

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

2.1.1.1.(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.

2.1.1.1.1.

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 deve-

lop 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 and 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. bibliography. (Fr.) (Publ. C.E.E.M.A.T., Parc de Tourvoie, 92160 Antony, Haute de Seine, France. Price f4.50).

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

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 Tropicale 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. f2.40. (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 (Bambara 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 respon-

sible 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 damage 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/ Buenos 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 made to the microorganisms and rodents. Other topics include types of storage, in-store drying, methods of stacking, equipment, procedures for inspecting grain, sources of infestation and the economics of pest control. - condensed from 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 refer-
ences, 1942-1965.

SUBBRAHMANYAN, V. (1973)

Drying of cereals and pulses -
chemical methods and their im-
plications. Post harvest tech-
nology 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 mois-
ture content and advocates
its use at village level to
avoid the loss of at least
4-5% of the kernel material
between harvesting and market-
ing 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 con-
tent needs to be tackled at farm
or local storage depot. The Food
Corporation of India has intro-
duced a mobile grain drier which
uses paddy husk as fuel.

SEBESTYEN, E.J. (1970)

Grain aeration and drying. Mill
ing, 1970 152 (10) p 24-25, p 29-30,

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 EXTEN-
SION SERVICE/LOUISIANA STATE UNI-
VERSITY (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 dry-
ing 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 struc-
tures, and suitable layouts. There
are some notes on the process of
grain drying, and a chart indicates
estimate of weight losses when dry-
ing 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; compatibility
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 difficult with millet and early maize, which are harvested during the rains in June-October. Insect attack, principally by Sitotroga cerealella and Sitophilus oryzae occurs in the field prior to harvest, during drying, and from infested residues in the granaries. The methods of storage described comprise granaries or "rumbus" constructed of dried earth or woven plant materials; modern silos of cement block or dried earth plastered with cement; underground pits - usually for long term storage; various containers in the farmers' houses, such as sacks, earthenware pots and calabashes. The rumbu is the commonest 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, Columbus, 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 improvements 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 Agriculture,
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 coun-
tries). 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 scien-
tific principles of airtight
storage, and includes: respira-
tion of grain; respiration and
pest control; storage trials
with dry grain; airtight storage
of high moisture grain; and the
creation of oxygen free condi-
tions. The second chapter dis-
cusses small scale structures
including: traditional methods
- e.g. gourds, underground pits;
plastic sacks; metal drums and
bins; earthen 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 proce-
dure, 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 stor-
age 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), 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 approximately 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 linings were found to be effective in reducing mould damage as compared with an unlined pit used as control. The poorest lining was that of matting and straw. Further tests were carried out on polythene linings, - 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. food-grains. A circular flexible bin formed from high molecular weight, high density polyethylene (600-1000 gauge) having a base and an airtight cap was developed to replace the more expensive masonry, cement or metal structures (in collaboration with other 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. Gaborones: Dept. of Agriculture, Information Service, 1969. 2p. Also issued in Setswana.

GRAIN STORAGE IN BASKETS. Gaborones: 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, tabs, 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.

POINTEI, 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 OF 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 (Northern 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. 2.1.1.2.2.2.1.

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. Artificial 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

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, cow-peas.) 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. stored 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)

Discusses 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 'Editorial', 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 und 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 symptoms in the grain. The second section provides keys for the identification of insects, both adults and larvae, and covers some primitive species, e.g. Lepinotus, Liposcelis, as well as the more common Coleoptera and Lepidoptera. There is a table for the recognition of mites (e.g. Acarus, Tyrophagus, Glycyphagus, Cheyletus etc.) A key for the identification of rodents covers Rattus norvegicus, R. rattus, Mus musculus domesticus and M. musculus musculus. - 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 prevent 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), p.211-214, 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 DHALI WAL, 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 larvae 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 disinfection 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)p294.

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

Interaction of gamma radiation and fumigation on confused flour beetles. J. econ. Ent., 1972 65 (1) p245-248.

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 di-

chlorvos. 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 storage 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 granarius 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, report 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 F₁ 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 F₁ 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 pyrethrum 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 BENALET, 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 (Sitophilus 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 in stored products are discussed, followed by a synopsis of the more important pests found in S. Africa. A review is given of research carried out in the past, followed by a detailed description of the present mode of operation regarding the testing of 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, the treated 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, 50 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), pl-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 extraction method but not when a cold solvent extraction process was used. In addition, the effectiveness of removal of carbon tetrachloride from wheat and maize during a 3.5 h steam distillation was progressively lessened, in comparison with the cold extraction process, as the length of time that residual fumigant had been associated with grain increased.

The rate of elimination of carbon tetrachloride from wheat and maize during airing at two temperatures was determined and though partially dependent on the temperature of fumigation, airing was consistently more rapid at 25°C than at 10°C. Residues in wheat disappeared more rapidly than those in maize. Grinding initially caused a sharp reduction in carbon tetrachloride 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 Testaceus F. and Tribolium confusum Duv., the highest insect population always occurred in the top layer has a low moisture content and that these insects

prefer a dry atmosphere. In Sitophilus oryzae (L.) Oryzaephilus surinamensis (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 diatoms-ceous 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.

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. Chem. 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 airtight 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, artificial drying is necessary, and the Samaru dryer is recommended. For the same reason, storage in bags is not advised, and metal silos, or old oil drums are preferred. - 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 artificial drying and storage of the crop until a suitable selling price can be obtained. Storage is in bags and metal or butyl silos. Measures recommended to control the main storage pests, Calandra (Sitophilus) oryzae, Mussidia nigrivenella, and Tribolium castaneum, include spraying with 0.6% 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)p21.

JONES, C.R. (1974) Better maize handling in Southern Nigeria. Appropriate Technol., 1 (2), p14-15, 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 siló 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 Tecnologia 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 ADESUJI, 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, Curculionidae). 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 summarised 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 determined 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 malathion 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 a 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. castaneum 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) Resistência 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 Fitotecnica, Instituto Agromomica. 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/m² 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 conditions 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 condi-
tions. Trop. Sci., 10 (2), p.
107-114.

HAYS, H.M. (1975) The market-
ing 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 typhoi-*
deum) (syn. *Typhoides*) and
included: the traditional
marketing system; production,
storage and marketing patterns
at the producer level; detail-
ed evaluation of marketing
costs in terms of the services
provided: budgeting of incomes
of marketing intermediaries;
examination of intermarket
price differentials in rela-
tion to transport and other
costs; examination of storage
costs as a factor in deter-
mining price changes. Three
villages and three major mar-
kets were examined in detail,
and data were collected from
farmers and traders. Some
descriptions are given of
production and marketing.
Estimates indicate that appro-
ximately 20% of millet and
sorghum are dissipated as
ritual gifts, tithes, etc.,
the balance being stored.
Village storage methods ob-
served were in-hut storage
of threshed grain in sacks,
and storage of bundles of un-

threshed 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 esti-
mated 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 im-
provement 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.

SORGHUM 2068

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'YA-POL'SKAYA, O.P. (1955)
Izmeneniya kolichestvennogo i vidovogo sostava mikroflory prosa i pshena pri khramenii pod vliyaniem tepla i vlagi. (Changes in quantitative 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 30p114-123. 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)p45-47.

P. Ward, M. George, J. Riley and M. Cornes, joint authors.
SORGHUM 2101

SORENSEN, 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) p73-81, illus. Jan. 1963.

English and Spanish summaries.
Processing and storage.

MILLET 1018

UVAROVA, Z.A., and PRIKHOD'KO, L. S. (1962)

Izuchenie fizicheskikh i biokhimi-cheskikh 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 ORGANIZATION (1972)

Report of the meeting of experts on the mechanization of rice production and processing. Paramaribo (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 outturns and quality of milled rice. The report examines the results and recommends courses of action. Principal recommendations include more careful inspection at time of procurement, evaluation of suitability of storage premises, planned stacking, **regular** and careful inspection, regular checking of physical stocks, accurate keeping of tallies, planned movement of stock to ensure first in -- first out, and provision for pest control including fumigation. - 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, parboiling, 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 communications 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

Rizicut. 4(2/3)p85-96, illus.
Second and Third Q. 1958.
English, French, and Spanish
summaries.
Using the Cristallo process.
5975

2.1.5.2.1.1.

--- PRE-STORAGE PROCESSING

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 par-
boiling of rice in Guinea and
in Upper Volta.) Riz Rizicut,
5(1):42-48. First Q. 1959.
English and Spanish summaries.
6005

2.1.5.2.1.1.1.

Crops, Cereals, Rice, Pre-
Storage, Loss Factors, Process-
ing ----- HULLING

2.1.5.2.1.1.3.

-----DRYING AND STORAGE

ESTEVEZ, 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

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

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)p359-362, illus.
July 1960
English summary
Includes relative loss in clean-
ing.

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

TORRES, A.B.M. (1958)
A industria do descasque de
arroz em Mocambique. (The rice
hulling industry in Mozambique.)
Gaz. Agr. 10(104)p8-21; (105)p.
34-39; (106)p66-72; (107)p98-
111, pl. Jan./Apr. 1958.
5958

BARR, H.T. and COONROD, L.G. (1969)
Situacion 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)p6-9 June 1969
RICE 5599

2.1.5.2.1.1.2.

Crops, Cereals, Rice, Pre-
Storage, Loss factors, Process-
ing ----- PARBOILING

BERGOMI, I. (1953)
Progetti di impianto per trebbia-
tura, essiccazione e immagazzina-
mento. (Plan for installation
for threshing, drying and storage.)
Riso 2(6)p24-25, illus. June 1953
RICE 5600

FISCHER, E. (1958)
Note sur une installation d'
etuvage du paddy a Tamani.
(Note on a paddy parboiling
plant in Tamani, Mali.) Riz

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 PRODUCT-
IVITEIT (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. xviii, 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 Reistrock-
nung, Lagerung und Bearbeitung
seit 1948. (Progress in rice
drying, storage and milling
since 1948.) In Arbeitsgemein-
schaft 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: Appro-
priate Technology Cell (Storage
and Handling), Bangladesh Agri-
cultural Research Council, 130-
C, Road 1, Dhanmandi, Dacca,
Bangladesh).

The Government of Bangladesh
has given high priority to the
programme to increase food pro-
duction within the country.
An important feature is preven-
tion of post harvest losses,
and advance planning for
storage and handling of increa-
sed 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 im-
provements. Mention is made of
difficulties in introducing
methods of small scale drying.
There are notes on grain treatment
for small scale storage, includ-
ing phosphine fumigation, fumi-
gant 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 Engin-
eering, Michigan State University
East Lansing, Michigan, USA).

Notes that most new improved rice
varieties have relatively short
growing periods, and can be har-
vested all year round. Harvesting
may therefore occur in a rainy
season, and some kind of mechan-
ical 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, convec-
tion 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 describ-
ed 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. Engng. 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., EPP0 Conference on Storage Pests and Diseases, Paris, 11-14 June 1974. EPP0 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 oil-seeds 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, PESTICI-
DES

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) p9-10. (Summary only). (Division of Entomology, Indian Agricultural Research Institute, New Delhi 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),p78. (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 multi-species 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 Comm. 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. Inter-african Phytosan. Bull., 1972 (3),p 49-50, Lagos: OAU/STRC: PMB 2359.

The principal pests are listed as Rhizopertha dominica, Sitophilus oryzae, Tribolium castaneum 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/1000ft². On concrete surfaces methoxychlor at the same rate should be used, but not inside machinery.

As a protective treatment premium grade malathion or pyrethrin 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 insectes 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 Headquarters 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 characteristics 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), pl-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 exhibited two distinct stages of hydrolysis, an initial rapid rate for the first 7 weeks of storage and a subsequent slower rate throughout the remainder of the storage period. This latter stage was independent of variety. The long grain variety showed a lower rate of lipid hydrolysis for both parboiled and untreated samples than a short-grain one, although preboiled, 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

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

2.1.5.2.3.1.1.

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

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 occurrence 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. News1., 5 (1), p.2. (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 1959-1972, comprising 230 fumigations of some 125,000 beans with 1-10% infestation. Individual samples were from 1-2 kg. It was noted that the efficiency of the fumigation increased with temperature. Survival of one or more adults occurred with a dosage of 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) (Coleoptera: Bruchidae). Trop. Grain Legume Bull., 1976, (5), p. II-13. 8 refs.

Notes that bruchid attack develops in the field and is then carried into store. Suggest that storing unshelled cowpeas might reduce damage. Author's address: Dept. of Plant Science, University of Ife, Ife-Ife, Nigeria.

AKPAETOCK, O.I. (1974)

Drying and storage of cowpeas with ashes in airtight containers. J. agric. Engng Res., 19 (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 preferred 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. 1962, tech. rep. No. 19, 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 1973. (Appendix VII), p.51-57, 2 tabl, refs. (Author's address: Institute for Agricultural Research, Ahmadu Bello University, Samaru, PMB 1044. Zaria, Nigeria).

Production of cowpeas in Nigeria has been steadily increasing, mainly in northern Nigeria, where production rose from 375,000 tons in 1957/58 to 810,000 tons in 1961/62. An account is given of the internal trade and it is noted that cowpeas consumed in principal towns might pass through the hands of four middlemen before reaching the consumer, each transaction involving the possibility of admixture with old, infested stocks. The principal storage pests are Callosobruchus maculatus and Bruchidius atrolineatus, and short notes on the progress of infestation and the damage caused are given. Storage structures briefly described comprise: earthenware pots; mud granaries or 'rumbus'; jute bags; drums; butyl rubber silos; 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 polythene 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 for Agricultural Research, 1970. 3p. (Samaru Research Bulletin - no. 120) Reprinted from Proc. agric. Soc. Nigeria, 5 July 2-6 1968.

"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 (2I) 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, Ahmadu Bello Univ.,

1971. (Samaru miscellaneous papers - no. 3I).

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. 4Ip. 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 (O.I.) (Col. Bruchidae) attacking stored groundnuts in The Gambia. Symp. 1st. int. Working Conf. stored Prod. Ent. Oct. 7-II, 1974, Savannah, Georgia, USA. (Abstract only). (Author's address: Crop Protection Unit, Dept. Agric., Yundum Experimental Station, Western Division, The Gambia).

Caryedon serratus (O.I.) (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.) (1975)

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 322I. 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

ŽDÁRKOVÁ, 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; Hrishii, 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.