dr. W. E. Dove to International Conference of Entomologists, Montreal, Aug 1956.

2.1.1.2.2.3.2.1.

Crops, Cereals, Loss Factors
--- PESTS, INSECTS AND 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 J. agric. Sci. 7 (1), 63-70. (Authors' address: Northeast Agricultural Centre, Kohn Kaen, Thailand).

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. - Trop. storage Abstracts.

ASHMAN, F., ELIAS, D.G., ELLISON, J.F. and SPRATLEY, R. (1970) Ashman - Simon infestation detector: an instrument for detecting insects within food grains. Trop. stored Prod. Inf., 1970 (19)p15-19. illus, ref.

Reprinted from Milling, 1969 151 (3),p32-36.

Describes a simple machine, electrically or hand operated, for testing samples of grain. A description of its use for testing maize is given in "News Review", pp 8-9 of the same issue.

BATTU, G.S. and DHALIWAL, G.S. (1975) On the activity of certain spider predators against stored grain insect pests. Curr. Sci., 44 (24),p893-894,1 tabl. (Authors' address: Punjab Agricultural University, Ludhiana, Punjab, India.

Reports on trials of six spp. of spiders against adults and larve of Sitophilus oryzae, Rhizopertha dominica, Tribolium castaneum and Alphitobius sp. All six spider spp. preyed actively on the host insects. Larvae of T. castaneum appeared to be the preferred host. Artemis atlanta and Selenops agumbensis were equally good in preying upon S. oryzae and R. dominica respectively. - Trop. storage Abstracts.

BECKLEY, V.A. (1948) Protection of grain against weevils E. Afr. agric. J., 14 (2),p71-76.

BHATIA, S.K. (1976)

Resistance to insects in stored grains. Trop. stored Prod. Inf., 1976 (31)p21-35.

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.

CHAMP, B.R. (1974) World survey of pesticide resistance. CSIRO Div. Ent. A. Rep. 1973-74, 36. (Abstract only). (Author's address: Commonwealth Scientific and Industrial Research Organisation, Division of Entomology, P O Box 1700, Canberra City, A.C.T. Australia 2601).

This survey sponsored by the Food and Agriculture Organisation of the United Nations and conducted in conjunction with the Pest Infestation Control Laboratory of the United Kingdom continued during the year. 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. Collection finished during August and examination of the resultant 1,400 strains for susceptibility to malathion, lindane, methyl bromide and phosphine is almost complete. The emergence of resistance to fumi-

gants os of particular concern because the world has been dependent on fumigation both as a routine disinfestation 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 Trop. storage Abstracts.

COCKBILL, C.F. (1970)
Investigations on the control of insect pests of stored grain and pulses. Rhod. agric. J., 1953, (50)p 294.

COGBURN, R.R. and GILLENWATER, H.B. (1972)

Interaction of gamma radiation and fumigation on confused flour beetles. J. econ. Ent., 1972 65 (1) p 245-248.

GIRISH, G.K., GOVAL, R.H. and KRISHNAMURTHY, K. (1971)

Efficacy and residual toxicity of iodofenphos and malathion (5% dust) against stored grain pests. Part II - Pesticides India, 1971 5 (6) p18-20
Test species were adults of Sitophilus oryzae and Tribolium castaneum and larvae of Trogoderma granarium.

GREEN, A.A. (1968)
The prevention of insect damage to grain in stores.
Ceres, Lond. No. 4, Oct 1968 p. 13-17.

Lists 4 items 1961-1966, on damage by saw toothed grain beetle and the grain weevil.

GREEN, A.A. and WILKIN, D.R. (1969)

The control of insects in bagged grain by injection of dichlorvos. J. stored Prod. Res., 1969 5, (1)p11-19 (PICL reprint no.758).

JAY, E.G. (1971)

Suggested conditions and procedures for using carbon dioxide to control insects in grain stroage facilities.
6p. (U.S. Dept. of Agriculture. Research Service Reports. - no. ARS 51-46).

KOURA,A. and EL-HALFAWY, M.A. (1973) Weight loss in stored grains caused by insect infestation in Egypt. Bull. Soc. ent. Egypte, 56,p413-417 + 2 tabl. + ref. (Author's address: Plant Protection Department, Ministry of Agriculture, Cairo, UAR).

Two types of experiments were conducted in the laboratory to estimate losses due to insect feeding on different cereals. Under natural storage conditions wheat, sorghum and maize grains exhibiting emergence holes of adult insects showed on the average, weight losses amounting to 32.64, 33.80 and 22.18% respectively. In the laboratory, Sitophilus granrius larvae caused greater losses in weight due to breeding in barley varieties than in rice or wheat. S. oryzae consumed higher percentages of rice varieties than of barley or wheat. Rhizopertha dominica caused the highest weight losses in barley followed by rice and finally wheat varieties. - Trop. storage Abstracts.

LA HUE, D.W. (1970b)

Laboratory evaluation of dichlorvos as a short-term protectant for wheat, shelled corn and grain sorghum against stored-grain insects.

1970. 25p. (U.S. Dept. of Agriculture, Agricultural Research Service, repot no. ARS 51-37). Duplicated. Abstracted in Trop. stored Prod. Inf., 1970 (20) p41.

LA HUE, D.W. (1975) Pirimiphos methyl as a short term protectant of grain against stored-produce insects. J. econ. Ent. 68 (2), p. 235-236, 2 tabl, ref. (Author's address: Grain Marketing Research Centre, Agric. Res. Serv., USDA,

1515 College Avenue, Manhattan, KS 66502, USA).

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 h 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. Trop. storage Abstracts, 1975 (3)p38-9

LOSCHIAVO, S.R. and ATKINSON, J.M. (1967)

A trap for the detection and recovery of insects in stored grain. Can. Ent., 1967 99(11)p. 1160-1163.

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. J. stored Prod. Res., 1969 4 (4),p285-293.

NATIONAL PEST CONTROL ASSOCIATION (1970)

Angoumois grain moth.

1970. 3p (U.S. National Pest Control Association, Technical Release, no. 1) Duplicated.

Gives a description of the life-stages and control of Sitotroga Cerealella.

OXLEY, T.A. and WICKENDEN, G. (1963)

The effect of restricted air supply on some insects which infest grain. Ann. Appl. Biol., 1963 (51)p313-324.

PARKIN, E.A. (1961)

The potentialities of pyrethrum in the bag storage of grain. Trop. stored Prod. Inf., 1961 (3)p77-81. 11 refs, 1948-60.
Describes 5 methods of warehouse use of pyretheum insecticides.

PAPWORTH, D.S. (1961)

The protection of stored cereals by malathion admixture techniques. Agric. vet. Chem., 2, 1961.p160-165

12 references (no titles cited) 1924-1960.

RAJAN, P., SANJEEVARAYAPPA, K.V., DANIEL, V.A., JAYARAJ, A.P. and SWAMINATHAN, M. (1975) Effect of insect infestation on the chemical composition and nutritive value of maize and cowpea. Indian J. Nutr. Dietetics, 12 (10),p325-332, 4 tabl, 4 figs, 6 ref. (Authors' address: Central Food Technological Research Institute, Mysore, India).

Maize was subjected to infestation by Sitophilus oryzae and cowpea by Callosobruchus chinensis for periods of six and five months respectively. The changes in the hygienic conditions and nutritive value of the grains were studied. Kernel damage was 65% in the case of maize and 68% in cowpea. There was marked reduction in thiamine contents. Rat growth studies indicated a decrease in growth rate of rats fed on infested grain as compared with those fed on uninfested material. Post mortem studies showed deterioration in the livers of rats fed on infested grains. - Trop. storage Abstracts, 1976 (4)p52-3.

SINGH, R.H. and BENAZET, J. (1974)
Chemical intervention on all stages and on all scales of tropical storage practice. Symp. 1st int. working Con. stored Prod Ent., Oct. 7-11 1974, Savannah, Georgia,

USA. (Abstract only). (Authors' address: International Institute of Tropical Agriculture, Ibadan, Nigeria).

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 1940's, 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%, 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 practised, but comparatively little change has come at the level of the tropical subsistence farmer. - Trop. storage Abstracts, 1975 (3)p42-3

SINHA, R.N. and CAMPBELL, A. (1975) Energy loss in stored grain by pest infestation. Canada Agric., Spring 1975, 3 pp, 5 illus. (Authors' address: Agriculture Canada Research Station, Winnipeg, Manitoba, Canada).

Discusses the need for a universally acceptable criterion for the measurement of losses in stored grain. Reports briefly on studies of calorific loss of energy caused by two stored product pests, the granary weevil (Sithophilus granarius) and the flat grain beetle (Cryptolestes Ferrugineus). It was found that although the energy consumed by Cryptolestes individuals is only approximately one fourteenth of that consumed by Sitophilus individuals, the much higher reproductive rate of the former results in high total losses. The study demonstrated that measurement of energy loss of wheat kernels by insect infestation can be quantified in calorie values. Further work is proposed in the hope that the information obtained will provide an accurate indication of the actual and potential commercial loss of stored grain caused by stored product insects. - Trop. storage Abstracts, 1975 (6)p84.

UNITED STATES. AGRICULTURAL RESEARCH SERVICE. MARKET QUALITY RESEARCH DIVISION. (1969)

Controlling insects in farm-stored grain. Department of Agriculture, 1969. 8p. (Leaflet no. 563)

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, Dept. of Agricultural and Technical Services, Republic of South Africa. No. 105, ii + 9 pp. Paper presented at the Entomological Symposium, Pretoria, 27 September - 1 October 1971. (Authors' address: Plant Protection Research Institute, Pretoria).

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 is 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 con-

tact 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). - Trop. storage Abstracts, 1973 (2)p36.

WALKER, D.J. (1976)
Fumigation: a method of protecting your stored grain and legumes against insect damage. Swaziland's rur. Dev. News, 1976, 2 (4).

Describes fumigation of bulk grain in gas-tight metal drums or containers. This method has no residual protective effect.

WARNER, J.L. (1954)

Protection of stored grain with 'Pybuthin' insecticides. World crops June 1954 6 (6) p. 251-2.

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 16½ months, thetreated grain was in better condition than the untreated.

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. J. stored Prod. Res., 11 (2),p65-70, 7 tabl, 13 ref. (Author's address: Ministry of Agriculture, Department of Research and Specialist Services, Salisbury, Rhodesia).

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 order 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 though responses to given doses of insecticide were less on the latter grain. - Trop. storage abstracts, 1975 (3)p. 45.

WILKIN, D.R. and GREEN, A.A. (1970)

Polythene sacks for the control of insects in bagged grain. J. stored Prod. Res., 1970 6 (1)p97-101. (PICL reprint no. 799)
Tests on heavily infested wheat.

WINKS, R.G. (1974) Characteristics of response of grain pests to phosphine. CSIRO Div. Ent., A. Rep. 1973-74. (Abstract only) (Author's address: Commonwealth Scientific and Industrial Research Organisation, Division of Entomology, P O Box 1700, Canberra City, A.C.T. Australia 2601).

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 Trop. storage Abstracts, 1975 (2)p. 30.

WINKS, R.G. (1974) Fumigant resistance studies. CSIRO, Div. Ent. A. Rep. 1973-74,p38-39. (Abstract only). (author's address: Commonwealth Scientific and Industrial Research Organization, Division of Entomology, P O Box 1700, Canberra City, A.C.T. Australia

2601).

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 Trop. storage Abstracts, 1975 (2)p31

2.1.1.2.2.3.2.2.

Crops, Cereals, Loss Factors, -- PESTS, RODENTS, RODENTICIDES

GIRISH, G.K., ARORA, K.K. and KRISHNAMURTHY, K. (1974) Studies on rodents and their control. Part X. Storage losses in food grains by rats. Bull. Grain Technol., 12 (2),p139-148 2 tabl, 5o refs.

Reviews the literature and quotes estimates of losses due to rats involving both physical loss by consumption and economic loss by contamination. Reports on a survey of traders' write-offs caused by rat damage. Quotes an experiment to assess the losses caused in 8 different commodities over a period of 30 days, resulting in average quantity damaged/eaten ranging from 3.75 to 1.07%. Discusses the various forms of damage, including quality loss, risk to human life, property damage and financial loss. Notes the difficulty of assessing storage losses caused by rats, and states the need for a standardised methodology. Finally emphasises the necessity for publicity and educational campaigns to create an awareness of the problems of rodents and their control. - Trop. storage Abstracts,

MAJUMDER, S.K. (1973) Prevention of development of toxics in food-grains. Post-harvest technology of cereals and pulses. Proc. Semin. held New Dehli, Dec. 21-23, 1972.p319-322, 9 refs.

2.1.1.2.2.3.2.3.

Crops, Cereals, Loss Factors, -- PESTS, FUNGI, FUNGICIDES

CHRISTENSEN, C.M. and KAUFMANN, H.H. (1969)

Grain storage: the role of fungi in quality loss. Minneapolis Univ. of Minnesota P., 1969. x, 153p.

Lists 111 items 1870-1967, on the role of fungi in the storage of grain and how losses may be prevented.

CHRISTENSEN, C.M. and KAUFMANN, H.H. (1969a) Grain storage: the role of fungi in quality loss. Minneapolis: Univ. of Minnesota P., 1969 vii, 153p $6.50

A critical but mainly appreciative review by J.H. Clarke is printed in Trop. stored Prod. Inf., 1970 (19)p25-26. States that this is the first book to deal primarily with problems in grain storage caused by fungi.

MARTIN, P.M.D. and GILMAN, G.A. (1976) A consideration of the mycotoxin hypothesis with special reference to the mycoflora of maize, sorghum, wheat and groundnuts. Rep., Trop. Prod. Inst., No G.105, vii + 112 pp, 21 tabl, 5 fig, 9 append, biblphy. (Author's address: Dr P M D Martin, Reader in Biology, University of Botswana,

Lesotho and Swaziland, Roma, Lesotho).

Review article which examines the connection between the mycology of foodstuffs and the development of diseases due to the toxins various fungi produce within the foodstuffs. Indicates that in developed countries improved preventive measures tend to obviate the long term effects of mycotoxin poisoning. In lesser developed countries, these effects are more readily observed. the relationship between geography, ethnic food habits, relative preferences of fungi for different foodstuffs and climatic and storage factors is discussed. The specific effects of various mycotoxins on different parts of the human body are noted, and the relationship between prolonged mycotoxin poisoning and various chronic diseases is discussed. - Trop. storage Abstracts, 1976 (3) p. 38-39

MARTIN, P.M.D. and GILMAN G.A. (1976a) A consideration of the mycotoxin hypothesis with special reference to the mycoflora of maize, sorghum, wheat and groundnuts.
London : Tropical Products Inst., 1976 vii, 122 p. Report G105.
Bibliog (of literature cited) pp. 78-112.
Attempts to trace the connection between the mycology of foodstuffs and the onset of disease due to the toxins that various fungi produce within those foodstuffs. Includes storage aspects.

2.1.1.2.2.4.

Crops, Cereals, Storage Conditions --- QUALITY CONTROL

BRITISH STANDARDS INSTITUTION (1969)

Methods for sampling cereals (as grain). London: BSI, 1969 17p. (BS 4510).

CHRISTENSEN, C.M. and KAUFMANN H.H. (1968)

Maintenance of quality in stored grains and seeds.
Stillwater, Oklahoma State University, University Extension 1968. 4p illus
(Circular E-796)

GREAT BRITAIN. MINISTRY OF AGRICULTURE, FISHERIES AND FOOD (1971)

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

SCUDAMORE, K.A. and HEUSER, S.G. (1973) Determination of carbon tetrachloride in fumigated cereal grains during storage. Pestic. Sci. 4 (1),p1-12 + 5 tabl. + 2 Fig + ref. (Authors' address: Ministry of Agriculture, Fisheries and Food, Pest Infestation Control Laboratory, London Road, Slough, Bucks., England).

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 extration 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 estraction 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 con-

tent 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 Trop. storage Abstracts, 1973 (2) p33-4

STUCKEY, B.N. (1955)
Increasing shelf life of cereals with phenolic antioxidants. Food technol. 9(11) p585-587, illus. Ref. Nov. 1955 RICE6006

WRIGHT, J. (1970)
Grain sampling on the farm. London: Home-Grown Cereals Authority, 1970. 4p. (Technical note, no. 15).

2.1.2.

Crops, Cereals -- WHEAT

ABOUL-NASR, S., SALAMA, H.S., ISMAIL, I.I. and SALEM, S.A. (1973) Ecological studies on insects infesting wheat grains in Egypt. Z. angew Ent., 73 (2), p203-212 + 7 Tabl + ref. (Authors' address Abou-Nasr and Ismail, Dept. of Plant Protection, Faculty of Agriculture, Cairo University, UAR: Salama and Salem, Laboratory of Plant Protection, National Research Centre, Dokki, Cairo, UAR).

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 has a low moisture content and that these insects prefer a dry atmosphere. In Sitophilus oryzae (L.) 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 more warm with a high moisture content. (Authors' abstract) - Trop storage Abstracts

DODDS, M.E. (1966)
Grain losses in the field when windrowing and combining wheat.

Can. Agr. Engng, 8, 1, Jan 1966.

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.

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. Z. angew Ent., 80 (1) p. 83-88, tabl, graph, 15 ref. (Engl. Ger. Summ.) (Authors' address: Plant Protection Department, Faculty of Agriculture, Al-Azhar University, Nasser City, Cairo, Egypt).

The damage caused by Sitotroga cerealella (Oliv.) infestation in stored wheat was much greater if the wheat was stored as ears than if it was threshed and stored as grains. Throughout a storage period of 10 months from harvest time, the average level of infestation was found to be 60.75% and 23.25% 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% and 113% 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% 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% in infested grain. - Trop. storage Abstracts, 1976 (4) p. 48.

GIRISH, G.K., JAIN, S.K., KUMAR, A. and AGRAWAL, N.S. (1975) Studies on the assessment of losses. Part V: Assessment of storage losses, quality and pesticidal contamination in wheat available in the markets of western Uttar Pradesh, Punjab and Haryana. Bull. Grain Technol., 13 (1), p8-18 7 tabl, 1 fig. 5 ref. (Authors' address: Indian Grain Storage Institute, Hapur, U.P., India).

A survey to assess storage losses, quality and pesticidal contamination in wheat grain available in the markets of western U.P., Punjab and Haryana was conducted during February 1975. The wheat samples collected were from the harvest of April and May 1974. Four hundred and twenty four samples of wheat were collected from 25 grain markets of western U.P., 18 from Punjab and 9 from Haryana. The average loss due to insect damage was found to be 2.90, 0.85 and 0.95% in those areas respectively. When the samples were analysed for the presence of chlorinated hydrocarbon residues, contamination was present in 4.93, 24.39 and 21.05% respectively. The samples were analysed for various fractions, and in all three states, foreign matter varied from 0.13 to 1.4%, other foodgrains from 0.1 to 6.80%, fungus damage from 0 to 3.10%, shrivelled grain from 0.16 to 5.0%, slightly damaged from 0 to 6.27%, insect damaged kernels from 0.1 to 9.0% and germ-eaten kernels from 0.1 to 7.0%. A formula is given for calculation of storage losses. - Trop. storage Abstracts, 1976 (1) p. 6.

GIRISH, G.K., KUMAR, A. and JAIN, S.K. (1975) Studies on the assessment of losses. Part VI: Assessment of the quality loss in wheat damaged by Trogoderma granarium Everts during storage. Bull. Grain Technol., 13 (1), p26-32, 2 tabl, 16 ref. (Authors' address: Indian Grain Storage Institute, Hapur, U.P., India).

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% 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, whilst alcoholic acidity and ffa increased. Germination decreased from 95% in the 100% sound kernels to 0 in the case of 100% germ eaten kernels. There was 16.36% weight loss in wheat. - Trop. storage Abstracts, 1976 (1)p7.

HACKETT, P.J. (1969)

Costs of grain storage on farms. J. Agric. West. Aust., 1969 10 (9)p381-386, illus.
Relates to the storage of wheat.

KRISHNAMURTHY, K. (1972) Post harvest problems of wheat, Bull. Grain Technol., 10 (4), p291-296. (Author's address: Indian Grain Storage Institute, Hapur, (UP), India.

A review article. Discusses threshing losses which occur and their causes. Losses during handling and transportation are due mainly to spillage. The types of stores used at farmer, trader and government level (including the Food Corporation of India, Central and State Warehousing Corporation and Cooperatives) are described. Losses during storage are reviewed, and are classified as losses in weight, in quality, in nutritive value and hygiene. There are notes on the causal agents, and some estimates of losses are given. A brief account is given of problems which arise during processing. - Trop. storage Abstracts

LA HUE, D.W. (1970)

Evaluation of malathion, diazinon, a silica aerogel, and a diatomsceous earth as protectants on wheat against lesser grain borer

attack ... in small bins.

iv, 12p. (U.S. Dept. of Agriculture, Marketing Research reports, no. 860, 1970). Abstracted in Trop. stored Prod. Inf., 1970 (20)p41.

MUIR, W.E. and WALLACE, H.A.H. (1971)

Storage of high moisture grain in an air-tight butyl rubber bin. Canadian Agric. Engng, 1971 13 (1)p29-31.
High moisture wheat stored for a 12 week summer period in an air-tight butyl rubber bin was compared with storage in a typical steel bin.

RAO, H.A.G. and WILBUR, D.A. (1972) Loss of wheat weight from feeding of lesser grain borer. J. Kans. Ent. Soc., 45, (2),p238-241. (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%. Weight losses from adult feeding were 19.4, 12.0, 9.5 and 6.5% per kernel during the 1st, 2nd, 3rd and 4th weeks, respectively, after adult emergence. - Trop. storage Abstracts.

NAVARRO, S. and DONAHAYE, E. (1976).

Conservation of wheat grain in butyl rubber/EPDM containers during three storage seasons. Trop. stored Prod. Inf., 1976 (32)p13-23. illus., 7 refs, 1968-74.
Describes experiments in Israel in which wheat grain was stored in 30 containers of 1,000 ton capacity each during 1972-75. Grain was preserved at a satisfactory level throughout the storage seasons.

ROWLANDS, D.G. (1970)

The metabolic fate of dichlorvos on stored wheat grains. J. stored Prod. Res., 1970 6 (1)p19-32. (PICL reprint no. 798).

SHUEY, W.C., YOUNGS, V.L. and GETZENDANER, M.E. (1971)

Bromide residues in flour streams milled from fumigated wheats. Cereal Chem., 1971 48 (1)p34-39.

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. Bull. Grain Technol., 10 (4), p. 271-275 + 2 tabl + ref. (Authors' addresses: K. Singh and G.K. Girish, Indian Grain Storage Institute, Hapur (UP), India; N.S. Agrawal, Ministry of Agriculture, Department of Food (Government of India), Krishi Bhavan, New Delhi, India).

An investigation into the loss in weight of different varieties of wheat caused by a small population of S. oryzae larvae at 30°C and 75% RH is described. The average amounts of grain damage by weight, by number and amount of grain consumed per insect during development from egg to adult were found to be different in different varieties. The average loss in weight, percentage damaged grain and consumption per insect were 1.5 to 3.7%, 13.2 to 22.7% and 9.75 and 13.5 mg. The weight of each adult produced averaged 2.1 to 2.4 mg. - Trop. storage Abstracts, 1973 (5)p78.

SHRIVASTAVA, P.K., TRIPATHI, B.P., GIRISH, G.K. and KRISHNAMURTHY, K. (1973)
Code of practice for safe storage of foodgrains (wheat) in villages. Bull. Grain Technol., 1973 11 (3 and 4),p206-210.

Successful control of grain damage was achieved in two selected villages after implementation of the code.

TEOTIA, T.P.S. and TIWARI, G.C. (1971)

Dharek drupes and leaves as protectants against Sitotroga cerealella, infesting wheat seeds. Bull.

Grain Technol., 1971 9 (1) p. 7-12.

2.1.3.

Crops, Cereals -- MAIZE

ALDRICH, S.R. and LENG, E.R. (1965)

Modern corn production. Cincinnati, Farm Quarterly, 1965. xii, 308p.

Includes chapters on harvesting, storage and marketing of maize.

BOSHOFF, W.H. (1976)
FAO/African rural storage centre. In INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE. Annual report, 1975. Ibadan: IITA, 1976. pp. 69-70.
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. Address: Project Manager, FAO/African Rural Storage Centre International Institute of Tropical Agriculture, Oyo Road, PMB 5320, Ibadan, Nigeria

DU TOIT, F.P. (1973)Bulk handling and Storage: commercial maize. Rhodesia agric. J., 70 (2),p23-40 + illus. + ref. (Author's address: Senior Architect, Department of Conservation and Extension, Salisbury, Rhodesia).

Discusses in detail the processes involved from harvesting to delivery to commercial storage. For mechanical harvesting, grain is normally at less than 20% m.c. 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 put forward. 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.
Trop. Storage Abstracts

GILES, P.H. (1966)

Maize storage: the problem of today. Trop. Stored Prod. Inf., 1967 (14) p9-19. illus.
Reprinted (with addition of illus.) from Kenya Weekly News, October 14th, 1966.
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.

GLANZE, Peter (1973)
Mechanized production of grain: maize in tropical and subtropical regions.
Trans. from the German by H. Liebocher.
Edn. Leipzig, 1973.
(Technical Fundamentals Series)
196p. 130 illus.

MIRACLE, M.P. (1958)

Maize in tropical African agriculture. Trop. Agric. Trin., 1958 35,p1-15
Contains 53 references from 1876 - 1956.

RAUSHER, M. (1958)
Agricultural mechanization. Harvesting and storage of grain maize.
Geneva, U.N. Economic Commission for Europe, 1958. 63p (AGRI/MECH/10)

SOBRAL, E.F.(1966)

Corn bibliography available in the Pergamino Agricultural Experiment Station. Pergamino, P.H.E.S. (1966) 197p.

WHEATLEY, P.E. (1973) The maize storage problem in the less developed countries of Africa. Post harvest deterioration. Paper presented to the Pesticides Group of the Society of Chemical Industry in London on 20 November 1972. Chemy Ind., 1973 (22), p. 1049-1052. (Author's address: Tropical Stored Products Centre, Tropical Products Institute, London Road, Slough, Bucks SL3 7HL, England).

Discusses the causes of losses in store, and gives estimates of losses in farm stored maize in Kenya, Uganda, Ghana, Malawi and Zambia. Suggests that there are already available simple cheap storage techniques that can be applied by African peasant farmers. In the drier parts of Africa where crib drying and storage is traditional, simple improvement in crib structure and siting are easily achieved, and admixture of cobs with insecticides can give good insect control. Mention is made of interest aroused in agricultural extension services in some African countries in bringing these improved practices to the farmers' notice. The use of newer insecticides such as phoxim and pirimphos methyl is discussed, and mention is made of preferred storage of shelled maize, admixture of insecticides, and the use of relatively air-tight structures. In humid tropical areas, artificial drying is essential. Central storage in large depots is discussed, and the maintenance of strategic reserves as in Kenya is described. Finally the problems of new improved maize varieties, and their high susceptibility to insect infestation are outlined. - Trop. storage Abstracts, 1974 (1)p14.

2.1.3.2.1.1.4.

Crops, Cereals, Maize, Loss Factors, --- DRYING

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 Prod. Res. Inst., A.Rep., 1963, tech. rep. No. 12, p. 101-105.

2.1.3.2.2.

STORAGE LOSSES AND THEIR CONTROL
STORAGE CONDITIONS

COYNE, F.P. (1970)

Improving farm storage of maize: general principles and their application to small farms. Nairobi: Ministry of Agriculture, Agricultural Information Centre, 1970. Free. iii, 38p. Reviewed in Trop. stored Prod. Inf., 1971 (21) p34.

2.1.3.2.2.1.

Crops, Cereals, Maize, Storage Conditions, --- AREA STUDIES

ADAMS, J.M. and HARMAN, G.W. (197?)

The evaluation of losses in maize stored on a selection of small farms in Zambia with particular reference to the development of methodology. Tropical Products Institute G. Report (forthcoming)

DAHNIYA, M.T. and FUNNAH, S.M. (1973) Increasing maize production in Sierra Leone. Sierra Leone agric. J., 2 (1), p45-53 + ref. (Authors' address: Department of Agronomy, Njala University College, Private Mail Bag, Freetown, Sierra Leone).

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 difficul-

ties 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, artifical 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. - Trop. storage Abstracts, 1973 (5)p69.

GURNAH, A.M. (1973) Large scale maize production in Ghana. Wld. Crops, 25 (6),p 308-311, 2 tabl, illus, rep. (Author's address: Lecturer, Crop Production, University of Nairobi, Kenya).

Notes that Ghana in the past has been a net importer of maize. Early attempts to establish large scale mechanised 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 artifical 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% 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. - Trop. storage Abstracts, 1974 (2)p 21.

JONES, C.R. (1974) Better maize handling in Southern Nigeria. Appropriate Technol., 1 (2),p 14-15, 3 fig. (Author's address: Technical Coordinator, Committee for Agricultural and Rural Development, Enugu, Nigeria).

Describes the conditions in which maize is harvested and stored, and comments that these encourage attack by pests. An account is given of a simple dryer normally wood fired but adaptable for use with a diesel driven fan and heater. Directions for operating the dryer include method of arranging the dehusked maize cobs, control of fire, drying period, and suggested use of a simple moisture meter. Cement block stores, with netted ventilators instead of windows, asbestos roofing, and rodent proofing are recommended, and there are notes on phosphine fumigation. The dryer is stated to be capable of drying up to 12 tons of maize per month. - Trop. storage Abstracts. 1975 (1)p 7.

LEPIGRE, A.L. and POINTEL, J.G. (1971)

Protection of maize stored in traditional Togolese granaries. Trop. stored Prod. Inf., 1971 (21) p7-12. illus. 2 refs. Based on extension work in Togoland, 1962-68. Experimental work conducted by J.G. Pointel has been separately published See Pointel (1969)

PATEL, A.U. and ADESUYI, S.A. (1975)

Crib storage of maize under tropical village conditions, in the Ibadan area of Nigeria. Trop. stored Prod. Inf., 1975 (29) p33-40. illus. 8 refs, 1959-73. 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.

POINTEL, J.G. (1969)

Essai et enquete sur greniers a mais Togolais. (A trial and survey on Togolese maize granaries). Agron. trop. Nogent, 1969, 24 (8)p 709-718. See also LEPIGRE, A.L. and POINTEL, J.G. (1971).

RILEY, J., MATHESON, K.C., NDUKWE, K.U., EFFIONG, E.A., OJO, J.B., and ADERIBIGBE, O. (1959)

Cribs storage of maize at Ilora. West Afr. Stored Prod. Res. Unit. A. Rep., 1959, pp. 45-48.

READER, R.A. (1971)

Survey of damage to maize stored under village conditions. Evaluation Section, Lilongwe Land Development Project. Report no. 6, August 1971.

SWAINE, G. (1957)
Trials on the underground storage of maize of high moisture content in Tanganyika. Bull. ent. Res, 1957,48 (2) p. 397-406.

WALKER, D.J. (1974)

A survey of shelled maize and its associated problems in the stores of Swazi nation farmers 1973-74. Preliminary report.

7p + appendix. Typewritten

2.1.3.2.2.2.1.

STORAGE STRUCTURES

IMPROVED FARM STORAGE PROJECT - FREEDOM FROM HUNGER.
Nairobi: Ministry of Agriculture, 1970. 4p. Describes maize storage in cribs. Also issued in Swahili.

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). Bolm. Inst. Tecnol. Aliment., 1975 (42), p55-69, 2 tabl, 5 fig, 7 refs. (Port.). (Authors' address: Instituto de Tecnologis de Alimentos, Caixa Postal 139-13100, Campinas S.P., Brazil).

Newly harvested maize with 12% 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. - Trop. storage Abstracts.

TRIPLEHORN, G.A. and others (1966)

Wire-netting cribs for the storage of maize. Biologico, 1966 32 (12) p257-266.
Reviewed in Trop. stored Prod. Inf., 1968 (16) p26; abstracted in Rev. appl. Ent., A,1968 56 (4) p828.
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.

13p. Typewritten.

2.1.3.2.2.3.1.

STORAGE MOISTURE LEVELS
ADESUYI, S.A. (1968)

A survey of the moisture content of early maize during harvest in the Western State.
Nigerian Stored Prod. Res. Inst. A. Rep., 1968, tech. rep. No. 7, p. 59-61.

2.1.3.2.2.3.2.

PESTS, PESTICIDES

PROTECTING Shelled corn against pests. Kumasi: Crops Research Institute, 1967. (Farming Guide - CC1/1) Complete ed. 8p; leaflet ed. 3p.

2.1.3.2.2.3.2.1.

Crops, Cereals, Maize, Loss

Factors, Pests, --- INSECTS INSECTICIDES

ADAMS, J.M. (1976)
Weight loss caused by development of Sitophilus Zeamais Morsch. in maize. J. stored Prod. Res., 1976, 12 (4)p269

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. Tech. Rep., Rep. Nigerian stored Prod. Res. Inst. 1970, 1973, No. 5,p39-46 + 4 tabl + 2 fig + ref. (Authors' address: Nigerian Stored Products Research Institute, Federal Ministry of Trade, Private Mail Bag No. 12543, Ikoyi, Lagos, Nigeria).

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 per cent malathion at 30 ppm, 5 per cent iodofenphos at 20 ppm and one per cent 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. - Trop. storage Abstracts.

ASHMAN, F. (1966)
An assessment of the value of dilute dust insecticides for the protection of stored maize in Kenya. J. appl. Ecol., 3(1)p. 169-179.

ASHMAN, F. (1964)
Insect reinfestation problems in fumigated maize on the Kenya coast. Bull. ent. Res., 55 (1)p. 139-146.

ASHMAN, F. (1965)
Sampling methods used in an insecticide field trial in Kenya to measure population levels of three pest species in stored maize. Proc. XIIth Int. Congr. Ent. London, 1964,p639-640 (abstr).

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).

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 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. - Trop. storage Abstracts.

CORNES, M.A. and ADEYEMI, S.A.O. (1968)

Phosphine fumigation of maize in an open top steel bin. Nigerian Ent. Mag., 1968 1 (6)p. 108-114.

CORNES, M.A. and RILEY, J. (1962)

An investigation of drying rates and insect control in a maize crib with improved ventilation. West Afr. Stored Prod Res. Unit, A. Rep., 1962, tech. rep. No. 12,p. 72-78.

DE LIMA, C.P.F. (1972)

Lindane resistance in field strains of Sitophilus zeamais (Motsch.) in Kenya. J. Stored

Prod. Res., 1972 8 (3) p167-175.
Tests showed that in general strains with high resistance factors came from localities where lindane had been in regular use in stored maize.

DOBIE, P. (1974) The Laboratory assessment of the inherent susceptibility of maize varieties to post-harvest infestation by Sitophilus zeamais Motsch. (Coleoptera, Curuculionidae). J. stored Prod. Res., 10 (3/4), p183-197 7 tabl, 3 fig, ref. (Author's address: Tropical Stored Products centre, Tropical Products Institute, London Road, Slough SL3 7HL, Berks, England).

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 summaried 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 correlated with amylose content. It was concluded that susceptibility was determinated in these varieties by factors operating after oviposition. - Abridged from Trop. storage Abstracts, 1975 (1) p. 5.

DOBIE, P. (1973) Laboratory assessment of the inherent susceptibilities of 25 varieties of Malawi maize to post-harvest infestation by Sitophilus zeamais Motsch. Trop. Prod. Inst. Rep. L.33. iii + 17 pp. (Obtainable from : Tropical Products Institute, 56/62 Gray's Inn Road, London WC1X, 8LU).

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% 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) - Trop. storage Abstracts, 1973 (2) p23.

DOBSON, R.M. (1969)

A new species of Carpophilus Stephens (Col., Nitidulidae) from East Africa. Entomologist's mon. Mag., 1969, 105 (1259-1261) p99-100.
Describes Carpophilus zeaphilus found on maize residues and maize cobs in Kenya and in a wheat store previously used for maize grains.

GILES, P.H. and LEON, O.V. (1974) Infestation problems in farm-stored maize in Nicaragua. Symp. 1st int. Conf. stored Prod. Ent. Oct. 7-11, 1974, Savannah, Georgia, USA (Abstract only). (Authors' address: Seccion de Productos Almacenados (SEPRAL), Ministry Agric. and Livestock, Apartado 592, Managua, Nicaragua).

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 (aluminium phosphide, carbon tetrachloride /ethylene dichloride). - Trop. storage Abstracts, 1975 (3) p37-8

GRAHAM, W.M. (1959)
Fumigation of maize in a large shell-concrete building. J. Sci. Fd Agric., 1959, 10 (9) p. 478-483.

GRAHAM, W.M. (1970)

Warehouse ecology studies of bagged maize in Kenya; I - IV J. stored Prod. Res., 1970 6 (2) p147-155; p157-167; p169-175; p. 177-180.
I - The distribution of adult Ephestia (Cadra) cautella (Walker) Lepidoptera, Phycitidae . (PICL reprint no. 803.)
II - Ecological observations of an infestation by Ephestia (Cadra) cautella (Walker) (Lepidoptera, Phycitidae). (PICL reprint no. 804).
III - Distribution of the immature stages of Ephestia (Cadra) cautella (Walker) (Lepidoptera, Phycitidae). (PICL reprint no. 805).
IV - Reinfestation following fumigation with methyl bromide gas. (PICL reprint no. 806)

GRAHAM, W.M. and KOCKUM, S. (1961) Admixture of malation and lindane with bagged maize. Bull. ent. Res., 1961, 52 (4), p. 727-739.

GRAHAM, W.M. and KOCKUM, S. (1958b)
Protection of bagged maize with lindane and D.D.T. Trop. Agric. Trin., 1958, 35, p293-298.

KOCKUM, S. (1958)
Control of insects attacking maize on the cob in crib stores. E.Afr. agric. J., 1958 23 (4), p275-279.

KOCKUM, S. (1965)
Crib storage of maize: a trial with pyrethrin and lindane formulations. E. Afr. agric. For. J., 1965 31 (1), p8-10.

MALAWI. Ministry of Agriculture and Natural Resources

Grain storage project. Protection of maize cobs in storage. Protection of maize cobs from insect damage by the use of "Red Triangle" insecticide. Limbe: Ministry of Agriculture and Natural Resources, 1971. 4p. (Circular no. 6/71)
Simple notes for farmers on insect attack on s red maize cob and the use of lindane dusts to control infestation. Bilingual English/ vernacular.

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. Trop. Agric. 51 (1), p63-67 + 1 tabl. + 8 ref. (authors' address: Department of Agricultural Research, Royal Tropical Institute, Amsterdam, The Netherlands).

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 unslected 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 highly resistant to 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. - Trop. storage Abstracts, 1974 (1) p10-11

PROCTOR, D. and others (1961)

The safe storage of maize. Trop. stored Prod. Inf., 1961 (3) p54-63. illus. 15 refs, 1953-60.
Refers especially to warehouse hygiene and insect pests. Author mentioned in editorial.

ROSSETTO, C.J. (1972) Resistencia de milho a pragas da espiga, Helicoverpa zea (Boddie), Sitophilus zeamais Motschulsky and Sitotroga cerealella (Olivier). (Resistance of corn to the ear pests, 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, Bolsista do CNPq, T.C. 1518, Brasil).

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. - Trop. storage Abstracts.

SCHULTEN, G.G.M. (1975) Further insecticide trials on the control of Ephestia cautella on stacks of bagged maize in Malawi. Int. Pest Control, 15 (2), p18-21. (Author's address: Royal Tropical Institute, Amsterdam, The Netherlands).

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 very effective against E. cautella. - Trop. storage Abstracts.

SCHULTEN, G.G.M. (1976) Insects in stored maize ears. Abstr. trop. Agric., 2 (6), p9-17, 73 ref. (Author's address: Department of Agricultural Research, Royal Tropical Institute, 63 Mauritskade, Amsterdam-5, The Netherlands).

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. - Trop. storage Abstracts.

WEAVING, A.J.S. (1975)
Grain protectants for use under tribal storage condiions in Rhodesia - Comparative toxicities of some insecticides on maize and sorghum. J. stored Prod. Res., 1975, 11 (2) p65-70 13 refs. 1965-71.
Of the five insecticides tested fenitrothion was the most toxic. Loss of insecticidal effect was more rapid on maize than on sorghum though responses to given doses of insecticide were less on the latter grain.

2.1.3.2.2.3.2.3.

Crops, Cereals, Maize, Loss Factors, Pests, - FUNGI FUNGICIDES

LOPEZ, L.C. and CHRISTENSEN, C.M. (1967)

Effect of moisture content and temperature on invasion of stored corn by Aspergillus flavus. Phytopathology, 1967 57 (6) p588-590. 7 refs. 1958-65.
A. flavus did not invade any samples of corn stored with moisture contents below 17.5%, wet weight basis, but did invade those stored with moisture contents of 18.5% and above. A storage temperature of 35°C did not reduce, detectably, the moisture content limit for invasion by this fungus.

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).

An account of studies of moisture, mould and aflatoxin contents of maize samples obtained from various sources soon after harvest is given. Discoloured factors concerned with microbiological deterioration is discussed. Samples of maize on the cob had mainly field fungi. Typical storage moulds 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 mould development, unless facilities exist for immediate artificial drying. - Trop. storage Abstracts.

2.1.4.

Crops, Cereals, ---MILLET SORGHUM

BECHTEL, H.E., and others
Pit silos for the storage of Atlas sorgo grain and of soft corn. J. Anim. Sci. 4(4) p438-452, illus. Ref. Nov. 1945.
F.W. Atkeson, F.C. Fenton, and W. M. Carleton, joint authors.
SORGHUM 2068

DOGGETT, H. (1970)

Sorghum. London: Longmans, 1970. £7.10.0. xvi, 403p. illus., bibl. (Tropical Agriculture series).
Critical review Trop. stored Prod. Inf., 1970 (20) p35.

FESTA, N. YA., and AKIVIS, S.I. (1951)
Vliyanie uslovii khraneniya na kachestvo prosa. (Effect of storage conditions on the quality of millet). Tr. Vses. Nauch.-Issled. Inst. Zerna Prod. Ego Pererabotki 22p92-115, illus 1951.

GHANA. Grains and Legumes Development Board. (c1975)
Recommended practices for the production of sorghum. Kumasi, (Technical bulletin - no. 4)

GILES, P.H. (1965)
Control of insects infesting stored sorghum in Northern Nigeria. J. stored Prod. Res., 1, p145-158.

GILES, P.H. (1962)
The storage of guinea corn and millet by farmers in Northern Nigeria. Tech. Rep. Reg. Res. Sta. Samaru no. 20, 7 p. 1962.
Guinea corn (Sorghum spp.) and millet (Pennisetum spp.)

GONEN, M. and CALDERON, M. (1968)

Changes in the microfloral composition of moist sorghum stored under hermetic conditions. Trop. Sci., 10 (2), p. 107-114.

HAYS, H.M. (1975) The marketing and storage of food grains in northern Nigeria. Samaru misc. Pap. 50, x + 155 pp, 36 tabl, 17 fig, 40 refs. 11 append. (Publ. Institute for Agricultural Research, Samaru Ahmadu Bello University, PMB 1044, Zaria, Nigeria. Price 2 naira ($3.04)

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; 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% 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. - Trop. storage Abstracts.

HAYS, H.M. (1975) The storage of cereal grains in three villages of Zaria Province, Northern Nigeria. Savanna, 4 (2), p119-123, 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).

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 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. - Trop. storage Abstracts, 1976 (3) p.36.

JINDAL, V.K. and THOMPSON, T.L. (1972)

Air pressure patterns and flow path in two dimensiona- triangular shaped piles of sorghum using forced convection. Trans. Am. Soc. agric. Engrs., 15 (4)p 737-741. illus., bibl.

KHALIFA, A. (1960)
On open-air and underground grain (Sorghum vulgare) storage in the Sudan. Bull. Soc. Entomol. Egypte 53(44)p 129-142. 1960.
With reference to infestation by Trogoderma granarium.

KHALIFA, A. (1962)
The relative susceptibility of some varieties of sorghum to Trogoderma attack. Empire J. Exp. Agr. 30(118):132-136. Apr. 1962.

Trogoderma granarium in stored sorghum in Sudan.

LA HUE, D.W. (1967)

Evaluation of malathion, synergised pyrethrum and a diatomaceous earth as protectants against insects in sorghum grain - in small bins. U.S.Dep. Agric., Mktg Res. Rep., no. 781, 1967, 11p. 15 cents.

The MILLETS: A bibliography of the world literature covering the years 1930-1963

Metuchen, Scarecrow P., 1967-
xvii, 154p.
(Biological sciences communication project of the George Washington University).
This is the source of items marked "MILLET" followed by the reference number used herein.

MIRZOEVA, V.A., and POD'YAPOL'SKAYA, O.P. (1955)
Izmeneniya kolichestvennogo i vidovogo sostava mikroflory prosa i pshena pri khramenii pod vliyaniem tepla i vlagi. (Changes in quantitive and specific composition of proso millet and millet microflora during storage under the influence of heat and moisture). Tr. Vses. Nauch-Issled Inst. Zerna Prod. Ego Pererabotki 30p 114-123. 1955.
MILLET 1014

OZBURN, G.W. and others (1960)
Hermetic storage of guinea corn. Ann Rep. West Afr. Stored Prod. Res. Unit Nigeria 1960 (11)p 45-47.
P. Ward, M. George, J. Riley and M. Cornes, joint authors.
SORGHUM 2101

SORENSON, J.W. and others (1971)

Storing, processing and handling sorghum grain, by J.W. Sorenson, N.K. Person, P. Hobgood, B.R. Steward, W.E. McCune and D.G. Hailes. In Consolidated report, Texas A and M University Texas Agricultural Experiment Station, PR-2938-2949. p. 60-71 illus, 28 refs.

SORGHUM and millets abstracts

Farnham Royal, Slough, Commonwealth Agricultural Bureaux.

Monthly 1976 -

SORGHUM: a bibliography of the world literature covering the years 1930 - 1963

Metuchen, Scarecrow P., 1967
xxix, 301p
(Biological Science Communication Project of the George Washington University).
Contents include a few refs. to pests of the stored grain.
This is the source of items returned to as "SORGHUM" followed by the reference number used herein.

SPEARS, B. (1971)

Extension education in grain sorghum. Rep. Texas A and M Univ. Agric. Exp. Stn. Consolidated PR 2938 - 2949
+ 8 figs + 1 table.

Includes storage.

TOURTE, R., NICOU, R., and BONLIEU, A. (1963)
Traitement apres recolte des mils et sorghos. (Post-harvest treatment of millet and sorghum). Agron. Trop. 18(1) p 73-81, illus. Jan. 1963.
English and Spanish summaries.
Processing and storage.
MILLET 1018

UVAROVA, Z.A., and PRIKHOD'KO, L. S. (1962)
Izuchenie fizicheskikh i biokhimicheskikh osobennostei sozrevaniya i khraneniya prosa. (A study of physical and biochemical features of the maturation and storage of millet.) Tr. inst. Bot. Akad. Nauk Kaz. SSR 12: p. 161-168. Ref 1962
MILLET 1019

WALL, W.M. and ROSS, J.S.( )
Sorghum production and utilization.
Avi Publishing Co., £15-50
702p.

2.1.5. Crops, Cereals, -- RICE

FOOD AND AGRICULTURAL ORGANIATION (1972)

Report of the meeting of experts on the mechanization of rice production and processing. Paramarimbo (Surinam), 27 September - 2 October 1971. Rome: FAO, 1972, vii, 203p £1.20
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.

INTERNATIONAL RICE RESEARCH INSTITUTE (1963)
International bibliography of rice research.
New York, Scarecrow P., 1963 vi. 881p.
Over 600 entries covering 1951-60. Supplement covering 1962-1966.

Includes sections on harvesting, storage disease, storage pests. 28 entries under losses.

Items marked as "RICE" followed by a reference number were traced herein. Where obviously on the subject of rice the ref. number usually appears without prefix.

TEUNISSON, D.J. (1954)
Yeasts from freshly combined rough rice stored in a sealed bin. Appl. Microbiol., 1954, 2 (4),p215-220.

2.1.5.1.

Crops, Cereals, Rice, -- AREA STUDIES

PADUA, Dante B. de (1974)

Post-harvest rice technology in Indonesia, Malaysia, the Phillipines, Thailand: a state of the art survey. (Ottawa): International Development Research Centre, (preface 1974) (3), 66p. illus. cover title
On cover - Appendix A.
Background paper issued in connection with Commonwealth ministerial meeting on food production and development, London, 4-12 March 1975. (This is the Appendix A referred to in HULSE, Joseph H. (1975).
Chapter readings are (I) Introduction, (II) Overview of the rice industry, (III) Post production practices, (IV) Problems, (V) Recommendations.

PREVETT, P.F.(1959)
An investigation into storage problems of rice in Sierra Leone. London, H.M. Stationery Office, 1959. 52 p., illus., maps. Ref. (Colonial research studies, no. 28)
Includes storage infestations, insecticides, and fumigants.
5671

PREVETT, P.F. (1959)

-- A study of rice storage under tropical conditions. J. Agr. Engin. Res. 4(3)p 243-254, illus. 1959.
French and German summaries.
Storage of raw parboiled, and native-cleaned rice in corrugated iron store and plywood silos in Sierra Leone.

TAIWAN. Dept. of Agriculture and Forestry (1955)
A report on Taiwan's rice losses on fields and drying grounds during harvest, April 1955, trans. by P.S. Shih.
9p. illus., 1955
Chinese Amer. Joint Comn. Rur. Reconstr. Food Fert. Ser 2.
RICE 3404

WIKRAMANAYAKE, V.E.A. and PERERA, H.E.M. (1975) Report on the survey of storage losses. Res. Bull. 2/75, 13 pp, 3 tabl, 2 Fig, 2 append (Publ. The Paddy Marketing Board, 5, Elibank Road, Colombo 5, Sri Lanka).

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 outurns 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. - Trop. storage Abstracts, 1975 (5), p. 72-3.

WIMBERLEY, J.E. (1975) Ford Foundation Rice Research Institute post production projects in India and Sri Lanka. Pap. pres. Plann Meet. post Harvest Crop Prot., East-West Fd Inst. Honolulu, Hawaii, Sept. 1975. duplic., 18 pp. (Author's address: The Paddy Marketing Board, P O Box 205, Colombo, Sri Lanka).

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 organised, 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, driving, storage, parnoiling, milling, procurement and marketing; systems coordination. It was estimated that losses of paddy due to these factors totalled 25-30% of total paddy production. The lack of trained personnel was emphasised, 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 cummonications and exchange of technical expertise between Asian nations is discussed, and suggestions for future overall systems development are made. Trop. storage Abstracts, 1975 (5), p. 73.

INTERNATIONAL RICE COMMISSION (1956) Report of the Meeting ad hoc Working Group on Storage and Processing of Rice, held at Calcutta, India, 5-10 Nov, 1956 Roma, 1956 60p (Food and agriculture organization of the United Nations. Agriculture Division. Meeting report 1956)

RICE 5607

2.1.5.2.1.

Crops, Cereals, Rice - LOSS FACTORS

2.1.5.2.1.1.

--- PRE-STORAGE PROCESSING

2.1.5.2.1.1.1.

Crops, Cereals, Rice, Pre-Storage, Loss Factors, Processing ----- HULLING

ESTEVES, J.D. (1958)
Estudo sobre a debulha mecanica do arroz. (Study of mechanical hulling of rice.) Gaz. Agr. 1(108)p134-135. May, 1958.
Mozambique varieties suitable for mechanical hulling.
5913

NAGATO, K., EBATA, M., and TANDA, Y. (1960)
On the quality of rice kernel in early season cultivation. (In Japanese). Proc. Crop/Sci. Japan 28 (4)p 359-362, illus. July 1960
English summary
Includes relative loss in cleaning.

TORRES, A.B.M. (1958)
A industria do descasque de arroz em Mocambique. (The rice hulling industry in Mozambique.) Gaz. Agr. 10(104)p 8-21; (105)p. 34-39; (106)p 66-72; (107)p 98-111, pl. Jan./Apr. 1958.
5958

2.1.5.2.1.1.2.

Crops, Cereals, Rice, Pre-Storage, Loss factors, Processing ---- PARBOILING

FISCHER, E. (1958)
Note sur une installation d' etuvage du paddy a Tamani. (Note on a paddy parboiling plant in Tamani, Mâli.) Riz Rizicut. 4(2/3)p85-96, illus. Second and Third Q. 1958.
English, French, and Spanish summaries.
Using the Cristallo process.
5975

SILVESTER, P. (1959)
Note sur deux installations a caractere artisanal d'etuvage du riz en Guinee et en Haute Volta. (Note on two systems of cottage industry for the parboiling of rice in Guinea and in Upper Volta.) Riz Rizicut, 5(1):42-48. First Q. 1959.
English and Spanish summaries.
6005

2.1.5.2.1.1.3.

------DRYING AND STORAGE

ALDRED, F.L.,(Ed) (1953)
Recent research on drying and storage of rough rice. Jan 1953 29p. illus.
(Southern Cooperative series bulletin - 29)
Work conducted at the Arkansas, Louisiana, and Texas Agricultural Stations by G.W. Sorenson and others.
5596

BARR, H.T., and COONROD, L.G.(1952)
Bulk drying and storage of rice on the fram. Agr. Engin. 33(3): p. 158, 160, 162, 164. illus. Mar 1952
RICE 5598

BARR, H.T. and COONROD, L.G (1969)
Situation actual del secado y el almacenamiento a granel del arroz en la granja. (Present situation of drying and bulk storage of rice on the farm.) Arroz (Argentina) 5(57)p 6-9 June 1969
RICE 5599

BERGOMI, I. (1953)
Progetti di impianto per trebbiatura, essiccazione e immagazzinamento. (Plan for installation for threshing, drying and storage.) Riso 2(6)p 24-25, illus. June 1953
RICE 5600

BILLINGTON, A.E. (1957)
Report on the processing and storage of rice in Malaya. Internatl. Rice Coms. News Let.

6(2)p16-20. June 1957
Ref. Threshing, milling, drying, and storage.
RICE 5601

CONTACTGROEP OPVOERING PRODUCTIVITEIT (1951?)
Drogen en opslag van ruwe rijst. (drying and storage of rice)
'sGravenhage, 1951?, 118p illus.
English summary.
RICE 5604

HOUSTON, D.F. (1972)
Rice: chemistry and technology. St. Paul, Minnesota, American Association of Cereal chemists, 1972. xvii, 517p $21.50
(Monograph series - vol 4)

Extensive review in Trop. stored Prod. Inf., 1974, (28), p. 49-50. Contains chapters reviewing the research carried out in the previous 15 years on rough rice (paddy) drying and storage.

KEESENBERG, H. (1960)
Fortschritte in der Reistrocknung, Lagerung und Bearbeiting seit 1948. (Progress in rice drying, storage and milling since 1948.) In Arbeitsgemeinschaft Getreideforschung. Reis-Tagung, May 17-18, 1960, p. 65-73, pl.
RICE 5608

LOCKWOOD, L.M. (1975) Small scale storage and drying of paddy in Bangladesh, the scope for reducing losses. Rep. IVS/CORR Grain Storage Project, Jalchatra, Tangail District, Bangladesh. duplic, ii + 20 pp, refs. (Author's address: Appropriate Technology Cell (Storage and Handling), Bangladesh Agricultural Research Council, 130-C, Road 1, Dhanmandi, Dacca, Bangladesh).

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 emphasised. - Trop. storage Abstracts, 1975, (3), p. 39.

2.1.5.2.1.1.4.

----- DRYING, DRYERS

CALDERWOOD, D.L. (1975)
Rough rice (paddy) drying methods in the United States. Trop. stored Prod. Inf. 1975 (30), p.13-22. illus. 17 refs. 1953-72, probably all American.

ESMAY, M.L. and THOMFORDE, C. (1973) A farm and village paddy rice dryer for less developed countries of the tropical and semi- tropical regions. Agric. Mechaniz. Asia, 4 (2), p 89-93, 5 fig, ref. (Authors' address: Professor of Agricultural Engineering, Michigan State University East Lansing, Michigan, USA).

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. - Trop. storage Abstracts

FELICIANO, H. (1951)
The "Central" rice mills and "Central" Columnas Palay Driers Philippine Agr. Enging. J., 2 (1)p29-30. First Q. 1951
RICE 5605

HEMELRIJCK, M. van (1960)
Quelques 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.).) B. Inform. Inst. Natl. Etude Agron. Congo Belge 9(6)p351-360, illus. Dec. 1960 In B. Agr. Congo 51(6). Dec 1960.
Includes drying of rice.
5859

HENDERSON, S.M. (1953)
Ranch grain drying; adequate drying capacity, short hauls, lower costs among advantages. Calif. Agr. 7(7)p9, illus. July 1953. RICE 5606

INTERNATIONAL RICE RESEARCH INSTITUTE (1976) The IRRI batch dryer. Appropriate Technol. 2 (4), p30, illus. (Enquiries to The Agricultural Engineering Department, The International Rice Research Institute, P O Box 933, Manila, Philippines).

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. - Trop. storage Abstracts, 1976,(1), p.9.

2.1.5.2.2.2.1.

Crops, Cereals, Rice, Loss Factors,--------STORAGE STRUCTURES (BUILDINGS, SILOS, PITS, ETC)

LIPTON, M., COOK, I. and NAIR, N. (1974)Cost-benefit analysis of crop storage improvements: a south Indian pilot study. Pap., EPPO Conference on Storage Pests and Diseases, Paris, 11-14 June 1974. EPPO BULL., 4 (4), p. 447-453,(Eng. summ.), 17 refs. (Authors' address: Institute of Development Studies, Brighton, England).

Storage research, especially at small-farm level, makes too little impact on policy, largely for want of evidence that the benefits of grain savings - especially to the poor and hungry - justify the costs of improved structures. A description is given of a pilot survey of the costs and benefits of alternative means of paddy storage in two South Indian villages. Preliminary results suggest that subsequent, ongoing work in a larger sample of villages, will justify substantial outlays on improved stores for small farmers and landless labourers. - Trop. storage Abstracts

2.1.5.2.2.2.2
Crops, Cereals, Rice, Loss Factors, --- PROCESSING MACHINERY

KHAN, A.U., DUFF,B., KUETHER, D.O. and McMENNAMY, J.A. (1976)

Rice machinery development and mechanisation research. Manila: International Rice Research Inst., 1976. 61p. illus.
(Agricultural Engineering Dept., Semi-annual progress report, no. 21, July 1 - Dec 31, 1975)

2.1.5.2.2.3.1.

Crops, Cereals, Rice, ---- CLIMATE

PIXTON, S.W. and WARBURTON, S. (1975) The moisture content-equilibrium relative humidity relationship of rice bran at different temperatures. J. stored Prod. Res., 11 (1),p1-8, 2 tabl, 9 fig, refs. (Authors' address: Ministry of Agriculture, Fisheries and Food, Pest Infestation Control Laboratory London Road, Slough SL3 7HL, England).

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% 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% R.H. fell within a range of 9 - 13% - Trop. storage Abstracts, 1975 (2) p26-7.

2.1.5.2.2.3.2.

Crops, Cereals, Rice, Loss Factors, ----- PESTS, PESTICIDES

FEAKIN, S.D.(Editor)(1976) Pest control in rice. 2nd ed. London: Centre for Overseas Pest Research, 1976. iv, 295p illus (PANS Manual no. 3) (£2.25 +26p surface mail: in countries eligible for British aid free copies may be applied for by institutions). Deals mainly with growing crops in the field but has a 19p section on storage pests.

PREVETT, P.F. (1971)

Storage of paddy and rice (with particular reference to pest infestation). Trop. stored Prod. Inf., 1971 (22)p35-49. illus., 16 refs 1956-68. Reprinted (revised) from PANS Manual no. 3, "Pest control in rice", 1970, pp. 219-236. Discusses those aspects of loss, quantitative and qualitative, which result from attack by insects and moulds in storage and considers physical conditions conducive to such attacks.

2.1.5.2.2.3.2.1.

Crops, Cereals, Rice, Loss Factors, Pests, ---- INSECTS , INSECTICIDES

BANDYOPADHYAN, M.K. (1975) Studies on the hermetic storage of paddy for the control of Stitotroga cerealella (Lepidoptera: Gelechiidae). Ph.D. Thesis, Indian agric. Res. Inst., Ent. Newsl., India, 5 (2),p 9-10. (Summary only). (Division of Entomology, Indian Agricultural Research Institute, New Dehli 110012, India).

Reports on laboratory investigations on the susceptibility of the immature stages of S. cerealella to air tight storage and the effect of airtight storage on paddy and storage fungi associated with it. Paddy of 14, 16 and 18% m.c. was stored at 25, 30 and 35°C. Eggs were not killed at 15% m.c. and below, but 100% mortality was recorded in paddy at 18% m.c. stored at 30-35°C when the oxygen content had fallen to 0.6%. First instar larvae were killed in paddy at 14% m.c. when oxygen concentration fell to 3%, whilst in grain of 16 and 18% mortality only occurred when oxygen content fell to 0.24%. Fourth instar larvae and pupae were killed under all conditions when oxygen concentration fell to 0.21%. The relative susceptibility to airtight storage was in the descending order first, fourth instar larvae pupa. Desiccation was also a

factor affecting mortality in airtight conditions. Deteriorative changes in paddy were not eliminated by hermetic storage, but were related to moisture content and temperature. Fungal growth was retarded. - Trop. storage Abstracts.

BREESE, M.H. (1964)

The infestibility of paddy and rice. Trop. stored Prod. Inf., 1964 (8)p289-299, illus., 10 refs 1942-63.
Deals with infestation by Sitotroga cerealella (Ol.), Rhyzopertha dominica (F.) and Sitophilus oryzae (L.).

COGBURN, R.R. (1975) Stored rice insects research. 1975. Rice J., 78 (7),p 78. (Author's address: Research Entomologist, Agricultural Research Service, USDA, Beaumont, Texas 77706, USA).

Reports on tests to find an alternative for malathion, to which many stored products insects are developing resistance. Rice in small bins, subjected to very heavy infestation pressure from a multispecies insect population, treated with primiphose-methyl at dosage of 10 and 15 ppm, was protected for 9 months, even from some malathion resistant insects. Trials were also carried out to estimate the amount of damage inflicted by stored products insects on rice. Preliminary results indicate that rough rice is much less subject to damage than is brown rice. Damage to brown rice varies according to insect species and rice variety. The maximum loss observed to date equals 29% of the value of the rice. A starting population equal to one gravid female Sitotroga cerealella in 500 g will totally destroy brown rice within three generations. Approximately 1000 varieties of rice were screened for susceptibility to attack by S. cerealella. About 10% appeared to be resistant. Hull morphology is one factor affecting susceptibility and varieties differ markedly in their nutritional suitability for some insects. - Trop. storage Abstracts

FERNANDO, H.E. (1959)
Storage loss of paddy due to Sitotroga cerealella and its control. Internatl. Rice Comn. News Let. 8(1)p20-25. Mar. 1959.
Seed treatment with malathion dust, and spraying storage bags with malathion. 5743

GOARIN, P. (1953)
Insectes du paddy et du riz en magasin et essai de traitement des stocks a l'H.C.H. Rech. Agron. Madagascar 2p130-131, illus. 1953.
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. 5747

INTERAFRICAN PHYTOSANITARY COUNCIL (1972) Control of insect pests of stored rice. Interafrican Phystosan. Bull., 1972 (3),p 49-50, Lagos: OAU/STRC: PMB 2359.

The principal pests are listed as Rhizopertha dominica, Sithophilus 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 gall/ 1000ft^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. - Trop. storage Abstracts

MALLAMAIRE, A. (1954)
Les insects nuisibles aux produits vegetaux et denrees alimentaires entreposes a Dakar. (Insect pests of vegetable products and stored food in Dakar.) B. Prot. Veg. Afrique Occident. Franc. 1p49-57, illus. Ref. Jan. 1954
RICE 5770

PREVETT, P. and others (1960)

Protection of paddy against insect pests during storage. Trop. stored Prod. Inf., 1960 (2)p23-26. illus Refers to both bag and bulk storage.

PREVETT, P. and others (1960a)

Treatment of rice stored in jute bags against insect pests. Trop. stored Prod. Inf., (1960) (1)p4-9 illus
P. referred to as joint author in Editorial

SALMOND, K.F. (1956)
Insect infestation in stored rice in Nyasaland. Trop. Agr. (Trinidad) 33(2)p134-135. Apr. 1956.
Rhyzopertha dominica, Sitophilus oryzae and Sitotroga cerealella. 5797

STEELE, B.,(Editor)(1970)

Pest control in rice. London: Tropical Pesticides Research Headquaters and Information Unit, 1970. 12/6d. ii, 270p illus., bibl. (PANS Manual no. 3, 1970)
Section on storage pp.219-236. Free to agricultural and educational establishments in countries eligible for British aid. Reviewed in Trop. stored Prod. Inf., 1970 (20)p36.

UNITED STATES AGRICULTURAL RESEARCH SERVICE (1971)

Controlling insect pests of stored rice. Rev. ed. Washington, U.S. Govt. Printing Office, 1971. iv, 19p. (Agricultural handbooks - no. 129)

2.1.5.2.2.3.2.3.

Crops, Cereals, Rice, Loss Factors, Pests ----FUNGI, FUNGICIDES

CALDERWOOD, D.L. and SCHROEDER, H.W. (1968)
Aflatoxin development and grade of undried rough rice following prolonged storage in aerated bins.
1968. 32p.
(U.D. Dept. of Agriculture reports: Agriculture Research Service no. ARS 52-56)
Mimeographed.

CHRISTENSEN, C.M. (1969)

Influence of moisture content, temperature and time of storage upon invasion of rough rice by storage fungi. Phytopathology, 59 (2),p145-148.

2.1.5.2.2.4

Crops, Cereals, Rice, Loss Factors, ---- QUALITY CONTROL

ARKANSAS UNIVERSITY. INSTITUTE OF SCIENCE AND TECHNOLOGY (1953)

Pilot plant investigations of the effects of drying, storage and processing factors on the quality of rice, terminal report. Fayetteville,Arkansas ,1953, 55p. illus RICE 5597

MIGNARD, C. (1955)

Reception et usinage du riz. (The receipt and milling of rice) B. Inform. Rizicult. France 39:p 15-23, illus. July/Aug 1955.
Sampling for quality, drying, storage, and milling.
RICE 5610

ROSEMAN, A.S. and DEOBALD, H.J. (1958)

The effect of freezing on the hydration characteristices of rice. Food Technol. 12(9)p464-468, illus. Ref. Sept. 1958
6000

SHAHEEN, A.B., EL-DASH, A.A. and EL-SHIRBEENY, A.E. (1975) Effect of parboiling of rice on the rate of lipid hydrolysis and deteriora-

tion of rice bran. Cereal Chem., 52 (1),p1-8, 2 tabl, 3 fig, 12 ref. (Authors' address: Department of Food Technology, Al-Azhar University, Cairo, Arab Republic of Egypt.)

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 exhited 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, 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. - Trop. storage Abstracts

2.1.5.2.3.1.1.

Crops, Cereals, Rice, Post-Storage ----- MILLING

CRAUFURD, R.Q. (1961?)

Breakage of rice during milling : (extract from Scientific Report no. 11 of the West African Rice Research Station, Sierra Leone). Trop. stored Prod. Inf., 1961 (3)p64-67.
Shows that the percentage recovery of whole grains is very largely determined by the treatment received by the paddy before milling - both in the field and after harvest. Author mentioned in editorial.

MASSARD, J. (1952)
L'usinage du riz en A.O.F. (Rice milling in French West Africa.) Entrep. Prod. Madagascar 11/12:p 70-71, illus. Apr./Sept. 1952.
5930

2.2 Crops, -- LEGUMES, PULSES

BRITISH STANDARDS INSTITUTION (1969b)

Methods for sampling pulses. London: BSI, 1969. 8/-. 14p. (BS 4511:1969)

DAVIES, J.C. (1973)

A note on the occurence of Zabrotes subfasciatus Boh., Coleoptera (Bruchidae) on legumes in Uganda. E. Afr. agric. For. J.,1972 37 (4)p. 294-299.
Gives a description of the life cycle of this insect which is now the commonest bruchid pest of stored beans and cowpeas.

WEAVING, A.J.S. (1970)

Susceptibility of some Bruchid beetles of stored pulses to powders containing pyrethrins and piperonyl butoxide. J. stored Prod. Res., 1970 6 (1)p. 71-77.
Laboratory tests in Kenya.

YADAV, T.D. and PANT, N.C. (1975) Immunity of processed pulses to bruchids. Entomol. Newsl., 5 (1),p2. (Authors' address: Division of Entomology, Indian Agricultural Research Institute, New Delhi - 110012, India).

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. - Trop. storage Abstracts, 1975 (4)p 58-59.

2.2.2 Crops, Legumes --- BEANS

DAVIES, J.C. (1963)

In-sack storage of beans using 0.04% gamma-BHC dust. Trop. stored Prod. Inf., 1963 (6)p213-221. 2 refs.
Three varieties of beans, common in Uganda, were tested for resistance to attack by Acanthoscelides obtectus Say. Weight losses were calculated and an economic return from insecticidal measures was demonstrated.

FRIENDSHIP, R. (1975) Insect pest control and haricot beans. Ethiopian Grain Rev., 2 (1),p10-13, 4 pl. (Author's address: P O Box 3721, Addis Ababa, Ethiopia).

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 buildings and 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. - Trop. storage Abstracts, 1975 (3) p36.

McFARLANE, J.A. (1969a) Control of the bean Bruchid Acanthoscelides obtectus (Say.) by synergised pyrethrins powders Pyrethrum Post, 1969 10 (1),p34-40.

ROTH, H. and RICHARDSON, H.H. (1974) Broad bean weevil: methyl bromide fumigation of infested Faba beans. J. econ. Ent., 67 (6),p799, 4 refs. (Author's address: Plant Protection and Quarantine Programs, Animal and Plant Health Inspection Service Hoboken, NJ07030, USA).

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 I959-I972, comprising 230 fumigations of some I25,000 beans with I-I0%infestation. Individual samples were from I-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 40 mg/I for 2½ hr at 32.8°C. Complete kill was obtained with 48mg/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. - Trop. storage Abstracts

2.2.3. Crops, Legumes --- PEAS

AKINGBOHUNGE, A.E. (1976)
A note on the relative susceptibility of unshelled cowpeas to the cowpea weevil (Callosobruchus maculatus Fabricius) (Coleopters.Bruchidae). Trop. Grain Legume Bull., I976, (5), p. II-I3. 8 refs.
Notes that bruchid attact 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,Ife-Ife, Nigeria.

AKPAETOCK, O,I. (1974)
Drying and storage of cowpeas with ashes in airtight containers. J. agric. Engng Res., I9 (3),p279-287, 2 tabl, 4 fig.
(Author's address: Agricultural Engineering Department, University of Ife, Ife-Ife, Nigeria).

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 ratio and to be dependent upon the grain variety. Mathematical formulae are proferred to establish the relationship between drying and experimental constants. - Trop. storage Abstracts.

ANTHONIO, Q.B.O. (1962)
WASPRU/UCI Grain Storage Project 6. The economics of cowpeas in storage in a concrete bin.
West Afr. Stored Prod. Res. Unit Rep. I962, tech. rep. No. I9, p. 94-95.

BOOTH, S.A. (1974)
Cowpea storage. Proc. Symp. 'Problems Storage Handling Groundnuts, other Food grains and Animal Feeds' org. Afr. Groundnut Coun. Kaduna I973. (Appendix VII), p.5I-57, 2 tabl, refs.
(Author's address: Institute for Agricultural Research, Ahmadu Bello University, Samaru, PMB I044. Zaria, Nigeria).

Production of cowpeas in Nigeria has been steadily increasing, mainly in northern Nigeria, where production rose from 375,000 tons in I957/58 to 8I0,000 tons in I96I/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 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; 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 polthene bags with cotton liners shows promise. - Trop. storage Abstracts

CASWELL, G.H. (1970)
The storage of cowpea in the northern states of Nigeria. Zaria: Institute forAgricultural Research, I970. 3p. (Samaru Research Bulletin - no. I20)
Reprinted from Proc. agric. Soc. Nigeria, 5 July 2-6 I968.

"Describes a method of estimating losses in stored cowpeas, and gives an estimate of gross monthly losses for the region" - reviewer in Trop. stored Prod. Inf., 1971 (21) p.35.

CASWELL, G. H. (1973).
The storage of cowpeas. Samaru agric. Newsl., 15 (2), p.73-75. (Author's address: Senior Entomologist, Institute for Agricultural Research, Samaru, Ahmadu Bello University, PMB 1044, Zaria, Nigeria).

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% 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.- Trop storage Abstracts.

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE (1976).
Control of cowpea weevil in storage. Annual report, 1975. Ibadan: IITA, 1976. p.101.

Describes an easy method for control of cowpea weevil in storage and advocates its use in rural areas.

O'DOWD, E.T. ((1971).
Hermetic storage of cowpea (Vigna unguiculata Walp) in small granaries, silos and pits in Northern Nigeria. Zaria, Nigeria: Institute for Agricultural Research, Ahmado Bello Univ., 1971. (Samaru miscellaneous papers - no. 31).

2.2.4. Crops, Legumes --- GROUNDNUTS

A'BROOK, J. (1963)
Artificial drying of groundnuts: a method suitable for the small farmer. Trop. Agriculture, Trin., 1963, 40 (3), p.251-245.

A'BROOK, J. (1964)
A cheap crop drier for the farmer. Trop. stored Prod. Inf., 1964 (7). p.257-268. illus., 2 refs.

Describes the methods of construction and operation of two driers made of locally available materials, using unskilled labour. They were built in Northern Nigeria to dry groundnuts in shell.

A'BROOK, J. (1964b)
A cheap crop drier for the farmer: results and recommended design. Trop. stored Prod. Inf., 1964 (8), p.301-307. illus., 4 refs.

Reports the results of tests of the 1961 and 1962 driers (A'Brook, 1963 and 1964) and the design of the 1963, recommended model groundnut drier developed at Mokwa, Northern Nigeria.

CARLING, K.E. (1969)
Agricultural notes.
41p. Duplicated.
Produced especially for groundnut inspectors in Eastern Province of Zambia.

CONWAY, J.A. (1974)
Investigations into the origin, development and control of Caryedon serratus (Ol.) (Col. Bruchidae) attacking stored groundnuts in The Gambia. Symp. Ist. int. Working Conf. stored Prod. Ent. Oct. 7-11, 1974, Savannah, Georgia, USA. (Abstract only). (Author's address: Crop Protection Unit, Dept. Agric., Yundum Experimental Station, Western Division, The Gambia).

Caryedon serratus (Ol.) (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 populations 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. (£1.00 = 4 Dalasi = 400 bututs). - Trop.storage Abstracts. 1975 (3), p.34-5.

DAVEY, P.M. & SWINBURNE, K. (1960)

Infestation problems of the groundnut industry in The Gambia. Trop.stored Prod. Inf., 1960 (2) p.27-30. 10 refs, 1947-60.

Deals largely with post-harvest infestation by Caryedon gonagra F. Authors named in Editorial.

FEAKIN, S.D. (Ed.) (1973)

Pest control in groundnuts. PANS Manual No. 3. 3rd Edn. ISBN 085135 059 1, iii + 197 pp, 21 tabl, 90 fig, append, index. Publ. Centre for Overseas Pest Research, PANS Office, College House, Wrights Lane, London W8 5SJ, England.

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. -Trop.storage Abstracts, 1974 (3), p.35. Reviewed in Trop. stored Prod. Inf., 1974. (28), p.52.

FOOD AND AGRICULTURE ORGANIZATION (1973)

Report to the Government of Nigeria on aflatoxin in groundnuts and groundnut products, based on the work of P.C. Crowther. An appraisal of the situation in Nigeria. UN Dev. Progm. AGP: TA/249. No TA 3221. vi + 33pp, 10 append, refs. Rome: UN,FAO.

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. - Trop. storage Abstracts, 1974 (3) p. 44.

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 I. Pattison. AGS: SF/SEN 5. Rapport Technique 10. 43 pp + 10 photos. (Fr.). (Obtainable from: UN:FAO, Distribution and Sales Section, Via delle Terme di Caracalla, 00100- Rome, Italy).

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 funigated under sheets, before entering the store. For the future it is worth considering the construction of fumigable stores for groundnut seed, as total disinfestation of small stacks is easy and will be less onerous than treatment with insecticide. -
Trop. storage Abstracts

FRIENDSHIP, R. (1974)

A preliminary investigation of field and secco infestation of Gambian groundnuts by Caryedon Serratus (01)

London: Tropical Products Institute, 1974. iv, 14p. illus., 8 refs.
(Report no L38)
ISBN: 0 85954 029 4.

GAMBIA CROP PROTECTION UNIT (1969)

Annual Report, 1968/69. Yundum: Agricultural Station, 1969. 15p. Duplicated.

Deals largely with the post-harvest 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. (c1975)

Recommended practices for the production of groundnuts. Kumasi. (Technical bulletins - no. 3)

GIBBONS, R.W., LAURENCE, R.C.N., NORSE, D. AND COX, R.A.J. (1975)

Groundnut drying trials in Malawi. Trop. Sci. 17 (1), p. 15-24, 4 tabl, refs. (Authors' address: Grain Legume Research Laboratory, Agricultural Research Council, P O Box 215, Lilongwe, Malawi).

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. -
Trop. storage Abstracts, 1975, (4), p. 52.

GROUNDNUT REVIEW

(1973 -) Lagos: African Groundnut Council.
"Covers all scientific disciplines of groundnut research."

JACKSON, C.R. (1967)

Studies on control of peanut pod fungi. Part I. Effects on pre-planting soil funigants 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. Res. Rep. Univ. Ga, Coll. Agric. Exp. Stn, no. 11, 1967, 18p.

JACKSON, C.R. (1967b)

Development of fungi in peanuts during artificial drying. Res. Rep. Univ. Ga, Coll. Agric. Exp. Stn, no. 19, 10p.

MAGAR, W.Y. (1974)

Problems of storage and handling of groundnuts and other food grains and animal feeds. Proc. Symp. 'Problems Storage Handling Groundnut, other Food Grains and Animal Feeds' org. Afr. Groundnut Coun. Kaduna 1973. (Appendix IV), p. 24-40, 3 tabl, refs. (Author's address: African Groundnut Council Secretariat, P O Box 3025, Lagos, Nigeria).

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. -
Trop. storage Abstracts

PATTINSON, I. (1967)

Statutory quality control in The Gambia. Trop. stored Prod. Inf., 1967 (13), p. 5-8.

Discusses the causes of post-harvest losses in groundnuts and legal measures taken to ensure quality control in this crop and to prevent infestation from imported rice and wheat flour.

PREVETT, P.F. (1970)

Callosobruchus subinnotatus (Pic) (Coleoptera, Bruchidae) a potential pest of stored groundnuts. J. stored Prod. Res., 1970 6 (3), p. 279-280.

PROCTOR, D.L. AND ASHMAN, F. (1972)

The control of insects in exported Zambian groundnuts using phosphine and polyethylene lined sacks. J. stored Prod. Res., 1972 8 (2), p. 127-137. (PICL reprint no. 852)

REDLINGER, L.M. (1976)

Pirimiphos-methyl as a protectant for farmers'stock peanuts. J. econ. Ent., 69 (3), p. 377-379, 3 tabl, 7 refs. (Author's address: Stored-Product Insects Research and Development Laboratory, Agric. Res. Serv., USDA, Savannah, GA 31403, U.S.A.).

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 addi-

tion, groundnuts treated with pirimiphos-methyl had fewer insectdamaged kernels than the control. Tribolium castaneum and Ephestia cautella were the predominant species found. Residues of pirimiphos-methyl decreased at a rate approximately 33% less than malathion during the trial period. - Trop. storage Abstracts, 1976

ŽĎÁRKOVÁ, E. AND REŠKA, M. (1976)

Weight losses of groundnuts (Arachis Hypogae L.) from infestation by the mites Acarus Siro L. and Pyrophagus Putrescentiae (Schrank). J. stored Prod. Res., 1976, 12 (2) p. 101-104. 6 refs 1940-1970.

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.

2.3 CROPS - ROOT CROPS

2.3.2

Crops, Root Crops, ---- CASSAVA

ARAULLO, E.V., NESTEL, B. AND CAMPBELL, M. (ED.) (1974)

Cassava processing and storage. Proc. interdisciplinary Workshop, Pattaya, Thailand, 17-19 April 1974. 125 pp, figs, ref. ISBN 0 88936 036 7. Publ. International Development Research Centre, Box 8500, Ottawa, Canada K1G 3H9. Price, microfiche ed. 1.00 $

Individual papers are given in full, together with abstracts. Most aspects of the cassava industry are discussed. Among others are: Phillips, T.P., World market prospects for cassava and its products; Booth, R.H. and Coursey, D.G., Storage of cassava roots and related post-harvest problems; Tulanada, D., Problems of the Thai tapioca trade; Hrishi, N., Problems and prospects in cassava production in India; Castillo, L.S., The cassava industry of the Philippines; Wijeratne, W.B., Cultivation, processing and utilization of cassava in Sri Lanka; Manurung, F., Technology of cassava chips and pellets processing in Indonesia, Malaysia and Thailand; Nguyen Cong Thanh, Technology of cassava chips and pellet processing in Thailand. - Trop. storage Abstracts.

INGRAM, J.S. AND HUMPHRIES, J.R.O. (1972)

Cassava storage - a review. Trop. Sci., 1972 14 (2) p. 131-148. illus., 76 refs.

2.3.3

Crops, Root Crops, ---- YAMS

COURSEY, D.G. (1964)

The storage behaviour of yams: a summary of recent investigations in Nigeria. Trop. stored Prod. Inf., 1964 (7), p. 269-275. 11 refs 1921-62.

Quantifies the weight losses of stored yam tubers and describes experiments designed to reduce these losses. Concludes that a fundamental physiological change takes place in the tuber 10-14 weeks after harvesting.

COURSEY, D.G. (1967)

Yams: an account of the nature, origins, cultivation and utilization of the useful members of the Dioscoreaceae. London: Longmans, 1967. xiv, 230p. illus. (Tropical Agriculture series).

Contents include an 18p section on storage, including magnitude of, and factors responsible for, storage losses.

3 CROPS: LOSSES AND THEIR CONTROL DURING POST-HARVEST OPERATIONS 3.03

ADAMS, H.R. AND OTHERS (1965)

Losses in agriculture. Washington, D.C., U.S. Dept., Agricultural Research Service, 1965 vi, 120p. (Agriculture Handbook 291)

Information on the losses occurring during production transportation and marketing of farm and forest products in the U.S.A. Over 25 references, 1941-1964.

CHIARAPPA, L. (ED.) (1972)

Group loss assessment methods. Commonwealth Agricultural Bureaus, 1972. 276p Loose-leaf.

FOOD AND AGRICULTURE ORGANIZATION (1969)

Food losses: the tragedy ... and some solutions. Rome: F.A.O., 1969. iv, 38p. (PI/ 83132/2.69/E/1/5000).

Largely waste of land resources but includes world losses and costs to stored products, the damage and means of prevention.

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.

JAMIESON, M.F.S. (1970)

A simple tool for calculating loss or gain in weight resulting from a change in the moisture content of produce. Trop. stored Prod. Inf., 1970 (20), p. 19-20. 1 ref.

Gives a nomograph for calculating changes in weight.

HULSE, JOSEPH 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. (ii), 18p. On cover: Commonwealth Secretariat.

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 (dealt with further in separately published appendices).

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)

3.1

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE (1974)

Annual Report Ibadan, IITA, 1974. 199p.

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE (1975)

Annual Report Ibadan, IITA, 1975. 219p.

5.2 -LOSS FACTORS

COURSEY, D.G. & PROCTOR, F.J. (1975)
Towards the quantification of post-harvest loss in Horticultural produce. Acta Horticulturae 49, 1975, p. 55-66. 47 refs 1949-73.

Suggests that 25% of horticultural crops are lost between harvest and consumption. Paper reviews the limited information on subject, discusses the major causative factors, illustrating the principles with examples from temperate and tropical countries, indicates ways of reducing loss and stresses the importance of quantifying the elements in loss.

HALL, D.W. (1968)
Prevention of waste of agricultural produce during handling, storage and transportation. Trop. stored Prod. Inf., 1968 (15) p. 15-23. illus.

Revision of a paper read at the 8th F.A.O. Regional Conference for Asia and the Far East, Seoul, Korea, 15th-24th Sept., 1966. Considers the factors causing loss, from harvesting to transportation, the economic results of losses and suggests measure for controlling such losses. No refs.

HALL, T.H.R. (1967)
World crops international directory and handbook.
L. Hill, 1967.
320p.

HOWE, R.W. (1976)
Some obvious and not so obvious sources of post-harvest loss. Proc. 8th Br. Insectic. Fungic. Conf., Brighton, 1975, 3, p. 975-980, 3 refs. (Author's address: Ministry of Agriculture, Fisheries and Food, Pest Infestation Control Laboratory, London Road, Slough, Berks. SL3 7HL, England).

A distinction is made between real losses of weight and quality which are often high in tropical countries and business losses which are important in temperate countries. Three reasons why our knowledge of the extent of national losses of produce in storage are so imprecise are discussed. The patchy distribution of insects, mites and fungi and consequently of the damage they cause makes it almost impossible to estimate losses exactly in single large stacks. We know that moisture is so seldom uniformly distributed in produce that we cannot easily use dry weight as a basis for estimates. In any event, temperature gradients cause the translocation of moisture around a stack and can raise an acceptable moisture content to a dangerous level. Feeding trials are difficult to perform because we cannot be sure that the diets are palatable and free from unwanted toxins, live or dead pests, or disease organisms.- Trop. storage abstracts, 1976 (2) p. 22.

HUGHES, HAROLD D. & HENSON, E.R. (1972)
Crop production. 3rd rev. ed. rev. by D. Metculfe. Collier Macmillan, 1972.
640p.

KIPPS, M.S. (1970)
Production of field crops. 6th ed. rev. McGraw-Hill, 1970. (Agricultural Science Series.)
688p.

POST HARVEST FOOD LOSSES IN DEVELOPING COUNTRIES (1976)
Fmg Dev. - IFAP Liaison Bull., 12 (1), p. 21-22.
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; losses resulting from marketing systems. Each

stage is examined briefly and a few examples are given.- Trop. storage Abstracts.

SPENSLEY, P.C. (1976)
Harvest home - and the destruction starts. The Times, 8 April, V, illus. (Author's address: The Director, Tropical Products Institute, 56/62 Grays Inn Road, London WC1X 8LU, England.

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, whilst micro-organisms cause most damage to horticultural produce. Points out that there is a considerable body of technology available to reduce post harvest losses, and at farmer level many simple, low cost techniques have been developed. Some of these are discussed. The need for care in using chemical treatments is emphasised. 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.-
Trop. storage Abstracts, 1976 (2) p. 28.

TROPICAL PRODUCTS INSTITUTE, LONDON. (1975)
The reduction of post-harvest food losses.

In FOOD production and rural development: meeting of Commonwealth Ministers, London, 4-12 March 1975. London, Commonwealth Secretariat, (1975?). Pages 308-319. Paper FRDMM (75) P5 - RESTRICTED.

Reviews losses occurring in durable food grains and perishables such as fish, fruit, vegetables and root crops under the following headings: Extent of losses; causes of loss; availability of technology and equipment to prevent losses; problems facing adoption of remedial measures; work of the TPI on the problem; possible actions by governments. Discussion of the paper by delegates is reported on pages 109-119.

3.2.1.1.3

----DRYING & STORAGE

DE BEER, A.G. (1972)
Drying and storing agricultural produce on the farm. Fmg. S. Africa., 1972 48 (5) p. 29-68. illus., ref.

NEW EQUIPMENT FOR CROP DRYING AND STORAGE (1975)
World crops, Sept/Oct 1975 27 (5) p. 204-5.

Brief description of several new commercially available items of equipment including tropical applications.

3.2.1.1.4

----DRYING, DRYERS

HEARLE, H.F. & HALL, D.W. (1962?)
The use of low temperature high air volume drying of tropical crops. Trop. stored Prod. Inf., 1962?, (5), p 168-173. illus.

Discussed use of Lister Moisture Extraction unit in drying certain crops - including cereals. Unit is portable and suitable for larger farms and plantations. The subject is also discussed in the Editorial, p. 153.

INDIAN AGRICULTURAL RESEARCH INSTITUTE: AGRICULTURAL ENGINEERING DIVISION (1975).

Solar dryer for small farmers. Pesticides, India, 9 (4), p. 59.

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% m.c. could be dried to 15% 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.- Trop. storage Abstracts

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).

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.- Trop. storage Abstracts, 1975 (3), p. 39-40.

MC CLOY, J. (1955)
Artificial drying in remote territories and the fuel problem.

World crops, March 1955, 7 (3) p. 109-113.

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

MUCKLE, T.B. & STIRLING, H.G. (1971)
Review of the drying of cereals and legumes in the tropics. Trop. stored Prod. Inf., 1971 (22), p. 11-30* Natural and artificial drying are described and the methods of operation of artificial driers are explained. Considers the factors in selecting appropriate driers. Maize, rice, groundnuts, peas and beans are dealt with individually.

* illus. bibliog. (37 entries, 1946-71).

OXLEY, T.A. (1962)
Loss in weight on drying. Trop. stored Prod. Inf., 1962 , (4), p. 129-130. Also note in Editorial, p. 93.

Table, p. 130 shows why the change in moisture content in drying is always less than the percentage loss in weight.

Author mentioned in Editorial note.

PETERSEN, W.H. (1975)
New developments-solar heat for crop drying. Proc. Grain Conditioning Conf., Univ. Ill., Champaign 1975, p. 47-48, illus. (Author's address: William H. Petersen, Extension Agricultural Engineer, South Dakota State University, Brookings, South Dakota, 57006, USA).

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. Firstly,

a temperature rise rather than a fixed temperature is adequate for crop drying, making it possible to use a simple inexpensive heat collector. Secondly 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. Thirdly, 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.-
Trop. storage Abstracts, 1975 (5), p. 67-8.

3.2.2 --STORAGE LOSSES, STORAGE CONDITIONS.

ADAMS, J.M. (1976)
A guide to the objective and reliable estimation of food losses in small scale farmer storage. Trop. stored Prod. Inf., 1976 (32), p. 5-12. illus., 7 refs 1965-76.

Shows that losses in storage are of different types (quantitative, qualitative, nutritional, and loss in seed germination), and states that the use of any estimates must be considered when conducting loss assessments. Describes procedures to be followed and the methods of analysis to be used to produce an estimate of total loss. The main causes of loss are insects, rodents, birds and fungi. The guide is based mainly on experience with maize in Africa.

CARESCHE, L. AND OTHERS (1969)
Handbook for phytosanitary inspectors in Africa, by L. Caresche, G.S. Cotterell, J.E. Peachey, R.W. Rayner and H. Jacques-Felix. Lagos, Organisation of African Unity Scientific, Technical and Research Commission, 1969. 444p. illus.

Contains 3 appendices. Stored products and sampling techniques are dealt with in the appendices.

DAVIES, J.C. (1962)
Storage of agricultural produce. Kampala, Department of Agriculture, 1962. 31p.

FOOD STORAGE MANUAL (1970)
Prepared by Tropical Stored Products Centre, Ministry of Overseas Development, Slough, England.

Rome; World Food Programme. 1970
3 vi illus. Looseleaf.

A comprehensive study of the whole problem of food wastage in storage particularly those problems associated with the range of commodities being shipped to developing countries as Food Aid.

Part I discusses the biological, physical and chemical aspects.

Part II deals with the technological aspects, including packaging, handling and storing.

Part III covers the practical aspects - buildings, warehouse management, inspection and control of pests.

The index is included in part III.

Reviewed in Trop. stored Prod. Inf., 1971 (21), p. 3-4.

Part I xvi, 304p.
Part II vi, 305-569p.
Part III v, 570-799p.
Includes refs.

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, 1970. 161p.

HALL, D.W. (1969)
Food storage in the developing countries. Trop. Sci. 1969, 11 (4), p. 298-318.

HALL, D.W. (1963)

Stored products organizations in some overseas countries. Trop. stored Prod. Inf., 1963 (6), p. 191-196. 3 refs 1950-62.

Describes the work then being undertaken in all parts of Commonwealth Africa, excluding Southern Africa. Also includes West Indies and South East Asia.

HALL, D.W. & HYDE, M.B. (1954)
The modern method of hermetic storage. Trop. agric. Trin., 1954, 31 (2), p. 149-60.

HUTCHINSON, J. (Chairman). (1975)
British aid and the relief of malnutrition. Report of the ODA advisory committee on protein. Minist. Overseas Dev., Overseas Dev. Pap. No 2, ISBO 0 11 580165 0, vi + 44 pp. London: HMSO. Price 51p net.

The terms of reference of the committee were to advise on the scientific, economic and other relevant aspects of problems of the production and consumption of conventional and non-conventional protein foods and supplements with particular reference to the needs of developing countries, bearing in mind the relationship between protein supplies and calorie requirements. The committee finds that protein deficiency in diet is directly related to general malnutrition and poverty. The basic recommendation made is that in the interests of better nutrition, aid should be directed to projects that will generate income among the poor, even where such projects do not have any marked effect on the national income of the country concerned. Other recommendations relate to the provision of personnel with nutrition expertise, suitable training and job opportunities for trained personnel, and increased attention to less productive farming areas and poorer farmers. Finally the report emphasises the importance of food technology, storage, marketing and distribution in developing countries in reducing the effects of food shortages.-
Trop. storage Abstracts, 1975 (4), p. 52-3.

JOURNAL OF STORED PRODUCTS RESEARCH (1965-)
Oxford: Pergamon, 1965-
Quarterly

Article on this journal in Tropical Stored Products Information no. 9.

LUCA, Y DE. (1975)
Ecologie des denrees stockees (milieu, peuplement, agressions). (Ecology of stored products - environment, populations, attacks). Bull. Ass. Nat. Enseignement Agric. publ., Numero Special, 39pp, 65 ref. (Author's address: Maitre Assistant de Zoologie et d'Ecologie, ENSAM, 9 Place Viala, 34060 Montpellier, CEDEX, France).

Discusses the medium in sensu stricto depending upon the characteristics and condition of the commodity or article stored, and in senso lato, the latter including problems of climate, handling and of storage. Analyses the population of the stored items; systematic structure-animals, plants, microorganisms; qualitative-pests and associated agents; autecology and synecology - relation between the medium, animals, plants, associated agents and man. Discusses attacks (impacts on stored products and environment); causes (climate handling and storage, state of stored produce); nature of the attacker (flora and fauna and man). Notes criteria for detection of changes in stored products and discusses means of control. Finally discusses the seriousness of the damage to the product and its social significance.-
Trop. storage Abstracts, 1976 (1). p. 10.

MAJUMDER. S.K. (1970)
Protecting food from deterioration during storage, handling and distribution in technologically less developed countries of the world. Proc. 3rd int. Congr. Fd Sci. Technol., Washington,

D.C. 1970, P518-531 + 7 tables + 8 Pl. + 2 figs. (Author's address: Infestation Control and Pesticides, Central Food Technological Research Institute, Mysore 2A, India)

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, specialised 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 rodent 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.-
Trop. storage Abstracts, 1973 (1), p. 10-11.

NIGERIAN STORED PRODUCTS RESEARCH INSTITUTE (1967)
Annual report, 1966. Lagos, Nigerian Stored Products Research Institute, 1967. 148p.

Contain 23 technical reports.

STORM, L. (1974)
Agricultural marketing storage course. Moshi, Tanzania: Cooperative College, 1974. 74p. (FAO/UNDP Project SF TAN 27)

TEMPANY, SIR HAROLD & GRIST, D.H. (1958)
An introduction to tropical agriculture. London: Longmans, 1958. xvi, 347p. bibl. pp 314-324.

(2nd imp. with corrections 1960; 3rd imp 1964).

Chapter 16, pp 245-258, Storage of crop products. Deals extensively with losses, including quantification, and preventative measures. Refs in text.

TROPICAL PRODUCTS INSTITUTE (1969)
Food storage bibliography, with special reference to tropical foods.

Slough, Tropical Stored Products Centre, 1969. ii, 7p.

TROPICAL STORED PRODUCTS CENTRE (1960-) TROPICAL STORED PRODUCTS INFORMATION (Trop. stored Prod. Inf.)

Slough

Nos 1 & 2, 1960; 3, 1961;

4, 1962; 5, 1963. 32 issues to 1976. Reprints of some articles are available.

Most, if not all, issues are relevant. 'News Review' in each issue contains many short items some of which are relevant to post-harvest losses. The longer items have been noted but all issues are worth checking. Most articles include lists of references, some very extensive. Some issues contain reviews of major investigations and earlier issues contained lists of recent publications (which have been listed where relevant).

TROPICAL STORED PRODUCTS CENTRE (1968) TROPICAL STORED PRODUCTS INFORMATION, 15, 1968
News Review includes:- "'Cyprus' grain bins in Kenya", illus.; "Groundnut fumigation trials in Zambia".

TROPICAL STORED PRODUCTS CENTRE (1968 a)TROPICAL STORED PRODUCTS INFORMATION, 16, 1968.
News Review includes:-"Crib storage of maize in Brazil" a review of an article by Triplehorn (1966) 'Wire netting cribs for the storage of maize'; "Recent stored-products work in Nigeria"-a list of 23 reports contained in the 1966 annual report of the Nigerian Stored Products Research Institute.

TROPICAL STORED PRODUCTS CENTRE (1969), TROPICAL STORED PRODUCTS INFORMATION, 18, 1969
News Review includes a section "Losses to stored maize in Malawi", "Trials with small capacity metal grain silos in Dar-es-Salaam, Tanzania" and "Tanzanian Produce Export (Fumigation) Rules, 1968".

TROPICAL STORED PRODUCTS CENTRE (1970) TROPICAL STORED PRODUCTS INFORMATION, 19, 1970
'News Review' includes:- "Food storage in Zambia", "Crop storage problems in Tanzania", "Food storage by the Bantu in Southern Africa", (illus.), "Tests on the use of the Ashman-Simon infestation detector for maize", -(see also Ashman, F. and others 1970, in same issue).

TROPICAL STORED PRODUCTS CENTRE (1971) TROPICAL STORED PRODUCTS INFORMATION, 21, 1971
News Review includes:- "Approval scheme for the use of 'Phostoxin'/'Celphos' in Kenya"; "FAO - two new publications" - publications reviewed include 'Handling and storage of food grains in Tropical and Sub-Tropical areas' by D.W. Hall (q.v.); "World Food Programme-Food Storage Manual" (q.v. under Food).

TROPICAL STORED PRODUCTS CENTRE (1971 a)TROPICAL STORED PRODUCTS INFORMATION, 22, 1971
News Review includes:- "A new hermetic storage bin for rice" illus.; "Use of butyl rubber silos for paddy storage in the tropics" illus.; "Insecticidal dust admixture treatments -Effect of biological factors on insecticide efficiency"; "International Agricultural Research Institutes"; "Trader/ Government co-operation on safer storage and improved insect control in Mombasa Port".

TROPICAL STORED PRODUCTS CENTRE (1972) TROPICAL STORED PRODUCTS INFORMATION, 23, 1972
"Small,on-farm, storage system"-an account of a low-cost maize storage unit designed in Dahomey for tropical climates; illus; "Recent FAO activities on grain storage"; "Group for Assistance on Storage of Grains in Africa (GASGA)"; "Survey of rodent damage to growing crops and in farm and village storage"; "Formulations for phosphine fumigation"; "Control of insects infesting rice bran".

TROPICAL STORED PRODUCTS CENTRE (1973), TROPICAL STORED PRODUCTS INFORMATION, 24, 1973
News Review includes:- "Improved storage for farmers in Northern Ghana" (illus); "Recent FAO activities on grain storage"; "Farmer storage extension projects in Africa" (illus); "Safe storage moisture content for groundnuts";

"14th International Congress of Entomology" - this symposium, held at Canberra, 22-30 August 1972, was devoted to Stored Products Entomology. Lists authors and titles of 14 papers presented - bound volume of abstracts obtainable from Australian Academy of Science. Proceedings not being published but most papers will be published independently.

TROPICAL STORED PRODUCTS CENTRE (1975) TROPICAL STORED PRODUCTS INFORMATION, 29, 1975
News Review includes:- "A simple dosage for the fumigation of commodities with methyl bromide under gas-proof sheets or in freight containers"p4-6, 6 refs; "Rural grain storage project in Swaziland"p6-9 illus.; "A bait trap technique for assessment of stored product beetle populations"p9-11, illus.

TROPICAL STORED PRODUCTS CENTRE (1975a) TROPICAL STORED PRODUCTS INFORMATION, 30, 1975
News Review section includes "FAO activities on grain storage, January-May 1975" (which includes reports on activities in Uganda, East Africa, Mali and Mauretania, Sudan, Chad, Ghana), "Farmers act to reduce losses" (of stored maize in Zambia), "Malawi", "West African seminar on farm and village-level grain storage", "Report on the 8th FAO regional conference for Africa...", etc.

TROPICAL STORED PRODUCTS CENTRE (1976) TROPICAL STORED PRODUCTS INFORMATION, 32, 1976
News Review includes: "Small metal grain silos in Swaziland", p. 1-2, illus. (It is estimated that 15,000 silos, similar to water tanks, are in use in Swaziland, mainly for storage of grain); Brief storage news from Mali, Niger, Senegal and Ghana; "Mini grain dryer" p. 3; "A new rodenticide" p. 3-4; "Recent FAO activities on storage and post-harvest loss reduction", p. 4 (including a brief note on the work of the FAO Interdepartmental Sub-Committee on Reduction of Post-Harvest and Food Losses in Developing Countries).

TYLER, P.S. (1970)
Handbook of crop storage (For the use of officers in the Division of Extension of the Ministry of Agriculture, Botswana).

25p

VOLUNTEERS FOR INTERNATIONAL TECHNICAL ASSISTANCE (1970)
Village technology handbook. Rev. ed. Schenectady, N.Y.: VITA, 1970. £4.05. xii, 387p.

Illus. notes on various village development projects for developing countries - including storage.

WHEATLEY, P.E. (1974)
Research being undertaken by the Tropical Stored Products Centre in the United Kingdom and Overseas. EPPO Bull., 4 (4), p. 495-500. (Author's address: Tropical Stored Products Centre, Tropical Products Institute, London Road, Slough SL3 7HL, England).

Research is undertaken by the Centre both overseas and in the United Kingdom on storage problems facing developing countries. Much of it is of a strictly applied nature although some longer-term basic studies are also underway. Brief notes are given on current work on biological, chemical and engineering studies at all levels of storage, from farm to central storage depot, on a wide range of durable agricultural products and associated pests. Reference is also made to the Centre's publications, and to the various training programmes.-
Trop. storage Abstracts, 1975 (3), p. 45.

WYE, A.J. (1971)
Selected bibliography on improving farm storage. Trop. stored Prod. Inf., 1971 (21), p. 13-17.

Contains 83 entries 1923-70.

ZAMBIA. FOOD CONSERVATION AND STORAGE UNIT, MOUNT MAKULU RESEARCH STATION (1971-)
Annual report 1st October 1971 - 30th September 1972.
23p Limited distribution.

Research work included a survey of traditional food storage methods in selected areas, and a survey of lindane resistance in Tribolium castaneum.

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 moulds 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 ppm 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% up to 12 months after harvest.

Trials were also carried out in depot storage, on shelled maize in jute sacks.
Trop. storage Abstracts (abridged)

3.2.2.1.

---AREA STUDIES
-AFRICA

BYARUHANGA, E.K. & NYIRA, Z.M. (1970)
Variability in techniques of crop storage and an appraisal of the crop loss on farmers farms in Uganda. Report of the Kawande Research Station. Kampala.

12p

DEUSE, J.P.L. AND POINTEL, J.G. (1974)
Assessment of research at farm level storage in Francophone Africa. 1st int. Working Conf. stored Prod. Ent. Oct. 7-11, 1974. Savannah, Georgia, USA.

(Abstract only). (Author's address: Institut de Recherches Agronomiques Tropicales (IRAT), Crop Prot. Divn. 110, Rue de l'Universite, Paris, 7 eme, France).

The losses caused by stored products insects reduce the amount of available food and its nutritional value. This is particularly important in West Africa where the quantity of foodstuffs is hardly enough to assure food for all the population. IRAT has therefore oriented its research principally towards post harvest protection in view of improvement of groundnut storage, groundnuts being the principal cash crop of West Africa. Protection of cowpeas and maize have equally been improved in Senegal and in Togo. In West Africa it has been shown that pre-storage damage during drying and threshing, was important and influenced greatly the losses incurred during storage. Research has been carried out to modernize methods of storage. The farmer has already been introduced to low cost maize cribs, plastic bags in which a capsule of carbon tetrachloride was used for insect fumigation, and oil drums. Studies have also been carried out to develop a three-ton capacity bin which responds to the peasants' needs. Finally studies of irradiation for insect control in dried fish in Mali have permitted the introduction of a practical method by irradiation but the method is still rather costly.-
Trop. storage Abstracts

FOOD AND AGRICULTURE ORGANIZATION. AFRICAN RURAL STORAGE CENTRE (1975)
Report of work carried out in Nigeria to June 1975. TF/AFR/45 (DEN). Based at IITA, Ibadan, Nigeria.

GRAHAM, J.F. (1964)
Stored products work in Kenya. Trop. stored Prod. Inf., 1964

(8), p. 287-288.

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

HAMILTON, A.G. (1975)
Review of post-harvest technologies: Botswana. Rep. Projects Div. Can. Univ. Serv. Overseas (CUSO), 151 Slater Str., Ottawa, Ontario, Can. KIP 5H5 Canada. xii + 200 + xii pp, tabl, 49 pl, refs, 3 append. (Author's address: University of Alberta, Edmonton, Alberta, Canada).

Reports on a survey conducted in four villages in an area of approximately 500 km^2. 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.- Trop. storage Abstracts, 1976 (1) p. 7-8.

HARRIS, W.V. (1941)
Native methods of food storage in Tanganyika. E. Afr. agric. J. 1941, (6), p. 135-138.

HINDMARSH, P.S. (1973)
Food storage work in Zambia. Fmg. Zambia, 7 (3), p. 22-25. (Author's address: Ministry of Agriculture, Research Branch, Mount Makulu Research Station, P O Box 7, Chilanga, Zambia.

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.- Trop. storage Abstracts, 1973 (3) p. 44-45.

HINDMARSH, P.S. (1976)
Reduction of post-harvest losses to durable produce in Zambia. Trop stored Prod. Inf., 1976 (31), p. 13-15.

Describes the agents of deterioration - insects, mites, rodents and fungi - and discusses the role of the Zambian Food Conservation and Storage Unit in reducing losses.

HOYLE, B.S. (1967)
The seaports of East Africa. Nairobi: East African Publishing House, 1967. 137p.; illus.

Reviewed in Trop. stored Prod.

Inf., 1971 (22), p. 51-
"It is essential as a reference book for those interested in the problems of storing, transporting and disinfesting East African exports" - reviewer.

JAMESON, J.D. (EDITOR) (1970)
Agriculture in Uganda. Rev. ed. London, O.U.P., for Ministry of Agriculture and Forestry, Uganda, 1970. £5.00 xvi, 395p. maps, illus.

Previous ed. edited by J.D. Tothill, 1940. Includes a section on crop storage.

LAWRENCE, E. (1940)
Native methods of food storage in Nyasaland. E. Afr. agric. J. 1940, 5 (5) p. 376-379.

MPHURU, A.M. (1971)
A review of storage problems in Tanzania. Proc. of 2nd Conference of Land Use in Tanzania June 1971.

NIGERIAN STORED PRODUCTS RESEARCH INSTITUTE (1973)
9th Annual Report. Jan-Dec 1971. 1973.

NYANTENG, V.K. (1972)
The storage of foodstuffs in Ghana. Univ. Ghana: Inst. statist, soc. econ. Res., Tech, Publ. Ser. No. 18. vii + 92 pp + 75 pl + 17 tables + 2 fig + ref + append. (Author's address: Institute of Statistical, Social and Economic Research, University of Ghana, P O Box 24, Legon, Accra, Ghana).

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.-
Trop. storage Abstracts

PATTINSON, I. (1964)
The history and organisation of stored products work in The Gambia. Trop. stored Prod. Inf., 1964 (9), p. 323-336. illus., 16 refs 1953-64.

Account of the history and organisation of stored products work in The Gambia arising from the realisation in 1951 that losses during storage were affecting the oil groundnut crop. Reference is also made to other crops.

PATTINSON, I. (1968)
Report to the government of Tanzania on crop storage problems. Rome, F.A.O., 1968. vii, 42p. illus.

(United Nations Development Programme Reports - no. TA 2454).

PATTINSON, I. (1969)
The National Agricultural Products Board, Tanganyika. Part 2: Storage problems. Trop, stored Prod. Inf., 1969, (17) p. 23-31. illus., 3 refs.

RILEY, J., PREVETT, P.F. & SIMMONS, E.A. (1964)
The Nigerian Stored Products Research Institute. Trop. stored Prod. Inf., 1964 (7), p. 249-256. illus.

Summarises the history of the organisation from its origins in 1946 to its new status and change of name in 1963. Describes the current work of the various laboratories, including yam losses during storage, and small scale crib storage of maize-on-the-cob.

SHRIVASTAVA, P.K., TRIPATHI, B.P., GIRISH, G.K. & KRISHNAMURTHY, K. (1973)
Studies on the assessment of losses Conventional grain storage practices and losses in rural areas in Western U.P. Bull. Grain Technol., 1973, 11 (2), p. 129-139. 2 refs.

Reports on a survey made during Jan-Dec 1971.

IndianGrain Storage Institute, Hapar, U.P., India.

Crops, Loss Factors, Storage Conditions, Storage Structures and Equipment Structures, ---- STORAGE STRUCTURES (BUILDINGS, SILOS, PITS, ETC)

AGRAWAL, N.S. (1973) Design of storage structures. Post harvest technology of cereals and pulses.

Proc. Semin. held New Delhi, Dec 21-23, 1972. p.153-157. New Delhi: Indian National Science Academy.

BUGUNDU, L.M. (1970)

The storage of farm products by farmers in my small village. Samaru Agric. Newsletter, 1970 12 (1), p. 2-9.
Describes traditional storage structures of village in North Guinea Savanna zone of Nigeria.

DANBY, M. (1973)

The design of buildings in hot dry climates and the internal environment. Build int., 6 (1), p55-75 + 12 pl + 8 fig. (Author's address: University of Newcastle-upon-Tyne, Great Britain).

The interaction between buildings and the external climate produces the internal environment and this presents special problems in hot dry climates. Accurate weather data are needed and a knowledge of the effects of different shapes, orientation and materials on thermal performance is necessary. The elimination of direct solar radiation from the interior is a first essential, and accurate data and information are available for prediction of solar angles and the design of shading devices.

Shape, form and orientation are important factors, and their rationalisation to obtain the minimum solar heat load is discussed, together with the concept of the Minimum Thermal Axis. The relative merits of solid mud walls and cavity walls have been deduced from a series of tests carried out at the University of Khartoum on a building of traditional construction. A type of wall construction is suggested for use in hot dry areas. The effect of natural ventilation through doors and windows on the interior environment is shown to be very important, as is the correct timing for it.

Economic conditions in hot dry areas do not normally permit the use of air conditioning, and recommendations are made for the use of desert air coolers, adopting the traditional methods of cooling by evaporation. (From author's summary). - Trop. storage Abstracts

FULLERTON, R.L. (1968)

Low-cost farm buildings for storage and equipment housing in Ghana. Ghana Jnl agric. Sci., 1 (2), p. 165-170.

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., 1975 (2), p.12-14, illus. (Enquiries to: Senior Entomologist, National Agricultural Laboratories, P O Box 30028, Nairobi, Kenya).

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. - Trop storage Abstracts, 1976 (3), p. 37.

MUHIHU, S.K. (1975)

Traditional aspects in store design. Kenya Ent. Newsl., 1975, (1), p3-6,5 illus.

(Author's address: National Agricultural Laboratories, P O Box 30028, Nairobi, Kenya).

Briefly describes the basic traditional type of structure. Comments on factors influencing the design of such stores and lists: the inherent knowledge of the people upon which several factors play; type and availability of building materials; social and cultural standards of the people including security and risk; local customs; the skills of the people concerned. Suggests that the modern improved grain store should be seen as a development of the traditional store if it is to gain local acceptance. - Trop.storage Abstracts, 1976 (3), p. 38.

McFARLANE, J.A. (1970)

Insect control by airtight storage in small containers. Trop. stored Prod. Inf., 1970 (19), p. 10-14. illus., 7 refs.

Discusses the use of gourds and other containers.

NATIONAL ACADEMY OF SCIENCES. (1973)

Ferrocement applications in developing countries. xiv + 89 pp + fig. (Eng. with Sp. and Fr. summ.) Publ. Office of the Foreign Secretary (JH 210), National Academy of Sciences, 2101 Constitution Avenue, Washington, D.C. 20418, U.S.A.

This is a report by an ad hoc panel of the Advisory Committee on Technical Innovation Board on Science and Technology for International Development. Ferrocement is described as a thin-shell concrete reinforced with wire mesh, a high quality construction material whose ingredients are widely available in developing countries. It can be used to build a wide range of structures and can be worked mainly by unskilled but supervised labour. Among subjects discussed are ferrocement for food storage structures (the Thai rice silo is given as an example); ferrocement in food technology; ferrocement for low cost roofing; ferrocement materials technology. One appendix describes, with costings, the construction of ferrocement-lined underground grain silos in Ethiopia.

ROBERTSON, J.V. (1969)

Trials with small capacity metal grain silos in Dar-es-Salaam, Tanzania. E. Afr. agric. For. J. 1969 34 (2), p. 263-276.

STIRLING, H.G. (1971)

A comparison of storage costs for structures of different materials. Trop. stored Prod. Inf., 1971 (22), p. 31-33. Table.
Based on U.K. prices in 1970-71 but takes tropical conditions into account.

TROPICAL STORED PRODUCTS CENTRE (1972)

Underground storage of crops: a selected bibliography. Trop. stored Prod. Inf., 1972 (23) p. 45-46.
7 refs on traditional methods 1920-70; 15 on modern methods 1939-67.

WEBB, E.R. (1969)

A crop dryer and grain storage silo for the small farm. Ibadan, Ministry of Agriculture & Natural Resources, 1969. 31p.

3.2.2.2.2.

Crops, Loss Factors, Storage Conditions, Storage Structures and Equipment Structures, ---- EQUIPMENT (MACHINERY, ETC)

APPROPRIATE TECHNOLOGY (1974-)

London: Intermediate Technology Development Group. Quarterly.
"Aimed at field workers who are concerned in developing 'intermediate technology' equipment for use at village level in developing countries."

ESMAY, M.L. and HALL, C.W. (Ed.). (1973)

Agricultural mechanisation in developing countries. xi + 221 pp, tabls, illus, ref. Publ. Sales Dept., Shin-Norinsha Co Ltd., 7-2 Chome, Kanda Nishikicho chiyoda-Ku, Tokyo, 102, Japan. Price $9.00.

The eight chapters comprise: principles of agricultural mechanisation; mechanisation in Equatorial Africa; in Asia; in Latin America; ownership patterns for tractors and machinery; drying, storing and handling food grains in developing countries; irrigation; education and training for agricultural mechanisation. The chapter on drying and storing (Chap. 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' organisations; storage principles; drying principles; mechanical drying systems; a proposed flat bed batch dryer for paddy rice; storage requirements; grain storage; storage design; storage summary; storage programme recommendation; transportation; guide lines. Each chapter has a summary and a list of selected references. - Trop. storage Abstracts

GOUGH, M.C. and CALVERLEY, D.J.B. (1976)

The influence of tropical climates on flexible liners for welded mesh silos. Trop. stored Prod. Inf., 1976 (32), p. 25-31. illus., 2 refs.

Describes the effects of weathering in three tropical climates (hot/humid, hot/dry, uplands equatorial) on sheet materials fabricated from butyl, EPDM and a mixture of the two. For use as liners of welded mesh silos a black blend of butyl and EPDM and black polythene were found to be excellent.

TROPICAL CROP PROCESSING, DRYING AND STORAGE EQUIPMENT: (1975)
A selection of machines, driers and silos abailable for use in hot climates. World Crops, Sept/Oct 1975, 27 (5), p. 207-209, 211-214, 216.

Gives names and addresses of suppliers. Some details are given of types available, such as processing rate, power requirements, capacity. Machines mentioned include threshers, shellers, separators, hullers, crop driers. Brief notes are given on a number of crop storage and animal feed silos.

3.2.2.3.1.

Crops, Loss Factors, Storage Conditions, Storage Structures and Equipment Structures, ---- CLIMATE

BRITISH STANDARDS INSTITUTION. (1971)

Guide to hazards in the transport and storage of packages. London: BSI, 1971. 2v. (BS 4672)
Pt.1 Climatic hazards 25p.
Pt. 2 Climatic hazards (maps and diagrams) 63p.
Examples are given from a range of climatic zones.

DAVEY, Pauline M. and ELCOATE, S. (1965)

Moisture content/relative humidity equilibria of tropical stored produce.
Part 1 Cereals. Trop. stored Prod. Inf., 1965 (11), p. 439-467.

DAVEY, Pauline M. and ELCOATE, S. (1966)

Moisture content/relative humidity equilibria of tropical stored produce.
Part 2 Oilseeds. Trop. stored Prod. Inf., 1966 (12), p. 495-512.

DAVEY, Pauline M. and ELCOATE S. (1967)

Moisture content/relative humidity equilibria of tropical stored produce.
Part 3 Legumes, spices and

beverages. Trop. stored Prod. Inf., 1967 (13), p. 15-34. refs (in text).
Commodities considered include beans, peas, soya beans.

MacKAY, P.J. (1967)

Theory of moisture in stored produce. Trop. stored Prod. Inf., 1967 (13), p. 9-14. 4 refs.
Discusses the importance of moisture content/relative humidity equilibrium and illustrates this in the case of several tropical products by means of a graph.

WARD, N. and CALVERLEY, D.J.B. (1972)

A literature survey on the climate relationships in stores. Trop. stored Prod. Inf., 1972 (23), p. 35-44.
"The survey is intended to cover work carried out on relationships between the ambient or outside climate, the macro-climate of the store, and micro-climate within the stored product" - Introduction.
61 refs 1941-71.

3.2.2.3.2.

Crops, Loss Factors, Storage Conditions, Storage Structures and Equipment Structures, ---- PESTS, PESTICIDES

BAKER, A.A. and TAYLOR, R.W.D. (1974)

A review of the fumigation of railtrucks during transit in East Africa. Trop. stored Prod. Inf., 1974 (26), p. 17-32. illus. 19 refs 1952-1973.

BARNES, J.M. (1969)

Pesticide residues as hazards. PANS, 15 (1), p. 2-8.

Review article with some reference to residues in stored products.

BROWN, W.B. (1974)

Fumigation with methyl bromide under gas proof sheets; 3rd ed rev. by H.K. Heseltine and R.H. Thompson. London, Ministry of Agriculture, Fisheries and Food, 1974. vii, 58p. £0.40
Reviewed in Trop. stored Prod. Inf., 1974 (28), p. 51-52.

EUROPEAN AND MEDITERRANEAN PLANT PROTECTION ORGANIZATION. (1968)

Rep. int. Conf. "Prot. of stored Prod"
Paris, 1968. 171p. £1.13.0

Many papers including "Infestation control of primary produce exported from tropical countries" by P.E. Wheatley.

FOOD AND AGRICULTURE ORGANIZATION. (1975)

Report on the second course of the FAO/SIDA/TANZANIA Sub-Regional Training Centre on storage pest control. Rome: FAO/SWE/TF, TF AFR 49 (SWE). v + 29 pp, 8 figs, 7 append. (Publ. UN:FAO, Via delle Terme di Caracalla, 00100-Rome, Italy.

The course was attended by 12 participants from eight countries: Botswana, Ethiopia, Lesotho, Malawi, Somalia, Swaziland, Tanzania and Zambia. Its objectives were to reinforce for participants the principles of grain storage and pest control, to give some practice in control techniques and provide experience in teaching and extension pest control. The course was based at the Faculty of Agriculture and Forestry of the University of Dar-es-Salaam at Morogoro. Visits were made to a number of storage locations to inspect stores and conduct exercises. The course concentrated on small scale storage pest control problems, although mention was made of pest control at all levels of storage. Data for a full scale evaluation of the course was collected throughout and the analysis of this data is being carried out in FAO, Rome. - Trop. storage Abstracts, 1976 (2), p. 28.

FREYBURG, G. (1972)

Schadilngsbekampfung und Vorratschtuz mit phosphorwasserstoff heute aktueller den (Pest control and stored product protection with phosphine today more up-to-date than before). (Germ.) Muhle, 1972, 109 (16), p. 244. Deals with the Detia Gas Ex systems employing phosphine.

GRAHAM, W.M. and KOCKUM, S. (1958)

Fumigation under a polythene envelope. Nature, Lond., 181 (4624), p. 1675.

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: H.M.S.O., 1973. 205p. illus. £1.30.

Reviewed in Trop. stored Prod. Inf. 1974 (26), p. 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..."

HESELTINE, H.K. (1973)

A guide to fumigation with phosphine in the tropics. Trop. stored Prod. Inf., 1973 (24), p. 25-36. illus. 14 refs 1963-73.

HEUSER, S.G. (1975)

The occurrence and significance of bromide residues in foodstuffs in relation to fumigation practice. Trop. stored Prod. Inf., 1975 (29) p. 15-20. 21 refs 1946-73.
Shows that the residue can arise from different sources, e.g. natural traces in the soil, and that they vary greatly in their mammalian toxicity.

KAMEL, A.H. (1974)

Storage pests. Proc. 1st FAO/SIDA Semin. Improv. Prod. Field Fd Crops Pl. Sci. from Afric. and Near E., Cairo, Egypt. 1-20 Sept. 1973, 1974.p. 585-593, 5 ref. (Author's address: Dr Abdel Hakim Kamel, Director, Stored Products Pests Reasearch, Ministry of Agriculture, Dokki Giza, Arab Republic of Egypt).

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. - Trop. storage Abstracts.

LEVER, B.G. (1970)

Agricultural extension in Botswana. Reading: Univ. of Reading, Dept. of Agricultural Economics, 1970. 140p. bibl. (Development Study no. 7, Feb. 1970). Abstract of section on crop storage pests, Trop. stored Prod. Inf., 1970 (20), p. 41. The majority of farmers failed to appreciate the need for either insecticides or storage hygiene.

MUNRO, J.W. (1966)

Pests of stored products. Hutchinson, 1966. 234p. illus.

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. Newsl., 1976, (3), p. 16-23, illus. (Authors' address: Officer-in-charge, Infestation Control Survey, P O Box 80126, Mombasa, Kenya).

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. - Trop. storage Abstracts.

NIGERIAN STORED PRODUCTS RESEARCH INSTITUTE. (1968)

Annual report, 1967. Lagos, Nigerian Stored Products Research Institute, 1968. 158p.

Contains 19 technical reports including:-

Cornes, M.A. and Oyeniran, J.O.: Fumigation of maize in an aluminium silo using a 1:1 carbon tetrachloride: 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.

PAGE, B. G. and THOMSON, W.T. (1971)

The 1971 insecticide, herbicide, fungicide quick guide. Fresno, Calif., Thomson publications, 1971. v, 157p.

Looseleaf. Includes pesticides suitable for use on agricultural premises.

PREVETT, P.F. (1975)

Stored product pests causing losses of stored food. FAO Pl. Prot. Bull., 23 (3/4), p. 115-117. (Author's address: Tropical Stored Products Centre (TPI), London Road, Slough SL3 7HL. England).

Discusses various estimates of losses in stored foodstuffs, especially at farm level. Insects are the most important agents responsible for post-harvest 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. - Trop. storage Abstracts, 1976 (2), p. 26-7.

PRICE JONES, D. and SOLOMON, M.E. (eds) (1974)

Biology in pest and disease control; the 13th Symposium of the British ecological soc., Oxford, 4-7 Jan. 1972; Wiley, 1974. Includes bibliog.

SCHMÜTTERER, H. (1971)

Contribution to the knowledge of the crop pest fauna in Ethiopia. Z. angew. Ent., 1971 67 (4), p. 371-389. bibliog.
Includes storage pests. Reviewed in Trop. stored Prod. Inf., 1971 (22), p. 60.

SCHULTEN, G.G.M. (1974)

Pesticides and post-harvest control. Lect. 12th int. Summer Course Industrialisation, 9 August 1974, The Hague, Netherlands, duplic. 22 pp, refs. (Author's address: Department of Agricultural Research, Royal Tropical Institute, 63 Maurtiskade, Amsterdam-Oost, The Netherlands).

A general review of storage problems. The various forms of losses are examined and there is a brief discussion on the assessment of losses in storage. The effect of moisture is noted, and the maximum moisture contents for safe storage of a number of selected commodities e.g. maize, paddy, cowpeas, are given. The most important stored products insect pests are listed and ther is discussion of infestation by insects and mites. There are notes on micro-organisms and mycotoxins, and on the common rodent pests. Storage methods for unshelled produce are mentioned as well as underground storage and airtight storage. There is a general discussion on pesticides, and specific notes on malathion, lindane, pyrethrins, dichlorvos and the use of inert materials. The importance of the CT product in fumigation is emphasized, and there are notes on the use of methyl bromide, phosphine, and liquid fumigants. Other pesticides mentioned are the acute and chronic rodenticides, and the fungicide propionic acid. Finally it notes that the development of resistance to pesticides and even fumigants has been demonstrated in a recent world survey carried out under the auspices of the FAO. - Trop. storage Abstracts, 1975 (3), p. 41.

SINHA, R.N. (1974)

Climate and the infestation of foodstuffs by pests. 1st Int. Working Conf. stored Prod. Ent. Oct. 7-11 1974, Savannah, Georgia, USA. (Abstract only). (Author's address: Research Station, Canada Department of Agriculture, Winnipeg, Manitoba, Canada).

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 Eash 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 post-harvest 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 infestation data from 41 crop districts in the Canadian Prairies. - Trop. storage Abstracts, 1975 (3), p. 43.

SWARRAY, K.A.D. (1971)

Pest control in Sierra Leone. Paper presented to the 1st annual conference of the Africultural Society of Sierra Leone, 17-19 Sept., 1971. (Pest Control Technical Papers - no 2 of 1971)

SWEENEY, R.C.H. (1965)

Stored product work in Malawi. Trop. stored Prod. Inf., 1965 (10), p. 371-376. illus., 11 refs, 1954-63.
Outlines the history of stored product infestation control in Malawi.

WHEATLEY, P.E. (1968)

Infestation control of primary produce exported from tropical countries. Rep. int. Conf. "Prot. of stored Prodd.", Lisbon-Oeiras 1967, p. 97-102. (E.P.P.O. Punlns Ser. A, No. 46-E.)

WHITNEY, K.W. (1974)

A general survey of physical means for control of storage pests. Symp. 1st int. Working Conf. stored Prod. Ent. Oct. 7-11, 1974. Savannah, Georgia, USA. (Abstract only). (Author's address: Cyanamid International, Princeton, New Jersey, USA).

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. - Trop. storage Abstracts, 1975 (3), p. 45-6.

3.2.2.3.2.1.

Crops, Storage Losses, ---- INSECTS, INSECTICIDES

AGRICULTURAL RESEARCH COUNCIL. PEST INFESTATION LABORATORY (1969)

Pest Infestation Research 1969: the report of the Pest Infestation Laboratory. Slough: Pest Infestation Laboratory; London: H.M.S.O., 1970. iv, 70p. illus., refs.

Reviewed in Trop. stored Prod. Inf., 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. (Ed) (1975)

Insect travellers. Vol. 1 Coleoptera. London: H.M.S.O., 1975. xvi, 191p. (Ministry of Agriculture, Fisheries and Food, Technical Bulletins - no. 31)
Reviewer (C.P. Haines) in Trop. stored Prod. Inf., 1976 (31),

p. 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.

JAY, E.G. and PEARMAN, G.C. junior (1971)

Susceptibility of two species of Tribolium (Coleoptera, Tenebrionidae) to alterations of atmospheric gas concentrations. J. stored Prod. Res., 1971 7 (3), p. 181-186.

ASHMAN, F. and KEMPTON, R.J. (1967)

Stability of malathion dilute dust formulations manufactured in Kenya. E.Afr. agric. For. J., 33 (2), p. 212-218.

BURGES, D.H. and others (1962)

The increasing importance of certain moth pests. Trop. stored Prod. Inf., 1962 (5), p. 174-176. Despite the use of fumigants some moth pests have become more prominent. This leads to a re-examination of the biology of the moths. The subject is also dealt with at some length in the Editorial, p. 153-4.

CARMI, Y. (1974)

The toxicity of pirimiphos-methyl to Ephestia cautella (Wlk.). Prog. Rep. Israel Minist. Agric., Inst. Technol. Storage agric. Prod., Div. stored Prod. for yr 1973/74, p. 77-80 in Hebrew, Eng. summ. X, No 10. (Author's address: Ministry of Agriculture, Agricultural Research Organization, Institute for Technology and Storage and Agricultural Products, Division of Stored Products, Yafo, Israel).

The toxicity of pirimiphos-methyl to E. cautella was compared with that of three common insecticides, malathion, lindane and baythion. Each insecticide was mixed with wheat grain at dosages of 2, 4 and 8 ppm. Two sizes of larvae were used; small, up to 3mm long; large, over 5mm. The insects were exposed to grain for 24 hr, after which mortality counts were taken. Toxicity indicated was: baythion, pirimiphos-methyl, malathion, lindane in decreasing order. The toxicity of pirimiphos-methyl was almost equal to that of baythion at the 8 ppm level, but less at the lower levels. Differences were found in the susceptibility of the two sizes of larvae. With pirimiphos-methyl and baythion, the small larvae were the more susceptible; with lindane and malathion the small larvae were the more resistant at 4 and 8 ppm, but more susceptible at 2 ppm. A special note is made that lindane was slightly less toxic than malathion, which is known to be inefficient for moth control. - Trop. storage Abstracts.

CHADDICK, P.R. and FILCE LEEK, F. (1972)

Further specimens of stored products insects found in ancient Egyptian tombs. J. stored Prod. Res., 1972, 8 (1), p. 83-86.

COYNE, F.P. (1970)

Weevils cost Kenya £1,000,000. Kenya Farmer, 1970, (170), p. 7-8.

DAVEY, Pauline M. (1965)

Insect pests of stored products in the tropics and the commodities and conditions in which they occur. Trop. stored Prod. Inf., 1965, (10), p. 377-386.
Bibl.p378-386 (58 entries); contains two tables in which the knowledge of the pests is summarised and reference is made to the items in the bibliography on each pest.

DONNELLY, J. (comp.) (1970)

Handbook of agricultural insecticides available in Nigeria.

2nd ed. rev. by S.A.O. Adeyemi. Ibadan: Ministry of Agriculture and Natural Resources (Western Nigeria) and Entomological Society of Nigeria, 1970. vii, p. 569.
Reviewed in Trop. stored Prod. Inf., 1971, (22), p. 52.

DYTE, C.E. (1970)

Insecticide resistance in stored-produce insects with special reference to Tribolium castaneum. Trop. stored Prod. Inf., 1970, (20), p. 13-18. 16 refs 1958-70.

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 Bull., 4 (3), p. 275-89, 7 tabl, ref. (Author's address: Pest Infestation Control Laboratory, London Road, Slough SL3 7HL, England).

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 localised, and in others it is almost universal. Tribolium castaneum is known to be resistant to lindane in 71 countries, and lindane-resistant strains of Oryzaephilus surinamensis, Rhysopertha 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 organophosphorus 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. - Trop. storage Abstracts

FAO: WORKING PARTY OF EXPERTS ON THE RESISTANCE OF PESTS TO PESTICIDES. (1974)

Recommended methods for the detection and measurement of resistance of agricultural pests to pesticides. Tentative method for adults of some major beetle pests of stored cereals with malathion or lindane. FAO Method No 15. FAO Pl. Prot. Bull., 22 (5/6), p. 127-137, 31 fig, 4 append.

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.- Trop. storage Abstracts, 1975 (5), p. 63-4.

FAO: WORKING PARTY OF EXPERTS ON THE RESISTANCE OF PESTS TO PESTICIDES. (1975)

Recommended methods for the detection and measurement of resistance of agricultural pests to insecticides. Tentative method for adults of some major pest species of stored cereals, with methyl bromide and phosphine. FAO Method No 16, FAO Pl. Prot.

Bull., 23 (1), p. 12-25, 6 fig, 5 append.

A test method is described for detecting and measuring resistance to the fumigants methyl bromide and phosphine in Sitophilus oryzae, S. zeamais, S. granarius, Rhyzopertha dominica, Tribolium castaneum, T. confusum, Oryzaephilus surinamensis and O. mercator. The method is based on exposure of adult insects to discrete atmospheres containing fumigant. Exposure periods are 5h for methyl bromide and 20h for phosphine. Responses are determined 14 days following termination of the exposure. Base-line data are established with reference strains of known susceptibility from which it is possible to select discriminating doses that may be used to monitor samples of beetles for resistance. Survival in such tests is indicative of resistance, following which extensive testing should be carried out to determine the degree of resistance present. - Trop. storage Abstracts

FRINGS, H. and FRINGS, M. (1971)

Sound production and reception by stored product insect pests: a review of present knowledge. J. stored Prod. Res., 1971, 7 (3), p. 153-162.

GILES, P.H. (1969)

Observations in Kenya on the flight activity of stored product insects, particularly Sitophilus zeamais Motsch. J. stored Prod. Res., 4 (4), p. 317-329.

HALSTEAD, D.G.H. (1967)

A new genus and species of Lathridiini (Coleoptera: Lathridiidae) from farm stores in Kenya. Proc. R. ent. Soc. Lond., B. 36 (11-12), p. 177-180.

HANI-SOLIMAN, M. and HARDIN, R.T. (1972)

Variation in populations of Tribolium castaneum (Herbst) (Coleoptera, Tenebrionidae) Developmental rate and productivity. J. stored Prod. Res., 1972 8 (1), p. 1-10.

HILL, Dennis S. (1975)

Agricultural insect pests of the tropics and their control. Cambridge, 1975. Bibliography p. 473-84.

KARNAVAR, G.K. (1971)

Mating behaviour and fecundity in Trogoderma granarium (Coleoptera: Dermestidae). J. stored Prod. Res., 1971, 8 (1), p. 65-69.

KEM, T.R. (1975)

Studies on the development of resistance to phosphine in Tribolium castaneum (Herbst). Ph.D. Thesis, Indian agric. Res. Inst., Ent. Newsl., India, 5 (2), p. 6-7. (Summary only). (Division of Entomology, Indian Agricultural Research Institute, New Delhi - 110012, India).

The thesis reports the results of investigations carried out in the laboratory on the selection of a phosphine-resistant strain of T. castaneum and its cross-resistance characteristics. By selection over ten generations, a strain was obtained which was 11.95 times more resistant than the normal susceptible strain. Bioassay tests with other fumigants did not reveal cross-resistance to EDCT mixture, ethylene dichloride, carbon tetrachloride, carbon disulphide, ethylene dibromide or methyl bromide. No cross resistance was observed in tests with eleven insecticides which included malathion, iodofenphos and pyrethrins. - Trop. storage Abstracts, 1975 (4), p. 53-4.

LAMB, K.P. (1973)

Economic entomology in the tropics. London: Academic P., 1973. 195p.

Reviewed in Trop. stored Prod. Inf., 1974 (28), p. 50-1. The reviewer states that information on post-harvest pests is scant and incomplete in relation to that on other pests.

LE PELLEY, R. (1969)

Agricultural insects of East Africa. Nairobi, East Africa High Commission, 1969.

LINDGREN, D.L., SINCLAIR, W.B. and VINCENT, L.E. (1968)

Residues in raw and processed foods resulting from post-harvest insecticide treatments. Residue Rev., 1968 21 121p.

McFARLANE, J.A. (1963)

Prospects for pyrethrum with particular reference to its use in the control of pests of stored foodstuffs. Trop. stored Prod. Inf., 1963 (6), p. 202-212. 24 refs, 1948-62.
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 the the safety factor.

McFARLANE, J.A. (1968)

The productivity and rate of development of Sitophilus oryzae (L) in various parts of Kenya. J. stored Prod. Res., 1968 4 (1), p. 31-51.

McFARLANE, J.A. (1969)

Stored products insect control in Kenya. Illus. Trop. stored Prod. Inf., 1969, (18). Includes a review of previous research and lists 31 references 1948-69 including unpublished works.

McFARLANE, J.A. (1969b)

The effects of synergised pyrethrins and lindane on pre-emergence mortality of Acanthoscelides obtectus (Say.). J. stored Prod. Res., 1969 5 (2), p. 177-180.

McFARLANE, J.A. and WARUI, C. (1973)

A simple technique for stored products infestation surveys. Trop. stored Prod. Inf., 1973 (24), p. 17-24. illus.
Describes an insect trapping method used in Mombasa. 2 refs 1970.

MPHURU, A.N. (1974)

Araecerus fasciculatus De Geer (Coleoptera: Anthribiidae): a review. Trop. stored Prod. Inf., 1974 (26), p. 7-15. illus.
Whilst primarily a pest of coffee and cacao it attacks a wide variety of crops - these are listed under countries in Table 1. 71 refs 1775-1970.

NYIIRA, Z.M. (1970)

Infestation of cereals and pulses in the field by stored products insects and two new records of stored products Coleoptera in Uganda. E.Afr. agric. for. J., 1970, 35 (4), p. 411-413.

PARKIN, E.A. (1957)

A provisional assessment of malathion for stored product insect control. Trop. stored Prod. Inf., 1960 (2),p. 38-43.
A summary of information given by Dr Parkin in a paper given at the IVth International Congress of Crop Protection, Hamburg, 1957 which was published in J. Sci. Fd. Agric., 1958 (6), p. 370-375. Includes "Code of practice on the use of malathion on stored foodstuffs in Colonial territories".

PREVETT, P.F. (1966)

Observations on the biology of six species of Bruchidae (Coleoptera) in Northern Nigeria. Entomologist's mon. Mag., 1966 102 (1226-1228), p. 174-180.

PROCTOR, D.L. (1970)

An annotated list of arthropods associated with stored food products in Zambia. London: Tropical Products Inst., 1970. 10p. (Tropical Products Inst., report no. L 18).

RAPPORT d'activite de la Commission d'Evaluation des Pestes dans les Denrees Stockees crie a l'issue du Congres de Marseille sur la Protection des Cultures Tropicales.

Aglon. trop. Nogent, 1969, 24 (9), p. 872-876.
Discusses methods of determining losses caused by insects, sampling methods and methods of expressing results.

SABA, F. and LABORIUS, A. (1976)

Vorratsschadliche Insekten in Marroko (Stored product insect pests of Morocco). Anz. Schadlingsk., 1976, 49 (10), p. 149-153. illus., 6 refs.
Contains English summary.
Over a period of 3 years 48 Lepidoptera and Coleoptera were detected from markets, storage places, houses, etc; 17 are important economically.

SWEENEY, R.H.C. (1962)

Insect pests of stored products in Nyasaland. Zomba: Dept. of Agriculture, 1962. 50p.

TAYLOR, T.A. and AGBATE, L.A. (1974)

Flight activity in normal and active forms of Callosobruchus maculatus (F) in a store in Nigeria. J. stored Prod. Res., 10 (1), p. 9-16, 4 fig, ref. (Authors' address: Department of Agricultural Biology, University of Ibadan, Ibadan, Nigeria).

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 these were of the active form. Adults were also removed from in all, 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 ± 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. - Trop. storage Abstracts, 1974 (3), p. 44.

WALKER, D.J. and BOXALL, R.A. (1974)

An annotated list of the insects associated with stored products in Ethiopia, including notes on mites found in Harar Province. E. Afr. agric. For. J., 39 (3), p.330-335, 8 refs. (Authors' address: Tropical Stored Products Centre, London Road, Slough SL3 7 HL, England).

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 Compaign, 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, Thysanura 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. - Trop. storage Abstracts

WARUI, C.M. (1976)

Insecticide resistance in field strains of Tribolium castaneum collected in Mombasa, Kenya, 1973/74. Kenya Ent. Newsl., 1976, (3), p. 10-16, 3 tabl. (Author's address: National Agricultural Laboratories, P O Box 30028, Nairobi, Kenya).

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. - Trop. storage Abstracts.

WATTERS, F.L. (1972)

Control of storage insects by physical means. Trop. stored Prod. Inf., 1972 (23), p. 13-28. illus.
Alternatives to chemical insecticides such as electromagnetic energy, temperature and sound are described.
104 refs 1893-1972.

WOOD, D.L. and others, (editors) (1970)

Control of insect behaviour by natural products, edited by D.L. Wood, R.M. Silversten and M. Nakajima. London: Academic P., 1970. 346p.

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 weevel and cheese mite.

3.2.2.3.2.2.

Crops, Storage Losses, ---- RODENTS, RODENTICIDES

BUENA conservacion y manejo = buenos pesos (II parte), (Good storage management leads to increased profits).

Boln ANDSA, 1974 4 (43),p4-5. (Span.). (Publ: Almancenes Nacionales de Deposito, S.A., Organizacion Nacional Auxiliar de Credito, Plaza de la Constitution No 7, Mexico 1, D.F.).

Comments on the importance of rodent infestation and its effect on the quality of stored foods, such as contamination by hair, urine and excreta. Rodents are known to transmit at least 10 diseases of man. A description is given of the three most important rodent species in Mexico, Rattus norvegicus, Rattus rattus, and Mus musculus. Various control methods are discussed, and it is pointed out

that poisons used in control methods should be specific, and not affect the grain. The economic implications are mentioned. Precautions to be taken during handling and application are listed. The use of fumigants is discussed, and commercial types available are named - methyl bromide, carbon tetrachloride/carbon bisulphide 4:1 mixture and phosphine. The use of plastic gas-proof sheets is discussed and a description of a phosphine fumigation is given. Other rodent control methods noted include rodent proofing and traps. As regards baiting, reference is made to rats' need for water, and a simple bait container which does not allow access to children and domestic animals. - Trop. storage Abstracts.

FOOD AND AGRICULTURE ORGANIZATION AND WORLD HEALTH ORGANIZATION. (1973)

Bibliography on rodent pest biology and control, 1950-1959. Rome: FAO and WHO, 1973. 2v. Part I v, 210p. Part II iii, 211-448p. Contains 3791 entries in continuation of the previously published bibliography covering 1960-1969.

"...refers to articles dealing with rodent taxonomy, distribution, ecology, biology and behaviour, as well as those concerning rodent damage to stored food products, agriculture and forestry, rodents as carriers of human and animal disease, and the public health importance of rodents and their ectoparasites. Articles are also listed on measures, methods and materials for the control of rodents and their ectoparasites" - Introduction.

Note: the 1960-1969 bibliography is by WHO and FAO (not FAO and WHO).

FRANTZ, S.C. (1976)

The web of hunger: Rats in the granary. Nat. Hist., 85 (2), p. 10-21. (Author's address: The John Hopkins University, International Centre for Medical Research, 550 N. Broadway, Suite 115, Baltimore, Maryland 21205, USA).

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 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. Trop. storage Abstracts, 1976 (3), p. 34-35.

FRÖHLICH, Gerd. and others. (1970)

Pests and diseases of tropical crops and their control; tr. by H. Liebscher and F. Koehler; ed. by H. Liebscher. Oxford: Pergamon, 1970. ix, 371p. bibliogs. Includes a survey "Pests of stored food and their control" pp. 314-325.

GREAT BRITAIN. PEST INFESTATION LABORATORY (1976)

Control of rats and mice: reference manual for pest control personnel. Surbiton: Pest Infestation Control Laboratory, 1976. v, 97p. illus, bibliog. Produced in cooperation with

the Local Government Training Board.
Written primarily for use in Britain but the general principles of control are universal.

HOPF, H.S., MORLEY, G.E.J. and HUMPHRIES, J.R.O. (Editors) (1976)

Rodent damage to growing crops and to farm and village stores in tropical and sub-tropical regions: results of a postal survey 1972-73. London: Centre for Overseas Pest Research and Tropical Products Institute, 1976. vi, 115p.

PINGALE, S.V. (1970)

Mechanical proofing against rodents. Bull. Grain Technol., 1970, 8 (3), p. 89-91.

TAYLOR, K.D. (1963)

Rodent control with special reference to the use of poisons. Trop. stored Prod. Inf., 1963, (6), p. 222-225.
No refs.
Shows that the principal rodent pests of stored products in tropical countries are usually the same as those in temperate regions.

TROPICAL STORED PRODUCTS CENTRE (1974)

Tropical stored Products Information, 26, 1974. News Review includes:- "Rodents and Sacks", "Recent FAO activities on grain storage" (this includes a note about a bibliography on rodent pest biology and control*) and a review of "Pest infestation control. Combining the report of the Infestation Control Laboratory 1968-70 and Pest Infestation Research, 1970 by the Director of the Pest Infestation Control Laboratory". (q.v.).

*See FOOD AND AGRICULTURE ORGANIZATION AND WORLD HEALTH ORGANIZATION; Also WORLD HEALTH ORGANIZATION AND FOOD AND AGRICULTURE ORGANIZATION.

WOODS, Arthur (1974)

Pest control: a survey; consulting ed: D.L. Lee. Wiley 1974. (xiii), 407p.
Bibliog. p. 361-82.
Advocates the use of integrated crop control measures. Contains some reference to storage pests and discusses the difficulty of expressing crop losses.

WORLD HEALTH ORGANIZATION AND FOOD AND AGRICULTURE ORGANIZATION. (n.d.)

Bibliography on rodent pest biology and control, 1960-1969. (Rome): WHO and FAO, n.d. 4v. (VCB/71.9)
Part I (i), iii, 232p. Prepared by FAO and previously issued, in 1970, as document VBC/70.18.
Part II (iii), 242p.
Part III (i), iii, 267p.
Part IV (iii), 206p.

Parts II-IV prepared by WHO.

Over 7,000 refs "... on rodents ... distribution and taxonomy, ...rodent biology, ecology and behaviour, the economic importance of rodents in relation to stored food products, ... and on measures, methods and materials for rodent control" - Introduction.

Note: a continuation covering the period 1950-1959 was prepared by FAO and WHO (not WHO and FAO).

Copies of each available on request substantiated by a statement of need from:
Dr. H.R. Shuyler, Crop Storage Pest Control Officer, FAO-UN, Via delle Terme di Caracalla, 00100 - Rome, Italy.

3.2.2.3.2.3.

Crops, Storage Losses, ---- FUNGI, FUNGICIDES

CLARKE, J.H. (1968)

Fungi in stored products. Trop. stored Prod. Inf., 1968 (15) p. 3-14. illus., 46 refs 1935-1968.
Outlines the occurrence and

and significance of fungi in stored products and some methods for their isolation.

3.2.2.4.

Crops, Storage Losses, ---- QUALITY CONTROL

GOLOB, P. (1976)

Techniques for sampling bagged produce. Trop. stored Prod. Inf., 1976 (31) p. 37-48. illus. 6 refs. 1969-72.

GOLOB, P. and NICHOLS, W. (1975)

The design and development of the TPI produce inspection sieve. Rep., Trop. Prod. Inst. No L.42 iv + 10pp, 3 tabl, 4 fig, 1 pl, append. ISBN: 0 85954 0391 (Authors' address: Tropical Products Institute, 56/62 Grays Inn Road, London WC1X 8LU, England).

Describes the development of a sieve which deals with large samples of a commodity, i.e. whole sacks. It eliminates in-sack variations in factors such as broken grain, insects and dust, which often occur in isolated pockets. Some advantages claimed are: that the sieve permits a visual inspection of the commodity in each sack; a composite sample may by taken by hand from all parts of the commodity as it flows over the sieve; dust, broken grains, etc. can be collected and weighed as an indication of the degree of damage; insects can be isolated, and very small numbers, e.g. 5-10 insects per sack can be detected. Tests of the sieve using coffee beans are described. An average 60 kg sack could be sieved in 2 min. 20 sec. It is concluded that satisfactory results were obtained with coffee, and that the sieve would probably perform equally well with other commodities. - condensed from Trop. storage Abstracts, 1975 (3) p. 37.

INTERNATIONAL ORGANISATION FOR STANDARDISATION. (1969)

ISO recommendation R950. Cereals. Sampling (as grain) 1969.
ISO recommendation R951. Pulses. Sampling. 1969.
ISO recommendation 2170. Cereals and pulses - sampling of milled products.

JELIER, G. (1970)

Sampling of grains, milled products, starch products and potato starch. Int. Assoc. for Cer. Chem. ICC standard 101.

WILLIS, I.D. (1972)

Evaluation of the produce flow sampler for sampling unshelled groundnuts, yellow maize and soft wheat. Tropical Products Institute Rep. L26, London.

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.

Regulations governing the acceptance of produce by the Grain Marketing Board. Commodities concerned include maize, groundnuts, beans, cowpeas, soya beans and sorghum.

ZAMBIA - NATIONAL AGRICULTURAL MARKETING BOARD (1970)

The National Agricultural Marketing (Acceptance standards) Regulations. Lusaka: Government Printer, 1970. 15p. (Statutory instruments - no. 207 of 1970). Acceptance standards for maize, shelled and unshelled groundnuts, seed cotton, beans and sorghum. Brief review in Trop. stored Prod. Inf., 1971 (22), p. 55.

SUBJECT INDEX

Note: most subjects are dealt with from the aspect of control of post-harvest losses, expecially during farmer storage, and this is usually implied even if not stated in index entries.
No attempt has been made to cover every possible subject dealt within the items listed but rather to indicate the pages on which relevant material may be found; e.g. individual species of insect pests are not listed, but the pages on which material dealing with insect pests may be found are indicated.
Where a subject is covered outside the main sections devoted to that subject the individual author is indicated as well as the page number to aid rapid identification of the item required.
However, subjects appearing in general sections, e.g. AREA STUDIES, are only selectively indexed.

AUTHOR INDEX

Printed and published by
The Commonwealth Secretariat

May be purchased from
Commonwealth Secretariat Publications
Marlborough House
London SW1Y 5HX

ISBN 0 85092 130 9

ISBN 978-1-84859-253-7